



**TETER, LLP**

ARCHITECTS ENGINEERS CONNECTED

# PROJECT MANUAL

TECHNICAL SPECIFICATIONS

FOR

**REPLACE SURGERY EXHAUST SYSTEM  
BLDG. 1, 3<sup>RD</sup> FLOOR**

**VA CENTRAL CALIFORNIA HEALTH CARE SYSTEM  
2615 EAST CLINTON AVENUE  
FRESNO, CALIFORNIA**

VA CONTRACT NO.: VA261-P-0654  
VA PROJECT NO.: 570-13-211

100% Construction Documents  
February 27, 2015

TTP Project No.: 13-9111.00

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## SECTION 01 00 00 GENERAL REQUIREMENTS

### 1.1 SAFETY REQUIREMENTS

Refer to section 01 35 26, SAFETY REQUIREMENTS for safety and infection control requirements.

### 1.2 GENERAL INTENTION

- A. Contractor shall furnish labor and materials and perform work for Surgical Suite heating, ventilation and air conditioning system modifications as required by drawings and specifications.
- B. Visits to the site by Bidders may be made only by appointment with the Contractors Officers Representative.
- C. Offices of Teter, as Architect-Engineers, will render certain technical services during construction. Such services shall be considered as advisory to the Government and shall not be construed as expressing or implying a contractual act of the Government without affirmations by Contracting Officer or his duly authorized representative.
- D. All employees of general contractor and subcontractors shall comply with VA security management program and obtain permission of the VA police, be identified by project and employer, and restricted from unauthorized access.

### 1.3 STATEMENT OF BID ITEM(S)

- A. ITEM I, Modification of Surgical Suite Heating, Ventilation and Air Conditioning System. Work includes general construction, alterations, electrical work, mechanical work, roof work, demolition and certain other items.

### 1.4 SPECIFICATIONS AND DRAWINGS FOR CONTRACTOR

- A. Drawings and contract documents may be obtained from the website where the solicitation is posted. Additional copies will be at Contractor's expense.

### 1.5 CONSTRUCTION SECURITY REQUIREMENTS

- A. Security Plan:

1. The security plan defines both physical and administrative security procedures that will remain effective for the entire duration of the project.
2. The General Contractor is responsible for assuring that all sub-contractors working on the project and their employees also comply with these regulations.

B. Security Procedures:

1. General Contractor's employees shall not enter the project site without appropriate badge. They may also be subject to inspection of their personal effects when entering or leaving the project site.
2. Before starting work the General Contractor shall give one week's notice to the Contracting Officer so that security arrangements can be provided for the employees. This notice is separate from any notices required for utility shutdown described later in this section.
3. No photography of VA premises is allowed without written permission of the Contracting Officer.
4. VA reserves the right to close down or shut down the project site and order General Contractor's employees off the premises in the event of a national emergency. The General Contractor may return to the site only with the written approval of the Contracting Officer.

C. Key Control:

1. The General Contractor shall provide duplicate keys and lock combinations to the Contracting officers representative for the purpose of security inspections of every area of project including tool boxes and parked machines and take any emergency action.

D. Document Control:

1. The General Contractor is responsible for safekeeping of all drawings, project manual and other project information. This information shall be shared only with those with a specific need to accomplish the project.

2. All paper waste or electronic media such as CD's and diskettes shall be shredded and destroyed in a manner acceptable to the VA.

E. Motor Vehicle Restrictions

1. Onsite parking is limited; Contractors personnel will be required to park off station in the adjacent neighborhood.

1.6 OPERATIONS AND STORAGE AREAS

- A. The Contractor shall confine all operations (including storage of materials) on Government premises to areas authorized or approved by the Contracting Officer. The Contractor shall hold and save the Government, its officers and agents, free and harmless from liability of any nature occasioned by the Contractor's performance.
- B. Temporary buildings (e.g., storage sheds, shops, offices) and utilities may be erected by the Contractor only with the approval of the Contracting Officer and shall be built with labor and materials furnished by the Contractor without expense to the Government. The temporary buildings and utilities shall remain the property of the Contractor and shall be removed by the Contractor at its expense upon completion of the work. With the written consent of the Contracting Officer, the buildings and utilities may be abandoned and need not be removed.
- C. The Contractor shall, under regulations prescribed by the Contracting Officer, use only established roadways, or use temporary roadways constructed by the Contractor when and as authorized by the Contracting Officer. When materials are transported in prosecuting the work, vehicles shall not be loaded beyond the loading capacity recommended by the manufacturer of the vehicle or prescribed by any Federal, State, or local law or regulation. When it is necessary to cross curbs or sidewalks, the Contractor shall protect them from damage. The Contractor shall repair or pay for the repair of any damaged curbs, sidewalks, or roads.

(FAR 52.236-10)

- D. Working space and space available for storing materials shall be as determined by the COR



- E. Workmen are subject to rules of Medical Center applicable to their conduct.
- F. Execute work so as to interfere as little as possible with normal functioning of Medical Center as a whole, including operations of utility services, fire protection systems and any existing equipment, and with work being done by others. Use of equipment and tools that transmit vibrations and noises through the building structure, are not permitted in buildings that are occupied, during construction, jointly by patients or medical personnel, and Contractor's personnel, except as permitted by Resident COR.
  - 1. Do not store materials and equipment in other than assigned areas.

G. Phasing:

The Medical Center must maintain its operation 24 hours a day 7 days a week. Therefore, any interruption in service must be scheduled and coordinated with the COR to ensure that no lapses in operation occur. It is the CONTRACTOR'S responsibility to develop a work plan and schedule detailing, at a minimum, the procedures to be employed, the equipment and materials to be used, the interim life safety measure to be used during the work, and a schedule defining the duration of the work with milestone subtasks.

To insure such executions, Contractor shall furnish the COR with a schedule of approximate dates on which the Contractor intends to accomplish work in each specific area of site, building or portion thereof. In addition, Contractor shall notify the COR two weeks in advance of the proposed date of starting work in each specific area of site, building or portion thereof. Arrange such dates to insure accomplishment of this work in successive phases mutually agreeable to COR and Contractor.

- H. Building(s) Number 1 and the Outpatient Clinic (OPC) will be occupied during performance of work; but immediate areas of alterations will be vacated.

Contractor shall take all measures and provide all material necessary for protecting existing equipment and property in affected areas of construction against dust and debris, so that equipment and affected areas to be used in the Medical Centers operations will not be hindered. Contractor shall permit access to Department of Veterans Affairs personnel and patients through other construction areas which serve as routes of access to such affected areas and equipment. These routes

whether access or egress shall be isolated from the construction area by temporary partitions and have walking surfaces, lighting etc to facilitate patient and staff access. Coordinate alteration work in areas occupied by Department of Veterans Affairs so that Medical Center operations will continue during the construction period.

2. Immediate areas of alterations not mentioned in preceding Subparagraph 1 will be temporarily vacated while alterations are performed.
- I. When a building and/or construction site is turned over to Contractor, Contractor shall accept entire responsibility including upkeep and maintenance therefore:
  1. Contractor shall maintain a minimum temperature of 4 degrees C (40 degrees F) at all times, except as otherwise specified.
  2. Contractor shall maintain in operating condition existing fire protection and alarm equipment.
- J. Utilities Services: Maintain existing utility services for Medical Center at all times. Provide temporary facilities, labor, materials, equipment, connections, and utilities to assure uninterrupted services. Where necessary to cut existing water, steam, gases, sewer or air pipes, or conduits, wires, cables, etc. of utility services or of fire protection systems and communications systems (including telephone), they shall be cut and capped at suitable places where shown; or, in absence of such indication, where directed by COR.
  1. No utility service such as water, gas, steam, sewers or electricity, or fire protection systems and communications systems may be interrupted without prior approval of COR. Electrical work shall be accomplished with all affected circuits or equipment de-energized. When an electrical outage cannot be accomplished, work on any energized circuits or equipment shall not commence without a detailed work plan, the Medical Center Director's prior knowledge and written approval.
  2. Contractor shall submit a request to interrupt any such services to COR, in writing, 10 business days in advance of proposed interruption. Request shall state reason, date, exact time of, and approximate duration of such interruption.

3. Contractor will be advised (in writing) of approval of request, or of which other date and/or time such interruption will cause least inconvenience to operations of Medical Center. Interruption time approved by Medical Center may occur at other than Contractor's normal working hours.
  4. Major interruptions of any system must be requested, in writing, at least 15 calendar days prior to the desired time and shall be performed as directed by the COR.
  5. In case of a contract construction emergency, service will be interrupted on approval of COR. Such approval will be confirmed in writing as soon as practical.
- K. Abandoned Lines: All service lines such as wires, cables, conduits, ducts, pipes and the like, and their hangers or supports, which are to be abandoned but are not required to be entirely removed, shall be sealed, capped or plugged at the main, branch or panel they originate from. The lines shall not be capped in finished areas, but shall be removed and sealed, capped or plugged in ceilings, within furred spaces, in unfinished areas, or within walls or partitions; so that they are completely behind the finished surfaces.
- L. To minimize interference of construction activities with flow of Medical Center traffic, comply with the following:
1. Keep roads, walks and entrances to grounds, to parking and to occupied areas of buildings clear of construction materials, debris and standing construction equipment and vehicles.
- M. Coordinate the work for this contract with other construction operations as directed by COR. This includes the scheduling of traffic and the use of roadways, as specified in Article, USE OF ROADWAYS.

## 1.7 ALTERATIONS

- A. Survey: Before any work is started, the Contractor shall make a thorough survey with the COR, of areas of buildings in which alterations occur and areas which are anticipated routes of access, and furnish a report, signed by both, to the Contracting Officer. This report shall list by rooms and spaces:
1. Existing condition and types of resilient flooring, doors, windows, walls and other surfaces not required to be altered throughout affected areas of buildings.

2. Existence and conditions of items such as plumbing fixtures and accessories, electrical fixtures, equipment, venetian blinds, shades, etc., required by drawings to be either reused or relocated, or both.
  3. Shall note any discrepancies between drawings and existing conditions at site.
  4. Shall designate areas for working space, materials storage and routes of access to areas within buildings where alterations occur and which have been agreed upon by Contractor and COR.
- B. Any items required by drawings to be either reused or relocated or both, found during this survey to be nonexistent, or in opinion of COR to be in such condition that their use is impossible or impractical, shall be furnished and/or replaced by Contractor with new items in accordance with specifications which will be furnished by Government. Provided the contract work is changed by reason of this subparagraph B, the contract will be modified accordingly, under provisions of clause entitled "DIFFERING SITE CONDITIONS" (FAR 52.236-2) and "CHANGES" (FAR 52.243-4 and VAAR 852.236-88).
- C. Re-Survey: Five days before expected partial or final inspection date, the Contractor and COR together shall make a thorough re-survey of the areas of buildings involved. They shall furnish a report on conditions then existing, of resilient flooring, doors, windows, walls and other surfaces as compared with conditions of same as noted in first condition survey report:
1. Re-survey report shall also list any damage caused by Contractor to such flooring and other surfaces, despite protection measures; and, will form basis for determining extent of repair work required of Contractor to restore damage caused by Contractor's workmen in executing work of this contract.
- D. Protection: Provide the following protective measures:
1. Wherever existing roof surfaces are disturbed they shall be protected against water infiltration. In case of leaks, they shall be repaired immediately upon discovery.
  2. Temporary protection against damage for portions of existing structures and grounds where work is to be done, materials handled and equipment moved and/or relocated.

3. Protection of interior of existing structures at all times, from damage, dust and weather inclemency. Wherever work is performed, floor surfaces that are to remain in place shall be adequately protected prior to starting work, and this protection shall be maintained intact until all work in the area is completed.

#### 1.8 DISPOSAL AND RETENTION

- A. Materials and equipment accruing from work removed and from demolition of buildings or structures, or parts thereof, shall be disposed of as follows:
  1. Reserved items which are to remain property of the Government are noted on drawings as items to be stored. Items that remain property of the Government shall be removed or dislodged from present locations in such a manner as to prevent damage which would be detrimental to re-installation and reuse. Store such items where directed by COR.
  2. Items not reserved shall become property of the Contractor and be removed by Contractor from Medical Center.
  3. Items of portable equipment and furnishings located in rooms and spaces in which work is to be done under this contract shall remain the property of the Government. When rooms and spaces are vacated by the Department of Veterans Affairs during the alteration period, such items which are NOT required by drawings and specifications to be either relocated or reused will be removed by the Government in advance of work to avoid interfering with Contractor's operation.

#### 1.9 PROTECTION OF EXISTING VEGETATION, STRUCTURES, EQUIPMENT, UTILITIES, AND IMPROVEMENTS

- A. The Contractor shall preserve and protect all structures, equipment, and vegetation (such as trees, shrubs, and grass) on or adjacent to the work site, which are not to be removed and which do not unreasonably interfere with the work required under this contract. The Contractor shall only remove trees when specifically authorized to do so, and shall avoid damaging vegetation that will remain in place. If any limbs or branches of trees are broken during contract performance, or by the careless operation of equipment, or by workmen, the Contractor shall trim those limbs or branches with a clean cut and paint the cut with a tree-pruning compound as directed by the Contracting Officer.

- B. The Contractor shall protect from damage all existing improvements and utilities at or near the work site and on adjacent property of a third party, the locations of which are made known to or should be known by the Contractor. The Contractor shall repair any damage to those facilities, including those that are the property of a third party, resulting from failure to comply with the requirements of this contract or failure to exercise reasonable care in performing the work. If the Contractor fails or refuses to repair the damage promptly, the Contracting Officer may have the necessary work performed and charge the cost to the Contractor.

(FAR 52.236-9)

#### 1.10 RESTORATION

- A. Remove, cut, alter, replace, patch and repair existing work as necessary to install new work. Except as otherwise shown or specified, do not cut, alter or remove any structural work, and do not disturb any ducts, plumbing, steam, gas, or electric work without approval of the COR. Existing work to be altered or extended and that is found to be defective in any way, shall be reported to the COR before it is disturbed. Materials and workmanship used in restoring work, shall conform in type and quality to that of original existing construction, except as otherwise shown or specified.
- B. Upon completion of contract, deliver work complete and undamaged. Existing work (walls, ceilings, partitions, floors, mechanical and electrical work, lawns, paving, roads, walks, etc.) disturbed or removed as a result of performing required new work, shall be patched, repaired, reinstalled, or replaced with new work, and refinished and left in as good condition as existed before commencing work.
- C. At Contractor's own expense, Contractor shall immediately restore to service and repair any damage caused by Contractor's workmen to existing piping and conduits, wires, cables, etc., of utility services or of fire protection systems and communications systems (including telephone) which are not scheduled for discontinuance or abandonment.
- D. Expense of repairs to such utilities and systems not shown on drawings or locations of which are unknown will be covered by adjustment to contract time and price in accordance with clause entitled "CHANGES" (FAR 52.243-4 and VAAR 852.236-88) and "DIFFERING SITE CONDITIONS" (FAR 52.236-2).

#### 1.11 PHYSICAL DATA-REMOVED

#### 1.12 PROFESSIONAL SURVEYING SERVICES-REMOVED

#### 1.13 LAYOUT OF WORK-REMOVED

#### 1.14 AS-BUILT DRAWINGS

- A. The contractor shall maintain two full size sets of as-built drawings which will be kept current during construction of the project, to include all contract changes, modifications and clarifications.
- B. All variations shall be shown in the same general detail as used in the contract drawings. To insure compliance, as-built drawings shall be made available for the COR as often as requested.
- C. Contractor shall deliver two approved completed sets of as-built drawings to the COR within 15 calendar days after the acceptance of the project by the COR.
- D. Paragraphs A, B, & C shall also apply to all shop drawings.

#### 1.15 USE OF ROADWAYS

- A. For hauling, use only established public roads and roads on Medical Center property and, when authorized by the COR, such temporary roads which are necessary in the performance of contract work. Temporary roads shall be constructed and restoration performed by the Contractor at Contractor's expense. When necessary to cross curbing, sidewalks, or similar construction, they must be protected by well-constructed bridges.

#### 1.16 RESIDENT ENGINEER'S FIELD OFFICE-REMOVED

#### 1.17 TEMPORARY USE OF MECHANICAL AND ELECTRICAL EQUIPMENT

- A. Use of new installed mechanical and electrical equipment to provide heat, ventilation, plumbing, light and power will be permitted subject to written approval and compliance with the following provisions:
  - 1. Permission to use each unit or system must be given in writing. If the equipment is not installed and maintained in accordance with the written agreement and following provisions, the COR will withdraw permission for use of the equipment.
  - 2. Electrical installations used by the equipment shall be completed in accordance with the drawings and specifications to prevent damage to the equipment and the

electrical systems, i.e. transformers, relays, circuit breakers, fuses, conductors, motor controllers and their overload elements shall be properly sized, coordinated and adjusted. Installation of temporary electrical equipment or devices shall be in accordance with NFPA 70, National Electrical Code, (2014 Edition), Article 590, *Temporary Installations*. Voltage supplied to each item of equipment shall be verified to be correct and it shall be determined that motors are not overloaded. The electrical equipment shall be thoroughly cleaned before using it and again immediately before final inspection including vacuum cleaning and wiping clean interior and exterior surfaces.

3. Units shall be properly lubricated, balanced, and aligned. Vibrations must be eliminated.
  4. Automatic temperature control systems for preheat coils shall function properly and all safety controls shall function to prevent coil freeze-up damage.
  5. The air filtering system utilized shall be that which is designed for the system when complete, and all filter elements shall be replaced at completion of construction and prior to testing and balancing of system.
  6. All components of heat production and distribution system, metering equipment, condensate returns, and other auxiliary facilities used in temporary service shall be cleaned prior to use; maintained to prevent corrosion internally and externally during use; and cleaned, maintained and inspected prior to acceptance by the Government.
- B. Prior to final inspection, the equipment or parts used which show wear and tear beyond normal, shall be replaced with identical replacements, at no additional cost to the Government.
- C. This paragraph shall not reduce the requirements of the mechanical and electrical specifications sections.
- D. Any damage to the equipment or excessive wear due to prolonged use will be repaired replaced by the contractor at the contractor's expense.



#### 1.18 TEMPORARY USE OF EXISTING ELEVATORS

- A. Use of existing elevators for handling building materials and Contractor's personnel will be permitted subject to following provisions:
1. Contractor makes all arrangements with COR for use of elevators. The COR will ascertain that elevators are in proper condition. Contractor may use elevators Numbers S3 and S4 in Building Number One for daily use. Personnel for operating elevators will not be provided by the Department of Veterans Affairs.
  2. Contractor covers and provides maximum protection of following elevator components:
    - a. Entrance jambs, heads soffits and threshold plates.
    - b. Entrance columns, canopy, return panels and inside surfaces of car enclosure walls.
    - c. Finish flooring.
  3. Government will accept hoisting ropes of elevator and rope of each speed governor if they are worn under normal operation. However, if these ropes are damaged by action of foreign matter such as sand, lime, grit, stones, etc., during temporary use, they shall be removed and replaced by new hoisting ropes at the contractors expense.
  4. If brake lining of elevators are excessively worn or damaged during temporary use, they shall be removed and replaced by new brake lining at the contractors expense.
  5. All parts of main controller, starter, relay panel, selector, etc., worn or damaged during temporary use shall be removed and replaced with new parts at the contractors expense, if recommended by elevator inspector after elevator is released by Contractor.
  6. Place elevator in condition equal, less normal wear, to that existing at time it was placed in service of Contractor as approved by Contracting Officer.

#### 1.19 TEMPORARY USE OF NEW ELEVATORS-REMOVED

#### 1.20 TEMPORARY TOILETS

- A. Contractor may have for use of Contractor's workmen, such toilet accommodations as may be assigned to Contractor by Medical Center. Contractor shall keep such places clean and be responsible for any damage done thereto by Contractor's workmen. Failure to maintain satisfactory condition in toilets will deprive Contractor of the privilege to use such toilets.

#### 1.21 AVAILABILITY AND USE OF UTILITY SERVICES

- A. The Government shall make all reasonably required amounts of utilities available to the Contractor from existing outlets and supplies, as specified in the contract. The amount to be paid by the Contractor for chargeable electrical services shall be the prevailing rates charged to the Government. The Contractor shall carefully conserve any utilities furnished without charge.
- B. The Contractor, at Contractor's expense and in a workmanlike manner, in compliance with code and as satisfactory to the Contracting Officer, shall install and maintain all necessary temporary connections and distribution lines, and all meters required to measure the amount of electricity used for the purpose of determining charges. Before final acceptance of the work by the Government, the Contractor shall remove all the temporary connections, distribution lines, meters, and associated paraphernalia and repair restore the infrastructure as required.
- C. Contractor shall install meters at Contractor's expense and furnish the Medical Center a monthly record of the Contractor's usage of electricity as hereinafter specified.
- D. Heat: Furnish temporary heat necessary to prevent injury to work and materials through dampness and cold. Use of open salamanders or any temporary heating devices which may be fire hazards or may smoke and damage finished work, will not be permitted. Maintain minimum temperatures as specified for various materials:
- E. Electricity (for Construction and Testing): Furnish all temporary electric services.
  - 1. Obtain electricity by connecting to the Medical Center electrical distribution system. The Contractor shall meter and pay for electricity required for electric cranes and hoisting devices, electrical welding devices and any electrical heating devices

providing temporary heat. Electricity for all other uses is available at no cost to the Contractor.

F. Water (for Construction and Testing): Furnish temporary water service.

1. Obtain water by connecting to the Medical Center water distribution system. Provide reduced pressure backflow preventer at each connection as per code. Water is available at no cost to the Contractor.
2. Maintain connections, pipe, fittings and fixtures and conserve water-use so none is wasted. Failure to stop leakage or other wastes will be cause for revocation (at COR discretion) of use of water

1.22 NEW TELEPHONE EQUIPMENT-REMOVED

1.23 TESTS

- A. As per specification section 23 05 93 the contractor shall provide a written testing and commissioning plan complete with component level, equipment level, sub-system level and system level breakdowns. The plan will provide a schedule and a written sequence of what will be tested, how and what the expected outcome will be. This document will be submitted for approval prior to commencing work. The contractor shall document the results of the approved plan and submit for approval with the as built documentation.
- B. Pre-test mechanical and electrical equipment and systems and make corrections required for proper operation of such systems before requesting final tests. Final test will not be conducted unless pre-tested.
- C. Conduct final tests required in various sections of specifications in presence of an authorized representative of the Contracting Officer. Contractor shall furnish all labor, materials, equipment, instruments, and forms, to conduct and record such tests.
- D. Mechanical and electrical systems shall be balanced, controlled and coordinated. A system is defined as the entire system which must be coordinated to work together during normal operation to produce results for which the system is designed. For example, air conditioning supply air is only one part of entire system which provides comfort conditions for a building. Other related components are return air, exhaust air, steam, chilled water, refrigerant, hot water, controls and electricity, etc. Another example

of a system which involves several components of different disciplines is a boiler installation. Efficient and acceptable boiler operation depends upon the coordination and proper operation of fuel, combustion air, controls, steam, feedwater, condensate and other related components.

- E. All related components as defined above shall be functioning when any system component is tested. Tests shall be completed within a reasonable period of time during which operating and environmental conditions remain reasonably constant and are typical of the design conditions.
- F. Individual test result of any component, where required, will only be accepted when submitted with the test results of related components and of the entire system.

#### 1.24 INSTRUCTIONS

- A. Contractor shall furnish Maintenance and Operating manuals (hard copies and electronic) and verbal instructions when required by the various sections of the specifications and as hereinafter specified.
- B. Manuals: Maintenance and operating manuals and one compact disc (four hard copies and one electronic copy each) for each separate piece of equipment shall be delivered to the COR coincidental with the delivery of the equipment to the job site. Manuals shall be complete, detailed guides for the maintenance and operation of equipment. They shall include complete information necessary for starting, adjusting, maintaining in continuous operation for long periods of time and dismantling and reassembling of the complete units and sub-assembly components. Manuals shall include an index covering all component parts clearly cross-referenced to diagrams and illustrations. Illustrations shall include "exploded" views showing and identifying each separate item. Emphasis shall be placed on the use of special tools and instruments. The function of each piece of equipment, component, accessory and control shall be clearly and thoroughly explained. All necessary precautions for the operation of the equipment and the reason for each precaution shall be clearly set forth. Manuals must reference the exact model, style and size of the piece of equipment and system being furnished. Manuals referencing equipment similar to but of a different model, style, and size than that furnished will not be accepted.

- C. Instructions: Contractor shall provide qualified, factory-trained manufacturers' representatives to give detailed training to assigned Department of Veterans Affairs personnel in the operation and complete maintenance for each piece of equipment. All such training will be at the job site. These requirements are more specifically detailed in the various technical sections. Instructions for different items of equipment that are component parts of a complete system, shall be given in an integrated, progressive manner. All instructors for every piece of component equipment in a system shall be available until instructions for all items included in the system have been completed. This is to assure proper instruction in the operation of inter-related systems. All instruction periods shall be at such times as scheduled by the COR and shall be considered concluded only when the COR is satisfied in regard to complete and thorough coverage. The contractor shall submit a course outline with associated material to the COR for review and approval prior to scheduling training to ensure the subject matter covers the expectations of the VA and the contractual requirements. The Department of Veterans Affairs reserves the right to request the removal of, and substitution for, any instructor who, in the opinion of the COR, does not demonstrate sufficient qualifications in accordance with requirements for instructors above.

#### 1.25 GOVERNMENT-FURNISHED PROPERTY-REMOVED

#### 1.26 RELOCATED // EQUIPMENT // ITEMS //

- A. Contractor shall disconnect, dismantle as necessary, remove and reinstall in new location, all existing equipment and items indicated by symbol "R" or otherwise shown to be relocated by the Contractor.
- B. Perform relocation of such equipment or items at such times and in such a manner as directed by the COR.
- C. Suitably cap existing service lines, such as steam, condensate return, water, drain, gas, air, vacuum and/or electrical, at the main whenever such lines are disconnected from equipment to be relocated. Remove abandoned lines in finished areas and cap as specified herein before under paragraph "Abandoned Lines".
- D. Provide all mechanical and electrical service connections, fittings, fastenings and any other materials necessary for assembly and installation of relocated equipment; and leave such equipment in proper operating condition.

- E. All service lines such as noted above for relocated equipment shall be in place at point of relocation ready for use before any existing equipment is disconnected. Make relocated existing equipment ready for operation or use immediately after reinstallation.

1.27 STORAGE SPACE FOR DEPARTMENT OF VETERANS AFFAIRS EQUIPMENT-REMOVED

1.28 CONSTRUCTION SIGN-REMOVED

1.29 SAFETY SIGN-REMOVED

1.30 PHOTOGRAPHIC DOCUMENTATION-REMOVED

1.31 FINAL ELEVATION DIGITAL IMAGES-REMOVED

1.32 HISTORIC PRESERVATION-REMOVED

1.33 VA TRIRIGA CPMS-REMOVED

END OF SECTION

SECTION 01 33 23  
SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES

- 1-1. Refer to Articles titled SPECIFICATIONS AND DRAWINGS FOR CONSTRUCTION (FAR 52.236-21) and, SPECIAL NOTES (VAAR 852.236-91), in GENERAL CONDITIONS.
- 1-2. For the purposes of this contract, samples, test reports, certificates, and manufacturers' literature and data shall also be subject to the previously referenced requirements. The following text refers to all items collectively as SUBMITTALS.
- 1-3. Submit for approval, all of the items specifically mentioned under the separate sections of the specification, with information sufficient to evidence full compliance with contract requirements. Materials, fabricated articles and the like to be installed in permanent work shall equal those of approved submittals. After an item has been approved, no change in brand or make will be permitted unless:
  - A. Satisfactory written evidence is presented to, and approved by Contracting Officer, that manufacturer cannot make scheduled delivery of approved item or;
  - B. Item delivered has been rejected and substitution of a suitable item is an urgent necessity or;
  - C. Other conditions become apparent which indicates approval of such substitute item to be in best interest of the Government.
- 1-4. Forward submittals in sufficient time to permit proper consideration and approval action by Government. Time submission to assure adequate lead time for procurement of contract - required items. Delays attributable to untimely and rejected submittals (including any laboratory samples to be tested) will not serve as a basis for extending contract time for completion.
- 1-5. Submittals will be reviewed for compliance with contract requirements by Architect-Engineer, and action thereon will be taken by Contracting Officers Representative (COR) on behalf of the Contracting Officer.
- 1-6. Upon receipt of submittals, Architect-Engineer will assign a file number thereto. Contractor, in any subsequent correspondence, shall refer to this file and identification number to expedite replies relative to previously approved or disapproved submittals.
- 1-7. The Government reserves the right to require additional submittals, whether or not particularly mentioned in this contract. If additional submittals beyond those required by

the contract are furnished pursuant to request therefor by Contracting Officer, adjustment in contract price and time will be made in accordance with Articles titled CHANGES (FAR 52.243-4) and CHANGES - SUPPLEMENT (VAAR 852.236-88) of the GENERAL CONDITIONS.

- 1-8. Schedules called for in specifications and shown on shop drawings shall be submitted for use and information of Department of Veterans Affairs and Architect-Engineer. However, the Contractor shall assume responsibility for coordinating and verifying schedules. The Contracting Officer and Architect-Engineer assumes no responsibility for checking schedules or layout drawings for exact sizes, exact numbers and detailed positioning of items.
- 1-9. Submittals must be submitted by Contractor only and shipped prepaid. Contracting Officer assumes no responsibility for checking quantities or exact numbers included in such submittals.
  - A. Submit samples in single units unless otherwise specified. Submit shop drawings, schedules, manufacturers' literature and data, and certificates in quadruplicate, except where a greater number is specified.
  - B. Submittals will receive consideration only when covered by a transmittal letter signed by Contractor. Letter shall be sent via first class mail or electronic mail and shall contain the list of items, name of Medical Center, name of Contractor, contract number, applicable specification paragraph numbers, applicable drawing numbers (and other information required for exact identification of location for each item), manufacturer and brand, ASTM or Federal Specification Number (if any) and such additional information as may be required by specifications for particular item being furnished. In addition, catalogs shall be marked to indicate specific items submitted for approval.
    1. A copy of letter must be enclosed with items, and any items received without identification letter will be considered "unclaimed goods" and held for a limited time only.
    2. Each sample, certificate, manufacturers' literature and data shall be labeled to indicate the name and location of the Medical Center, name of Contractor, manufacturer, brand, contract number and ASTM or Federal Specification Number as applicable and location(s) on project.
    3. Required certificates shall be signed by an authorized representative of manufacturer or supplier of material, and by Contractor.



- C. If submittal samples have been disapproved, resubmit new samples as soon as possible after notification of disapproval. Such new samples shall be marked "Resubmitted Sample" in addition to containing other previously specified information required on label and in transmittal letter.
- D. Approved samples will be kept on file by the COR at the site until completion of contract, at which time such samples will be delivered to Contractor as Contractor's property. Where noted in technical sections of specifications, approved samples in good condition may be used in their proper locations in contract work. At completion of contract, samples that are not approved will be returned to Contractor only upon request and at Contractor's expense. Such request should be made prior to completion of the contract. Disapproved samples that are not requested for return by Contractor will be discarded after completion of contract.
- E. Submittal drawings (shop, erection or setting drawings) and schedules, required for work of various trades, shall be checked before submission by technically qualified employees of Contractor for accuracy, completeness and compliance with contract requirements. These drawings and schedules shall be stamped and signed by Contractor certifying to such check.
  - 1. For each drawing required, submit one legible photographic paper or vellum reproducible.
  - 2. Reproducible shall be full size.
  - 3. Each drawing shall have marked thereon, proper descriptive title, including Medical Center location, project number, manufacturer's number, reference to contract drawing number, detail Section Number, and Specification Section Number.
  - 4. A space 120 mm by 125 mm (4-3/4 by 5 inches) shall be reserved on each drawing to accommodate approval or disapproval stamp.
  - 5. Submit drawings, ROLLED WITHIN A MAILING TUBE, fully protected for shipment.
  - 6. One reproducible print of approved or disapproved shop drawings will be forwarded to Contractor.
  - 7. When work is directly related and involves more than one trade, shop drawings shall be submitted to Architect-Engineer under one cover.
- 1-10. Samples, shop drawings, test reports, certificates and manufacturers' literature and data, shall be submitted for approval to

Teter Attn: Joelon Chinn

VA Medical Center  
Fresno, CA

Replace Surgery Exhaust System, Bldg. 1, 3<sup>rd</sup> Floor  
Project #570-13-211

7535 N. Palm Ave, Suite 201

Fresno, CA. 93711

(559) 437-0887

- 1-11. At the time of transmittal to the Architect-Engineer, the Contractor shall also send a copy of the complete submittal directly to the COR.

END OF SECTION

SECTION 01 35 26  
SAFETY REQUIREMENTS

1.1 APPLICABLE PUBLICATIONS:

A. Latest publications listed below form part of this Article to extent referenced. Publications are referenced in text by basic designations only.

B. American Society of Safety Engineers (ASSE):

A10.1-2011 ..... Pre-Project & Pre-Task Safety and Health Planning

A10.34-2012 ..... Protection of the Public on or Adjacent to Construction Sites

A10.38-2013 ..... Basic Elements of an Employer's Program to Provide a Safe and Healthful Work Environment American National Standard Construction and Demolition Operations

C. American Society for Testing and Materials (ASTM):

E84-2013 ..... Surface Burning Characteristics of Building Materials

D. The Facilities Guidelines Institute (FGI):

FGI Guidelines-2010 Guidelines for Design and Construction of Healthcare Facilities

E. National Fire Protection Association (NFPA):

10-2013 ..... Standard for Portable Fire Extinguishers

30-2012 ..... Flammable and Combustible Liquids Code

51B-2014 ..... Standard for Fire Prevention During Welding, Cutting and Other Hot Work

70-2014 ..... National Electrical Code

70B-2013 ..... Recommended Practice for Electrical Equipment Maintenance

70E-2012 ..... Standard for Electrical Safety in the Workplace

99-2012 ..... Health Care Facilities Code

241-2013 ..... Standard for Safeguarding Construction, Alteration, and  
Demolition Operations

F. The Joint Commission (TJC)

TJC Manual ..... Comprehensive Accreditation and Certification Manual

G. U.S. Nuclear Regulatory Commission

10 CFR 20 ..... Standards for Protection Against Radiation

H. U.S. Occupational Safety and Health Administration (OSHA):

29 CFR 1904 ..... Reporting and Recording Injuries & Illnesses

29 CFR 1910 ..... Safety and Health Regulations for General Industry

29 CFR 1926 ..... Safety and Health Regulations for Construction Industry

CPL 2-0.124 ..... Multi-Employer Citation Policy

I. VHA Directive 2005-007

1.2 DEFINITIONS:

A. OSHA "Competent Person" (CP). One who is capable of identifying existing and predictable hazards in the surroundings and working conditions which are unsanitary, hazardous or dangerous to employees, and who has the authorization to take prompt corrective measures to eliminate them (see 29 CFR 1926.32(f)).

B. "Qualified Person" means one who, by possession of a recognized degree, certificate, or professional standing, or who by extensive knowledge, training and experience, has successfully demonstrated his ability to solve or resolve problems relating to the subject matter, the work, or the project.

C. High Visibility Accident. Any mishap which may generate publicity or high visibility.

D. Medical Treatment. Treatment administered by a physician or by registered professional personnel under the standing orders of a physician. Medical treatment does not include first aid treatment even though provided by a physician or registered personnel.

E. Recordable Injuries or Illnesses. Any work-related injury or illness that results in:

1. Death, regardless of the time between the injury and death, or the length of the illness;
2. Days away from work (any time lost after day of injury/illness onset);
3. Restricted work;
4. Transfer to another job;
5. Medical treatment beyond first aid;
6. Loss of consciousness; or
7. A significant injury or illness diagnosed by a physician or other licensed health care professional, even if it did not result in (1) through (6) above.

#### 1.3 REGULATORY REQUIREMENTS:

- A. In addition to the detailed requirements included in the provisions of this contract, comply with 29 CFR 1926, comply with 29 CFR 1910 as incorporated by reference within 29 CFR 1926, comply with ASSE A10.34, and all applicable [federal, state, and local] laws, ordinances, criteria, rules and regulations. Submit matters of interpretation of standards for resolution before starting work. Where the requirements of this specification, applicable laws, criteria, ordinances, regulations, and referenced documents vary, the most stringent requirements govern except with specific approval and acceptance by the Contracting Officer Representative or Government Designated Authority.

#### 1.4 ACCIDENT PREVENTION PLAN (APP):

- A. The APP (aka Construction Safety & Health Plan) shall interface with the Contractor's overall safety and health program. Include any portions of the Contractor's overall safety and health program referenced in the APP in the applicable APP element and ensure it is site-specific. The Government considers the Prime Contractor to be the "controlling authority" for all worksite safety and health of each subcontractor(s). Contractors are responsible for informing their subcontractors of the safety provisions under the terms of

the contract and the penalties for noncompliance, coordinating the work to prevent one craft from interfering with or creating hazardous working conditions for other crafts, and inspecting subcontractor operations to ensure that accident prevention responsibilities are being carried out.

B. The APP shall be prepared as follows:

1. Written in English by a qualified person who is employed by the Prime Contractor articulating the specific work and hazards pertaining to the contract (model language can be found in ASSE A10.33). Specifically articulating the safety requirements found within these VA contract safety specifications.
2. Address both the Prime Contractors and the subcontractors work operations.
3. State measures to be taken to control hazards associated with materials, services, or equipment provided by suppliers.
4. Address all the elements/sub-elements and in order as follows:
  - a. SIGNATURE SHEET. Title, signature, and phone number of the following:
    - 1) Plan preparer (Qualified Person such as corporate safety staff person or contracted Certified Safety Professional with construction safety experience);
    - 2) Plan approver (company/corporate officers authorized to obligate the company);
    - 3) Plan concurrence (e.g., Chief of Operations, Corporate Chief of Safety, Corporate Industrial Hygienist, project manager or superintendent, project safety professional). Provide concurrence of other applicable corporate and project personnel (Contractor).
  - b. BACKGROUND INFORMATION. List the following:
    - 1) Contractor;
    - 2) Contract number;
    - 3) Project name;

- 4) Brief project description, description of work to be performed, and location; phases of work anticipated (these will require an AHA).
- c. STATEMENT OF SAFETY AND HEALTH POLICY. Provide a copy of current corporate/company Safety and Health Policy Statement, detailing commitment to providing a safe and healthful workplace for all employees. The Contractor's written safety program goals, objectives, and accident experience goals for this contract should be provided.
- d. RESPONSIBILITIES AND LINES OF AUTHORITIES. Provide the following:
  - 1) A statement of the employer's ultimate responsibility for the implementation of his SOH program;
  - 2) Identification and accountability of personnel responsible for safety at both corporate and project level. Contracts specifically requiring safety or industrial hygiene personnel shall include a copy of their resumes.
  - 3) The names of Competent and/or Qualified Person(s) and proof of competency/qualification to meet specific OSHA Competent/Qualified Person(s) requirements must be attached.;
  - 4) Requirements that no work shall be performed unless a designated competent person is present on the job site;
  - 5) Requirements for pre-task Activity Hazard Analysis (AHAs);
  - 6) Lines of authority;
  - 7) Policies and procedures regarding noncompliance with safety requirements (to include disciplinary actions for violation of safety requirements) should be identified;
- e. SUBCONTRACTORS AND SUPPLIERS. If applicable, provide procedures for coordinating SOH activities with other employers on the job site:
  - 1) Identification of subcontractors and suppliers (if known);
  - 2) Safety responsibilities of subcontractors and suppliers.

f. TRAINING.

- 1) Site-specific SOH orientation training at the time of initial hire or assignment to the project for every employee before working on the project site is required.
- 2) Mandatory training and certifications that are applicable to this project (e.g., explosive actuated tools, crane operator, rigger, crane signal person, fall protection, electrical lockout/NFPA 70E, machine/equipment lockout, confined space, etc...) and any requirements for periodic retraining/recertification are required.
- 3) Procedures for ongoing safety and health training for supervisors and employees shall be established to address changes in site hazards/conditions.
- 4) OSHA 10-hour training is required for all workers on site and the OSHA 30-hour training is required for Trade Competent Persons (CPs)

g. SAFETY AND HEALTH INSPECTIONS.

- 1) Specific assignment of responsibilities for a minimum daily job site safety and health inspection during periods of work activity: Who will conduct (e.g., "Site Safety and Health CP"), proof of inspector's training/qualifications, when inspections will be conducted, procedures for documentation, deficiency tracking system, and follow-up procedures.
- 2) Any external inspections/certifications that may be required (e.g., contracted CSP or CSHT)

h. ACCIDENT INVESTIGATION & REPORTING. The Contractor shall conduct mishap investigations of all OSHA Recordable Incidents. The APP shall include accident/incident investigation procedure & identify person(s) responsible to provide the following to the Contracting Officer Representative or Government Designated Authority:

- 1) Exposure data (man-hours worked);



2) Accident investigations, reports, and logs.

- i. PLANS (PROGRAMS, PROCEDURES) REQUIRED. Based on a risk assessment of contracted activities and on mandatory OSHA compliance programs, the Contractor shall address all applicable occupational risks in site-specific compliance and accident prevention plans. These Plans shall include but are not limited to procedures for addressing the risks associated with the following:

- 1) Emergency response ;
- 2) Contingency for severe weather;
- 3) Fire Prevention ;
- 4) Medical Support;
- 5) Posting of emergency telephone numbers;
- 6) Prevention of alcohol and drug abuse;
- 7) Site sanitation (housekeeping, drinking water, toilets);
- 8) Night operations and lighting ;
- 9) Hazard communication program;
- 10) Welding/Cutting "Hot" work ;
- 11) Electrical Safe Work Practices (Electrical LOTO/NFPA 70E);
- 12) General Electrical Safety
- 13) Hazardous energy control (Machine LOTO);
- 14) Site-Specific Fall Protection & Prevention;
- 15) Excavation/trenching;
- 16) Asbestos abatement;
- 17) Lead abatement;

- 18) Crane Critical lift;
- 19) Respiratory protection;
- 20) Health hazard control program;
- 21) Radiation Safety Program;
- 22) Abrasive blasting;
- 23) Heat/Cold Stress Monitoring;
- 24) Crystalline Silica Monitoring (Assessment);
- 25) Demolition plan (to include engineering survey);
- 26) Formwork and shoring erection and removal;
- 27) PreCast Concrete.

- C. Submit the APP to the Contracting Officer Representative for review for compliance with contract requirements in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA AND SAMPLES 15 calendar days prior to the date of the preconstruction conference for acceptance. Work cannot proceed without an accepted APP.
- D. Once accepted by the Contracting Officer Representative, the APP and attachments will be enforced as part of the contract. Disregarding the provisions of this contract or the accepted APP will be cause for stopping of work, at the discretion of the Contracting Officer, until the matter has been rectified.
- E. Once work begins, changes to the accepted APP shall be made with the knowledge and concurrence of the Contracting Officer Representative Government Designated Authority. Should any severe hazard exposure, i.e. imminent danger, become evident, stop work in the area, secure the area, and develop a plan to remove the exposure and control the hazard. Notify the Contracting Officer within 24 hours of discovery. Eliminate/remove the hazard. In the interim, take all necessary action to restore and maintain safe working conditions in order to safeguard onsite personnel, visitors, the public (as defined by ASSE/SAFE A10.34) and the environment.

### 1.5 ACTIVITY HAZARD ANALYSES (AHAS):

- A. AHAs are also known as Job Hazard Analyses, Job Safety Analyses, and Activity Safety Analyses. Before beginning each work activity involving a type of work presenting hazards not experienced in previous project operations or where a new work crew or sub-contractor is to perform the work, the Contractor(s) performing that work activity shall prepare an AHA (Example electronic AHA forms can be found on the US Army Corps of Engineers web site)
- B. AHAs shall define the activities being performed and identify the work sequences, the specific anticipated hazards, site conditions, equipment, materials, and the control measures to be implemented to eliminate or reduce each hazard to an acceptable level of risk.
- C. Work shall not begin until the AHA for the work activity has been accepted by the Contracting Officer Representative or Government Designated Authority and discussed with all engaged in the activity, including the Contractor, subcontractor(s), and Government on-site representatives at preparatory and initial control phase meetings.
  - 1. The names of the Competent/Qualified Person(s) required for a particular activity (for example, excavations, scaffolding, fall protection, other activities as specified by OSHA and/or other State and Local agencies) shall be identified and included in the AHA. Certification of their competency/qualification shall be submitted to the Government Designated Authority (GDA) for acceptance prior to the start of that work activity.
  - 2. The AHA shall be reviewed and modified as necessary to address changing site conditions, operations, or change of competent/qualified person(s).
    - a. If more than one Competent/Qualified Person is used on the AHA activity, a list of names shall be submitted as an attachment to the AHA. Those listed must be Competent/Qualified for the type of work involved in the AHA and familiar with current site safety issues.
    - b. If a new Competent/Qualified Person (not on the original list) is added, the list shall be updated (an administrative action not requiring an updated AHA). The

new person shall acknowledge in writing that he or she has reviewed the AHA and is familiar with current site safety issues.

3. Submit AHAs to the Contracting Officer Representative for review for compliance with contract requirements in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA AND SAMPLES for review at least 15 calendar days prior to the start of each phase. Subsequent AHAs shall be formatted as amendments to the APP. The analysis should be used during daily inspections to ensure the implementation and effectiveness of the activity's safety and health controls.
4. The AHA list will be reviewed periodically (at least monthly) at the Contractor supervisory safety meeting and updated as necessary when procedures, scheduling, or hazards change.
5. Develop the activity hazard analyses using the project schedule as the basis for the activities performed. All activities listed on the project schedule will require an AHA. The AHAs will be developed by the contractor, supplier, or subcontractor and provided to the prime contractor for review and approval and then submitted to the Contracting Officer Representative.

#### 1.6 PRECONSTRUCTION CONFERENCE:

- A. Contractor representatives who have a responsibility or significant role in implementation of the accident prevention program, as required by 29 CFR 1926.20(b)(1), on the project shall attend the preconstruction conference to gain a mutual understanding of its implementation. This includes the project superintendent, subcontractor superintendents, and any other assigned safety and health professionals.
- B. Discuss the details of the submitted APP to include incorporated plans, programs, procedures and a listing of anticipated AHAs that will be developed and implemented during the performance of the contract. This list of proposed AHAs will be reviewed at the conference and an agreement will be reached between the Contractor and the Contracting Officer's representative as to which phases will require an analysis. In addition, establish a schedule for the preparation, submittal, review, and acceptance of AHAs to preclude project delays.

- C. Deficiencies in the submitted APP will be brought to the attention of the Contractor within 14 days of submittal, and the Contractor shall revise the plan to correct deficiencies and re-submit it for acceptance. Do not begin work until there is an accepted APP.

1.7 "SITE SAFETY AND HEALTH OFFICER" (SSHO) AND "COMPETENT PERSON" (CP):

- A. The Prime Contractor shall designate a minimum of one SSHO at each project site that will be identified as the SSHO to administer the Contractor's safety program and government-accepted Accident Prevention Plan. Each subcontractor shall designate a minimum of one CP in compliance with 29 CFR 1926.20 (b)(2) that will be identified as a CP to administer their individual safety programs.
- B. Further, all specialized Competent Persons for the work crews will be supplied by the respective contractor as required by 29 CFR 1926 (i.e. Asbestos, Electrical, Cranes, & Derricks, Demolition, Fall Protection, Fire Safety/Life Safety, Ladder, Rigging, Scaffolds, and Trenches/Excavations).
- C. These Competent Persons can have collateral duties as the subcontractor's superintendent and/or work crew lead persons as well as fill more than one specialized CP role (i.e. Asbestos, Electrical, Cranes, & Derricks, Demolition, Fall Protection, Fire Safety/Life Safety, Ladder, Rigging, Scaffolds, and Trenches/Excavations).
- D. The SSHO or an equally-qualified Designated Representative/alternate will maintain a presence on the site during construction operations in accordance with FAR Clause 52.236-6: *Superintendence by the Contractor*. CPs will maintain presence during their construction activities in accordance with above mentioned clause. A listing of the designated SSHO and all known CPs shall be submitted prior to the start of work as part of the APP with the training documentation and/or AHA as listed in Section 1.8 below.
- E. The repeated presence of uncontrolled hazards during a contractor's work operations will result in the designated CP as being deemed incompetent and result in the required removal of the employee in accordance with FAR Clause 52.236-5: Material and Workmanship, Paragraph (c).

1.8 TRAINING:

- A. The designated Prime Contractor SSHO must meet the requirements of all applicable OSHA standards and be capable (through training, experience, and qualifications) of

ensuring that the requirements of 29 CFR 1926.16 and other appropriate Federal, State and local requirements are met for the project. As a minimum the SSHO must have completed the OSHA 30-hour Construction Safety class and have five (5) years of construction industry safety experience or three (3) years if he/she possesses a Certified Safety Professional (CSP) or certified Construction Safety and Health Technician (CSHT) certification or have a safety and health degree from an accredited university or college.

- B. All designated CPs shall have completed the OSHA 30-hour Construction Safety course within the past 5 years.
- C. In addition to the OSHA 30 Hour Construction Safety Course, all CPs with high hazard work operations such as operations involving asbestos, electrical, cranes, demolition, work at heights/fall protection, fire safety/life safety, ladder, rigging, scaffolds, and trenches/excavations shall have a specialized formal course in the hazard recognition & control associated with those high hazard work operations. Documented "repeat" deficiencies in the execution of safety requirements will require retaking the requisite formal course.
- D. All other construction workers shall have the OSHA 10-hour Construction Safety Outreach course and any necessary safety training to be able to identify hazards within their work environment.
- E. Submit training records associated with the above training requirements to the Contracting Officer Representative or Government Designated Authority for review for compliance with contract requirements in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA AND SAMPLES 15 calendar days prior to the date of the preconstruction conference for acceptance.
- F. Prior to any worker for the contractor or subcontractors beginning work, they shall undergo a safety briefing provided by the SSHO or his/her designated representative. As a minimum, this briefing shall include information on the site-specific hazards, construction limits, VAMC safety guidelines, means of egress, break areas, work hours, locations of restrooms, use of VAMC equipment, emergency procedures, accident reporting etc... Documentation shall be provided to the Contracting Officers Representative that individuals have undergone contractor's safety briefing.

- G. Ongoing safety training will be accomplished in the form of weekly documented safety meeting.

#### 1.9 INSPECTIONS:

- A. The SSHO shall conduct frequent and regular safety inspections (daily) of the site and each of the subcontractors CPs shall conduct frequent and regular safety inspections (daily) of the their work operations as required by 29 CFR 1926.20(b)(2). Each week, the SSHO shall conduct a formal documented inspection of the entire construction areas with the subcontractors' "Trade Safety and Health CPs" present in their work areas. Coordinate with, and report findings and corrective actions weekly to Contracting Officer Representative.

#### 1.10 ACCIDENTS, OSHA 300 LOGS, AND MAN-HOURS:

- A. Notify the Contracting Officer Representative as soon as practical, but no more than four hours after any accident meeting the definition of OSHA Recordable Injuries or Illnesses or High Visibility Accidents, property damage equal to or greater than \$5,000, or any weight handling equipment accident. Within notification include contractor name; contract title; type of contract; name of activity, installation or location where accident occurred; date and time of accident; names of personnel injured; extent of property damage, if any; extent of injury, if known, and brief description of accident (to include type of construction equipment used, PPE used, etc.). Preserve the conditions and evidence on the accident site until the Contracting Officer Representative or Government Designated Authority determines whether a government investigation will be conducted.
- B. Conduct an accident investigation for recordable injuries and illnesses, for Medical Treatment defined in paragraph DEFINITIONS, and property damage accidents resulting in at least \$20,000 in damages, to establish the root cause(s) of the accident. Complete the VA Form 2162, and provide the report to the Contracting Officer Representative or Government Designated Authority within 5 calendar days of the accident. The Contracting Officer Representative or Government Designated Authority will provide copies of any required or special forms.
- C. A summation of all man-hours worked by the contractor and associated sub-contractors for each month will be reported to the Contracting Officer Representative or Government Designated Authority monthly.

- D. A summation of all OSHA recordable accidents experienced on site by the contractor and associated sub-contractors for each month will be provided to the Contracting Officer Representative monthly. The contractor and associated sub-contractors' OSHA 300 logs will be made available to the Contracting Officer Representative.

#### 1.11 PERSONAL PROTECTIVE EQUIPMENT (PPE):

- A. PPE is governed in all areas by the nature of the work the employee is performing. For example, specific PPE required for performing work on electrical equipment is identified in NFPA 70E, Standard for Electrical Safety in the Workplace.
- B. Mandatory PPE includes:
  - 1. Hard Hats – unless written authorization is given by the Contracting Officer Representative in circumstances of work operations that have limited potential for falling object hazards such as during finishing work or minor remodeling. With authorization to relax the requirement of hard hats, if a worker becomes exposed to an overhead falling object hazard, then hard hats would be required in accordance with the OSHA regulations.
  - 2. Safety glasses - unless written authorization is given by the Contracting Officer Representative appropriate safety glasses meeting the ANSI Z.87.1 standard must be worn by each person on site.
  - 3. Appropriate Safety Shoes – based on the hazards present, safety shoes meeting the requirements of ASTM F2413-11 shall be worn by each person on site unless written authorization is given by the Contracting Officer Representative or Government Designated Authority.
  - 4. Hearing protection - Use personal hearing protection at all times in designated noise hazardous areas or when performing noise hazardous tasks.

#### 1.12 INFECTION CONTROL

- A. Infection Control is critical in all medical center facilities. Interior construction activities causing disturbance of existing dust, or creating new dust, must be conducted within ventilation-controlled areas that minimize the flow of airborne particles into patient areas. Exterior construction activities causing disturbance of soil or that create dust in some other manner must be controlled.



B. An AHA associated with infection control will be performed by VA personnel in accordance with FGI Guidelines (i.e. Infection Control Risk Assessment (ICRA)). Infection Control permits will be issued by the Contracting Officers Representative. The Infection Control Permits will be posted outside the appropriate construction area. More than one permit may be issued for a construction project if the work is located in separate areas requiring separate classes. The primary project scope area for this project is: Class IV, however, work outside the primary project scope area may vary. The required infection control precautions with each class are as follows:

1. Class I requirements: Exterior construction.
  - a. During Construction Work:
    - 1) Notify the Contracting Officer Representative.
    - 2) Execute work by methods to minimize raising dust from construction operations. Wet down area prior to and during work activities.
2. Class II requirements:
  - a. During Construction Work:
    - 1) Notify the Contracting Officer Representative.
    - 2) Provide active means to prevent airborne dust from dispersing into atmosphere such as wet methods or tool mounted dust collectors where possible.
    - 3) Immediately replace a ceiling tile displaced for visual inspection.
  - b. Upon Completion:
    - 1) Wipe work surfaces with cleaner/disinfectant.
    - 2) Contain construction waste before transport in tightly covered containers.
    - 3) Wet mop and/or vacuum with HEPA filtered vacuum before leaving work area.
    - 4) Notify the Contracting Officer Representative

3. Class III requirements:

a. During Construction Work:

- 1) Obtain permit from the Contracting Officer Representative
- 2) Remove or Isolate HVAC system in area where work is being done to prevent contamination of duct system.
- 3) Complete all critical barriers i.e. sheetrock, plywood, plastic, to seal area from non work area or implement control cube method (cart with plastic covering and sealed connection to work site with HEPA vacuum for vacuuming prior to exit) before construction begins. Install construction barriers and ceiling protection carefully, outside of normal work hours.
- 4) Maintain negative air pressure, 0.01 inches of water gauge, within work site utilizing HEPA equipped air filtration units and continuously monitored with a digital display, recording and alarm instrument, which must be calibrated on installation, maintained with periodic calibration and monitored by the contractor.
- 5) Contain construction waste before transport in tightly covered containers.
- 6) Cover transport receptacles or carts. Tape covering unless solid lid.

b. Upon Completion:

- 1) Do not remove barriers from work area until completed project is inspected by the Contracting Officer Representative and thoroughly cleaned by the VA Environmental Services Department.
- 2) Remove construction barriers and ceiling protection carefully to minimize spreading of dirt and debris associated with construction, outside of normal work hours.
- 3) Vacuum work area with HEPA filtered vacuums.
- 4) Wet mop area with cleaner/disinfectant.
- 5) Upon completion, restore HVAC system where work was performed.

6) Return permit to the Contracting Officer Representative.

4. Class IV requirements:

a. During Construction Work:

- 1) Obtain permit from the Contracting Officer Representative.
- 2) Isolate HVAC system in area where work is being done to prevent contamination of duct system.
- 3) Complete all critical barriers i.e. sheetrock, plywood, plastic, to seal area from non work area or implement control cube method (cart with plastic covering and sealed connection to work site with HEPA vacuum for vacuuming prior to exit) before construction begins. Install construction barriers and ceiling protection carefully, outside of normal work hours.
- 4) Maintain negative air pressure, 0.01 inches of water gauge, within work site utilizing HEPA equipped air filtration units and continuously monitored with a digital display, recording and alarm instrument, which must be calibrated on installation, maintained with periodic calibration and monitored by the contractor.
- 5) Seal holes, pipes, conduits, and punctures.
- 6) Construct anteroom and require all personnel to pass through this room so they can be vacuumed using a HEPA vacuum cleaner before leaving work site or they can wear cloth or paper coveralls that are removed each time they leave work site.
- 7) All personnel entering work site are required to wear shoe covers. Shoe covers must be changed each time the worker exits the work area.
- 8) All personnel leaving the work site are required to wear coveralls, head, shoe and applicable beard covers when exiting the construction area into the sterile corridor.f

b. Upon Completion:

- 1) Do not remove barriers from work area until completed project is inspected by the Contracting Officer Representative with thorough cleaning by the VA Environmental Services Dept.
- 2) Remove construction barriers and ceiling protection carefully to minimize spreading of dirt and debris associated with construction, outside of normal work hours.
- 3) Contain construction waste before transport in tightly covered containers.
- 4) Cover transport receptacles or carts. Tape covering unless solid lid.
- 5) Vacuum work area with HEPA filtered vacuums.
- 6) Wet mop area with cleaner/disinfectant.
- 7) Upon completion, restore HVAC system where work was performed.
- 8) Return permit to the Contracting Officer Representative.

C. Barriers shall be erected as required based upon classification (Class III & IV requires barriers) and shall be constructed as follows:

1. Class III and IV - closed door with masking tape applied over the frame and door is acceptable for projects that can be contained in a single room.
2. Construction, demolition or reconstruction not capable of containment within a single room must have the following barriers erected and made presentable on hospital occupied side:
  - a. Class III & IV (where dust control is the only hazard, and an agreement is reached with the Medical Center - Airtight plastic barrier that extends from the floor to ceiling. Seams must be sealed with duct tape to prevent dust and debris from escaping
  - b. Class III & IV - Drywall barrier erected with joints covered or sealed to prevent dust and debris from escaping.
  - c. Class III & IV - Seal all penetrations in existing barrier in order to assure the barrier is airtight.

- d. Class III & IV - Barriers at penetration of ceiling envelopes, chases and ceiling spaces to stop movement air and debris
  - e. Class IV only - Anteroom or double entrance openings that allow workers to remove protective clothing or vacuum off existing clothing
  - f. Class III & IV - At elevators shafts or stairways within the field of construction, overlapping flap minimum of two feet wide of polyethylene enclosures for personnel access.
- D. Products and Materials:
- 1. Sheet Plastic: Fire retardant polystyrene, 6-mil thickness meeting local fire codes
  - 2. Barrier Doors: Self Closing solid core wood in steel frame, painted
  - 3. Dust proof, fire-rated drywall
  - 4. High Efficiency Particulate Air-Equipped filtration machine rated at 95% capture of 0.3 microns including pollen, mold spores and dust particles. HEPA filters should have ASHRAE 85 or other prefilter to extend the useful life of the HEPA. Provide both primary and secondary filtrations units. Maintenance of equipment and replacement of the HEPA filters and other filters will be in accordance with manufacturer's instructions.
  - 5. Exhaust Hoses: Heavy duty, flexible steel reinforced; Ventilation Blower Hose
  - 6. Adhesive Walk-off Mats: Provide minimum size mats of 24 inches x 36 inches
  - 7. Disinfectant: Hospital-approved disinfectant or equivalent product
  - 8. Portable Ceiling Access Module
- E. Before any construction on site begins, all contractor personnel involved in the construction or renovation activity shall be educated and trained in infection prevention measures established by the medical center.
- F. A dust control program will be establish and maintained as part of the contractor's infection preventive measures in accordance with the FGI Guidelines for Design and Construction of Healthcare Facilities. Prior to start of work, prepare a plan detailing

project-specific dust protection measures with associated product data, including periodic status reports, and submit to Contracting Officers Representative for review for compliance with contract requirements in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA AND SAMPLES.

- G. Medical center Infection Control personnel will monitor for airborne disease (e.g. aspergillosis) during construction. A baseline of conditions will be established by the medical center prior to the start of work and periodically during the construction stage to determine impact of construction activities on indoor air quality with safe thresholds established.
- H. In general, the following preventive measures shall be adopted during construction to keep down dust and prevent mold.
  - 1. Contractor shall verify that construction exhaust to exterior is not reintroduced to the medical center through intake vents, or building openings. HEPA filtration is required where the exhaust dust may reenter the medical center.
  - 2. Exhaust hoses shall be exhausted so that dust is not reintroduced to the medical center.
  - 3. Adhesive Walk-off/Carpet Walk-off Mats shall be used at all interior transitions from the construction area to occupied medical center area. These mats shall be changed as often as required to maintain clean work areas directly outside construction area at all times.
  - 4. Vacuum and wet mop all transition areas from construction to the occupied medical center at the end of each workday. Vacuum shall utilize HEPA filtration. Maintain surrounding area frequently. Remove debris as it is created. Transport these outside the construction area in containers with tightly fitting lids.
  - 5. The contractor shall not haul debris through patient-care areas without prior approval of the Contracting Officers Representative and the Medical Center. When, approved, debris shall be hauled in enclosed dust proof containers or wrapped in plastic and sealed with duct tape. No sharp objects should be allowed to cut through the plastic. Wipe down the exterior of the containers with a damp rag to remove dust. All

equipment, tools, material, etc. transported through occupied areas shall be made free from dust and moisture by vacuuming and wipe down.

6. There shall be no standing water during construction. This includes water in equipment drip pans and open containers within the construction areas. All accidental spills must be cleaned up and dried within 12 hours. Remove and dispose of porous materials that remain damp for more than 72 hours.
7. At completion, remove construction barriers and ceiling protection carefully, outside of normal work hours. Vacuum and clean all surfaces free of dust after the removal.

I. Final Cleanup:

1. Upon completion of project, or as work progresses, remove all construction debris from above ceiling, vertical shafts and utility chases that have been part of the construction.
2. Perform HEPA vacuum cleaning of all surfaces in the construction area. This includes walls, ceilings, cabinets, furniture (built-in or free standing), partitions, flooring, etc.
3. All new air ducts shall be cleaned prior to final inspection.

J. Exterior Construction

1. Contractor shall verify that dust will not be introduced into the medical center through intake vents, or building openings. HEPA filtration on intake vents is required where dust may be introduced.
2. Dust created from disturbance of soil such as from vehicle movement will be wetted with use of a water truck as necessary
3. All cutting, drilling, grinding, sanding, or disturbance of materials shall be accomplished with tools equipped with either local exhaust ventilation (i.e. vacuum systems) or wet suppression controls.

1.13 TUBERCULOSIS SCREENING

- A. Contractor shall provide written certification that all contract employees assigned to the work site have had a pre-placement tuberculin screening within 90 days prior to

assignment to the worksite and been found to have negative TB screening reactions. Contractors shall be required to show documentation of negative TB screening reactions for any additional workers who are added after the 90-day requirement before they will be allowed to work on the work site. NOTE: This can be the Center for Disease Control (CDC) and Prevention and two-step skin testing or a Food and Drug Administration (FDA)-approved blood test.

1. Contract employees manifesting positive screening reactions to the tuberculin shall be examined according to current CDC guidelines prior to working on VHA property.
2. Subsequently, if the employee is found without evidence of active (infectious) pulmonary TB, a statement documenting examination by a physician shall be on file with the employer (construction contractor), noting that the employee with a positive tuberculin screening test is without evidence of active (infectious) pulmonary TB.
3. If the employee is found with evidence of active (infectious) pulmonary TB, the employee shall require treatment with a subsequent statement to the fact on file with the employer before being allowed to return to work on VHA property.

#### 1.14 FIRE SAFETY

- A. Fire Safety Plan: Establish and maintain a site-specific fire protection program in accordance with 29 CFR 1926. Prior to start of work, prepare a plan detailing project-specific fire safety measures, including periodic status reports, and submit to Contracting Officer Representative for review for compliance with contract requirements in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA AND SAMPLES. This plan may be an element of the Accident Prevention Plan.
- B. Site and Building Access: Maintain free and unobstructed access to facility emergency services and for fire, police and other emergency response forces in accordance with NFPA 241.
- C. Separate temporary facilities, such as trailers, storage sheds, and dumpsters, from existing buildings and new construction by distances in accordance with NFPA 241. For small facilities with less than 6 m (20 feet) exposing overall length, separate by 3m (10 feet).
- D. Temporary Construction Partitions:



1. Install and maintain temporary construction partitions to provide smoke-tight separations between construction areas and adjoining areas. Construct partitions of gypsum board or treated plywood (flame spread rating of 25 or less in accordance with ASTM E84) on both sides of fire retardant treated wood or metal steel studs. Extend the partitions through suspended ceilings to floor slab deck or roof. Seal joints and penetrations. At door openings, install smoke rated doors with self-closing devices.
  2. Install two-hour temporary construction partitions as shown on drawings to maintain integrity of existing exit stair enclosures, exit passageways, fire-rated enclosures of hazardous areas, horizontal exits, smoke barriers, vertical shafts and openings enclosures.
  3. Close openings in smoke barriers and fire-rated construction to maintain fire ratings. Seal penetrations with listed through-penetration firestop materials in accordance with Section 07 84 00, FIRESTOPPING.
- E. Temporary Heating and Electrical: Install, use and maintain installations in accordance with 29 CFR 1926, NFPA 241 and NFPA 70.
- F. Means of Egress: Do not block exiting for occupied buildings, including paths from exits to roads. Minimize disruptions and coordinate with Contracting Officer Representative.
- G. Egress Routes for Construction Workers: Maintain free and unobstructed egress. Inspect daily. Report findings and corrective actions weekly to Contracting Officer Representative.
- H. Fire Extinguishers: Provide and maintain extinguishers in construction areas and temporary storage areas in accordance with 29 CFR 1926, NFPA 241 and NFPA 10.
- I. Flammable and Combustible Liquids: Store, dispense and use liquids in accordance with 29 CFR 1926, NFPA 241 and NFPA 30.
- J. Existing Fire Protection: Do not impair automatic sprinklers, smoke and heat detection, and fire alarm systems, except for portions immediately under construction, and temporarily for connections. Provide fire watch for impairments more than 4 hours in a 24-hour period. Request interruptions in accordance with Article, OPERATIONS AND

STORAGE AREAS, and coordinate with Contracting Officer Representative. All existing or temporary fire protection systems (fire alarms, sprinklers) located in construction areas shall be tested as coordinated with the medical center. Parameters for the testing and results of any tests performed shall be recorded by the medical center and copies provided to the Contracting Officers Representative.

- K. Smoke Detectors: Prevent accidental operation. Remove temporary covers at end of work operations each day. Coordinate with Contracting Officer Representative.
- L. Hot Work: Perform and safeguard hot work operations in accordance with NFPA 241 and NFPA 51B. Coordinate with Contracting Officers Representative. Obtain permits from facility Safety Manager at least four hours in advance.
- M. Fire Hazard Prevention and Safety Inspections: Inspect entire construction areas weekly. Coordinate with, and report findings and corrective actions weekly to Contracting Officer Representative.
- N. Smoking: Smoking is prohibited in and adjacent to construction areas inside existing buildings and additions under construction. In separate and detached buildings under construction, smoking is prohibited except in designated smoking rest areas.
- O. Dispose of waste and debris in accordance with NFPA 241. Remove from buildings daily.

#### 1.15 ELECTRICAL

- A. All electrical work shall comply with NFPA 70 (NEC), NFPA 70B, NFPA 70E, 29 CFR Part 1910 Subpart J – General Environmental Controls, 29 CFR Part 1910 Subpart S – Electrical, and 29 CFR 1926 Subpart K in addition to other references required by contract.
- B. All qualified persons performing electrical work under this contract shall be licensed journeyman or master electricians. All apprentice electricians performing under this contract shall be deemed unqualified persons unless they are working under the immediate supervision of a licensed electrician or master electrician.
- C. All electrical work will be accomplished de-energized and in the Electrically Safe Work Condition ( refer to NFPA 70E for Work Involving Electrical Hazards, including

Exemptions to Work Permit). Any Contractor, subcontractor or temporary worker who fails to fully comply with this requirement is subject to immediate termination in accordance with FAR clause 52.236-5(c). Only in rare circumstance where achieving an electrically safe work condition prior to beginning work would increase or cause additional hazards, or is infeasible due to equipment design or operational limitations is energized work permitted. The Contracting Officer Representative with approval of the Medical Center Director will make the determination if the circumstances would meet the exception outlined above. An AHA specific to energized work activities will be developed, reviewed, and accepted prior to the start of that work.

1. Development of a Hazardous Electrical Energy Control Procedure is required prior to de-energization. A single Simple Lockout/Tagout Procedure for multiple work operations can only be used for work involving qualified person(s) de-energizing one set of conductors or circuit part source. Task specific Complex Lockout/Tagout Procedures are required at all other times.
  2. Verification of the absence of voltage after de-energization and lockout/tagout is considered "energized electrical work" (live work) under NFPA 70E, and shall only be performed by qualified persons wearing appropriate shock protective (voltage rated) gloves and arc rate personal protective clothing and equipment, using Underwriters Laboratories (UL) tested and appropriately rated contact electrical testing instruments or equipment appropriate for the environment in which they will be used.
  3. Personal Protective Equipment (PPE) and electrical testing instruments will be readily available for inspection by the Facility Safety Manager or Contracting Officer Representative.
- D. Before beginning any electrical work, an Activity Hazard Analysis (AHA) will be conducted to include Shock Hazard and Arc Flash Hazard analyses (NFPA Tables can be used only as a last alternative and it is strongly suggested a full Arc Flash Hazard Analyses be conducted). Work shall not begin until the AHA for the work activity has been accepted by the Contracting Officer Representative and discussed with all engaged in the activity, including the Contractor, subcontractor(s), and Government on-site representatives at preparatory and initial control phase meetings.

- E. Ground-fault circuit interrupters. All 120-volt, single-phase 15- and 20-ampere receptacle outlets on construction sites shall have approved ground-fault circuit interrupters for personnel protection. "Assured Equipment Grounding Conductor Program" only is not allowed.

#### 1.16 FALL PROTECTION

- A. The fall protection (FP) threshold height requirement is 6 ft (1.8 m) for ALL WORK, unless specified differently or the OSHA 29 CFR 1926 requirements are more stringent, to include steel erection activities, systems-engineered activities (prefabricated) metal buildings, residential (wood) construction and scaffolding work.
  - 1. The use of a Safety Monitoring System (SMS) as a fall protection method is prohibited.
  - 2. The use of Controlled Access Zone (CAZ) as a fall protection method is prohibited.
  - 3. A Warning Line System (WLS) may ONLY be used on floors or flat or low-sloped roofs (between 0 - 18.4 degrees or 4:12 slope) and shall be erected around all sides of the work area (See 29 CFR 1926.502(f) for construction of WLS requirements). No worker shall be allowed in the area between the roof or floor edge and the WLS without FP. FP is required when working outside the WLS.
  - 4. Fall protection while using a ladder will be governed by the OSHA requirements.

#### 1.17 SCAFFOLDS AND OTHER WORK PLATFORMS

- A. All scaffolds and other work platforms construction activities shall comply with 29 CFR 1926 Subpart L.
- B. The fall protection (FP) threshold height requirement is 6 ft (1.8 m) as stated in Section 1.16.
- C. The following hierarchy and prohibitions shall be followed in selecting appropriate work platforms.
  - 1. Scaffolds, platforms, or temporary floors shall be provided for all work except that can be performed safely from the ground or similar footing.

2. Ladders less than 20 feet may be used as work platforms only when use of small hand tools or handling of light material is involved.
  3. Ladder jacks, lean-to, and prop-scaffolds are prohibited.
  4. Emergency descent devices shall not be used as working platforms.
- D. Contractors shall use a scaffold tagging system in which all scaffolds are tagged by the Competent Person. Tags shall be color-coded: green indicates the scaffold has been inspected and is safe to use; red indicates the scaffold is unsafe to use. Tags shall be readily visible, made of materials that will withstand the environment in which they are used, be legible and shall include:
1. The Competent Person's name and signature;
  2. Dates of initial and last inspections.
- E. Mast Climbing work platforms: When access ladders, including masts designed as ladders, exceed 20 ft (6 m) in height, positive fall protection shall be used.

#### 1.18 EXCAVATION AND TRENCHES

- A. All excavation and trenching work shall comply with 29 CFR 1926 Subpart P.
- B. All excavations and trenches 5 feet in depth or greater shall require a written trenching and excavation permit (NOTE – some States and other local jurisdictions require separate state/jurisdiction-issued excavation permits). The permit shall be completed and provided to the Contracting Officer Representative prior to commencing work for the day. At the end of the day, the permit shall be closed out and provided to the Contracting Officer Representative. The permit shall be maintained onsite and include the following:
1. Determination of soil classification
  2. Indication that utilities have been located and identified. If utilities could not be located after all reasonable attempt, then excavating operations will proceed cautiously.
  3. Indication of selected excavation protective system.

4. Indication that the spoil pile will be stored at least 2 feet from the edge of the excavation and safe access provided within 25 feet of the workers.
  5. Indication of assessment for a potential toxic, explosive, or oxygen deficient atmosphere.
- C. If not using an engineered protective system such as a trench box, shielding, shoring, or other Professional Engineer designed system and using a sloping or benching system, soil classification cannot be Solid Rock or Type A. All soil will be classified as Type B or Type C and sloped or benched in accordance with Appendix B of 29 CFR 1926.

#### 1.19 CRANES

- A. All crane work shall comply with 29 CFR 1926 Subpart CC.
- B. Prior to operating a crane, the operator must be licensed, qualified or certified to operate the crane. Thus, all the provisions contained with Subpart CC are effective and there is no "Phase In" date of November 10, 2014.
- C. A detailed lift permit shall be submitted 14 days prior to the scheduled lift complete with route for truck carrying load, crane load analysis, siting of crane and path of swing. The lift will not be allowed without approval of this document.
- D. Crane operators shall not carry loads
  1. over the general public or VAMC personnel
  2. over any occupied building unless
    - a. the top two floors are vacated
    - b. or overhead protection with a design live load of 300 psf is provided

#### 1.20 CONTROL OF HAZARDOUS ENERGY (LOCKOUT/TAGOUT)

- A. All installation, maintenance, and servicing of equipment or machinery shall comply with 29 CFR 1910.147 except for specifically referenced operations in 29 CFR 1926 such as concrete & masonry equipment [1926.702(j)], heavy machinery & equipment [1926.600(a)(3)(i)], and process safety management of highly hazardous chemicals (1926.64). Control of hazardous electrical energy during the installation, maintenance,

or servicing of electrical equipment shall comply with Section 1.15 to include NFPA 70E and other VA specific requirements discussed in the section.

#### 1.21 CONFINED SPACE ENTRY

- A. All confined space entry shall comply with 29 CFR 1910.146 except for specifically referenced operations in 29 CFR 1926 such as excavations/trenches [1926.651(g)].
- B. A site-specific Confined Space Entry Plan (including permitting process) shall be developed and submitted to the Contracting Officers Representative.

#### 1.22 WELDING AND CUTTING

As specified in section 1.14, Hot Work: Perform and safeguard hot work operations in accordance with NFPA 241 and NFPA 51B. Coordinate with Contracting Officers Representative. Obtain permits from Facility Safety Manager and/or other Government Designated Authority at least four hours in advance.

#### 1.23 LADDERS

- A. All Ladder use shall comply with 29 CFR 1926 Subpart X.
- B. All portable ladders shall be of sufficient length and shall be placed so that workers will not stretch or assume a hazardous position.
- C. Manufacturer safety labels shall be in place on ladders
- D. Step Ladders shall not be used in the closed position
- E. Top steps or cap of step ladders shall not be used as a step
- F. Portable ladders, used as temporary access, shall extend at least 3 ft (0.9 m) above the upper landing surface.
  - 1. When a 3 ft (0.9-m) extension is not possible, a grasping device (such as a grab rail) shall be provided to assist workers in mounting and dismounting the ladder.
  - 2. In no case shall the length of the ladder be such that ladder deflection under a load would, by itself, cause the ladder to slip from its support.
- G. Ladders shall be inspected for visible defects on a daily basis and after any occurrence that could affect their safe use. Broken or damaged ladders shall be immediately tagged

"DO NOT USE," or with similar wording, and withdrawn from service until restored to a condition meeting their original design.

#### 1.24 FLOOR & WALL OPENINGS

- A. All floor and wall openings shall comply with 29 CFR 1926 Subpart M.
- B. Floor and roof holes/openings are any that measure over 2 in (51 mm) in any direction of a walking/working surface which persons may trip or fall into or where objects may fall to the level below. See 21.F for covering and labeling requirements. Skylights located in floors or roofs are considered floor or roof hole/openings.
- C. All floor, roof openings or hole into which a person can accidentally walk or fall through shall be guarded either by a railing system with toe boards along all exposed sides or a load-bearing cover. When the cover is not in place, the opening or hole shall be protected by a removable guardrail system or shall be attended when the guarding system has been removed, or other fall protection system.
  - 1. Covers shall be capable of supporting, without failure, at least twice the weight of the worker, equipment and material combined.
  - 2. Covers shall be secured when installed, clearly marked with the word "HOLE", "COVER" or "Danger, Roof Opening-Do Not Remove" or color-coded or equivalent methods (e.g., red or orange "X"). Workers must be made aware of the meaning for color coding and equivalent methods.
  - 3. Roofing material, such as roofing membrane, insulation or felts, covering or partly covering openings or holes, shall be immediately cut out. No hole or opening shall be left unattended unless covered.
  - 4. Non-load-bearing skylights shall be guarded by a load-bearing skylight screen, cover, or railing system along all exposed sides.
  - 5. Workers are prohibited from standing/walking on skylights.

END OF SECTION



SECTION 01 57 19  
TEMPORARY ENVIRONMENTAL CONTROLS

EP-1. DESCRIPTION

- A. This section specifies the control of environmental pollution and damage that the Contractor must consider for air, water, and land resources. It includes management of visual aesthetics, noise, solid waste, radiant energy, and radioactive materials, as well as other pollutants and resources encountered or generated by the Contractor. The Contractor is obligated to consider specified control measures with the costs included within the various contract items of work.
- B. Environmental pollution and damage is defined as the presence of chemical, physical, or biological elements or agents which:
  - 1. Adversely effect human health or welfare,
  - 2. Unfavorably alter ecological balances of importance to human life,
  - 3. Effect other species of importance to humankind, or;
  - 4. Degrade the utility of the environment for aesthetic, cultural, and historical purposes.
- C. Definitions of Pollutants:
  - 1. Chemical Waste: Petroleum products, bituminous materials, salts, acids, alkalis, herbicides, pesticides, organic chemicals, and inorganic wastes.
  - 2. Debris: Combustible and noncombustible wastes, such as leaves, tree trimmings, ashes, and waste materials resulting from construction or maintenance and repair work.
  - 3. Sediment: Soil and other debris that has been eroded and transported by runoff water.
  - 4. Solid Waste: Rubbish, debris, garbage, and other discarded solid materials resulting from industrial, commercial, and agricultural operations and from community activities.
  - 5. Surface Discharge: The term "Surface Discharge" implies that the water is discharged with possible sheeting action and subsequent soil erosion may occur. Waters that are surface discharged may terminate in drainage ditches, storm sewers, creeks, and/or "water of the United States" and would require a permit to discharge water from the governing agency.
  - 6. Rubbish: Combustible and noncombustible wastes such as paper, boxes, glass and crockery, metal and lumber scrap, tin cans, and bones.

7. Sanitary Wastes:

- a. Sewage: Domestic sanitary sewage and human and animal waste.
- b. Garbage: Refuse and scraps resulting from preparation, cooking, dispensing, and consumption of food.

EP-2. QUALITY CONTROL

- A. Establish and maintain quality control for the environmental protection of all items set forth herein.
- B. Record on daily reports any problems in complying with laws, regulations, and ordinances. Note any corrective action taken.

EP-3. REFERENCES

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.
- B. U.S. National Archives and Records Administration (NARA):  
33 CFR 328 ..... Definitions

EP-4. SUBMITTALS

- A. In accordance with Section, 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES, furnish the following:
  - 1. Environmental Protection Plan: After the contract is awarded and prior to the commencement of the work, the Contractor shall meet with the Resident Engineer to discuss the proposed Environmental Protection Plan and to develop mutual understanding relative to details of environmental protection. Not more than 20 days after the meeting, the Contractor shall prepare and submit to the Resident Engineer for approval, a written and/or graphic Environmental Protection Plan including, but not limited to, the following:
    - a. Name(s) of person(s) within the Contractor's organization who is (are) responsible for ensuring adherence to the Environmental Protection Plan.
    - b. Name(s) and qualifications of person(s) responsible for manifesting hazardous waste to be removed from the site.
  - C. Name(s) and qualifications of person(s) responsible for training the Contractor's environmental protection personnel.

- d. Description of the Contractor's environmental protection personnel training program.
  - e. A list of Federal, State, and local laws, regulations, and permits concerning environmental protection, pollution control, noise control and abatement that are applicable to the Contractor's proposed operations and the requirements imposed by those laws, regulations, and permits.
  - f. Methods for protection of features to be preserved within authorized work areas including trees, shrubs, vines, grasses, ground cover, landscape features, air and water quality, fish and wildlife, soil, historical, and archeological and cultural resources.
  - g. Procedures to provide the environmental protection that comply with the applicable laws and regulations. Describe the procedures to correct pollution of the environment due to accident, natural causes, or failure to follow the procedures as described in the Environmental Protection Plan.
  - h. Permits, licenses, and the location of the solid waste disposal area.
  - i. Drawings showing locations of any proposed temporary excavations or embankments for haul roads, material storage areas, structures, sanitary facilities, and stockpiles of excess or spoil materials. Include as part of an Erosion Control Plan approved by the District Office of the U.S. Soil Conservation Service and the Department of Veterans Affairs.
  - j. Environmental Monitoring Plans for the job site including land, water, air, and noise.
  - k. Work Area Plan showing the proposed activity in each portion of the area and identifying the areas of limited use or nonuse. Plan should include measures for marking the limits of use areas. This plan may be incorporated within the Erosion Control Plan.
- B. Approval of the Contractor's Environmental Protection Plan will not relieve the Contractor of responsibility for adequate and continued control of pollutants and other environmental protection measures.

#### EP-5. PROTECTION OF ENVIRONMENTAL RESOURCES

- A. Protect environmental resources within the project boundaries and those affected outside the limits of permanent work during the entire period of this contract. Confine activities to areas defined by the specifications and drawings.
- B. Protection of Land Resources: Prior to construction, identify all land resources to be preserved within the work area. Do not remove, cut, deface, injure, or destroy land resources including trees, shrubs, vines, grasses, top soil, and land forms without permission from the Resident Engineer. Do not fasten or attach ropes, cables, or guys

to trees for anchorage unless specifically authorized, or where special emergency use is permitted.

1. **Work Area Limits:** Prior to any construction, mark the areas that require work to be performed under this contract. Mark or fence isolated areas within the general work area that are to be saved and protected. Protect monuments, works of art, and markers before construction operations begin. Convey to all personnel the purpose of marking and protecting all necessary objects.
2. **Protection of Landscape:** Protect trees, shrubs, vines, grasses, land forms, and other landscape features shown on the drawings to be preserved by marking, fencing, or using any other approved techniques.
  - a. Box and protect from damage existing trees and shrubs to remain on the construction site.
  - b. Immediately repair all damage to existing trees and shrubs by trimming, cleaning, and painting with antiseptic tree paint.
  - c. Do not store building materials or perform construction activities closer to existing trees or shrubs than the farthest extension of their limbs.
3. **Reduction of Exposure of Unprotected Erodible Soils:** Plan and conduct earthwork to minimize the duration of exposure of unprotected soils. Clear areas in reasonably sized increments only as needed to use. Form earthwork to final grade as shown. Immediately protect side slopes and back slopes upon completion of rough grading.
4. **Temporary Protection of Disturbed Areas:** Construct diversion ditches, benches, and berms to retard and divert runoff from the construction site to protected drainage areas approved under paragraph 208 of the Clean Water Act.
5. **Erosion and Sedimentation Control Devices:** The erosion and sediment controls selected and maintained by the Contractor shall be such that water quality standards are not violated as a result of the Contractor's activities. Construct or install all temporary and permanent erosion and sedimentation control features. Maintain temporary erosion and sediment control measures such as berms, dikes, drains, sedimentation basins, grassing, and mulching, until permanent drainage and erosion control facilities are completed and operative.
6. **Manage and control spoil areas on Government property to limit spoil to areas and prevent erosion of soil or sediment from entering nearby water courses or lakes.**
7. **Protect adjacent areas from despoilment by temporary excavations and embankments.**
8. **Handle and dispose of solid wastes in such a manner that will prevent contamination of the environment. Place solid wastes (excluding clearing debris) in containers that are emptied on a regular schedule. Transport all solid waste off Government property and dispose of waste in compliance with Federal, State, and local requirements.**

9. Store chemical waste away from the work areas in corrosion resistant containers and dispose of waste in accordance with Federal, State, and local regulations.
  10. Handle discarded materials other than those included in the solid waste category as directed by the Resident Engineer.
- C. Protection of Water Resources: Keep construction activities under surveillance, management, and control to avoid pollution of surface and ground waters and sewer systems. Implement management techniques to control water pollution by the listed construction activities that are included in this contract.
1. Washing and Curing Water: Do not allow wastewater directly derived from construction activities to enter water areas. Collect and place wastewater in retention ponds allowing the suspended material to settle, the pollutants to separate, or the water to evaporate.
  2. Control movement of materials and equipment at stream crossings during construction to prevent violation of water pollution control standards of the Federal, State, or local government.
  3. Monitor water areas affected by construction.
- D. Protection of Air Resources: Keep construction activities under surveillance, management, and control to minimize pollution of air resources. Burning is not permitted on the job site. Keep activities, equipment, processes, and work operated or performed, in strict accordance with the San Joaquin Valley Air Pollution Control District and Federal emission and performance laws and standards. Maintain ambient air quality standards set by the Environmental Protection Agency, for those construction operations and activities specified.
1. Particulates: Control dust particles, aerosols, and gaseous by-products from all construction activities, processing, and preparation of materials (such as from asphaltic batch plants) at all times, including weekends, holidays, and hours when work is not in progress.
  2. Particulates Control: Maintain all excavations, stockpiles, haul roads, permanent and temporary access roads, plant sites, spoil areas, borrow areas, and all other work areas within or outside the project boundaries free from particulates which would cause a hazard or a nuisance. Sprinklering, chemical treatment of an approved type, light bituminous treatment, baghouse, scrubbers, electrostatic precipitators, or other methods are permitted to control particulates in the work area.
  3. Hydrocarbons and Carbon Monoxide: Control monoxide emissions from equipment to Federal and State allowable limits.
  4. Odors: Control odors of construction activities and prevent obnoxious odors from occurring.

E. Reduction of Noise: Minimize noise using every action possible. Perform noise-producing work in less sensitive hours of the day or week as directed by the Resident Engineer. Maintain noise-produced work at or below the decibel levels and within the time periods specified.

1. Perform construction activities involving repetitive, high-level impact noise only as permitted by the Resident Engineer. Repetitive impact noise on the property shall not exceed the following dB limitations:

| Time Duration of Impact Noise       | Sound Level in dB |
|-------------------------------------|-------------------|
| More than 12 minutes in any hour    | 70                |
| Less than 30 seconds of any hour    | 85                |
| Less than three minutes of any hour | 80                |
| Less than 12 minutes of any hour    | 75                |

2. Provide sound-deadening devices on equipment and take noise abatement measures that are necessary to comply with the requirements of this contract, consisting of, but not limited to, the following:

- a. Maintain maximum permissible construction equipment noise levels at 15 m (50 feet) (dBA):

| EARTHMOVING        |    | MATERIALS HANDLING |    |
|--------------------|----|--------------------|----|
| FRONT LOADERS      | 75 | CONCRETE MIXERS    | 75 |
| BACKHOES           | 75 | CONCRETE PUMPS     | 75 |
| DOZERS             | 75 | CRANES             | 75 |
| TRACTORS           | 75 | DERRICKS IMPACT    | 75 |
| SCAPERS            | 80 | PILE DRIVERS       | 95 |
| GRADERS            | 75 | JACK HAMMERS       | 75 |
| TRUCKS             | 75 | ROCK DRILLS        | 80 |
| PAVERS, STATIONARY | 80 | PNEUMATIC TOOLS    | 80 |
| GENERATORS         | 75 | SAWS               | 75 |
| COMPRESSOR         | 75 | VIBRATORS          | 75 |

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- b. Use shields or other physical barriers to restrict noise transmission.
  - c. Provide soundproof housings or enclosures for noise-producing machinery.
  - d. Use efficient silencers on equipment air intakes.
  - e. Use efficient intake and exhaust mufflers on internal combustion engines that are maintained so equipment performs below noise levels specified.
  - f. Line hoppers and storage bins with sound deadening material.
  - g. Conduct truck loading, unloading, and hauling operations so that noise is kept to a minimum.
3. Measure sound level for noise exposure due to the construction at least once every five successive working days while work is being performed above 55 dB(A) noise level. Measure noise exposure at the property line or 15 m (50 feet) from the noise source, whichever is greater. Measure the sound levels on the A weighing network of a General Purpose sound level meter at slow response. To minimize the effect of reflective sound waves at buildings, take measurements at 900 to 1800 mm (three to six feet) in front of any building face. Submit the recorded information to the Resident Engineer noting any problems and the alternatives for mitigating actions.
- F. Restoration of Damaged Property: If any direct or indirect damage is done to public or private property resulting from any act, omission, neglect, or misconduct, the Contractor shall restore the damaged property to a condition equal to that existing before the damage at no additional cost to the Government. Repair, rebuild, or restore property as directed or make good such damage in an acceptable manner.
- G. Final Clean-up: On completion of project and after removal of all debris, rubbish, and temporary construction, Contractor shall leave the construction area in a clean condition satisfactory to the Resident Engineer. Cleaning shall include off the station disposal of all items and materials not required to be salvaged, as well as all debris and rubbish resulting from demolition and new work operations.

END OF SECTION

## SECTION 01 58 16 TEMPORARY INTERIOR SIGNAGE

### PART 1- GENERAL

#### DESCRIPTION

This section specifies temporary interior signs.

### PART 2 PRODUCTS

#### 2.1 TEMPORARY SIGNS

- A. Fabricate from 50 Kg (110 pound) mat finish white paper.
- B. Graphics shall be mechanically produced (no hand lettering).
- C. Cut to 100 mm (4-inch) wide by 300 mm (12 inch) long size tag.
- D. Punch 3 mm (1/8-inch) diameter hole centered on 100 mm (4-inch) dimension of tag. Edge of Hole spaced approximately 13 mm (1/2-inch) from one end on tag.
- E. Reinforce hole on both sides with gummed cloth washer or other suitable material capable of preventing tie pulling through paper edge.
- F. Ties: Steel wire 0.3 mm (0.0120-inch) thick, attach to tag with twist tie, leaving 150 mm (6-inch) long free ends.

### PART 3 EXECUTION

#### 3.1 INSTALLATION

- A. Install temporary signs attached to room door frame or room door knob, lever, or pull for doors on corridor openings.
- B. Mark on signs with felt tip marker having approximately 3 mm (1/8-inch) wide stroke for clearly legible numbers or letters.
- C. Identify room with numbers as designated on floor plans.

#### 3.2 LOCATION

- A. Install on doors that have room, corridor, and space numbers shown.
- B. Doors that do not require signs are as follows:
  - 1. Corridor barrier doors (cross-corridor) in corridor with same number.
  - 2. Folding doors or partitions.



3. Toilet or bathroom doors within and between rooms.
  4. Communicating doors in partitions between rooms with corridor entrance doors.
  5. Closet doors within rooms.
- C. Replace missing, damaged, or illegible signs.

END OF SECTION

## SECTION 01 91 00

### GENERAL COMMISSIONING REQUIREMENTS

#### PART 1 - GENERAL

##### 1.1 COMMISSIONING DESCRIPTION

- A. This Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS shall form the basis of the construction phase commissioning process and procedures. The Commissioning Agent shall add, modify, and refine the commissioning procedures, as approved by the Department of Veterans Affairs (VA), to suit field conditions and actual manufacturer's equipment, incorporate test data and procedure results, and provide detailed scheduling for all commissioning tasks.
- B. Various sections of the project specifications require equipment startup, testing, and adjusting services. Requirements for startup, testing, and adjusting services specified in the Division 7, Division 21, Division 23, Division 26 series sections of these specifications are intended to be provided in coordination with the commissioning services and are not intended to duplicate services. The Contractor shall coordinate the work required by individual specification sections with the commissioning services requirements specified herein.
- C. Where individual testing, adjusting, or related services are required in the project specifications and not specifically required by this commissioning requirements specification, the specified services shall be provided and copies of documentation, as required by those specifications shall be submitted to the VA and the Commissioning Agent to be indexed for future reference.
- D. Where training or educational services for VA are required and specified in other sections of the specifications, including but not limited to Division 7, Division 8, Division 21, Division 23, and Division 26 series sections of the specification, these services are intended to be provided in addition to the training and educational services specified herein.
- E. Commissioning is a systematic process of verifying that the building systems perform interactively according to the construction documents and the VA's operational needs. The commissioning process shall encompass and coordinate the system documentation, equipment startup, control system calibration, testing and balancing, performance testing and training. Commissioning during the construction and post-occupancy phases is

intended to achieve the following specific objectives according to the contract documents:

1. Verify that the applicable equipment and systems are installed in accordance with the contract documents and according to the manufacturer's recommendations.
  2. Verify and document proper integrated performance of equipment and systems.
  3. Verify that Operations & Maintenance documentation is complete.
  4. Verify that all components requiring servicing can be accessed, serviced and removed without disturbing nearby components including ducts, piping, cabling or wiring.
  5. Verify that the VA's operating personnel are adequately trained to enable them to operate, monitor, adjust, maintain, and repair building systems in an effective and energy-efficient manner.
  6. Document the successful achievement of the commissioning objectives listed above.
- F. The commissioning process does not take away from or reduce the responsibility of the Contractor to provide a finished and fully functioning product.

## 1.2 CONTRACTUAL RELATIONSHIPS

- A. For this construction project, the Department of Veterans Affairs contracts with a Contractor to provide construction services. The contracts are administered by the VA Contracting Officer and the Resident Engineer as the designated representative of the Contracting Officer. On this project, the authority to modify the contract in any way is strictly limited to the authority of the Contracting Officer.
- B. In this project, only two contract parties are recognized and communications on contractual issues are strictly limited to VA Resident Engineer and the Contractor. It is the practice of the VA to require that communications between other parties to the contracts (Subcontractors and Vendors) be conducted through the Resident Engineer and Contractor. It is also the practice of the VA that communications between other parties of the project (Commissioning Agent and Architect/Engineer) be conducted through the Resident Engineer.
- C. Whole Building Commissioning is a process that relies upon frequent and direct communications, as well as collaboration between all parties to the construction process. By its nature, a high level of communication and cooperation between the Commissioning Agent and all other parties (Architects, Engineers, Subcontractors, Vendors, third party testing agencies, etc.) is essential to the success of the Commissioning effort.

D. With these fundamental practices in mind, the commissioning process described herein has been developed to recognize that, in the execution of the Commissioning Process, the Commissioning Agent must develop effective methods to communicate with every member of the construction team involved in delivering commissioned systems while simultaneously respecting the exclusive contract authority of the Contracting Officer and Resident Engineer. Thus, the procedures outlined in this specification must be executed within the following limitations:

1. No communications (verbal or written) from the Commissioning Agent shall be deemed to constitute direction that modifies the terms of any contract between the Department of Veterans Affairs and the Contractor.
2. Commissioning Issues identified by the Commissioning Agent will be delivered to the Resident Engineer and copied to the designated Commissioning Representatives for the Contractor and subcontractors on the Commissioning Team for information only in order to expedite the communication process. These issues must be understood as the professional opinion of the Commissioning Agent and as suggestions for resolution.
3. In the event that any Commissioning Issues and suggested resolutions are deemed by the Resident Engineer to require either an official interpretation of the construction documents or require a modification of the contract documents, the Contracting Officer or Resident Engineer will issue an official directive to this effect.
4. All parties to the Commissioning Process shall be individually responsible for alerting the Resident Engineer of any issues that they deem to constitute a potential contract change prior to acting on these issues.
5. Authority for resolution or modification of design and construction issues rests solely with the Contracting Officer or Resident Engineer, with appropriate technical guidance from the Architect/Engineer and/or Commissioning Agent.

Spec Writer Note: Edit the following paragraph to include only those related work sections that are included in the contract. Add related work references as necessary and delete any related work references not included in the contract.

### 1.3 RELATED WORK

- A. Section 01 00 00 GENERAL REQUIREMENTS.
- B. Section 01 33 23 SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES
- C. Section 21 08 00 COMMISSIONING OF FIRE PROTECTION SYSTEMS.
- D. Section 23 08 00 COMMISSIONING OF HVAC SYSTEMS.

E. Section 26 08 00 COMMISSIONING OF ELECTRICAL SYSTEMS.

1.4 SUMMARY

- A. This Section includes general requirements that apply to implementation of commissioning without regard to systems, subsystems, and equipment being commissioned.
- B. The commissioning activities have been developed to support the VA requirements to meet guidelines for Federal Leadership in Environmental, Energy, and Economic Performance.
- D. The commissioning activities have been developed to support the Green Buildings Initiative's Green Globes rating program and to support delivery of project performance in accordance with the VA requirements developed for the project.

1.5 ACRONYMS

| List of Acronyms |   |
|------------------|---|
| Acronym          | Meaning   |
| A/E              | Architect / Engineer Design Team  |
| AHJ              | Authority Having Jurisdiction   |
| ASHRAE           | Association Society for Heating Air Condition and Refrigeration Engineers |
| BOD              | Basis of Design   |
| BSC              | Building Systems Commissioning  |
| CCTV             | Closed Circuit Television   |
| CD               | Construction Documents  |
| CMMS             | Computerized Maintenance Management System                                |
| CO               | Contracting Officer (VA)  |
| COR              | Contracting Officer's Representative (see also VA-RE)                     |
| COBie            | Construction Operations Building Information Exchange                     |
| CPC              | Construction Phase Commissioning  |
| Cx               | Commissioning   |
| CxA              | Commissioning Agent   |
| CxM              | Commissioning Manager   |
| CxR              | Commissioning Representative  |
| DPC              | Design Phase Commissioning  |
| FPT              | Functional Performance Test   |

| List of Acronyms |   |
|------------------|---|
| Acronym          | Meaning   |
| GBI-GG           | Green Building Initiative - Green Globes                        |
| HVAC             | Heating, Ventilation, and Air Conditioning                      |
| LEED             | Leadership in Energy and Environmental Design                   |
| NC               | Department of Veterans Affairs National Cemetery                |
| NCA              | Department of Veterans Affairs National Cemetery Administration |
| NEBB             | National Environmental Balancing Bureau                         |
| O&M              | Operations & Maintenance  |
| OPR              | Owner's Project Requirements                                    |
| PFC              | Pre-Functional Checklist  |
| PFT              | Pre-Functional Test   |
| SD               | Schematic Design  |
| SO               | Site Observation  |
| TAB              | Test Adjust and Balance   |
| VA               | Department of Veterans Affairs                                  |
| VAMC             | VA Medical Center   |
| VA CFM           | VA Office of Construction and Facilities Management             |
| VACO             | VA Central Office   |
| VA PM            | VA Project Manager  |
| VA-RE            | VA Resident Engineer  |
| USGBC            | United States Green Building Council                            |

## 1.6 DEFINITIONS

Acceptance Phase Commissioning: Commissioning tasks executed after most construction has been completed, most Site Observations and Static Tests have been completed and Pre-Functional Testing has been completed and accepted. The main commissioning activities performed during this phase are verification that the installed systems are functional by conducting Systems Functional Performance tests and Owner Training.

Accuracy: The capability of an instrument to indicate the true value of a measured quantity.

Back Check: A back check is a verification that an agreed upon solution to a design comment has been adequately addressed in a subsequent design review

Basis of Design (BOD): The Engineer's Basis of Design is comprised of two components: the Design Criteria and the Design Narrative, these documents record the concepts, calculations, decisions, and product selections used to meet the Owner's Project Requirements (OPR) and to satisfy applicable regulatory requirements, standards, and guidelines.

Benchmarks: Benchmarks are the comparison of a building's energy usage to other similar buildings and to the building itself.. For example, ENERGY STAR Portfolio Manager is a frequently used and nationally recognized building energy benchmarking tool.

Building Information Modeling (BIM): Building Information Modeling is a parametric database which allows a building to be designed and constructed virtually in 3D, and provides reports both in 2D views and as schedules. This electronic information can be extracted and reused for pre-populating facility management CMMS systems. Building Systems Commissioning (BSC): NEBB acronym used to designate its commissioning program.

Calibrate: The act of comparing an instrument of unknown accuracy with a standard of known accuracy to detect, correlate, report, or eliminate by adjustment any variation in the accuracy of the tested instrument.

CCTV: Closed circuit Television. Normally used for security surveillance and alarm detections as part of a special electrical security system.

COBie: Construction Operations Building Information Exchange (COBie) is an electronic industry data format used to transfer information developed during design, construction, and commissioning into the Computer Maintenance Management Systems (CMMS) used to operate facilities. See the Whole Building Design Guide website for further information (<http://www.wbdg.org/resources/cobie.php>)

Commissionability: Defines a design component or construction process that has the necessary elements that will allow a system or component to be effectively measured, tested, operated and commissioned

Commissioning Agent (CxA): The qualified Commissioning Professional who administers the Cx process by managing the Cx team and overseeing the Commissioning Process. Where CxA is used in this specification it means the Commissioning Agent, members of

his staff or appointed members of the commissioning team. Note that LEED uses the term Commissioning Authority in lieu of Commissioning Agent.

Commissioning Checklists: Lists of data or inspections to be verified to ensure proper system or component installation, operation, and function. Verification checklists are developed and used during all phases of the commissioning process to verify that the Owner's Project Requirements (OPR) is being achieved.

Commissioning Design Review: The commissioning design review is a collaborative review of the design professionals design documents for items pertaining to the following: owner's project requirements; basis of design; operability and maintainability (O&M) including documentation; functionality; training; energy efficiency, control systems' sequence of operations including building automation system features; commissioning specifications and the ability to functionally test the systems.

Commissioning Issue: A condition identified by the Commissioning Agent or other member of the Commissioning Team that adversely affects the commissionability, operability, maintainability, or functionality of a system, equipment, or component. A condition that is in conflict with the Contract Documents and/or performance requirements of the installed systems and components. (See also – Commissioning Observation).

Commissioning Manager (CxM): A qualified individual appointed by the Contractor to manage the commissioning process on behalf of the Contractor.

Commissioning Observation: An issue identified by the Commissioning Agent or other member of the Commissioning Team that does not conform to the project OPR, contract documents or standard industry best practices. (See also Commissioning Issue)

Commissioning Plan: A document that outlines the commissioning process, commissioning scope and defines responsibilities, processes, schedules, and the documentation requirements of the Commissioning Process.

Commissioning Process: A quality focused process for enhancing the delivery of a project. The process focuses upon verifying and documenting that the facility and all of its systems, components, and assemblies are planned, designed, installed, tested, can be operated, and maintained to meet the Owner's Project Requirements.

Commissioning Report: The final commissioning document which presents the commissioning process results for the project. Cx reports include an executive summary, the commissioning plan, issue log, correspondence, and all appropriate check sheets and test forms.



Commissioning Representative (CxR): An individual appointed by a sub-contractor to manage the commissioning process on behalf of the sub-contractor.

Commissioning Specifications: The contract documents that detail the objective, scope and implementation of the commissioning process as developed in the Commissioning Plan.

Commissioning Team: Individual team members whose coordinated actions are responsible for implementing the Commissioning Process.

Construction Phase Commissioning: All commissioning efforts executed during the construction process after the design phase and prior to the Acceptance Phase Commissioning.

Contract Documents (CD): Contract documents include design and construction contracts, price agreements and procedure agreements. Contract Documents also include all final and complete drawings, specifications and all applicable contract modifications or supplements.

Construction Phase Commissioning (CPC): All commissioning efforts executed during the construction process after the design phase and prior to the Acceptance Phase Commissioning.

Coordination Drawings: Drawings showing the work of all trades that are used to illustrate that equipment can be installed in the space allocated without compromising equipment function or access for maintenance and replacement. These drawings graphically illustrate and dimension manufacturers' recommended maintenance clearances. On mechanical projects, coordination drawings include structural steel, ductwork, major piping and electrical conduit and show the elevations and locations of the above components.

Data Logging: The monitoring and recording of temperature, flow, current, status, pressure, etc. of equipment using stand-alone data recorders.

Deferred System Test: Tests that cannot be completed at the end of the acceptance phase due to ambient conditions, schedule issues or other conditions preventing testing during the normal acceptance testing period.

Deficiency: See "Commissioning Issue".

Design Criteria: A listing of the VA Design Criteria outlining the project design requirements, including its source. These are used during the design process to show the design elements meet the OPR.

**Design Intent:** The overall term that includes the OPR and the BOD. It is a detailed explanation of the ideas, concepts, and criteria that are defined by the owner to be important. The design intent documents are utilized to provide a written record of these ideas, concepts and criteria.

**Design Narrative:** A written description of the proposed design solutions that satisfy the requirements of the OPR.

**Design Phase Commissioning (DPC):** All commissioning tasks executed during the design phase of the project.

**Environmental Systems:** Systems that use a combination of mechanical equipment, airflow, water flow and electrical energy to provide heating, ventilating, air conditioning, humidification, and dehumidification for the purpose of human comfort or process control of temperature and humidity.

**Executive Summary:** A section of the Commissioning report that reviews the general outcome of the project. It also includes any unresolved issues, recommendations for the resolution of unresolved issues and all deferred testing requirements.

**Functionality:** This defines a design component or construction process which will allow a system or component to operate or be constructed in a manner that will produce the required outcome of the OPR.

**Functional Test Procedure (FTP):** A written protocol that defines methods, steps, personnel, and acceptance criteria for tests conducted on components, equipment, assemblies, systems, and interfaces among systems.

**Industry Accepted Best Practice:** A design component or construction process that has achieved industry consensus for quality performance and functionality. Refer to the current edition of the NEBB Design Phase Commissioning Handbook for examples.

**Installation Verification:** Observations or inspections that confirm the system or component has been installed in accordance with the contract documents and to industry accepted best practices.

**Integrated System Testing:** Integrated Systems Testing procedures entail testing of multiple integrated systems performance to verify proper functional interface between systems. Typical Integrated Systems Testing includes verifying that building systems respond properly to loss of utility, transfer to emergency power sources, re-transfer from emergency power source to normal utility source; interface between HVAC controls and Fire Alarm systems for equipment shutdown, interface between Fire Alarm system and elevator control systems for elevator recall and shutdown; interface between Fire Alarm

System and Security Access Control Systems to control access to spaces during fire alarm conditions; and other similar tests as determined for each specific project.

**Issues Log:** A formal and ongoing record of problems or concerns – and their resolution – that have been raised by members of the Commissioning Team during the course of the Commissioning Process.

**Lessons Learned Workshop:** A workshop conducted to discuss and document project successes and identify opportunities for improvements for future projects.

**Maintainability:** A design component or construction process that will allow a system or component to be effectively maintained. This includes adequate room for access to adjust and repair the equipment. Maintainability also includes components that have readily obtainable repair parts or service.

**Manual Test:** Testing using hand-held instruments, immediate control system readouts or direct observation to verify performance (contrasted to analyzing monitored data taken over time to make the 'observation').

**Owner's Project Requirements (OPR):** A written document that details the project requirements and the expectations of how the building and its systems will be used and operated. These include project goals, measurable performance criteria, cost considerations, benchmarks, success criteria, and supporting information.

**Peer Review:** A formal in-depth review separate from the commissioning review processes. The level of effort and intensity is much greater than a typical commissioning facilitation or extended commissioning review. The VA usually hires an independent third-party (called the IDIQ A/E) to conduct peer reviews.

**Precision:** The ability of an instrument to produce repeatable readings of the same quantity under the same conditions. The precision of an instrument refers to its ability to produce a tightly grouped set of values around the mean value of the measured quantity.

**Pre-Design Phase Commissioning:** Commissioning tasks performed prior to the commencement of design activities that includes project programming and the development of the commissioning process for the project

**Pre-Functional Checklist (PFC):** A form used by the contractor to verify that appropriate components are onsite, correctly installed, set up, calibrated, functional and ready for functional testing.

**Pre-Functional Test (PFT):** An inspection or test that is done before functional testing. PFT's include installation verification and system and component start up tests.

Procedure or Protocol: A defined approach that outlines the execution of a sequence of work or operations. Procedures are used to produce repeatable and defined results.

Range: The upper and lower limits of an instrument's ability to measure the value of a quantity for which the instrument is calibrated.

Resolution: This word has two meanings in the Cx Process. The first refers to the smallest change in a measured variable that an instrument can detect. The second refers to the implementation of actions that correct a tested or observed deficiency.

Site Observation Visit: On-site inspections and observations made by the Commissioning Agent for the purpose of verifying component, equipment, and system installation, to observe contractor testing, equipment start-up procedures, or other purposes.

Site Observation Reports (SO): Reports of site inspections and observations made by the Commissioning Agent. Observation reports are intended to provide early indication of an installation issue which will need correction or analysis.

Special System Inspections: Inspections required by a local code authority prior to occupancy and are not normally a part of the commissioning process.

Static Tests: Tests or inspections that validate a specified static condition such as pressure testing. Static tests may be specification or code initiated.

Start Up Tests: Tests that validate the component or system is ready for automatic operation in accordance with the manufactures requirements.

Systems Manual: A system-focused composite document that includes all information required for the owners operators to operate the systems.

Test Procedure: A written protocol that defines methods, personnel, and expectations for tests conducted on components, equipment, assemblies, systems, and interfaces among systems.

Testing: The use of specialized and calibrated instruments to measure parameters such as: temperature, pressure, vapor flow, air flow, fluid flow, rotational speed, electrical characteristics, velocity, and other data in order to determine performance, operation, or function.

Testing, Adjusting, and Balancing (TAB): A systematic process or service applied to heating, ventilating and air-conditioning (HVAC) systems and other environmental systems to achieve and document air and hydronic flow rates. The standards and procedures for providing these services are referred to as "Testing, Adjusting, and

Balancing” and are described in the Procedural Standards for the Testing, Adjusting and Balancing of Environmental Systems, published by NEBB or AABC.

Thermal Scans: Thermographic pictures taken with an Infrared Thermographic Camera. Thermographic pictures show the relative temperatures of objects and surfaces and are used to identify leaks, thermal bridging, thermal intrusion, electrical overload conditions, moisture containment, and insulation failure.

Training Plan: A written document that details, in outline form the expectations of the operator training. Training agendas should include instruction on how to obtain service, operate, startup, shutdown and maintain all systems and components of the project.

Trending: Monitoring over a period of time with the building automation system.

Unresolved Commissioning Issue: Any Commissioning Issue that, at the time that the Final Report or the Amended Final Report is issued that has not been either resolved by the construction team or accepted by the VA. Validation: The process by which work is verified as complete and operating correctly:

1. First party validation occurs when a firm or individual verifying the task is the same firm or individual performing the task.
2. Second party validation occurs when the firm or individual verifying the task is under the control of the firm performing the task or has other possibilities of financial conflicts of interest in the resolution (Architects, Designers, General Contractors and Third Tier Subcontractors or Vendors).
3. Third party validation occurs when the firm verifying the task is not associated with or under control of the firm performing or designing the task.

Verification: The process by which specific documents, components, equipment, assemblies, systems, and interfaces among systems are confirmed to comply with the criteria described in the Owner's Project Requirements.

Warranty Phase Commissioning: Commissioning efforts executed after a project has been completed and accepted by the Owner. Warranty Phase Commissioning includes follow-up on verification of system performance, measurement and verification tasks and assistance in identifying warranty issues and enforcing warranty provisions of the construction contract.

Warranty Visit: A commissioning meeting and site review where all outstanding warranty issues and deferred testing is reviewed and discussed.

Whole Building Commissioning: Commissioning of building systems such as Building Envelope, HVAC, Electrical, Special Electrical (Fire Alarm, Security & Communications), Plumbing and Fire Protection as described in this specification.

#### 1.7 SYSTEMS TO BE COMMISSIONED

- A. Commissioning of a system or systems specified for this project is part of the construction process. Documentation and testing of these systems, as well as training of the VA's Operation and Maintenance personnel, is required in cooperation with the VA and the Commissioning Agent.

B. The following systems will be commissioned as part of this project:

| Systems To Be Commissioned       |   |
|----------------------------------|---|
| System                           | Description   |
| Building Exterior Closure        |   |
| Exterior Closure                 | Exterior penetrations.  |
| Roofing                          | Roof system (including parapet), roof openings (pipe penetrations, ducts, equipment curbs, etc.)  |
| Note:                            | The emphasis on commissioning the above building envelope systems is on control of air flow, heat flow, noise, infrared, ultraviolet, rain penetration, moisture, durability, security, reliability, constructability, maintainability, and sustainability. |
| Fire Suppression                 |   |
| Fire Sprinkler Systems           | Wet pipe system   |
| HVAC                             |   |
| Noise and Vibration Control      | Noise and vibration levels for critical equipment such as Chillers and equipment skid will be commissioned as part of the system commissioning  |
| Direct Digital Control System    | Operator Interface Computer, Operator Work Station (including graphics, point mapping, trends, alarms), Network Communications Modules and Wiring, Integration Panels. [DDC Control panels will be commissioned with the systems controlled by the panel]   |
| Chilled Water System             | Chillers (centrifugal, rotary screw, air-cooled), pumps (primary, secondary, variable primary), VFDs associated with chilled water system components, DDC Control Panels (including integration with Building Control System)                               |
| HVAC Ventilation/Exhaust Systems | General exhaust, room pressurization control systems  |

| Systems To Be Commissioned          |   |
|-------------------------------------|---|
| System                              | Description   |
| HVAC Terminal Unit Systems          | CAV terminal units,   |
| Humidity Control Systems            | Humidifiers, de-humidifiers, controls, interface with facility DDC  |
| Hydronic Distribution Systems       | Pumps, DDC control panels, heat exchangers,   |
| Electrical                          |   |
| Low-Voltage Distribution System     | Normal power distribution system, Life-safety power distribution system, critical power distribution system, equipment power distribution system, switchboards, distribution panels, panelboards, verify breaker testing results (injection current, etc) |
| Lighting & Lighting Control Systems | Emergency lighting, occupancy sensors, lighting control systems, architectural dimming systems, theatrical dimming systems, exterior lighting and controls  |
| Loss of Power Response              | Loss of power to building, loss of power to campus, restoration of power to building, restoration of power to campus.   |
| Fire Alarm Response                 | Integrated System Response to Fire Alarm Condition and Return to Normal   |

## 1.8 COMMISSIONING TEAM

- A. The commissioning team shall consist of, but not be limited to, representatives of Contractor, including Project Superintendent and subcontractors, installers, schedulers, suppliers, and specialists deemed appropriate by the Department of Veterans Affairs (VA) and Commissioning Agent.
- B. Members Appointed by Contractor:
  - 1. Contractor' Commissioning Manager: The designated person, company, or entity that plans, schedules and coordinates the commissioning activities for the construction team.



2. Contractor's Commissioning Representative(s): Individual(s), each having authority to act on behalf of the entity he or she represents, explicitly organized to implement the commissioning process through coordinated actions.

C. Members Appointed by VA:

1. Commissioning Agent: The designated person, company, or entity that plans, schedules, and coordinates the commissioning team to implement the commissioning process. The VA will engage the CxA under a separate contract.
2. User: Representatives of the facility user and operation and maintenance personnel.
3. A/E: Representative of the Architect and engineering design professionals.

1.9 VA'S COMMISSIONING RESPONSIBILITIES

- A. Appoint an individual, company or firm to act as the Commissioning Agent.
- B. Assign operation and maintenance personnel and schedule them to participate in commissioning team activities including, but not limited to, the following:
  1. Coordination meetings.
  2. Training in operation and maintenance of systems, subsystems, and equipment.
  3. Testing meetings.
  4. Witness and assist in Systems Functional Performance Testing.
  5. Demonstration of operation of systems, subsystems, and equipment.
- C. Provide the Construction Documents, prepared by Architect and approved by VA, to the Commissioning Agent and for use in managing the commissioning process, developing the commissioning plan, systems manuals, and reviewing the operation and maintenance training plan.

1.10 CONTRACTOR'S COMMISSIONING RESPONSIBILITIES

- A. The Contractor shall assign a Commissioning Manager to manage commissioning activities of the Contractor, and subcontractors.
- B. The Contractor shall ensure that the commissioning responsibilities outlined in these specifications are included in all subcontracts and that subcontractors comply with the requirements of these specifications.
- C. The Contractor shall ensure that each installing subcontractor shall assign representatives with expertise and authority to act on behalf of the subcontractor and schedule them to participate in and perform commissioning team activities including, but not limited to, the following:
  1. Participate in commissioning coordination meetings.

2. Conduct operation and maintenance training sessions in accordance with approved training plans.
3. Verify that Work is complete and systems are operational according to the Contract Documents, including calibration of instrumentation and controls.
4. Evaluate commissioning issues and commissioning observations identified in the Commissioning Issues Log, field reports, test reports or other commissioning documents. In collaboration with entity responsible for system and equipment installation, recommend corrective action.
5. Review and comment on commissioning documentation.
6. Participate in meetings to coordinate Systems Functional Performance Testing.
7. Provide schedule for operation and maintenance data submittals, equipment startup, and testing to Commissioning Agent for incorporation into the commissioning plan.
8. Provide information to the Commissioning Agent for developing commissioning plan.
9. Participate in training sessions for VA's operation and maintenance personnel.
10. Provide technicians who are familiar with the construction and operation of installed systems and who shall develop specific test procedures to conduct Systems Functional Performance Testing of installed systems.

#### 1.11 COMMISSIONING AGENT'S RESPONSIBILITIES

- A. Organize and lead the commissioning team.
- B. Prepare the commissioning plan. See Paragraph 1.11-A of this specification Section for further information.
- C. Review and comment on selected submittals from the Contractor for general conformance with the Construction Documents. Review and comment on the ability to test and operate the system and/or equipment, including providing gages, controls and other components required to operate, maintain, and test the system. Review and comment on performance expectations of systems and equipment and interfaces between systems relating to the Construction Documents.
- D. At the beginning of the construction phase, conduct an initial construction phase coordination meeting for the purpose of reviewing the commissioning activities and establishing tentative schedules for operation and maintenance submittals; operation and maintenance training sessions; TAB Work; Pre-Functional Checklists, Systems Functional Performance Testing; and project completion.
- E. Convene commissioning team meetings for the purpose of coordination, communication, and conflict resolution; discuss status of the commissioning processes. Responsibilities

include arranging for facilities, preparing agenda and attendance lists, and notifying participants. The Commissioning Agent shall prepare and distribute minutes to commissioning team members and attendees within five workdays of the commissioning meeting.

- F. Observe construction and report progress, observations and issues. Observe systems and equipment installation for adequate accessibility for maintenance and component replacement or repair, and for general conformance with the Construction Documents.
- G. Prepare Project specific Pre-Functional Checklists and Systems Functional Performance Test procedures.
- H. Coordinate Systems Functional Performance Testing schedule with the Contractor.
- I. Witness selected systems startups.
- J. Verify selected Pre-Functional Checklists completed and submitted by the Contractor.
- K. Witness and document Systems Functional Performance Testing.
- L. Compile test data, inspection reports, and certificates and include them in the systems manual and commissioning report.
- M. Review and comment on operation and maintenance (O&M) documentation and systems manual outline for compliance with the Contract Documents. Operation and maintenance documentation requirements are specified in Paragraph 1.25, Section 01 00 00 GENERAL REQUIREMENTS.
- N. Review operation and maintenance training program developed by the Contractor. Verify training plans provide qualified instructors to conduct operation and maintenance training.
- O. Prepare commissioning Field Observation Reports.
- P. Prepare the Final Commissioning Report.
- Q. Return to the site at 10 months into the 12 month warranty period and review with facility staff the current building operation and the condition of outstanding issues related to the original and seasonal Systems Functional Performance Testing. Also interview facility staff and identify problems or concerns they have operating the building as originally intended. Make suggestions for improvements and for recording these changes in the O&M manuals. Identify areas that may come under warranty or under the original construction contract. Assist facility staff in developing reports, documents and requests for services to remedy outstanding problems.

- R. Assemble the final commissioning documentation, including the Final Commissioning Report and Addendum to the Final Commissioning Report.

#### 1.12 COMMISSIONING DOCUMENTATION

- A. Commissioning Plan: A document, prepared by Commissioning Agent, that outlines the schedule, allocation of resources, and documentation requirements of the commissioning process, and shall include, but is not limited, to the following:
  - 1. Plan for delivery and review of submittals, systems manuals, and other documents and reports. Identification of the relationship of these documents to other functions and a detailed description of submittals that are required to support the commissioning processes. Submittal dates shall include the latest date approved submittals must be received without adversely affecting commissioning plan.
  - 2. Description of the organization, layout, and content of commissioning documentation (including systems manual) and a detailed description of documents to be provided along with identification of responsible parties.
  - 3. Identification of systems and equipment to be commissioned.
  - 4. Schedule of Commissioning Coordination meetings.
  - 5. Identification of items that must be completed before the next operation can proceed.
  - 6. Description of responsibilities of commissioning team members.
  - 7. Description of observations to be made.
  - 8. Description of requirements for operation and maintenance training.
  - 9. Schedule for commissioning activities with dates coordinated with overall construction schedule.
  - 10. Process and schedule for documenting changes on a continuous basis to appear in Project Record Documents.
  - 11. Process and schedule for completing prestart and startup checklists for systems, subsystems, and equipment to be verified and tested.
  - 12. Preliminary Systems Functional Performance Test procedures.
- B. Systems Functional Performance Test Procedures: The Commissioning Agent will develop Systems Functional Performance Test Procedures for each system to be commissioned, including subsystems, or equipment and interfaces or interlocks with other systems. Systems Functional Performance Test Procedures will include a separate entry, with space for comments, for each item to be tested. Preliminary Systems Functional Performance Test Procedures will be provided to the VA, Architect/Engineer, and Contractor for review and comment. The Systems Performance

Test Procedure will include test procedures for each mode of operation and provide space to indicate whether the mode under test responded as required. Each System Functional Performance Test procedure, regardless of system, subsystem, or equipment being tested, shall include, but not be limited to, the following:

1. Name and identification code of tested system.
  2. Test number.
  3. Time and date of test.
  4. Indication of whether the record is for a first test or retest following correction of a problem or issue.
  5. Dated signatures of the person performing test and of the witness, if applicable.
  6. Individuals present for test.
  7. Observations and Issues.
  8. Issue number, if any, generated as the result of test.
- C. Pre-Functional Checklists: The Commissioning Agent will prepare Pre-Functional Checklists. Pre-Functional Checklists shall be completed and signed by the Contractor, verifying that systems, subsystems, equipment, and associated controls are ready for testing. The Commissioning Agent will spot check Pre-Functional Checklists to verify accuracy and readiness for testing. Inaccurate or incomplete Pre-Functional Checklists shall be returned to the Contractor for correction and resubmission.
- D. Test and Inspection Reports: The Commissioning Agent will record test data, observations, and measurements on Systems Functional Performance Test Procedure. The report will also include recommendation for system acceptance or non-acceptance. Photographs, forms, and other means appropriate for the application shall be included with data. Commissioning Agent Will compile test and inspection reports and test and inspection certificates and include them in systems manual and commissioning report.
- E. Corrective Action Documents: The Commissioning Agent will document corrective action taken for systems and equipment that fail tests. The documentation will include any required modifications to systems and equipment and/or revisions to test procedures, if any. The Commissioning Agent will witness and document any retesting of systems and/or equipment requiring corrective action and document retest results.
- F. Commissioning Issues Log: The Commissioning Agent will prepare and maintain Commissioning Issues Log that describes Commissioning Issues and Commissioning Observations that are identified during the Commissioning process. These observations and issues include, but are not limited to, those that are at variance with the Contract

Documents. The Commissioning Issues Log will identify and track issues as they are encountered, the party responsible for resolution, progress toward resolution, and document how the issue was resolved. The Master Commissioning Issues Log will also track the status of unresolved issues.

1. Creating an Commissioning Issues Log Entry:

- a. Identify the issue with unique numeric or alphanumeric identifier by which the issue may be tracked.
- b. Assign a descriptive title for the issue.
- c. Identify date and time of the issue.
- d. Identify test number of test being performed at the time of the observation, if applicable, for cross reference.
- e. Identify system, subsystem, and equipment to which the issue applies.
- f. Identify location of system, subsystem, and equipment.
- g. Include information that may be helpful in diagnosing or evaluating the issue.
- h. Note recommended corrective action.
- i. Identify commissioning team member responsible for corrective action.
- j. Identify expected date of correction.
- k. Identify person that identified the issue.

2. Documenting Issue Resolution:

- a. Log date correction is completed or the issue is resolved.
- b. Describe corrective action or resolution taken. Include description of diagnostic steps taken to determine root cause of the issue, if any.
- c. Identify changes to the Contract Documents that may require action.
- d. State that correction was completed and system, subsystem, and equipment are ready for retest, if applicable.
- e. Identify person(s) who corrected or resolved the issue.
- f. Identify person(s) verifying the issue resolution.

G. Final Commissioning Report: The Commissioning Agent will document results of the commissioning process, including unresolved issues, and performance of systems, subsystems, and equipment. The Commissioning Report will indicate whether systems, subsystems, and equipment have been properly installed and are performing according to the Contract Documents. This report will be used by the Department of Veterans Affairs when determining that systems will be accepted. This report will be used to evaluate systems, subsystems, and equipment and will serve as a future reference

document during VA occupancy and operation. It shall describe components and performance that exceed requirements of the Contract Documents and those that do not meet requirements of the Contract Documents. The commissioning report will include, but is not limited to, the following:

1. Lists and explanations of substitutions; compromises; variances with the Contract Documents; record of conditions; and, if appropriate, recommendations for resolution. Design Narrative documentation maintained by the Commissioning Agent.
  2. Commissioning plan.
  3. Pre-Functional Checklists completed by the Contractor, with annotation of the Commissioning Agent review and spot check.
  4. Systems Functional Performance Test Procedures, with annotation of test results and test completion.
  5. Commissioning Issues Log.
  6. Listing of deferred and off season test(s) not performed, including the schedule for their completion.
- H. Addendum to Final Commissioning Report: The Commissioning Agent will prepare an Addendum to the Final Commissioning Report near the end of the Warranty Period. The Addendum will indicate whether systems, subsystems, and equipment are complete and continue to perform according to the Contract Documents. The Addendum to the Final Commissioning Report shall include, but is not limited to, the following:
1. Documentation of deferred and off season test(s) results.
  2. Completed Systems Functional Performance Test Procedures for off season test(s).
  3. Documentation that unresolved system performance issues have been resolved.
  4. Updated Commissioning Issues Log, including status of unresolved issues.
  5. Identification of potential Warranty Claims to be corrected by the Contractor.
- I. Systems Manual: The Commissioning Agent will gather required information and compile the Systems Manual. The Systems Manual will include, but is not limited to, the following:
1. Design Narrative, including system narratives, schematics, single-line diagrams, flow diagrams, equipment schedules, and changes made throughout the Project.
  2. Reference to Final Commissioning Plan.
  3. Reference to Final Commissioning Report.
  4. Approved Operation and Maintenance Data as submitted by the Contractor.

### 1.13 SUBMITTALS

- A. Preliminary Commissioning Plan Submittal: The Commissioning Agent has prepared a Preliminary Commissioning Plan based on the final Construction Documents. The Preliminary Commissioning Plan is included as an Appendix to this specification section. The Preliminary Commissioning Plan is provided for information only. It contains preliminary information about the following commissioning activities:
1. The Commissioning Team: A list of commissioning team members by organization.
  2. Systems to be commissioned. A detailed list of systems to be commissioned for the project. This list also provides preliminary information on systems/equipment submittals to be reviewed by the Commissioning Agent; preliminary information on Pre-Functional Checklists that are to be completed; preliminary information on Systems Performance Testing, including information on testing sample size (where authorized by the VA).
  3. Commissioning Team Roles and Responsibilities: Preliminary roles and responsibilities for each Commissioning Team member.
  4. Commissioning Documents: A preliminary list of commissioning-related documents, include identification of the parties responsible for preparation, review, approval, and action on each document.
  5. Commissioning Activities Schedule: Identification of Commissioning Activities, including Systems Functional Testing, the expected duration and predecessors for the activity.
  6. Pre-Functional Checklists: Preliminary Pre-Functional Checklists for equipment, components, subsystems, and systems to be commissioned. These Preliminary Pre-Functional Checklists provide guidance on the level of detailed information the Contractor shall include on the final submission.
  7. Systems Functional Performance Test Procedures: Preliminary step-by-step System Functional Performance Test Procedures to be used during Systems Functional Performance Testing. These Preliminary Systems Functional Performance procedures provide information on the level of testing rigor, and the level of Contractor support required during performance of system's testing.
- B. Final Commissioning Plan Submittal: Based on the Final Construction Documents and the Contractor's project team, the Commissioning Agent will prepare the Final Commissioning Plan as described in this section. The Commissioning Agent will submit three hard copies and three sets of electronic files of Final Commissioning Plan. The



Contractor shall review the Commissioning Plan and provide any comments to the VA. The Commissioning Agent will incorporate review comments into the Final Commissioning Plan as directed by the VA.

- C. Systems Functional Performance Test Procedure: The Commissioning Agent will submit preliminary Systems Functional Performance Test Procedures to the Contractor, and the VA for review and comment. The Contractor shall return review comments to the VA and the Commissioning Agent. The VA will also return review comments to the Commissioning Agent. The Commissioning Agent will incorporate review comments into the Final Systems Functional Test Procedures to be used in Systems Functional Performance Testing.
- D. Pre-Functional Checklists: The Commissioning Agent will submit Pre-Functional Checklists to be completed by the Contractor.
- E. Test and Inspection Reports: The Commissioning Agent will submit test and inspection reports to the VA with copies to the Contractor and the Architect/Engineer.
- F. Corrective Action Documents: The Commissioning Agent will submit corrective action documents to the VA Resident Engineer with copies to the Contractor and Architect.
- G. Preliminary Commissioning Report Submittal: The Commissioning Agent will submit three electronic copies of the preliminary commissioning report. One electronic copy, with review comments, will be returned to the Commissioning Agent for preparation of the final submittal.
- H. Final Commissioning Report Submittal: The Commissioning Agent will submit four sets of electronically formatted information of the final commissioning report to the VA. The final submittal will incorporate comments as directed by the VA.
- I. Data for Commissioning:
  - 1. The Commissioning Agent will request in writing from the Contractor specific information needed about each piece of commissioned equipment or system to fulfill requirements of the Commissioning Plan.
  - 2. The Commissioning Agent may request further documentation as is necessary for the commissioning process or to support other VA data collection requirements, including Construction Operations Building Information Exchange (COBIE), Building Information Modeling (BIM), etc.

#### 1.14 COMMISSIONING PROCESS

- A. The Commissioning Agent will be responsible for the overall management of the commissioning process as well as coordinating scheduling of commissioning tasks with

the VA and the Contractor. As directed by the VA, the Contractor shall incorporate Commissioning tasks, including, but not limited to, Systems Functional Performance Testing (including predecessors) with the Master Construction Schedule.

- B. Within 30 days of contract award, the Contractor shall designate a specific individual as the Commissioning Manager (CxM) to manage and lead the commissioning effort on behalf of the Contractor. The Commissioning Manager shall be the single point of contact and communications for all commissioning related services by the Contractor.
- C. Within 30 days of contract award, the Contractor shall ensure that each subcontractor designates specific individuals as Commissioning Representatives (CXR) to be responsible for commissioning related tasks. The Contractor shall ensure the designated Commissioning Representatives participate in the commissioning process as team members providing commissioning testing services, equipment operation, adjustments, and corrections if necessary. The Contractor shall ensure that all Commissioning Representatives shall have sufficient authority to direct their respective staff to provide the services required, and to speak on behalf of their organizations in all commissioning related contractual matters.

#### 1.15 QUALITY ASSURANCE

- A. Instructor Qualifications: Factory authorized service representatives shall be experienced in training, operation, and maintenance procedures for installed systems, subsystems, and equipment.
- B. Test Equipment Calibration: The Contractor shall comply with test equipment manufacturer's calibration procedures and intervals. Recalibrate test instruments immediately whenever instruments have been repaired following damage or dropping. Affix calibration tags to test instruments. Instruments shall have been calibrated within six months prior to use.

#### 1.16 COORDINATION

- A. Management: The Commissioning Agent will coordinate the commissioning activities with the VA and Contractor. The Commissioning Agent will submit commissioning documents and information to the VA. All commissioning team members shall work together to fulfill their contracted responsibilities and meet the objectives of the contract documents.
- B. Scheduling: The Contractor shall work with the Commissioning Agent and the VA to incorporate the commissioning activities into the construction schedule. The

Commissioning Agent will provide sufficient information (including, but not limited to, tasks, durations and predecessors) on commissioning activities to allow the Contractor and the VA to schedule commissioning activities. All parties shall address scheduling issues and make necessary notifications in a timely manner in order to expedite the project and the commissioning process. The Contractor shall update the Master Construction as directed by the VA.

- C. Initial Schedule of Commissioning Events: The Commissioning Agent will provide the initial schedule of primary commissioning events in the Commissioning Plan and at the commissioning coordination meetings. The Commissioning Plan will provide a format for this schedule. As construction progresses, more detailed schedules will be developed by the Contractor with information from the Commissioning Agent.
- D. Commissioning Coordinating Meetings: The Commissioning Agent will conduct periodic Commissioning Coordination Meetings of the commissioning team to review status of commissioning activities, to discuss scheduling conflicts, and to discuss upcoming commissioning process activities.
- E. Pretesting Meetings: The Commissioning Agent will conduct pretest meetings of the commissioning team to review startup reports, Pre-Functional Checklist results, Systems Functional Performance Testing procedures, testing personnel and instrumentation requirements.
- F. Systems Functional Performance Testing Coordination: The Contractor shall coordinate testing 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. The Contractor shall coordinate the schedule times for tests, inspections, obtaining samples, and similar activities.

## PART 2 - PRODUCTS

### 2.1 TEST EQUIPMENT

- A. The Contractor shall provide all standard and specialized testing equipment required to perform Systems Functional Performance Testing. Test equipment required for Systems Functional Performance Testing will be identified in the detailed System Functional Performance Test Procedure prepared by the Commissioning Agent.
- B. Data logging equipment and software required to test equipment shall be provided by the Contractor.
- C. All testing equipment shall be of sufficient quality and accuracy to test and/or measure system performance with the tolerances specified in the Specifications. If not otherwise

noted, the following minimum requirements apply: Temperature sensors and digital thermometers shall have a certified calibration within the past year to an accuracy of 0.5 °C (1.0 °F) and a resolution of + or - 0.1 °C (0.2 °F). Pressure sensors shall have an accuracy of + or - 2.0% of the value range being measured (not full range of meter) and have been calibrated within the last year. All equipment shall be calibrated according to the manufacturer's recommended intervals and following any repairs to the equipment. Calibration tags shall be affixed or certificates readily available.

## PART 3 - EXECUTION

### 3.1 COMMISSIONING PROCESS ROLES AND RESPONSIBILITIES

A. The following table outlines the roles and responsibilities for the Commissioning Team members during the Construction Phase:

| Construction Phase                     |   | CxA = Commissioning Agent<br>RE = Resident Engineer<br>A/E = Design Arch/Engineer<br>PC = Prime Contractor<br>O&M = Gov't Facility O&M |    |     |    |     | L = Lead<br>P = Participate<br>A = Approve<br>R = Review<br>O = Optional |
|--|---|--|----|-----|----|-----|--|
| Commissioning Roles & Responsibilities |   |  |    |     |    |     |  |
| Category                               | Task Description  | CxA  | RE | A/E | PC | O&M | Notes  |
| Meetings                               | Construction Commissioning Kick Off meeting   | L  | A  | O   | P  | O   |  |
|  | Commissioning Meetings  | L  | A  | O   | P  | O   |  |
|  | Project Progress Meetings   | P  | A  | O   | L  | O   |  |
|  | Controls Meeting  | L  | A  | O   | P  | O   |  |
|  |   |  |    |     |    |     |  |
| Coordination                           | Coordinate with [OGC's, AHJ, Vendors, etc.] to ensure that Cx interacts properly with other systems as needed to support the OPR and BOD. | L  | A  | O   | P  | N/A |  |
|  |   |  |    |     |    |     |  |
| Cx Plan & Spec                         | Final Commissioning Plan  | L  | A  | R   | R  | O   |  |
|  |   |  |    |     |    |     |  |
| Schedules                              | Duration Schedule for Commissioning Activities  | L  | A  | O   | R  | N/A |  |

| Construction Phase                     |  | CxA = Commissioning Agent<br>RE = Resident Engineer<br>A/E = Design Arch/Engineer<br>PC = Prime Contractor<br>O&M = Gov't Facility O&M |    |     |    |     | L = Lead<br>P = Participate<br>A = Approve<br>R = Review<br>O = Optional |
|--|--|--|----|-----|----|-----|--|
| Commissioning Roles & Responsibilities |  |  |    |     |    |     |  |
| Category                               | Task Description                               | CxA  | RE | A/E | PC | O&M | Notes  |
|  |  |  |    |     |    |     |  |
| OPR and BOD                            | Maintain OPR on behalf of Owner                | L  | A  | O   | R  | O   |  |
|  | Maintain BOD/DID on behalf of Owner            | L  | A  | O   | R  | O   |  |
|  |  |  |    |     |    |     |  |
| Document Reviews                       | TAB Plan Review                                | L  | A  | R   | R  | O   |  |
|  | Submittal and Shop Drawing Review              | R  | A  | R   | L  | O   |  |
|  | Review Contractor Equipment Startup Checklists | L  | A  | R   | R  | N/A |  |
|  | Review Change Orders, ASI, and RFI             | L  | A  | R   | R  | N/A |  |
|  |  |  |    |     |    |     |  |
|  |  |  |    |     |    |     |  |
| Site Observations                      | Witness Factory Testing                        | P  | A  | N/A | L  | O   |  |
|  | Construction Observation Site Visits           | L  | A  | N/A | R  | O   |  |
|  |  |  |    |     |    |     |  |
|  |  |  |    |     |    |     |  |
| Functional Test Protocols              | Final Pre-Functional Checklists                | L  | A  | N/A | R  | O   |  |
|  | Final Functional Performance Test Protocols    | L  | A  | N/A | R  | O   |  |

| Construction Phase                     |                                   | CxA = Commissioning Agent   |    |     |    |     | L = Lead   |
|--|-----------------------------------|---|----|-----|----|-----|--|
| Commissioning Roles & Responsibilities |                                   | RE = Resident Engineer<br>A/E = Design Arch/Engineer<br>PC = Prime Contractor<br>O&M = Gov't Facility O&M |    |     |    |     | P = Participate<br>A = Approve<br>R = Review<br>O = Optional |
| Category                               | Task Description                  | CxA   | RE | A/E | PC | O&M | Notes  |
|  |                                   |   |    |     |    |     |  |
| Technical Activities                   | Issues Resolution Meetings        | P   | A  | P   | L  | O   |  |
|  |                                   |   |    |     |    |     |  |
| Reports and Logs                       | Status Reports                    | L   | A  | R   | R  | O   |  |
|  | Maintain Commissioning Issues Log | L   | A  | R   | R  | O   |  |
|  |                                   |   |    |     |    |     |  |

B. The following table outlines the roles and responsibilities for the Commissioning Team members during the Acceptance Phase:

| Acceptance Phase                       |                        | CxA = Commissioning Agent  |    |     |    |     | L = Lead        |
|--|------------------------|----------------------------|----|-----|----|-----|-----------------|
| Commissioning Roles & Responsibilities |                        | RE = Resident Engineer     |    |     |    |     | P = Participate |
|  |                        | A/E = Design Arch/Engineer |    |     |    |     | A = Approve     |
|  |                        | PC = Prime Contractor      |    |     |    |     | R = Review      |
|  |                        | O&M = Gov't Facility O&M   |    |     |    |     | O = Optional    |
| Category                               | Task Description       | CxA                        | RE | A/E | PC | O&M | Notes           |
| Meetings                               | Commissioning Meetings | L                          | A  | P   | P  | O   |                 |

| Acceptance Phase                       |  | CxA = Commissioning Agent   |    |     |    |     | L = Lead   |
|--|--|---|----|-----|----|-----|--|
| Commissioning Roles & Responsibilities |  | RE = Resident Engineer<br>A/E = Design Arch/Engineer<br>PC = Prime Contractor<br>O&M = Gov't Facility O&M |    |     |    |     | P = Participate<br>A = Approve<br>R = Review<br>O = Optional |
| Category                               | Task Description   | CxA   | RE | A/E | PC | O&M | Notes  |
|  | Project Progress Meetings  | P   | A  | P   | L  | O   |  |
|  | Pre-Test Coordination Meeting  | L   | A  | P   | P  | O   |  |
|  | Lessons Learned and Commissioning Report Review Meeting  | L   | A  | P   | P  | O   |  |
|  |  |   |    |     |    |     |  |
| Coordination                           | Coordinate with [OGC's, AHJ, Vendors, etc.] to ensure that Cx interacts properly with other systems as needed to support OPR and BOD | L   | P  | N/A | P  | O   |  |
|  |  |   |    |     |    |     |  |
| Cx Plan & Spec                         | Maintain/Update Commissioning Plan   | L   | A  | N/A | R  | O   |  |
|  |  |   |    |     |    |     |  |
| Schedules                              | Prepare Functional Test Schedule   | L   | A  | N/A | R  | O   |  |
|  |  |   |    |     |    |     |  |
| OPR and BOD                            | Maintain OPR on behalf of Owner  | L   | A  | N/A | R  | O   |  |
|  | Maintain BOD/DID on behalf of Owner  | L   | A  | N/A | R  | O   |  |
|  |  |   |    |     |    |     |  |
| Document Reviews                       | Review Completed Pre-Functional Checklists   | L   | A  | N/A | R  | O   |  |
|  | Pre-Functional Checklist Verification  | L   | A  | N/A | R  | O   |  |
|  | Review Operations & Maintenance Manuals  | L   | A  | O   | R  | R   |  |
|  | Training Plan Review   | L   | A  | O   | R  | R   |  |
|  | Warranty Review  | L   | A  | O   | R  | O   |  |



| Acceptance Phase                       |  | CxA = Commissioning Agent<br>RE = Resident Engineer<br>A/E = Design Arch/Engineer<br>PC = Prime Contractor<br>O&M = Gov't Facility O&M |    |     |    |     | L = Lead<br>P = Participate<br>A = Approve<br>R = Review<br>O = Optional |
|--|--|--|----|-----|----|-----|--|
| Commissioning Roles & Responsibilities |  |  |    |     |    |     |  |
| Category                               | Task Description                       | CxA  | RE | A/E | PC | O&M | Notes  |
|  | Review TAB Report                      | L  | A  | O   | R  | O   |  |
|  |  |  |    |     |    |     |  |
| Site Observations                      | Construction Observation Site Visits   | L  | A  | N/A | R  | O   |  |
|  | Witness Selected Equipment Startup     | L  | A  | N/A | R  | O   |  |
|  |  |  |    |     |    |     |  |
| Functional Test Protocols              | TAB Verification                       | L  | A  | N/A | R  | O   |  |
|  | Systems Functional Performance Testing | L  | A  | N/A | P  | P   |  |
|  | Retesting                              | L  | A  | N/A | P  | P   |  |
|  |  |  |    |     |    |     |  |
| Technical Activities                   | Issues Resolution Meetings             | P  | A  | N/A | L  | O   |  |
|  | Systems Training                       | L  | S  | N/A | P  | P   |  |
|  |  |  |    |     |    |     |  |
| Reports and Logs                       | Status Reports                         | L  | A  | N/A | R  | O   |  |
|  | Maintain Commissioning Issues Log      | L  | A  | N/A | R  | O   |  |
|  | Final Commissioning Report             | L  | A  | N/A | R  | R   |  |
|  | Prepare Systems Manuals                | L  | A  | N/A | R  | R   |  |
|  |  |  |    |     |    |     |  |

C. The following table outlines the roles and responsibilities for the Commissioning Team members during the Warranty Phase:

| Warranty Phase                         |  | CxA = Commissioning Agent   |    |     |    |     | L = Lead   |
|--|--|---|----|-----|----|-----|--|
| Commissioning Roles & Responsibilities |  | RE = Resident Engineer<br>A/E = Design Arch/Engineer<br>PC = Prime Contractor<br>O&M = Gov't Facility O&M |    |     |    |     | P = Participate<br>A = Approve<br>R = Review<br>O = Optional |
| Category                               | Task Description   | CxA   | RE | A/E | PC | O&M | Notes  |
| Meetings                               | Post-Occupancy User Review Meeting   | L   | A  | O   | P  | P   |  |
|  |  |   |    |     |    |     |  |
| Site Observations                      | Periodic Site Visits   | L   | A  | O   | O  | P   |  |
| Functional Test Protocols              | Deferred and/or seasonal Testing   | L   | A  | O   | P  | P   |  |
|  |  |   |    |     |    |     |  |
| Technical Activities                   | Issues Resolution Meetings   | L   | S  | O   | O  | P   |  |
|  | Post-Occupancy Warranty Checkup and review of Significant Outstanding Issues | L   | A  |     | R  | P   |  |
| Reports and Logs                       | Final Commissioning Report Amendment   | L   | A  |     | R  | R   |  |
|  | Status Reports   | L   | A  |     | R  | R   |  |
|  |  |   |    |     |    |     |  |

### 3.2 STARTUP, INITIAL CHECKOUT, AND PRE-FUNCTIONAL CHECKLISTS

- A. The following procedures shall apply to all equipment and systems to be commissioned, according to Part 1, Systems to Be Commissioned.
1. Pre-Functional Checklists are important to ensure that the equipment and systems are hooked up and operational. These ensure that Systems Functional Performance Testing may proceed without unnecessary delays. Each system to be commissioned shall have a full Pre-Functional Checklist completed by the Contractor prior to Systems Functional Performance Testing. No sampling strategies are used.
    - a. The Pre-Functional Checklist will identify the trades responsible for completing the checklist. The Contractor shall ensure the appropriate trades complete the checklists.
    - b. The Commissioning Agent will review completed Pre-Functional Checklists and field-verify the accuracy of the completed checklist using sampling techniques.
  2. Startup and Initial Checkout Plan: The Contractor shall develop detailed startup plans for all equipment. The primary role of the Contractor in this process is to ensure that there is written documentation that each of the manufacturer recommended procedures have been completed. Parties responsible for startup shall be identified in the Startup Plan and in the checklist forms.
    - a. The Contractor shall develop the full startup plan by combining (or adding to) the checklists with the manufacturer's detailed startup and checkout procedures from the O&M manual data and the field checkout sheets normally used by the Contractor. The plan shall include checklists and procedures with specific boxes or lines for recording and documenting the checking and inspections of each procedure and a summary statement with a signature block at the end of the plan.
    - b. The full startup plan shall at a minimum consist of the following items:
      - 1) The Pre-Functional Checklists.
      - 2) The manufacturer's standard written startup procedures copied from the installation manuals with check boxes by each procedure and a signature block added by hand at the end.
      - 3) The manufacturer's normally used field checkout sheets.
    - c. The Commissioning Agent will submit the full startup plan to the VA and Contractor for review. Final approval will be by the VA.

- d. The Contractor shall review and evaluate the procedures and the format for documenting them, noting any procedures that need to be revised or added.
  - 3. Sensor and Actuator Calibration
    - a. All field installed temperature, relative humidity, CO2 and pressure sensors and gages, and all actuators (dampers and valves) on all equipment shall be calibrated using the methods described in Division 21, Division 23, Division 26, Division 27, and Division 28 specifications.
    - b. All procedures used shall be fully documented on the Pre-Functional Checklists or other suitable forms, clearly referencing the procedures followed and written documentation of initial, intermediate and final results.
  - 4. Execution of Equipment Startup
    - a. Four weeks prior to equipment startup, the Contractor shall schedule startup and checkout with the VA and Commissioning Agent. The performance of the startup and checkout shall be directed and executed by the Contractor.
    - b. The Commissioning Agent will observe the startup procedures for selected pieces of primary equipment.
    - c. The Contractor shall execute startup and provide the VA and Commissioning Agent with a signed and dated copy of the completed startup checklists, and contractor tests.
    - d. Only individuals that have direct knowledge and witnessed that a line item task on the Startup Checklist was actually performed shall initial or check that item off.
- It is not acceptable for witnessing supervisors to fill out these forms.

### 3.3 DEFICIENCIES, NONCONFORMANCE, AND APPROVAL IN CHECKLISTS AND STARTUP

- A. The Contractor shall clearly list any outstanding items of the initial startup and Pre-Functional Checklist procedures that were not completed successfully, at the bottom of the procedures form or on an attached sheet. The procedures form and any outstanding deficiencies shall be provided to the VA and the Commissioning Agent within two days of completion.
- B. The Commissioning Agent will review the report and submit comments to the VA. The Commissioning Agent will work with the Contractor to correct and verify deficiencies or uncompleted items. The Commissioning Agent will involve the VA and others as necessary. The Contractor shall correct all areas that are noncompliant or incomplete in the checklists in a timely manner, and shall notify the VA and Commissioning Agent as

soon as outstanding items have been corrected. The Contractor shall submit an updated startup report and a Statement of Correction on the original noncompliance report. When satisfactorily completed, the Commissioning Agent will recommend approval of the checklists and startup of each system to the VA.

- C. The Contractor shall be responsible for resolution of deficiencies as directed the VA.

### 3.4 PHASED COMMISSIONING

- A. The project may require startup and initial checkout to be executed in phases. This phasing shall be planned and scheduled in a coordination meeting of the VA, Commissioning Agent, and the Contractor. Results will be added to the master construction schedule and the commissioning schedule.

### 3.5 DDC SYSTEM TRENDING FOR COMMISSIONING

- A. Trending is a method of testing as a standalone method or to augment manual testing. The Contractor shall trend any and all points of the system or systems at intervals specified below.
- B. Alarms are a means to notify the system operator that abnormal conditions are present in the system. Alarms shall be structured into three tiers – Critical, Priority, and Maintenance.
1. Critical alarms are intended to be alarms that require the immediate attention of and action by the Operator. These alarms shall be displayed on the Operator Workstation in a popup style window that is graphically linked to the associated unit's graphical display. The popup style window shall be displayed on top of any active window within the screen, including non DDC system software.
  2. Priority level alarms are to be printed to a printer which is connected to the Operator's Work Station located within the engineer's office. Additionally Priority level alarms shall be able to be monitored and viewed through an active alarm application. Priority level alarms are alarms which shall require reaction from the operator or maintenance personnel within a normal work shift, and not immediate action.
  3. Maintenance alarms are intended to be minor issues which would require examination by maintenance personnel within the following shift. These alarms shall be generated in a scheduled report automatically by the DDC system at the start of each shift. The generated maintenance report will be printed to a printer located within the engineer's office.

- C. The Contractor shall provide a wireless internet network in the building for use during controls programming, checkout, and commissioning. This network will allow project team members to more effectively program, view, manipulate and test control devices while being in the same room as the controlled device.
- D. The Contractor shall provide graphical trending through the DDC control system of systems being commissioned. Trending requirements are indicated below and included with the Systems Functional Performance Test Procedures. Trending shall occur before, during and after Systems Functional Performance Testing. The Contractor shall be responsible for producing graphical representations of the trended DDC points that show each system operating properly during steady state conditions as well as during the System Functional Testing. These graphical reports shall be submitted to the Resident Engineer and Commissioning Agent for review and analysis before, during dynamic operation, and after Systems Functional Performance Testing. The Contractor shall provide, but not limited to, the following trend requirements and trend submissions:
  - 1. Pre-testing, Testing, and Post-testing – Trend reports of trend logs and graphical trend plots are required as defined by the Commissioning Agent. The trend log points, sampling rate, graphical plot configuration, and duration will be dictated by the Commissioning Agent. At any time during the Commissioning Process the Commissioning Agent may recommend changes to aspects of trending as deemed necessary for proper system analysis. The Contractor shall implement any changes as directed by the Resident Engineer. Any pre-test trend analysis comments generated by the Commissioning Team should be addressed and resolved by the Contractor, as directed by the Resident Engineer, prior to the execution of Systems Functional Performance Testing.
  - 2. Dynamic plotting – The Contractor shall also provide dynamic plotting during Systems Functional Performance testing at frequent intervals for points determined by the Systems Functional Performance Test Procedure. The graphical plots will be formatted and plotted at durations listed in the Systems Functional Performance Test Procedure.
  - 3. Graphical plotting - The graphical plots shall be provided with a dual y-axis allowing 15 or more trend points (series) plotted simultaneously on the graph with each series in distinct color. The plots will further require title, axis naming, legend etc. all described by the Systems Functional Performance Test Procedure. If this cannot be

sufficiently accomplished directly in the Direct Digital Control System then it is the responsibility of the Contractor to plot these trend logs in Microsoft Excel.

4. The following tables indicate the points to be trended and alarmed by system. The Operational Trend Duration column indicates the trend duration for normal operations. The Testing Trend Duration column indicates the trend duration prior to Systems Functional Performance Testing and again after Systems Functional Performance Testing. The Type column indicates point type: AI = Analog Input, AO = Analog Output, DI = Digital Input, DO = Digital Output, Calc = Calculated Point. In the Trend Interval Column, COV = Change of Value. The Alarm Type indicates the alarm priority; C = Critical, P = Priority, and M = Maintenance. The Alarm Range column indicates when the point is considered in the alarm state. The Alarm Delay column indicates the length of time the point must remain in an alarm state before the alarm is recorded in the DDC. The intent is to allow minor, short-duration events to be corrected by the DDC system prior to recording an alarm.

| Dual-Path Air Handling Unit Trending and Alarms |      |                |                            |                        |            |              |             |
|---|------|----------------|----------------------------|------------------------|------------|--------------|-------------|
| Point   | Type | Trend Interval | Operational Trend Duration | Testing Trend Duration | Alarm Type | Alarm Range  | Alarm Delay |
| OA Temperature                                  | AI   | 15 Min         | 24 hours                   | 3 days                 | N/A        |              |             |
| RA Temperature                                  | AI   | 15 Min         | 24 hours                   | 3 days                 | N/A        |              |             |
| RA Humidity                                     | AI   | 15 Min         | 24 hours                   | 3 days                 | P          | >60% RH      | 10 min      |
| Mixed Air Temp                                  | AI   | None           | None                       | None                   | N/A        |              |             |
| SA Temp   | AI   | 15 Min         | 24 hours                   | 3 days                 | C          | ±5°F from SP | 10 min      |
| Supply Fan Speed                                | AI   | 15 Min         | 24 hours                   | 3 days                 | N/A        |              |             |
| Return Fan Speed                                | AI   | 15 Min         | 24 hours                   | 3 days                 | N/A        |              |             |
| RA Pre-Filter Status                            | AI   | None           | None                       | None                   | N/A        |              |             |
| OA Pre-Filter Status                            | AI   | None           | None                       | None                   | N/A        |              |             |
| After Filter Status                             | AI   | None           | None                       | None                   | N/A        |              |             |
| SA Flow   | AI   | 15 Min         | 24 hours                   | 3 days                 | C          | ±10% from SP | 10 min      |
| OA Supply Temp                                  | AI   | 15 Min         | 24 hours                   | 3 days                 | P          | ±5°F from SP | 10 min      |

| Dual-Path Air Handling Unit Trending and Alarms |      |                |                            |                        |            |                   |             |
|---|------|----------------|----------------------------|------------------------|------------|-------------------|-------------|
| Point   | Type | Trend Interval | Operational Trend Duration | Testing Trend Duration | Alarm Type | Alarm Range       | Alarm Delay |
| RA Supply Temp                                  | AI   | 15 Min         | 24 hours                   | 3 days                 | N/A        |                   |             |
| RA CHW Valve Position                           | AI   | 15 Min         | 24 hours                   | 3 days                 | N/A        |                   |             |
| OA CHW Valve Position                           | AI   | 15 Min         | 24 hours                   | 3 days                 | N/A        |                   |             |
| OA HW Valve Position                            | AI   | 15 Min         | 24 hours                   | 3 days                 | N/A        |                   |             |
| OA Flow   | AI   | 15 Min         | 24 hours                   | 3 days                 | P          | ±10% from SP      | 5 min       |
| RA Flow   | AI   | 15 Min         | 24 hours                   | 3 days                 | P          | ±10% from SP      | 5 min       |
| Initial UVC Intensity (%)                       | AI   | None           | None                       | None                   | N/A        |                   |             |
| Duct Pressure                                   | AI   | 15 Min         | 24 hours                   | 3 days                 | C          | ±25% from SP      | 6 min       |
| CO2 Level                                       | AI   | 15 Min         | 24 hours                   | 3 days                 | P          | ±10% from SP      | 10 min      |
|   |      |                |                            |                        |            |                   |             |
| Supply Fan Status                               | DI   | COV            | 24 hours                   | 3 days                 | C          | Status <> Command | 10 min      |
| Return Fan Status                               | DI   | COV            | 24 hours                   | 3 days                 | C          | Status <> Command | 10 Min      |
| High Static Status                              | DI   | COV            | 24 hours                   | 3 days                 | P          | True              | 1 min       |
| Fire Alarm Status                               | DI   | COV            | 24 hours                   | 3 days                 | C          | True              | 5 min       |
| Freeze Stat Level 1                             | DI   | COV            | 24 hours                   | 3 days                 | C          | True              | 10 min      |
| Freeze Stat Level 2                             | DI   | COV            | 24 hours                   | 3 days                 | C          | True              | 5 min       |
| Freeze Stat Level 3                             | DI   | COV            | 24 hours                   | 3 days                 | P          | True              | 1 min       |
| Fire/Smoke Damper Status                        | DI   | COV            | 24 hours                   | 3 days                 | P          | Closed            | 1 min       |
| Emergency AHU Shutdown                          | DI   | COV            | 24 hours                   | 3 days                 | P          | True              | 1 min       |
| Exhaust Fan #1 Status                           | DI   | COV            | 24 hours                   | 3 days                 | C          | Status <> Command | 10 min      |



| Dual-Path Air Handling Unit Trending and Alarms |      |                |                            |                        |            |                   |             |
|---|------|----------------|----------------------------|------------------------|------------|-------------------|-------------|
| Point   | Type | Trend Interval | Operational Trend Duration | Testing Trend Duration | Alarm Type | Alarm Range       | Alarm Delay |
| Exhaust Fan #2 Status                           | DI   | COV            | 24 hours                   | 3 days                 | C          | Status <> Command | 10 min      |
| Exhaust Fan #3 Status                           | DI   | COV            | 24 hours                   | 3 days                 | C          | Status <> Command | 10 min      |
| OA Alarm  | DI   | COV            | 24 hours                   | 3 days                 | C          | True              | 10 min      |
| High Static Alarm                               | DI   | COV            | 24 hours                   | 3 days                 | C          | True              | 10 min      |
| UVC Emitter Alarm                               | DI   | COV            | 24 hours                   | 3 days                 | P          | True              | 10 min      |
| CO2 Alarm                                       | DI   | COV            | 24 hours                   | 3 days                 | P          | True              | 10 min      |
| Power Failure                                   | DI   | COV            | 24 hours                   | 3 days                 | P          | True              | 1 min       |
|   |      |                |                            |                        |            |                   |             |
| Supply Fan Speed                                | AO   | 15 Min         | 24 hours                   | 3 days                 | N/A        |                   |             |
| Return Fan Speed                                | AO   | 15 Min         | 24 hours                   | 3 days                 | N/A        |                   |             |
| RA CHW Valve Position                           | AO   | 15 Min         | 24 hours                   | 3 days                 | N/A        |                   |             |
| OA CHW Valve Position                           | AO   | 15 Min         | 24 hours                   | 3 days                 | N/A        |                   |             |
| OA HW Valve Position                            | AO   | 15 Min         | 24 hours                   | 3 days                 | N/A        |                   |             |
|   |      |                |                            |                        |            |                   |             |
| Supply Fan S/S                                  | DO   | COV            | 24 hours                   | 3 days                 | N/A        |                   |             |
| Return Fan S/S                                  | DO   | COV            | 24 hours                   | 3 days                 | N/A        |                   |             |
| Fire/Smoke Dampers                              | DO   | COV            | 24 hours                   | 3 days                 | N/A        |                   |             |
| Exhaust Fan S/S                                 | DO   | COV            | 24 hours                   | 3 days                 | N/A        |                   |             |
| Exhaust Fan S/S                                 | DO   | COV            | 24 hours                   | 3 days                 | N/A        |                   |             |
| Exhaust Fan S/S                                 | DO   | COV            | 24 hours                   | 3 days                 | N/A        |                   |             |
|   |      |                |                            |                        |            |                   |             |
| AHU Energy                                      | Calc | 1 Hour         | 30 day                     | N/A                    | N/A        |                   |             |
|   |      |                |                            |                        |            |                   |             |

Terminal Unit (VAV, CAV, etc.) Trending and Alarms

| Point                       | Type | Trend Interval | Operational Trend Duration | Testing Trend Duration | Alarm Type | Alarm Range   | Alarm Delay |
|-----------------------------|------|----------------|----------------------------|------------------------|------------|---------------|-------------|
| Space Temperature           | AI   | 15 Min         | 12 hours                   | 3 days                 | P          | ±5°F from SP  | 10 min      |
| Air Flow                    | AI   | 15 Min         | 12 hours                   | 3 days                 | P          | ±5°F from SP  | 10 min      |
| SA Temperature              | AI   | 15 Min         | 12 hours                   | 3 days                 | P          | ±5°F from SP  | 10 min      |
| Local Setpoint              | AI   | 15 Min         | 12 hours                   | 3 days                 | M          | ±10°F from SP | 60 min      |
| Space Humidity              | AI   | 15 Min         | 12 hours                   | 3 days                 | P          | > 60% RH      | 5 min       |
|                             |      |                |                            |                        |            |               |             |
| Unoccupied Override         | DI   | COV            | 12 hours                   | 3 days                 | M          | N/A           | 12 Hours    |
| Refrigerator Alarm          | DI   | COV            | 12 hours                   | 3 days                 | C          | N/A           | 10 min      |
|                             |      |                |                            |                        |            |               |             |
| Damper Position             | AO   | 15 Minutes     | 12 hours                   | 3 days                 | N/A        |               |             |
| Heating coil Valve Position | AO   | 15 Minutes     | 12 hours                   | 3 days                 | N/A        |               |             |

| 4-Pipe Fan Coil Trending and Alarms |      |                |                            |                        |            |                   |             |
|-------------------------------------|------|----------------|----------------------------|------------------------|------------|-------------------|-------------|
| Point                               | Type | Trend Interval | Operational Trend Duration | Testing Trend Duration | Alarm Type | Alarm Range       | Alarm Delay |
| Space Temperature                   | AI   | 15 Minutes     | 12 hours                   | 3 days                 | P          | ±5°F from SP      | 10 min      |
| SA Temperature                      | AI   | 15 Minutes     | 12 hours                   | 3 days                 | P          | ±5°F from SP      | 10 min      |
| Pre-Filter Status                   | AI   | None           | None                       | None                   | M          | > SP              | 1 hour      |
|                                     |      |                |                            |                        |            |                   |             |
| Water Sensor                        | DI   | COV            | 12 hours                   | 3 days                 | M          | N/A               | 30 Min      |
|                                     |      |                |                            |                        |            |                   |             |
| Cooling Coil Valve Position         | AO   | 15 Minutes     | 12 hours                   | 3 days                 | N/A        |                   |             |
| Heating coil Valve Position         | AO   | 15 Minutes     | 12 hours                   | 3 days                 | N/A        |                   |             |
| Fan Coil ON/OFF                     | DO   | COV            | 12 hours                   | 3 days                 | M          | Status <> Command | 30 min      |

| 2-Pipe Fan Coil Unit Trending and Alarms |      |                |                            |                        |            |                   |             |
|--|------|----------------|----------------------------|------------------------|------------|-------------------|-------------|
| Point                                    | Type | Trend Interval | Operational Trend Duration | Testing Trend Duration | Alarm Type | Alarm Range       | Alarm Delay |
| Space Temperature                        | AI   | 15 Minutes     | 12 hours                   | 3 days                 | P          | ±5°F from SP      | 10 min      |
| SA Temperature                           | AI   | 15 Minutes     | 12 hours                   | 3 days                 | P          | ±5°F from SP      | 10 min      |
| Pre-Filter Status                        | AI   | None           | None                       | None                   | M          | > SP              | 1 hour      |
|  |      |                |                            |                        |            |                   |             |
| Water Sensor                             | DI   | COV            | 12 hours                   | 3 days                 | M          | N/A               | 30 Min      |
|  |      |                |                            |                        |            |                   |             |
| Cooling Coil Valve Position              | AO   | 15 Minutes     | 12 hours                   | 3 days                 | N/A        |                   |             |
| Fan Coil ON/OFF                          | DO   | COV            | 12 hours                   | 3 days                 | M          | Status <> Command | 30 min      |

| Unit Heater Trending and Alarms |      |                |                            |                        |            |                   |             |
|---------------------------------|------|----------------|----------------------------|------------------------|------------|-------------------|-------------|
| Point                           | Type | Trend Interval | Operational Trend Duration | Testing Trend Duration | Alarm Type | Alarm Range       | Alarm Delay |
| Space Temperature               | AI   | 15 Minutes     | 12 hours                   | 3 days                 | P          | ±5°F from SP      | 10 min      |
|                                 |      |                |                            |                        |            |                   |             |
| Heating Valve Position          | AO   | 15 Minutes     | 12 hours                   | 3 days                 | N/A        |                   |             |
|                                 |      |                |                            |                        |            |                   |             |
| Unit Heater ON/OFF              | DO   | COV            | 12 hours                   | 3 days                 | M          | Status <> Command | 30 min      |

| Steam and Condensate Pumps Trending and Alarms |      |                |                            |                        |            |             |             |
|--|------|----------------|----------------------------|------------------------|------------|-------------|-------------|
| Point  | Type | Trend Interval | Operational Trend Duration | Testing Trend Duration | Alarm Type | Alarm Range | Alarm Delay |

| Steam and Condensate Pumps Trending and Alarms |      |                |                            |                        |            |                   |             |
|--|------|----------------|----------------------------|------------------------|------------|-------------------|-------------|
| Point  | Type | Trend Interval | Operational Trend Duration | Testing Trend Duration | Alarm Type | Alarm Range       | Alarm Delay |
| Steam Flow (LB/HR)                             | AI   | 15 Minutes     | 12 hours                   | 3 days                 | N/A        |                   |             |
| Condensate Pump Run Hours                      | AI   | 15 Minutes     | 12 hours                   | 3 days                 | N/A        |                   |             |
| Water Meter (GPM)                              | AI   | 15 Minutes     | 12 hours                   | 3 days                 | N/A        |                   |             |
| Electric Meter (KW/H)                          | AI   | 15 Minutes     | 12 hours                   | 3 days                 | N/A        |                   |             |
| Irrigation Meter (GPM)                         | AI   | 15 Minutes     | 12 hours                   | 3 days                 | N/A        |                   |             |
| Chilled Water Flow (TONS)                      | AI   | 15 Minutes     | 12 hours                   | 3 days                 | N/A        |                   |             |
| Condensate Flow (GPM)                          | AI   | 15 Minutes     | 12 hours                   | 3 days                 | N/A        |                   |             |
|  |      |                |                            |                        |            |                   |             |
| High Water Level Alarm                         | DI   | COV            | 12 hours                   | 3 days                 | C          | True              | 5 Min       |
|  |      |                |                            |                        |            |                   |             |
| Condensate Pump Start/Stop                     | DO   | COV            | 12 hours                   | 3 days                 | P          | Status <> Command | 10 min      |

| Domestic Hot Water Trending and Alarms |      |                |                            |                        |            |                   |             |
|--|------|----------------|----------------------------|------------------------|------------|-------------------|-------------|
| Point                                  | Type | Trend Interval | Operational Trend Duration | Testing Trend Duration | Alarm Type | Alarm Range       | Alarm Delay |
| Domestic HW Setpoint WH-1              | AI   | 15 Minute      | 12 Hours                   | 3 days                 | N/A        |                   |             |
| Domestic HW Setpoint WH-2              | AI   | 15 Minute      | 12 Hours                   | 3 days                 | N/A        |                   |             |
| Domestic HW Temperature                | AI   | 15 Minute      | 12 Hours                   | 3 days                 | C          | > 135 oF          | 10 Min      |
| Domestic HW Temperature                | AI   | 15 Minute      | 12 Hours                   | 3 days                 | P          | ±5°F from SP      | 10 Min      |
|  |      |                |                            |                        |            |                   |             |
| Dom. Circ. Pump #1 Status              | DI   | COV            | 12 Hours                   | 3 days                 | M          | Status <> Command | 30 min      |

| Domestic Hot Water Trending and Alarms |      |                |                            |                        |            |                   |             |
|--|------|----------------|----------------------------|------------------------|------------|-------------------|-------------|
| Point                                  | Type | Trend Interval | Operational Trend Duration | Testing Trend Duration | Alarm Type | Alarm Range       | Alarm Delay |
| Dom. Circ. Pump #2 Status              | DI   | COV            | 12 Hours                   | 3 days                 | M          | Status <> Command | 30 min      |
|  |      |                |                            |                        |            |                   |             |
| Dom. Circ. Pump #1 Start/Stop          | DO   | COV            | 12 Hours                   | 3 days                 | N/A        |                   |             |
| Dom. Circ. Pump #2 Start/Stop          | DO   | COV            | 12 Hours                   | 3 days                 | N/A        |                   |             |
| Domestic HW Start/Stop                 | DO   | COV            | 12 Hours                   | 3 days                 | N/A        |                   |             |

| Hydronic Hot Water Trending and Alarms |      |                |                            |                        |            |                   |             |
|--|------|----------------|----------------------------|------------------------|------------|-------------------|-------------|
| Point                                  | Type | Trend Interval | Operational Trend Duration | Testing Trend Duration | Alarm Type | Alarm Range       | Alarm Delay |
| System HWS Temperature                 | AI   | 15 min         | 12 hours                   | 3 days                 | C          | ±5°F from SP      | 10 Min      |
| System HWR Temperature                 | AI   | 15 min         | 12 hours                   | 3 days                 | M          | ±15°F from SP     | 300 Min     |
| HX-1 Entering Temperature              | AI   | 15 min         | 12 hours                   | 3 days                 | P          | ±5°F from SP      | 10 Min      |
| HX-2 Entering Temperature              | AI   | 15 min         | 12 hours                   | 3 days                 | P          | ±5°F from SP      | 10 Min      |
| HX-2 Leaving Temperature               | AI   | 15 min         | 12 hours                   | 3 days                 | P          | ±5°F from SP      | 10 Min      |
|  |      |                |                            |                        |            |                   |             |
| System Flow (GPM)                      | AI   | 15 min         | 12 hours                   | 3 days                 | N/A        |                   |             |
| System Differential Pressure           | AI   | 15 min         | 12 hours                   | 3 days                 | P          | ±10% from SP      | 8 Min       |
|  |      |                |                            | 3 days                 |            |                   |             |
| HW Pump 1 Status                       | DI   | COV            | 12 Hours                   | 3 days                 | C          | Status <> Command | 30 min      |
| HW Pump 2 Status                       | DI   | COV            | 12 Hours                   | 3 days                 | C          | Status <> Command | 30 min      |
|  |      |                |                            |                        |            |                   |             |

| Hydronic Hot Water Trending and Alarms      |      |                |                            |                        |            |             |             |
|---|------|----------------|----------------------------|------------------------|------------|-------------|-------------|
| Point                                       | Type | Trend Interval | Operational Trend Duration | Testing Trend Duration | Alarm Type | Alarm Range | Alarm Delay |
| HW Pump 1 VFD Speed                         | AO   | 15 Min         | 12 Hours                   | 3 days                 | N/A        |             |             |
| HW Pump 2 VFD Speed                         | AO   | 15 Min         | 12 Hours                   | 3 days                 | N/A        |             |             |
| Steam Station #1 1/3 Control Valve Position | AO   | 15 Min         | 12 Hours                   | 3 days                 | N/A        |             |             |
| Steam Station #1 2/3 Control Valve Position | AO   | 15 Min         | 12 Hours                   | 3 days                 | N/A        |             |             |
| Steam Station #2 1/3 Control Valve Position | AO   | 15 Min         | 12 Hours                   | 3 days                 | N/A        |             |             |
| Steam Station #2 2/3 Control Valve Position | AO   | 15 Min         | 12 Hours                   | 3 days                 | N/A        |             |             |
| Steam Station Bypass Valve Position         | AO   | 15 Min         | 12 Hours                   | 3 days                 | N/A        |             |             |
|   |      |                |                            |                        |            |             |             |
| HW Pump 1 Start/Stop                        | DO   | COV            | 12 Hours                   | 3 days                 | N/A        |             |             |
| HW Pump 2 Start/Stop                        | DO   | COV            | 12 Hours                   | 3 days                 | N/A        |             |             |
| HWR #1 Valve                                | DO   | COV            | 12 Hours                   | 3 days                 | N/A        |             |             |
| HWR #2 Valve                                | DO   | COV            | 12 Hours                   | 3 days                 | N/A        |             |             |

| Chilled Water System Trending and Alarms |      |                |                            |                        |            |              |             |
|--|------|----------------|----------------------------|------------------------|------------|--------------|-------------|
| Point                                    | Type | Trend Interval | Operational Trend Duration | Testing Trend Duration | Alarm Type | Alarm Range  | Alarm Delay |
| Chiller 1 Entering Temperature           | AI   | 15 Minutes     | 12 Hours                   | 3 days                 | N/A        |              |             |
| Chiller 1 Leaving Temperature            | AI   | 15 Minutes     | 12 Hours                   | 3 days                 | P          | ±5°F from SP | 10 Min      |
| Chiller 1 Flow                           | AI   | 15 Minutes     | 12 Hours                   | 3 days                 | N/A        |              |             |
| Chiller 1 Percent Load                   | AI   | 15 Minutes     | 12 Hours                   | 3 days                 | N/A        |              |             |

| Chilled Water System Trending and Alarms |      |                |                            |                        |            |                   |             |
|--|------|----------------|----------------------------|------------------------|------------|-------------------|-------------|
| Point                                    | Type | Trend Interval | Operational Trend Duration | Testing Trend Duration | Alarm Type | Alarm Range       | Alarm Delay |
| Chiller 1 KW Consumption                 | AI   | 15 Minutes     | 12 Hours                   | 3 days                 | N/A        |                   |             |
| Chiller 1 Tonnage                        | AI   | 15 Minutes     | 12 Hours                   | 3 days                 | N/A        |                   |             |
| Chiller 2 Entering Temperature           | AI   | 15 Minutes     | 12 Hours                   | 3 days                 | N/A        |                   |             |
| Chiller 2 Leaving Temperature            | AI   | 15 Minutes     | 12 Hours                   | 3 days                 | P          | ±5°F from SP      | 10 Min      |
| Chiller 2 Flow                           | AI   | 15 Minutes     | 12 Hours                   | 3 days                 | N/A        |                   |             |
| Chiller 2 Percent Load                   | AI   | 15 Minutes     | 12 Hours                   | 3 days                 | N/A        |                   |             |
| Chiller 2 KW Consumption                 | AI   | 15 Minutes     | 12 Hours                   | 3 days                 | N/A        |                   |             |
| Chiller 2 Tonnage                        | AI   | 15 Minutes     | 12 Hours                   | 3 days                 | N/A        |                   |             |
| Primary Loop Decoupler Flow              | AI   | 15 Minutes     | 12 Hours                   | 3 days                 | N/A        |                   |             |
| Primary Loop Flow                        | AI   | 15 Minutes     | 12 Hours                   | 3 days                 | N/A        |                   |             |
| Primary Loop Supply Temperature          | AI   | 15 Minutes     | 12 Hours                   | 3 days                 | N/A        |                   |             |
| Secondary Loop Differential Pressure     | AI   | 15 Minutes     | 12 Hours                   | 3 days                 | P          | ±5% from SP       | 10 Min      |
| Secondary Loop Flow                      | AI   | 15 Minutes     | 12 Hours                   | 3 days                 | N/A        |                   |             |
| Secondary Loop Supply Temperature        | AI   | 15 Minutes     | 12 Hours                   | 3 days                 | N/A        |                   |             |
| Secondary Loop Return Temperature        | AI   | 15 Minutes     | 12 Hours                   | 3 days                 | N/A        |                   |             |
| Secondary Loop Tonnage                   | AI   | 15 Minutes     | 12 Hours                   | 3 days                 | N/A        |                   |             |
|  |      |                |                            |                        |            |                   |             |
| Primary Loop Pump 1 Status               | DI   | COV            | 12 Hours                   | 3 days                 | C          | Status <> Command | 30 min      |
| Primary Loop Pump 2 Status               | DI   | COV            | 12 Hours                   | 3 days                 | C          | Status <> Command | 30 min      |

| Chilled Water System Trending and Alarms |      |                |                            |                        |            |                   |             |
|--|------|----------------|----------------------------|------------------------|------------|-------------------|-------------|
| Point                                    | Type | Trend Interval | Operational Trend Duration | Testing Trend Duration | Alarm Type | Alarm Range       | Alarm Delay |
| Secondary Loop Pump 1 Status             | DI   | COV            | 12 Hours                   | 3 days                 | C          | Status <> Command | 30 min      |
| Secondary Loop Pump 2 Status             | DI   | COV            | 12 Hours                   | 3 days                 | C          | Status <> Command | 30 min      |
| Chiller 1 Status                         | DI   | COV            | 12 Hours                   | 3 days                 | C          | Status <> Command | 30 min      |
| Chiller 1 Evaporator Iso-Valve           | DI   | COV            | 12 Hours                   | 3 days                 | N/A        |                   |             |
| Chiller 1 Evaporator Flow Switch         | DI   | COV            | 12 Hours                   | 3 days                 | N/A        |                   |             |
| Chiller 1 Unit Alarm                     | DI   | COV            | 12 Hours                   | 3 days                 | C          | True              | 10 Min      |
| Chiller 2 Status                         | DI   | COV            | 12 Hours                   | 3 days                 | C          | Status <> Command | 30 min      |
| Chiller 2 Evaporator Iso-Valve           | DI   | COV            | 12 Hours                   | 3 days                 | N/A        |                   |             |
| Chiller 2 Evaporator Flow Switch         | DI   | COV            | 12 Hours                   | 3 days                 | N/A        |                   |             |
| Chiller 2 Unit Alarm                     | DI   | COV            | 12 Hours                   | 3 days                 | C          | True              | 10 Min      |
| Refrigerant Detector                     | DI   | COV            | 12 Hours                   | 3 days                 | C          | True              | 10 Min      |
| Refrigerant Exhaust Fan Status           | DI   | COV            | 12 Hours                   | 3 days                 | M          | Status <> Command | 30 min      |
| Emergency Shutdown                       | DI   | COV            | 12 Hours                   | 3 days                 | P          | True              | 1 Min       |
|  |      |                |                            |                        |            |                   |             |
| Primary Loop Pump 1 VFD Speed            | AO   | 15 Minutes     | 12 Hours                   | 3 days                 | N/A        |                   |             |
| Primary Loop Pump 2 VFD Speed            | AO   | 15 Minutes     | 12 Hours                   | 3 days                 | N/A        |                   |             |



| Chilled Water System Trending and Alarms |      |                |                            |                        |            |             |             |
|--|------|----------------|----------------------------|------------------------|------------|-------------|-------------|
| Point                                    | Type | Trend Interval | Operational Trend Duration | Testing Trend Duration | Alarm Type | Alarm Range | Alarm Delay |
| Secondary Loop Pump 1 VFD Speed          | AO   | 15 Minutes     | 12 Hours                   | 3 days                 | N/A        |             |             |
| Secondary Loop Pump 2 VFD Speed          | AO   | 15 Minutes     | 12 Hours                   | 3 days                 | N/A        |             |             |
|  |      |                |                            |                        |            |             |             |
| Primary Pump 1 Start / Stop              | DO   | COV            | 12 Hours                   | 3 days                 | N/A        |             |             |
| Primary Pump 2 Start / Stop              | DO   | COV            | 12 Hours                   | 3 days                 | N/A        |             |             |
| Secondary Pump 1 Start / Stop            | DO   | COV            | 12 Hours                   | 3 days                 | N/A        |             |             |
| Secondary Pump 2 Start / Stop            | DO   | COV            | 12 Hours                   | 3 days                 | N/A        |             |             |
| Chiller 1 Enable                         | DO   | COV            | 12 Hours                   | 3 days                 | N/A        |             |             |
| Chiller 1 Iso-Valve Command              | DO   | COV            | 12 Hours                   | 3 days                 | N/A        |             |             |
| Chiller 2 Enable                         | DO   | COV            | 12 Hours                   | 3 days                 | N/A        |             |             |
| Chiller 2 Iso-Valve Command              | DO   | COV            | 12 Hours                   | 3 days                 | N/A        |             |             |
| Refrigerant Exhaust Fan Start / Stop     | DO   | COV            | 12 Hours                   | 3 days                 | N/A        |             |             |

| Condenser Water System Trending and Alarms |      |                |                            |                        |            |             |             |
|--|------|----------------|----------------------------|------------------------|------------|-------------|-------------|
| Point                                      | Type | Trend Interval | Operational Trend Duration | Testing Trend Duration | Alarm Type | Alarm Range | Alarm Delay |
| Chiller 1 Condenser Entering Temp          | AI   | 15 Minutes     | 12 Hours                   | 3 days                 | N/A        |             |             |
| Chiller 1 Condenser Leaving Temp           | AI   | 15 Minutes     | 12 Hours                   | 3 days                 | N/A        |             |             |
| Chiller 2 Condenser Entering Temp          | AI   | 15 Minutes     | 12 Hours                   | 3 days                 | N/A        |             |             |

| Condenser Water System Trending and Alarms |      |                |                            |                        |            |                   |             |
|--|------|----------------|----------------------------|------------------------|------------|-------------------|-------------|
| Point                                      | Type | Trend Interval | Operational Trend Duration | Testing Trend Duration | Alarm Type | Alarm Range       | Alarm Delay |
| Chiller 2 Condenser Leaving Temp           | AI   | 15 Minutes     | 12 Hours                   | 3 days                 | N/A        |                   |             |
| Cooling Tower 1 Supply Temp                | AI   | 15 Minutes     | 12 Hours                   | 3 days                 | N/A        |                   |             |
| Cooling Tower 1 Return Temp                | AI   | 15 Minutes     | 12 Hours                   | 3 days                 | N/A        |                   |             |
| Cooling Tower 1 Basin Temp                 | AI   | 15 Minutes     | 12 Hours                   | 3 days                 | P          | < 45 oF           | 10 Min      |
| Cooling Tower 2 Supply Temp                | AI   | 15 Minutes     | 12 Hours                   | 3 days                 | N/A        |                   |             |
| Cooling Tower 2 Return Temp                | AI   | 15 Minutes     | 12 Hours                   | 3 days                 | N/A        |                   |             |
| Cooling Tower 2 Basin Temp                 | AI   | 15 Minutes     | 12 Hours                   | 3 days                 | P          | < 45 oF           | 10 Min      |
| Condenser Water Supply Temp                | AI   | 15 Minutes     | 12 Hours                   | 3 days                 | N/A        |                   |             |
| Condenser Water Return Temp                | AI   | 15 Minutes     | 12 Hours                   | 3 days                 | N/A        |                   |             |
| Outdoor Air Wet Bulb                       | AI   | 15 Minutes     | 12 Hours                   | 3 days                 | N/A        |                   |             |
|  |      |                |                            |                        |            |                   |             |
| Cooling Tower 1 Fan Status                 | DI   | COV            | 12 Hours                   | 3 days                 | P          | Status <> Command | 1 min       |
| Cooling Tower 1 Basin Heat                 | DI   | COV            | 12 Hours                   | 3 days                 | N/A        |                   |             |
| Cooling Tower 1 Heat Trace                 | DI   | COV            | 12 Hours                   | 3 days                 | N/A        |                   |             |
| Cooling Tower 2 Fan Status                 | DI   | COV            | 12 Hours                   | 3 days                 | P          | Status <> Command | 1 min       |
| Cooling Tower 2 Basin Heat                 | DI   | COV            | 12 Hours                   | 3 days                 | N/A        |                   |             |
| Cooling Tower 2 Heat Trace                 | DI   | COV            | 12 Hours                   | 3 days                 | N/A        |                   |             |
| Chiller 1 Isolation Valve                  | DI   | COV            | 12 Hours                   | 3 days                 | P          | Status <> Command | 1 min       |
| Chiller 2 Isolation Valve                  | DI   | COV            | 12 Hours                   | 3 days                 | P          | Status <> Command | 1 min       |

| Condenser Water System Trending and Alarms |      |                |                            |                        |            |                   |             |
|--|------|----------------|----------------------------|------------------------|------------|-------------------|-------------|
| Point                                      | Type | Trend Interval | Operational Trend Duration | Testing Trend Duration | Alarm Type | Alarm Range       | Alarm Delay |
| Condenser Water Pump 1 Status              | DI   | COV            | 12 Hours                   | 3 days                 | P          | Status <> Command | 1 min       |
| Condenser Water Pump 2 Status              | DI   | COV            | 12 Hours                   | 3 days                 | P          | Status <> Command | 1 min       |
|  |      |                |                            |                        |            |                   |             |
| Chiller 1 Condenser Bypass Valve           | AO   | 15 Minutes     | 12 Hours                   | 3 days                 | N/A        |                   |             |
| Chiller 2 Condenser Bypass Valve           | AO   | 15 Minutes     | 12 Hours                   | 3 days                 | N/A        |                   |             |
| Cooling Tower 1 Bypass Valve               | AO   | 15 Minutes     | 12 Hours                   | 3 days                 | N/A        |                   |             |
| Cooling Tower 1 Fan Speed                  | AO   | 15 Minutes     | 12 Hours                   | 3 days                 | N/A        |                   |             |
| Cooling Tower 2 Bypass Valve               | AO   | 15 Minutes     | 12 Hours                   | 3 days                 | N/A        |                   |             |
| Cooling Tower 2 Fan Speed                  | AO   | 15 Minutes     | 12 Hours                   | 3 days                 | N/A        |                   |             |
|  |      |                |                            |                        |            |                   |             |
| Cooling Tower 1 Fan Start / Stop           | DO   | COV            | 12 Hours                   | 3 days                 | N/A        |                   |             |
| Cooling Tower 2 Fan Start / Stop           | DO   | COV            | 12 Hours                   | 3 days                 | N/A        |                   |             |
| Condenser Water Pump 1 Start / Stop        | DO   | COV            | 12 Hours                   | 3 days                 | N/A        |                   |             |
| Condenser Water Pump 2 Start / Stop        | DO   | COV            | 12 Hours                   | 3 days                 | N/A        |                   |             |

| Steam Boiler System Trending and Alarms |      |                |                            |                        |            |             |             |
|---|------|----------------|----------------------------|------------------------|------------|-------------|-------------|
| Point                                   | Type | Trend Interval | Operational Trend Duration | Testing Trend Duration | Alarm Type | Alarm Range | Alarm Delay |
| Boiler 1 Steam Pressure                 | AI   | 15 Minutes     | 12 Hours                   | 3 days                 | P          | ±5% from SP | 10 Min      |
| Boiler 1 Steam Temperature              | AI   | 15 Minutes     | 12 Hours                   | 3 days                 | N/A        |             |             |

| Steam Boiler System Trending and Alarms |      |                |                            |                        |            |                   |             |
|---|------|----------------|----------------------------|------------------------|------------|-------------------|-------------|
| Point                                   | Type | Trend Interval | Operational Trend Duration | Testing Trend Duration | Alarm Type | Alarm Range       | Alarm Delay |
| Boiler 1 Fire Signal                    | AI   | 15 Minutes     | 12 Hours                   | 3 days                 | N/A        |                   |             |
| Boiler 2 Steam Pressure                 | AI   | 15 Minutes     | 12 Hours                   | 3 days                 | P          | ±5% from SP       | 10 Min      |
| Boiler 2 Steam Temperature              | AI   | 15 Minutes     | 12 Hours                   | 3 days                 | N/A        |                   |             |
| Boiler 2 Fire Signal                    | AI   | 15 Minutes     | 12 Hours                   | 3 days                 | N/A        |                   |             |
| System Steam Pressure                   | AI   | 15 Minutes     | 12 Hours                   | 3 days                 | P          | ±5% from SP       | 10 Min      |
|   |      |                |                            |                        |            |                   |             |
| Boiler 1 Enable                         | DI   | COV            | 12 Hours                   | 3 days                 | N/A        |                   |             |
| Boiler 1 Status                         | DI   | COV            | 12 Hours                   | 3 days                 | P          | Status <> Command | 10 min      |
| Boiler 1 Alarm                          | DI   | COV            | 12 Hours                   | 3 days                 | C          | True              | 1 Min       |
| Boiler 1 on Fuel Oil                    | DI   | COV            | 12 Hours                   | 3 days                 | N/A        |                   |             |
| Boiler 1 Low Water Alarm                | DI   | COV            | 12 Hours                   | 3 days                 | C          | True              | 5 Min       |
| Boiler 1 High Water Alarm               | DI   | COV            | 12 Hours                   | 3 days                 | C          | True              | 5 Min       |
| Boiler 1 Feed Pump                      | DI   | COV            | 12 Hours                   | 3 days                 | N/A        |                   |             |
| Boiler 2 Enable                         | DI   | COV            | 12 Hours                   | 3 days                 | N/A        |                   |             |
| Boiler 2 Status                         | DI   | COV            | 12 Hours                   | 3 days                 | P          | Status <> Command | 10 min      |
| Boiler 2 Alarm                          | DI   | COV            | 12 Hours                   | 3 days                 | C          | True              | 1 Min       |
| Boiler 2 on Fuel Oil                    | DI   | COV            | 12 Hours                   | 3 days                 | N/A        |                   |             |
| Boiler 2 Low Water Alarm                | DI   | COV            | 12 Hours                   | 3 days                 | C          | True              | 5 Min       |
| Boiler 2 High Water Alarm               | DI   | COV            | 12 Hours                   | 3 days                 | C          | True              | 5 Min       |
| Boiler 2 Feed Pump                      | DI   | COV            | 12 Hours                   | 3 days                 | N/A        |                   |             |
| Combustion Damper Status                | DI   | COV            | 12 Hours                   | 3 days                 | P          | Status <> Command | 5 min       |
| Condensate Recovery Pump Status         | DI   | COV            | 12 Hours                   | 3 days                 | P          | Status <> Command | 5 min       |

| Steam Boiler System Trending and Alarms |      |                |                            |                        |            |             |             |
|---|------|----------------|----------------------------|------------------------|------------|-------------|-------------|
| Point                                   | Type | Trend Interval | Operational Trend Duration | Testing Trend Duration | Alarm Type | Alarm Range | Alarm Delay |
|   |      |                |                            |                        |            |             |             |
| Boiler 1 Feed Pump Start / Stop         | DO   | COV            | 12 Hours                   | 3 days                 | N/A        |             |             |
| Boiler 2 Start / Stop                   | DO   | COV            | 12 Hours                   | 3 days                 | N/A        |             |             |
| Combustion Damper Command               | DO   | COV            | 12 Hours                   | 3 days                 | N/A        |             |             |
| Condensate Recovery Pump Start / Stop   | DO   | COV            | 12 Hours                   | 3 days                 | N/A        |             |             |

| Hot Water Boiler System Trending and Alarms |      |                |                            |                        |            |             |             |
|---|------|----------------|----------------------------|------------------------|------------|-------------|-------------|
| Point                                       | Type | Trend Interval | Operational Trend Duration | Testing Trend Duration | Alarm Type | Alarm Range | Alarm Delay |
| Outside Air Temperature                     | AI   | 15 Minutes     | 12 Hours                   | 3 days                 | N/A        |             |             |
| Boiler 1 Fire Signal                        | AI   | 15 Minutes     | 12 Hours                   | 3 days                 | N/A        |             |             |
| Boiler 1 Entering Water Temperature         | AI   | 15 Minutes     | 12 Hours                   | 3 days                 | N/A        |             |             |
| Boiler 1 Leaving Water Temperature          | AI   | 15 Minutes     | 12 Hours                   | 3 days                 | N/A        |             |             |
| Boiler 2 Fire Signal                        | AI   | 15 Minutes     | 12 Hours                   | 3 days                 | N/A        |             |             |
| Boiler 2 Entering Water Temperature         | AI   | 15 Minutes     | 12 Hours                   | 3 days                 | N/A        |             |             |
| Boiler 2 Leaving Water Temperature          | AI   | 15 Minutes     | 12 Hours                   | 3 days                 | N/A        |             |             |

| Hot Water Boiler System Trending and Alarms |      |                |                            |                        |            |                   |             |
|---|------|----------------|----------------------------|------------------------|------------|-------------------|-------------|
| Point                                       | Type | Trend Interval | Operational Trend Duration | Testing Trend Duration | Alarm Type | Alarm Range       | Alarm Delay |
| Hot Water Supply Temperature                | AI   | 15 Minutes     | 12 Hours                   | 3 days                 | P          | ±5 oF from SP     | 10 Min      |
| Hot Water Return Temperature                | AI   | 15 Minutes     | 12 Hours                   | 3 days                 | N/A        |                   |             |
| Secondary Loop Differential Pressure        | AI   | 15 Minutes     | 12 Hours                   | 3 days                 | C          | ±5% from SP       | 10 Min      |
| Lead Boiler                                 | AI   | 15 Minutes     | 12 Hours                   | 3 days                 | N/A        |                   |             |
|   |      |                |                            |                        |            |                   |             |
| Boiler 1 Enable                             | DI   | COV            | 12 Hours                   | 3 days                 | N/A        |                   |             |
| Boiler 1 Status                             | DI   | COV            | 12 Hours                   | 3 days                 | P          | Status <> Command | 10 min      |
| Boiler 1 Isolation Valve                    | DI   | COV            | 12 Hours                   | 3 days                 | N/A        |                   |             |
| Boiler 1 on Fuel Oil                        | DI   | COV            | 12 Hours                   | 3 days                 | N/A        |                   |             |
| Boiler 1 Alarm                              | DI   | COV            | 12 Hours                   | 3 days                 | C          | True              | 1 Min       |
| Boiler 2 Enable                             | DI   | COV            | 12 Hours                   | 3 days                 | N/A        |                   |             |
| Boiler 2 Status                             | DI   | COV            | 12 Hours                   | 3 days                 | P          | Status <> Command | 10 min      |
| Boiler 2 Isolation Valve                    | DI   | COV            | 12 Hours                   | 3 days                 | N/A        |                   |             |
| Boiler 2 on Fuel Oil                        | DI   | COV            | 12 Hours                   | 3 days                 | N/A        |                   |             |
| Boiler 2 Alarm                              | DI   | COV            | 12 Hours                   | 3 days                 | C          | True              | 1 Min       |
| Combustion Dampers Open                     | DI   | COV            | 12 Hours                   | 3 days                 | P          | Status <> Command | 10 min      |
| Primary Pump 1 Status                       | DI   | COV            | 12 Hours                   | 3 days                 | P          | Status <> Command | 10 min      |
| Primary Pump 2 Status                       | DI   | COV            | 12 Hours                   | 3 days                 | P          | Status <> Command | 10 min      |
| Secondary Pump 1 Status                     | DI   | COV            | 12 Hours                   | 3 days                 | P          | Status <> Command | 10 min      |

| Hot Water Boiler System Trending and Alarms |      |                |                            |                        |            |                   |             |
|---|------|----------------|----------------------------|------------------------|------------|-------------------|-------------|
| Point                                       | Type | Trend Interval | Operational Trend Duration | Testing Trend Duration | Alarm Type | Alarm Range       | Alarm Delay |
| Secondary Pump 2 Status                     | DI   | COV            | 12 Hours                   | 3 days                 | P          | Status <> Command | 10 min      |
|   |      |                |                            |                        |            |                   |             |
| Primary Pump 1 VFD Speed                    | AO   | COV            | 12 Hours                   | 3 days                 | N/A        |                   |             |
| Primary Pump 2 VFD Speed                    | AO   | COV            | 12 Hours                   | 3 days                 | N/A        |                   |             |
| Secondary Pump 1 VFD Speed                  | AO   | COV            | 12 Hours                   | 3 days                 | N/A        |                   |             |
| Secondary Pump 2 VFD Speed                  | AO   | COV            | 12 Hours                   | 3 days                 | N/A        |                   |             |
|   |      |                |                            |                        |            |                   |             |
| Hot Water System Enable                     | DO   | COV            | 12 Hours                   | 3 days                 | N/A        |                   |             |
| Combustion Dampers Command                  | DO   | COV            | 12 Hours                   | 3 days                 | N/A        |                   |             |
| Primary Pump 1 Start / Stop                 | DO   | COV            | 12 Hours                   | 3 days                 | N/A        |                   |             |
| Primary Pump 2 Start / Stop                 | DO   | COV            | 12 Hours                   | 3 days                 | N/A        |                   |             |
| Secondary Pump 1 Start / Stop               | DO   | COV            | 12 Hours                   | 3 days                 | N/A        |                   |             |
| Secondary Pump 2 Start / Stop               | DO   | COV            | 12 Hours                   | 3 days                 | N/A        |                   |             |

E. The Contractor shall provide the following information prior to Systems Functional Performance Testing. Any documentation that is modified after submission shall be recorded and resubmitted to the Resident Engineer and Commissioning Agent.

1. Point-to-Point checkout documentation;
2. Sensor field calibration documentation including system name, sensor/point name, measured value, DDC value, and Correction Factor.
3. A sensor calibration table listing the referencing the location of procedures to following in the O&M manuals, and the frequency at which calibration should be

performed for all sensors, separated by system, subsystem, and type. The calibration requirements shall be submitted both in the O&M manuals and separately in a standalone document containing all sensors for inclusion in the commissioning documentation. The following table is a sample that can be used as a template for submission.

| SYSTEM                    |                       |                                     |
|---------------------------|-----------------------|-------------------------------------|
| Sensor                    | Calibration Frequency | O&M Calibration Procedure Reference |
| Discharge air temperature | Once a year           | Volume I Section D.3.aa             |
| Discharge static pressure | Every 6 months        | Volume II Section A.1.c             |

4. Loop tuning documentation and constants for each loop of the building systems. The documentation shall be submitted in outline or table separated by system, control type (e.g. heating valve temperature control); proportional, integral and derivative constants, interval (and bias if used) for each loop. The following table is a sample that can be used as a template for submission.

| AIR HANDLING UNIT AHU-1 |                       |                   |                     |          |
|-------------------------|-----------------------|-------------------|---------------------|----------|
| Control Reference       | Proportional Constant | Integral Constant | Derivative Constant | Interval |
| Heating Valve Output    | 1000                  | 20                | 10                  | 2 sec.   |

### 3.6 SYSTEMS FUNCTIONAL PERFORMANCE TESTING

- A. This paragraph applies to Systems Functional Performance Testing of systems for all referenced specification Divisions.
- B. Objectives and Scope: The objective of Systems Functional Performance Testing is to demonstrate that each system is operating according to the Contract Documents. Systems Functional Performance Testing facilitates bringing the systems from a state of substantial completion to full dynamic operation. Additionally, during the testing process, areas of noncompliant performance are identified and corrected, thereby improving the operation and functioning of the systems. In general, each system shall be operated



through all modes of operation (seasonal, occupied, unoccupied, warm-up, cool-down, part- and full-load, fire alarm and emergency power) where there is a specified system response. The Contractor shall verify each sequence in the sequences of operation. Proper responses to such modes and conditions as power failure, freeze condition, low oil pressure, no flow, equipment failure, etc. shall also be tested.

- C. Development of Systems Functional Performance Test Procedures: Before Systems Functional Performance Test procedures are written, the Contractor shall submit all requested documentation and a current list of change orders affecting equipment or systems, including an updated points list, program code, control sequences and parameters. Using the testing parameters and requirements found in the Contract Documents and approved submittals and shop drawings, the Commissioning Agent will develop specific Systems Functional Test Procedures to verify and document proper operation of each piece of equipment and system to be commissioned. The Contractor shall assist the Commissioning Agent in developing the Systems Functional Performance Test procedures as requested by the Commissioning Agent i.e. by answering questions about equipment, operation, sequences, etc. Prior to execution, the Commissioning Agent will provide a copy of the Systems Functional Performance Test procedures to the VA, the Architect/Engineer, and the Contractor, who shall review the tests for feasibility, safety, equipment and warranty protection.
- D. Purpose of Test Procedures: The purpose of each specific Systems Functional Performance Test is to verify and document compliance with the stated criteria of acceptance given on the test form. Representative test formats and examples are found in the Commissioning Plan for this project. (The Commissioning Plan is issued as a separate document and is available for review.) The test procedure forms developed by the Commissioning Agent will include, but not be limited to, the following information:
1. System and equipment or component name(s)
  2. Equipment location and ID number
  3. Unique test ID number, and reference to unique Pre-Functional Checklists and startup documentation, and ID numbers for the piece of equipment
  4. Date
  5. Project name
  6. Participating parties
  7. A copy of the specification section describing the test requirements

8. A copy of the specific sequence of operations or other specified parameters being verified
  9. Formulas used in any calculations
  10. Required pretest field measurements
  11. Instructions for setting up the test.
  12. Special cautions, alarm limits, etc.
  13. Specific step-by-step procedures to execute the test, in a clear, sequential and repeatable format
  14. Acceptance criteria of proper performance with a Yes / No check box to allow for clearly marking whether or not proper performance of each part of the test was achieved.
  15. A section for comments.
  16. Signatures and date block for the Commissioning Agent. A place for the Contractor to initial to signify attendance at the test.
- E. Test Methods: Systems Functional Performance Testing shall be achieved by manual testing (i.e. persons manipulate the equipment and observe performance) and/or by monitoring the performance and analyzing the results using the control system's trend log capabilities or by standalone data loggers. The Contractor and Commissioning Agent shall determine which method is most appropriate for tests that do not have a method specified.
1. Simulated Conditions: Simulating conditions (not by an overwritten value) shall be allowed, although timing the testing to experience actual conditions is encouraged wherever practical.
  2. Overwritten Values: Overwriting sensor values to simulate a condition, such as overwriting the outside air temperature reading in a control system to be something other than it really is, shall be allowed, but shall be used with caution and avoided when possible. Such testing methods often can only test a part of a system, as the interactions and responses of other systems will be erroneous or not applicable. Simulating a condition is preferable. e.g., for the above case, by heating the outside air sensor with a hair blower rather than overwriting the value or by altering the appropriate setpoint to see the desired response. Before simulating conditions or overwriting values, sensors, transducers and devices shall have been calibrated.

3. Simulated Signals: Using a signal generator which creates a simulated signal to test and calibrate transducers and DDC constants is generally recommended over using the sensor to act as the signal generator via simulated conditions or overwritten values.
  4. Altering Setpoints: Rather than overwriting sensor values, and when simulating conditions is difficult, altering setpoints to test a sequence is acceptable. For example, to see the Air Conditioning compressor lockout initiate at an outside air temperature below 12 C (54 F), when the outside air temperature is above 12 C (54 F), temporarily change the lockout setpoint to be 2 C (4 F) above the current outside air temperature.
  5. Indirect Indicators: Relying on indirect indicators for responses or performance shall be allowed only after visually and directly verifying and documenting, over the range of the tested parameters, that the indirect readings through the control system represent actual conditions and responses. Much of this verification shall be completed during systems startup and initial checkout.
- F. Setup: Each function and test shall be performed under conditions that simulate actual conditions as closely as is practically possible. The Contractor shall provide all necessary materials, system modifications, etc. to produce the necessary flows, pressures, temperatures, etc. necessary to execute the test according to the specified conditions. At completion of the test, the Contractor shall return all affected building equipment and systems, due to these temporary modifications, to their pretest condition.
- G. Sampling: No sampling is allowed in completing Pre-Functional Checklists. Sampling is allowed for Systems Functional Performance Test Procedures execution. The Commissioning Agent will determine the sampling rate. If at any point, frequent failures are occurring and testing is becoming more troubleshooting than verification, the Commissioning Agent may stop the testing and require the Contractor to perform and document a checkout of the remaining units, prior to continuing with Systems Functional Performance Testing of the remaining units.
- I. Coordination and Scheduling: The Contractor shall provide a minimum of 7 days' notice to the Commissioning Agent and the VA regarding the completion schedule for the Pre-Functional Checklists and startup of all equipment and systems. The Commissioning Agent will schedule Systems Functional Performance Tests with the Contractor and VA. The Commissioning Agent will witness and document the Systems Functional

Performance Testing of systems. The Contractor shall execute the tests in accordance with the Systems Functional Performance Test Procedure.

- J. Testing Prerequisites: In general, Systems Functional Performance Testing will be conducted only after Pre-Functional Checklists have been satisfactorily completed. The control system shall be sufficiently tested and approved by the Commissioning Agent and the VA before it is used to verify performance of other components or systems. The air balancing and water balancing shall be completed before Systems Functional Performance Testing of air-related or water-related equipment or systems are scheduled. Systems Functional Performance Testing will proceed from components to subsystems to systems. When the proper performance of all interacting individual systems has been achieved, the interface or coordinated responses between systems will be checked.
- K. Problem Solving: The Commissioning Agent will recommend solutions to problems found, however the burden of responsibility to solve, correct and retest problems is with the Contractor.

### 3.7 DOCUMENTATION, NONCONFORMANCE AND APPROVAL OF TESTS

- A. Documentation: The Commissioning Agent will witness, and document the results of all Systems Functional Performance Tests using the specific procedural forms developed by the Commissioning Agent for that purpose. Prior to testing, the Commissioning Agent will provide these forms to the VA and the Contractor for review and approval. The Contractor shall include the filled out forms with the O&M manual data.
- B. Nonconformance: The Commissioning Agent will record the results of the Systems Functional Performance Tests on the procedure or test form. All items of nonconformance issues will be noted and reported to the VA on Commissioning Field Reports and/or the Commissioning Master Issues Log.
  - 1. Corrections of minor items of noncompliance identified may be made during the tests. In such cases, the item of noncompliance and resolution shall be documented on the Systems Functional Test Procedure.
  - 2. Every effort shall be made to expedite the systems functional Performance Testing process and minimize unnecessary delays, while not compromising the integrity of the procedures. However, the Commissioning Agent shall not be pressured into overlooking noncompliant work or loosening acceptance criteria to satisfy scheduling or cost issues, unless there is an overriding reason to do so by direction from the VA.

3. As the Systems Functional Performance Tests progresses and an item of noncompliance is identified, the Commissioning Agent shall discuss the issue with the Contractor and the VA.
  4. When there is no dispute on an item of noncompliance, and the Contractor accepts responsibility to correct it:
    - a. The Commissioning Agent will document the item of noncompliance and the Contractor's response and/or intentions. The Systems Functional Performance Test then continues or proceeds to another test or sequence. After the day's work is complete, the Commissioning Agent will submit a Commissioning Field Report to the VA. The Commissioning Agent will also note items of noncompliance and the Contractor's response in the Master Commissioning Issues Log. The Contractor shall correct the item of noncompliance and report completion to the VA and the Commissioning Agent.
    - b. The need for retesting will be determined by the Commissioning Agent. If retesting is required, the Commissioning Agent and the Contractor shall reschedule the test and the test shall be repeated.
  5. If there is a dispute about item of noncompliance, regarding whether it is an item of noncompliance, or who is responsible:
    - a. The item of noncompliance shall be documented on the test form with the Contractor's response. The item of noncompliance with the Contractor's response shall also be reported on a Commissioning Field Report and on the Master Commissioning Issues Log.
    - b. Resolutions shall be made at the lowest management level possible. Other parties are brought into the discussions as needed. Final interpretive and acceptance authority is with the Department of Veterans Affairs.
    - c. The Commissioning Agent will document the resolution process.
    - d. Once the interpretation and resolution have been decided, the Contractor shall correct the item of noncompliance, report it to the Commissioning Agent. The requirement for retesting will be determined by the Commissioning Agent. If retesting is required, the Commissioning Agent and the Contractor shall reschedule the test. Retesting shall be repeated until satisfactory performance is achieved.
- D. Failure Due to Manufacturer Defect: If 10%, or three, whichever is greater, of identical pieces (size alone does not constitute a difference) of equipment fail to perform in

compliance with the Contract Documents (mechanically or substantively) due to manufacturing defect, not allowing it to meet its submitted performance specifications, all identical units may be considered unacceptable by the VA. In such case, the Contractor shall provide the VA with the following:

1. Within one week of notification from the VA, the Contractor shall examine all other identical units making a record of the findings. The findings shall be provided to the VA within two weeks of the original notice.
  2. Within two weeks of the original notification, the Contractor shall provide a signed and dated, written explanation of the problem, cause of failures, etc. and all proposed solutions which shall include full equipment submittals. The proposed solutions shall not significantly exceed the specification requirements of the original installation.
  3. The VA shall determine whether a replacement of all identical units or a repair is acceptable.
  4. Two examples of the proposed solution shall be installed by the Contractor and the VA shall be allowed to test the installations for up to one week, upon which the VA will decide whether to accept the solution.
  5. Upon acceptance, the Contractor shall replace or repair all identical items, at their expense and extend the warranty accordingly, if the original equipment warranty had begun. The replacement/repair work shall proceed with reasonable speed beginning within one week from when parts can be obtained.
- E. Approval: The Commissioning Agent will note each satisfactorily demonstrated function on the test form. Formal approval of the Systems Functional Performance Test shall be made later after review by the Commissioning Agent and by the VA. The Commissioning Agent will evaluate each test and report to the VA using a standard form. The VA will give final approval on each test using the same form, and provide signed copies to the Commissioning Agent and the Contractor.

### 3.8 DEFERRED TESTING

- A. Unforeseen Deferred Systems Functional Performance Tests: If any Systems Functional Performance Test cannot be completed due to the building structure, required occupancy condition or other conditions, execution of the Systems Functional Performance Testing may be delayed upon approval of the VA. These Systems Functional Performance Tests shall be conducted in the same manner as the seasonal tests as soon as possible. Services of the Contractor to conduct these unforeseen

Deferred Systems Functional Performance Tests shall be negotiated between the VA and the Contractor.

- B. Deferred Seasonal Testing: Deferred Seasonal Systems Functional Performance Tests are those that must be deferred until weather conditions are closer to the systems design parameters. The Commissioning Agent will review systems parameters and recommend which Systems Functional Performance Tests should be deferred until weather conditions more closely match systems parameters. The Contractor shall review and comment on the proposed schedule for Deferred Seasonal Testing. The VA will review and approve the schedule for Deferred Seasonal Testing. Deferred Seasonal Systems Functional Performances Tests shall be witnessed and documented by the Commissioning Agent. Deferred Seasonal Systems Functional Performance Tests shall be executed by the Contractor in accordance with these specifications.

### 3.9 OPERATION AND MAINTENANCE TRAINING REQUIREMENTS

- A. Training Preparation Conference: Before operation and maintenance training, the Commissioning Agent will convene a training preparation conference to include VA's Resident Engineer, VA's Operations and Maintenance personnel, and the Contractor. The purpose of this conference will be to discuss and plan for Training and Demonstration of VA Operations and Maintenance personnel.
- B. The Contractor shall provide training and demonstration as required by other Division 21, Division 23, Division 26, Division 27, Division 28, and Division 31 sections. The Training and Demonstration shall include, but is not limited to, the following:
1. Review the Contract Documents.
  2. Review installed systems, subsystems, and equipment.
  3. Review instructor qualifications.
  4. Review instructional methods and procedures.
  5. Review training module outlines and contents.
  6. Review course materials (including operation and maintenance manuals).
  7. Review and discuss locations and other facilities required for instruction.
  8. Review and finalize training schedule and verify availability of educational materials, instructors, audiovisual equipment, and facilities needed to avoid delays.
  9. For instruction that must occur outside, review weather and forecasted weather conditions and procedures to follow if conditions are unfavorable.
- C. Training Module Submittals: The Contractor shall submit the following information to the VA and the Commissioning Agent:

1. Instruction Program: Submit two copies of outline of instructional program for demonstration and training, including a schedule of proposed dates, times, length of instruction time, and instructors' names for each training module. Include learning objective and outline for each training module. At completion of training, submit two complete training manuals for VA's use.
  2. Qualification Data: Submit qualifications for facilitator and/or instructor.
  3. Attendance Record: For each training module, submit list of participants and length of instruction time.
  4. Evaluations: For each participant and for each training module, submit results and documentation of performance-based test.
  5. Demonstration and Training Recording:
    - a. General: Engage a qualified commercial photographer to record demonstration and training. Record each training module separately. Include classroom instructions and demonstrations, board diagrams, and other visual aids, but not student practice. At beginning of each training module, record each chart containing learning objective and lesson outline.
    - b. Video Format: Provide high quality color DVD color on standard size DVD disks.
    - c. Recording: Mount camera on tripod before starting recording, unless otherwise necessary to show area of demonstration and training. Display continuous running time.
    - d. Narration: Describe scenes on video recording by audio narration by microphone while demonstration and training is recorded. Include description of items being viewed. Describe vantage point, indicating location, direction (by compass point), and elevation or story of construction.
    - e. Submit two copies within seven days of end of each training module.
  6. Transcript: Prepared on 8-1/2-by-11-inch paper, punched and bound in heavy-duty, 3-ring, vinyl-covered binders. Mark appropriate identification on front and spine of each binder. Include a cover sheet with same label information as the corresponding videotape. Include name of Project and date of videotape on each page.
- D. Quality Assurance:
1. Facilitator Qualifications: A firm or individual experienced in training or educating maintenance personnel in a training program similar in content and extent to that indicated for this Project, and whose work has resulted in training or education with a record of successful learning performance.



2. Instructor Qualifications: A factory authorized service representative, complying with requirements in Division 01 Section "Quality Requirements," experienced in operation and maintenance procedures and training.
3. Photographer Qualifications: A professional photographer who is experienced photographing construction projects.

E. Training Coordination:

1. Coordinate instruction schedule with VA's operations. Adjust schedule as required to minimize disrupting VA's operations.
2. Coordinate instructors, including providing notification of dates, times, length of instruction time, and course content.
3. Coordinate content of training modules with content of approved emergency, operation, and maintenance manuals. Do not submit instruction program until operation and maintenance data has been reviewed and approved by the VA.

F. Instruction Program:

1. Program Structure: Develop an instruction program that includes individual training modules for each system and equipment not part of a system, as required by individual Specification Sections, and as follows:
  - a. Fire protection systems, including fire alarm, fire pumps, and fire suppression systems.
  - b. Intrusion detection systems.
  - c. Conveying systems, including elevators, wheelchair lifts, escalators, and automated materials handling systems.
  - d. Medical equipment, including medical gas equipment and piping.
  - e. Laboratory equipment, including laboratory air and vacuum equipment and piping.
  - f. Heat generation, including boilers, feedwater equipment, pumps, steam distribution piping, condensate return systems, heating hot water heat exchangers, and heating hot water distribution piping.
  - g. Refrigeration systems, including chillers, cooling towers, condensers, pumps, and distribution piping.
  - h. HVAC systems, including air handling equipment, air distribution systems, and terminal equipment and devices.
  - i. HVAC instrumentation and controls.

- j. Electrical service and distribution, including switchgear, transformers, switchboards, panelboards, uninterruptible power supplies, and motor controls.
  - k. Packaged engine generators, including synchronizing switchgear/switchboards, and transfer switches.
  - l. Lighting equipment and controls.
  - m. Communication systems, including intercommunication, surveillance, nurse call systems, public address, mass evacuation, voice and data, and entertainment television equipment.
  - n. Site utilities including lift stations, condensate pumping and return systems, and storm water pumping systems.
- G. Training Modules: Develop a learning objective and teaching outline for each module. Include a description of specific skills and knowledge that participants are expected to master. For each module, include instruction for the following:
- 1. Basis of System Design, Operational Requirements, and Criteria: Include the following:
    - a. System, subsystem, and equipment descriptions.
    - b. Performance and design criteria if Contractor is delegated design responsibility.
    - c. Operating standards.
    - d. Regulatory requirements.
    - e. Equipment function.
    - f. Operating characteristics.
    - g. Limiting conditions.
    - H. Performance curves.
  - 2. Documentation: Review the following items in detail:
    - a. Emergency manuals.
    - b. Operations manuals.
    - c. Maintenance manuals.
    - d. Project Record Documents.
    - e. Identification systems.
    - f. Warranties and bonds.
    - g. Maintenance service agreements and similar continuing commitments.
  - 3. Emergencies: Include the following, as applicable:
    - a. Instructions on meaning of warnings, trouble indications, and error messages.
    - b. Instructions on stopping.

- c. Shutdown instructions for each type of emergency.
  - d. Operating instructions for conditions outside of normal operating limits.
  - e. Sequences for electric or electronic systems.
  - f. Special operating instructions and procedures.
- 4. Operations: Include the following, as applicable:
  - a. Startup procedures.
  - b. Equipment or system break-in procedures.
  - c. Routine and normal operating instructions.
  - d. Regulation and control procedures.
  - e. Control sequences.
  - f. Safety procedures.
  - g. Instructions on stopping.
  - h. Normal shutdown instructions.
  - i. Operating procedures for emergencies.
  - j. Operating procedures for system, subsystem, or equipment failure.
  - k. Seasonal and weekend operating instructions.
  - l. Required sequences for electric or electronic systems.
  - m. Special operating instructions and procedures.
- 5. Adjustments: Include the following:
  - a. Alignments.
  - b. Checking adjustments.
  - c. Noise and vibration adjustments.
  - d. Economy and efficiency adjustments.
- 6. Troubleshooting: Include the following:
  - a. Diagnostic instructions.
  - b. Test and inspection procedures.
- 7. Maintenance: Include the following:
  - a. Inspection procedures.
  - b. Types of cleaning agents to be used and methods of cleaning.
  - c. List of cleaning agents and methods of cleaning detrimental to product.
  - d. Procedures for routine cleaning
  - e. Procedures for preventive maintenance.
  - f. Procedures for routine maintenance.
  - g. Instruction on use of special tools.

8. Repairs: Include the following:

- a. Diagnosis instructions.
- b. Repair instructions.
- c. Disassembly; component removal, repair, and replacement; and reassembly instructions.
- d. Instructions for identifying parts and components.
- e. Review of spare parts needed for operation and maintenance.

H. Training Execution:

1. Preparation: Assemble educational materials necessary for instruction, including documentation and training module. Assemble training modules into a combined training manual. Set up instructional equipment at instruction location.
2. Instruction:
  - a. Facilitator: Engage a qualified facilitator to prepare instruction program and training modules, to coordinate instructors, and to coordinate between Contractor and Department of Veterans Affairs for number of participants, instruction times, and location.
  - b. Instructor: Engage qualified instructors to instruct VA's personnel to adjust, operate, and maintain systems, subsystems, and equipment not part of a system.
    - 1) The Commissioning Agent will furnish an instructor to describe basis of system design, operational requirements, criteria, and regulatory requirements.
    - 2) The VA will furnish an instructor to describe VA's operational philosophy.
    - 3) The VA will furnish the Contractor with names and positions of participants.
3. Scheduling: Provide instruction at mutually agreed times. For equipment that requires seasonal operation, provide similar instruction at start of each season. Schedule training with the VA and the Commissioning Agent with at least seven days' advance notice.
4. Evaluation: At conclusion of each training module, assess and document each participant's mastery of module by use of an oral, or a written, performance-based test.
5. Cleanup: Collect used and leftover educational materials and remove from Project site. Remove instructional equipment. Restore systems and equipment to condition existing before initial training use.

I. Demonstration and Training Recording:

1. General: Engage a qualified commercial photographer to record demonstration and training. Record each training module separately. Include classroom instructions and demonstrations, board diagrams, and other visual aids, but not student practice. At beginning of each training module, record each chart containing learning objective and lesson outline.
2. Video Format: Provide high quality color DVD color on standard size DVD disks.
3. Recording: Mount camera on tripod before starting recording, unless otherwise necessary to show area of demonstration and training. Display continuous running time.
4. Narration: Describe scenes on videotape by audio narration by microphone while demonstration and training is recorded. Include description of items being viewed. Describe vantage point, indicating location, direction (by compass point), and elevation or story of construction.

END OF SECTION

## SECTION 024119 SELECTIVE DEMOLITION

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. This Section includes the following:
  - 1. Demolition and removal of selected portions of building or structure.
  - 2. Demolition and removal of selected site elements.
  - 3. Salvage of existing items to be reused or returned to Owner.
- B. Related Sections include the following:
  - 1. Division 01 Section "Temporary Facilities and Controls" for temporary construction and environmental-protection measures for selective demolition operations.
  - 2. Division 01 Section "Execution" for cutting and patching procedures.
  - 3. Division 01 Section "Construction Waste Management and Disposal" for salvaging, recycling, and disposing of nonhazardous demolition and construction waste.
  - 4. Division 09 Sections as applicable to adhered floor systems.

#### 1.3 DEFINITIONS

- A. Remove: Detach items from existing construction and legally dispose of them off-site, unless indicated to be salvaged or reinstalled.
- B. Remove and Salvage to Owner: Detach item from existing construction in a manner to prevent damage and deliver to Owner ready for reuse.
- C. Remove and Salvage for Reinstallation: Detach item from existing construction in a manner to prevent damage, prepare for reuse, and securely store item until it is to be reinstalled at locations indicated.
- D. Existing to Remain: Existing items or improvements that are to remain and not be removed. Existing items to remain shall be protected from damage during the course of construction.

#### 1.4 MATERIALS OWNERSHIP

- A. Unless otherwise indicated, demolition waste becomes property of Contractor.

#### 1.5 SUBMITTALS

- A. Proposed Protection Measures: Submit report, including drawings, that indicates the measures proposed for protecting individuals and property, for physical damage, for dust control, and for noise control. Indicate proposed locations and construction of barriers.
- B. Schedule of Selective Demolition Activities: Indicate the following:
  - 1. Detailed sequence of selective demolition and removal work, with starting and ending dates for each activity. Ensure Owner's on-site operations are uninterrupted.
  - 2. Interruption of utility services. Indicate how long utility services will be interrupted.
  - 3. Coordination for shutoff, capping, and continuation of utility services.
  - 4. Use of elevator and stairs.
  - 5. Coordination of Owner's continuing occupancy of portions of existing building and of Owner's partial occupancy of completed Work.
- C. Inventory of Items to be Salvaged: Prior to start of demolition, submit lists of items to be removed and salvaged as follows:
  - 1. Items to be removed, salvaged, and delivered to Owner.
  - 2. Items to be removed, salvaged, and reinstalled.
- D. Predemolition Photographs: Show existing conditions of adjoining construction, including finish surfaces, that might be misconstrued as damage caused by demolition operations. Comply with Division 01 Section "Photographic Documentation." Submit before Work begins.
- E. Qualification Data: For refrigerant recovery technician.
- F. Statement of Refrigerant Recovery: Signed by refrigerant recovery technician responsible for recovering refrigerant, stating that all refrigerant that was present was recovered and that recovery was performed according to EPA regulations. Include name and address of technician and date refrigerant was recovered.
- G. Warranties: Documentation indicated that existing warranties are still in effect after completion of selective demolition.

#### 1.6 QUALITY ASSURANCE

- A. Demolition Firm Qualifications: An experienced firm that has specialized in demolition work similar in material and extent to that indicated for this Project.

- B. Refrigerant Recovery Technician Qualifications: Certified by an EPA-approved certification program.
- C. Regulatory Requirements: Comply with governing EPA notification regulations before beginning selective demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.
- D. Standards: Comply with ANSI A10.6 and NFPA 241.
- E. Predemolition Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination." Review methods and procedures related to selective demolition.

#### 1.7 PROJECT CONDITIONS

- A. Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.
- B. Owner will occupy portions of building immediately adjacent to selective demolition area. Conduct selective demolition so Owner's operations will not be disrupted.
- C. Notify Architect of discrepancies between existing conditions and Drawings before proceeding with selective demolition.
- D. Hazardous Materials: It is expected that hazardous materials will not be encountered in the Work.
  - 1. If materials suspected of containing hazardous materials are encountered, do not disturb; immediately notify Architect and Owner. Owner will remove hazardous materials under a separate contract.
- E. Utility Services: Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.
  - 1. Maintain fire-protection facilities in service during selective demolition operations.
- F. Storage or sale of removed items or materials on-site is not permitted.

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

#### PART 3 - EXECUTION

##### 3.1 EXAMINATION

- A. Verify that utilities have been disconnected and capped before starting selective demolition operations.



- B. Survey existing conditions and correlate with requirements indicated to determine extent of selective demolition required.
  - 1. If unanticipated mechanical, electrical, or structural elements conflict with intended function or design are encountered, investigate and measure the nature and extent of conflict. Promptly submit a written report to Architect.
- C. Inventory and record the condition of items to be removed and salvaged or removed and reinstalled. Provide photographs of conditions that might be misconstrued as damage caused by salvage operations.

### 3.2 PREPARATION AND PROTECTION

- A. Site Access and Temporary Controls: Conduct selective demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
  - 1. Comply with requirements for access and protection specified in Division 01 Section "Temporary Facilities and Controls."
- B. Temporary Facilities: Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.
  - 1. Provide temporary weather protection, during interval between selective demolition of existing construction on exterior surfaces and new construction, to prevent water leakage and damage to structure and interior areas.
  - 2. Protect walls, ceilings, floors, and other existing finish work that are to remain or that are exposed during selective demolition operations.
- C. Temporary Shoring: Provide and maintain shoring, bracing, and structural supports as required to preserve stability and prevent movement, settlement, or collapse of construction and finishes to remain, and to prevent unexpected or uncontrolled movement or collapse of construction being demolished.
  - 1. Strengthen or add new supports when required during progress of selective demolition.

### 3.3 UTILITY SERVICES AND MECHANICAL/ELECTRICAL SYSTEMS

- A. HVAC Equipment Refrigerant: Before starting demolition, remove refrigerant from mechanical equipment according to 40 CFR 82 and regulations of authorities having jurisdiction.
- B. Existing Services/Systems to Remain: Maintain services/systems indicated to remain and protect them against damage.
- C. Existing Services/Systems to Be Removed, Relocated, or Abandoned: Locate, identify, disconnect, and seal or cap off utility services and mechanical/electrical systems serving areas to be selectively demolished.

1. Arrange to shut off utilities with Owner and/or utility companies.
2. If services/systems are required to be removed, relocated, or abandoned, provide temporary services/systems that bypass area of selective demolition and that maintain continuity of services/systems to other parts of building.
3. Disconnect, demolish, and remove fire-suppression systems, plumbing, and HVAC systems, equipment, and components indicated on Drawings to be removed.
  - a. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
  - b. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material and leave in place.
  - c. Equipment to Be Removed: Disconnect and cap services and remove equipment.
  - d. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
  - e. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
  - f. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.
  - g. Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material and leave in place.

### 3.4 SELECTIVE DEMOLITION, GENERAL

- A. General: Remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete the Work within limitations of governing regulations and as follows:
  1. Proceed with selective demolition systematically, from higher to lower level. Complete selective demolition operations above each floor or tier before disturbing supporting members on the next lower level.
  2. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping, to minimize disturbance of adjacent surfaces. Temporarily cover openings to remain.
  3. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
  4. Do not use plasma or flame cutting torches without written approval from Architect. Where allowed, clear area of flammable materials. At concealed spaces, such as duct and pipe interiors, verify condition and contents of hidden space before starting flame-cutting operations. Maintain portable fire-suppression devices during flame-cutting operations. Maintain fire watch during and for at least two hours after flame-cutting operations. Maintain adequate ventilation when using cutting torches.

5. Remove decayed, vermin-infested, or otherwise dangerous or unsuitable materials and promptly dispose of off-site.
  6. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
  7. Dispose of demolished items and materials promptly.
- B. Minor Accessories and Fixtures: Remove minor accessories and fixtures as required to accommodate removal of existing finishes or application new finishes whether items are indicated to be removed or not.
1. Minor accessories and fixtures shall include but not be limited to toilet room accessories; classroom accessories such as pencil sharpeners coat hooks, flag holders, and similar items.
  2. Where new replacement items are not indicated or specified in other sections, minor accessories and fixtures shall be considered to be items to be removed and reinstalled.
- C. Removed and Salvaged Items:
1. Clean salvaged items.
  2. Pack or crate items after cleaning. Identify contents of containers.
  3. Store items in a secure area until delivery to Owner.
  4. Transport items to Owner's storage area.
  5. Protect items from damage during transport and storage.
- D. Removed and Reinstalled Items:
1. Clean and repair items to functional condition adequate for intended reuse.
  2. Pack or crate items after cleaning and repairing. Identify contents of containers.
  3. Protect items from damage during transport and storage.
  4. Reinstall items in locations indicated. Comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make item functional for use indicated.
- E. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective demolition. When permitted by Architect, items may be removed to a suitable, protected storage location during selective demolition and reinstalled in their original locations after selective demolition operations are complete.
1. Items removed, salvaged, and reinstalled for the Contractor's convenience shall be considered the same as items to be removed and salvaged for reinstallation.
- 3.5 SELECTIVE DEMOLITION PROCEDURES FOR SPECIFIC MATERIALS
- A. Concrete Slabs-on-Grade: Using power-driven saw, cut perimeter of area to be demolished, then break up and remove.
1. Where possible or feasible, cut concrete at existing joints.

- B. Resilient Floor Coverings: Remove floor coverings and adhesive according to recommendations in RFCI's "Recommended Work Practices for the Removal of Resilient Floor Coverings." Do not use methods requiring solvent-based adhesive strippers.
- C. Roofing: Remove no more existing roofing than what can be covered in one day by new roofing and so that building interior remains watertight and weathertight. Refer to applicable Division 07 Section for new roofing requirements.
  - 1. Remove existing roof membrane, flashings, copings, and roof accessories.
  - 2. Remove existing roofing system down to substrate.

### 3.6 DISPOSAL OF DEMOLISHED MATERIALS

- A. Recycle or dispose demolition waste materials according to Division 01 Section "Construction Waste Management and Disposal." Remove demolition waste materials from Project site and legally dispose of them in an EPA-approved construction and demolition waste landfill acceptable to authorities having jurisdiction.
  - 1. Do not allow demolished materials to accumulate on-site.
  - 2. Remove and transport debris in accordance with local regulations and in a manner that will prevent spillage on adjacent surfaces and areas.
- B. Burning: Do not burn demolished materials.

### 3.7 CLEANING

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

END OF SECTION

SECTION 02 83 33.13  
LEAD-BASED PAINT REMOVAL AND DISPOSAL

PART 1 - GENERAL

1.1 DESCRIPTION

This section specifies abatement and disposal of lead-based paint (LBP) and controls needed to limit occupational and environmental exposure to lead hazards.

1.2 RELATED WORK

- A. Section 02 82 11, TRADITIONAL ASBESTOS ABATEMENT.
- B. Section 02 82 13.19, ASBESTOS FLOOR TILE AND MASTIC ABATEMENT
- B. Section 02 41 19, SELECTIVE DEMOLITION.

1.3 APPLICABLE PUBLICATIONS

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.
- B. Code of Federal Regulations (CFR):
  - CFR 29 Part 1910 ..... Occupational Safety and Health Standards
  - CFR 29 Part 1926 ..... Safety and Health Regulations for Construction
  - CFR 40 Part 148 ..... Hazardous Waste Injection Restrictions
  - CFR 40 Part 260 ..... Hazardous Waste Management System: General
  - CFR 40 Part 261 ..... Identification and Listing of Hazardous Waste
  - CFR 40 Part 262 ..... Standards Applicable to Generators of Hazardous Waste
  - CRF 40 Part 263 ..... Standards Applicable to Transporters of Hazardous Waste

CFR 40 Part 264 ..... Standards for Owners and Operations of Hazardous Waste  
Treatment, Storage, and Disposal Facilities

CFR 40 Part 265 ..... Interim Status Standards for Owners and Operators of  
Hazardous Waste Treatment, Storage, and Disposal  
Facilities

CFR 40 Part 268 ..... Land Disposal Restrictions

CFR 49 Part 172 ..... Hazardous Material Table, Special Provisions, Hazardous  
Material Communications, Emergency Response  
Information, and Training Requirements

CFR 49 Part 178 ..... Specifications for Packaging

C. National Fire Protection Association (NFPA):

NFPA 701-2004..... Methods of Fire Test for Flame-Resistant Textiles and  
Films

D. National Institute for Occupational Safety And Health (NIOSH)

NIOSH OSHA Booklet 3142 .            Lead in Construction

E. Underwriters Laboratories (UL)

UL 586-1996 (Rev 2009) .....            High-Efficiency, Particulate, Air Filter            Units

F. American National Standards Institute

Z9.2-2006..... Fundamentals Governing the Design and Operation of  
Local Exhaust Systems

Z88.6-2006..... Respiratory Protection

## 1.4 DEFINITIONS

- A. Action Level: Employee exposure, without regard to use of respirations, to an airborne concentration of lead of 30 micrograms per cubic meter of air averaged over an 8-hour

period. As used in this section, "30 micrograms per cubic meter of air" refers to the action level.

- B. Area Monitoring: Sampling of lead concentrations within the lead control area and inside the physical boundaries which is representative of the airborne lead concentrations which may reach the breathing zone of personnel potentially exposed to lead.
- C. Physical Boundary: Area physically roped or partitioned off around an enclosed lead control area to limit unauthorized entry of personnel. As used in this section, "inside boundary" shall mean the same as "outside lead control area."
- D. Certified Industrial Hygienist (CIH): As used in this section, refers to an Industrial Hygienist employed by the Contractor and is certified by the American Board of Industrial Hygiene in comprehensive practice.
- E. Change Rooms and Shower Facilities: Rooms within the designated physical boundary around the lead control area equipped with separate storage facilities for clean protective work clothing and equipment and for street clothes which prevent cross-contamination.
- F. Competent Person: A person capable of identifying lead hazards in the work area and is authorized by the contractor to take corrective action.
- G. Decontamination Room: Room for removal of contaminated personal protective equipment (PPE).
- H. Eight-Hour Time Weighted Average (TWA): Airborne concentration of lead averaged over an 8-hour workday to which an employee is exposed.
- I. High Efficiency Particulate Air (HEPA) Filter Equipment: HEPA filtered vacuuming equipment with a UL 586 filter system capable of collecting and retaining lead-contaminated paint dust. A high efficiency particulate filter means 99.97 percent efficient against 0.3 micron size particles.
- J. Lead: Metallic lead, inorganic lead compounds, and organic lead soaps. Excluded from this definition are other organic lead compounds.

- K. Lead Control Area: An enclosed area or structure with full containment to prevent the spread of lead dust, paint chips, or debris of lead-containing paint removal operations. The lead control area is isolated by physical boundaries to prevent unauthorized entry of personnel.
- L. Lead Permissible Exposure Limit (PEL): Fifty micrograms per cubic meter of air as an 8-hour time weighted average as determined by 29 CFR 1910.1025. If an employee is exposed for more than 8 hours in a work day, the PEL shall be determined by the following formula.  $PEL (\text{micrograms/cubic meter of air}) = 400/\text{No. of hrs worked per day}$
- M. Personnel Monitoring: Sampling of lead concentrations within the breathing zone of an employee to determine the 8-hour time weighted average concentration in accordance with 29 CFR 1910.1025. Samples shall be representative of the employee's work tasks. Breathing zone shall be considered an area within a hemisphere, forward of the shoulders, with a radius of 150 mm to 225 mm (6 to 9 inches) and the center at the nose or mouth of an employee.

## 1.5 QUALITY ASSURANCE

- A. Before exposure to lead-contaminated dust, provide workers with a comprehensive medical examination as required by 29 CFR 1926.62 (l) (1) (i) & (ii). The examination shall not be required if adequate records show that employees have been examined as required by 29 CFR 1926.62(l) without the last year.
- B. Medical Records: Maintain complete and accurate medical records of employees in accordance with 29 CFR 1910.20.
- C. CIH Responsibilities: The Contractor shall employ a certified Industrial Hygienist who will be responsible for the following:
  - 1. Certify Training.
  - 2. Review and approve lead-containing paint removal plan for conformance to the applicable referenced standards.
  - 3. Inspect lead-containing paint removal work for conformance with the approved plan.
  - 4. Direct monitoring.



5. Ensure work is performed in strict accordance with specifications at all times.
  6. Ensure hazardous exposure to personnel and to the environment is adequately controlled at all times.
- D. Training: Train each employee performing paint removal, disposal, and air sampling operations prior to the time of initial job assignment, in accordance with 29 CFR 1926.62.
- E. Training Certification: Submit certificates signed and dated by the CIH and by each employee stating that the employee has received training.
- F. Respiratory Protection Program:
1. Furnish each employee required to wear a negative pressure respirator or other appropriate type with a respirator fit test at the time of initial fitting and at least every 6 months thereafter as required by 29 CFR 1926.62.
  2. Establish and implement a respiratory protection program as required by 29 CFR 1910.134, 29 CFR 1910.1025, and 29 CFR 1926.62.
- G. Hazard Communication Program: Establish and implement a Hazard Communication Program as required by 29 CFR 1910.1200.
- H. Hazardous Waste Management: The Hazardous Waste Management plan shall comply with applicable requirements of Federal, State, and local hazardous waste regulations and address:
1. Identification of hazardous wastes associated with the work.
  2. Estimated quantities of wastes to be generated and disposed of.
  3. Names and qualifications of each contractor that will be transporting, storing, treating, and disposing of the wastes. Include the facility location and a 24-hour point of contact. Furnish two copies of EPA, state and local hazardous waste permit applications/permits and EPA Identification numbers.

4. Names and qualifications (experience and training) of personnel who will be working on-site with hazardous wastes.
5. List of waste handling equipment to be used in performing the work, to include cleaning, volume reduction, and transport equipment.
6. Spill prevention, containment, and cleanup contingency measures to be implemented.
7. Work plan and schedule for waste containment, removal and disposal. Wastes shall be cleaned up and containerized daily.
8. Cost for hazardous waste disposal according to this plan.

I. Safety and Health Compliance:

1. In addition to the detailed requirements of this specification, comply with laws, ordinances, rules, and regulations of federal, state, and local authorities regarding removing, handling, storing, transporting, and disposing of lead waste materials. Comply with the applicable requirements of the current issue of 29 CFR 1910.1025. Submit matters regarding interpretation of standards to the Contracting Officer for resolution before starting work.
2. Where specification requirements and the referenced documents vary, the most stringent requirements shall apply.
3. Local laws, ordinances, criteria, rules and regulations regarding removing, handling, storing, transporting, and disposing of lead-contaminated materials shall apply.

- J. Pre-Construction Conference: Along with the CIH, meet with the Contracting Officer to discuss in detail the lead-containing paint removal work plan, including work procedures and precautions for the work plan.

## 1.6 SUBMITTALS

- A. Submit the following in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

B. Manufacturer's Catalog Data:

Vacuum filters

Respirators

C. Instructions: Paint removal materials. Include applicable material safety data sheets.

D. Statements Certifications and Statements:

1. Qualifications of CIH: Submit name, address, and telephone number of the CIH selected to perform responsibilities in paragraph entitled "CIH Responsibilities." Provide previous experience of the CIH. Submit proper documentation that the Industrial Hygienist is certified by the American Board of Industrial Hygiene in comprehensive practice, including certification number and date of certification/recertification.
2. Testing Laboratory: Submit the name, address, and telephone number of the testing laboratory selected to perform the monitoring, testing, and reporting of airborne concentrations of lead. Provide proper documentation that persons performing the analysis have been judged proficient by successful participation within the last year in the National Institute for Occupational Safety and Health (NIOSH) Proficiency Analytical Testing (PAT) Program. The laboratory shall be accredited by the American Industrial Hygiene Association (AIHA). Provide AIHA documentation along with date of accreditation/reaccreditation.
3. Lead-Containing Paint Removal Plan:
  - a. Submit a detailed job-specific plan of the work procedures to be used in the removal of lead-containing paint. The plan shall include a sketch showing the location, size, and details of lead control areas, location and details of decontamination rooms, change rooms, shower facilities, and mechanical ventilation system.
  - b. Include in the plan, eating, drinking, smoking and restroom procedures, interface of trades, sequencing of lead related work, collected wastewater and paint debris disposal plan, air sampling plan, respirators, protective equipment, and a detailed

description of the method of containment of the operation to ensure that airborne lead concentrations of 30 micrograms per cubic meter of air are not exceeded outside of the lead control area.

- c. Include air sampling, training and strategy, sampling methodology, frequency, duration of sampling, and qualifications of air monitoring personnel in the air sampling portion on the plan.
- 4. Field Test Reports: Monitoring Results: Submit monitoring results to the Contracting Officer within 3 working days, signed by the testing laboratory employee performing the air monitoring, the employee that analyzed the sample, and the CIH.
- 5. Records:
  - a. Completed and signed hazardous waste manifest from treatment or disposal facility.
  - b. Certification of Medical Examinations.
  - c. Employee training certification.

## PART 2- PRODUCTS

PAINT REMOVAL PRODUCTS: Submit applicable Material Safety Data Sheets for paint removal products used in paint removal work. Use the least toxic product, suitable for the job and acceptable to the Industrial Hygienist.

## PART 3- EXECUTION

### 3.1 PROTECTION

- A. Notification: Notify the Contracting Officer 20 days prior to the start of any paint removal work.
- B. Lead Control Area Requirements.
  - 1. Establish a lead control area by completely enclosing with containment screens the area or structure where lead-containing paint removal operations will be performed.

2. Contain removal operations by the use of a negative pressure full containment system with at least one change room and with HEPA filtered exhaust.
- C. Protection of Existing Work to Remain: Perform paint removal work without damage or contamination of adjacent areas. Where existing work is damaged or contaminated, restore work to its original condition.
- D. Boundary Requirements: Provide physical boundaries around the lead control area by roping off the area [designated on the drawings] or providing curtains, portable partitions or other enclosures to ensure that airborne concentrations of lead will not reach 30 micrograms per cubic meter of air outside of the lead control area.
- E. Heating, Ventilating and Air Conditioning (HVAC) Systems: Shut down, lock out, and isolate HVAC systems that supply, exhaust, or pass through the lead control areas. Seal intake and exhaust vents in the lead control area with 6-mil plastic sheet and tape. Seal seams in HVAC components that pass through the lead control area.
- F. Change Room and Shower Facilities: Provide clean change rooms and shower facilities within the physical boundary around the designated lead control area in accordance with requirements of 29 CFR 1926.62.
- G. Mechanical Ventilation System:
  1. Use adequate ventilation to control personnel exposure to lead in accordance with 29 CFR 1926.57.
  2. To the extent feasible, use fixed local exhaust ventilation connected to HEPA filters or other collection systems, approved by the industrial hygienist. Local exhaust ventilation systems shall be designed, constructed, installed, and maintained in accordance with ANSI Z9.2.
  3. If air from exhaust ventilation is recirculated into the work place, the system shall have a high efficiency filter with reliable back-up filter and controls to monitor the concentration of lead in the return air and to bypass the recirculation system automatically if it fails. Air may be recirculated only where exhaust to the outside is not feasible.

- H. Personnel Protection: Personnel shall wear and use protective clothing and equipment as specified herein. Eating, smoking, or drinking is not permitted in the lead control area. No one will be permitted in the lead control area unless they have been given appropriate training and protective equipment.
- I. Warning Signs: Provide warning signs at approaches to lead control areas. Locate signs at such a distance that personnel may read the sign and take the necessary precautions before entering the area. Signs shall comply with the requirements of 29 CFR 1926.62.

### 3.2 WORK PROCEDURES

- A. Perform removal of lead-containing paint in accordance with approved lead-containing paint removal plan. Use procedures and equipment required to limit occupational and environmental exposure to lead when lead- containing paint is removed in accordance with 29 CFR 1926.62, except as specified herein. Dispose of removed paint chips and associated waste in compliance with Environmental Protection Agency (EPA), federal, state, and local requirements.
- B. Personnel Exiting Procedures:
  - 1. Whenever personnel exit the lead-controlled area, they shall perform the following procedures and shall not leave the work place wearing any clothing or equipment worn during the work day:
    - a. Vacuum themselves off.
    - b. Remove protective clothing in the decontamination room, and place them in an approved impermeable disposal bag.
    - c. Shower.
    - d. Change to clean clothes prior to leaving the physical boundary designated around the lead-contaminated job site.
- C. Monitoring: Monitoring of airborne concentrations of lead shall be in accordance with 29 CFR 1910.1025 and as specified herein. Air monitoring, testing, and reporting shall be

performed by a CIH or an Industrial Hygiene (IH) Technician who is under the direction of the CIH:

1. The CIH or the IH Technician under the direction of the CIH shall be on the job site directing the monitoring, and inspecting the lead-containing paint removal work to ensure that the requirements of the Contract have been satisfied during the entire lead-containing paint removal operation.
2. Take personal air monitoring samples on employees who are anticipated to have the greatest risk of exposure as determined by the CIH. In addition, take air monitoring samples on at least 25 percent of the work crew or a minimum of two employees, whichever is greater, during each work shift.
3. Submit results of air monitoring samples, signed by the CIH, within 24 hours after the air samples are taken. Notify the Contracting Officer immediately of exposure to lead at or in excess of the action level of 30 micrograms per cubic meter of air outside of the lead control area.

D. Monitoring During Paint Removal Work:

1. Perform personal and area monitoring during the entire paint removal operation. Sufficient area monitoring shall be conducted at the physical boundary to ensure unprotected personnel are not exposed above 30 micrograms per cubic meter of air at all times. If the outside boundary lead levels are at or exceed 30 micrograms per cubic meter of air, work shall be stopped and the CIH shall immediately correct the condition(s) causing the increased levels and notify the Contracting Officer immediately.
2. The CIH shall review the sampling data collected on that day to determine if condition(s) requires any further change in work methods. Removal work shall resume when approval is given by the CIH. The Contractor shall control the lead level outside of the work boundary to less than 30 micrograms per cubic meter of air at all times. As a minimum, conduct area monitoring daily on each shift in which lead paint removal operations are performed in areas immediately adjacent to the lead control area.

3. For outdoor operations, at least one sample on each shift shall be taken on the downwind side of the lead control area. If adjacent areas are contaminated, clean and visually inspect contaminated areas. The CIH shall certify that the area has been cleaned of lead contamination.

### 3.3 LEAD-CONTAINING PAINT REMOVAL

- A. Remove paint within the areas designated on the drawings in order to completely expose the substrate. Take whatever precautions are necessary to minimize damage to the underlying substrate.
- B. Indoor Lead Paint Removal: Select paint removal processes to minimize contamination of work areas with lead-contaminated dust or other lead-contaminated debris/waste. This paint removal process should be described in the lead-containing paint removal plan. Perform manual sanding and scraping to the maximum extent feasible.
- C. Mechanical Paint Removal and Blast Cleaning: Perform mechanical paint removal and blast cleaning in lead control areas using negative pressure full containments with HEPA filtered exhaust. Collect paint residue and spent grit (used abrasive) from blasting operations for disposal in accordance with EPA, state and local requirements.
- D. Outside Lead Paint Removal: Select removal processes to minimize contamination of work areas with lead-contaminated dust or other lead-contaminated debris/waste. This paint removal process should be described in the lead-containing paint removal plan. Perform manual sanding and scraping to the maximum extent feasible.

### 3.4 SURFACE PREPARATIONS

Avoid flash rusting or other deterioration of the substrate. Provide surface preparations for painting in accordance with Section 09 91 00, PAINTING.

### 3.5 CLEANUP AND DISPOSAL

- A. Cleanup: Maintain surfaces of the lead control area free of accumulations of paint chips and dust. Restrict the spread of dust and debris; keep waste from being distributed over



the work area. Do not dry sweep or use compressed air to clean up the area. At the end of each shift and when the paint removal operation has been completed, clean the area of visible lead paint contamination by vacuuming with a HEPA filtered vacuum cleaner and wet mopping the area.

- B. Certification: The CIH shall certify in writing that the inside and outside the lead control area air monitoring samples are less than 30 micrograms per cubic meter of air, the respiratory protection for the employees was adequate, the work procedures were performed in accordance with 29 CFR 1926.62, and that there were no visible accumulations of lead-contaminated paint and dust on the worksite. Do not remove the lead control area or roped-off boundary and warning signs prior to the Contracting Officer's receipt of the CIH's certification. Reclean areas showing dust or residual paint chips.
- C. Testing of Lead-Containing Paint Residue and Used Abrasive Where indicated or when directed by the Contracting Officer, test lead containing paint residue and used abrasive in accordance with 40 CFR 261 for hazardous waste.
- D. Disposal:
  - 1. Collect lead-contaminated waste, scrap, debris, bags, containers, equipment, and lead-contaminated clothing, which may produce airborne concentrations of lead particles.
  - 2. Store removed paint, lead-contaminated clothing and equipment, and lead-contaminated dust and cleaning debris into U.S. Department of Transportation (49 CFR 178) approved 55-gallon drums. Properly labels each drum to identify the type of waste (49 CFR 172) and the date lead-contaminated wastes were first put into the drum. Obtain and complete the Uniform Hazardous Waste Manifest forms from [Activity Staff Civil Engineer located at \_\_\_\_\_. Comply with land disposal restriction notification requirements as required by 40 CFR 268:
    - a. At least 14 days prior to delivery, notify the Contracting Officer who will arrange for job site inspection of the drums and manifests by PWC Hazardous Waste Storage Facility personnel.

- b. As necessary, make lot deliveries of hazardous wastes to the PWC Hazardous Waste Storage Facility to ensure that drums do not remain on the jobsite longer than 90 calendar days from the date affixed to each drum.
  - a. Collect lead-contaminated waste, scrap, debris, bags, containers, equipment, and lead-contaminated clothing which may produce airborne concentrations of lead particles. Label the containers in accordance with 29 CFR 1926.62. Dispose of lead-contaminated waste material at a EPA or state approved hazardous waste treatment, storage, or disposal facility off Government property.
  - b. Store waste materials in U.S. Department of Transportation (49 CFR 178) approved 55-gallon drums. Properly label each drum to identify the type of waste (49 CFR 172) and the date the drum was filled. The Contracting Officer or an authorized representative will assign an area for interim storage of waste-containing drums. Do not store hazardous waste drums in interim storage longer than 90 calendar days from the date affixed to each drum.
  - c. Handle, store, transport, and dispose lead or lead-contaminated waste in accordance with 40 CFR 260, 40 CFR 261, 40 CFR 262, 40 CFR 263, 40 CFR 264, and 40 CFR 265. Comply with land disposal restriction notification requirements as required by 40 CFR 268.
- E. Disposal Documentation Submit written evidence that the hazardous waste treatment, storage, or disposal facility (TSD) is approved for lead disposal by the EPA and state or local regulatory agencies. Submit one copy of the completed manifest, signed and dated by the initial transporter in accordance with 40 CFR 262.

END OF SECTION

## SECTION 055000 METAL FABRICATIONS

### 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. Steel framing and supports for countertops.
  - 2. Steel framing and supports for mechanical and electrical equipment.
  - 3. Steel framing and supports for applications where framing and supports are not specified in other Sections.
- B. Related Sections include the following:
  - 1. Division 05 Section "Structural Steel Framing."
  - 2. Division 09 Section "Gypsum Board" for metal backing anchoring railings.

#### 1.3 SUBMITTALS

- A. Product Data: For the following:
  - 1. Paint products.
- B. Shop Drawings: Show fabrication and installation details for metal fabrications.
  - 1. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items.
  - 2. Provide templates for anchors and bolts specified for installation under other Sections.
- C. Welding certificates.

#### 1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Fabricator of products.
- B. Welding: Qualify procedures and personnel according to the following:

1. AWS D1.1, "Structural Welding Code--Steel."

## 1.5 PROJECT CONDITIONS

- A. Field Measurements: Verify actual locations of walls and other construction contiguous with metal fabrications by field measurements before fabrication and indicate measurements on Shop Drawings.

1. Provide allowance for trimming and fitting at site.

## 1.6 COORDINATION

- A. Coordinate installation of anchorages for metal fabrications. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.
- B. Schedule installation so wall attachments are made only to completed walls. Do not support railings temporarily by any means that do not satisfy structural performance requirements.

## 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.

### 2.2 METALS, GENERAL

- A. Metal Surfaces, General: Provide materials with smooth, flat surfaces, unless otherwise indicated. For metal fabrications exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.

### 2.3 FERROUS METALS

- A. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
- B. Steel Tubing: ASTM A 500, cold-formed steel tubing.
- C. Steel Pipe: ASTM A 53/A 53M, standard weight (Schedule 40), unless another weight is indicated or required by structural loads.

1. Provide galvanized finish for exterior installations where indicated.

## 2.4 FASTENERS

- A. General: Unless otherwise indicated, provide Type 304 stainless-steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B 633, Class Fe/Zn 5, at exterior walls. Provide stainless-steel fasteners for fastening aluminum. Select fasteners for type, grade, and class required.

## 2.5 MISCELLANEOUS MATERIALS

- A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.
- B. Shop Primers: Provide primers that comply with Division 09 painting Sections.
- C. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

## 2.6 FABRICATION, GENERAL

- A. Shop Assembly: Preassemble items in the shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.
- B. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch, unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
- C. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.
- D. Form exposed work true to line and level with accurate angles and surfaces and straight edges.
- E. Weld corners and seams continuously to comply 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. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
- F. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible. Where exposed fasteners are required, use Phillips flat-

head (countersunk) screws or bolts, unless otherwise indicated. Locate joints where least conspicuous.

- G. Fabricate seams and other connections that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.
- H. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.
- I. Provide for anchorage of type indicated in drawings.
- J. Weld connections to comply 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. Weld exposed corners and seams continuously, unless otherwise indicated.
  - 5. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

## 2.7 MISCELLANEOUS FRAMING AND SUPPORTS

- A. General: Provide steel framing and supports not specified in other Sections as needed to complete the Work.
- B. Fabricate units from steel shapes, plates, and bars of welded construction, unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction retained by framing and supports. Cut, drill, and tap units to receive hardware, hangers, and similar items.
  - 1. Fabricate units from slotted channel framing where indicated.
  - 2. Furnish inserts if units are installed after concrete is placed.

## 2.8 FINISHES, GENERAL

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Finish metal fabrications after assembly.

## 2.9 STEEL AND IRON FINISHES

- A. Galvanizing: Hot-dip galvanize items as indicated to comply with applicable standard listed below:

1. ASTM A 123/A 123M, for galvanizing steel and iron products.
  2. ASTM A 153/A 153M, for galvanizing steel and iron hardware.
- B. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with minimum requirements indicated below for SSPC surface preparation specifications and environmental exposure conditions of installed metal fabrications.
- C. Shop Priming: Apply shop primer to uncoated surfaces of metal fabrications, except those with galvanized finishes and those to be embedded in concrete, sprayed-on fireproofing, or masonry, unless otherwise indicated. Comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.
1. Stripe paint corners, crevices, bolts, welds, and sharp edges.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION, GENERAL

- A. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.
- B. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.
- C. Field Welding: Comply with the following requirements:
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 no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
- D. Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction. Provide threaded fasteners for use with concrete and masonry inserts, toggle bolts, through bolts, lag bolts, wood screws, and other connectors.
- E. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

- 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.

### 3.2 INSTALLING MISCELLANEOUS FRAMING AND SUPPORTS

- A. General: Install framing and supports to comply with requirements of items being supported, including manufacturers' written instructions and requirements indicated on Shop Drawings.

### 3.3 ADJUSTING AND CLEANING

- A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
  - 1. Apply by brush or spray to provide a minimum 2.0-mil (0.05-mm) dry film thickness.
- B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

END OF SECTION



SECTION 06 10 00  
ROUGH CARPENTRY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
  - 1. Rooftop equipment bases and support curbs.
  - 2. Wood blocking and nailers.
  - 3. Wood sleepers.
  - 4. Plywood backing panels.

1.3 DEFINITIONS

- A. Exposed Framing: Framing not concealed by other construction.
- B. Dimension Lumber: Lumber of 2 inches nominal or greater but less than 5 inches nominal in least dimension.
- C. Timber: Lumber of 5 inches nominal or greater in least dimension.
- D. Lumber grading agencies, and the abbreviations used to reference them, include the following:
  - 1. NLGA: National Lumber Grades Authority.
  - 2. WCLIB: West Coast Lumber Inspection Bureau.
  - 3. WWPA: Western Wood Products Association.

1.4 SUBMITTALS

- A. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.
  - 1. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Indicate type of preservative used and net amount of preservative retained.
  - 2. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Include physical properties of treated materials based on testing by a qualified independent testing agency.

3. For fire-retardant treatments specified to be High-Temperature (HT) type, include physical properties of treated lumber both before and after exposure to elevated temperatures, based on testing by a qualified independent testing agency according to ASTM D 5664.
4. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.

B. Research/Evaluation Reports: For the following, showing compliance with building code in effect for Project:

1. Wood-preservative-treated wood.
2. Fire-retardant-treated wood.
3. Expansion anchors.
4. Metal framing anchors.

## 1.5 DELIVERY, STORAGE, AND HANDLING

- A. Stockpile materials sufficiently in advance of need to assure their availability in a timely manner for this Work.
- B. Deliver material to the job site and store in a safe area out of the way of traffic. Keep material under cover and dry. Protect against exposure to weather and contact with damp or wet surface. Stack lumber as well as plywood and other panels; provide for air circulation within and around stacks and under temporary coverings including polyethylene and similar materials.
1. Identify framing lumber by grade, and store each grade separately from other grades.
  2. Protect metals with adequate waterproof outer wrapping.
  3. Use extreme care in off loading of lumber to prevent damage, splitting, and breaking of materials.
  4. For lumber and plywood pressure treated with waterborne chemicals, provide spacers between each course to provide air circulation.

## PART 2 - PRODUCTS

### 2.1 WOOD PRODUCTS, GENERAL

- A. Lumber: DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, provide lumber that complies with the applicable rules of any rules-writing agency certified by the ALSC Board of Review. Provide lumber graded by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.
1. Factory mark each piece of lumber with grade stamp of grading agency.

2. Where nominal sizes are indicated, provide actual sizes required by DOC PS 20 for moisture content specified. Where actual sizes are indicated, they are minimum dressed sizes for dry lumber.
3. Provide dressed lumber, S4S, unless otherwise indicated.

## 2.2 WOOD-PRESERVATIVE-TREATED LUMBER

### A. Preservative Treatment by Pressure Process: AWPAC2.

1. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium.
2. For exposed items indicated to receive a stained or natural finish, use chemical formulations that do not require incising, contain colorants, bleed through, or otherwise adversely affect finishes.

### B. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Do not use material that is warped or does not comply with requirements for untreated material.

### C. Mark lumber with treatment quality mark of an inspection agency approved by the ALSC Board of Review.

### D. Application: Treat items indicated on Drawings, and the following:

1. Wood cants, nailers, curbs, equipment support bases, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers, and waterproofing.
2. Wood sills, sleepers, blocking, furring, stripping, and similar concealed members in contact with masonry or concrete.

## 2.3 FIRE-RETARDANT-TREATED MATERIALS

### A. General: Comply with performance requirements in AWPAC20 (lumber) and AWPAC27 (plywood).

1. Use Exterior type for exterior locations and where indicated.

### B. Identify fire-retardant-treated wood with appropriate classification marking of testing and inspecting agency acceptable to authorities having jurisdiction.

### C. Application: Treat all wood items unless otherwise indicated.

## 2.4 DIMENSION LUMBER FRAMING

### A. All Framing Lumber: Provide lumber of grade and species meeting or exceeding the following standards of quality:

1. Grade marked Douglas Fir No. 1 or better, unless otherwise indicated on Drawings. (Douglas Fir graded under WCLIB or WWPAC Rules).

## 2.5 BOARDS

- A. Exposed Boards: Where boards will not be concealed by other work, provide lumber of 19 percent maximum moisture content (S-DRY). Where painted finish is indicated, provide Select Merchantable Boards per WCLIP rules.
- B. Concealed Boards: Where boards will be concealed by other work, provide lumber of 19 percent maximum moisture content (S-DRY) and of the following species and grade:
  - 1. Any species graded construction boards or WCLIP No. 1 or better.

## 2.6 MISCELLANEOUS LUMBER

- A. General: Provide miscellaneous lumber indicated and lumber for support or attachment of other construction, including the following:
  - 1. Blocking.
  - 2. Nailers.
  - 3. Rooftop equipment bases and support curbs.
  - 4. Cants.
  - 5. Furring.
  - 6. Grounds.
- B. Provide No. 1 grade, or better, Douglas Fir, light framing or board size lumber as required.
- C. Moisture Content 19 percent maximum at the time of installation for lumber items not specified to receive wood preservative treatment.
- D. For blocking not used for attachment of other construction, Utility, Stud, or No. 3 grade lumber of any species may be used provided that it is cut and selected to eliminate defects that will interfere with its attachment and purpose.
- E. For blocking and nailers used for attachment of other construction, select and cut lumber to eliminate knots and other defects that will interfere with attachment of other work.

## 2.7 PLYWOOD BACKING PANELS

- A. Roof Platform Sheathing: DOC PS 1, Exposure 1, C-D Plugged, fire-retardant treated, in thickness indicated or, if not indicated, not less than 3/4-inch nominal thickness.

## 2.8 FASTENERS

- A. General: Provide fasteners of size and type indicated that comply with requirements specified in this Article for material and manufacture.

1. Where rough carpentry is exposed to weather, in ground contact, pressure-preservative treated, or in area of high relative humidity, provide fasteners with hot-dip zinc coating complying with ASTM A 153/A 153M.
- B. Nails, Brads, and Staples: ASTM F 1667.
- C. Power-Driven Fasteners: NES NER-272.
- D. Wood Screws: ASME B18.6.1.
- E. Lag Bolts: ASME B18.2.1 (ASME B18.2.3.8M).
- F. Bolts: Steel bolts complying with ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6); with ASTM A 563 (ASTM A 563M) hex nuts and, where indicated, flat washers.
- G. Expansion Anchors: Anchor bolt and sleeve assembly of material indicated below with capability to sustain, without failure, a load equal to 6 times the load imposed when installed in unit masonry assemblies and equal to 4 times the load imposed when installed in concrete as determined by testing per ASTM E 488 conducted by a qualified independent testing and inspecting agency.
  1. Material: Carbon-steel components, zinc plated to comply with ASTM B 633, Class Fe/Zn 5.
  2. Material: Stainless steel with bolts and nuts complying with ASTM F 593 and ASTM F 594, Alloy Group 1 or 2 (ASTM F 738M and ASTM F 836M, Grade A1 or A4).

## 2.9 METAL FRAMING ANCHORS AND HARDWARE

- A. Manufacturers: Subject to compliance with requirements, provide products as indicated on Drawings by the following:
  1. Simpson Strong-Tie Co., Inc.
- B. Material: Galvanized steel sheet, hot-dip, zinc-coated steel sheet complying with ASTM A 653/A 653M, G60 (Z180) coating designation.
  1. Use for interior locations where stainless steel is not indicated.

## PART 3 - EXECUTION

### 3.1 INSTALLATION, GENERAL

- A. General: Install framing as indicated on drawings and herein specified. Notes and details on Structural Drawings shall take precedence over these specifications.
- B. Set rough carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit rough carpentry to other construction; scribe and cope as needed for

accurate fit. Locate furring, nailers, blocking, grounds, and similar supports to comply with requirements for attaching other construction.

- C. Framing Standard: Comply with AF&PA's "Details for Conventional Wood Frame Construction," unless otherwise indicated.
- D. Install plywood backing panels by fastening to framing; coordinate locations with utilities requiring backing panels. Install fire-retardant treated plywood backing panels with classification marking of testing agency exposed to view.
- E. Metal Framing Anchors: Install metal framing to comply with manufacturer's written instructions.
- F. Do not splice structural members between supports, unless otherwise indicated.
- G. Provide blocking and framing as indicated and as required to support facing materials, fixtures, specialty items, and trim.
  - 1. Provide metal clips for fastening gypsum board or lath at corners and intersections where framing or blocking does not provide a surface for fastening edges of panels. Space clips not more than 16 inches on center.
- H. Provide fire blocking in furred spaces, stud spaces, and other concealed cavities in accordance with 2013 CBC Section 718 "Concealed Spaces," as indicated, and as follows:
- I. Sort and select lumber so that natural characteristics will not interfere with installation or with fastening other materials to lumber. Do not use materials with defects that interfere with function of member or pieces that are too small to use with minimum number of joints or optimum joint arrangement.
- J. Comply with AWPAC M4 for applying field treatment to cut surfaces of preservative-treated lumber.
  - 1. Use inorganic boron for items that are continuously protected from liquid water.
  - 2. Use copper naphthenate for items not continuously protected from liquid water.
- K. Securely attach rough carpentry work to substrate by anchoring and fastening as indicated on Drawings and complying with the following:
  - 1. NES NER-272 for power-driven fasteners.
  - 2. 2013 CBC Table 2304.9.1 "Fastening Schedule."
- L. Use common wire nails, unless otherwise indicated. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood; do not countersink nail heads, unless otherwise indicated.

### 3.2 WOOD GROUND, SLEEPER, BLOCKING, AND NAILER INSTALLATION

- A. Install where indicated and where required for screeding or attaching other work. Form to shapes indicated and cut as required for true line and level of attached work. Coordinate locations with other work involved.
- B. Attach items to substrates to support applied loading. Recess bolts and nuts flush with surfaces, unless otherwise indicated.
- C. Provide permanent grounds of dressed, pressure-preservative-treated, key-beveled lumber not less than 1-1/2 inches wide and of thickness required to bring face of ground to exact thickness of finish material. Remove temporary grounds when no longer required.

### 3.3 WOOD FURRING INSTALLATION

- A. Install level and plumb with closure strips at edges and openings. Shim with wood as required for tolerance of finish work.
- B. Furring to Receive Plywood: Install 1-by-3-inch nominal- size furring horizontally and vertically at 24 inches on center

### 3.4 PROTECTION

- A. Use all necessary means to protect the installed work and materials of all other trades. In the event of damage, immediately make all repairs and replacements necessary to, the approval of the Architect and at no additional cost to the Owner.
- B. Protect rough carpentry from weather. If, despite protection, rough carpentry becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

END OF SECTION

## SECTION 072100 THERMAL INSULATION

### 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. Glass fiber blanket insulation.
- B. Related Sections include the following:
  - 1. Division 07 Sections as applicable to roofing systems for rigid board insulation installed as part of the roof system.
  - 2. Division 23 Sections as applicable to air distribution duct systems for insulation for ducts.

#### 1.3 SUBMITTALS

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

#### 1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain each type of building insulation through one source from a single manufacturer.
- B. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

#### 1.5 DELIVERY, STORAGE, AND HANDLING

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



## PART 2 - PRODUCTS

### 2.1 GLASS-FIBER BLANKET INSULATION

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. CertainTeed Corporation.
  - 2. Guardian Fiberglass, Inc.
  - 3. Johns Manville.
  - 4. Knauf Fiber Glass.
  - 5. Owens-Corning.
- B. Unfaced Glass-Fiber Blanket Insulation: ASTM C 665, Type I (blankets without membrane facing); consisting of fibers; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively; passing ASTM E 136 for combustion characteristics.
- C. Reinforced-Foil-Faced Glass-Fiber Blanket Insulation: ASTM C 665, Type III (blankets with reflective membrane facing), Class A (membrane-faced surface with a flame-spread index of 25 or less); Category 1 (membrane is a vapor barrier), faced with foil-scrim-kraft, vapor-retarder membrane on 1 face.
- D. Thermal Resistance Values and Thicknesses: Where Drawings indicate thermal resistance values, provide units of the following nominal equivalent thicknesses:
  - 1. R-13; 3-1/2 inch thickness.
  - 2. R-19; 6 inch thickness.
  - 3. R-25; 8 inch thickness.
  - 4. R-30; 10 inch thickness.
  - 5. R-38; 12 inch thickness.

### 2.2 SPRAY POLYURETHANE FOAM INSULATION

- A. Closed-Cell Polyurethane Foam Insulation: ASTM C 1029, Type II, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, per ASTM E 84. Use for filling miscellaneous voids.

### 2.3 ACCESSORY MATERIALS

- A. Accessory materials shall be as recommended in writing by insulation manufacturer.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine conditions, with Installer present, for conditions affecting performance of the Work.
  - 1. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Clean substrates of substances harmful to insulation or vapor retarders, including removing projections capable of puncturing vapor retarders or of interfering with insulation attachment.

### 3.3 INSTALLATION, GENERAL

- A. Comply with insulation manufacturer's written instructions applicable to products and application indicated.
- B. Install insulation to provide a complete thermal envelope having thermal resistance values indicated on drawings.
- C. Install insulation that is undamaged, dry, and unsoiled and that has not been left exposed to ice, rain, or snow at any time.
- D. Extend insulation to envelop entire area to be insulated. Cut and fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.
- E. Provide sizes to fit applications indicated and selected from manufacturer's standard thicknesses, widths, and lengths. Apply single layer of insulation units to produce thickness indicated unless multiple layers are otherwise shown or required to make up total thickness.

### 3.4 INSTALLATION OF INSULATION FOR FRAMED CONSTRUCTION

- A. Apply insulation units to substrates by method indicated, complying with manufacturer's written instructions. If no specific method is indicated, bond units to substrate with adhesive or use mechanical anchorage to provide permanent placement and support of units.
- B. Glass-Fiber Blanket Insulation: Install in cavities formed by framing members according to the following requirements:
  - 1. Install insulation of types indicated below:

- a. Exterior Walls: Vapor retarder faced thermal insulation.
- b. Interior Walls:
  - 1) Walls Between Conditioned and Unconditioned Spaces: Vapor retarder faced thermal insulation.
  - 2) Walls Between Conditioned Spaces: Un-faced acoustical insulation at locations indicated on drawings.
- c. Gypsum Board Ceilings: Unfaced thermal insulation where required to provide a complete thermal envelope.
- d. Underside of Roof Deck: Vapor retarder faced thermal insulation.
  - 1) Maintain a 1 inch minimum clear ventilating space between the bottom of the roof sheathing and the top of the insulation.
- 2. Use insulation widths and lengths that fill the cavities formed by framing members. If more than one length is required to fill the cavities, provide lengths that will produce a snug fit between ends.
- 3. Place insulation in cavities formed by framing members to produce a friction fit between edges of insulation and adjoining framing members.
- 4. Maintain 3-inch clearance of insulation around recessed lighting fixtures not rated for or protected from contact with insulation.
- 5. For metal-framed wall cavities where cavity heights exceed 96 inches, support unfaced blankets mechanically and support faced blankets by taping flanges of insulation to flanges of metal studs.
- 6. Vapor-Retarder-Faced Blankets: Install vapor retarder faced insulation in stud wall cavities of exterior walls of building and walls between conditioned and unconditioned spaces to provide a complete thermal envelope between the interior and exterior of the building and between conditioned and unconditioned spaces. Tape joints and ruptures in vapor-retarder facings, and seal each continuous area of insulation to ensure airtight installation.
  - a. Exterior Walls: Set units with facing placed toward interior of construction.
  - b. Interior Walls: Set units with facing toward climate conditioned side of wall.
- 7. Unfaced Blankets: Install unfaced insulation in stud wall cavities of interior walls between conditioned interior spaces where indicated on the Drawings, thickness of insulation to match stud width.
  - a. Install unfaced insulation in ceilings where indicated on the Drawings and where required to provide a complete thermal envelope.
- C. Miscellaneous Voids: Install insulation in miscellaneous voids and cavity spaces where required to prevent gaps in insulation using the following materials:
  - 1. Glass-Fiber Insulation: Stuff glass-fiber loose-fill insulation into miscellaneous voids and cavity spaces of walls and around door and window frames. Compact to approximately 40 percent of normal maximum volume equaling a density of approximately 2.5 lb/cu. ft.

- 2. Spray Polyurethane Insulation: Apply according to manufacturer's written instructions.
- D. Water-Piping in Walls: If water piping is located within insulated exterior walls, coordinate location of piping to ensure that it is placed on warm side of insulation and insulation encapsulates piping.
- E. Use mechanical anchorage to provide permanent placement and support of units.

### 3.5 PROTECTION

- A. Protect installed insulation and vapor retarders from damage due to harmful weather exposures, moisture, physical abuse, and other causes. Provide temporary coverings or enclosures where insulation is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

END OF SECTION

## SECTION 07 50 05 BUILT-UP ROOF PATCHING

### 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, where applicable, apply to this Section.

#### 1.2 SUMMARY

- A. This Section includes the following:
  - 1. Cutting and patching existing built-up roof system where new roof mounted equipment is to be installed.
  - 2. Where existing equipment and access platforms are to be removed.
- B. Related Sections include but are not limited to the following:
  - 1. Section 06 10 00 ROUGH CARPENTRY for wood nailers, cants, and blocking.
  - 2. Section 07 60 00 FLASHING AND SHEET METAL.

#### 1.3 DEFINITIONS

- A. Roofing Terminology: Refer to ASTM D 1079 and glossary of NRCA's "The NRCA Roofing and Waterproofing Manual" for definition of terms related to roofing work in this Section.

#### 1.4 PERFORMANCE REQUIREMENTS

- A. General: Provide installed roofing materials that remain watertight; do not permit the passage of water; and resist specified uplift pressures, thermally induced movement, and exposure to weather without failure.
- B. Material Compatibility: Provide roofing and patching materials that are compatible with one another under conditions of service and application required, as demonstrated by roofing manufacturer based on testing and field experience.

#### 1.5 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Installer Certificates: Signed by roofing system manufacturer certifying that Installer is approved, authorized, or licensed by manufacturer to install roofing system.

#### 1.6 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified firm that is approved, authorized, or licensed by roofing system manufacturer to install manufacturer's product and that is eligible to receive manufacturer's warranty.
- B. Source Limitations: Obtain components for roofing system from or approved in writing by roofing system manufacturer.

#### 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver roofing materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, and directions for storage.
  - 1. Where roofing system is indicated as requiring FMG classification or UL listing, containers shall bear label indicating manufacture in compliance with FMG classification or UL listing quality assurance requirements.
- B. Do not store materials in open or in contact with ground or roof surface.
- C. Store materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing system manufacturer. Store roll goods on ends only.
- D. Protect stored liquid material from direct sunlight.
- E. Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.
- F. Handle and store roofing materials and place equipment in a manner to avoid temporary overloading or permanent deflection of deck.

#### 1.8 PROJECT CONDITIONS

- A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing system to be installed according to manufacturer's written instructions and warranty requirements.
- B. Existing Roof System: Determine the following:
  - 1. Condition and components of existing roof built-up system.
  - 2. Manufacturer of existing roof system.
  - 3. Installer of existing roof system.
  - 4. Remaining life of current roof system warranty.

#### 1.9 WARRANTY

- A. Existing Warranties: Patch existing roofing system using methods and materials so as not to void existing warranties.

1. Confirm existing roof system manufacturer and remaining warranty.
- B. Special Project Warranty: Submit warranty signed by Installer covering the Work of this Section to warrant materials, labor, and weathertightness, for the following warranty period:
  1. Warranty Period: Two years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

- A. Membrane Roofing Materials: Use materials identical to in-place materials.
  1. If identical materials are unavailable or cannot be used, use materials that are compatible with existing in-place materials and when installed will match the visual and functional performance of in-place materials.
    - a. Membrane materials shall be as recommended by manufacturer and installer.
    - b. Existing rock ballast can be reused subject to approval by the Resident Engineer.

### 2.2 AUXILIARY ROOFING MATERIALS

- A. General: Auxiliary materials recommended by roofing system manufacturer for intended use and compatible with roofing membrane.
  1. Liquid-type auxiliary materials shall comply with VOC limits of authorities having jurisdiction.
- B. Cold-Applied Adhesive: Asphalt-based, one or two-part, asbestos-free, cold-applied adhesive specially formulated for compatibility and use with roofing membrane and base flashings.
  1. Adhesive shall be compatible with new and existing roofing materials.
- C. Asphalt Roofing Cement: ASTM D 4586, asbestos free, of consistency required by roofing system manufacturer for application.
- D. Mastic Sealant: Polyisobutylene, plain or modified bitumen, nonhardening, nonmigrating, nonskinning, and nondrying.
- E. Metal Flashing Sheet: Metal flashing sheet is specified in Division 07 Section "Sheet Metal Flashing and Trim."
- F. Insulation Cant Strips: ASTM C 208, Type II, Grade 1, cellulosic-fiber insulation board.

- G. Miscellaneous Accessories: Provide miscellaneous accessories recommended by roofing system manufacturer.

## EXECUTION

### 2.3 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with the following requirements and other conditions affecting performance of work:
1. Verify that wood cants, blocking, curbs, and nailers are securely anchored to roof deck at penetrations and terminations and that nailers match thicknesses of insulation.
  2. Compatibility: Verify compatibility with and suitability of patching materials with existing in-place materials.
  3. Examine existing roof system for leaks in the area of work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected

### 2.4 PREPARATION

- A. Clean substrate of dust, debris, moisture, and other substances detrimental to roofing installation according to roofing system manufacturer's written instructions. Remove sharp projections.
- B. Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction. Remove roof-drain plugs when no work is taking place or when rain is forecast.

### 2.5 INSTALLATION, GENERAL

- A. Install materials in accordance with original roof system manufacturer's requirements and in accordance with applicable requirements of the National Roofing Contractors Association recommendations.
1. Install materials in a manner that will maintain a weather tight condition.
- B. Cant Strips: Install and secure preformed 45-degree insulation cant strips at junctures of roofing membrane system with vertical surfaces or angle changes more than 45 degrees.
- C. Install base flashing over cant strips and other sloped and vertical surfaces, at roof edges, and at penetrations through roof; secure to substrates according to roofing system manufacturer's written instructions, and as follows:
- D. Mechanically fasten top of base flashing securely at terminations.
- E. Flashing Sheet Application: Adhere flashing sheet to substrate in cold-applied adhesive or asphalt roofing cement at rate required by roofing system manufacturer.



- F. Extend base flashing up walls or parapets a minimum of 8 inches above roofing membrane and 4 inches onto field of roofing membrane.

#### 3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Technical Representative: Contractor will engage a qualified technical representative of original roof system manufacturer for review and observation of patching work and to prepare inspection reports.
  - 1. Notify Architect and Owner 48 hours in advance of date and time of inspection.
- B. Repair or remove and replace components inspections indicate that they do not comply with specified requirements.
- C. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

#### 3.5 PROTECTING AND CLEANING

- A. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION

## SECTION 076200 SHEET METAL FLASHING AND TRIM

### 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. Manufactured Sheet Metal Flashing Products:
    - a. Manufactured reglets and counter flashing.
  - 2. Formed Sheet Metal Flashing Products:
    - a. Formed sheet metal flashing and trim.
    - b. Formed rain drainage sheet metal fabrications.
    - c. Formed roof sheet metal fabrications.
- B. Related Sections include the following:
  - 1. Division 07 Sections as applicable to metal roof and wall panels for installation of sheet metal flashing and trim integral with roof and wall panel systems.
  - 2. Division 07 Section "Joint Sealants" for field-applied sheet metal flashing and trim sealants.

#### 1.3 PERFORMANCE REQUIREMENTS

- A. General: Sheet metal flashing and trim assemblies shall withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Completed sheet metal flashing and trim shall not rattle, leak, or loosen, and shall remain watertight.
- B. Thermal Movements: Sheet metal flashing and trim shall allow for thermal movements from ambient and surface temperature changes to prevent buckling, opening of joints, hole elongation, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Provide clips that resist rotation and avoid shear stress as a result of sheet metal and trim thermal movements.
  - 1. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

#### 1.4 SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each manufactured product and accessory.
- B. Shop Drawings: Show fabrication and installation layouts of sheet metal flashing and trim, including plans, elevations, expansion-joint locations, and keyed details. Distinguish between shop and field-assembled work. Include the following:
  - 1. Identification of material, thickness, weight, and finish for each item and location in Project.
  - 2. Details for forming sheet metal flashing and trim, including profiles, shapes, seams, and dimensions.
  - 3. Details for joining, supporting, and securing sheet metal flashing and trim, including layout of fasteners, cleats, clips, and other attachments. Include pattern of seams.
  - 4. Details of termination points and assemblies, including fixed points.
  - 5. Details of expansion joints and expansion-joint covers, including showing direction of expansion and contraction.
  - 6. Details of edge conditions, including eaves, ridges, valleys, rakes, crickets, and counterflashings as applicable.
  - 7. Details of special conditions.
  - 8. Details of connections to adjoining work.
  - 9. Detail formed flashing and trim at a scale of not less than 3 inches per 12 inches.
- C. Samples for Initial Selection: For each type of sheet metal flashing, trim, and accessory indicated with factory-applied color finishes involving color selection.

#### 1.5 QUALITY ASSURANCE

- A. Fabricator Qualifications: Shop that employs skilled workers who custom fabricate sheet metal flashing and trim similar to that required for this Project and whose products have a record of successful in-service performance.
- B. Sheet Metal Flashing and Trim Standard: Comply with SMACNA's "Architectural Sheet Metal Manual" and NRCA's Roofing and Waterproofing Manuals as applicable to project conditions. Conform to dimensions and profiles shown unless more stringent requirements are indicated.
- C. Preinstallation Conference: Conduct conference at Project site.
  - 1. Meet with Owner, Architect, Installer, and installers whose work interfaces with or affects sheet metal flashing and trim including installers of roofing materials, roof accessories, unit skylights, and roof-mounted equipment.
  - 2. Review methods and procedures related to sheet metal flashing and trim.
  - 3. Examine substrate conditions for compliance with requirements, including flatness and attachment to structural members.
  - 4. Document proceedings, including corrective measures and actions required, and furnish copy of record to each participant.

## 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Do not store sheet metal flashing and trim materials in contact with other materials that might cause staining, denting, or other surface damage. Store sheet metal flashing and trim materials away from uncured concrete and masonry.
- B. Protect strippable protective covering on sheet metal flashing and trim from exposure to sunlight and high humidity, except to the extent necessary for the period of sheet metal flashing and trim installation.

## 1.7 COORDINATION

- A. Coordinate installation of sheet metal flashing and trim with interfacing and adjoining construction to provide a leakproof, secure, and noncorrosive installation.

## 1.8 WARRANTY

- A. Special Warranty on Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace sheet metal flashing and trim that shows evidence of deterioration of factory-applied finishes within specified warranty period.
  - 1. Exposed Finish: Deterioration includes, but is not limited to, the following:
    - a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
    - b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
    - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
  - 2. Finish Warranty Period: 20 years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 SHEET METALS

- A. General: Protect mechanical and other finishes on exposed surfaces from damage by applying a strippable, temporary protective film before shipping.
- B. Aluminum Sheet: ASTM B 209, alloy as standard with manufacturer for finish required, with temper as required to suit forming operations and performance required.
  - 1. As-Milled Finish: Mill finish.
  - 2. Surface: Smooth, flat.
  - 3. Clear Anodic Finish, Coil Coated: AAMA 611, AA-M12C22A41, Class I, 0.018 mm or thicker.
  - 4. Color Anodic Finish, Coil Coated: AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm or thicker.

- a. Color: As selected by Architect from full range of industry colors and color densities
    - b. Color Range: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
  5. Exposed Coil-Coated Finishes:
    - a. Two-Coat Fluoropolymer: AAMA 620. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
    - b. Siliconized Polyester: Epoxy primer and silicone-modified, polyester-enamel topcoat; with a dry film thickness of not less than 0.2 mil (0.005 mm) for primer and 0.8 mil (0.02 mm) for topcoat.
  6. Color: As selected by Architect from manufacturer's full range.
  7. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil.
- C. Metallic-Coated Steel Sheet: Restricted flatness steel sheet, metallic coated by the hot-dip process and prepainted by the coil-coating process to comply with ASTM A 755/A 755M.
1. Zinc-Coated (Galvanized) Steel Sheet: ASTM A 653/A 653M, G90 (Z275) coating designation; structural quality.
  2. Aluminum-Zinc Alloy-Coated Steel Sheet: ASTM A 792/A 792M, Class AZ50 coating designation, Grade 40 (Class AZM150 coating designation, Grade 275); structural quality.
  3. Surface: Smooth, flat.
  4. Exposed Coil-Coated Finish:
    - a. Two-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
  5. Color: As selected by Architect from manufacturer's full range.
  6. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil.

## 2.2 UNDERLAYMENT MATERIALS

- A. Polyethylene Sheet: 6-mil thick polyethylene sheet complying with ASTM D 4397.
- B. Felt: ASTM D 226, Type II (No. 30), asphalt-saturated organic felt, nonperforated.

## 2.3 MISCELLANEOUS MATERIALS

- A. General: Provide materials and types of fasteners, solder, welding rods, protective coatings, separators, sealants, and other miscellaneous items as required for complete sheet metal flashing and trim installation and recommended by manufacturer of primary sheet metal or manufactured item unless otherwise indicated.
- B. Fasteners: Wood screws, annular threaded nails, self-tapping screws, self-locking rivets and bolts, and other suitable fasteners designed to withstand design loads and recommended by manufacturer of primary sheet metal or manufactured item.
  - 1. Self-drilling screws, gasketed, with hex-washer head.
  - 2. Blind Fasteners: High-strength aluminum or stainless-steel rivets suitable for metal being fastened.
  - 3. Fasteners for Aluminum Sheet: Aluminum or Series 300 stainless steel.
  - 4. Fasteners for Zinc-Coated (Galvanized) or Aluminum-Zinc Alloy-Coated Steel Sheet: Hot-dip galvanized steel according to ASTM A 153/A 153M or ASTM F 2329 or Series 300 stainless steel.
- C. Solder for Zinc-Coated (Galvanized) Steel: ASTM B 32, Grade Sn50, 50 percent tin and 50 percent lead or Grade Sn60, 60 percent tin and 40 percent lead.
- D. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch wide and 1/8 inch thick.
- E. Elastomeric Sealant: ASTM C 920, elastomeric polyurethane, polysulfide, or silicone polymer sealant; low modulus; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.
- F. Butyl Sealant: ASTM C 1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for hooked-type expansion joints with limited movement.
- G. Bituminous Coating: Cold-applied asphalt emulsion complying with ASTM D 1187.
- H. Asphalt Roofing Cement: ASTM D 4586, asbestos free, of consistency required for application.

## 2.4 MANUFACTURED SHEET METAL FLASHING AND TRIM

- A. Reglets: Units of type, material, and profile indicated, formed to provide secure interlocking of separate reglet and counterflashing pieces, and compatible with flashing indicated with factory-mitered and welded corners and junctions.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Fry Reglet Corporation.
    - b. Heckmann Building Products Inc.

c. Hickman, W. P. Company.

2. Material: Galvanized steel, 0.0217 inch thick.
3. Surface-Mounted Type: Provide with slotted holes for fastening to substrate, with neoprene or other suitable weatherproofing washers and with channel for sealant at top edge.
4. Flexible Flashing Retainer: Provide resilient plastic or rubber accessory to secure flexible flashing in reglet where clearance does not permit use of standard metal counterflashing or where Drawings show reglet without metal counterflashing.
5. Counterflashing Wind-Restraint Clips: Provide clips to be installed before counterflashing to prevent wind uplift of counterflashing lower edge.

## 2.5 FABRICATION, GENERAL

- A. General: Custom fabricate sheet metal flashing and trim as indicated on Drawings and to comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, geometry, metal thickness, and other characteristics of item indicated. Fabricate items at the shop to greatest extent possible.
  1. Fabricate sheet metal flashing and trim in thickness or weight needed to comply with performance requirements, but not less than that specified for each application and metal.
  2. Obtain field measurements for accurate fit before shop fabrication.
  3. Form sheet metal flashing and trim without excessive oil canning, buckling, and tool marks and true to line and levels indicated, with exposed edges folded back to form hems.
  4. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces exposed to view.
- B. Fabrication Tolerances: Fabricate sheet metal flashing and trim that is capable of installation to a tolerance of 1/4 inch in 20 feet on slope and location lines as indicated and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.
- C. Sealed Joints: Form nonexpansion but movable joints in metal to accommodate elastomeric sealant.
- D. Expansion Provisions: Where lapped expansion provisions cannot be used, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with butyl sealant concealed within joints.
- E. Fabricate cleats and attachment devices from same material as accessory being anchored and of sizes as recommended by SMACNA's "Architectural Sheet Metal Manual" for application, but not less than thickness of metal being secured.
- F. Seams: Fabricate nonmoving seams with flat-lock seams and as follows:
  1. Seams for Pre-Finished Metal: Form seams and seal with elastomeric sealant unless otherwise recommended by sealant manufacturer for intended use. Rivet joints where necessary for strength.

2. Seams for Unfinished Sheet Steel: Tin edges to be seamed, form seams, and solder.
3. Seams for Unfinished Aluminum: Form seams and seal with epoxy seam sealer. Rivet joints where necessary for strength.

- G. Do not use graphite pencils to mark metal surfaces.
- H. Conceal fasteners and expansion provisions where possible on exposed-to-view sheet metal flashing and trim, unless otherwise indicated.

## 2.6 LOW-SLOPE ROOF SHEET METAL FABRICATIONS

- A. Roof Edge Flashing and Fascia Caps: Fabricate in minimum 96-inch long, but not exceeding 10 foot long, sections. Furnish with 6-inch wide joint cover plates. Fabricate from 0.028 inch (24 gage) thick galvanized steel.
1. Joint Style: Lap, 4 inches wide.
- B. Copings: Fabricate to cross section indicated in minimum 96-inch long, but not exceeding 10 foot long, sections. Fabricate joint plates of same thickness as copings. Furnish with continuous cleats to support edge of external leg and drill elongated holes for fasteners on interior leg. Miter corners, seal, and solder or weld watertight. Fabricate from 0.028 inch (24 gage) thick galvanized steel.
1. Joint Style: Butt, with 12-inch wide, concealed backup plate and 6-inch wide, exposed cover plates
- C. Counterflashing: Fabricate from 0.028 inch (24 gage) thick galvanized steel.
- D. Roof-Penetration Flashing: Fabricate from the following material:
1. Lead: 4.0-lb/sq.ft., hard tempered.
- E. Roof-Drain Flashing: Fabricate from 0.028 inch (24 gage) thick galvanized steel.

## 2.7 STEEP-SLOPE ROOF SHEET METAL FABRICATIONS

- A. Apron, Step, Cricket, and Backer Flashing: Fabricate from 0.028 inch (24 gage) thick galvanized steel.
- B. Drip Edges: Fabricate from 0.028 inch (24 gage) thick galvanized steel.
- C. Base Flashing: Fabricate from 0.028 inch (24 gage) thick galvanized steel.
- D. Roof-Penetration Flashing: Fabricate from 0.028 inch (24 gage) thick galvanized steel.



## 2.8 WALL SHEET METAL FABRICATIONS

- A. Through-Wall Flashing: Fabricate continuous flashings in minimum 96-inch long, but not exceeding 12 foot long, sections, under copings, at shelf angles, and where indicated. Fabricate discontinuous lintel, sill, and similar flashings to extend 6 inches beyond each side of wall openings. Form with 2-inch high end dams. Fabricate from 0.028 inch (24 gage) thick galvanized steel.

## 2.9 MISCELLANEOUS SHEET METAL FABRICATIONS

- A. Miscellaneous Sheet Metal Fabrications: Fabricate from 0.028 inch (24 gage) thick galvanized steel unless otherwise indicated.

## 2.10 FINISHES

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions and other conditions affecting performance of work.
  - 1. Verify compliance with requirements for installation tolerances of substrates.
  - 2. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.
  - 3. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 UNDERLAYMENT INSTALLATION

- A. Polyethylene Sheet: Install polyethylene sheet with adhesive for anchorage to minimize use of mechanical fasteners under sheet metal flashing and trim. Apply in shingle fashion to shed water, with lapped and taped joints of not less than 2 inches.

- B. Felt Underlayment: Install felt underlayment with adhesive for temporary anchorage to minimize use of mechanical fasteners under sheet metal flashing and trim. Apply in shingle fashion to shed water, with lapped joints of not less than 2 inches.

### 3.3 INSTALLATION, GENERAL

- A. General: Anchor sheet metal flashing and trim and other components of the Work securely in place, with provisions for thermal and structural movement. Use fasteners, solder, welding rods, protective coatings, separators, sealants, and other miscellaneous items as required to complete sheet metal flashing and trim system.
  - 1. Install sheet metal flashing and trim true to line and levels indicated. Provide uniform, neat seams with minimum exposure of solder, welds, and sealant.
  - 2. Install sheet metal flashing and trim to fit substrates and to result in watertight performance. Verify shapes and dimensions of surfaces to be covered before fabricating sheet metal.
  - 3. Space cleats not more than 12 inches apart. Anchor each cleat with two fasteners. Bend tabs over fasteners.
  - 4. Install exposed sheet metal flashing and trim without excessive oil canning, buckling, and tool marks.
  - 5. Install sealant tape where indicated.
  - 6. Torch cutting of sheet metal flashing and trim is not permitted.
  - 7. Do not use graphite pencils to mark metal surfaces.
- B. Metal Protection: Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with bituminous coating or by other permanent separation as recommended by SMACNA.
  - 1. Coat back side of uncoated aluminum sheet metal flashing and trim with bituminous coating where flashing and trim will contact wood, ferrous metal, or cementitious construction.
  - 2. Underlayment: Where installing metal flashing directly on cementitious or wood substrates, install a course of felt underlayment and cover with a slip sheet or install a course of polyethylene sheet.
- C. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet with no joints allowed within 24 inches of corners or intersections. Where lapped expansion provisions cannot be used or would not be sufficiently watertight, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with sealant concealed within joints.
- D. Fastener Sizes:
  - 1. Metal Framing, Backing, and Decking: Use fasteners of sizes that will penetrate metal framing, backing, and decking not less than recommended by fastener manufacturer to achieve maximum pull-out resistance.
- E. Seal joints as shown and as required for watertight construction.
  - 1. Where sealant-filled joints are used, embed hooked flanges of joint members not less than 1 inch into sealant. Form joints to completely conceal sealant. When

ambient temperature at time of installation is moderate, between 40 and 70 deg F, set joint members for 50 percent movement each way. Adjust setting proportionately for installation at higher ambient temperatures. Do not install sealant-type joints at temperatures below 40 deg F.

2. Prepare joints and apply sealants to comply with requirements in Division 07 Section "Joint Sealants."

- F. Soldered Joints: Clean surfaces to be soldered, removing oils and foreign matter. Pre-tin edges of sheets to be soldered to a width of 1-1/2 inches, except reduce pre-tinning where pre-tinned surface would show in completed Work.

1. Do not solder coil-coated steel and aluminum sheet.
2. Do not use torches for soldering. Heat surfaces to receive solder and flow solder into joint. Fill joint completely. Completely remove flux and spatter from exposed surfaces.

### 3.4 ROOF DRAINAGE SYSTEM INSTALLATION

- A. General: Install sheet metal roof drainage items to produce complete roof drainage system according to SMACNA recommendations and as indicated. Coordinate installation of roof perimeter flashing with installation of roof drainage system.

### 3.5 ROOF FLASHING INSTALLATION

- A. General: Install sheet metal flashing and trim to comply with performance requirements, SMACNA's "Architectural Sheet Metal Manual," and NRCA's Roofing and Waterproofing Manuals as applicable to project conditions. Provide concealed fasteners where possible, set units true to line, and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.
- B. Roof Edge Flashing: Anchor to resist uplift and outward forces according to referenced requirements and as indicated. Interlock bottom edge of roof edge flashing with continuous cleat anchored to substrate at staggered 3-inch centers.
- C. Copings: Anchor to resist uplift and outward forces according to recommendations in SMACNA's "Architectural Sheet Metal Manual" and as indicated.
1. Interlock exterior bottom edge of coping with continuous cleat anchored to substrate at 16-inch centers.
  2. Anchor interior leg of coping with washers and screw fasteners through slotted holes at 24-inch centers.
- D. Pipe or Post Counterflashing: Install counterflashing umbrella with close-fitting collar with top edge flared for elastomeric sealant, extending a minimum of 4 inches over base flashing. Install stainless-steel draw band and tighten.
- E. Counterflashing: Coordinate installation of counterflashing with installation of base flashing. Insert counterflashing in reglets or receivers and fit tightly to base flashing. Extend counterflashing 4 inches over base flashing. Lap counterflashing joints a

minimum of 4 inches and bed with sealant. Secure in a waterproof manner by means of snap-in installation and sealant or lead wedges and sealant.

- F. Roof-Penetration Flashing: Coordinate installation of roof-penetration flashing with installation of roofing and other items penetrating roof. Seal with elastomeric sealant and clamp flashing to pipes that penetrate roof.

### 3.6 WALL FLASHING INSTALLATION

- A. General: Install sheet metal wall flashing to intercept and exclude penetrating moisture according to SMACNA recommendations and as indicated. Coordinate installation of wall flashing with installation of wall-opening components such as windows, doors, and louvers.
- B. Reglets and Counterflashing: Install in accordance with manufacturer's written installation instructions.
- C. Openings Flashings in Frame Construction: Install continuous head, sill, jamb, and similar flashings to extend 4 inches beyond wall openings, unless shown otherwise on the drawings.

### 3.7 ERECTION TOLERANCES

- A. Installation Tolerances: Shim and align sheet metal flashing and trim within installed tolerance of 1/4 inch in 20 feet on slope and location lines as indicated and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.

### 3.8 CLEANING AND PROTECTION

- A. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.
- B. Clean and neutralize flux materials. Clean off excess solder and sealants.
- C. Remove temporary protective coverings and strippable films as sheet metal flashing and trim are installed. On completion of installation, clean finished surfaces, including removing unused fasteners, metal filings, pop rivet stems, and pieces of flashing. Maintain in a clean condition during construction.
- D. Replace sheet metal flashing and trim that have been damaged or that have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION

## SECTION 07 84 00 FIRESTOPPING

### PART 1 GENERAL

#### 1.1 DESCRIPTION

- A. Closures of openings in walls, floors, and roof decks against penetration of flame, heat, and smoke or gases in fire resistant rated construction.
- B. Closure of openings in walls against penetration of gases or smoke in smoke partitions.

#### 1.2 RELATED WORK

- A. Spray applied fireproofing: Section 07 81 00, APPLIED FIREPROOFING
- B. Sealants and application: Section 07 92 00, JOINT SEALANTS.
- C. Fire and smoke damper assemblies in ductwork: Section 23 00 00, HEATING, VENTILATING AND AIR CONDITIONING.

#### 1.3 SUBMITTALS

- A. Manufacturers literature, data, and installation instructions for types of firestopping and smoke stopping used.
- B. List of FM, UL, or WH classification number of systems installed.
- C. Certified laboratory test reports for ASTM E814 tests for systems not listed by FM, UL, or WH proposed for use.

#### 1.4 DELIVERY AND STORAGE

- A. Deliver materials in their original unopened containers with manufacturer's name and product identification.
- B. Store in a location providing protection from damage and exposure to the elements.

#### 1.5 WARRANTY

- A. Firestopping work subject to the terms of the Article "Warranty of Construction", FAR clause 52.246-21, except extend the warranty period to five years.

#### 1.6 QUALITY ASSURANCE

- A. FM, UL, or WH or other approved laboratory tested products will be acceptable.

#### 1.7 APPLICABLE PUBLICATIONS

- A. Publications listed below form a part of this specification to the extent referenced. Publications are referenced in the text by the basic designation only.
- B. American Society for Testing and Materials (ASTM):
  - 1...E84-10 Surface Burning Characteristics of Building Materials
  - 2...E814-11 Fire Tests of Through-Penetration Fire Stops

- C. Factory Mutual Engineering and Research Corporation (FM): Annual Issue Approval Guide Building Materials
- D. Underwriters Laboratories, Inc. (UL):
  - 1...Annual Issue Building Materials Directory
  - 2...Annual Issue Fire Resistance Directory: 1479-10; Fire Tests of Through-Penetration Firestops
- E. Warnock Hersey (WH): Annual Issue Certification Listings

## PART 2 - PRODUCTS

### 2.1 FIRESTOP SYSTEMS

- A. Use either factory built (Firestop Devices) or field erected (through-Penetration Firestop Systems) to form a specific building system maintaining required integrity of the fire barrier and stop the passage of gases or smoke.
- B. Through-penetration firestop systems and firestop devices tested in accordance with ASTM E814 or UL 1479 using the "F" or "T" rating to maintain the same rating and integrity as the fire barrier being sealed. "T" ratings are not required for penetrations smaller than or equal to 100 mm (4 in) nominal pipe or 0.01 m<sup>2</sup> (16 sq. in.) in overall cross sectional area.
- C. Products requiring heat activation to seal an opening by its intumescence shall exhibit a demonstrated ability to function as designed to maintain the fire barrier.
- D. Firestop sealants used for firestopping or smoke sealing shall have following properties:
  - 1. Contain no flammable or toxic solvents.
  - 2. Have no dangerous or flammable out gassing during the drying or curing of products.
  - 3. Water-resistant after drying or curing and unaffected by high humidity, condensation or transient water exposure.
  - 4. When used in exposed areas, shall be capable of being sanded and finished with similar surface treatments as used on the surrounding wall or floor surface.
- E. Firestopping system or devices used for penetrations by glass pipe, plastic pipe or conduits, unenclosed cables, or other non-metallic materials shall have following properties:
  - 1. Classified for use with the particular type of penetrating material used.
  - 2. Penetrations containing loose electrical cables, computer data cables, and communications cables protected using firestopping systems that allow unrestricted cable changes without damage to the seal.

3. Intumescent products which would expand to seal the opening and act as fire, smoke, toxic fumes, and, water sealant.

F. Maximum flame spread of 25 and smoke development of 50 when tested in accordance with ASTM E84.

G. FM, UL, or WH rated or tested by an approved laboratory in accordance with ASTM E814.

H. Materials to be asbestos free.

## 2.2 SMOKE STOPPING IN SMOKE PARTITIONS

A. Use silicone sealant in smoke partitions as specified in Section 07 92 00, JOINT SEALANTS.

B. Use mineral fiber filler and bond breaker behind sealant.

C. Sealants shall have a maximum flame spread of 25 and smoke developed of 50 when tested in accordance with E84.

D. When used in exposed areas capable of being sanded and finished with similar surface treatments as used on the surrounding wall or floor surface.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

Submit product data and installation instructions, as required by article, submittals, after an on site examination of areas to receive firestopping.

### 3.2 PREPARATION

A. Remove dirt, grease, oil, loose materials, or other substances that prevent adherence and bonding or application of the firestopping or smoke stopping materials.

B. Remove insulation on insulated pipe for a distance of 150 mm (six inches) on either side of the fire rated assembly prior to applying the firestopping materials unless the firestopping materials are tested and approved for use on insulated pipes.

### 3.3 INSTALLATION

A. Do not begin work until the specified material data and installation instructions of the proposed firestopping systems have been submitted and approved.

B. Install firestopping systems with smoke stopping in accordance with FM, UL, WH, or other approved system details and installation instructions.

C. Install smoke stopping seals in smoke partitions.

### 3.4 CLEAN-UP AND ACCEPTANCE OF WORK

A. As work on each floor is completed, remove materials, litter, and debris.

- B. Do not move materials and equipment to the next-scheduled work area until completed work is inspected and accepted by the Resident Engineer.
- C. Clean up spills of liquid type materials.

END OF SECTION



## SECTION 079200 JOINT SEALANTS

### PART 1 - GENERAL

#### RELATED DOCUMENTS

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

#### SUMMARY

Section Includes:

1. Silicone joint sealants.
2. Urethane joint sealants.
3. Latex joint sealants.
4. Acoustical joint sealants.
5. Joint sealant Backings

Related Sections:

6. Division 04 Section "Concrete Unit Masonry" for masonry control and expansion joint fillers and gaskets.
7. Division 07 Section "Expansion Control" for building expansion joints.
8. Division 07 Section "Penetration Firestopping" for sealing joints in fire-resistance-rated construction.

#### SUBMITTALS

Product Data: For each joint-sealant product indicated.

Samples for Initial Selection: Manufacturer's color charts consisting of strips of cured sealants showing the full range of colors available for each product exposed to view.

Joint-Sealant Schedule: Include the following information:

9. Joint-sealant application, joint location, and designation.
10. Joint-sealant manufacturer and product name.
11. Joint-sealant formulation.
12. Joint-sealant color.

Qualification Data: For qualified Installer.

Product Certificates: For each kind of joint sealant and accessory, from manufacturer.

Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, indicating that sealants comply with requirements.

Preconstruction Field-Adhesion Test Reports: Indicate which sealants and joint preparation methods resulted in optimum adhesion to joint substrates based on testing specified in "Preconstruction Testing" Article.

Field-Adhesion Test Reports: For each sealant application tested.

Warranties: Sample of special warranties.

## QUALITY ASSURANCE

Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.

Source Limitations: Obtain each kind of joint sealant from single source from single manufacturer.

Product Testing: Test joint sealants using a qualified testing agency.

13. Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1021 to conduct the testing indicated.

Mockups: Install sealant in mockups of assemblies specified in other Sections that are indicated to receive joint sealants specified in this Section. Use materials and installation methods specified in this Section.

## FIELD CONDITIONS

Do not proceed with installation of joint sealants under the following conditions:

14. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40 deg F.
15. When joint substrates are wet.
16. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
17. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

## WARRANTY

Special Installer's Warranty: Manufacturer's standard form in which Contractor and Installer agree to repair or replace joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.

18. Warranty Period: Two years from date of Substantial Completion.

Special Manufacturer's Warranty: Manufacturer's standard form in which joint-sealant manufacturer agrees to furnish joint sealants to repair or replace those that do not

comply with performance and other requirements specified in this Section within specified warranty period.

19. Warranty Period: Two years from date of Substantial Completion.

Special warranties specified in this article shall warrant that all exposed sealants will be guaranteed against any crazing developing on the surfaces of the material, any staining of adjacent surfaces by sealant or by primer (yellowing, etc.), chalking, or color changes on surface of cured sealant.

Special warranties specified in this article exclude deterioration or failure of joint sealants from the following:

20. Movement of the structure caused by structural settlement or errors attributable to design or construction resulting in stresses on the sealant exceeding sealant manufacturer's written specifications for sealant elongation and compression.
21. Disintegration of joint substrates from natural causes exceeding design specifications.
22. Mechanical damage caused by individuals, tools, or other outside agents.
23. Changes in sealant appearance caused by accumulation of dirt or other atmospheric contaminants.

## PART 2 - PRODUCTS

### JOINT SEALANTS, GENERAL

Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.

VOC Content of Sealants: VOC content of sealants shall comply with requirements of authorities having jurisdiction. Sealants and sealant primers used inside the weatherproofing system shall comply with the following limits for VOC content when calculated according to 40 CFR 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.

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.

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.

Suitability for Contact with Food: Where sealants are used in areas of food preparation, use products that comply with 21 CFR 177.2600 and are USDA approved.

Colors of Exposed Joint Sealants: As selected by Architect from manufacturer's full range.

## SILICONE JOINT SEALANTS

Single-Component, Nonsag, Neutral-Curing Silicone Joint Sealant: ASTM C 920, Type S, Grade NS, Class 100/50, for Use NT.

4. Products: Subject to compliance with requirements, provide one of the following:
  - a. Dow Corning Corporation; 790.
  - b. GE Advanced Materials - Silicones; SilPruf LM SCS2700.
  - c. Tremco Incorporated; Spectrem 1.
5. Joint Sealant Application: Exterior joints where one or both joint faces are masonry, stone, concrete or other porous materials.

Single-Component, Nonsag, Acid-Curing Silicone Joint Sealant: ASTM C 920, Type S, Grade NS, Class 25, for Use NT.

6. Products: Subject to compliance with requirements, provide one of the following:
  - a. Dow Corning Corporation; 999-A.
  - b. GE Advanced Materials - Silicones; Contractors SCS1000.
  - c. Tremco Incorporated; Proglaze.
7. Joint Sealant Application: Exterior joints where both joint faces are metal, glass, plastic, or other non-porous material.

Mildew-Resistant, Single-Component, Acid-Curing Silicone Joint Sealant: ASTM C 920, Type S, Grade NS, Class 25, for Use NT.

8. Products: Subject to compliance with requirements, provide one of the following:
  - a. Dow Corning Corporation; 786 Mildew Resistant.
  - b. GE Advanced Materials - Silicones; Sanitary SCS1700.
  - c. Tremco Incorporated; Tremsil 200 Sanitary.
9. Joint Sealant Application: Interior joints between plumbing fixtures and floor or wall surfaces of non-porous materials.

## URETHANE JOINT SEALANTS

Single-Component, Nonsag, Urethane Joint Sealant: ASTM C 920, Type S, Grade NS, Class 25, for Use NT.

10. Products: Subject to compliance with requirements, provide one of the following:

- a. BASF Building Systems; Sonolastic NP1.
  - b. Pecora Corporation; Dynatrol I-XL.
  - c. Sika Corporation, Construction Products Division; Sikaflex - 1a.
11. Joint Sealant Application: Exterior joints of hollow metal frames, exterior joints in concrete and masonry walls, and interior and exterior joints requiring painting.

Single-Component, Pourable, Traffic-Grade, Urethane Joint Sealant: ASTM C 920, Type S, Grade P, Class 25, for Use T.

12. Products: Subject to compliance with requirements, provide one of the following:
- a. BASF Building Systems; Sonolastic SL 1.
  - b. Pecora Corporation; Urexpan NR-201.
  - c. Sika Corporation. Construction Products Division; Sikaflex - 1CSL.
13. Joint Sealant Application: Interior concrete slab floor joints and exterior paving joints.

#### LATEX JOINT SEALANTS

Latex Joint Sealant: Acrylic latex or siliconized acrylic latex, ASTM C 834, Type OP, Grade NF.

14. Products: Subject to compliance with requirements, provide one of the following:
- a. BASF Building Systems; Sonolac.
  - b. Pecora Corporation; AC-20+.
  - c. Tremco Incorporated; Tremflex 834.
15. Joint Sealant Application: Interior non-moving joints between gypsum board and adjacent materials, trim, or similar surfaces.

#### ACOUSTICAL JOINT SEALANTS

Acoustical Joint Sealant: Manufacturer's standard nonsag, paintable, nonstaining latex sealant complying with ASTM C 834. Product effectively reduces airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90.

16. Products: Subject to compliance with requirements, provide one of the following:
- a. GE Construction Sealants; RCS20 Acoustical.
  - b. Pecora Corporation; AC-20 FTR or AIS-919.
  - c. Tremco, Incorporated; Tremco Acoustical Sealant.
  - d. USG Corporation; SHEETROCK Acoustical Sealant.
17. Joint Sealant Application: Interior joints of acoustically rated construction and where indicated on Drawings.

## JOINT SEALANT BACKING

General: Provide sealant backings of material that are nonstaining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.

Cylindrical Sealant Backings: ASTM C 1330, Type C (closed-cell material with a surface skin) or Type B (bicellular material with a surface skin), as approved in writing by joint-sealant manufacturer for joint application indicated, and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.

Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint. Provide self-adhesive tape where applicable.

## MISCELLANEOUS MATERIALS

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.

Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants to joint substrates.

Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

## PART 3 - EXECUTION

### EXAMINATION

Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.

Proceed with installation only after unsatisfactory conditions have been corrected.

### PREPARATION

Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions and the following requirements:

1. Remove laitance and form-release agents from concrete.

2. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
3. Clean porous joint substrate surfaces by brushing, grinding, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air. Porous joint substrates include the following:
  - a. Concrete.
  - b. Unglazed surfaces of ceramic tile.
4. 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. Nonporous joint substrates include the following:
  - a. Metal.
  - b. Glass.
  - c. Porcelain enamel.
  - d. Glazed surfaces of ceramic tile.

**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.

**Etch concrete and masonry joint surfaces** as recommended by manufacturer to remove excess alkalinity, unless sealant manufacturer's printed instructions indicate that alkalinity does not interfere with sealant bond and performance. Etch with 5% solution of muriatic acid; neutralize with diluted ammonia solution, rinse thoroughly with water and allow to dry before sealant installation.

**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.

## INSTALLATION OF JOINT SEALANTS

**General:** Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.

Do not allow sealants or compounds to overflow or spill onto adjoining surfaces, or to migrate into voids of adjoining surfaces.

**Sealant Installation Standard:** Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

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.

5. Do not leave gaps between ends of sealant backings.
6. Do not stretch, twist, puncture, or tear sealant backings.
7. Remove absorbent sealant backings that have become wet before sealant application and replace them with dry materials.

Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.

Install sealants using proven techniques that comply with the following and at the same time backings are installed:

8. Place sealants so they directly contact and fully wet joint substrates.
9. Completely fill recesses in each joint configuration.
10. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

Install sealant to depths as shown or, if not shown, as recommended by sealant manufacturer but within the following general limitations, measured at center (thin) section of bead:

11. For sidewalks, pavements and similar joints sealed with elastomeric sealants and subject to traffic and other abrasion and indentation exposures, fill joints to a depth equal to 75 percent of joint width, but neither more than 5/8 inch deep nor less than 3/8 inch deep.
12. For normal moving joints sealed with elastomeric sealants but not subject to traffic, fill joints to a depth equal to 50 percent of joint width, but neither more than 1/2 inch deep nor less than 1/4 inch deep.
13. For joints sealed with non-elastomeric sealants and caulking compounds, fill joints to a depth in range of 75 to 125 percent of joint width.

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.

14. Remove excess sealant from surfaces adjacent to joints.
15. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
16. Provide concave joint profile per Figure 8A in ASTM C 1193, unless otherwise indicated.

Acoustical Sealant Installation: At sound-rated assemblies and elsewhere as indicated, seal construction at perimeters, behind control joints, and at openings and penetrations with a continuous bead of acoustical sealant. Install acoustical sealant at both faces of partitions at perimeters and through penetrations. Comply with ASTM C 919 and with manufacturer's written recommendations.



STC-Rated Assemblies: Seal construction at perimeters, behind control joints, and at openings and penetrations with a continuous bead of acoustical joint sealant. Install acoustical joint sealants at both faces of partitions, at perimeters, and through penetrations. Comply with ASTM C 919, ASTM C 1193, and manufacturer's written recommendations for closing off sound-flanking paths around or through assemblies, including sealing partitions to underside of floor slabs above acoustical ceilings.

## FIELD QUALITY CONTROL

Field-Adhesion Testing: Field test joint-sealant adhesion to joint substrates as follows:

17. Extent of Testing: Test completed and cured sealant joints as follows:
  - a. Perform 1 test for each 1000 feet of joint length thereafter or 1 test per each floor per elevation.
18. 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.
  - a. For joints with dissimilar substrates, verify adhesion to each substrate separately; extend cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.
19. Inspect tested joints and report on the following:
  - a. Whether sealants filled joint cavities and are free of voids.
  - b. Whether sealant dimensions and configurations comply with specified requirements.
  - c. Whether sealants in joints connected to pulled-out portion failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each kind of product and joint substrate. Compare these results to determine if adhesion passes sealant manufacturer's field-adhesion hand-pull test criteria.
20. Record test results in a field-adhesion-test log. Include dates when sealants were installed, names of persons who installed sealants, test dates, test locations, whether joints were primed, adhesion results and percent elongations, sealant fill, sealant configuration, and sealant dimensions.
21. Repair sealants pulled from test area by applying new sealants following same procedures used originally to seal joints. Ensure that original sealant surfaces are clean and that new sealant contacts original sealant.

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.

## CLEANING

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.

## PROTECTION

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

END OF SECTION

## SECTION 083113 ACCESS DOORS AND FRAMES

### 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:
  - 1. Access doors and frames for walls and ceilings.
- B. Related Sections include the following:
  - 1. Division 07 Section "Roof Access Hatches" for roof hatches.
  - 2. Division 22 and 23 Sections as applicable for access to Plumbing and Mechanical valves and equipment behind finished surfaces.
  - 3. Division 26 Sections as applicable for access to Electrical equipment behind finished surfaces.

#### 1.3 SUBMITTALS

- A. Product Data: For each type of access door and frame indicated. Include construction details, materials, individual components and profiles, and finishes.
- B. Access Door and Frame Schedule: Provide access door and frame schedule, including types, locations, sizes, latching or locking provisions, and other data pertinent to installation.

#### 1.4 COORDINATION

- A. Coordinate locations and sizes for access doors needed to gain access to concealed plumbing, mechanical, or other concealed work with mechanical and plumbing trades.

### PART 2 - PRODUCTS

#### 2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Rated Access Doors and Frames: Units complying with NFPA 80 that are identical to access door and frame assemblies tested for fire-test-response

characteristics per the following test method and that are listed and labeled by UL or another testing and inspecting agency acceptable to authorities having jurisdiction:

1. NFPA 252 or UL 10B for vertical access doors and frames.
2. NFPA 288 for fire-rated access door assemblies installed horizontally.

## 2.2 ACCESS DOORS AND FRAMES FOR WALLS AND CEILINGS

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

1. Babcock-Davis.
2. Dur-Red Products.
3. J. L. Industries, Inc.
4. Karp Associates, Inc.
5. Larsen's Manufacturing Company.
6. Milcor Inc.
7. Nystrom, Inc.

B. Source Limitations: Obtain each type of access door and frame from single source from single manufacturer.

C. Non-Fire Resistance Rated Flush Access Doors and Frames with Exposed Trim:

1. Assembly Description: Fabricate door to fit flush to frame. Provide manufacturer's standard-width exposed flange, proportional to door size.
2. Material:

a. Uncoated or Metallic Coated Steel Sheet:

- 1) Locations: Non-fire resistance rated wall and ceiling surfaces of painted gypsum board.
- 2) Doors: Nominal 0.074 inch (uncoated) or 0.078 inch (coated) (14 gage) thickness.
- 3) Frames: Nominal 0.060 inch (uncoated) or 0.064 inch (coated) (16 gage) thickness.
- 4) Finish: Factory prime finish, manufacturer's standard baked on rust inhibitive gray primer.

b. Stainless Steel Sheet:

- 1) Locations: Non-fire resistance rated wall and ceiling surfaces with ceramic tile finish or prefinished wall paneling.
- 2) Doors: Nominal 0.062 inch (16 gage) thickness.
- 3) Frames: Same material and thickness as doors.
- 4) Finish: No. 4.

3. Hinges: Manufacturer's standard concealed spring pin hinge.
4. Latch/Lock:

- a. Latch: Cam latch operated by screwdriver with interior release.
  - 1) Provide where access doors are located in private or semi-private areas such as office spaces, storage rooms, equipment rooms, and private toilet rooms.
- b. Lock: Manufacturer's standard key operated cylinder cam lock. Furnish two keys per lock and key all locks alike.
  - 1) Provide where access doors are located in public areas such as exterior walls and ceilings, and public toilet rooms.
- 5. Size: As indicated on drawings or as required to provide access to valves and equipment concealed behind finished surfaces.

## 2.3 MATERIALS

- A. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
- B. Steel Sheet: Uncoated or electrolytic zinc coated, ASTM A 879/A 879M, with cold-rolled steel sheet substrate complying with ASTM A 1008/A 1008M, Commercial Steel (CS), exposed.
- C. Stainless-Steel Sheet, Strip, Plate, and Flat Bars: ASTM A 666, Type 304. Remove tool and die marks and stretch lines or blend into finish.
  - 1. Finish: Directional satin finish, No. 4.

## 2.4 FABRICATION

- A. General: Provide access door and frame assemblies manufactured as integral units ready for installation.
- B. Size: As indicated on Drawings or size as required for access to concealed spaces, valves, or equipment.
  - 1. Access to attic spaces shall not be less than 22 x 30 inches clear opening.
  - 2. Size Variations: Obtain Architect's acceptance of manufacturer's standard-size units, which may vary slightly from sizes indicated.
- C. Metal Surfaces: For metal surfaces exposed to view in the completed Work, provide materials with smooth, flat surfaces without blemishes. Do not use materials with exposed pitting, seam marks, roller marks, rolled trade names, or roughness.
- D. Doors and Frames: Grind exposed welds smooth and flush with adjacent surfaces. Furnish attachment devices and fasteners of type required to secure access panels to types of supports indicated.
  - 1. Exposed Flanges: Nominal 1 to 1-1/2 inches wide around perimeter of frame.

2. Provide mounting holes in frames for attachment of units to metal or wood framing, mounting holes shall not be located in exposed surfaces of frames.
- E. Latching Mechanisms: Furnish number required to hold doors in flush, smooth plane when closed.

## 2.5 FINISHES

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- D. Steel and Metallic-Coated-Steel Finishes:
  1. Factory Prime: Apply manufacturer's standard, fast-curing, lead- and chromate-free, universal primer immediately after surface preparation and pretreatment.
  2. Factory Finish: Immediately after cleaning and pretreating, apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat, with a minimum dry-film thickness of 1 mil for topcoat.
- E. Stainless-Steel Finishes:
  1. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
  2. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.
    - a. Run grain of directional finishes with long dimension of each piece.
    - b. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
    - c. Directional Satin Finish: No. 4.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. Comply with manufacturer's written instructions for installing access doors and frames.
- B. Install doors flush with adjacent finish surfaces or recessed to receive finish material.

### 3.3 ADJUSTING AND CLEANING

- A. Adjust doors and hardware after installation for proper operation.
- B. Remove and replace doors and frames that are warped, bowed, or otherwise damaged.

END OF SECTION

SECTION 092216  
NON-STRUCTURAL METAL FRAMING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
  - 1. Non-load-bearing steel framing systems for gypsum board assemblies.
- B. Related Sections:
  - 1. Division 09 Section "Gypsum Board" for gypsum board attached to steel framing systems.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated, include manufacturer's written installation procedures and details.

1.4 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Manufacturer shall be a current member of the Steel Stud Manufacturers Association (SSMA).
- B. Source Limitations: Obtain metal framing systems for a single source from a single manufacturer.
- C. Fire-Test-Response Characteristics: For fire-resistance-rated assemblies that incorporate non-load-bearing steel framing, provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by an independent testing agency.
- D. 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.



## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide cold-formed metal framing by one of the following:
1. California Expanded Metal Products Company.
  2. Clark Steel Framing.
  3. Dietrich Metal Framing; a Worthington Industries Company.
  4. MarinoWare; a division of Ware Industries.

### 2.2 NON-LOAD-BEARING STEEL FRAMING SYSTEMS

- A. Framing Members, General: Comply with ASTM C 754 and Steel Stud Manufacturers Association, Product Technical Information, ICBO ER-4943P, for conditions indicated.
1. Steel Sheet Components: Comply with ASTM C 645 requirements for metal, unless otherwise indicated.
  2. Protective Coating: ASTM A653/A 653M, G40, hot-dip galvanized, unless otherwise indicated.
- B. Steel Studs, Joists, and Runners: ASTM C 645, of minimum base metal thickness and size as indicated on the Drawings.
1. Joists shall be un-punched.
- C. Deflection Track: Steel sheet top runner manufactured to prevent cracking of finishes applied to interior partition framing resulting from deflection of structure above; in thickness not less than indicated for studs and in width to accommodate depth of studs.
1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Dietrich Metal Framing; SLP-TRK.
    - b. Steel Network Inc. (The); VertiClip SLD or VertiTrack VTD Series.
    - c. Superior Metal Trim; Superior Flex Track System (SFT).
- D. Firestop Tracks: Top runner manufactured to allow partition heads to expand and contract with movement of the structure while maintaining continuity of fire-resistance-rated assembly indicated; in thickness not less than indicated for studs and in width to accommodate depth of studs.
1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Dietrich Metal Framing; SLP-TRK.
    - b. Fire Trak Corp.; Fire Trak
    - c. Metal-Lite, Inc.; The System.

- E. Backing Plate: Steel sheet for blocking and bracing in length and width indicated.
- F. Flat Strapping: 1-1/2 inch wide by 0.0312 inch thick (20 gage) flat steel strapping unless otherwise indicated on Drawings.
- G. Cold-Rolled Channel Bridging: 0.0538-inch bare-steel thickness, with minimum 1/2-inch wide flanges.
  - 1. Depth: 3/4 inch unless otherwise indicated on Drawings.
  - 2. Clip Angle: Not less than 1-1/2 by 1-1/2 inches, 0.068-inch thick, galvanized steel.
- H. Hat-Shaped, Rigid Furring Channels: ASTM C 645, of minimum base metal thickness and depth as indicated on the Drawings.
- I. Resilient Furring Channels: 1/2-inch deep, asymmetrical shaped, steel sheet members designed to reduce sound transmission.

## 2.3 AUXILIARY MATERIALS

- A. General: Provide auxiliary materials that comply with referenced installation standards.
- B. Fasteners for Metal Framing: Of type, material, size, corrosion resistance, holding power and other properties required to fasten steel members to substrates.
- C. Isolation Strip at Exterior Walls: Provide adhesive-backed, closed-cell vinyl foam strips that allow fastener penetration without foam displacement, 1/8 inch thick, in width to suit steel stud size.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

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

### 3.2 INSTALLATION OF FRAMING

- A. Install framing components in sizes and spacings indicated on Drawings, but not less than those required by referenced installation standards for assembly types and other assembly components indicated. Comply with the following installation standards:
  - 1. ASTM C754.
  - 2. ASTM C 840 as applicable to metal framing systems for gypsum board.

3. SSMA, ICC ER-4943P.
- B. Install supplementary framing, and blocking to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction.
- C. Install studs and joists so flanges within framing system point in same direction.
- D. Installation Tolerance: Install each framing member so fastening surfaces vary not more than 1/8 inch from the plane formed by faces of adjacent framing.
- E. Install bracing at terminations in assemblies.
- F. Where studs are installed directly against exterior masonry walls or dissimilar metals at exterior walls, install isolation strip between studs and exterior wall.
- G. Slip-Type Head Joints: Where framing extends to overhead structural supports, install to slip-type head joints at tops of framing systems to prevent axial loading of finished assemblies. Provide slip-type head joints as indicated on the Drawings, or if not indicated, by one of the following methods:
  1. Single Long-Leg Runner System: ASTM C 645 top runner with 2-inch deep flanges in thickness not less than indicated for studs, installed with studs friction fit into top runner and with continuous bridging located within 12 inches of the top of studs to provide lateral bracing.
  2. Double-Runner System: ASTM C 645 top runners, inside runner with 2-inch deep flanges in thickness not less than indicated for studs and fastened to studs, outside runner fastened to overhead structure and sized to friction fit inside runner with not less than 1 inch overlap of flanges and providing not less than 1 inch vertical deflection.
  3. Deflection type top track.
- H. Install tracks (runners) at floors and overhead supports and fasten to structure as indicated on Drawings.
- I. Extend framing full height to structural supports or substrates above suspended ceilings, except where partitions are indicated to terminate at suspended ceilings. Continue framing around ducts penetrating partitions above ceiling.
- J. Door Openings: Screw vertical studs at jambs to jamb anchor clips on door frames; install runner track section (for cripple studs) at head and secure to jamb studs.
  1. Install not less than two studs at each jamb, unless otherwise indicated.
  2. Extend jamb studs to the structure above, or where jamb studs do not extend to the structure above, provide diagonal bracing perpendicular to the wall and located directly above jamb studs and fasten bracing to the structure above.
- K. Other Framed Openings: Frame openings other than door openings the same as required for door openings, unless otherwise indicated. Install framing below sills of openings to match framing required above door heads.

- L. Fire-Resistance-Rated Partitions: Install framing to comply with fire-resistance-rated assembly indicated and support closures and to make partitions continuous from floor to underside of solid structure. Frame top of wall condition as indicated on Drawings to maintain continuity of fire-resistance-rated assembly indicated.
- M. Sound-Rated Partitions: Install framing to comply with sound-rated assembly indicated.
- N. Curved Partitions:
  - 1. Bend track to uniform curve and locate straight lengths so they are tangent to arcs.
  - 2. Begin and end each arc with a stud, and space intermediate studs equally along arcs. On straight lengths of not less than 2 studs at ends of arcs, place studs 6 inches on center

END OF SECTION

## SECTION 09 26 00 VENEER PLASTERING

### PART 1 GENERAL

#### 1.1 DESCRIPTION

This section specifies veneer plaster and veneer plaster base.

#### 1.2 RELATED WORK

- A. Metal framing: Section 09 22 16, NON-STRUCTURAL METAL FRAMING.
- B. Gypsum backing board on multi-layer systems: Section 09 29 00, GYPSUM BOARD.
- C. Application of sealants: Section 07 92 00, JOINT SEALANTS.
- D. Lead lined veneer base: Section 13 49 00, RADIATION PROTECTION

#### 1.3 TERMINOLOGY

- A. Definitions and description of terms in accordance with ASTM C11, C843, C844, and as specified.
- B. Underside of Structure Overhead: Where steel trusses or bar joists are shown, the underside of structure overhead is the underside of the floor or roof construction supported by the trusses or bar joists.
- C. "Yoked" Gypsum Board cut out for opening with no joint at the opening corners.

#### 1.4 SUBMITTALS

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Manufacturer's Literature and Data:
  - 1. Gypsum veneer plaster.
  - 2. Gypsum Base for Veneer Plaster.
  - 3. Accessories.
  - 4. Joint reinforcing materials.
  - 5. Laminating adhesive.
- C. Shop Drawings:

Typical veneer plaster installation, showing corner details, casing details, control joint details, and other similar details.

## 1.5 APPLICABLE PUBLICATIONS

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

B. American Society for Testing and Materials (ASTM):

|                      |  |
|----------------------|--|
| C11-10 .....         | Terminology Relating to Gypsum and Related Building Materials and Systems  |
| C472-99(R2009).....  | Physical Testing of Gypsum, Gypsum Plasters and Gypsum Concrete  |
| C475-02(R2007).....  | Joint Compound and Joint Tape for Finish Gypsum Board Construction   |
| C587-04(R2009).....  | Gypsum Veneer Plaster  |
| C1396-04 .....       | Specification Gypsum Board   |
| C631-09 .....        | Bonding Compounds for Interior Plastering  |
| C843-99(R2006).....  | Application of Gypsum Veneer Plaster   |
| C844-04(R2010).....  | Application of Gypsum Base to Receive Gypsum Veneer Plaster  |
| C954-10 .....        | Steel Drill Screws for the Application of Gypsum Panel Products Board or Metal Plaster Bases to Steel Studs from 0.033 in. (0.84mm) to 0.112 in. (2.84mm) in thickness |
| C1002-07 .....       | Steel Drill Screws for the Applications of Gypsum Panel Products Board or Metal Plaster Bases  |
| C1047-10 .....       | Accessories for Gypsum Wallboard and Gypsum Veneer Base  |
| D3678-97(R2008)..... | Rigid Poly (Vinyl Chloride) (PVC) Interior-Profile Extrusions  |

SPEC WRITER NOTE: Make material requirements agree with applicable requirements specified in the referenced Applicable Publications. Update and specify only that which applies to the project.

## PART 2 - PRODUCTS

### 2.1 VENEER BASE

ASTM C1396, plain, Type "X", 16 mm (5/8-inch) thick.

SPEC WRITER NOTE: Use 17.2 MPa (2500 psi) plaster for finish coat on projects where the veneer plaster finished walls/partitions are not protected with handrails and guardrails.

### 2.2 GYPSUM VENEER PLASTER

ASTM C587. // Minimum compressive strength of finish coat plaster shall be 17.2 MPa (2500 psi) in accordance with ASTM C472.//

### 2.3 ACCESSORIES

- A. Corner Bead, Edge Trim and Control Joints: ASTM C1047 or D3678, except as specified.
- B. Corner bead and edge trim (casings): Minimum 0.38 mm (0.015-inch) thick zinc-coated steel sheet or rigid PVC plaster.
- C. Flanges not less than 22 mm (7/8-inch) wide with punch-outs or deformations as required to provide plaster bond.

### 2.4 JOINT REINFORCING TAPE

ASTM C475, Paper tape.

### 2.5 LAMINATING ADHESIVE

ASTM C475 joint compound chemical setting type or as recommended by veneer base manufacturer. VOC not to exceed 20g/l; free of antifreeze and pesticides.

### 2.6 FASTENERS

- A. Screws: ASTM C1002 or C954.
- B. Staples: Flattened zinc-coated steel wire, minimum 15 mm (9/16-inch) leg for securing corner beads or casing and minimum 9 mm (3/8-inch) leg for securing joint reinforcement.

### 2.7 BONDING COMPOUND

ASTM C631.

## PART 3 EXECUTION

### SPEC WRITER NOTE:

1. Read ASTM C840, C843, and C844; coordinate with project specification and drawing requirements.
2. Extend finish to underside of structure overhead for fire partitions, smoke partitions, shafts, and sound rated partitions. Seal penetrations and edges for fire, smoke or acoustical requirements.
3. At new suspended ceilings, extend finish not less than 100 mm (4 inches) above suspended ceiling.
4. At existing ceilings, finish may terminate at ceiling except for conditions stated in NOTE 2.
5. Insure partitions are fully detailed for all requirements and types. Detail construction to conform to UL rated assemblies. Show location of control joints.

### 3.1 INSTALLATION CRITERIA

- A. Where fire rated construction is required for walls, partitions, columns, beams and floor-ceiling assemblies, construct the same as that used in fire rating test.
- B. Requirements for fire rated and sound rated assemblies and materials: Construct as shown and specified; the provisions of the Scope Paragraphs 1.2 and 1.3 of ASTM C843 and 1.2, 1.3, and 1.4 of ASTM C844 regarding details of construction shall not apply.
- C. Requirements for ventilating unheated spaces above veneer plaster ceilings: Construct as shown and specified; the provisions of the Scope Paragraph 1.5 of ASTM C844 regarding ventilation shall not apply.

### 3.2 APPLICATION OF VENEER BASE

- A. Gypsum Board Heights:
  1. Extend gypsum board from floor to underside of structure overhead on partitions and furring as follows:
    - a. Two sides of the following:



SPEC WRITER NOTE: Delete "5. Corridor Partitions,")" from list, if buildings are fully sprinklered.

- 1) Fire rated partitions.
  - 2) Smoke partitions including cross corridor smoke partitions.
  - 3) Sound rated partitions.
  - 4) Full height partitions shown (FHP).
  - 5) Corridor partitions.
- b. One side of the following:
- 1) Inside of exterior walls and furring.
  - 2) Room side of rooms without suspended ceilings.
  - 3) Furring for pipes and duct shafts, except where fire rated construction is shown.
2. Extend layers of gypsum board construction used for fireproofing of columns from floor to underside of structure overhead, unless shown otherwise.
3. In locations other than those specified above, extend gypsum board as follows:
- a. Not less than 100 mm (four inches) above suspended acoustical ceilings.
  - b. To ceiling of suspended gypsum board ceilings.
- //c. To existing ceilings. //
- B. Installation:
1. Apply veneer base in accordance with ASTM C844, except as otherwise specified or shown.
  2. Use veneer base of maximum practical length.
  3. Install veneer base with long dimension direction as follows:
    - a. On ceilings, at 90 degrees to framing to which it is applied.
    - b. On partitions, horizontally or vertically, except when the partition is fire rated apply base as designed in the fire rating test.

4. In vertical application of veneer base, use panels of length required to reach full height of vertical surfaces in one continuous piece.
5. Erect veneer base so that the leading edge of the base is first attached to the open end of the metal stud flange.
6. Leave a space approximately 6 mm (1/4-inch) at bottom and top of veneer base for caulking or sealant.
7. Edge and End Joints:
  - a. Locate edge joints over framing in fire rated partitions.
  - b. Locate end joints over furring or framing in all cases.
  - c. Stagger end joints of adjoining boards or multiple layer boards.

SPEC WRITER NOTE:

1. Show and clearly define on drawings locations of control joints.
2. Detail control joints.
3. See ASTM C844 for design criteria.

8. Control Joints:
  - a. ASTM C844, paragraph 7.4.
  - b. Locate at both side of jambs of openings if gypsum board is not "yoked". Use only one system throughout.
  - c. Not required for wall length less than 9 m (30 feet).
  - d. Do not extend veneer base across control joints.
  - e. Extend control joints the full height of the wall or length of soffit/ceiling veneer plaster membrane.
9. Two-Ply Construction:
  - a. Apply in accordance with ASTM C844 with joints between layers staggered or offset and falling over framing member, except at control joints.
  - b. Use screws to hold veneer base in place.
10. Accessories:

- a. Set plastering accessories plumb, level and true to line, neatly mitered at corners and intersections, and securely attach to supporting surfaces with screws or staples.
- b. Install in one piece, within the limits of the longest commercially available lengths.
- c. Corner Beads:
  - 1) At all external corners.
  - 2) Where required as grounds.
  - 3) Where shown.

SPEC WRITER NOTE: Detail and show expansion and control joints. Maintain integrity of fire, smoke, and sound partitions.

- d. Casings Beads:
  - 1) At both sides of expansion and control joints, except as otherwise shown.
  - 2) Where veneer plaster terminates against dissimilar materials and at perimeter of openings, except where covered by flanges, casings or permanently built-in equipment.
  - 3) Where non-load bearing veneer plastered surfaces abuts load bearing members.
  - 4) Where shown.

### 3.3 SEALANT APPLICATION

- A. Apply sealants to veneer plaster base to cut outs, penetrations, and intersections with adjoining materials prior to application of veneer plaster for acoustical partitions.
- B. Coordinate with Section 07 92 00, JOINT SEALANTS, for application of sealants.

### 3.4 VENEER PLASTER APPLICATION OVER GYPSUM BASE

- A. Mix and apply veneer plaster in accordance with ASTM C843 for one-component plasters, except as specified otherwise.
- B. Joint Reinforcement: ASTM C843.
- C. Apply smooth-trowel finish.

- D. On fire rated, smoke barrier, sound barrier and other partitions specified or shown to extend to underside of structure overhead or full height (floor to floor), the veneer plaster finish may terminate 100 mm (four inches) above the suspended ceiling.
- E. Seal and reinforce all joints and fastener heads above ceilings.

SPEC WRITER NOTE:

- 1. Add new paragraphs for direct applications on masonry or concrete if this occurs in project.
- 2. See ASTM C843 for Surface Preparation.
- 3. Coordinate and specify substrate requirements in appropriate sections. Require flush joints on new masonry work to receive veneer plaster.

### 3.5 CLEANUP AND PATCHING

Remove any plaster splashes from adjacent surfaces. Repair defects in veneer plaster. Plaster surfaces shall be smooth, clean, and in condition to receive the finishing materials that will be applied.

### 3.6 UNACCESSIBLE CEILINGS

At Mental Health and Behavioral Nursing Units, areas accessible to patients and not continuously observable by staff (e.g., patient bedrooms, day rooms), ceilings should be a solid material such as veneer plaster. This will limit patient access. Access doors are needed to access electrical and mechanical equipment above the ceiling. These doors should be locked to prevent unauthorized access and secured to the ceiling using tamper resistant fasteners.

END OF SECTION

## SECTION 092900 GYPSUM BOARD

### 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. Interior gypsum board.
  - 2. Tile backing panels.
  - 3. Acoustical board panels.
- B. Related Sections include, but are not limited to the following:
  - 1. Division 07 Section "Insulation" for batt and blanket insulation and vapor retarders installed in assemblies that incorporate gypsum board.
  - 2. Division 09 Section "Non-Structural Metal Framing" for non-structural framing that supports gypsum board.
  - 3. Division 09 Section "Tiling" for cementitious backer units installed as substrates for ceramic tile.
  - 4. Division 09 Section "Painting" for primers applied to gypsum board surfaces.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: Manufacturer's product data for each type of product indicated or incorporated into the Work.
  - 1. Include statement of VOC content for any adhesives or sealants.
- B. Samples: For the following products:
  - 1. Textured Finishes: Three (3) 48 inch square samples for each textured finish indicated and on same backing indicated for Work.

#### 1.4 DELIVERY, STORAGE, AND HANDLING

- A. Store materials inside under cover and keep them dry and protected against weather, condensation, direct sunlight, construction traffic, and other potential causes of damage. Stack panels flat and supported on risers on a flat platform to prevent sagging.

## 1.5 FIELD CONDITIONS

- A. Environmental Limitations: Comply with ASTM C 840 requirements or gypsum board manufacturer's written recommendations, whichever are more stringent.
- B. Do not install panels that are wet, those that are moisture damaged, and those that are 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.

## PART 2 - PRODUCTS

### 2.1 INTERIOR GYPSUM BOARD

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. American Gypsum Co.
  - 2. Georgia-Pacific Gypsum, LLC.
  - 3. Lafarge North America Inc.
  - 4. National Gypsum Company.
  - 5. PABCO Gypsum.
  - 6. USG Corporation.
- B. Gypsum Wallboard: Provide gypsum wallboard complying with ASTM C 1396/C 1396M, as applicable to type of gypsum board indicated.
  - 1. Regular Type:
    - a. Thickness: 5/8 inch.
    - b. Long Edges: Tapered.
  - 2. Moisture and Mold-Resistant Type: With moisture and mold-resistant core and surfaces.
    - a. Core: 5/8 inch, Type X.
    - b. Long Edges: Tapered.
    - c. Mold Resistance: ASTM D 3273, score of 10 as rated according to ASTM D 3274.
  - 3. Flexible Type: Manufactured to bend to fit radii and to be more flexible than standard regular-type gypsum board of same thickness.
    - a. Thickness: 1/4 inch.
    - b. Long Edges: Tapered.

## 2.2 TILE BACKING PANELS

- A. Cementitious Backer Units: ANSI A118.9 and ASTM C 1288 or 1325, with manufacturer's standard edges.
  - 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. CertainTeed Corp.; FiberCement BackerBoard.
    - b. Custom Building Products; Wonderboard.
    - c. FinPan, Inc.; Util-A-Crete Concrete Backer Board.
    - d. James Hardie Building Products, Inc.; Hardiebacker.
    - e. National Gypsum Company, Permabase Cement Board.
    - f. USG Corporation; DUROCK Cement Board.
  - 2. Thickness: 5/8 inch.
  - 3. Mold Resistance: ASTM D 3273, score of 10 as rated according to ASTM D 3274.

## 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. LC-Bead: J-shaped; exposed long flange receives joint compound.
    - c. L-Bead: L-shaped; exposed long flange receives joint compound.
    - d. U-Bead: J-shaped; exposed short flange does not receive joint compound.

## 2.4 JOINT TREATMENT MATERIALS

- A. General: Comply with ASTM C 475/C 475M.
- B. Joint Tape:
  - 1. Interior Gypsum Board: Paper.
  - 2. Tile Backing Panels: As recommended by panel manufacturer.
- C. Joint Compound for Interior Gypsum Board: For each coat use formulation that is compatible with other compounds applied on previous or for successive coats.
  - 1. Prefilling: At open joints 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 drying-type, all-purpose compound.
  - 3. Fill Coat: For second coat, use drying-type, all-purpose compound.
  - 4. Finish Coat: For third coat, use drying-type, all-purpose compound.

D. Joint Compound for Tile Backing Panels:

1. 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. 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 thick (20 gage structural and heavier).
2. For fastening cementitious backer units, use screws of type and size recommended by panel manufacturer.

- C. Acoustical Sealant: As specified in Division 07 Section "Joint Sealants."

1. Sealants shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

- D. Insulation: As specified in Division 07 Section "Insulation."

2.6 TEXTURE FINISHES

- A. Primer: As recommended by textured finish manufacturer.

1. Coordinate primers with Division 09 Section "Painting."

- B. Non-Aggregate Finish: Pre-mixed, vinyl texture finish for spray application.

1. Texture: Orange Peel

- C. Where Work is adjacent to existing gypsum board surfaces, match existing texture.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and substrates including welded hollow-metal frames and framing, with Installer present, for compliance with requirements and other conditions affecting performance.

- B. Examine panels before installation. Reject panels that are wet, moisture damaged, and mold damaged.

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



### 3.2 APPLYING AND FINISHING GYPSUM PANELS, GENERAL

- A. Comply with ASTM C 840 and manufacturer's written installation instructions.
- B. Install ceiling panels across framing to minimize the number of abutting end joints and to avoid abutting end joints in central area of each ceiling. Stagger abutting end joints of adjacent panels not less than one framing member.
- C. Install panels with face side out. Butt panels together for a light contact at edges and ends with not more than 1/16 inch of open space between panels. Do not force into place.
- D. Locate edge and end joints over supports, except in ceiling applications where intermediate supports or gypsum board back-blocking is provided behind end joints. Do not place tapered edges against cut edges or ends. Stagger vertical joints on opposite sides of partitions. Do not make joints other than control joints at corners of framed openings.
- E. Form control and expansion joints with space between edges of adjoining gypsum panels.
- F. Cover both faces of support framing with gypsum panels in concealed spaces (above ceilings, etc.), except in chases braced internally.
  - 1. Unless concealed application is indicated or required for sound, fire, air, or smoke ratings, coverage may be accomplished with scraps of not less than 8 sq. ft. in area.
  - 2. Fit gypsum panels around ducts, pipes, and conduits.
  - 3. Where partitions intersect structural members projecting below underside of floor/roof slabs and decks, cut gypsum panels to fit profile formed by structural members; allow 1/4 to 3/8-inch wide joints to install sealant.
- G. Isolate perimeter of gypsum board applied to non-load-bearing partitions at structural abutments, except floors. Provide 1/4 to 1/2-inch 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.
- H. Attachment to Steel Framing: Attach panels so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.
- I. STC-Rated Assemblies: Seal construction at perimeters, behind control joints, and at openings and penetrations with a continuous bead of acoustical sealant. Install acoustical sealant at both faces of partitions at perimeters and through penetrations. Comply with ASTM C 919 and with manufacturer's written recommendations for locating edge trim and closing off sound-flanking paths around or through assemblies, including sealing partitions above acoustical ceilings.
- J. Coordinate gypsum panel installation with insulation work specified in Division 07 Section "Insulation."

1. Thermal and sound attenuation batt/blanket insulation shall be installed before installing gypsum panels, unless blankets are readily installed after panels have been installed on one side of framing members.

### 3.3 APPLYING INTERIOR GYPSUM BOARD

#### A. Install interior gypsum board in the following locations:

1. Regular Type: At vertical and horizontal surfaces, unless otherwise indicated.
2. Flexible Type: Apply in double layer at curved assemblies.
3. Moisture and Mold-Resistant Type: At walls of toilet and janitor rooms, walls within 2 feet (horizontally) of plumbing fixtures, and other locations as indicated on Drawings.

#### B. Single-Layer Application:

1. On ceilings, apply gypsum panels before wall/partition board application to greatest extent possible and at right angles to framing, unless otherwise indicated.
2. On partitions/walls, apply gypsum panels vertically (parallel to framing) using continuous panels without abutting end joints unless otherwise indicated.
  - a. Stagger abutting end joints not less than one framing member in alternate courses of panels.
  - b. At stairwells and other high walls where the vertical dimension of the wall without horizontal offsets exceeds the maximum available panel length, install panels horizontally, unless otherwise indicated.

#### C. Multilayer Application:

1. On ceilings, apply gypsum board indicated for base layers before applying base layers on walls/partitions; apply face layers in same sequence. Apply base layers at right angles to framing members and offset face-layer joints 1 framing member, 16 inches minimum, from parallel base-layer joints, unless otherwise indicated or required by fire-resistance-rated assembly.
2. On partitions/walls, apply gypsum board indicated for base layers and face layers parallel to framing members, as required for single layer application, with joints of base layers located over stud or furring member and face-layer joints offset at least one stud or furring member with base-layer joints, unless otherwise indicated or required by fire-resistance-rated assembly. Stagger joints on opposite sides of partitions.
3. Fastening Methods: Fasten base layers and face layers separately to supports with screws or as required for fire resistance rated design.

#### D. Curved Surfaces:

1. Install panels horizontally (perpendicular to supports) and unbroken, to extent possible, across curved surface plus not less than 12-inch long straight sections at ends of curves and tangent to them.

2. For double-layer construction, fasten base layer to studs with screws 16 inches on center. Center gypsum board face layer over joints in base layer, and fasten to studs with screws spaced 12 inches on center at framing members.

### 3.4 APPLYING TILE BACKING PANELS

- A. Cementitious Backer Units: ANSI A108.11, at locations indicated to receive thinset tile.
- B. Where tile backing panels abut other types of panels in same plane, provide panels of matching thickness or shim surfaces to produce a uniform plane across panel surfaces.

### 3.5 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 at locations indicated on Drawings and 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. LC-Bead: Use at exposed panel edges.
  3. L-Bead: Use at exposed panel edges where LC-Bead cannot be used.
  4. U-Bead: Use where indicated.

### 3.6 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 and damaged surface areas.
- C. Apply joint tape over gypsum board joints, except for trim products specifically indicated as not intended to receive tape.
- D. Gypsum Board Finish Levels: Finish panels to levels indicated below and according to ASTM C 840:
  1. Level 1: All joints and interior angles shall have tape embedded in joint compound; surface shall be free of excess joint compound; tool marks and ridges are acceptable.
    - a. Locations: Concealed areas and areas above ceilings.

2. Level 2: All joints and interior angles shall have tape embedded in joint compound and one separate coat of joint compound applied over all joints, angles, fastener heads, and accessories; surface shall be free of excess joint compound; tool marks and ridges are acceptable.
  - a. Locations: Panels that are substrate for applied rigid panels having a thickness not less than 3/8 inches.
3. Level 3: All joints and interior angles shall have tape embedded in joint compound and two (2) separate coats of joint compound applied over all joints, angles, fastener heads, and accessories; all joint compound shall be smooth and free of tool marks and ridges.
  - a. Locations: Not used unless otherwise indicated on Drawings.
4. Level 4: All joints and interior angles shall have tape embedded in joint compound and Three (3) separate coats of joint compound applied over all joints, angles, fastener heads, and accessories; all joint compound shall be smooth and free of tool marks and ridges.
  - a. Locations: At panel surfaces that will be exposed to view and painted or will be substrates for wall coverings.
  - b. Primer and its application to surfaces are specified in Division 09 Section "Painting."
  - c. Where suspended ceilings are to be installed, wall finish shall extend not less than 6 inches above the ceiling height.
5. Level 5: All joints and interior angles shall have tape embedded in joint compound and Three (3) separate coats of joint compound applied over all joints, angles, fastener heads, and accessories; a thin skim coat of joint compound or similar material specific for this purpose shall be applied to the entire surface; the surface shall be smooth and free of tool marks and ridges.
  - a. Locations: Not used unless otherwise indicated on Drawings
  - b. Primer and its application to surfaces are specified in Division 09 Section "Painting."

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

### 3.7 APPLYING TEXTURE FINISHES

- A. Surface Preparation and Primer: Prepare and apply primer to gypsum panels and other surfaces receiving texture finishes prior to application of 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 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.

### 3.8 PROTECTION

- A. Protect adjacent surfaces from drywall compound and promptly remove from floors and other non-drywall surfaces. Repair surfaces stained, marred, or otherwise damaged during drywall application.
- B. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.
- C. 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 095113 ACOUSTICAL PANEL CEILINGS

### 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 acoustical panels and exposed suspension systems for ceilings.
- B. Related Requirements:
  - 1. Division 09 Section "Acoustical Tile Ceilings" for ceilings consisting of acoustical tiles used with adhesive bonding.

#### 1.3 SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples for Verification: For each component indicated and for each exposed finish required, prepared on Samples of size indicated below.
  - 1. Acoustical Panels: 6-inch square samples of each type, color, pattern, and texture.
  - 2. Exposed Suspension-System Members, Moldings, and Trim: Set of 6-inch long Samples of each type, finish, and color.
- C. Evaluation Reports: For each acoustical panel ceiling suspension system and anchor and fastener type, from ICC-ES.
- D. Maintenance Data: For finishes to include in maintenance manuals.

#### 1.4 DELIVERY, STORAGE, AND HANDLING

- A. Deliver acoustical panels, suspension-system components, and accessories to Project site in original, unopened packages and store them in a fully enclosed, conditioned space where they will be protected against damage from moisture, humidity, temperature extremes, direct sunlight, surface contamination, and other causes.
- B. Before installing acoustical panels, permit them to reach room temperature and a stabilized moisture content.

- C. Handle acoustical panels carefully to avoid chipping edges or damaging units in any way.

## 1.5 FIELD CONDITIONS

- A. Environmental Limitations: Do not install acoustical panel ceilings until spaces are enclosed and weatherproof, wet work in spaces is complete and dry, work above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.
  - 1. Pressurized Plenums: Operate ventilation system for not less than 48 hours before beginning acoustical panel ceiling installation.

## 1.6 COORDINATION

- A. Coordinate layout and installation of acoustical panels and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Acoustical ceiling shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
- B. Surface-Burning Characteristics: Acoustical panels shall have surface-burning characteristics complying with ASTM E 1264 for Class A materials as determined by testing identical products per ASTM E 84 and having a Smoke-Developed Index of 50 or less.

### 2.2 ACOUSTICAL PANELS, GENERAL

- A. Source Limitations:
  - 1. Acoustical Ceiling Panels: Obtain each type from a single source from a single manufacturer.
  - 2. Suspension Systems: Obtain each type from a single source from a single manufacturer.
- B. Glass-Fiber-Based Panels: Made with binder containing no urea formaldehyde.
- C. Acoustical Panel Standard: Provide manufacturer's standard panels of configuration indicated that comply with ASTM E 1264 classifications as designated by types, patterns, acoustical ratings, and light reflectances unless otherwise indicated.

1. Mounting Method for Measuring NRC: Type E-400; plenum mounting in which face of test specimen is 15-3/4 inches away from test surface according to ASTM E 795.
- D. Broad Spectrum Antimicrobial Fungicide and Bactericide Treatment: Provide acoustical panels treated with manufacturer's standard antimicrobial formulation that inhibits fungus, mold, mildew, and gram-positive and gram-negative bacteria and showing no mold, mildew, or bacterial growth when tested according to ASTM D 3273 and evaluated according to ASTM D 3274 or ASTM G 21.
- E. Acoustical Panel Colors and Patterns: Match appearance characteristics indicated for each product type.

## 2.3 ACOUSTICAL PANEL TYPES

- A. Basis-of-Design Products: Where named manufacturer's products are indicated, Drawings and Specifications are based on products manufactured by:
  1. Armstrong World Industries, Inc.
    - a. Subject to compliance with requirements, provide products indicated or comparable products by one of the following:
      - 1) BPB USA.
      - 2) CertainTeed Corp.
      - 3) USG Interiors, Inc.; Subsidiary of USG Corporation.
- B. Acoustical Panel Types:
  1. Type ACP-1: Armstrong World Industries; Ultima No. 1894.
    - a. Type and Form: Type IV, mineral base with painted finish; Form 2, water felted.
    - b. Pattern: No Pattern.
    - c. Size: 24 x 24 x 3/4 inches.
    - d. Edge: Beveled tegular for 15/16 inch grid.
    - e. Color: White.
    - f. LR: Not less than 0.90
    - g. NRC: Not less than 0.60.
  2. Type ACP-2: Armstrong World Industries; Ultima, No. 1995.
    - a. Type and Form: Type IV, mineral base with painted finish; Form 2, water felted.
    - b. Pattern: No Pattern.
    - c. Size: 12 x 72 x 3/4 inches.
    - d. Edge: Beveled tegular for 9/16 inch grid.
    - e. Color: White.
    - f. LR: Not less than 0.90
    - g. NRC: Not less than 0.60.



3. Type ACP-3: Armstrong World Industries; Metalworks 4" Plank.

- a. Form: Metal.
- b. Pattern: No Pattern.
- c. Size: 4 x 96 x 1 inches.
- d. Color: To Be Selected by Architect.
- e. LR: Not less than 0.77

2.4 METAL SUSPENSION SYSTEMS, GENERAL

- A. Metal Suspension-System Standard: Provide manufacturer's standard direct-hung metal suspension systems of types, structural classifications, and finishes indicated that comply with applicable requirements in ASTM C 635/C 635M.
- B. Attachment Devices: Size for five times the design load indicated in ASTM C 635/C 635M, Table 1, "Direct Hung," unless otherwise indicated. Comply with seismic design requirements.
- C. Wire Hangers, Braces, and Ties: Zinc-coated, carbon-steel wire, ASTM A 641/A 641M, Class 1 zinc coating, soft temper. 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 12 gage (0.106 inch diameter) wire.
- D. Seismic Struts: As indicated on Drawings.
- E. Perimeter Seismic Clips: Manufacturer's proprietary perimeter seismic clips as necessary to comply with standards indicated.
- F. Seismic Expansion Joints: Manufacturer's standard seismic expansion joints as necessary to comply with standards indicated.

2.5 METAL SUSPENSION SYSTEM TYPES

- A. For Type ACP-1 and ACP-3: Wide-Face, Capped, 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 coating designation; with prefinished 15/16-inch wide metal caps on flanges.
  - 1. Structural Classification: Heavy-duty system.
  - 2. End Condition of Cross Runners: Override (stepped) type.
  - 3. Face Design: Flat, flush.
  - 4. Cap Material: Steel cold-rolled sheet.
  - 5. Cap Finish: Painted white.
  - 6. Products: Subject to compliance with requirements, provide one of the following:
    - a. Armstrong World Industries, Prelude XL (ESR-1308).
      - 1) Main Runners: No. 7301.

- 2) Cross Runners: No. XL7341 (4'), XL7328 (2').
  - 3) Perimeter Seismic Clips: No. BERC2.
- b. Chicago Metallic Corp., 1200 (ER-1905).
- 1) Main Runners: No. 200.01H.
  - 2) Cross Runners: No. 1214.01H (4'), 1202.01H (2').
  - 3) Perimeter Seismic Clips: No. 1496.
- B. For Type ACP-2: Narrow-Face, Capped, 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 coating designation; with prefinished, cold-rolled, 9/16-inch wide metal caps on flanges.
1. Structural Classification: Heavy-duty system.
  2. End Condition of Cross Runners: Override (stepped) type.
  3. Face Design: Flat, flush.
  4. Cap Material: Steel cold-rolled sheet.
  5. Cap Finish: Painted white.
  6. Products: Subject to compliance with requirements, provide one of the following:
- a. Armstrong World Industries, Suprafine XL (ESR-1308).
- 1) Main Runners: No. 7501.
  - 2) Cross Runners: No. XL7541 (4'), XL7520 (2').
  - 3) Perimeter Seismic Clips: No. BERC2.
- b. Chicago Metallic Corp., 4000 Tempra (ER-1905).
- 1) Main Runners: No. 4040.01CH.
  - 2) Cross Runners: No. 4014.01CH (4'), 4022.01 (2').
  - 3) Perimeter Seismic Clips: No. 1496.
- C. Edge Moldings and Trim: Manufacturer's standard roll formed sheet metal edge moldings for edges and penetrations that comply with seismic design requirements; formed from sheet metal of same material, finish, and color as that used for exposed flanges of suspension-system runners.
1. Provide manufacturer's standard angle edge molding with hemmed edges having nominal 7/8 inch legs that fit acoustical panel edge details and suspension systems indicated.
  2. Provide manufacturer's proprietary perimeter seismic clips at ends of main and cross runners at wall angles to comply with seismic standards indicated.
  3. For lay-in panels with reveal edge details, provide stepped edge molding that forms reveal of same depth and width as that formed between edge of panel and flange at exposed suspension member.
  4. For circular penetrations of ceiling, provide edge moldings fabricated to diameter required to fit penetration exactly.

## 2.6 ACOUSTICAL SEALANT

- A. Acoustical Sealant: Manufacturer's standard sealant complying with ASTM C 834 and effective in reducing airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90.
  - 1. Exposed and Concealed Joints: Nonsag, paintable, nonstaining latex sealant.
  - 2. Concealed Joints: Nondrying, nonhardening, nonskinning, nonstaining, gunnable, synthetic-rubber sealant.
  - 3. Acoustical sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, including structural framing to which acoustical panel ceilings attach or abut, with Installer present, for compliance with requirements specified in this and other Sections that affect ceiling installation and anchorage and with requirements for installation tolerances and other conditions affecting performance of acoustical panel ceilings.
- B. Examine acoustical panels before installation. Reject acoustical panels that are wet, moisture damaged, or mold damaged.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. 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, and comply with layout shown on reflected ceiling plans.

### 3.3 INSTALLATION

- A. General: Install acoustical panel ceilings to comply with ASTM C 636/C 636M and seismic design requirements indicated, according to manufacturer's written instructions and CISCA's "Ceiling Systems Handbook."
- B. Hanger Wires: Suspend ceiling hanger wires from building's structural members and attach to grid members as indicated on Drawings and as follows:
  - 1. Secure wire hangers to ceiling suspension members and to supports above with a minimum of three tight turns in 1-1/2 inches. Connect hangers directly either to structure or to inserts, eye screws, or other devices that are secure and

- appropriate for substrate and that will not deteriorate or otherwise fail due to age, corrosion, or elevated temperatures.
2. Space hangers not more than 48 inches on center along each member supported directly from hangers, unless otherwise indicated; provide hangers not more than 8 inches from ends of each member.
  3. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structure or of ceiling suspension system.
  4. Splay hangers only where required to miss obstructions; offset resulting horizontal forces by bracing, counter splaying, or other equally effective means.
  5. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with location of hangers at spacings required to support standard suspension system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices.
  6. Do not support ceilings directly from permanent metal forms, floor or roof deck. Fasten hangers to cast-in-place hanger inserts, postinstalled mechanical or adhesive anchors, or power-actuated fasteners that extend through forms into concrete.
  7. 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.
  8. Do not attach hangers to steel deck tabs.
- C. Seismic Bracing: Seismic bracing assemblies shall consist of a compression strut and sets of 4 splayed brace wires oriented 90 degrees from each other attached to suspension grid main runners and the structure above as indicated on Drawings and as follows:
1. Space bracing assemblies not more than 12 feet on center each way and not more than 6 feet from walls.
  2. Secure brace wires to ceiling suspension main runners and to building structural members above with a minimum of four tight turns in 1-1/2 inches. Brace wires shall attach to main runners within 2 inches of the intersection of main and cross runners. The slope of brace wires shall not exceed 45 degrees from the plane of the ceiling.
  3. Compression struts shall attach to ceiling grid main runners at the intersection of the brace wires and shall be installed not more than 1 horizontal to 6 vertical out of plumb.
  4. Ceiling areas of 144 square feet or less surrounded by walls attached or braced to the structure above shall be exempt from bracing requirements.
- D. Edge Molding and Trim: Install edge moldings and trim of type indicated at perimeter of acoustical ceiling area and where necessary to conceal edges of acoustical panels.
1. Apply acoustical sealant in a continuous ribbon concealed on back of vertical legs of moldings before they are installed.
  2. Screw-attach moldings to substrate at intervals not more than 16 inches on center and not more than 3 inches from ends, leveling with ceiling suspension system to a tolerance of 1/8 inch in 12 feet. Miter corners accurately and connect securely.

- E. Suspension System Runners: Install suspension-system runners so they are level, square, and securely interlocked with one another. Remove and replace dented, bent, or kinked members.
- F. Expansion Joints: Provide expansion joints as indicated on Drawings and as follows:
  - 1. Ceiling areas exceeding 2,500 square feet shall be separated by seismic joints so that no area exceeds 2,500 square feet.
  - 2. Expansion joints shall be provided at the intersections of corridors and at junctions of corridors with lobbies or similar areas.
- G. Acoustic Panels: 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.
  - 1. For square-edged panels, install panels with edges fully hidden from view by flanges of suspension system runners and moldings.
  - 2. For reveal-edged panels on suspension system runners, install panels with bottom of reveal in firm contact with top surface of runner flanges.
  - 3. Penetrations: Penetrations through ceiling panels for sprinkler heads and similar rigid penetrating items that are not connected to the ceiling system shall have 2 inch oversized openings to allow for horizontal movement of 1 inch in all directions. Penetrations shall be finished with escutcheons to seal off oversized openings.
    - a. Flexible pipe penetrations shall not require oversize openings.

### 3.4 CLEANING

- A. Clean exposed surfaces of acoustical panel ceilings, including trim, edge moldings, and suspension-system members. Comply with manufacturer's written instructions for cleaning and touchup of minor finish damage. Remove and replace ceiling components that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

END OF SECTION

## SECTION 096516 LINOLEUM SHEET FLOORING

### 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. Linoleum sheet floor covering.
- B. Related Sections:
  - 1. Division 09 Section "Flooring Moisture and Alkalinity Testing."
  - 2. Division 09 Section "Resilient Base and Accessories" for resilient base, reducer strips, and other accessories installed with resilient floor coverings.
  - 3. Division 09 Section "Resilient Tile Flooring" for resilient floor tile.

#### 1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For each type of floor covering. Include floor covering layouts, locations of seams, edges, columns, doorways, enclosing partitions, built-in furniture, cabinets, and cutouts.
- C. Samples for Initial Selection: For each type of floor covering indicated.
- D. Samples for Verification: In manufacturer's standard size, but not less than 6-by-9 inch sections of each different color and pattern of floor covering required.
- E. Maintenance Data: For each type of floor covering to include in maintenance manuals.

#### 1.4 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified installer who employs workers for this Project who are competent in techniques required by manufacturer for floor covering installation indicated.

- B. Fire-Test-Response Characteristics: As determined by testing identical products according to ASTM E 648 or NFPA 253 by a qualified testing agency.

- 1. Critical Radiant Flux Classification: Class I, not less than 0.45 W/sq. cm.

## 1.5 DELIVERY, STORAGE, AND HANDLING

- A. Delivery: Deliver materials in manufacturer's original, unopened, undamaged containers with identification labels intact.
- B. Store floor coverings and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 65 deg F or more than 90 deg F. Store rolls upright.

## 1.6 PROJECT CONDITIONS

- A. Maintain ambient temperatures within range recommended by manufacturer, but not less than 65 deg F or more than 85 deg F, in spaces to receive floor coverings during the following time periods:
  - 1. 48 hours before installation.
  - 2. During installation.
  - 3. 48 hours after installation.
- B. Until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than 60 deg F or more than 85 deg F.
- C. Close spaces to traffic during floor covering installation.
- D. Close spaces to traffic for 48 hours after floor covering installation.
- E. Install floor coverings after other finishing operations, including painting, have been completed.

## PART 2 - PRODUCTS

### 2.1 LINOLEUM SHEET FLOOR COVERING

- A. Basis of Design Product: Drawings and Specifications are based on the following:
  - 1. Armstrong World Industries, Inc.; Marmoret<sup>TM</sup> with NaturCote<sup>TM</sup> linoleum sheet flooring.
    - a. Subject to compliance with requirements, provide product indicated or a comparable product subject to request for substitution.

- B. Linoleum Sheet Floor Covering: ASTM F 2034, Type I, Standard Specification for Sheet Linoleum Floor Covering.
  - 1. Sheet Width: 6.5 feet.
  - 2. Overall Thickness: 0.100 inches.
  - 3. Critical Radiant Flux Classification: ASTM E648, Class I, 0.45 W/sq. cm.
  - 4. Wear Surface: Polyurethane-coated homogeneous mixture of linoleum cement (linseed oil, natural tree resins, drying oil catalysts), wood flour, cork flour, color pigments and filler calendered onto a jute fabric backing.
- C. Seaming Method: Heat welded.
- D. Colors and Patterns: As indicated on Drawings or as selected by Architect from full range of manufacturer's colors.

## 2.2 INSTALLATION MATERIALS

- A. Trowelable Leveling and Patching Compounds: Latex-modified, portland cement based or blended hydraulic-cement-based formulation provided or approved by manufacturer for applications indicated.
- B. Adhesives: Water-resistant type recommended by manufacturer to suit floor covering and substrate conditions indicated.
  - 1. Adhesives shall have a VOC content of not more than 50 g/L when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- C. Seamless-Installation Accessories:
  - 1. Heat-Welding Rod: Manufacturer's solid-color product for heat welding seams.
    - a. Color: Match floor covering.
- D. Integral-Flash-Cove-Base Accessories:
  - 1. Cove Strip: 1-inch radius provided or approved by manufacturer.
  - 2. Top Edge Strip: Square metal, provided or approved by manufacturer.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates, with Installer present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
- B. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of floor coverings.



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

### 3.2 PREPARATION

- A. Prepare substrates according to manufacturer's written instructions to ensure adhesion of floor coverings.
- B. Concrete Substrates: Prepare according to ASTM F 710.
  - 1. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
  - 2. Remove substrate coatings and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by manufacturer. Do not use solvents.
    - a. Remove adhesive residue from areas where adhesively applied flooring has been removed.
  - 3. Alkalinity and Adhesion Testing: Perform tests recommended by manufacturer. Proceed with installation only after substrates pass testing.
  - 4. Moisture Testing: Perform tests recommended by manufacturer and as follows. Proceed with installation only after substrates pass testing.
    - a. Perform anhydrous calcium chloride test, ASTM F 1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. in 24 hours.
- C. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound and remove bumps and ridges to produce a uniform and smooth substrate.
- D. Do not install floor coverings until they are same temperature as space where they are to be installed.
  - 1. Move floor coverings and installation materials into spaces where they will be installed at least 48 hours in advance of installation.
- E. Sweep and vacuum clean substrates to be covered by floor coverings immediately before installation.

### 3.3 FLOOR COVERING INSTALLATION

- A. Comply with manufacturer's written instructions for installing floor coverings.
  - 1. Install flooring in strict accordance with the latest edition of "Armstrong Guaranteed Installation System", F-5061.
- B. Unroll floor coverings and allow them to stabilize before cutting and fitting.
- C. Lay out floor coverings as follows:

1. Maintain uniformity of floor covering direction.
  2. Minimize number of seams; place seams in inconspicuous and low-traffic areas, at least 6 inches away from parallel joints in floor covering substrates.
  3. Match edges of floor coverings for color shading at seams.
  4. Avoid cross seams.
- D. Scribe and cut floor coverings to butt neatly and tightly to vertical surfaces, permanent fixtures, and built-in furniture including cabinets, pipes, outlets, and door frames.
- E. Extend floor coverings into toe spaces, door reveals, closets, and similar openings.
- F. Maintain reference markers, holes, or openings that are in place or marked for future cutting by repeating on floor coverings as marked on substrates. Use chalk or other nonpermanent marking device.
- G. Adhere floor coverings to substrates using a full spread of adhesive applied to substrate to produce a completed installation without open cracks, voids, raising and puckering at joints, telegraphing of adhesive spreader marks, and other surface imperfections.
- H. Seamless Installation:
1. Heat-Welded Seams: Comply with ASTM F 1516. Rout joints and use welding bead to permanently fuse sections into a seamless floor covering. Prepare, weld, and finish seams to produce surfaces flush with adjoining floor covering surfaces.
- I. Integral-Flash-Cove Base: Cove floor coverings 6 inches up vertical surfaces. Support floor coverings at horizontal and vertical junction by cove strip. Butt at top against top edge strip.

### 3.4 CLEANING AND PROTECTION

- A. Comply with manufacturer's written instructions for cleaning and protection of floor coverings.
- B. Perform the following operations immediately after completing floor covering installation:
1. Remove adhesive and other blemishes from floor covering surfaces.
  2. Sweep and vacuum floor coverings thoroughly.
  3. Damp-mop floor coverings to remove marks and soil.
- C. Protect floor coverings from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.
- D. Cover floor coverings until Substantial Completion.

VA Medical Center  
Fresno, CA

Replace Surgery Exhaust System, Bldg. 1, 3<sup>rd</sup> Floor  
Project #570-13-211

END OF SECTION

## SECTION 099100 PAINTING

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. This Section includes surface preparation and field painting, staining or refinishing of the following:
  - 1. Exposed exterior items and surfaces.
  - 2. Exposed interior items and surfaces.
  - 3. Surface preparation, priming, and finish coats specified in this Section are in addition to shop priming and surface treatment specified in other Sections.
- B. Related Sections include but are not limited to the following:
  - 1. Division 05 Sections for shop priming of metal substrates with primers specified in this Section.
  - 2. Division 06 Sections for shop priming carpentry with primers specified in this Section.
  - 3. Division 08 Sections for shop priming of metal doors and frames with primers specified in this Section.
  - 4. Division 09 Section "Gypsum Board" for sealing gypsum board surfaces before application of surface textures with primers/sealers specified in this Section.
  - 5. Division 21 through 23 Sections for additional requirements for painting of plumbing and mechanical items.
  - 6. Division 26 through 28 Sections for additional requirements for painting of electrical items.

#### 1.3 SPECIAL REQUIREMENTS

- A. Unauthorized removal or disconnecting of electrical fixtures, switches, or control devices may result in additional electrical work to comply with energy regulations of governing agencies. Contractor shall be financially responsible with no additional cost to the Owner for additional electrical work due to unauthorized removal or disconnecting of electrical fixtures, switches, or control devices.

#### 1.4 DEFINITIONS

- A. Definitions of gloss levels below are from "MPI Architectural Painting Specification Manual" (hereafter, "MPI Manual").
  - 1. Gloss Level 1: Not more than 5 units at 60 degrees and 10 units at 85 degrees, according to ASTM D 523.
  - 2. Gloss Level 3: 10 to 25 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D 523.
  - 3. Gloss Level 4: 20 to 35 units at 60 degrees and not less than 35 units at 85 degrees, according to ASTM D 523.
  - 4. Gloss Level 5: 35 to 70 units at 60 degrees, according to ASTM D 523.
  - 5. Gloss Level 6: 70 to 85 units at 60 degrees, according to ASTM D 523.
  - 6. Gloss Level 7: More than 85 units at 60 degrees, according to ASTM D 523.

#### 1.5 SUBMITTALS

- A. Product Data: For each type of product. Include preparation requirements and application instructions.
- B. Samples for Initial Selection: Manufacturer's color charts showing the full range of colors available for each type of finish-coat material indicated.
- C. Samples for Verification: For each type of paint system and each color and gloss of topcoat.
  - 1. Submit Samples on 8 inch square samples of actual material to be painted or stained. For masonry surfaces, include a mortar joint.
  - 2. Step coats on Samples to show each coat required for system.
  - 3. Label each coat of each Sample.
  - 4. Label each Sample for location and application area.
- D. Product List: For each product indicated, include the following:
  - 1. Cross-reference to paint system and locations of application areas. Use same designations indicated on Drawings and in schedules.
  - 2. VOC content.

#### 1.6 QUALITY ASSURANCE

- A. Applicator Qualifications: Engage an experienced applicator who has completed painting system applications similar in material and extent to that indicated for this Project with a record of successful in-service performance.
- B. Source Limitations: Obtain block fillers, primers, and undercoat materials for each coating system from the same manufacturer as the finish coats.

## 1.7 DELIVERY, STORAGE, AND HANDLING

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

## 1.8 PROJECT CONDITIONS

- A. Apply paints only when the temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F.
- B. Do not apply paint in snow, rain, fog, or mist; or when the relative humidity exceeds 85 percent; or at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces.
- C. Protection:
  - 1. Cover or otherwise protect finished work of other trades, work not to be painted concurrently, landscaping, and adjacent property from damage.
  - 2. When not in use, store paints in designated areas. Keep containers closed. At end of day's work, remove empty containers, paint soaked rags, and debris. Vent fumes. Take precautions to prevent fire.
- D. Sequencing, Scheduling:
  - 1. Coordinate removal and replacement of hardware, electrical fixtures and trim, and related work of other Sections.
  - 2. Stain, prime, back paint, and pre-finish items before installation as required.
- E. Cleaning and Disposal:
  - 1. Do not use Project plumbing fixtures or piping systems for:

- a. Cleaning painting equipment and utensils.
- b. Disposal of waste from cleaning or disposal of paints.

## PART 2 - PRODUCTS

### 2.1 SCHEDULED PAINT SYSTEMS

- A. Provide paint systems as scheduled in Part 3 Article "Paint Systems" to comply with requirements in this Section.
  - 1. Named Manufacturers' Products: Manufacturer and product designations indicated in the scheduled paint systems are for the purpose of establishing minimum requirements; unless otherwise indicated, paint products are based on products manufactured by the following:
    - a. Frazee Paints.
      - 1) Subject to compliance with requirements, provide the named products or comparable products by one of the following:
        - a) Dunn-Edwards Paints.
        - b) Fuller O'Brien Paints.
        - c) Glidden Professional.
        - d) Sherwin Williams Paints.
        - e) Tnemec.

### 2.2 PAINT MATERIALS, GENERAL

- A. Material Compatibility: Provide materials for use within each paint system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
  - 1. For each coat in a paint system, provide products recommended in writing by manufacturers of topcoat for use in paint system and on substrate indicated.
- B. Material Quality: Provide manufacturer's best-quality paint material of the various coating types specified. Paint-material containers not displaying manufacturer's product identification will not be acceptable.
- C. VOC Content: Provide materials that comply with VOC limits of authorities having jurisdiction. For paints and coatings applied at Project site, the following VOC limits, exclusive of colorants added to a tint base, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  - 1. Flat Paints and Coatings: 50 g/L.
  - 2. Nonflat Paints and Coatings: 100 g/L.
  - 3. Nonflat High Gloss Paints and Coatings: 150 g/L.
  - 4. Dry-Fog Coatings: 150 g/L.

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

- D. Colors: Provide color selections made by the Architect. Colors shall be factory mixed and match approved samples.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
- B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:
1. Wood: 15 percent.
  2. Portland Cement Plaster: 12 percent.
  3. Gypsum Board: 12 percent.
- C. Portland Cement Plaster Substrates: Verify that plaster is fully cured.
- D. Gypsum Board Substrates: Verify that finishing compound is sanded smooth.
- E. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.
- F. Proceed with coating application only after unsatisfactory conditions have been corrected.
1. Application of coating indicates acceptance of surfaces and conditions.
- G. Coordination of Work: Review other Sections in which primers are provided to ensure compatibility of the total system for various substrates. On request, furnish information on characteristics of finish materials to ensure use of compatible primers.
1. Notify the Architect of anticipated problems using the materials specified over substrates primed by others.



### 3.2 PREPARATION

- A. Comply with manufacturer's written instructions and recommendations in "MPI Manual" applicable to substrates and paint systems indicated.
- B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.
  - 1. Electrical Items: Remove only switch and outlet cover plates and similar items that do not require disconnecting wiring. Do not disconnect wiring or remove electrical fixtures, switches, or control devices unless otherwise indicated on Electrical Drawings.
    - a. Contractor may be subject to additional costs due to unauthorized removal of items, refer to Part 1 Article "Special Requirements."
  - 2. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection.
- C. Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, grease, and incompatible paints and encapsulants.
  - 1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce paint systems indicated.
  - 2. Schedule cleaning and painting so dust and other contaminants from the cleaning process will not fall on wet, newly painted surfaces.
- D. Concrete and Masonry Substrates: Remove release agents, curing compounds, efflorescence, and chalk. Perform appropriate tests to determine alkalinity and moisture content of surfaces; testing shall be performed or witnessed by a certified representative of the paint manufacturer. Do not paint surfaces if moisture content or alkalinity of surfaces or mortar joints exceeds that permitted in manufacturer's written instructions.
  - 1. Cracks and defects at concrete and masonry surfaces shall be filled with cement grout; match surface texture.
  - 2. Clean concrete floors to be painted with a 5 percent solution of muriatic acid or other etching cleaner. Flush the floor with clean water to remove acid, neutralize with ammonia, rinse, allow to dry, and vacuum before painting.
- E. Steel Substrates: Remove rust, loose mill scale, and shop primer if any. Clean using methods recommended in writing by paint manufacturer but not less than the following:
  - 1. SSPC-SP 11, "Power Tool Cleaning to Bare Metal."
- F. Shop-Primed Steel Substrates: Clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with the same material as used for shop priming to comply with SSPC-PA 1 for touching up shop-primed surfaces.

- G. Galvanized-Metal Substrates: Remove grease and oil residue from galvanized sheet metal by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied paints.
- H. Aluminum Substrates: Remove loose surface oxidation.
- I. Wood Substrates: Clean surfaces of dirt, oil, and other foreign substances with scrapers, mineral spirits, and sandpaper, as required.
  - 1. Scrape and clean knots. Before applying primer, apply coat of knot sealer recommended in writing by topcoat manufacturer for exterior use in paint system indicated.
  - 2. Sand surfaces that will be exposed to view, and dust off.
  - 3. Prime, stain, or seal wood to be painted immediately on delivery. Prime edges, ends, faces, undersides, and backsides of wood.
    - a. When transparent finish is required, backprime with spar varnish.
    - b. Backprime paneling on interior partitions where masonry, plaster, or other wet wall construction occurs on backside.
    - c. Seal tops, bottoms, and cutouts of unprimed wood doors with a heavy coat of varnish or sealer immediately on delivery.
  - 4. After priming, fill holes and imperfections in the finish surfaces with putty or plastic wood filler. Sand smooth when dried.
- J. Plastic Trim Fabrication Substrates: Remove dust, dirt, and other foreign material that might impair bond of paints to substrates.
- K. Materials Preparation: Mix and prepare paint materials according to manufacturer's written instructions.
  - 1. Maintain containers used in mixing and applying paint in a clean condition, free of foreign materials and residue.
  - 2. Stir material before application to produce a mixture of uniform density. Stir as required during application. Do not stir surface film into material. If necessary, remove surface film and strain material before using.
  - 3. Use only thinners approved by paint manufacturer and only within recommended limits.
- L. Drywall: Fill any cracks or defects with drywall joint compound. Sand any rough spots smooth. Do not raise nap on paper covering.

### 3.3 APPLICATION

- A. General: Apply paints according to manufacturer's written instructions and recommendations in "MPI Manual." Paint/stain exposed surfaces, except where schedules indicate that a surface or material is not to be painted/stained or is to remain natural. If schedules do not specifically mention an item or surface to be painted, paint the item or surface the same as similar adjacent materials or surfaces whether or not

schedules indicate colors. If the schedules do not indicate color or finish, the Architect will select from standard colors and finishes available.

1. Use applicators and techniques suited for paint and substrate indicated.
  2. Paint surfaces behind movable items same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed items with prime coat only.
  3. Paint both sides and edges of exterior doors and entire exposed surface of exterior door frames.
  4. Paint front and backsides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.
  5. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
  6. Primers specified in painting schedules may be omitted on items that are factory primed or factory finished if acceptable to topcoat manufacturers.
  7. Do not paint over dirt, rust, scale, grease, moisture, scuffed surfaces, or conditions detrimental to formation of a durable paint film.
  8. The term "exposed surfaces" includes areas visible when permanent or built-in fixtures, convactor covers, covers for finned-tube radiation, grilles, and similar components are in place. Extend coatings in these areas, as required, to maintain the system integrity and provide desired protection.
  9. Do not paint prefinished items, concealed surfaces, finished metal surfaces, operating parts, and labels.
    - a. Prefinished items include the following factory-finished components:
      - 1) Aluminum storefronts and entrances.
      - 2) Anodized aluminum gypsum board and plaster trim.
      - 3) Finished mechanical and electrical equipment.
      - 4) Light fixtures.
      - 5) Distribution cabinets.
    - b. Labels: Do not paint over Underwriters Laboratories (UL), Factory Mutual (FM), or other code-required labels or equipment name, identification, performance rating, or nomenclature plates.
- B. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.
- C. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.
- D. Apply first coat to surfaces that have been cleaned, pretreated, or otherwise prepared for painting as soon as practicable after preparation and before subsequent surface deterioration.
1. The number of coats and the film thickness required are the same regardless of application method. Do not apply succeeding coats until the previous coat has cured as recommended by the manufacturer. If sanding is required to produce a

- smooth, even surface according to manufacturer's written instructions, sand between applications.
2. Omit primer on metal surfaces that have been shop primed and touchup painted.
  3. If undercoats, stains, or other conditions show through final coat of paint, apply additional coats until paint film is of uniform finish, color, and appearance. Give special attention to ensure edges, corners, crevices, welds, and exposed fasteners receive a dry film thickness equivalent to that of flat surfaces.
  4. Allow sufficient time between successive coats to permit proper drying. Do not recoat surfaces until paint has dried to where it feels firm, does not deform or feel sticky under moderate thumb pressure, and where application of another coat of paint does not cause the undercoat to lift or lose adhesion.
- E. Application Procedures: Apply paints and coatings by brush, roller, spray, or other applicators according to manufacturer's written instructions and recommendations in "MPI Manual."
1. Brushes: Use brushes best suited for the type of material applied. Use brush of appropriate size for the surface or item being painted.
  2. Rollers: Use rollers of carpet, velvet back, or high-pile sheep's wool as recommended by the manufacturer for the material and texture required.
  3. Spray Equipment: Use airless spray equipment with orifice size as recommended by the manufacturer for the material and texture required.
- F. Minimum Coating Thickness: Apply paint materials no thinner than manufacturer's recommended spreading rate. Provide the total dry film thickness of the entire system as recommended by the manufacturer.
- G. Block Fillers: Apply block fillers to concrete masonry block at a rate to ensure complete coverage with pores filled.
- H. Prime Coats: Before applying finish coats, apply a prime coat of material, as recommended by the manufacturer, to material that is required to be painted or finished and that has not been prime coated by others. Recoat primed and sealed surfaces where evidence of suction spots or unsealed areas in first coat appears, to ensure a finish coat with no burn through or other defects due to insufficient sealing.
- I. Pigmented (Opaque) Finishes: Completely cover surfaces as necessary to provide a smooth, opaque surface of uniform finish, color, appearance, and coverage. Cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections will not be acceptable.
- J. Transparent (Clear) Finishes: Use multiple coats to produce a glass-smooth surface film of even luster. Provide a finish free of laps, runs, cloudiness, color irregularity, brush marks, orange peel, nail holes, or other surface imperfections.
1. Provide satin finish for final coats.
- K. Stipple Enamel Finish: Roll and redistribute paint to an even and fine texture. Leave no evidence of rolling, such as laps, irregularity in texture, skid marks, or other surface imperfections.

- L. Completed Work: Match approved samples for color, texture, and coverage. Remove, refinish, or repaint work not complying with requirements.
- M. Painting Fire Suppression, Plumbing, HVAC, Electrical, Communication, and Electronic Safety and Security Work: Paint the following work where exposed to view at applications indicated:
  - 1. Occupied areas:
    - a. Equipment, including panelboards.
    - b. Uninsulated metal piping.
    - c. Uninsulated plastic piping.
    - d. Pipe hangers and supports.
    - e. Metal conduit.
    - f. Plastic conduit.
    - g. Ducts, equipment, and pipe insulation having cotton or canvas insulation covering or other paintable jacket material.
    - h. Interior surfaces of ducts with a flat, nonspecular black paint where visible through registers or grilles.
    - i. Other items as directed by Architect.

### 3.4 CLEANING AND PROTECTION

- A. At the end of each workday, remove empty cans, rags, rubbish, and other discarded paint materials from the site.
- B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.
- C. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.
- D. Provide "Wet Paint" signs to protect newly painted finishes. Remove temporary protective wrappings provided by others to protect their work after completing painting operations.
- E. Correction of Defective Work:
  - 1. Repair abraded, damaged or incomplete paint surfaces by methods acceptable to Architect. Spot repairs to be well-blended into adjacent work. For large repairs, re-coat entire plane or building element in which damaged area occurs.
  - 2. Defaced surfaces of work not to be painted shall be cleaned and their original finish restored.
- F. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

### 3.5 PAINT SYSTEMS

#### Interior Paint Systems:

| SURFACE |                                  | PAINT SYSTEM |                       | COATS             | MANUFACTURER'S DESIGNATION |                                |
|---------|----------------------------------|--------------|-----------------------|-------------------|----------------------------|--------------------------------|
| (1)     | Gypsum Drywall                   | P12.A        | Flat, Latex           | First Coat        | 061                        | Pigmented PVA Sealer Aqua Seal |
|         |                                  |              |                       | Second Coat       | 015                        | Majestic                       |
|         |                                  |              |                       | Third Coat        | 015                        | Majestic                       |
|         |                                  | P12.B        | Semi-Gloss Latex      | First Coat        | 061                        | Pigmented PVA Sealer Aqua Seal |
|         |                                  |              |                       | Second Coat       | 124                        | Mirro Glide SG                 |
|         |                                  |              |                       | Third Coat        | 124                        | Mirro Glide SG                 |
|         |                                  | P12.C        | Eggshell Enamel Latex | First Coat        | 061                        | Pigmented PVA Sealer Aqua Seal |
|         |                                  |              |                       | Second Coat       | 022                        | Lo Glo                         |
|         |                                  |              |                       | Third Coat        | 022                        | Lo Glo                         |
|         | (Textured)                       | P12.D        | Flat                  | One Coat          | 019                        | Luxwall RTU                    |
| (2)     | Ferrous Metal                    | P14.A        | Flat Latex            | First Coat        | 561                        | Acrylic Metal Prime            |
|         |                                  |              |                       | Second Coat       | 015                        | Majestic                       |
|         |                                  |              |                       | Third Coat        | 015                        | Majestic                       |
|         |                                  | P14.B        | Semi-Gloss Latex      | First Coat        | 561                        | Acrylic Metal Prime            |
|         |                                  |              |                       | Second Coat       | 124                        | Mirro Glide SG                 |
|         |                                  |              |                       | Third Coat        | 124                        | Mirro Glide SG                 |
|         |                                  | P14.C        | Eggshell Latex        | First Coat        | 561                        | Acrylic Metal Prime            |
|         |                                  |              |                       | Second Coat       | 022                        | Lo Glo                         |
|         |                                  |              |                       | Third Coat        | 022                        | Lo Glo                         |
| (3)     | Galvanize d Metal/ Aluminum      | P15.A        | Flat Latex            | First Coat        | 561                        | Acrylic Metal Prime            |
|         |                                  |              |                       | Second Coat       | 015                        | Majestic                       |
|         |                                  |              |                       | Third Coat        | 015                        | Majestic                       |
|         |                                  | P15.B        | Semi-Gloss Latex      | First Coat        | 561                        | Acrylic Metal Prime            |
|         |                                  |              |                       | Second Coat       | 124                        | Mirro Glide SG                 |
|         |                                  |              |                       | Third Coat        | 124                        | Mirro Glide SG                 |
|         |                                  | P15.C        | Eggshell Latex        | First Coat        | 561                        | Acrylic Metal Prime            |
|         |                                  |              |                       | Second Coat       | 022                        | Lo Glo                         |
|         |                                  |              |                       | Third Coat        | 022                        | Lo Glo                         |
| (4)     | Acoustical Ceiling Tile/ Plaster | P18.A        | Latex                 | One Coat to Cover | 019                        | Luxwall RTU                    |

(Exterior Paint Systems start on the following page)

A. Exterior Paint Systems:

| SURFACE |                              | PAINT SYSTEM |                                 | COATS                                   | MANUFACTURER'S DESIGNATION |   |
|---------|------------------------------|--------------|---------------------------------|---|----------------------------|---|
| (1)     | Galv.<br>Metal &<br>Aluminum | P56.A        | Gloss                           | First Coat<br>Second Coat<br>Third Coat | 561<br>143<br>143          | Acrylic Metal Prime<br>Mirro Glide GL<br>Mirro Glide GL |
|         |                              | P56.B        | Flat, Acrylic                   | First Coat<br>Second Coat<br>Third Coat | 561<br>203<br>203          | Acrylic Metal Prime<br>Duratec II<br>Duratec II         |
|         |                              | P56.C        | Semi-Gloss<br>Enamel<br>Acrylic | First Coat<br>Second Coat<br>Third Coat | 561<br>124<br>124          | Acrylic Metal Prime<br>Mirro Glide SG<br>Mirro Glide SG |
|         |                              | P56.D        | Gloss                           | First Coat<br>Second Coat<br>Third Coat | 561<br>146<br>146          | Acrylic Metal Prime<br>Arothane GL<br>Arothane GL       |
|         |                              | P56.E        | Semi Gloss                      | First Coat<br>Second Coat<br>Third Coat | 561<br>136<br>136          | Acrylic Metal Prime<br>Arothane S/G<br>Arothane S/G     |

END OF SECTION

SECTION 13 05 41  
SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS

PART 1 – GENERAL

1.1 DESCRIPTION

- A. Provide seismic restraint in accordance with the requirements of this section in order to maintain the integrity of nonstructural components of the building so that they remain safe and functional in case of seismic event.
- B. Definitions: Non-structural building components are components or systems that are not part of the building's structural system whether inside or outside, above or below grade. Non-structural components of buildings include:
  - 1. Architectural Elements: Facades that are not part of the structural system and its shear resistant elements; cornices and other architectural projections and parapets that do not function structurally; glazing; nonbearing partitions; suspended ceilings; stairs isolated from the basic structure; cabinets; bookshelves; medical equipment; and storage racks.
  - 2. Electrical Elements: Power and lighting systems; substations; switchgear and switchboards; auxiliary engine-generator sets; transfer switches; motor control centers; motor generators; selector and controller panels; fire protection and alarm systems; special life support systems; and telephone and communication systems.
  - 3. Mechanical Elements: Heating, ventilating, and air-conditioning systems; medical gas systems; plumbing systems; sprinkler systems; pneumatic systems; boiler equipment and components.
  - 4. Transportation Elements: Mechanical, electrical and structural elements for transport systems, i.e., elevators and dumbwaiters, including hoisting equipment and counterweights.

1.2 RELATED WORK

- A. Section No. 09 51 00, ACOUSTICAL CEILINGS.
- B. Section No. 09 22 16, NON-STRUCTURAL METAL FRAMING.
- C. Division No. 23, HEATING, VENTILATING, AND AIR CONDITIONING.
- D. Division No. 26, ELECTRICAL.

1.3 QUALITY CONTROL

- A. Shop-Drawing Preparation:



1. Have seismic-force-restraint shop drawings and calculations prepared by a professional structural engineer experienced in the area of seismic force restraints. The professional structural engineer shall be registered in the state where the project is located.
2. Submit design tables and information used for the design-force levels, stamped and signed by a professional structural engineer registered in the State where project is located.

B. Coordination:

1. Do not install seismic restraints until seismic restraint submittals are approved by the Resident Engineer.
2. Coordinate and install trapezes or other multi-pipe hanger systems prior to pipe installation.

#### 1.4 SUBMITTALS

A. Submit a coordinated set of equipment anchorage drawings prior to installation including:

1. Description, layout, and location of items to be anchored or braced with anchorage or brace points noted and dimensioned.
2. Details of anchorage or bracing at large scale with all members, parts brackets shown, together with all connections, bolts, welds etc. clearly identified and specified.
3. Numerical value of design seismic brace loads.
4. For expansion bolts, include design load and capacity if different from those specified.

B. Submit prior to installation, a coordinated set of bracing drawings for seismic protection of piping, with data identifying the various support-to-structure connections and seismic bracing structural connections, include:

1. Single-line piping diagrams on a floor-by-floor basis. Show all suspended piping for a given floor on the same plain.
2. Type of pipe (Copper, steel, cast iron, insulated, non-insulated, etc.).
3. Pipe contents.
4. Structural framing.
5. Location of all gravity load pipe supports and spacing requirements.
6. Numerical value of gravity load reactions.

7. Location of all seismic bracing.
  8. Numerical value of applied seismic brace loads.
  9. Type of connection (Vertical support, vertical support with seismic brace etc.).
  10. Seismic brace reaction type (tension or compression). Details illustrating all support and bracing components, methods of connections, and specific anchors to be used.
- C. Submit prior to installation, bracing drawings for seismic protection of suspended ductwork and suspended electrical and communication cables, include:
1. Details illustrating all support and bracing components, methods of connection, and specific anchors to be used.
  2. Numerical value of applied gravity and seismic loads and seismic loads acting on support and bracing components.
  3. Maximum spacing of hangers and bracing.
  4. Seal of registered structural engineer responsible for design.
- D. Submit design calculations prepared and sealed by the registered structural engineer specified above in paragraph 1.3A.
- E. Submit for concrete anchors, the appropriate ICC evaluation reports, OSHPD pre-approvals, or lab test reports verifying compliance with OSHPD Testing, Inspection, and Observation Requirements.

#### 1.5 APPLICABLE PUBLICATIONS

- A. The Publications listed below (including amendments, addenda revisions, supplements and errata) form a part of this specification to the extent referenced. The publications are referenced in text by basic designation only.
- B. American Concrete Institute (ACI):
- 355.2-07 ..... Qualification for Post-Installed Mechanical Anchors in Concrete and Commentary
- C. American Institute of Steel Construction (AISC):
- Load and Resistance Factor Design, Volume 1, Second Edition.
- D. American Society for Testing and Materials (ASTM):
- A36/A36M-05 ..... Standard Specification for Carbon Structural Steel.

- A53/A53M-07 ..... Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
- A307 (REV A-07)..... Standard Specification for Carbon Steel Bolts and Studs; 60,000 PSI Tensile Strength.
- A325-07..... Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.
- A325M-05..... Standard Specification for High-Strength Bolts for Structural Steel Joints [Metric].
- A490-06..... Standard Specification for Heat-Treated Steel Structural Bolts, 150 ksi Minimum Tensile Strength.
- A490M (REV A-04)..... Standard Specification for High-Strength Steel Bolts, Classes 10.9 and 10.9.3, for Structural Steel Joints [Metric].
- A500/A500M-07 ..... Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
- A501-07..... Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.
- A615/A615M-07 ..... Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
- A992/A992M (REV A-06) ..... Standard Specification for Steel for Structural Shapes for Use in Building Framing.
- A996/A996M (REV A-06) ..... Standard Specification for Rail-Steel and Axel-Steel Deformed Bars for Concrete Reinforcement.
- E488-96(R2003)..... Standard Test Method for Strength of Anchors in Concrete and Masonry Elements.
- E. International Building Code (IBC) 2010 Edition.
- F. VA Seismic Design Requirements, H-18-8, February 2011.
- G. National Uniform Seismic Installation Guidelines (NUSIG).
- H. Sheet Metal and Air Conditioning Contractors National Association (SMACNA):
- I. Seismic Restraint Manual - Guidelines for Mechanical Systems, 3<sup>rd</sup> Edition, 2008 Edition.

## 1.6 REGULATORY REQUIREMENT

### A. IBC 2010.

### B. Exceptions: The seismic restraint of the following items may be omitted:

1. Equipment weighing less than 400 pounds, which is supported directly on the floor or roof.
2. Equipment weighing less than 20 pounds, which is suspended from the roof or floor or hung from a wall.
3. Gas and medical piping less than 2 ½ inches inside diameter.
4. Piping in boiler plants and equipment rooms less than 1 ¼ inches inside diameter.
5. All other piping less than 2 ½ inches inside diameter, except for automatic fire suppression systems.
6. All piping suspended by individual hangers, 12 inches or less in length from the top of pipe to the bottom of the support for the hanger.
7. All electrical conduits, less than 2 ½ inches inside diameter.
8. All rectangular air handling ducts less than six square feet in cross sectional area.
9. All round air handling ducts less than 28 inches in diameter.
10. All ducts suspended by hangers 12 inches or less in length from the top of the duct to the bottom of support for the hanger.

## PART 2 – PRODUCTS

### 2.1 STEEL

- A. Structural Steel: ASTM A36.
- B. Structural Tubing: ASTM A500, Grade B.
- C. Structural Tubing: ASTM A501.
- D. Steel Pipe: ASTM A53/A53M, Grade B.
- E. Bolts & Nuts: ASTM A307.

### 2.2 CAST-IN-PLACE CONCRETE

- A. Concrete: 28 day strength,  $f'_c = 25$  MPa (3,000 psi).

- B. Reinforcing Steel: ASTM A615/615M or ASTM A996/A996M deformed.

## PART 3 – EXECUTION

### 3.1 CONSTRUCTION, GENERAL

- A. Provide equipment supports and anchoring devices to withstand the seismic design forces, so that when seismic design forces are applied, the equipment cannot displace, overturn, or become inoperable.
- B. Provide anchorages in conformance with recommendations of the equipment manufacturer and as shown on approved shop drawings and calculations.
- C. Construct seismic restraints and anchorage to allow for thermal expansion.
- D. Testing Before Final Inspection:
  - 1. Test 10-percent of anchors in masonry and concrete per ASTM E488, and ACI 355.2 to determine that they meet the required load capacity. If any anchor fails to meet the required load, test the next 20 consecutive anchors, which are required to have zero failure, before resuming the 10-percent testing frequency.
  - 2. Before scheduling Final Inspection, submit a report on this testing indicating the number and location of testing, and what anchor-loads were obtained.

### 3.2 EQUIPMENT RESTRAINT AND BRACING

- A. See drawings for equipment to be restrained or braced.

### 3.3 MECHANICAL DUCTWORK AND PIPING; BOILER PLANT STACKS AND BREACHING; ELECTRICAL BUSWAYS, CONDUITS, AND CABLE TRAYS; AND TELECOMMUNICATION WIRES AND CABLE TRAYS

- A. Support and brace mechanical ductwork and piping; electrical busways, conduits and cable trays; and telecommunication wires and cable trays including boiler plant stacks and breeching to resist directional forces (lateral, longitudinal and vertical).
- B. Brace duct and breeching branches with a minimum of 1 brace per branch.
- C. Provide supports and anchoring so that, upon application of seismic forces, piping remains fully connected as operable systems which will not displace sufficiently to damage adjacent or connecting equipment, or building members.
- D. Seismic Restraint of Piping:
  - 1. Design criteria:

- a. Piping resiliently supported: Restrain to support 120-percent of the weight of the systems and components and contents.
- b. Piping not resiliently supported: Restrain to support 60-percent of the weight of the system components and contents.

2. Provide seismic restraints according to one of the following options:

- E. Piping Connections: Provide flexible connections where pipes connect to equipment. Make the connections capable of accommodating relative differential movements between the pipe and equipment under conditions of earthquake shaking.

### 3.4 PARTITIONS

- A. In buildings with flexible structural frames, anchor partitions to only structural element, such as a floor slab, and separate such partition by a physical gap from all other structural elements.
- B. Properly anchor masonry walls to the structure for restraint, so as to carry lateral loads imposed due to earthquake along with their own weight and other lateral forces.

### 3.5 CEILINGS AND LIGHTING FIXTURES

- A. At regular intervals, laterally brace suspended ceilings against lateral and vertical movements, and provide with a physical separation at the walls.
- B. Independently support and laterally brace all lighting fixtures. Refer to applicable portion of lighting specification, Section 26 51 00, INTERIOR LIGHTING.

### 3.6 FACADES AND GLAZING

- A. Install attachments to structure for all façade materials as shown on construction drawings to ensure strength against applicable seismic forces at the project location.

### 3.7 STORAGE RACKS, CABINETS, AND BOOKCASES

- A. Install storage racks to withstand earthquake forces and anchored to the floor or laterally braced from the top to the structural elements.
- B. Anchor medical supply cabinets to the floor or walls and equip them with properly engaged, lockable latches.
- C. Anchor filing cabinets that are more than 2 drawers high to the floor or walls, and equip all drawers with properly engaged, lockable latches.
- D. Anchor bookcases that are more than 30 inches high to the floor or walls, and equip any doors with properly engaged, lockable latches.

END OF SECTION

SECTION 210000  
FIRE SPRINKLER SYSTEM

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 Division.

1.2 GENERAL MECHANICAL PROVISIONS

- A. The preceding General Mechanical Provisions shall form a part of this Division with the same force and effect as though repeated here.

1.3 SCOPE

- A. General: Provide all labor, materials and services necessary for complete, lawful and operating systems as shown or noted on the drawings or as specified here. To comply with SB 575, the fire sprinkler system shall include all above ceiling spaces and other spaces which under SB 575 would otherwise require the installation of automatic heat detectors. Fire sprinklers shall be provided in lieu of automatic heat detectors. Exceptions in NFPA 13 allowing above-ceiling spaces to not be sprinklered shall not apply. Where demolition occurs, remove all equipment, piping, braces, supports and related items no longer required.
- B. Existing Conditions:
  - 1. Prior to Project Bid Date, the Contractor shall carefully examine the site and existing buildings, compare them with Drawings and Specifications, and shall have satisfied themselves as to the existing conditions to be encountered during the performance of the work. No subsequent allowance shall be made on Contractor's behalf for any additional expense, other than concealed or unforeseen, it may incur due to failure or neglect of Contractor to examine site and to include existing conditions in bid.
  - 2. Any work done as an addition, expansion, or revision of an existing system shall be compatible with that system.
  - 3. The Contractor shall examine all record drawings made available by the Owner to locate existing underground systems, utilities, and pipes prior to installing the fire sprinkler system. The Contractor shall also examine the site for possible locations of existing sprinkler pipes. Any damage done to the existing systems during the course of the fire sprinkler work, whose

locations could be reasonably determined, shall be repaired to the satisfaction of the Owner and the utility or agency involved, at the expense of the Contractor.

## PART 2 - PRODUCTS

### 2.1 STANDARDS

- A. All materials shall be in accordance with NFPA No.13 "Standard for the Installation of Sprinkler Systems". Underground mains shall be in accordance with NFPA No. 24 "Standard for the Installation of Private Fire Service Mains and Their Appurtenances".

### 2.2 PIPING MATERIALS

- A. General: The pressure rating of all piping, valves, flanges and other piping accessories shall be in accordance with code and fire authority requirements. Pressure ratings shall exceed the highest possible working pressure.
- B. Piping:
  - 1. Above Grade:
    - a. 2" and Smaller: Threaded black steel pipe, ASTM A53, A135 or A795, minimum wall thickness per NFPA 13. 175 psi WOG (min.) black cast iron threaded fittings, UL listed.
    - b. 2-1/2" and Larger: Welded black steel pipe, ASTM A53, minimum wall thickness per NFPA 13. Standard weight carbon steel welding fittings, ANSI B16.9. Roll grooved pipe couplings may be used for assembling welded sections.
- C. Gate Valve:
  - 1. 2" and Smaller: All bronze, rising stem. UL listed.
  - 2. 2-1/2" and Larger: Iron body, bronze mounted, outside screw and yoke. UL listed. (UL listed butterfly valves may be substituted for 4" and larger gate valves above grade.)
- D. Check Valve:
  - 1. 2" and Smaller: All bronze swing check. UL listed.
  - 2. 2-1/2" and Larger: Iron body, bronze mounted swing check. UL listed.



## 2.3 SPRINKLER HEAD

- A. Automatic sprinkler head, semi-recessed (Central Sprinkler Corp., Model A) in areas with finished ceilings, standard heads elsewhere. UL listed. Temperature ratings shall be in accordance with NFPA No. 13. Provide extra heads (of each type installed) in accordance with code requirements. Heads installed with deflector lower than 7'-6" above floor shall have wire guards. Heads shall have chrome finish in areas with finished ceilings and standard finish in areas with exposed piping. Heads installed in areas with finished ceilings shall have metal escutcheons with same finish as head.

## 2.4 ALARM VALVE ASSEMBLY

- A. Standard wet type alarm valve assembly and water motor gong complete with retarding chamber and trim as required by the authority having jurisdiction. Provide flow switch for connection to alarm system. Provide tamper switch. UL listed.

## 2.5 POST INDICATOR VALVE

- A. UL listed valve with lockable operating handle, tamper switch and target visible through a glass covered post, reading either "OPEN" or "SHUT".

# PART 3 - EXECUTION

## 3.1 PIPING INSTALLATION

- A. General: Piping shall be concealed in walls, above the ceilings or below grade unless otherwise noted. Exposed piping shall run parallel to room surfaces; location shall be approved by the Engineer. No structural member shall be weakened by cutting, notching, boring or otherwise, unless specifically allowed by structural drawings and/or specifications. Where such cutting is required, reinforcement shall be provided as specified or detailed. Depth of cover in traffic areas shall be 36 inches minimum.
- B. Standards: All piping shall be installed in accordance with NFPA No. 13 "Standard for the Installation of Sprinkler Systems". Underground mains shall be installed in accordance with NFPA No. 24 "Standard for the Installation of Private Fire Service Mains and Their Appurtenances".
- C. Miscellaneous:
  - 1. Escutcheons: Provide chrome plated escutcheons where piping penetrates walls, ceilings or floors in finished areas.

2. Pattern: Sprinklers shall be installed in a symmetrical pattern with lighting fixtures and with ceiling pattern. Heads located in lay-in ceilings shall be centered in panel.
3. Pipe Sleeves: All piping passing through concrete shall be provided with pipe sleeves. Allow 1" annular clearance between sleeve and pipe for piping 3" and smaller and 2" annular clearance for piping 4" and larger. Piping through walls below grade shall be sealed with Link-Seal.
4. Access: Provide access doors as required for all valves, devices, etc.
5. Pipes Passing through Fire Rated Surfaces: Pipes passing through fire rated walls, floors, ceilings, partitions, etc. shall have the annular space surrounding the pipe, or pipe insulation sealed with fire rated materials in accordance with the requirements of the fire authority having jurisdiction.
6. Concrete Thrust Blocks: Shall be constructed at all valves, tees, elbows, bends, crosses, reducers and dead ends in loose-joint pipe. Blocks shall cure a minimum of 7 days before pressure is applied. Concrete shall be 2500 psi mix. Size of thrust blocks shall be based on 1500 psf undisturbed soil bearing capacity.
7. Electrical Equipment: Piping shall not be run over electrical panels, motor control centers or switchboards.

### 3.2 IDENTIFICATION

- A. All controls, piping, valves and equipment shall be labeled for function and service in accordance with NFPA No.13.

### 3.3 TESTS AND ADJUSTMENTS

- A. Unless otherwise directed, tests shall be witnessed by a representative of the Engineer and an inspector of the authority having jurisdiction. Contractor shall notify fire authority at least 48 hours prior to testing. At various stages and upon completion, the system must be tested in the presence of the enforcing agency. Work to be concealed shall not be enclosed until prescribed tests are made. Should any work be enclosed before such tests, the Contractor shall, at his expense, uncover, test and repair all work to original conditions. Leaks and defects shown by tests shall be repaired and the entire work retested. Test all systems in accordance with fire authority requirements and NFPA No.13.

### 3.4 CERTIFICATION

- A. At completion of the project, a certificate of inspection from authority having jurisdiction indicating installation and testing in accordance with referenced standards shall be delivered to the Owner through the Engineer.

END OF SECTION

## SECTION 21 08 00

### COMMISSIONING OF FIRE SUPPRESSION SYSTEMS

#### PART 1 - GENERAL

##### 1.1 DESCRIPTION

- A. The requirements of this Section apply to all sections of Division 21.
- B. This project will have selected building systems commissioned. The complete list of equipment and systems to be commissioned is specified in Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS. The commissioning process, which the Contractor is responsible to execute, is defined in Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS. A Commissioning Agent (CxA) appointed by the VA will manage the commissioning process.

##### 1.2 RELATED WORK

- A. Section 01 00 00 GENERAL REQUIREMENTS.
- B. Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS.
- C. Section 01 33 23 SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

##### 1.3 SUMMARY

- A. This Section includes requirements for commissioning the Fire Suppression systems, subsystems and equipment. This Section supplements the general requirements specified in Section 01 91 00 General Commissioning Requirements.
- B. Refer to Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS for more details regarding processes and procedures as well as roles and responsibilities for all Commissioning Team members.

##### 1.4 DEFINITIONS

- A. Refer to Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS for definitions.

##### 1.5 COMMISSIONED SYSTEMS

- A. Commissioning of a system or systems specified in Division 21 is part of the construction process. Documentation and testing of these systems, as well as training of the VA's Operation and Maintenance personnel in accordance with the requirements of Section 01 91 00 and of Division 21, is required in cooperation with the VA and the Commissioning Agent.
- B. The Fire Suppression systems commissioning will include the systems listed in Section 01 19 00 General Commissioning Requirements:

## 1.6 SUBMITTALS

- A. The commissioning process requires review of selected Submittals. The Commissioning Agent will provide a list of submittals that will be reviewed by the Commissioning Agent. This list will be reviewed and approved by the VA prior to forwarding to the Contractor. Refer to Section 01 33 23 SHOP DRAWINGS, PRODUCT DATA, and SAMPLES for further details.
- B. The commissioning process requires Submittal review simultaneously with engineering review. Specific submittal requirements related to the commissioning process are specified in Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS.

## PART 2 - PRODUCTS (NOT USED)

## PART 3 - EXECUTION

### 3.1 CONSTRUCTION INSPECTIONS

- A. Commissioning of the building fire suppression systems will require inspection of individual elements of the fire suppression construction throughout the construction period. The Contractor shall coordinate with the Commissioning Agent in accordance with Section 01 19 00 and the Commissioning plan to schedule inspections as required to support the Commissioning Process.

### 3.2 PRE-FUNCTIONAL CHECKLISTS

- A. The Contractor shall complete Pre-Functional Checklists to verify systems, subsystems, and equipment installation is complete and systems are ready for Systems Functional Performance Testing. The Commissioning Agent will prepare Pre-Functional Checklists to be used to document equipment installation. The Contractor shall complete the checklists. Completed checklists shall be submitted to the VA and to the Commissioning Agent for review. The Commissioning Agent may spot check a sample of completed checklists. If the Commissioning Agent determines that the information provided on the checklist is not accurate, the Commissioning Agent will return the marked-up checklist to the Contractor for correction and resubmission. If the Commissioning Agent determines that a significant number of completed checklists for similar equipment are not accurate, the Commissioning Agent will select a broader sample of checklists for review. If the Commissioning Agent determines that a significant number of the broader sample of checklists is also inaccurate, all the checklists for the type of equipment will be returned to the Contractor for correction and resubmission. Refer to SECTION 01 91 00 GENERAL COMMISSIONING REQUIREMENTS for submittal requirements for Pre-Functional Checklists, Equipment Startup Reports, and other commissioning documents.

### 3.3 CONTRACTORS TESTS

- A. Contractor tests as required by other sections of Division 21 shall be scheduled and documented in accordance with Section 01 00 00 GENERAL REQUIREMENTS. All testing shall be incorporated into the project schedule. Contractor shall provide no less than 7 calendar days' notice of testing. The Commissioning Agent will witness selected Contractor tests at the sole discretion of the Commissioning Agent. Contractor tests shall be completed prior to scheduling Systems Functional Performance Testing.

### 3.4 SYSTEMS FUNCTIONAL PERFORMANCE TESTING

- A. The Commissioning Process includes Systems Functional Performance Testing that is intended to test systems functional performance under steady state conditions, to test system reaction to changes in operating conditions, and system performance under emergency conditions. The Commissioning Agent will prepare detailed Systems Functional Performance Test procedures for review and approval by the Resident Engineer. The Contractor shall review and comment on the tests prior to approval. The Contractor shall provide the required labor, materials, and test equipment identified in the test procedure to perform the tests. The Commissioning Agent will witness and document the testing. The Contractor shall sign the test reports to verify tests were performed. See Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS, for additional details.

### 3.5 TRAINING OF VA PERSONNEL

- A. Training of the VA operation and maintenance personnel is required in cooperation with the Resident Engineer and Commissioning Agent. Provide competent, factory authorized personnel to provide instruction to operation and maintenance personnel concerning the location, operation, and troubleshooting of the installed systems. Contractor shall submit training agendas and trainer resumes in accordance with the requirements of Section 01 19 00. The instruction shall be scheduled in coordination with the VA Resident Engineer after submission and approval of formal training plans. Refer to Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS and Division 21 Sections for additional Contractor training requirements.

----- END -----

## SECTION 230500

### COMMON WORK RESULTS FOR HVAC

#### PART 1 - GENERAL

##### 1.1 SUMMARY

- A. This Section includes the following:
  - 1. Piping materials and installation instructions common to most piping systems.
  - 2. Dielectric fittings.
  - 3. Sleeves.
  - 4. Escutcheons.
  - 5. HVAC demolition.
  - 6. Equipment installation requirements common to equipment sections.
  - 7. Concrete bases.
  - 8. Supports and anchorages.

##### 1.2 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.

##### 1.3 SUBMITTALS

- A. Welding certificates.

##### 1.4 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.

## PART 2 - PRODUCTS

### 2.1 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.

### 2.2 JOINING MATERIALS

- A. Refer to individual Division 23 piping Sections for special joining materials not listed below.
- B. Pipe-Flange Gasket Materials: ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch (3.2-mm) maximum thickness unless thickness or specific material is indicated.
- C. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.
- D. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- E. Brazing Filler Metals: AWS A5.8, BCuP Series or BAg1, unless otherwise indicated.
- F. Welding Filler Metals: Comply with AWS D10.12.

### 2.3 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 (1725-kPa) minimum working pressure at 180 deg F (82 deg C).
- D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig (1035- or 2070-kPa) minimum working pressure as required to suit system pressures.
- E. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig (2070-kPa) minimum working pressure at 225 deg F (107 deg C).
- F. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig (2070-kPa) minimum working pressure at 225 deg F (107 deg C).

## 2.4 SLEEVES

- A. Galvanized-Steel Sheet: 0.0239-inch (0.6-mm) 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.

## 2.5 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.



## 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.
- M. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
- N. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
  - 1. Install steel pipe for sleeves smaller than 6 inches (150 mm) in diameter.
  - 2. Install cast-iron "wall pipes" for sleeves 6 inches (150 mm) 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.
- O. 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 (25-mm) 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.
- P. 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.
- Q. Verify final equipment locations for roughing-in.
- R. 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.

### 3.4 PIPING CONNECTIONS

- A. Make connections according to the following, unless otherwise indicated:
  - 1. Install unions, in piping **NPS 2 (DN 50)** and smaller, adjacent to each valve and at final connection to each piece of equipment.
  - 2. Install flanges, in piping **NPS 2-1/2 (DN 65)** 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 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 (100 mm)** 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 (450-mm)** 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.

### 3.7 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.

### 3.8 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.

END OF SECTION 230500

## SECTION 230513

### COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

#### PART 1 - GENERAL

##### 1.1 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.

##### 1.2 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.

##### 2.2 MOTOR CHARACTERISTICS

- A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet (1000 m) 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 POLYPHASE MOTORS

- A. Description: NEMA MG 1, Design B, medium induction motor.
- B. Efficiency: Energy efficient, as defined in NEMA MG 1.
- C. Service Factor: 1.15.
- D. Multispeed Motors: Variable torque.
  - 1. For motors with 2:1 speed ratio, consequent pole, single winding.
  - 2. For motors with other than 2:1 speed ratio, separate winding for each speed.
- E. Rotor: Random-wound, squirrel cage.
- F. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
- G. Temperature Rise: Match insulation rating.
- H. Insulation: Class F .
- I. Code Letter Designation:
  - 1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
  - 2. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.
- J. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

## 2.4 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

- A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.
- B. Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.
  - 1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
  - 2. Energy- and Premium-Efficient Motors: Class B temperature rise; Class F insulation.
  - 3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
  - 4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

## 2.5 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 230513



## SECTION 230516

### EXPANSION FITTINGS AND LOOPS FOR HVAC PIPING

#### PART 1 - GENERAL

##### 1.1 SUMMARY

###### A. Section Includes:

1. Expansion-compensator packless expansion joints.
2. Metal-bellows packless expansion joints.
3. Pipe loops and swing connections.
4. Alignment guides and anchors.

##### 1.2 SUBMITTALS

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

##### 1.3 QUALITY ASSURANCE

###### A. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. ASME Boiler and Pressure Vessel Code: Section IX.

#### PART 2 - PRODUCTS

##### 2.1 PACKLESS EXPANSION JOINTS

###### A. Metal, Expansion-Compensator Packless Expansion Joints:

1. Basis-of-Design Product: Subject to compliance with requirements, provide comparable product by one of the following:
  - a. Adsko Manufacturing LLC.
  - b. Flexicraft Industries.
  - c. Metraflex, Inc.
2. Minimum Pressure Rating: 150 psig unless otherwise indicated.
3. Configuration for Copper Tubing: Two-ply, phosphor-bronze bellows with copper pipe ends.
  - a. End Connections for Copper Tubing NPS 2 and Smaller: Solder joint or threaded.

- b. End Connections for Copper Tubing NPS 2-1/2 threaded.
- 4. Configuration for Steel Piping: Two-ply, stainless-steel bellows; steel-pipe end connections; and carbon-steel shroud.
  - a. End Connections for Steel Pipe NPS 2 and Smaller: Threaded.
  - b. End Connections for Steel Pipe NPS 2-1/2 Flanged.
- B. Metal-Bellows Packless Expansion Joints:
  - 1. Basis-of-Design Product: Subject to compliance with requirements, provide comparable product by one of the following:
    - a. Adesco Manufacturing LLC.
    - b. Badger Industries, Inc.
    - c. Expansion Joint Systems, Inc.
    - d. Flo Fab inc.
  - 2. Standards: ASTM F 1120 and EJMA's "Standards of the Expansion Joint Manufacturers Association, Inc."
  - 3. Type: Circular, corrugated bellows with external tie rods.
  - 4. Minimum Pressure Rating: 150 psig unless otherwise indicated.
  - 5. Configuration: Single joint with base class(es) unless otherwise indicated.
  - 6. Expansion Joints for Copper Tubing: Single or multi-ply phosphor-bronze bellows, copper pipe ends, and brass shrouds.
    - a. End Connections for Copper Tubing NPS 2 and Smaller: Solder joint.
    - b. End Connections for Copper Tubing NPS 2-1/2 threaded.
    - c. End Connections for Copper Tubing NPS 5 and Larger: Flanged.
  - 7. Expansion Joints for Steel Piping: Single- or multi-ply stainless-steel bellows, steel pipe ends, and carbon-steel shroud.
    - a. End Connections for Steel Pipe NPS 2 and Smaller: Threaded.
    - b. End Connections for Steel Pipe NPS 2-1/2 and Larger: Flanged.

## 2.2 ALIGNMENT GUIDES AND ANCHORS

- A. Alignment Guides:
  - 1. Description: Steel, factory-fabricated alignment guide, with bolted two-section outer cylinder and base for attaching to structure; with two-section guiding spider for bolting to pipe.
- B. Anchor Materials:
  - 1. Steel Shapes and Plates: ASTM A 36/A 36M.
  - 2. Bolts and Nuts: ASME B18.10 or ASTM A 183, steel hex head.
  - 3. Washers: ASTM F 844, steel, plain, flat washers.

4. Mechanical Fasteners: Insert-wedge-type stud with expansion plug anchor for use in hardened portland cement concrete, with tension and shear capacities appropriate for application.
  - a. Stud: Threaded, zinc-coated carbon steel.
  - b. Expansion Plug: Zinc-coated steel.
  - c. Washer and Nut: Zinc-coated steel.
5. Chemical Fasteners: Insert-type-stud, bonding-system anchor for use with hardened portland cement concrete, with tension and shear capacities appropriate for application.
  - a. Bonding Material: ASTM C 881/C 881M, Type IV, Grade 3, two-component epoxy resin suitable for surface temperature of hardened concrete where fastener is to be installed.
  - b. Stud: ASTM A 307, zinc-coated carbon steel with continuous thread on stud unless otherwise indicated.
  - c. Washer and Nut: Zinc-coated steel.

## PART 3 - EXECUTION

### 3.1 EXPANSION-JOINT INSTALLATION

- A. Install expansion joints of sizes matching sizes of piping in which they are installed.
- B. Install packed-type expansion joints with packing suitable for fluid service.
- C. Install metal-bellows expansion joints according to EJMA's "Standards of the Expansion Joint Manufacturers Association, Inc."

### 3.2 PIPE LOOP AND SWING CONNECTION INSTALLATION

- A. Install pipe loops cold-sprung in tension or compression as required to partly absorb tension or compression produced during anticipated change in temperature.
- B. Connect risers and branch connections to mains with at least five pipe fittings including tee in main.
- C. Connect risers and branch connections to terminal units with at least four pipe fittings including tee in riser.
- D. Connect mains and branch connections to terminal units with at least four pipe fittings including tee in main.

### 3.3 ALIGNMENT-GUIDE AND ANCHOR INSTALLATION

- A. Install alignment guides to guide expansion and to avoid end-loading and torsional stress.

- B. Install two guide(s) on each side of pipe expansion fittings and loops. Install guides nearest to expansion joint not more than four pipe diameters from expansion joint.
- C. Attach guides to pipe and secure guides to building structure.
- D. Install anchors at locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.
- E. Anchor Attachments:
  - 1. Anchor Attachment to Steel Pipe: Attach by welding. Comply with ASME B31.9 and ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
  - 2. Anchor Attachment to Copper Tubing: Attach with pipe hangers. Use MSS SP-69, Type 24, U-bolts bolted to anchor.
- F. Fabricate and install steel anchors by welding steel shapes, plates, and bars. Comply with ASME B31.9 and AWS D1.1/D1.1M.
  - 1. Anchor Attachment to Steel Structural Members: Attach by welding.
  - 2. Anchor Attachment to Concrete Structural Members: Attach by fasteners. Follow fastener manufacturer's written instructions.
- G. Use grout to form flat bearing surfaces for guides and anchors attached to concrete.

END OF SECTION 230516

## SECTION 230519

### METERS AND GAGES FOR HVAC PIPING

#### PART 1 - GENERAL

##### 1.1 SUMMARY

###### A. Section Includes:

1. Bimetallic-actuated thermometers.
2. Liquid-in-glass thermometers.
3. Thermowells.
4. Dial-type pressure gages.
5. Gage attachments.
6. Pitot-tube flowmeters.
7. Turbine flowmeters.
8. Venturi flowmeters.
9. Impeller-turbine, thermal-energy meters.

##### 1.2 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Wiring Diagrams: For power, signal, and control wiring.
- C. Product certificates.
- D. Operation and maintenance data.

#### PART 2 - PRODUCTS

##### 2.1 BIMETALLIC-ACTUATED THERMOMETERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide comparable product by one of the following:
  1. REOTEMP Instrument Corporation.
  2. Tel-Tru Manufacturing Company.
  3. Weiss Instruments, Inc.
  4. WIKA Instrument Corporation - USA.
  5. Winters Instruments - U.S.
- B. Standard: ASME B40.200.
- C. Case: sealed type(s); stainless steel with 3-inch nominal diameter.

- D. Dial: Nonreflective aluminum with permanently etched scale markings and scales in deg F.
- E. Connector Type(s): Union joint, adjustable angle, with unified-inch screw threads.
- F. Connector Size: 1/2 inch, with ASME B1.1 screw threads.
- G. Stem: 0.375 inch in diameter; stainless steel.
- H. Window: Plain glass.
- I. Ring: Stainless steel.
- J. Element: Bimetal coil.
- K. Pointer: Dark-colored metal.
- L. Accuracy: Plus or minus **1.5** percent of scale range.

## 2.2 LIQUID-IN-GLASS THERMOMETERS

### A. Metal-Case, Industrial-Style, Liquid-in-Glass Thermometers:

1. Basis-of-Design Product: Subject to compliance with requirements, provide comparable product by one of the following:
  - a. Miljoco Corporation.
  - b. Tel-Tru Manufacturing Company.
  - c. Weiss Instruments, Inc.
2. Standard: ASME B40.200.
3. Case: Cast aluminum ; 7-inch nominal size unless otherwise indicated.
4. Case Form: Adjustable angle unless otherwise indicated.
5. Tube: Glass with magnifying lens and blue or red organic liquid.
6. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F.
7. Window: Glass.
8. Stem: Aluminum and of length to suit installation.
  - a. Design for Air-Duct Installation: With ventilated shroud.
  - b. Design for Thermowell Installation: Bare stem.
9. Connector: 1-1/4 inches, with ASME B1.1 screw threads.
10. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

### B. Plastic-Case, Industrial-Style, Liquid-in-Glass Thermometers:

1. Basis-of-Design Product: Subject to compliance with requirements, provide comparable product by one of the following:

- a. Miljoco Corporation.
  - b. REOTEMP Instrument Corporation.
  - c. Weiss Instruments, Inc.
- 2. Standard: ASME B40.200.
- 3. Case: Plastic; 7-inch nominal size unless otherwise indicated.
- 4. Case Form: Adjustable angle unless otherwise indicated.
- 5. Tube: Glass with magnifying lens and blue or red organic liquid.
- 6. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F.
- 7. Window: Glass.
- 8. Stem: Aluminum, brass, or stainless steel and of length to suit installation.
  - a. Design for Air-Duct Installation: With ventilated shroud.
  - b. Design for Thermowell Installation: Bare stem.
- 9. Connector: 1-1/4 inches with ASME B1.1 screw threads.
- 10. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

## 2.3 THERMOWELLS

### A. Thermowells:

- 1. Standard: ASME B40.200.
- 2. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.
- 3. Material for Use with Copper Tubing: CNR.
- 4. Material for Use with Steel Piping: CRES.
- 5. Type: Stepped shank unless straight or tapered shank is indicated.
- 6. External Threads: NPS 1/2, ASME B1.20.1 pipe threads.
- 7. Internal Threads: 1/2, with ASME B1.1 screw threads.
- 8. Bore: Diameter required to match thermometer bulb or stem.
- 9. Insertion Length: Length required to match thermometer bulb or stem.
- 10. Lagging Extension: Include on thermowells for insulated piping and tubing.
- 11. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.

### B. Heat-Transfer Medium: Mixture of graphite and glycerin.

## 2.4 PRESSURE GAGES

### A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:

- 1. Basis-of-Design Product: Subject to compliance with requirements, provide comparable product by one of the following:
  - a. REOTEMP Instrument Corporation.
  - b. Tel-Tru Manufacturing Company.

- c. Weiss Instruments, Inc.
  - 2. Standard: ASME B40.100.
  - 3. Case: Liquid-filled type(s); cast aluminum or drawn steel; 4-1/2-inch nominal diameter.
  - 4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
  - 5. Pressure Connection: Brass, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
  - 6. Movement: Mechanical, with link to pressure element and connection to pointer.
  - 7. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi and kPa.
  - 8. Pointer: Dark-colored metal.
  - 9. Window: Glass.
  - 10. Ring: Metal.
  - 11. Accuracy: Grade B, plus or minus 2 percent of middle half of scale range.
- B. Direct-Mounted, Plastic-Case, Dial-Type Pressure Gages:
- 1. Basis-of-Design Product: Subject to compliance with requirements, provide comparable product by one of the following:
    - a. REOTEMP Instrument Corporation.
    - b. Tel-Tru Manufacturing Company.
    - c. Weiss Instruments, Inc.
  - 2. Standard: ASME B40.100.
  - 3. Case: Sealed type; 4-1/2-inch nominal diameter.
  - 4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
  - 5. Pressure Connection: Brass, with NPS 1/2, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
  - 6. Movement: Mechanical, with link to pressure element and connection to pointer.
  - 7. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi.
  - 8. Pointer: Dark-colored metal.
  - 9. Window: Glass.
  - 10. Accuracy: Grade B, plus or minus 2 percent of middle half of scale range.
- C. Remote-Mounted, Metal-Case, Dial-Type Pressure Gages:
- 1. Basis-of-Design Product: Subject to compliance with requirements, provide comparable product by one of the following:
    - a. REOTEMP Instrument Corporation.
    - b. Tel-Tru Manufacturing Company.
    - c. Weiss Instruments, Inc.
  - 2. Standard: ASME B40.100.
  - 3. Case: Liquid-filled 4-1/2-inch nominal diameter with front flange and holes for panel mounting.
  - 4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.



5. Pressure Connection: Brass, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
6. Movement: Mechanical, with link to pressure element and connection to pointer.
7. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi.
8. Pointer: Dark-colored metal.
9. Window: Glass.
10. Ring: Metal.
11. Accuracy: Grade B, plus or minus 2 percent of middle half of scale range.

D. Remote-Mounted, Plastic-Case, Dial-Type Pressure Gages:

1. Basis-of-Design Product: Subject to compliance with requirements, provide comparable product by one of the following:
  - a. REOTEMP Instrument Corporation.
  - b. Tel-Tru Manufacturing Company.
  - c. Weiss Instruments, Inc.
2. Standard: ASME B40.100.
3. Case: Sealed type; plastic; 4-1/2-inch nominal diameter with front flange and holes for panel mounting.
4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
5. Pressure Connection: Brass, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
6. Movement: Mechanical, with link to pressure element and connection to pointer.
7. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi.
8. Pointer: Dark-colored metal.
9. Window: Glass.
10. Accuracy Grade B, plus or minus 2 percent of middle half of scale range.

## 2.5 GAGE ATTACHMENTS

- A. Snubbers: ASME B40.100, brass; with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and piston-type surge-dampening device. Include extension for use on insulated piping.
- B. Siphons: Loop-shaped section of stainless-steel pipe with NPS 1/4 or NPS 1/2 pipe threads.
- C. Valves: Brass or stainless-steel needle, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads.

## 2.6 FLOWMETERS

- A. Pitot-Tube Flowmeters:

1. Basis-of-Design Product: Subject to compliance with requirements, provide comparable product by one of the following:
  - a. ABB; Instrumentation and Analytical.
  - b. Emerson Process Management; Rosemount.
  - c. Preso Meters; a division of Racine Federated Inc.
  - d. TACO Incorporated.
2. Description: Flowmeter with sensor and indicator.
3. Flow Range: Sensor and indicator shall cover operating range of equipment or system served.
4. Sensor: Insertion type; for inserting probe into piping and measuring flow directly in gallons per minute.
  - a. Design: Differential-pressure-type measurement for oil.
  - b. Construction: Stainless-steel probe of length to span inside of pipe, with integral transmitter and direct-reading scale.
  - c. Minimum Pressure Rating: 150 psig.
  - d. Minimum Temperature Rating: 250 deg F.
5. Indicator: Hand-held meter; either an integral part of sensor or a separate meter.
6. Integral Transformer: For low-voltage power connection.
7. Accuracy: Plus or minus 3 percent.
8. Display: Shows rate of flow, with register to indicate total volume in gallons.
9. Operating Instructions: Include complete instructions with each flowmeter.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install thermowells with socket extending a minimum of 2 inches into fluid to center of pipe and in vertical position in piping tees.
- B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.
- C. Install thermowells with extension on insulated piping.
- D. Fill thermowells with heat-transfer medium.
- E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.
- F. Install remote-mounted thermometer bulbs in thermowells and install cases on panels; connect cases with tubing and support tubing to prevent kinks. Use minimum tubing length.
- G. Install duct-thermometer mounting brackets in walls of ducts. Attach to duct with screws.

- H. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.
- I. Install remote-mounted pressure gages on panel.
- J. Install valve and snubber in piping for each pressure gage for fluids (except steam).
- K. Install valve and syphon fitting in piping for each pressure gage for steam.
- L. Install flow indicators in piping systems in accessible positions for easy viewing.
- M. Assemble and install connections, tubing, and accessories between flow-measuring elements and flowmeters according to manufacturer's written instructions.
- N. Install flowmeter elements in accessible positions in piping systems.
- O. Install differential-pressure-type flowmeter elements, with at least minimum straight lengths of pipe, upstream and downstream from element according to manufacturer's written instructions.
- P. Install permanent indicators on walls or brackets in accessible and readable positions.
- Q. Install connection fittings in accessible locations for attachment to portable indicators.
- R. Mount thermal-energy meters on wall if accessible; if not, provide brackets to support meters.
- S. Install thermometers in the following locations:
  - 1. Inlet and outlet of each hydronic zone.
  - 2. Inlet and outlet of each hydronic boiler.
  - 3. Two inlets and two outlets of each chiller.
  - 4. Inlet and outlet of each hydronic coil in air-handling units.
  - 5. Two inlets and two outlets of each hydronic heat exchanger.
  - 6. Inlet and outlet of each thermal-storage tank.
  - 7. Outside-, return-, supply-, and mixed-air ducts.
- T. Install pressure gages in the following locations:
  - 1. Discharge of each pressure-reducing valve.
  - 2. Inlet and outlet of each chiller chilled-water and condenser-water connection.
  - 3. Suction and discharge of each pump.

### 3.2 CONNECTIONS

- A. Install meters and gages adjacent to machines and equipment to allow service and maintenance of meters, gages, machines, and equipment.
- B. Connect flowmeter-system elements to meters.
- C. Connect flowmeter transmitters to meters.

- D. Connect thermal-energy meter transmitters to meters.

### 3.3 ADJUSTING

- A. After installation, calibrate meters according to manufacturer's written instructions.
- B. Adjust faces of meters and gages to proper angle for best visibility.

### 3.4 THERMOMETER SCHEDULE

- A. Thermometers at inlet and outlet of each hydronic zone shall be one of the following:
  - 1. Liquid-filled, bimetallic-actuated type.
  - 2. Industrial-style, liquid-in-glass type.
- B. Thermometers at inlets and outlets of each chiller shall be one of the following:
  - 1. Liquid-filled, bimetallic-actuated type.
  - 2. Industrial-style, liquid-in-glass type.
- C. Thermometers at inlet and outlet of each hydronic coil in air-handling units and built-up central systems shall be one of the following:
  - 1. Liquid-filled, bimetallic-actuated type.
  - 2. Industrial-style, liquid-in-glass type.
- D. Thermometers at inlet and outlet of each thermal-storage tank shall be one of the following:
  - 1. Liquid-filled, bimetallic-actuated type.
  - 2. Industrial-style, liquid-in-glass type.
- E. Thermometer stems shall be of length to match thermowell insertion length.

### 3.5 THERMOMETER SCALE-RANGE SCHEDULE

- A. Scale Range for Chilled-Water Piping: 0 to 100 deg F (Minus 20 to plus 50 deg C).

### 3.6 PRESSURE-GAGE SCHEDULE

- A. Pressure gages at discharge of each pressure-reducing valve shall be one of the following:
  - 1. Liquid-filled-mounted, metal case.
  - 2. Sealed-mounted, plastic case.
- B. Pressure gages at inlet and outlet of each chiller chilled-water and condenser-water connection shall be one of the following:

1. Liquid-filled-mounted, metal case.
2. Sealed-mounted, plastic case.

C. Pressure gages at suction and discharge of each pump shall be one of the following:

1. Liquid-filled-mounted, metal case.
2. Sealed-mounted, plastic case.

### 3.7 PRESSURE-GAGE SCALE-RANGE SCHEDULE

- A. Scale Range for Chilled-Water Piping: 0 to 100 psi (0 to 600 kPa).

### 3.8 FLOWMETER SCHEDULE

- A. Flowmeters for Chilled-Water Piping: Pitot-tube type.

END OF SECTION 230519

## SECTION 230523

### GENERAL-DUTY VALVES FOR HVAC PIPING

#### PART 1 - GENERAL

##### 1.1 SUMMARY

###### A. Section Includes:

1. Brass ball valves.
2. Bronze ball valves.
3. High-performance butterfly valves.
4. Bronze swing check valves.

###### B. Related Sections:

1. Division 23 HVAC piping Sections for specialty valves applicable to those Sections only.
2. Division 23 Section "Identification for HVAC Piping and Equipment" for valve tags and schedules.

##### 1.2 SUBMITTALS

- ###### A. Product Data:
- For each type of valve indicated.

##### 1.3 QUALITY ASSURANCE

- ###### A. Source Limitations for Valves:
- Obtain each type of valve from single source from single manufacturer.
- ###### B. ASME Compliance:
- ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.

#### PART 2 - PRODUCTS

##### 2.1 GENERAL REQUIREMENTS FOR VALVES

- ###### A. Refer to HVAC valve schedule articles for applications of valves.
- ###### B. Valve Pressure and Temperature Ratings:
- Not less than indicated and as required for system pressures and temperatures.
- ###### C. Valve Sizes:
- Same as upstream piping unless otherwise indicated.
- ###### D. Valve Actuator Types:

1. Gear Actuator: For quarter-turn valves NPS 8 and larger.
2. Handwheel: For valves other than quarter-turn types.
3. Handlever: For quarter-turn valves NPS 6 and smaller except plug valves.
4. Chainwheel: Device for attachment to valve handwheel, stem, or other actuator; of size and with chain for mounting height, as indicated in the "Valve Installation" Article.

E. Valves in Insulated Piping: With 2-inch stem extensions and the following features:

1. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
2. Butterfly Valves: With extended neck.

F. Valve-End Connections:

1. Flanged: With flanges according to ASME B16.1 for iron valves.
2. Solder Joint: With sockets according to ASME B16.18.
3. Threaded: With threads according to ASME B1.20.1.

## 2.2 BRASS BALL VALVES

A. Two-Piece, Full-Port, Brass Ball Valves with Stainless-Steel Trim:

1. Manufacturers: Subject to compliance with requirements:
  - a. Crane Co.; Crane Valve Group; Crane Valves.
  - b. Flow-Tek, Inc.; a subsidiary of Bray International, Inc.
  - c. Hammond Valve.
  - d. Jamesbury; a subsidiary of Metso Automation.
  - e. Kitz Corporation.
  - f. Milwaukee Valve Company.
2. Description:
  - a. Standard: MSS SP-110.
  - b. SWP Rating: 150 psig.
  - c. CWP Rating: 600 psig.
  - d. Body Design: Two piece.
  - e. Body Material: Forged brass.
  - f. Ends: Threaded.
  - g. Seats: PTFE or TFE.
  - h. Stem: Stainless steel.
  - i. Ball: Stainless steel, vented.
  - j. Port: Full.

## 2.3 BRONZE BALL VALVES

A. Two-Piece, Full-Port, Bronze Ball Valves with Stainless-Steel Trim:

1. Manufacturers: Subject to compliance with requirements:

- a. Crane Co.; Crane Valve Group; Crane Valves.
- b. Hammond Valve.
- c. Milwaukee Valve Company.
- d. NIBCO INC.

2. Description:

- a. Standard: MSS SP-110.
- b. SWP Rating: 150 psig.
- c. CWP Rating: 600 psig.
- d. Body Design: Two piece.
- e. Body Material: Bronze.
- f. Ends: Threaded.
- g. Seats: PTFE or TFE.
- h. Stem: Stainless steel.
- i. Ball: Stainless steel, vented.
- j. Port: Full.

## 2.4 HIGH-PERFORMANCE BUTTERFLY VALVES

A. Class 150, Single-Flange, High-Performance Butterfly Valves:

1. Manufacturers: Subject to compliance with requirements:

- a. Hammond Valve.
- b. Jamesbury; a subsidiary of Metso Automation.
- c. Milwaukee Valve Company.
- d. NIBCO INC.
- e. Tyco Valves & Controls; a unit of Tyco Flow Control.

2. Description:

- a. Standard: MSS SP-68.
- b. CWP Rating: 285 psig at 100 deg F.
- c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
- d. Body Material: Carbon steel, cast iron, ductile iron, or stainless steel.
- e. Seat: Reinforced PTFE or metal.
- f. Stem: Stainless steel; offset from seat plane.
- g. Disc: Carbon steel.
- h. Service: Bidirectional.

## 2.5 BRONZE SWING CHECK VALVES

A. Class 125, Bronze Swing Check Valves with Bronze Disc:

1. Manufacturers: Subject to compliance with requirements:



- a. Crane Co.; Crane Valve Group; Crane Valves.
- b. Hammond Valve.
- c. Milwaukee Valve Company.
- d. NIBCO INC.

2. Description:

- a. Standard: MSS SP-80, Type 3.
- b. CWP Rating: 200 psig.
- c. Body Design: Horizontal flow.
- d. Body Material: ASTM B 62, bronze.
- e. Ends: Threaded.
- f. Disc: Bronze.

B. Class 125, Bronze Swing Check Valves with Nonmetallic Disc:

1. Manufacturers: Subject to compliance with requirements:

- a. Crane Co.; Crane Valve Group; Jenkins Valves.
- b. Hammond Valve.
- c. Milwaukee Valve Company.
- d. NIBCO INC.

2. Description:

- a. Standard: MSS SP-80, Type 4.
- b. CWP Rating: 200 psig.
- c. Body Design: Horizontal flow.
- d. Body Material: ASTM B 62, bronze.
- e. Ends: Threaded.
- f. Disc: PTFE or TFE.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- C. Examine threads on valve and mating pipe for form and cleanliness.
- D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

- E. Do not attempt to repair defective valves; replace with new valves.

### 3.2 VALVE INSTALLATION

- A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- B. Locate valves for easy access and provide separate support where necessary.
- C. Install valves in horizontal piping with stem at or above center of pipe.
- D. Install valves in position to allow full stem movement.
- E. Install swing check valves for proper direction of flow and in horizontal position with hinge pin level.

### 3.3 ADJUSTING

- A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

### 3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

- A. If valve applications are not indicated, use the following:
  - 1. Shutoff Service: Ball, butterfly, or gate valves.
  - 2. Throttling Service, Except Steam: Ball or butterfly valves.
  - 3. Throttling Service, Steam: Butterfly valves.
  - 4. Pump-Discharge Check Valves:
    - a. NPS 2 and Smaller: Bronze swing check valves with bronze or nonmetallic disc.
    - b. NPS 2-1/2 and Larger: Iron swing check valves with lever and weight or with spring.
- B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.
- C. Select valves, except wafer types, with the following end connections:
  - 1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.
  - 2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
  - 3. For Copper Tubing, NPS 5 and Larger: Flanged ends.
  - 4. For Steel Piping, NPS 2 and Smaller: Threaded ends.
  - 5. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.

6. For Steel Piping, NPS 5 and Larger: Flanged ends.

### 3.5 CHILLED-WATER VALVE SCHEDULE

#### A. Pipe NPS 2 and Smaller:

1. Bronze and Brass Valves: May be provided with solder-joint ends instead of threaded ends.
2. Bronze Swing Check Valves: Class 125, bronze disc.

#### B. Pipe NPS 2-1/2 and Larger:

1. High-Performance Butterfly Valves: Class 150, single flange.

END OF SECTION 230523

## SECTION 230529

### HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

#### PART 1 - GENERAL

##### 1.1 SUMMARY

###### A. Section Includes:

1. Metal pipe hangers and supports.
2. Trapeze pipe hangers.
3. Thermal-hanger shield inserts.
4. Fastener systems.
5. Equipment supports.

##### 1.2 PERFORMANCE REQUIREMENTS

###### A. Structural Performance: Hangers and supports for HVAC piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.

1. Design supports for multiple pipes capable of supporting combined weight of supported systems, system contents, and test water.
2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
3. Design seismic-restraint hangers and supports for piping and equipment and obtain approval from authorities having jurisdiction.

##### 1.3 SUBMITTALS

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

##### 1.4 QUALITY ASSURANCE

###### A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

###### B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

## PART 2 - PRODUCTS

### 2.1 METAL PIPE HANGERS AND SUPPORTS

#### A. Carbon-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Galvanized Metallic Coatings: Pregalvanized or hot dipped.
3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

#### B. Stainless-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
3. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

#### C. Copper Pipe Hangers:

1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel.

### 2.2 TRAPEZE PIPE HANGERS

- #### A.
- Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

### 2.3 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.
- #### B.
- Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

### 2.4 EQUIPMENT SUPPORTS

- #### A.
- Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

## 2.5 MISCELLANEOUS MATERIALS

- A. Structural Steel: ASTM A 36/A 36M, carbon-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 INSTALLATION

- A. Metal 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 the building structure.
- B. Metal 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 for individual pipe hangers.
  - 2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.
- C. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- D. 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.
- E. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- F. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- G. 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.

- H. Install lateral bracing with pipe hangers and supports to prevent swaying.
- I. 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.
- J. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- K. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.
- L. Insulated Piping:
  - 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 allowed by 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 or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
  - 6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

### 3.2 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 bearing surface smooth.
- C. Provide lateral bracing, to prevent swaying, for equipment supports.

### 3.3 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/D1.1M 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 so contours of welded surfaces match adjacent contours.

### 3.4 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.

### 3.5 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
  - 1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.



### 3.6 HANGER AND SUPPORT SCHEDULE

- A. Specific hanger and support requirements are 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 carbon-steel pipe hangers and supports and metal trapeze pipe hangers and attachments for general service applications.
- F. Use stainless-steel pipe hangers and stainless-steel or corrosion-resistant attachments for hostile environment applications.
- G. Use copper-plated pipe hangers and copper attachments for copper piping and tubing.
- H. Use padded hangers for piping that is subject to scratching.
- I. Use thermal-hanger shield inserts for insulated piping and tubing.
- J. 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 up to 1050 deg F, pipes NPS 4 to NPS 24, 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 36, requiring clamp flexibility and up to 4 inches of insulation.
  - 4. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
  - 5. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
  - 6. 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 or carbon-steel plate.
  - 7. 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 or carbon-steel plate, and with U-bolt to retain pipe.
  - 8. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.
  - 9. 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.

- K. 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 24.
  2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.
- L. 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.
- M. 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-joint 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. 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.
  8. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
  9. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
- N. 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.
- O. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
  2. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
  3. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.
- P. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.
- Q. Use mechanical-expansion anchors instead of building attachments where required in concrete construction.

END OF SECTION 230529

## SECTION 230548

### VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT

#### PART 1 - GENERAL

##### 1.1 SUMMARY

- A. This Section includes the following:

- 1. Housed spring mounts.

##### 1.2 PERFORMANCE REQUIREMENTS

- A. Seismic-Restraint Loading:

- 1. Site Class as Defined in the IBC: A
  - 2. Assigned Seismic Use Group or Building Category as Defined in the IBC: III.
    - a. Component Importance Factor: 1.5
    - b. Component Response Modification Factor: 1.5
    - c. Component Amplification Factor: 1

##### 1.3 SUBMITTALS

- A. Product Data: For each product indicated.
- B. Delegated-Design Submittal: For vibration isolation and seismic-restraint calculations and 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.
- C. Welding certificates.
- D. Qualification Data: For professional engineer.
- E. Field quality-control test reports.

##### 1.4 QUALITY ASSURANCE

- A. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.
- B. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

- C. Seismic-restraint devices shall have horizontal and vertical load testing and analysis 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. 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:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- C. Basis-of-Design Product: Subject to compliance with requirements, provide MASON INDUSTRIES or a comparable product by one of the following:
  - 1. California Dynamics Corporation.
  - 2. Kinetics Noise Control.
  - 3. Mason Industries.
- D. 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.
- E. 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.

## 2.2 SEISMIC-RESTRAINT DEVICES

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- C. Basis-of-Design Product: Subject to compliance with requirements, provide MASON INDUSTRIES or a comparable product by one of the following:
  - 1. Cooper B-Line, Inc.; a division of Cooper Industries.
  - 2. Mason Industries.
  - 3. TOLCO Incorporated; a brand of NIBCO INC.
  - 4. Unistrut; Tyco International, Ltd.
- D. 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.
- E. 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.
- F. Restraint Cables: ASTM A 603 galvanized -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.
- G. Hanger Rod Stiffener: steel slotted-support-system sleeve with internally bolted connections to hanger rod.
- H. 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.
- 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.

## PART 3 - EXECUTION

### 3.1 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.

### 3.2 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 resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch (3.2 mm).
  - 2. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction providing required submittals for component.
- C. Piping Restraints:
  - 1. Comply with requirements in MSS SP-127.
  - 2. Space lateral supports a maximum of [40 feet (12 m)] o.c., and longitudinal supports a maximum of [80 feet (24 m)] o.c.
  - 3. Brace a change of direction longer than 12 feet (3.7 m).
- 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. 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.
- H. 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. Set anchors to manufacturer's recommended torque, using a torque wrench.
5. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

### 3.3 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. Comply with requirements in Division 23 Section "Hydronic Piping" for piping flexible connections.

### 3.4 FIELD QUALITY CONTROL

- A. 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 post connection 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. 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.



### 3.5 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 active height of spring isolators.
- D. Adjust restraints to permit free movement of equipment within normal mode of operation.

END OF SECTION 230548

## SECTION 230553

### IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

#### PART 1 - GENERAL

##### 1.1 SUMMARY

###### A. Section Includes:

1. Equipment labels.
2. Warning signs and labels.
3. Pipe labels.
4. Duct labels.

##### 1.2 SUBMITTAL

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

#### PART 2 - PRODUCTS

##### 2.1 EQUIPMENT LABELS

###### A. Plastic Labels for Equipment:

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.
2. Letter Color: White.
3. Background Color: Blue.
4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
7. Fasteners: Stainless-steel rivets or self-tapping screws.
8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

###### B. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified.

###### C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the

Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

## 2.2 WARNING SIGNS AND LABELS

- A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 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 partially cover 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, 1/16 inch thick, and having predrilled holes for attachment hardware.
- B. Letter Color: White.
- C. Background Color: Black.
- 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.

## 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. 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.
- C. Pipe Label Color Schedule:
  - 1. Chilled-Water Piping:
    - a. Background Color: White.
    - b. Letter Color: Blue.
  - 2. Low-Pressure Steam Piping:
    - a. Background Color: Black.
    - b. Letter Color: Yellow.

### 3.4 DUCT LABEL INSTALLATION

- A. Install plastic-laminated duct labels with permanent adhesive on air ducts in the following color codes:
  - 1. Blue: For cold-air supply ducts.
  - 2. Yellow: For hot-air supply ducts.
  - 3. Green: For exhaust-, outside-, relief-, return-, and mixed-air ducts.
  - 4. ASME A13.1 Colors and Designs: For hazardous material exhaust.
- B. 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.

END OF SECTION 230553

## SECTION 230593

### TESTING, ADJUSTING, AND BALANCING FOR HVAC

#### PART 1 - GENERAL

##### 1.1 SUMMARY

- A. Section Includes:
  - 1. Balancing Air Systems:
    - a. Constant-volume air systems.
  - 2. Balancing Hydronic Piping Systems:
    - a. Constant-flow hydronic systems.

##### 1.2 DEFINITIONS

- A. AABC: Associated Air Balance Council.
- B. NEBB: National Environmental Balancing Bureau.
- C. TAB: Testing, adjusting, and balancing.
- D. TABB: Testing, Adjusting, and Balancing Bureau.
- E. TAB Specialist: An entity engaged to perform TAB Work.

##### 1.3 SUBMITTALS

- A. Strategies and Procedures Plan: Within 30 days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures as specified in "Preparation" Article.
- B. Certified TAB reports.

##### 1.4 QUALITY ASSURANCE

- A. TAB Contractor Qualifications: Engage a TAB entity certified by ABEB or AB.
  - 1. TAB Field Supervisor: Employee of the TAB contractor and certified by AABC, NEBB, or TABB.
  - 2. TAB Technician: Employee of the TAB contractor and who is certified by AABC, NEBB, or TABB as a TAB technician.

- B. Certify TAB field data reports and perform the following:
  - 1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
  - 2. Certify that the TAB team complied with the approved TAB plan and the procedures specified and referenced in this Specification.
- C. TAB Report Forms: Use standard TAB contractor's forms approved by Owner.
- D. Instrumentation Type, Quantity, Accuracy, and Calibration: As described in ASHRAE 111, Section 5, "Instrumentation."

## 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.
- B. Examine systems for installed balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are accessible.
- C. Examine the approved submittals for HVAC systems and equipment.
- D. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.
- E. Examine ceiling plenums and underfloor air plenums used for supply, return, or relief air to verify that they meet the leakage class of connected ducts as specified in Division 23 Section "Metal Ducts" and are properly separated from adjacent areas. Verify that penetrations in plenum walls are sealed and fire-stopped if required.
- F. Examine equipment performance data including fan and pump curves.
  - 1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
  - 2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.

- G. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.
- H. Examine test reports specified in individual system and equipment Sections.
- I. Examine HVAC equipment and filters and verify that bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.
- J. Examine terminal units, such as variable-air-volume boxes, and verify that they are accessible and their controls are connected and functioning.
- K. Examine strainers. Verify that startup screens are replaced by permanent screens with indicated perforations.
- L. Examine three-way valves for proper installation for their intended function of diverting or mixing fluid flows.
- M. Examine heat-transfer coils for correct piping connections and for clean and straight fins.
- N. Examine system pumps to ensure absence of entrained air in the suction piping.
- O. Examine operating safety interlocks and controls on HVAC equipment.
- P. 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 reports. Verify the following:
  - 1. Permanent electrical-power wiring is complete.
  - 2. Hydronic systems are filled, clean, and free of air.
  - 3. Automatic temperature-control systems are operational.
  - 4. Equipment and duct access doors are securely closed.
  - 5. Balance, smoke, and fire dampers are open.
  - 6. Isolating and balancing valves are open and control valves are operational.
  - 7. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
  - 8. Windows and doors can be closed so indicated conditions for system operations can be met.

### 3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

- A. Perform testing and balancing procedures on each system according to the procedures contained in NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and in this Section.



1. Comply with requirements in ASHRAE 62.1-2004, Section 7.2.2, "Air Balancing."
- B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.
  1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.
  2. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Division 23 Section "HVAC Insulation."
- C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.
- D. Take and report testing and balancing measurements in inch-pound (IP) units.

#### 3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

- A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.
- B. Prepare schematic diagrams of systems' "as-built" duct layouts.
- C. For variable-air-volume systems, develop a plan to simulate diversity.
- D. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.
- E. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.
- F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
- G. Verify that motor starters are equipped with properly sized thermal protection.
- H. Check dampers for proper position to achieve desired airflow path.
- I. Check for airflow blockages.
- J. Check condensate drains for proper connections and functioning.
- K. Check for proper sealing of air-handling-unit components.
- L. Verify that air duct system is sealed as specified in Division 23 Section "Metal Ducts."

### 3.5 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

- A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.
  - 1. Measure total airflow.
    - a. Where sufficient space in ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow.
  - 2. Measure fan static pressures as follows to determine actual static pressure:
    - a. Measure outlet static pressure as far downstream from the fan as practical and upstream from restrictions in ducts such as elbows and transitions.
    - b. Measure static pressure directly at the fan outlet or through the flexible connection.
    - c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from the flexible connection, and downstream from duct restrictions.
    - d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.
  - 3. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.
    - a. Report the cleanliness status of filters and the time static pressures are measured.
  - 4. Measure static pressures entering and leaving other devices, such as sound traps, heat-recovery equipment, and air washers, under final balanced conditions.
  - 5. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
  - 6. Obtain approval from Owner for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in Division 23 Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.
  - 7. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.
- B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.
  - 1. Measure airflow of submain and branch ducts.

- a. Where sufficient space in submain and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.
  2. Measure static pressure at a point downstream from the balancing damper, and adjust volume dampers until the proper static pressure is achieved.
  3. Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances.
- C. Measure air outlets and inlets without making adjustments.
1. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.
- D. Adjust air outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using branch volume dampers rather than extractors and the dampers at air terminals.
1. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.
  2. Adjust patterns of adjustable outlets for proper distribution without drafts.

### 3.6 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

- A. Prepare test reports with pertinent design data, and number in sequence starting at pump to end of system. Check the sum of branch-circuit flows against the approved pump flow rate. Correct variations that exceed plus or minus 5 percent.
- B. Prepare schematic diagrams of systems' "as-built" piping layouts.
- C. Prepare hydronic systems for testing and balancing according to the following, in addition to the general preparation procedures specified above:
  1. Open all manual valves for maximum flow.
  2. Check liquid level in expansion tank.
  3. Check makeup water-station pressure gage for adequate pressure for highest vent.
  4. Check flow-control valves for specified sequence of operation, and set at indicated flow.
  5. Set differential-pressure control valves at the specified differential pressure. Do not set at fully closed position when pump is positive-displacement type unless several terminal valves are kept open.
  6. Set system controls so automatic valves are wide open to heat exchangers.
  7. Check pump-motor load. If motor is overloaded, throttle main flow-balancing device so motor nameplate rating is not exceeded.
  8. Check air vents for a forceful liquid flow exiting from vents when manually operated.

### 3.7 PROCEDURES FOR CONSTANT-FLOW HYDRONIC SYSTEMS

- A. Measure water flow at pumps. Use the following procedures except for positive-displacement pumps:
  - 1. Verify impeller size by operating the pump with the discharge valve closed. Read pressure differential across the pump. Convert pressure to head and correct for differences in gage heights. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
    - a. If impeller sizes must be adjusted to achieve pump performance, obtain approval from Owner and comply with requirements in Division 23 Section "Hydronic Pumps."
  - 2. Check system resistance. With all valves open, read pressure differential across the pump and mark pump manufacturer's head-capacity curve. Adjust pump discharge valve until indicated water flow is achieved.
    - a. Monitor motor performance during procedures and do not operate motors in overload conditions.
  - 3. Verify pump-motor brake horsepower. Calculate the intended brake horsepower for the system based on pump manufacturer's performance data. Compare calculated brake horsepower with nameplate data on the pump motor. Report conditions where actual amperage exceeds motor nameplate amperage.
  - 4. Report flow rates that are not within plus or minus 10 percent of design.
- B. Measure flow at all automatic flow control valves to verify that valves are functioning as designed.
- C. Measure flow at all pressure-independent characterized control valves, with valves in fully open position, to verify that valves are functioning as designed.
- D. Set calibrated balancing valves, if installed, at calculated presettings.
- E. Measure flow at all stations and adjust, where necessary, to obtain first balance.
  - 1. System components that have Cv rating or an accurately cataloged flow-pressure-drop relationship may be used as a flow-indicating device.
- F. Measure flow at main balancing station and set main balancing device to achieve flow that is 5 percent greater than indicated flow.
- G. Adjust balancing stations to within specified tolerances of indicated flow rate as follows:
  - 1. Determine the balancing station with the highest percentage over indicated flow.
  - 2. Adjust each station in turn, beginning with the station with the highest percentage over indicated flow and proceeding to the station with the lowest percentage over indicated flow.
  - 3. Record settings and mark balancing devices.

- H. Measure pump flow rate and make final measurements of pump amperage, voltage, rpm, pump heads, and systems' pressures and temperatures including outdoor-air temperature.
- I. Measure the differential-pressure-control-valve settings existing at the conclusion of balancing.
- J. Check settings and operation of each safety valve. Record settings.

### 3.8 PROCEDURES FOR MOTORS

- A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:
  - 1. Manufacturer's name, model number, and serial number.
  - 2. Motor horsepower rating.
  - 3. Motor rpm.
  - 4. Efficiency rating.
  - 5. Nameplate and measured voltage, each phase.
  - 6. Nameplate and measured amperage, each phase.
  - 7. Starter thermal-protection-element rating.
- B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass of the controller to prove proper operation. Record observations including name of controller manufacturer, model number, serial number, and nameplate data.

### 3.9 PROCEDURES FOR CHILLERS

- A. Balance water flow through each evaporator and condenser to within specified tolerances of indicated flow with all pumps operating. With only one chiller operating in a multiple chiller installation, do not exceed the flow for the maximum tube velocity recommended by the chiller manufacturer. Measure and record the following data with each chiller operating at design conditions:
  - 1. Evaporator-water entering and leaving temperatures, pressure drop, and water flow.
  - 2. Evaporator and condenser refrigerant temperatures and pressures, using instruments furnished by chiller manufacturer.
  - 3. Power factor if factory-installed instrumentation is furnished for measuring kilowatts.
  - 4. Kilowatt input if factory-installed instrumentation is furnished for measuring kilowatts.
  - 5. Capacity: Calculate in tons of cooling.
  - 6. For air-cooled chillers, verify condenser-fan rotation and record fan and motor data including number of fans and entering- and leaving-air temperatures.

### 3.10 PROCEDURES FOR TESTING, ADJUSTING, AND BALANCING EXISTING SYSTEMS

- A. Perform a preconstruction inspection of existing equipment that is to remain and be reused.
  - 1. Measure and record the operating speed, airflow, and static pressure of each fan.
  - 2. Measure motor voltage and amperage. Compare the values to motor nameplate information.
  - 3. Check the refrigerant charge.
  - 4. Check the condition of filters.
  - 5. Check the condition of coils.
  - 6. Check the operation of the drain pan and condensate-drain trap.
  - 7. Check bearings and other lubricated parts for proper lubrication.
  - 8. Report on the operating condition of the equipment and the results of the measurements taken. Report deficiencies.
- B. Before performing testing and balancing of existing systems, inspect existing equipment that is to remain and be reused to verify that existing equipment has been cleaned and refurbished. Verify the following:
  - 1. New filters are installed.
  - 2. Coils are clean and fins combed.
  - 3. Drain pans are clean.
  - 4. Fans are clean.
  - 5. Bearings and other parts are properly lubricated.
  - 6. Deficiencies noted in the preconstruction report are corrected.
- C. Perform testing and balancing of existing systems to the extent that existing systems are affected by the renovation work.
  - 1. Compare the indicated airflow of the renovated work to the measured fan airflows, and determine the new fan speed and the face velocity of filters and coils.
  - 2. Verify that the indicated airflows of the renovated work result in filter and coil face velocities and fan speeds that are within the acceptable limits defined by equipment manufacturer.
  - 3. If calculations increase or decrease the air flow rates and water flow rates by more than 5 percent, make equipment adjustments to achieve the calculated rates. If increase or decrease is 5 percent or less, equipment adjustments are not required.
  - 4. Balance each air outlet.

### 3.11 TOLERANCES

- A. Set HVAC system's air flow rates and water flow rates within the following tolerances:
  - 1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 10 percent.

2. Air Outlets and Inlets: Plus or minus 10 percent.
3. Cooling-Water Flow Rate: Plus or minus 10 percent.

### 3.12 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: Prepare biweekly progress 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.

### 3.13 FINAL REPORT

- A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.
  1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
  2. Include a list of instruments used for procedures, along with proof of calibration.
- B. Final Report Contents: In addition to certified field-report data, include the following:
  1. Pump curves.
  2. Fan curves.
  3. Manufacturers' test data.
  4. Field test reports prepared by system and equipment installers.
  5. Other information relative to equipment performance; do not include Shop Drawings and product data.
- C. General Report Data: In addition to form titles and entries, include the following data:
  1. Title page.
  2. Name and address of the TAB contractor.
  3. Project name.
  4. Project location.
  5. Architect's name and address.
  6. Engineer's name and address.
  7. Contractor's name and address.
  8. Report date.
  9. Signature of TAB supervisor who certifies the report.
  10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
  11. Summary of contents including the following:

- a. Indicated versus final performance.
  - b. Notable characteristics of systems.
  - c. Description of system operation sequence if it varies from the Contract Documents.
- 12. Nomenclature sheets for each item of equipment.
- 13. Data for terminal units, including manufacturer's name, type, size, and fittings.
- 14. Notes to explain why certain final data in the body of reports vary from indicated values.
- 15. Test conditions for fans and pump performance forms including the following:
  - a. Settings for outdoor-, return-, and exhaust-air dampers.
  - b. Conditions of filters.
  - c. Cooling coil, wet- and dry-bulb conditions.
  - d. Face and bypass damper settings at coils.
  - e. Fan drive settings including settings and percentage of maximum pitch diameter.
  - f. Inlet vane settings for variable-air-volume systems.
  - g. Settings for supply-air, static-pressure controller.
  - h. Other system operating conditions that affect performance.
- D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:
  - 1. Quantities of outdoor, supply, return, and exhaust airflows.
  - 2. Water and steam flow rates.
  - 3. Duct, outlet, and inlet sizes.
  - 4. Pipe and valve sizes and locations.
  - 5. Terminal units.
  - 6. Balancing stations.
  - 7. Position of balancing devices.

END OF SECTION 230593



SECTION 230700  
HVAC INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Insulation Materials:
  - a. Cellular glass.
  - b. Mineral fiber.
2. Fire-rated insulation systems.
3. Insulating cements.
4. Adhesives.
5. Mastics.
6. Sealants.
7. Factory-applied jackets.
8. Field-applied jackets.
9. Tapes.
10. Securements.
11. Corner angles.

1.2 SUBMITTALS

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

1.3 QUALITY ASSURANCE

- A. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing and inspecting agency.
1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

## PART 2 - PRODUCTS

### 2.1 INSULATION MATERIALS

- A. Comply with requirements in Part 3 schedule articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- F. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type III with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
  - 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. CertainTeed Corp.; Duct Wrap.
    - b. Johns Manville; Microlite.
    - c. Knauf Insulation; Duct Wrap.
    - d. Owens Corning; All-Service Duct Wrap.

### 2.2 FIRE-RATED INSULATION SYSTEMS

- A. Fire-Rated Blanket: High-temperature, flexible, blanket insulation with FSK jacket that is tested and certified to provide a 2-hour fire rating by a NRTL acceptable to authority having jurisdiction.
  - 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. CertainTeed Corp.; FlameChek.
    - b. Johns Manville; Firetemp Wrap.
    - c. Thermal Ceramics; FireMaster Duct Wrap.
    - d. 3M; Fire Barrier Wrap Products.

### 2.3 INSULATING CEMENTS

- A. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449/C 449M.
  - 1. Products: Subject to compliance with requirements, provide one of the following:

- a. Insulco, Division of MFS, Inc.; SmoothKote.
- b. P. K. Insulation Mfg. Co., Inc.; PK No. 127, and Quik-Cote.
- c. Rock Wool Manufacturing Company; Delta One Shot.

## 2.4 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.
- B. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
  - 1. Products: Subject to compliance with requirements, provide one of the following
    - a. Childers Products, Division of ITW; CP-82.
    - b. Foster Products Corporation, H. B. Fuller Company; 85-20.
    - c. ITW TACC, Division of Illinois Tool Works; S-90/80.
    - d. Marathon Industries, Inc.; 225.
    - e. Mon-Eco Industries, Inc.; 22-25.
  - 2. For indoor applications, use adhesive that has a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- C. ASJ Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
  - 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Childers Products, Division of ITW; CP-82.
    - b. Foster Products Corporation, H. B. Fuller Company; 85-20.
    - c. ITW TACC, Division of Illinois Tool Works; S-90/80.
    - d. Marathon Industries, Inc.; 225.
    - e. Mon-Eco Industries, Inc.; 22-25.
  - 2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

## 2.5 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-C-19565C, Type II.
  - 1. For indoor applications, use mastics that have a VOC content of 500 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- B. Vapor-Barrier Mastic: Water based; suitable for indoor and outdoor use on below ambient services.
  - 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Childers Products, Division of ITW; CP-35.

- b. Foster Products Corporation, H. B. Fuller Company; 30-90.
    - c. ITW TACC, Division of Illinois Tool Works; CB-50.
    - d. Marathon Industries, Inc.; 590.
    - e. Mon-Eco Industries, Inc.; 55-40.
    - f. Vimasco Corporation; 749.
  - 2. Water-Vapor Permeance: ASTM E 96, Procedure B, 0.013 perm (0.009 metric perm) at 43-mil (1.09-mm) dry film thickness.
  - 3. Service Temperature Range: Minus 20 to plus 180 deg F (Minus 29 to plus 82 deg C).
  - 4. Solids Content: ASTM D 1644, 59 percent by volume and 71 percent by weight.
  - 5. Color: White.
- C. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.
- 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Childers Products, Division of ITW; CP-10.
    - b. Foster Products Corporation, H. B. Fuller Company; 35-00.
    - c. ITW TACC, Division of Illinois Tool Works; CB-05/15.
    - d. Marathon Industries, Inc.; 550.
    - e. Mon-Eco Industries, Inc.; 55-50.
    - f. Vimasco Corporation; WC-1/WC-5.
  - 2. Water-Vapor Permeance: ASTM F 1249, 3 perms (2 metric perms) at 0.0625-inch (1.6-mm) dry film thickness.
  - 3. Service Temperature Range: Minus 20 to plus 200 deg F (Minus 29 to plus 93 deg C).
  - 4. Solids Content: 63 percent by volume and 73 percent by weight.
  - 5. Color: White.

## 2.6 SEALANTS

### A. Joint Sealants:

- 1. Joint Sealants for Cellular-Glass Products: Subject to compliance with requirements, provide one of the following:
  - a. Childers Products, Division of ITW; CP-76.
  - b. Foster Products Corporation, H. B. Fuller Company; 30-45.
  - c. Marathon Industries, Inc.; 405.
  - d. Mon-Eco Industries, Inc.; 44-05.
  - e. Pittsburgh Corning Corporation; Pittseal 444.

### B. FSK and Metal Jacket Flashing Sealants:

- 1. Products: Subject to compliance with requirements, provide one of the following:
  - a. Childers Products, Division of ITW; CP-76-8.

- b. Foster Products Corporation, H. B. Fuller Company; 95-44.
    - c. Marathon Industries, Inc.; 405.
    - d. Mon-Eco Industries, Inc.; 44-05.
    - e. Vimasco Corporation; 750.
  - 2. Materials shall be compatible with insulation materials, jackets, and substrates.
  - 3. Fire- and water-resistant, flexible, elastomeric sealant.
  - 4. Service Temperature Range: Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).
  - 5. Color: Aluminum.
  - 6. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- C. ASJ Flashing Sealants and PVC Jacket Flashing Sealants:
- 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Childers Products, Division of ITW; CP-76.
  - 2. Materials shall be compatible with insulation materials, jackets, and substrates.
  - 3. Fire- and water-resistant, flexible, elastomeric sealant.
  - 4. Service Temperature Range: Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).
  - 5. Color: White.
  - 6. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

## 2.7 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
- B. Aluminum Jacket: Comply with ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105 or 5005, Temper H-14.
  - 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Childers Products, Division of ITW; Metal Jacketing Systems.
    - b. PABCO Metals Corporation; Surefit.
    - c. RPR Products, Inc.; Insul-Mate.
  - 2. Sheet and roll stock ready for shop or field sizing.
  - 3. Finish and thickness are indicated in field-applied jacket schedules.
  - 4. Moisture Barrier for Indoor Applications: 1-mil- (0.025-mm-) thick, heat-bonded polyethylene and kraft paper.
  - 5. Moisture Barrier for Outdoor Applications: 3-mil- (0.075-mm-) thick, heat-bonded polyethylene and kraft paper.
  - 6. Factory-Fabricated Fitting Covers:
    - a. Same material, finish, and thickness as jacket.

- b. Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
- c. Tee covers.
- d. Flange and union covers.
- e. End caps.
- f. Beveled collars.
- g. Valve covers.
- h. Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

## 2.8 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.

- 1. Products: Subject to compliance with requirements, provide one of the following:
  - a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0835.
  - b. Compac Corp.; 104 and 105.
  - c. Ideal Tape Co., Inc., an American Biltrite Company; 428 AWF ASJ.
  - d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.
- 2. Width: 3 inches (75 mm).
- 3. Thickness: 11.5 mils (0.29 mm).
- 4. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
- 5. Elongation: 2 percent.
- 6. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
- 7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

- B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.

- 1. Products: Subject to compliance with requirements, provide one of the following:
  - a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
  - b. Compac Corp.; 110 and 111.
  - c. Ideal Tape Co., Inc., an American Biltrite Company; 491 AWF FSK.
  - d. Venture Tape; 1525 CW, 1528 CW, and 1528 CW/SQ.
- 2. Width: 3 inches (75 mm).
- 3. Thickness: 6.5 mils (0.16 mm).
- 4. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
- 5. Elongation: 2 percent.
- 6. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
- 7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

- C. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.

- 1. Products: Subject to compliance with requirements, provide one of the following:

- a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
  - b. Compac Corp.; 120.
  - c. Ideal Tape Co., Inc., an American Biltrite Company; 488 AWF.
  - d. Venture Tape; 3520 CW.
- 2. Width: 2 inches (50 mm).
  - 3. Thickness: 3.7 mils (0.093 mm).
  - 4. Adhesion: 100 ounces force/inch (1.1 N/mm) in width.
  - 5. Elongation: 5 percent.
  - 6. Tensile Strength: 34 lbf/inch (6.2 N/mm) in width.

## 2.9 SECUREMENTS

### A. Insulation Pins and Hangers:

- 1. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
  - a. Products: Subject to compliance with requirements, provide one of the following:
    - 1) AGM Industries, Inc.; Tactoo Insul-Hangers, Series T.
    - 2) GEMCO; Perforated Base.
    - 3) Midwest Fasteners, Inc.; Spindle.
  - b. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch (0.76 mm) thick by 2 inches (50 mm) square.
  - c. Spindle: Copper- or zinc-coated, low carbon steel, fully annealed, 0.106-inch- (2.6-mm-) diameter shank, length to suit depth of insulation indicated.
  - d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
- 2. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- (0.41-mm) thick, galvanized-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches (38 mm) in diameter.
  - a. Products: Subject to compliance with requirements, provide one of the following:
    - 1) AGM Industries, Inc.; RC-150.
    - 2) GEMCO; R-150.
    - 3) Midwest Fasteners, Inc.; WA-150.
    - 4) Nelson Stud Welding; Speed Clips.
  - b. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.

3. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- (0.41-mm-) thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches (38 mm) in diameter.

a. Products: Subject to compliance with requirements, provide one of the following:

- 1) GEMCO.
- 2) Midwest Fasteners, Inc.

B. Staples: Outward-clinching insulation staples, nominal 3/4-inch- (19-mm-) wide, stainless steel or Monel.

C. Wire: 0.062-inch (1.6-mm) soft-annealed, galvanized steel.

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

- a. C & F Wire.
- b. Childers Products.
- c. PABCO Metals Corporation.
- d. RPR Products, Inc.

## 2.10 CORNER ANGLES

A. Aluminum Corner Angles: 0.040 inch (1.0 mm) thick, minimum 1 by 1 inch (25 by 25 mm), aluminum according to ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105 or 5005; Temper H-14.

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.
- C. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

### 3.2 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment, ducts and fittings, and piping including fittings, valves, and specialties.



- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment, duct system, and pipe system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- G. Keep insulation materials dry during application and finishing.
- H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- I. Install insulation with least number of joints practical.
- J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
  - 1. Install insulation continuously through hangers and around anchor attachments.
  - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
  - 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
  - 4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches (100 mm) beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
- O. For above ambient services, do not install insulation to the following:

1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. Manholes.
5. Handholes.
6. Cleanouts.

### 3.3 PENETRATIONS

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
  1. Seal penetrations with flashing sealant.
  2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
  3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches (50 mm) below top of roof flashing.
  4. Seal jacket to roof flashing with flashing sealant.
- B. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
  1. Seal penetrations with flashing sealant.
  2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
  3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches (50 mm).
  4. Seal jacket to wall flashing with flashing sealant.
- C. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- D. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions. Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches (50 mm).
  1. Comply with requirements in Division 07 Section "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

### 3.4 EQUIPMENT, TANK, AND VESSEL INSULATION INSTALLATION

- A. Insulation Installation on Pumps:

1. Fabricate metal boxes lined with insulation. Fit boxes around pumps and coincide box joints with splits in pump casings. Fabricate joints with outward bolted flanges. Bolt flanges on 6-inch centers, starting at corners. Install 3/8-inch-diameter fasteners with wing nuts. Alternatively, secure the box sections together using a latching mechanism.
2. Fabricate boxes from galvanized steel or aluminum or stainless steel, at least 0.050 inch thick.
3. For below ambient services, install a vapor barrier at seams, joints, and penetrations. Seal between flanges with replaceable gasket material to form a vapor barrier.

### 3.5 GENERAL PIPE INSULATION INSTALLATION

- A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.
- B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
  1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
  2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
  3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
  4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
  5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below ambient services, provide a design that maintains vapor barrier.
  6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
  7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below ambient services and a

- breather mastic for above ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
  9. Stencil or label the outside insulation jacket of each union with the word "UNION." Match size and color of pipe labels.
- C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes, vessels, and equipment. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.
- D. Install removable insulation covers at locations indicated. Installation shall conform to the following:
1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
  2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
  3. Construct removable valve insulation covers in same manner as for flanges except divide the two-part section on the vertical center line of valve body.
  4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches (50 mm) over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
  5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

### 3.6 MINERAL-FIBER INSULATION INSTALLATION

- A. Insulation Installation on Straight Pipes and Tubes:
1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
  2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
  3. For insulation with factory-applied jackets on above ambient surfaces, secure laps with outward clinched staples at 6 inches (150 mm) o.c.
  4. For insulation with factory-applied jackets on below ambient surfaces, do not staple longitudinal tabs but secure tabs with additional adhesive as

recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch (25 mm), and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

E. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
  - a. On duct sides with dimensions 18 inches (450 mm) and smaller, place pins along longitudinal centerline of duct. Space 3 inches (75 mm) maximum from insulation end joints, and 16 inches (400 mm) o.c.
  - b. On duct sides with dimensions larger than 18 inches (450 mm), place pins 16 inches (400 mm) o.c. each way, and 3 inches (75 mm) maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.

- c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
  - d. Do not overcompress insulation during installation.
  - e. Impale insulation over pins and attach speed washers.
  - f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches (50 mm) from 1 edge and 1 end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch (13-mm) outward-clinching staples, 1 inch (25 mm) o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
- a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
  - b. Install vapor stops for ductwork and plenums operating below 50 deg F (10 deg C) at 18-foot (5.5-m) intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to 2 times the insulation thickness but not less than 3 inches (75 mm).
5. Overlap unfaced blankets a minimum of 2 inches (50 mm) on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches (450 mm) o.c.
6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- (150-mm-) wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches (150 mm) o.c.

### 3.7 FIELD-APPLIED JACKET INSTALLATION

- A. Where FSK jackets are indicated, install as follows:
- 1. Draw jacket material smooth and tight.
  - 2. Install lap or joint strips with same material as jacket.
  - 3. Secure jacket to insulation with manufacturer's recommended adhesive.
  - 4. Install jacket with 1-1/2-inch (38-mm) laps at longitudinal seams and 3-inch- (75-mm-) wide joint strips at end joints.
  - 5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.
- B. Where metal jackets are indicated, install with 2-inch (50-mm) overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end

joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches (300 mm) o.c. and at end joints.

### 3.8 FIRE-RATED INSULATION SYSTEM INSTALLATION

- A. Where fire-rated insulation system is indicated, secure system to ducts and duct hangers and supports to maintain a continuous fire rating.
- B. Insulate duct access panels and doors to achieve same fire rating as duct.
- C. Install firestopping at penetrations through fire-rated assemblies. Fire-stop systems are specified in Division 07 Section "Penetration Firestopping."

### 3.9 DUCT INSULATION SCHEDULE, GENERAL

- A. Plenums and Ducts Requiring Insulation:
  - 1. Indoor, concealed supply and outdoor air.
  - 2. Indoor, concealed return located in nonconditioned space.
  - 3. Outdoor, concealed supply and return.
  - 4. Outdoor, exposed supply and return.
- B. Items Not Insulated:
  - 1. Fibrous-glass ducts.
  - 2. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.
  - 3. Factory-insulated flexible ducts.
  - 4. Factory-insulated plenums and casings.
  - 5. Flexible connectors.
  - 6. Vibration-control devices.
  - 7. Factory-insulated access panels and doors.

### 3.10 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

- A. Concealed, Supply-Air Duct and Plenum Insulation: Mineral-fiber blanket, 1-1/2 inches (38 mm) thick and 0.75-lb/cu. ft. (12-kg/cu. m) nominal density (R-8 minimum).
- B. Concealed, Return-Air Duct and Plenum Insulation: Mineral-fiber blanket, 1-1/2 inches (38 mm) thick and 0.75-lb/cu. ft. (12-kg/cu. m) nominal density (R-8 minimum).
- C. Concealed, Outdoor-Air Duct and Plenum Insulation: Mineral-fiber blanket, 1-1/2 inches (38 mm) thick and 0.75-lb/cu. ft. (12-kg/cu. m) nominal density (R-8 minimum).
- D. Exposed, Supply-Air Duct Insulation: Mineral-Fiber Board 1 inch thick and minimum 2-lb/cu. ft. nominal density.

### 3.11 EQUIPMENT INSULATION SCHEDULE

- A. Insulation materials and thicknesses are identified below. If more than one material is listed for a type of equipment, selection from materials listed is Contractor's option.
- B. Insulate indoor and outdoor equipment in paragraphs below that is not factory insulated.
- C. Chilled-water pump insulation shall be one of the following:
  - 1. Mineral-Fiber Board: 2 inches thick and 2-lb/cu. ft. nominal density.
- D. Dual-service heating and cooling pump insulation shall be one of the following:
  - 1. Mineral-Fiber Board: 2 inches thick and 2-lb/cu. ft. nominal density.
- E. Dual-service heating and cooling air-separator insulation shall be one of the following:
  - 1. Mineral-Fiber Board: 1 inch thick and 2-lb/cu. ft. nominal density.
  - 2. Mineral-Fiber Pipe and Tank: 1 inch thick.

### 3.12 PIPING INSULATION SCHEDULE, GENERAL

- A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.
- B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
  - 1. Drainage piping located in crawl spaces.
  - 2. Underground piping.
  - 3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

### 3.13 INDOOR PIPING INSULATION SCHEDULE

- A. Chilled Water Supply and Return Piping, above 40 Deg F:
  - 1. NPS 12 and Smaller: Insulation shall be one of the following:
    - a. Mineral-Fiber, Preformed Pipe, Type I: 1 inch thick.

### 3.14 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

- A. Chilled Water Supply and Return Piping, above 40 Deg F:
  - 1. NPS 12 and Smaller: Insulation shall be one of the following:
    - a. Mineral-Fiber, Preformed Pipe, Type I: 1-1/2 inch thick.



### 3.15 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. If more than one material is listed, selection from materials listed is Contractor's option.
- C. Ducts and Plenums, Concealed:
  - 1. None.
- D. Piping, Exposed:
  - 1. Aluminum, corrugated: 0.024 inches thick.

END OF SECTION 230700

SECTION 23 08 00  
COMMISSIONING OF HVAC SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. The requirements of this Section apply to all sections of Division 23.
- B. This project will have selected building systems commissioned. The complete list of equipment and systems to be commissioned is specified in Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS. The commissioning process, which the Contractor is responsible to execute, is defined in Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS. A Commissioning Agent (CxA) appointed by the VA will manage the commissioning process.

1.2 RELATED WORK

- A. Section 01 00 00 GENERAL REQUIREMENTS.
- B. Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS.
- C. Section 01 33 23 SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

1.3 SUMMARY

- A. This Section includes requirements for commissioning subsystems and related equipment. This Section supplements the general requirements specified in Section 01 91 00 General Commissioning Requirements.
- B. Refer to Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS for more details regarding processes and procedures as well as roles and responsibilities for all Commissioning Team members.

1.4 DEFINITIONS

- A. Refer to Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS for definitions.

1.5 COMMISSIONED SYSTEMS

- A. Commissioning of a system or systems specified in Division 23 is part of the construction process. Documentation and testing of these systems, as well as training of the VA's Operation and Maintenance personnel in accordance with the requirements of Section 01 91 00 and of Division 23, is required in cooperation with the VA and the Commissioning Agent.

## 1.6 SUBMITTALS

- A. The commissioning process requires review of selected Submittals that pertain to the systems to be commissioned. The Commissioning Agent will provide a list of submittals that will be reviewed by the Commissioning Agent. This list will be reviewed and approved by the VA prior to forwarding to the Contractor. Refer to Section 01 33 23 SHOP DRAWINGS, PRODUCT DATA, and SAMPLES for further details.
- B. The commissioning process requires Submittal review simultaneously with engineering review. Specific submittal requirements related to the commissioning process are specified in Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS.

## PART 2 - PRODUCTS (NOT USED)

## PART 3 - EXECUTION

### 3.1 CONSTRUCTION INSPECTIONS

- A. Commissioning of HVAC systems will require inspection of individual elements of the HVAC systems construction throughout the construction period. The Contractor shall coordinate with the Commissioning Agent in accordance with Section 01 19 00 and the Commissioning plan to schedule HVAC systems inspections as required to support the Commissioning Process.

### 3.2 PRE-FUNCTIONAL CHECKLISTS

- A. The Contractor shall complete Pre-Functional Checklists to verify systems, subsystems, and equipment installation is complete and systems are ready for Systems Functional Performance Testing. The Commissioning Agent will prepare Pre-Functional Checklists to be used to document equipment installation. The Contractor shall complete the checklists. Completed checklists shall be submitted to the VA and to the Commissioning Agent for review. The Commissioning Agent may spot check a sample of completed checklists. If the Commissioning Agent determines that the information provided on the checklist is not accurate, the Commissioning Agent will return the marked-up checklist to the Contractor for correction and resubmission. If the Commissioning Agent determines that a significant number of completed checklists for similar equipment are not accurate, the Commissioning Agent will select a broader sample of checklists for review. If the Commissioning Agent determines that a significant number of the broader sample of checklists is also inaccurate, all the checklists for the type of equipment will be returned to the Contractor for correction and resubmission. Refer to SECTION 01 91 00 GENERAL COMMISSIONING REQUIREMENTS for submittal requirements for Pre-Functional Checklists, Equipment Startup Reports, and other commissioning documents.

### 3.3 CONTRACTORS TESTS

- A. Contractor tests as required by other sections of Division 23 shall be scheduled and documented in accordance with Section 01 00 00 GENERAL REQUIREMENTS. All testing shall be incorporated into the project schedule. Contractor shall provide no less than 7 calendar days' notice of testing. The Commissioning Agent will witness selected Contractor tests at the sole discretion of the Commissioning Agent. Contractor tests shall be completed prior to scheduling Systems Functional Performance Testing.

### 3.4 SYSTEMS FUNCTIONAL PERFORMANCE TESTING:

- A. The Commissioning Process includes Systems Functional Performance Testing that is intended to test systems functional performance under steady state conditions, to test system reaction to changes in operating conditions, and system performance under emergency conditions. The Commissioning Agent will prepare detailed Systems Functional Performance Test procedures for review and approval by the Resident Engineer. The Contractor shall review and comment on the tests prior to approval. The Contractor shall provide the required labor, materials, and test equipment identified in the test procedure to perform the tests. The Commissioning Agent will witness and document the testing. The Contractor shall sign the test reports to verify tests were performed. See Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS, for additional details.

### 3.5 TRAINING OF VA PERSONNEL

- A. Training of the VA operation and maintenance personnel is required in cooperation with the Resident Engineer and Commissioning Agent. Provide competent, factory authorized personnel to provide instruction to operation and maintenance personnel concerning the location, operation, and troubleshooting of the installed systems. Contractor shall submit training agendas and trainer resumes in accordance with the requirements of Section 01 19 00. The instruction shall be scheduled in coordination with the VA Resident Engineer after submission and approval of formal training plans. Refer to Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS and Division 23 Sections for additional Contractor training requirements.

END OF SECTION

SECTION 23 09 23  
DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This facility's existing direct-digital control system is Metasys, manufactured by Johnson Controls. The contractor administered by this Section of the technical specifications shall observe the capabilities, communication network, services, spare capacity of the existing control system and its ECC prior to beginning work.
1. Leave existing direct-digital control system intact and in place. Provide a new ASHRAE Standard 135 BACnet-compliant control system serving the work in this project. Interoperability is required.
    - a. This campus has standardized on an existing standard ASHRAE Standard 135, BACnet/IP Control System supported by a preselected controls service company, Bedard Controls, Inc. (559-271-8990)
  2. The work administered by this Section of the technical specifications shall include all labor, materials, special tools, equipment, enclosures, power supplies, software, software licenses, Project specific software configurations and database entries, interfaces, wiring, tubing, installation, labeling, engineering, calibration, documentation, submittals, testing, verification, training services, permits and licenses, transportation, shipping, handling, administration, supervision, management, insurance, Warranty, specified services and items required for complete and fully functional Controls Systems.
  3. The control systems shall be designed such that each mechanical system shall operate under stand-alone mode. The contractor administered by this Section of the technical specifications shall provide controllers for each mechanical system. In the event of a network communication failure, or the loss of any other controller, the control system shall continue to operate independently. Failure of the ECC shall have no effect on the field controllers, including those involved with global strategies.
- B. Some products are furnished but not installed by the contractor administered by this Section of the technical specifications. The contractor administered by this Section of the technical specifications shall formally coordinate in writing and receive from other contractors formal acknowledgements in writing prior to submission the installation of the products. These products include the following:
1. Control valves.
  2. Flow switches.
  3. Flow meters.
  4. Sensor wells and sockets in piping.
  5. Terminal unit controllers.
- C. Some products are installed but not furnished by the contractor administered by this Section of the technical specifications. The contractor administered by this Section of the technical

specifications shall formally coordinate in writing and receive from other contractors formal acknowledgements in writing prior to submission the procurement of the products. These products include the following:

1. Refrigerant leak detection system.
2. Factory-furnished accessory thermostats and sensors furnished with unitary equipment.

D. Some products are not provided by, but are nevertheless integrated with the work executed by, the contractor administered by this Section of the technical specifications. The contractor administered by this Section of the technical specifications shall formally coordinate in writing and receive from other contractors formal acknowledgements in writing prior to submission the particulars of the products. These products include the following:

1. Fire alarm systems. If zoned fire alarm is required by the project-specific requirements, this interface shall require multiple relays, which are provided and installed by the fire alarm system contractor, to be monitored.
2. Advanced utility metering systems. These systems may take information from the control system or its component meters and sensors. There is no command or control action from the advanced utility monitoring system on the control system however.
3. Chiller controls. These controls, if not native BACnet, will require a BACnet Gateway.
4. Terminal units' velocity sensors,for (4) or VAV boxes.
5. Unitary HVAC equipment (rooftop air handler) controls. These include:
  - a. Discharge temperature control.
  - b. Flowrate control.
  - c. Setpoint reset.
  - d. Time of day indexing.
  - e. Status alarm.
6. Variable frequency drives. These controls, if not native BACnet, will require a BACnet Gateway.
7. The following systems have limited control (as individually noted below) from the ECC:
  - a. Constant temperature rooms: temperature out of acceptable range and status alarms.

E. Responsibility Table:

| <b>Work/Item/System</b>                             | <b>Furnish</b> | <b>Install</b> | <b>Low Voltage Wiring</b> | <b>Line Power</b> |
|---|----------------|----------------|---------------------------|-------------------|
| Control system low voltage and communication wiring | 23 09 23       | 23 09 23       | 23 09 23                  | N/A               |

| <b>Work/Item/System</b>   | <b>Furnish</b> | <b>Install</b> | <b>Low Voltage Wiring</b> | <b>Line Power</b> |
|---|----------------|----------------|---------------------------|-------------------|
| Terminal units  | 23             | 23             | N/A                       | 26                |
| Controllers for terminal units  | 23 09 23       | 23             | 23 09 23                  | 16                |
| LAN conduits and raceway  | 23 09 23       | 23 09 23       | N/A                       | N/A               |
| Automatic dampers (not furnished with equipment)                      | 23 09 23       | 23             | N/A                       | N/A               |
| Automatic damper actuators  | 23 09 23       | 23 09 23       | 23 09 23                  | 23 09 23          |
| Manual valves   | 23             | 23             | N/A                       | N/A               |
| Automatic valves  | 23 09 23       | 23             | 23 09 23                  | 23 09 23          |
| Pipe insertion devices and taps, flow and pressure stations.          | 23             | 23             | N/A                       | N/A               |
| Thermowells   | 23 09 23       | 23             | N/A                       | N/A               |
| Current Switches  | 23 09 23       | 23 09 23       | 23 09 23                  | N/A               |
| Control Relays  | 23 09 23       | 23 09 23       | 23 09 23                  | N/A               |
| Power distribution system monitoring interfaces                       | 23 09 23       | 23 09 23       | 23 09 23                  | 26                |
| Interface with chiller controls                                       | 23 09 23       | 23 09 23       | 23 09 23                  | 26                |
| Chiller controls interface with control system                        | 23             | 23             | 23 09 23                  | 26                |
| All control system nodes, equipment, housings, enclosures and panels. | 23 09 23       | 23 09 23       | 23 09 23                  | 26                |
| Smoke detectors   | 28 31 00       | 28 31 00       | 28 31 00                  | 28 31 00          |
| Fire/Smoke Dampers  | 23             | 23             | 28 31 00                  | 28 31 00          |
| Smoke Dampers   | 23             | 23             | 28 31 00                  | 28 31 00          |
| Fire Dampers  | 23             | 23             | N/A                       | N/A               |
| Chiller/starter interlock wiring                                      | N/A            | N/A            | 26                        | 26                |
| Chiller Flow Switches   | 23             | 23             | 23                        | N/A               |

| <b>Work/Item/System</b>                                     | <b>Furnish</b> | <b>Install</b> | <b>Low Voltage Wiring</b> | <b>Line Power</b> |
|---|----------------|----------------|---------------------------|-------------------|
| Boiler interlock wiring                                     | 23             | 23             | 23                        | 26                |
| Boiler Flow Switches  | 23             | 23             | 23                        | N/A               |
| Water treatment system                                      | 23             | 23             | 23                        | 26                |
| VFDs  | 23 09 23       | 26             | 23 09 23                  | 26                |
| Refrigerant monitors  | 23             | 23 09 23       | 23 09 23                  | 26                |
| Fire Alarm shutdown relay interlock wiring                  | 28             | 28             | 28                        | 26                |
| Control system monitoring of fire alarm smoke control relay | 28             | 28             | 23 09 23                  | 28                |
| Fire-fighter's smoke control station (FSCS)                 | 28             | 28             | 28                        | 28                |
| Starters, HOA switches                                      | 23             | 23             | N/A                       | 26                |

F. This facility's existing direct-digital control system is manufactured by Metasys. The contractor administered by this Section of the technical specifications shall observe the capabilities, communication network, services, spare capacity of the existing control system and its ECC prior to beginning work.

1. Leave existing direct-digital control system intact and in place. Provide a new ASHRAE Standard 135 BACnet-compliant ECC in the same room as the existing system's ECC, and provide a new standalone BACnet-compliant control system serving the work in this project. No interoperability is required.

G. This campus has standardized on an existing standard ASHRAE Standard 135, BACnet/IP Control System supported by a preselected controls service company. This entity is referred to as the "Control System Integrator" in this Section of the technical specifications. The Control system integrator is responsible for ECC system graphics and expansion. It also prescribes control system-specific commissioning/ verification procedures to the contractor administered by this Section of the technical specification. It lastly provides limited assistance to the contractor administered by this Section of the technical specification in its commissioning/verification work.

1. The General Contractor of this project shall directly hire the Control System Integrator in a contract separate from the contract procuring the controls contractor administered by this Section of the technical specifications.
2. The contractor administered by this Section of the technical specifications shall coordinate all work with the Control System Integrator. The contractor administered by this Section of the technical specifications shall integrate the ASHRAE Standard 135, BACnet/IP control network(s) with the Control System Integrator's area control through an Ethernet connection provided by the Control System Integrator.



3. The contractor administered by this Section of the technical specifications shall provide a peer-to-peer networked, stand-alone, distributed control system. This direct digital control (DDC) system shall include one portable operator terminal - laptop, one digital display unit, microprocessor-based controllers, instrumentation, end control devices, wiring, piping, software, and related systems. This contractor is responsible for all device mounting and wiring.

4. Responsibility Table:

| Item/Task   | Section 23<br>09 23<br>contractor | Control<br>system<br>integrator | VA |
|---|-----------------------------------|---------------------------------|----|
| ECC expansion   |                                   | X                               |    |
| ECC programming   |                                   | X                               |    |
| Devices, controllers, control panels and equipment  | X                                 |                                 |    |
| Point addressing: all hardware and software points including setpoint, calculated point, data point(analog/ binary), and reset schedule point | X                                 |                                 |    |
| Point mapping   |                                   | X                               |    |
| Network Programming   | X                                 |                                 |    |
| ECC Graphics  |                                   | X                               |    |
| Controller programming and sequences  | X                                 |                                 |    |
| Integrity of LAN communications   | X                                 |                                 |    |
| Electrical wiring   | X                                 |                                 |    |
| Operator system training  |                                   | X                               |    |
| LAN connections to devices  | X                                 |                                 |    |
| LAN connections to ECC  |                                   | X                               |    |
| IP addresses  |                                   |                                 | X  |
| Overall system verification   |                                   | X                               |    |
| Controller and LAN system verification  | X                                 |                                 |    |

- H. Unitary standalone systems including Unit Heaters, Cabinet Unit Heaters, Fan Coil Units, Base Board Heaters, thermal comfort ventilation fans, and similar units for control of room environment conditions may be equipped with integral controls furnished and installed by the equipment manufacturer or field mounted. Refer to equipment specifications and as indicated in project

documents. Application of standalone unitary controls is limited to at least those systems wherein remote monitoring, alarm and start-up are not necessary. Examples of such systems include:

1. Light-switch-operated toilet exhaust
2. Vestibule heater
3. Exterior stair heater
4. Attic heating and ventilation
5. Mechanical or electrical room heating and ventilation.

- I The direct-digital control system shall start and stop equipment, move (position) damper actuators and valve actuators, and vary speed of equipment to execute the mission of the control system. Use electricity as the motive force for all damper and valve actuators, unless use of pneumatics as motive force is specifically granted by the VA.

## 1.2 RELATED WORK

- A. Section 13 21 29, Constant Temperature Rooms.
- B. Section 23 21 13, Hydronic Piping.
- C. Section 23 31 00, HVAC Ducts and Casings.
- D. Section 23 36 00, Air Terminal Units.
- E. Section 23 64 00, Packaged Water Chillers.
- F. Section 23 74 13, Packaged, Outdoor, Central-Station Air-Handling Units.
- G. Section 26 05 11, Requirements for Electrical Installations.
- H. Section 26 05 26, Grounding and Bonding for Electrical Systems.
- I. Section 26 05 33, Raceway and Boxes for Electrical Systems.

## 1.3 DEFINITION

- A. Algorithm: A logical procedure for solving a recurrent mathematical problem; A prescribed set of well-defined rules or processes for the solution of a problem in a finite number of steps.
- B. Analog: A continuously varying signal value (e.g., temperature, current, velocity etc.
- C. BACnet: A Data Communication Protocol for Building Automation and Control Networks , ANSI/ASHRAE Standard 135. This communications protocol allows diverse building automation devices to communicate data over and services over a network.
- D. BACnet/IP: Annex J of Standard 135. It defines and allows for using a reserved UDP socket to transmit BACnet messages over IP networks. A BACnet/IP network is a collection of one or more IP sub-networks that share the same BACnet network number.

- E. BACnet Internetwork: Two or more BACnet networks connected with routers. The two networks may use different LAN technologies.
- F. BACnet Network: One or more BACnet segments that have the same network address and are interconnected by bridges at the physical and data link layers.
- G. BACnet Segment: One or more physical segments of BACnet devices on a BACnet network, connected at the physical layer by repeaters.
- H. BACnet Broadcast Management Device (BBMD): A communications device which broadcasts BACnet messages to all BACnet/IP devices and other BBMDs connected to the same BACnet/IP network.
- I. BACnet Interoperability Building Blocks (BIBBs): BACnet Interoperability Building Blocks (BIBBs) are collections of one or more BACnet services. These are prescribed in terms of an "A" and a "B" device. Both of these devices are nodes on a BACnet internetwork.
- J. BACnet Testing Laboratories (BTL). The organization responsible for testing products for compliance with the BACnet standard, operated under the direction of BACnet International.
- K. Baud: It is a signal change in a communication link. One signal change can represent one or more bits of information depending on type of transmission scheme. Simple peripheral communication is normally one bit per Baud. (e.g., Baud rate = 78,000 Baud/sec is 78,000 bits/sec, if one signal change = 1 bit).
- L. Binary: A two-state system where a high signal level represents an "ON" condition and an "OFF" condition is represented by a low signal level.
- M. BMP or bmp: Suffix, computerized image file, used after the period in a DOS-based computer file to show that the file is an image stored as a series of pixels.
- N. Bus Topology: A network topology that physically interconnects workstations and network devices in parallel on a network segment.
- O. Control Unit (CU): Generic term for any controlling unit, stand-alone, microprocessor based, digital controller residing on secondary LAN or Primary LAN, used for local controls or global controls
- P. Deadband: A temperature range over which no heating or cooling is supplied, i.e., 22-25 degrees C (72-78 degrees F), as opposed to a single point change over or overlap).
- Q. Device: a control system component that contains a BACnet Device Object and uses BACnet to communicate with other devices.
- R. Device Object: Every BACnet device requires one Device Object, whose properties represent the network visible properties of that device. Every Device Object requires a unique Object Identifier number on the BACnet internetwork. This number is often referred to as the device instance.
- S. Device Profile: A specific group of services describing BACnet capabilities of a device, as defined in ASHRAE Standard 135-2008, Annex L. Standard device profiles include BACnet Operator Workstations (B-OWS), BACnet Building Controllers (B-BC), BACnet Advanced Application Controllers (B-AAC), BACnet Application Specific Controllers (B-ASC), BACnet Smart Actuator (B-SA), and BACnet Smart Sensor (B-SS). Each device used in new construction is required to have a PICS statement listing which service and BIBBs are supported by the device.

- T. Diagnostic Program: A software test program, which is used to detect and report system or peripheral malfunctions and failures. Generally, this system is performed at the initial startup of the system.
- U. Direct Digital Control (DDC): Microprocessor based control including Analog/Digital conversion and program logic. A control loop or subsystem in which digital and analog information is received and processed by a microprocessor, and digital control signals are generated based on control algorithms and transmitted to field devices in order to achieve a set of predefined conditions.
- V. Distributed Control System: A system in which the processing of system data is decentralized and control decisions can and are made at the subsystem level. System operational programs and information are provided to the remote subsystems and status is reported back to the Engineering Control Center. Upon the loss of communication with the Engineering Control center, the subsystems shall be capable of operating in a stand-alone mode using the last best available data.
- W. Download: The electronic transfer of programs and data files from a central computer or operation workstation with secondary memory devices to remote computers in a network (distributed) system.
- X. DXF: An AutoCAD 2-D graphics file format. Many CAD systems import and export the DXF format for graphics interchange.
- Y. Electrical Control: A control circuit that operates on line or low voltage and uses a mechanical means, such as a temperature sensitive bimetal or bellows, to perform control functions, such as actuating a switch or positioning a potentiometer.
- Z. Electronic Control: A control circuit that operates on low voltage and uses a solid-state components to amplify input signals and perform control functions, such as operating a relay or providing an output signal to position an actuator.
- AA. Engineering Control Center (ECC): The centralized control point for the intelligent control network. The ECC comprises of personal computer and connected devices to form a single workstation.
- BB. Ethernet: A trademark for a system for exchanging messages between computers on a local area network using coaxial, fiber optic, or twisted-pair cables.
- CC. Firmware: Firmware is software programmed into read only memory (ROM) chips. Software may not be changed without physically altering the chip.
- DD. Gateway: Communication hardware connecting two or more different protocols. It translates one protocol into equivalent concepts for the other protocol. In BACnet applications, a gateway has BACnet on one side and non-BACnet (usually proprietary) protocols on the other side.
- EE. GIF: Abbreviation of Graphic interchange format.
- FF. Graphic Program (GP): Program used to produce images of air handler systems, fans, chillers, pumps, and building spaces. These images can be animated and/or color-coded to indicate operation of the equipment.
- GG. Graphic Sequence of Operation: It is a graphical representation of the sequence of operation, showing all inputs and output logical blocks.

- HH. I/O Unit: The section of a digital control system through which information is received and transmitted. I/O refers to analog input (AI), digital input (DI), analog output (AO) and digital output (DO). Analog signals are continuous and represent temperature, pressure, flow rate etc, whereas digital signals convert electronic signals to digital pulses (values), represent motor status, filter status, on-off equipment etc.
- II. I/P: a method for conveying and routing packets of information over LAN paths. User Datagram Protocol (UDP) conveys information to "sockets" without confirmation of receipt. Transmission Control Protocol (TCP) establishes "sessions", which have end-to-end confirmation and guaranteed sequence of delivery.
- JJ. JPEG: A standardized image compression mechanism stands for Joint Photographic Experts Group, the original name of the committee that wrote the standard.
- KK. Local Area Network (LAN): A communication bus that interconnects operator workstation and digital controllers for peer-to-peer communications, sharing resources and exchanging information.
- LL. Network Repeater: A device that receives data packet from one network and rebroadcasts to another network. No routing information is added to the protocol.
- MM. Native BACnet Device: A device that uses BACnet as its primary method of communication with other BACnet devices without intermediary gateways. A system that uses native BACnet devices at all levels is a native BACnet system.
- NN. Network Number: A site-specific number assigned to each network segment to identify for routing. This network number must be unique throughout the BACnet internetwork.
- OO. Object: The concept of organizing BACnet information into standard components with various associated properties. Examples include analog input objects and binary output objects.
- PP. Object Identifier: An object property used to identify the object, including object type and instance. Object Identifiers must be unique within a device.
- QQ. Object Properties: Attributes of an object. Examples include present value and high limit properties of an analog input object. Properties are defined in ASHRAE 135; some are optional and some are required. Objects are controlled by reading from and writing to object properties.
- RR. Operating system (OS): Software, which controls the execution of computer application programs.
- SS. PCX: File type for an image file. When photographs are scanned onto a personal computer they can be saved as PCX files and viewed or changed by a special application program as Photo Shop.
- TT. Peripheral: Different components that make the control system function as one unit. Peripherals include monitor, printer, and I/O unit.
- UU. Peer-to-Peer: A networking architecture that treats all network stations as equal partners- any device can initiate and respond to communication with other devices.
- VV. PICS: Protocol Implementation Conformance Statement, describing the BACnet capabilities of a device. All BACnet devices have published PICS.

WW.PID: Proportional, integral, and derivative control, used to control modulating equipment to maintain a setpoint.

XX. Repeater: A network component that connects two or more physical segments at the physical layer.

YY. Router: a component that joins together two or more networks using different LAN technologies. Examples include joining a BACnet Ethernet LAN to a BACnet MS/TP LAN.

ZZ. Sensors: devices measuring state points or flows, which are then transmitted back to the DDC system.

AAA. Thermostats : devices measuring temperatures, which are used in control of standalone or unitary systems and equipment not attached to the DDC system.

#### 1.4 QUALITY ASSURANCE

##### A. Criteria:

1. Single Source Responsibility of subcontractor: The Contractor shall obtain hardware and software supplied under this Section and delegate the responsibility to a single source controls installation subcontractor. The controls subcontractor shall be responsible for the complete design, installation, and commissioning of the system. The controls subcontractor shall be in the business of design, installation and service of such building automation control systems similar in size and complexity. The controls contractor shall be directly authorized by the manufacturer for the design, installation, start-up and service of their product.
2. Equipment and Materials: Equipment and materials shall be cataloged products of manufacturers regularly engaged in production and installation of HVAC control systems. Products shall be manufacturer's latest standard design and have been tested and proven in actual use.
3. The controls subcontractor shall provide a list of no less than five similar projects which have building control systems as specified in this Section. These projects must be on-line and functional such that the Department of Veterans Affairs (VA) representative would observe the control systems in full operation.
4. The controls subcontractor shall have in-place facility within 50 miles with technical staff, spare parts inventory for the next five (5) years, and necessary test and diagnostic equipment to support the control systems.
5. The controls subcontractor shall have minimum of three years experience in design and installation of building automation systems similar in performance to those specified in this Section. Provide evidence of experience by submitting resumes of the project manager, the local branch manager, project engineer, the application engineering staff, and the electronic technicians who would be involved with the supervision, the engineering, and the installation of the control systems. Training and experience of these personnel shall not be less than three years. Failure to disclose this information will be a ground for disqualification of the supplier.
6. Provide a competent and experienced Project Manager employed by the Controls Contractor. The Project Manager shall be supported as necessary by other Contractor employees in order to provide professional engineering, technical and management service for the work. The Project Manager shall attend scheduled Project Meetings as required and shall be

empowered to make technical, scheduling and related decisions on behalf of the Controls Contractor.

B. Codes and Standards:

1. All work shall conform to the applicable Codes and Standards.
2. Electronic equipment shall conform to the requirements of FCC Regulation, Part 15, Governing Radio Frequency Electromagnetic Interference, and be so labeled.

1.5 PERFORMANCE

A. The system shall conform to the following:

1. Graphic Display: The system shall display up to four (4) graphics on a single screen with a minimum of twenty (20) dynamic points per graphic. All current data shall be displayed within ten (10) seconds of the request.
2. Graphic Refresh: The system shall update all dynamic points with current data within eight (8) seconds. Data refresh shall be automatic, without operator intervention.
3. Object Command: The maximum time between the command of a binary object by the operator and the reaction by the device shall be two(2) seconds. Analog objects shall start to adjust within two (2) seconds.
4. Object Scan: All changes of state and change of analog values shall be transmitted over the high-speed network such that any data used or displayed at a controller or work-station will be current, within the prior six (6) seconds.
5. Alarm Response Time: The maximum time from when an object goes into alarm to when it is annunciated at the workstation shall not exceed (10) seconds.
6. Program Execution Frequency: Custom and standard applications shall be capable of running as often as once every (5) seconds. The Contractor shall be responsible for selecting execution times consistent with the mechanical process under control.
7. Multiple Alarm Annunciations: All workstations on the network shall receive alarms within five (5) seconds of each other.
8. Performance: Programmable Controllers shall be able to execute DDC PID control loops at a selectable frequency from at least once every one (1) second. The controller shall scan and update the process value and output generated by this calculation at this same frequency.
9. Reporting Accuracy: Listed below are minimum acceptable reporting end-to-end accuracies for all values reported by the specified system:

| Measured Variable       | Reported Accuracy                                     |
|-------------------------|---|
| Space temperature       | $\pm 0.5^{\circ}\text{C}$ ( $\pm 1^{\circ}\text{F}$ ) |
| Ducted air temperature  | $\pm 0.5^{\circ}\text{C}$ [ $\pm 1^{\circ}\text{F}$ ] |
| Outdoor air temperature | $\pm 1.0^{\circ}\text{C}$ [ $\pm 2^{\circ}\text{F}$ ] |

|                               |   |
|-------------------------------|---|
| Dew Point                     | $\pm 1.5^{\circ}\text{C}$ [ $\pm 3^{\circ}\text{F}$ ] |
| Water temperature             | $\pm 0.5^{\circ}\text{C}$ [ $\pm 1^{\circ}\text{F}$ ] |
| Relative humidity             | $\pm 2\%$ RH  |
| Water flow                    | $\pm 1\%$ of reading                                  |
| Air flow (terminal)           | $\pm 10\%$ of reading                                 |
| Air flow (measuring stations) | $\pm 5\%$ of reading                                  |
| Air pressure (ducts)          | $\pm 25$ Pa [ $\pm 0.1$ "w.c.]                        |
| Air pressure (space)          | $\pm 0.3$ Pa [ $\pm 0.001$ "w.c.]                     |
| Water pressure                | $\pm 2\%$ of full scale *Note 1                       |
| Electrical Power              | $\pm 0.5\%$ of reading                                |

Note 1: for both absolute and differential pressure

10. Control stability and accuracy: Control sequences shall maintain measured variable at setpoint within the following tolerances:



| Controlled Variable | Control Accuracy  | Range of Medium                            |
|---------------------|---|--|
| Air Pressure        | $\pm 50$ Pa ( $\pm 0.2$ in. w.g.)                       | 0–1.5 kPa (0–6 in. w.g.)                   |
| Air Pressure        | $\pm 3$ Pa ( $\pm 0.01$ in. w.g.)                       | -25 to 25 Pa<br>(-0.1 to 0.1 in. w.g.)     |
| Airflow             | $\pm 10\%$ of full scale                                |  |
| Space Temperature   | $\pm 1.0^{\circ}\text{C}$ ( $\pm 2.0^{\circ}\text{F}$ ) |  |
| Duct Temperature    | $\pm 1.5^{\circ}\text{C}$ ( $\pm 3^{\circ}\text{F}$ )   |  |
| Humidity            | $\pm 5\%$ RH  |  |
| Fluid Pressure      | $\pm 10$ kPa ( $\pm 1.5$ psi)                           | 0–1 MPa (1–150 psi)                        |
| Fluid Pressure      | $\pm 250$ Pa ( $\pm 1.0$ in. w.g.)                      | 0–12.5 kPa<br>(0–50 in. w.g.) differential |

11. Extent of direct digital control: control design shall allow for at least the points indicated on the points lists on the drawings.

#### 1.6 WARRANTY

- A. Labor and materials for control systems shall be warranted for a period as specified under Warranty in FAR clause 52.246-21.
- B. Control system failures during the warranty period shall be adjusted, repaired, or replaced at no cost or reduction in service to the owner. The system includes all computer equipment, transmission equipment, and all sensors and control devices.
- C. The on-line support service shall allow the Controls supplier to dial out over telephone lines to or connect via (through password-limited access) VPN through the internet monitor and control the facility's building automation system. This remote connection to the facility shall be within two (2) hours of the time that the problem is reported. This coverage shall be extended to include normal business hours, after business hours, weekend and holidays. If the problem cannot be resolved with on-line support services, the Controls supplier shall dispatch the qualified personnel to the job site to resolve the problem within 24 hours after the problem is reported.
- D. Controls and Instrumentation subcontractor shall be responsible for temporary operations and maintenance of the control systems during the construction period until final commissioning, training of facility operators and acceptance of the project by VA.

## 1.7 SUBMITTALS

- A. Submit shop drawings in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Manufacturer's literature and data for all components including the following:
  - 1. A wiring diagram for each type of input device and output device including DDC controllers, modems, repeaters, etc. Diagram shall show how the device is wired and powered, showing typical connections at the digital controllers and each power supply, as well as the device itself. Show for all field connected devices, including but not limited to, control relays, motor starters, electric or electronic actuators, and temperature pressure, flow and humidity sensors and transmitters.
  - 2. A diagram of each terminal strip, including digital controller terminal strips, terminal strip location, termination numbers and the associated point names.
  - 3. Control dampers and control valves schedule, including the size and pressure drop.
  - 4. Control air-supply components, and computations for sizing compressors, receivers and main air-piping, if pneumatic controls are furnished.
  - 5. Catalog cut sheets of all equipment used. This includes, but is not limited to software (by manufacturer and by third parties), DDC controllers, panels, peripherals, airflow measuring stations and associated components, and auxiliary control devices such as sensors, actuators, and control dampers. When manufacturer's cut sheets apply to a product series rather than a specific product, the data specifically applicable to the project shall be highlighted. Each submitted piece of literature and drawings should clearly reference the specification and/or drawings that it supposed to represent.
  - 6. Sequence of operations for each HVAC system and the associated control diagrams. Equipment and control labels shall correspond to those shown on the drawings.
  - 7. Color prints of proposed graphics with a list of points for display.
  - 8. Furnish a BACnet Protocol Implementation Conformance Statement (PICS) for each BACnet-compliant device.
  - 9. Schematic wiring diagrams for all control, communication and power wiring. Provide a schematic drawing of the central system installation. Label all cables and ports with computer manufacturers' model numbers and functions. Show all interface wiring to the control system.
  - 10. An instrumentation list for each controlled system. Each element of the controlled system shall be listed in table format. The table shall show element name, type of device, manufacturer, model number, and product data sheet number.
  - 11. Riser diagrams of wiring between central control unit and all control panels.
  - 12. Scaled plan drawings showing routing of LAN and locations of control panels, controllers, routers, gateways, ECC, and larger controlled devices.
  - 13. Construction details for all installed conduit, cabling, raceway, cabinets, and similar. Construction details of all penetrations and their protection.

14. Quantities of submitted items may be reviewed but are the responsibility of the contractor administered by this Section of the technical specifications.
- C. Product Certificates: Compliance with Article, QUALITY ASSURANCE.
- D. Licenses: Provide licenses for all software residing on and used by the Controls Systems and transfer these licenses to the Owner prior to completion.
- E. As Built Control Drawings:
1. Furnish three (3) copies of as-built drawings for each control system. The documents shall be submitted for approval prior to final completion.
  2. Furnish one (1) stick set of applicable control system prints for each mechanical system for wall mounting. The documents shall be submitted for approval prior to final completion.
  3. Furnish one (1) CD-ROM in CAD DWG and/or .DXF format for the drawings noted in subparagraphs above.
- F. Operation and Maintenance (O/M) Manuals:
1. Submit in accordance with Article, INSTRUCTIONS, in Specification Section 01 00 00, GENERAL REQUIREMENTS.
  2. Include the following documentation:
    - a. General description and specifications for all components, including logging on/off, alarm handling, producing trend reports, overriding computer control, and changing set points and other variables.
    - b. Detailed illustrations of all the control systems specified for ease of maintenance and repair/replacement procedures, and complete calibration procedures.
    - c. One copy of the final version of all software provided including operating systems, programming language, operator workstation software, and graphics software.
    - d. Complete troubleshooting procedures and guidelines for all systems.
    - e. Complete operating instructions for all systems.
    - f. Recommended preventive maintenance procedures for all system components including a schedule of tasks for inspection, cleaning and calibration. Provide a list of recommended spare parts needed to minimize downtime.
    - g. Training Manuals: Submit the course outline and training material to the Owner for approval three (3) weeks prior to the training to VA facility personnel. These persons will be responsible for maintaining and the operation of the control systems, including programming. The Owner reserves the right to modify any or all of the course outline and training material.
    - h. Licenses, guaranty, and other pertaining documents for all equipment and systems.
- G. Submit Performance Report to Resident Engineer prior to final inspection.

## 1.8 INSTRUCTIONS

- A. Instructions to VA operations personnel: Perform in accordance with Article, INSTRUCTIONS, in Specification Section 01 00 00, GENERAL REQUIREMENTS, and as noted below. Contractor shall also video tape instruction sessions noted below.
  - 1. First Phase: Formal instructions to the VA facilities personnel for a total of 16 hours, given in multiple training sessions (each no longer than four hours in length), conducted sometime between the completed installation and prior to the performance test period of the control system, at a time mutually agreeable to the Contractor and the VA.
  - 2. Second Phase: This phase of training shall comprise of on the job training during start-up, checkout period, and performance test period. VA facilities personnel will work with the Contractor's installation and test personnel on a daily basis during start-up and checkout period. During the performance test period, controls subcontractor will provide 8 hours of instructions, given in multiple training sessions (each no longer than four hours in length), to the VA facilities personnel.
  - 3. The O/M Manuals shall contain approved submittals as outlined in Article 1.7, SUBMITTALS. The Controls subcontractor will review the manual contents with VA facilities personnel during second phase of training.
  - 4. Training shall be given by direct employees of the controls system subcontractor.

## 1.9 PROJECT CONDITIONS (ENVIRONMENTAL CONDITIONS OF OPERATION)

- A. The ECC and peripheral devices and system support equipment shall be designed to operate in ambient condition of 20 to 35°C (65 to 90°F) at a relative humidity of 20 to 80% non-condensing.
- B. The CUs used outdoors shall be mounted in NEMA 4 waterproof enclosures, and shall be rated for operation at -40 to 65°C (-40 to 150°F).
- C. All electronic equipment shall operate properly with power fluctuations of plus 10 percent to minus 15 percent of nominal supply voltage.
- D. Sensors and controlling devices shall be designed to operate in the environment, which they are sensing or controlling.

## 1.10 APPLICABLE PUBLICATIONS

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE):
  - Standard 135-10 ..... BACNET Building Automation and Control Networks
- C. American Society of Mechanical Engineers (ASME):
  - B16.18-01 ..... Cast Copper Alloy Solder Joint Pressure Fittings.
  - B16.22-01 ..... Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.

D. American Society of Testing Materials (ASTM):

- B32-08 ..... Standard Specification for Solder Metal
- B88-09 ..... Standard Specifications for Seamless Copper Water Tube
- B88M-09 ..... Standard Specification for Seamless Copper Water Tube  
(Metric)
- B280-08 ..... Standard Specification for Seamless Copper Tube for Air-  
Conditioning and Refrigeration Field Service
- D2737-03 ..... Standard Specification for Polyethylene (PE) Plastic Tubing

E. Federal Communication Commission (FCC):

Rules and Regulations Title 47 Chapter 1-2001 Part 15: Radio Frequency Devices.

F. Institute of Electrical and Electronic Engineers (IEEE):

- 802.3-11 ..... Information Technology-Telecommunications and Information  
Exchange between Systems-Local and Metropolitan Area  
Networks- Specific Requirements-Part 3: Carrier Sense Multiple  
Access with Collision Detection (CSMA/CD) Access method and  
Physical Layer Specifications

G. National Fire Protection Association (NFPA):

- 70-11 ..... National Electric Code
- 90A-09 ..... Standard for Installation of Air-Conditioning and Ventilation  
Systems

H. Underwriter Laboratories Inc (UL):

- 94-10 ..... Tests for Flammability of Plastic Materials for Parts and Devices  
and Appliances
- 294-10 ..... Access Control System Units
- 486A/486B-10 ..... Wire Connectors
- 555S-11 ..... Standard for Smoke Dampers
- 916-10 ..... Energy Management Equipment
- 1076-10 ..... Proprietary Burglar Alarm Units and Systems

## PART 2 - PRODUCTS

### 2.1 MATERIALS

- A. Use new products that the manufacturer is currently manufacturing and that have been installed in a minimum of 25 installations. Spare parts shall be available for at least five years after completion of this contract.

### 2.2 CONTROLS SYSTEM ARCHITECTURE

#### A. General

1. The Controls Systems shall consist of multiple Nodes and associated equipment connected by industry standard digital and communication network arrangements.
2. The ECC, building controllers and principal communications network equipment shall be standard products of recognized major manufacturers available through normal PC and computer vendor channels – not "Clones" assembled by a third-party subcontractor.
3. The networks shall, at minimum, comprise, as necessary, the following:
  - a. A fixed ECC and a portable operator's terminal.
  - b. Network computer processing, data storage and BACnet-compliant communication equipment including Servers and digital data processors.
  - c. BACnet-compliant routers, bridges, switches, hubs, modems, gateways, interfaces and similar communication equipment.
  - d. Active processing BACnet-compliant building controllers connected to other BACnet-compliant controllers together with their power supplies and associated equipment.
  - e. Addressable elements, sensors, transducers and end devices.
  - f. Third-party equipment interfaces and gateways as described and required by the Contract Documents.
  - g. Other components required for a complete and working Control Systems as specified.

- B. The Specifications for the individual elements and component subsystems shall be minimum requirements and shall be augmented as necessary by the Contractor to achieve both compliance with all applicable codes, standards and to meet all requirements of the Contract Documents.

#### C. Network Architecture

1. The Controls communication network shall utilize BACnet communications protocol operating over a standard Ethernet LAN and operate at a minimum speed of 100 Mb/sec.
2. The networks shall utilize only copper and optical fiber communication media as appropriate and shall comply with applicable codes, ordinances and regulations. They may also utilize digital wireless technologies as appropriate to the application and if approved by the VA.
3. All necessary telephone lines, ISDN lines and internet Service Provider services and connections will be provided by the VA.

D. Third Party Interfaces:

1. The contractor administered by this Section of the technical specifications shall include necessary hardware, equipment, software and programming to allow data communications between the controls systems and building systems supplied by other trades.
2. Other manufacturers and contractors supplying other associated systems and equipment shall provide their necessary hardware, software and start-up at their cost and shall cooperate fully with the contractor administered by this Section of the technical specifications in a timely manner and at their cost to ensure complete functional integration.

E. Servers:

1. Provide data storage server(s) to archive historical data including trends, alarm and event histories and transaction logs.
2. Equip these server(s) with the same software tool set that is located in the BACnet building controllers for system configuration and custom logic definition and color graphic configuration.
3. Access to all information on the data storage server(s) shall be through the same browser functionality used to access individual nodes. When logged onto a server the operator will be able to also interact with any other controller on the control system as required for the functional operation of the controls systems. The contractor administered by this Section of the technical specifications shall provide all necessary digital processor programmable data storage server(s).
4. These server(s) shall be utilized for controls systems application configuration, for archiving, reporting and trending of data, for operator transaction archiving and reporting, for network information management, for alarm annunciation, for operator interface tasks, for controls application management and similar. These server(s) shall utilize IT industry standard data base platforms which utilize a database declarative language designed for managing data in relational database management systems (RDBMS) such as SQL.

## 2.3 COMMUNICATION

A. Control products, communication media, connectors, repeaters, hubs, and routers shall comprise a BACnet internetwork. Controller and operator interface communication shall conform to ANSI/ASHRAE Standard 135-2008, BACnet.

1. The Data link / physical layer protocol (for communication) acceptable to the VA throughout its facilities is Ethernet (ISO 8802-3) and BACnet/IP.

B. Each controller shall have a communication port for connection to an operator interface.

C. Project drawings indicate remote buildings or sites to be connected by a nominal 56,000 baud modem over voice-grade telephone lines. In each remote location a modem and field device connection shall allow communication with each controller on the internetwork as specified in Paragraph D.

D. Internetwork operator interface and value passing shall be transparent to internetwork architecture.

1. An operator interface connected to a controller shall allow the operator to interface with each internetwork controller as if directly connected. Controller information such as data, status,

reports, system software, and custom programs shall be viewable and editable from each internetwork controller.

2. Inputs, outputs, and control variables used to integrate control strategies across multiple controllers shall be readable by each controller on the internetwork. Program and test all cross-controller links required to execute specified control system operation. An authorized operator shall be able to edit cross-controller links by typing a standard object address.
- E. System shall be expandable to at least twice the required input and output objects with additional controllers, associated devices, and wiring. Expansion shall not require operator interface hardware additions or software revisions.
- F. ECCs and Controllers with real-time clocks shall use the BACnet Time Synchronization service. The system shall automatically synchronize system clocks daily from an operator-designated device via the internetwork. The system shall automatically adjust for daylight savings and standard time as applicable.

## 2.4 ENGINEERING CONTROL CENTER (ECC)

- A. The ECC shall reside on a high-speed network with controllers as shown on system drawings. The ECC and each standard browser connected to server shall be able to access all system information.
- B. ECC and controllers shall communicate using BACnet protocol. ECC and control network backbone shall communicate using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol and BACnet/IP addressing as specified in ASHRAE/ANSI 135-2008, BACnet Annex J.
- C. Hardware: ECC shall conform to the BACnet Advanced Workstation (B-AWS) Profile and shall be BTL-Listed as a B-AWS device.
  1. ECC shall be commercial standard with supporting 32- or 64-bit hardware (as required by the direct-digital control system software) and software enterprise server. Internet Explorer v6.0 SP1 or higher, Windows Script Hosting version 5.6 or higher, Windows Message Queuing, Windows Internet Information Services (IIS) v5.0 or higher, minimum 2.8 GHz processor, minimum 4GB DDR3 SDRAM (minimum 1333 Mhz) memory, 512 MB video card, and 16 speed high density DVD-RW+/- optical drive.
    - a. The hard drive shall be at the minimum 1 TB 7200 rpm SATA hard drive with 16 MB cache, and shall have sufficient memory to store:
      - 1) All required operator workstation software
      - 2) A DDC database at least twice the size of the delivered system database
      - 3) One year of trend data based on the points specified to be trended at their specified trend intervals.
    - b. Real-time clock:
      - 1) Accuracy: Plus or minus 1 minute per month.
      - 2) Time Keeping Format: 24-hour time format including seconds, minutes, hours, date, day, and month; automatic reset by software.



- 3) Clock shall function for one year without power.
- 4) Provide automatic time correction once every 24 hours by synchronizing clock with the Time Service Department of the U.S. Naval Observatory.
- c. Serial ports: Four USB ports and two RS-232-F serial ports for general use, with additional ports as required. Data transmission rates shall be selectable under program control.
- d. Parallel port: Enhanced.
- e. Sound card: For playback and recording of digital WAV sound files associated with audible warning and alarm functions.
- f. Color monitor: PC compatible, not less than 22 inches, LCD type, with a minimum resolution of 1280 by 1024 pixels, non-interlaced, and a maximum dot pitch of 0.28 mm.
- g. Keyboard: Minimum of 64 characters, standard ASCII character set based on ANSI INCITS 154.
- h. Mouse: Standard, compatible with installed software.
- i. Removable disk storage: Include the following, each with appropriate controller:
  - 1) Minimum 1 TB removable hard disk, maximum average access time of 10 ms.
- j. Network interface card (NIC): integrated 10-100-1000 Base-TX Ethernet NIC with an RJ45 connector or a 100Base-FX Ethernet NIC with an SC/ST connector.
- 2. Cable modem: 42.88 MBit/s, DOCSIS 2.0 Certified, also backwards compatible with DOCSIS 1.1/1.0 standards. Provide Ethernet or USB connectivity.
- 3. Optical modem: full duplex link, for use on 10 GBase-R single-mode and multi-mode fiber with a XENPAK module.
- 4. Auto-dial modem: 56,600 bps, full duplex for asynchronous communications. With error detection, auto answer/autodial, and call-in-progress detection. Modem shall comply with requirements in ITU-T v.34, ITU-T v.42, ITU-T v.42 Appendix VI for error correction, and ITU-T v.42 BIS for data compression standards; and shall be suitable for operating on unconditioned voice-grade telephone lines complying with 47 CFR 68.
- 5. Audible Alarm: Manufacturer's standard.
- 6. Printers:
  - a. Provide a dedicated, minimum resolution 600 dpi, color laser printer, connected to the ECC through a USB interface.
    - 1) If a network printer is used instead of this dedicated printer, it shall have a 100Base-T interface with an RJ45 connection and shall have a firmware print spooler compatible with the Operating System print spooler.
    - 2) RAM: 512 MB, minimum.

- 3) Printing Speed: Minimum twenty six pages per minute (color); minimum 30 pages per minute (black/white).
  - 4) Paper Handling: Automatic sheet feeder with 250-sheet x 8.5 inch x 11 inch paper cassette and with automatic feed.
  - b. Provide a dedicated black/white tractor-feed dot matrix printer for status/alarm message printing, minimum 10 characters per inch, minimum 160 characters per second, connected to the ECC through a USB interface.
    - 1) Paper: One box of 2000 sheets of 8-1/2x11 multi-fold type printer paper.
7. RS-232 ASCII Interface
- a. ASCII interface shall allow RS-232 connections to be made between a meter or circuit monitor operating as the host PC and any equipment that will accept RS-232 ASCII command strings, such as local display panels, dial-up modems, and alarm transmitters.
  - b. Pager System Interface: Alarms shall be able to activate a pager system with customized message for each input alarm.
  - c. Alarm System Interface: RS-232 output shall be capable of transmitting alarms from other monitoring and alarm systems to workstation software.
  - d. RS-232 output shall be capable of connection to a pager interface that can be used to call a paging system or service and send a signal to a portable pager. System shall allow an individual alphanumeric message per alarm input to be sent to paging system. This interface shall support both numeric and alphanumeric pagers.
  - e. Cables: provide Plenum-Type, RS-232 Cable: Paired, 2 pairs, No. 22 AWG, stranded (7x30) tinned copper conductors, plastic insulation, and individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage; plastic jacket. Pairs are cabled on common axis with No. 24 AWG, stranded (7x32) tinned copper drain wire.
    - 1) NFPA 70, Type CMP.
    - 2) Flame Resistance: NFPA 262, Flame Test.
8. Self-contained uninterruptible power supply (UPS):
- a. Size: Provide a minimum of six hours of operation of ECC equipment, including two hours of alarm printer operation.
  - b. Batteries: Sealed, valve regulated, recombinant, lead calcium.
  - c. Accessories:
    - 1) Transient voltage suppression.
    - 2) Input-harmonics reduction.
    - 3) Rectifier/charger.
    - 4) Battery disconnect device.

- 5) Static bypass transfer switch.
- 6) Internal maintenance bypass/isolation switch.
- 7) External maintenance bypass/isolation switch.
- 8) Output isolation transformer.
- 9) Remote UPS monitoring.
- 10) Battery monitoring.
- 11) Remote battery monitoring.

D. ECC Software:

1. Provide for automatic system database save and restore on the ECC's hard disk a copy of the current database of each Controller. This database shall be updated whenever a change is made in any system panel. In the event of a database loss in a building management panel, the ECC shall automatically restore the database for that panel. This capability may be disabled by the operator.
2. Provide for manual database save and restore. An operator with proper clearance shall be able to save the database from any system panel. The operator also shall be able to clear a panel database and manually initiate a download of a specified database to any panel in the system.
3. Provide a method of configuring the system. This shall allow for future system changes or additions by users with proper clearance.
4. Operating System. Furnish a concurrent multi-tasking operating system. The operating system also shall support the use of other common software applications. Acceptable operating systems are Windows XP, Windows System 7, Linux, and UNIX.
5. System Graphics. The operator workstation software shall be graphically oriented. The system shall allow display of up to 10 graphic screens at once for comparison and monitoring of system status. Provide a method for the operator to easily move between graphic displays and change the size and location of graphic displays on the screen. The system graphics shall be able to be modified while on-line. An operator with the proper password level shall be able to add, delete, or change dynamic objects on a graphic. Dynamic objects shall include analog and binary values, dynamic text, static text, and animation files. Graphics shall have the ability to show animation by shifting image files based on the status of the object.
6. Custom Graphics. Custom graphic files shall be created with the use of a graphics generation package furnished with the system. The graphics generation package shall be a graphically based system that uses the mouse to create and modify graphics that are saved in industry standard formats such as PCX, TIFF, and GEM. The graphics generation package also shall provide the capability of capturing or converting graphics from other programs such as Designer or AutoCAD.
7. Graphics Library. Furnish a complete library of standard HVAC equipment graphics such as chillers, boilers, air handlers, terminals, fan coils, and unit ventilators. This library also shall include standard symbols for other equipment including fans, pumps, coils, valves, piping, dampers, and ductwork. The library shall be furnished in a file format compatible with the graphics generation package program.

8. The Controls Systems Operator Interfaces shall be user friendly, readily understood and shall make maximum use of colors, graphics, icons, embedded images, animation, text based information and data visualization techniques to enhance and simplify the use and understanding of the displays by authorized users at the ECC. The operating system shall be Windows XP or better, and shall support the third party software.
9. Provide graphical user software, which shall minimize the use of keyboard through the use of the mouse and "point and click" approach to menu selection.
10. The software shall provide a multi-tasking type environment that will allow the user to run several applications simultaneously. The mouse or Alt-Tab keys shall be used to quickly select and switch between multiple applications. The operator shall be able automatically export data to and work in Microsoft Word, Excel, and other Windows based software programs, while concurrently on-line system alarms and monitoring information.
11. On-Line Help. Provide a context-sensitive, on-line help system to assist the operator in operating and editing the system. On-line help shall be available for all applications and shall provide the relevant data for that particular screen. Additional help information shall be available through the use of hypertext.
12. User access shall be protected by a flexible and Owner re-definable software-based password access protection. Password protection shall be multi-level and partition able to accommodate the varied access requirements of the different user groups to which individual users may be assigned. Provide the means to define unique access privileges for each individual authorized user. Provide the means to on-line manage password access control under the control of a project specific Master Password. Provide an audit trail of all user activity on the Controls Systems including all actions and changes.
13. The system shall be completely field-programmable from the common operator's keyboard thus allowing hard disk storage of all data automatically. All programs for the CUs shall be able to be downloaded from the hard disk. The software shall provide the following functionality as a minimum:
  - a. Point database editing, storage and downloading of controller databases.
  - b. Scheduling and override of building environmental control systems.
  - c. Collection and analysis of historical data.
  - d. Alarm reporting, routing, messaging, and acknowledgement.
  - e. Definition and construction of dynamic color graphic displays.
  - f. Real-time graphical viewing and control of environment.
  - g. Scheduling trend reports.
  - h. Program editing.
  - i. Operating activity log and system security.
  - j. Transfer data to third party software.
14. Provide functionality such that using the least amount of steps to initiate the desired event may perform any of the following simultaneously:

- a. Dynamic color graphics and graphic control.
  - b. Alarm management.
  - c. Event scheduling.
  - d. Dynamic trend definition and presentation.
  - e. Program and database editing.
  - f. Each operator shall be required to log on to the system with a user name and password to view, edit or delete the data. System security shall be selectable for each operator, and the password shall be able to restrict the operator's access for viewing and changing the system programs. Each operator shall automatically be logged off the system if no keyboard or mouse activity is detected for a selected time.
15. Graphic Displays:
- a. The workstation shall allow the operator to access various system schematics and floor plans via a graphical penetration scheme, menu selection, or text based commands. Graphic software shall permit the importing of AutoCAD or scanned pictures in the industry standard format (such as PCX, BMP, GIF, and JPEG) for use in the system.
  - b. System Graphics shall be project specific and schematically correct for each system. (ie: coils, fans, dampers located per equipment supplied with project.) Standard system graphics that do not match equipment or system configurations are not acceptable. Operator shall have capability to manually operate the entire system from each graphic screen at the ECC. Each system graphic shall include a button/tab to a display of the applicable sequence of operation.
  - c. Dynamic temperature values, humidity values, flow rates, and status indication shall be shown in their locations and shall automatically update to represent current conditions without operator intervention and without pre-defined screen refresh values.
  - d. Color shall be used to indicate status and change in status of the equipment. The state colors shall be user definable.
  - e. A clipart library of HVAC equipment, such as chillers, boilers, air handling units, fans, terminal units, pumps, coils, standard ductwork, piping, valves and laboratory symbols shall be provided in the system. The operator shall have the ability to add custom symbols to the clipart library.
  - f. A dynamic display of the site-specific architecture showing status of the controllers, the ECC and network shall be provided.
  - g. The windowing environment of the workstation shall allow the user to simultaneously view several applications at a time to analyze total building operation or to allow the display of graphic associated with an alarm to be viewed without interrupting work in progress. The graphic system software shall also have the capability to split screen, half portion of the screen with graphical representation and the other half with sequence of operation of the same HVAC system.
16. Trend reports shall be generated on demand or pre-defined schedule and directed to monitor display, printers or disk. As a minimum, the system shall allow the operator to easily obtain the following types of reports:

- a. A general list of all selected points in the network.
  - b. List of all points in the alarm.
  - c. List of all points in the override status.
  - d. List of all disabled points.
  - e. List of all points currently locked out.
  - f. List of user accounts and password access levels.
  - g. List of weekly schedules.
  - h. List of holiday programming.
  - i. List of limits and dead bands.
  - j. Custom reports.
  - k. System diagnostic reports, including, list of digital controllers on the network.
  - l. List of programs.
17. ASHRAE Standard 147 Report: Provide a daily report that shows the operating condition of each chiller as recommended by ASHRAE Standard 147. At a minimum, this report shall include:
- a. Chilled water (or other secondary coolant) inlet and outlet temperature
  - b. Chilled water (or other secondary coolant) flow
  - c. Chilled water (or other secondary coolant) inlet and outlet pressures
  - d. Evaporator refrigerant pressure and temperature
  - e. Condenser refrigerant pressure and liquid temperature
  - f. Condenser water inlet and outlet temperatures
  - g. Condenser water flow
  - h. Refrigerant levels
  - i. Oil pressure and temperature
  - j. Oil level
  - k. Compressor refrigerant discharge temperature
  - l. Compressor refrigerant suction temperature
  - m. Addition of refrigerant

- n. Addition of oil
  - o. Vibration levels or observation that vibration is not excessive
  - p. Motor amperes per phase
  - q. Motor volts per phase
  - r. PPM refrigerant monitor level
  - s. Purge exhaust time or discharge count
  - t. Ambient temperature (dry-bulb and wet-bulb)
  - u. Date and time logged
18. Electrical, Gas, and Weather Reports
- a. Electrical Meter Report: Provide a monthly report showing the daily electrical consumption and peak electrical demand with time and date stamp for each building meter.
  - b. Provide an annual (12-month) summary report showing the monthly electrical consumption and peak demand with time and date stamp for each meter.
  - c. Gas Meter Report: Provide a monthly report showing the daily natural gas consumption for each meter. Provide an annual (12-month) report that shows the monthly consumption for each meter.
  - d. Weather Data Report: Provide a monthly report showing the daily minimum, maximum, and average outdoor air temperature, as well as the number of heating and cooling degree-days for each day. Provide an annual (12-month) report showing the minimum, maximum, and average outdoor air temperature for the month, as well as the number of heating and cooling degree-days for the month.
19. Scheduling and Override:
- a. Provide override access through menu selection from the graphical interface and through a function key.
  - b. Provide a calendar type format for time-of-day scheduling and overrides of building control systems. Schedules reside in the ECC. The digital controllers shall ensure equipment time scheduling when the ECC is off-line. The ECC shall not be required to execute time scheduling. Provide the following spreadsheet graphics as a minimum:
    - 1) Weekly schedules.
    - 2) Zone schedules, minimum of 100 zones.
    - 3) Scheduling up to 365 days in advance.
    - 4) Scheduled reports to print at workstation.
20. Collection and Analysis of Historical Data:

- a. Provide trending capabilities that will allow the operator to monitor and store records of system activity over an extended period of time. Points may be trended automatically on time based intervals or change of value, both of which shall be user definable. The trend interval could be five (5) minutes to 120 hours. Trend data may be stored on hard disk for future diagnostic and reporting. Additionally trend data may be archived to network drives or removable disk media for off-site retrieval.
  - b. Reports may be customized to include individual points or predefined groups of at least six points. Provide additional functionality to allow pre-defined groups of up to 250 trended points to be easily accessible by other industry standard word processing and spreadsheet packages. The reports shall be time and date stamped and shall contain a report title and the name of the facility.
  - c. System shall have the set up to generate spreadsheet reports to track energy usage and cost based on weekly or monthly interval, equipment run times, equipment efficiency, and/or building environmental conditions.
  - d. Provide additional functionality that will allow the operator to view real time trend data on trend graph displays. A minimum of 20 points may be graphed regardless of whether they have been predefined for trending. In addition, the user may pause the graph and take snapshots of the screens to be stored on the workstation disk for future reference and trend analysis. Exact point values may be viewed and the graph may be printed. Operator shall be able to command points directly on the trend plot by double clicking on the point.
21. Alarm Management:
- a. Alarm routing shall allow the operator to send alarm notification to selected printers or operator workstation based on time of day, alarm severity, or point type.
  - b. Alarm notification shall be provided via two alarm icons, to distinguish between routine, maintenance type alarms and critical alarms. The critical alarms shall display on the screen at the time of its occurrence, while others shall display by clicking on their icon.
  - c. Alarm display shall list the alarms with highest priority at the top of the display. The alarm display shall provide selector buttons for display of the associated point graphic and message in English language. The operator shall be able to sort out the alarms.
  - d. Alarm messages shall be customized for each point to display detailed instructions to the operator regarding actions to take in the event of an alarm.
  - e. An operator with proper security level access may acknowledge and clear the alarm. All that have not been cleared shall be archived at workstation disk.
22. Remote Communications: The system shall have the ability to dial out in the event of an alarm. Receivers shall include operator workstations, e-mail addresses, and alpha-numeric pagers. The alarm message shall include the name of the calling location, the device that generated the alarm, and the alarm message itself.
23. System Configuration:
- a. Network control strategies shall not be restricted to a single digital controller, but shall be able to include data from all other network devices to allow the development of global control strategies.



- b. Provide automatic backup and restore of all digital controller databases on the workstation hard disk. In addition to all backup data, all databases shall be performed while the workstation is on-line without disturbing other system operations.

## 2.5 PORTABLE OPERATOR'S TERMINAL (POT)

- A. Provide a portable operator's terminal (POT) that shall be capable of accessing all system data. POT may be connected to any point on the system network or may be connected directly to any controller for programming, setup, and troubleshooting. POT shall communicate using BACnet protocol. POT may be connected to any point on the system network or it may be connected directly to controllers using the BACnet PTP (Point-To-Point) Data Link/ Physical layer protocol. The terminal shall use the Read (Initiate) and Write (Execute) BACnet Services. POT shall be an IBM-compatible notebook-style PC including all software and hardware required.
- B. Hardware: POT shall conform to the BACnet Advanced Workstation (B-AWS) Profile and shall be BTL-Listed as a B-AWS device.
  - 1. POT shall be commercial standard with supporting 32- or 64-bit hardware (as limited by the direct-digital control system software) and software enterprise server. Internet Explorer v6.0 SP1 or higher, Windows Script Hosting version 5.6 or higher, Windows Message Queuing, Windows Internet Information Services (IIS) v5.0 or higher, minimum 2.8 GHz processor, minimum 500 GB 7200 rpm SATA hard drive with 16 MB cache, minimum 2GB DDR3 SDRAM (minimum 1333 Mhz) memory, 512 MB video card, minimum 16 inch (diagonal) screen, 10-100-1000 Base-TX Ethernet NIC with an RJ45 connector or a 100Base-FX Ethernet NIC with an SC/ST connector, 56,600 bps modem, an ASCII RS-232 interface, and a 16 speed high density DVD-RW+/- optical drive.
- C. Software: POT shall include software equal to the software on the ECC.

## 2.6 BACNET PROTOCOL ANALYZER

- A. For ease of troubleshooting and maintenance, provide a BACnet protocol analyzer. Provide its associated fittings, cables and appurtenances, for connection to the communications network. The BACnet protocol analyzer shall be able to, at a minimum: capture and store to a file all data traffic on all network levels; measure bandwidth usage; filter out (ignore) selected traffic.

## 2.7 NETWORK AND DEVICE NAMING CONVENTION

### A. Network Numbers

- 1. BACnet network numbers shall be based on a "facility code, network" concept. The "facility code" is the VAMC's or VA campus' assigned numeric value assigned to a specific facility or building. The "network" typically corresponds to a "floor" or other logical configuration within the building. BACnet allows 65535 network numbers per BACnet internet work.
- 2. The network numbers are thus formed as follows: "Net #" = "FFFNN" where:
  - a. FFF = Facility code (see below)
  - b. NN = 00-99 This allows up to 100 networks per facility or building

### B. Device Instances

- 1. BACnet allows 4194305 unique device instances per BACnet internet work. Using Agency's unique device instances are formed as follows: "Dev #" = "FFFNDD" where

- a. FFF and N are as above and
  - b. DD = 00-99, this allows up to 100 devices per network.
2. Note Special cases, where the network architecture of limiting device numbering to DD causes excessive subnet works. The device number can be expanded to DDD and the network number N can become a single digit. In NO case shall the network number N and the device number D exceed 4 digits.
  3. Facility code assignments:
  4. 000-400 Building/facility number
  5. Note that some facilities have a facility code with an alphabetic suffix to denote wings, related structures, etc. The suffix will be ignored. Network numbers for facility codes above 400 will be assigned in the range 000-399.

#### C. Device Names

1. Name the control devices based on facility name, location within a facility, the system or systems that the device monitors and/or controls, or the area served. The intent of the device naming is to be easily recognized. Names can be up to 254 characters in length, without embedded spaces. Provide the shortest descriptive, but unambiguous, name. For example, in building #123 prefix the number with a "B" followed by the building number, if there is only one chilled water pump "CHWP-1", a valid name would be "B123.CHWP. 1.STARTSTOP". If there are two pumps designated "CHWP-1", one in a basement mechanical room (Room 0001) and one in a penthouse mechanical room (Room PH01), the names could be "B123.R0001.CHWP.1. STARTSTOP" or "B123.RPH01.CHWP.1.STARTSTOP". In the case of unitary controllers, for example a VAV box controller, a name might be "B123.R101.VAV". These names should be used for the value of the "Object\_Name" property of the BACnet Device objects of the controllers involved so that the BACnet name and the EMCS name are the same.

## 2.8 BACNET DEVICES

- A. All BACnet Devices – controllers, gateways, routers, actuators and sensors shall conform to BACnet Device Profiles and shall be BACnet Testing Laboratories (BTL) -Listed as conforming to those Device Profiles. Protocol Implementation Conformance Statements (PICSs), describing the BACnet capabilities of the Devices shall be published and available of the Devices through links in the BTL website.
  1. BACnet Building Controllers, historically referred to as NACs, shall conform to the BACnet B-BC Device Profile, and shall be BTL-Listed as conforming to the B-BC Device Profile. The Device's PICS shall be submitted.
  2. BACnet Advanced Application Controllers shall conform to the BACnet B-AAC Device Profile, and shall be BTL-Listed as conforming to the B-AAC Device Profile. The Device's PICS shall be submitted.
  3. BACnet Application Specific Controllers shall conform to the BACnet B-ASC Device Profile, and shall be BTL-Listed as conforming to the B-ASC Device Profile. The Device's PICS shall be submitted.
  4. BACnet Smart Actuators shall conform to the BACnet B-SA Device Profile, and shall be BTL-Listed as conforming to the B-SA Device Profile. The Device's PICS shall be submitted.

5. BACnet Smart Sensors shall conform to the BACnet B-SS Device Profile, and shall be BTL-Listed as conforming to the B-SS Device Profile. The Device's PICS shall be submitted.
6. BACnet routers and gateways shall conform to the BACnet B-OTH Device Profile, and shall be BTL-Listed as conforming to the B-OTH Device Profile. The Device's PICS shall be submitted.

## 2.9 CONTROLLERS

- A. General. Provide an adequate number of BTL-Listed B-BC building controllers and an adequate number of BTL-Listed B-AAC advanced application controllers to achieve the performance specified in the Part 1 Article on "System Performance." Each of these controllers shall meet the following requirements.
  1. The controller shall have sufficient memory to support its operating system, database, and programming requirements.
  2. The building controller shall share data with the ECC and the other networked building controllers. The advanced application controller shall share data with its building controller and the other networked advanced application controllers.
  3. The operating system of the controller shall manage the input and output communication signals to allow distributed controllers to share real and virtual object information and allow for central monitoring and alarms.
  4. Controllers that perform scheduling shall have a real-time clock.
  5. The controller shall continually check the status of its processor and memory circuits. If an abnormal operation is detected, the controller shall:
    - a. assume a predetermined failure mode, and
    - b. generate an alarm notification.
  6. The controller shall communicate with other BACnet devices on the internetwork using the BACnet Read (Execute and Initiate) and Write (Execute and Initiate) Property services.
  7. Communication.
    - a. Each controller shall reside on a BACnet network using the ISO 8802-3 (Ethernet) Data Link/Physical layer protocol for its communications. Each building controller also shall perform BACnet routing if connected to a network of custom application and application specific controllers.
    - b. The controller shall provide a service communication port using BACnet Data Link/Physical layer protocol for connection to a portable operator's terminal.
  8. Keypad. A local keypad and display shall be provided for each controller. The keypad shall be provided for interrogating and editing data. Provide a system security password shall be available to prevent unauthorized use of the keypad and display.
  9. Serviceability. Provide diagnostic LEDs for power, communication, and processor. All wiring connections shall be made to field-removable, modular terminal strips or to a termination card connected by a ribbon cable.

10. Memory. The controller shall maintain all BIOS and programming information in the event of a power loss for at least 72 hours.
  11. The controller shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80% nominal voltage. Controller operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W at 1 m (3 ft).
- B. Provide BTL-Listed B-ASC application specific controllers for each piece of equipment for which they are constructed. Application specific controllers shall communicate with other BACnet devices on the internetwork using the BACnet Read (Execute) Property service.
1. Each B-ASC shall be capable of stand-alone operation and shall continue to provide control functions without being connected to the network.
  2. Each B-ASC will contain sufficient I/O capacity to control the target system.
  3. Communication.
    - a. Each controller shall reside on a BACnet network using the ISO 8802-3 (Ethernet) Data Link/Physical layer protocol for its communications. Each building controller also shall perform BACnet routing if connected to a network of custom application and application specific controllers.
    - b. Each controller shall have a BACnet Data Link/Physical layer compatible connection for a laptop computer or a portable operator's tool. This connection shall be extended to a space temperature sensor port where shown.
  4. Serviceability. Provide diagnostic LEDs for power, communication, and processor. All wiring connections shall be made to field-removable, modular terminal strips or to a termination card connected by a ribbon cable.
  5. Memory. The application specific controller shall use nonvolatile memory and maintain all BIOS and programming information in the event of a power loss.
  6. Immunity to power and noise. Controllers shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80%. Operation shall be protected against electrical noise of 5-120 Hz and from keyed radios up to 5 W at 1 m (3 ft).
  7. Transformer. Power supply for the ASC must be rated at a minimum of 125% of ASC power consumption and shall be of the fused or current limiting type.
- C. Direct Digital Controller Software
1. The software programs specified in this section shall be commercially available, concurrent, multi-tasking operating system and support the use of software application that operates under DOS or Microsoft Windows.
  2. All points shall be identified by up to 30-character point name and 16-character point descriptor. The same names shall be used at the ECC.
  3. All control functions shall execute within the stand-alone control units via DDC algorithms. The VA shall be able to customize control strategies and sequences of operations defining the appropriate control loop algorithms and choosing the optimum loop parameters.

4. All controllers shall be capable of being programmed to utilize stored default values for assured fail-safe operation of critical processes. Default values shall be invoked upon sensor failure or, if the primary value is normally provided by the central or another CU, or by loss of bus communication. Individual application software packages shall be structured to assume a fail-safe condition upon loss of input sensors. Loss of an input sensor shall result in output of a sensor-failed message at the ECC. Each ACU and RCU shall have capability for local readouts of all functions. The UCUs shall be read remotely.
5. All DDC control loops shall be able to utilize any of the following control modes:
  - a. Two position (on-off, slow-fast) control.
  - b. Proportional control.
  - c. Proportional plus integral (PI) control.
  - d. Proportional plus integral plus derivative (PID) control. All PID programs shall automatically invoke integral wind up prevention routines whenever the controlled unit is off, under manual control of an automation system or time initiated program.
  - e. Automatic tuning of control loops.
6. System Security: Operator access shall be secured using individual password and operator's name. Passwords shall restrict the operator to the level of object, applications, and system functions assigned to him. A minimum of six (6) levels of security for operator access shall be provided.
7. Application Software: The controllers shall provide the following programs as a minimum for the purpose of optimizing energy consumption while maintaining comfortable environment for occupants. All application software shall reside and run in the system digital controllers. Editing of the application shall occur at the ECC or via a portable operator's terminal, when it is necessary, to access directly the programmable unit.
  - a. Alarm Reporting: The operator shall be able to determine the action to be taken in the event of an alarm. Alarms shall be routed to the ECC based on time and events. An alarm shall be able to start programs, login the event, print and display the messages. The system shall allow the operator to prioritize the alarms to minimize nuisance reporting and to speed operator's response to critical alarms. A minimum of six (6) priority levels of alarms shall be provided for each point.
  - b. Remote Communications: The system shall have the ability to dial out in the event of an alarm to the ECC and alpha-numeric pagers. The alarm message shall include the name of the calling location, the device that generated the alarm, and the alarm message itself. The operator shall be able to remotely access and operate the system using dial up communications. Remote access shall allow the operator to function the same as local access.
  - c. Maintenance Management (PM): The program shall monitor equipment status and generate maintenance messages based upon the operators defined equipment run time, starts, and/or calendar date limits. A preventative maintenance alarm shall be printed indicating maintenance requirements based on pre-defined run time. Each preventive message shall include point description, limit criteria and preventative maintenance instruction assigned to that limit. A minimum of 480-character PM shall be provided for each component of units such as air handling units.

- d. Chilled water Plant Operation: This program shall have the ability to sequence the multiple chillers to minimize energy consumption. The program shall provide sequence of operation as described on the drawings and include the following as a minimum:
- 1) Automatic start/stop of chillers and auxiliaries in accordance with the sequence of operation shown on the drawings, while incorporating requirements and restraints, such as starting frequency of the equipment imposed by equipment manufacturers.
  - 2) Secondary chilled water pumps and controls.
  - 3) Generate chilled water plant load profiles for different seasons for use in forecasting efficient operating schedule.
  - 4) Cooling Tower Operation Program: The objective of cooling tower control is to optimize chiller/tower energy use within the equipment restraints and minimum condenser water temperature limit recommended by the equipment manufacturer. Maintain chilled water plant performance records and print reports at intervals selected by the operator. It shall be possible for the operator to change the set points and the operating schedule.
  - 5) The chilled water plant program shall display the following as a minimum:
    - a) Secondary chilled flow rate.
    - b) Secondary chilled water supply and return temperature.
    - c) Condenser water supply and return temperature.
    - d) Outdoor air dry bulb temperature.
    - e) Outdoor air wet bulb temperature.
    - f) Ton-hours of chilled water per day/month/year.
    - g) On-off status for each chiller.
    - h) Chilled water flow rate.
    - i) Chilled water supply and return temperature.
    - j) Operating set points-temperature and pressure.
    - k) Kilowatts and power factor.
    - l) Current limit set point.
    - m) Date and time.
    - n) Operating or alarm status.
    - o) Operating hours.

## 2.10 SPECIAL CONTROLLERS

- A. Room Differential Pressure Controller: The differential pressure in operating rooms shall be maintained by controlling the quantity of air exhausted from or supplied to the room. A sensor-controller shall measure and control the velocity of air flowing into or out of the room through a sampling tube installed in the wall separating the room from the adjacent space, and display the value on its monitor. The sensor-controller shall meet the following as a minimum:
1. Operating range: -0.25 to +0.25 inches of water column
  2. Resolution: 5 percent of reading
  3. Accuracy: +/- 10 percent of reading +/- 0.005 inches of water column
  4. Analog output: 0-10 VDC or 4-20 ma
  5. Operating temperature range: 32°F-120°F

## 2.11 SENSORS (AIR, WATER AND STEAM)

- A. Sensors' measurements shall be read back to the DDC system, and shall be visible by the ECC.
- B. Temperature and Humidity Sensors shall be electronic, vibration and corrosion resistant for wall, immersion, and/or duct mounting. Provide all remote sensors as required for the systems.
1. Temperature Sensors: thermistor type for terminal units and Resistance Temperature Device (RTD) with an integral transmitter type for all other sensors.
    - a. Duct sensors shall be rigid or averaging type as shown on drawings. Averaging sensor shall be a minimum of 1 linear ft of sensing element for each sq ft of cooling coil face area.
    - b. Immersion sensors shall be provided with a separable well made of stainless steel, bronze or monel material. Pressure rating of well is to be consistent with the system pressure in which it is to be installed.
    - c. Space sensors shall be equipped with in-space User set-point adjustment, override switch, numerical temperature display on sensor cover, and communication port. Match room thermostats. Provide a tooled-access cover.
      - 1) Public space sensor: setpoint adjustment shall be only through the ECC or through the DDC system's diagnostic device/laptop. Do not provide in-space User set-point adjustment. Provide an opaque keyed-entry cover if needed to restrict in-space User set-point adjustment.
      - 2) Psychiatric patient room sensor: sensor shall be flush with wall, shall not include an override switch, numerical temperature display on sensor cover, shall not include a communication port and shall not allow in-space User set-point adjustment. Setpoint adjustment shall be only through the ECC or through the DDC system's diagnostic device/laptop. Provide a stainless steel cover plate with an insulated back and security screws.
    - d. Outdoor air temperature sensors shall have watertight inlet fittings and be shielded from direct sunlight.

- e. Room security sensors shall have stainless steel cover plate with insulated back and security screws.
  - f. Wire: Twisted, shielded-pair cable.
  - g. Output Signal: 4-20 ma.
- 2. Humidity Sensors: Bulk polymer sensing element type.
  - a. Duct and room sensors shall have a sensing range of 20 to 80 percent with accuracy of  $\pm 2$  to  $\pm 5$  percent RH, including hysteresis, linearity, and repeatability.
  - b. Outdoor humidity sensors shall be furnished with element guard and mounting plate and have a sensing range of 0 to 100 percent RH.
  - c. 4-20 ma continuous output signal.
- C. Static Pressure Sensors: Non-directional, temperature compensated.
  - 1. 4-20 ma output signal.
  - 2. 0 to 5 inches wg for duct static pressure range.
  - 3. 0 to 0.25 inch wg for Building static pressure range.
- D. Water flow sensors:
  - 1. Type: Insertion vortex type with retractable probe assembly and 2 inch full port gate valve.
    - a. Pipe size: 3 to 24 inches.
    - b. Retractor: ASME threaded, non-rising stem type with hand wheel.
    - c. Mounting connection: 2 inch 150 PSI flange.
    - d. Sensor assembly: Design for expected water flow and pipe size.
    - e. Seal: Teflon (PTFE).
  - 2. Controller:
    - a. Integral to unit.
    - b. Locally display flow rate and total.
    - c. Output flow signal to BMCS: Digital pulse type.
  - 3. Performance:
    - a. Turndown: 20:1
    - b. Response time: Adjustable from 1 to 100 seconds.
    - c. Power: 24 volt DC



4. Install flow meters according to manufacturer's recommendations. Where recommended by manufacturer because of mounting conditions, provide flow rectifier.
- E. Water Flow Sensors: shall be insertion turbine type with turbine element, retractor and preamplifier/transmitter mounted on a two-inch full port isolation valve; assembly easily removed or installed as a single unit under line pressure through the isolation valve without interference with process flow; calibrated scale shall allow precise positioning of the flow element to the required insertion depth within plus or minus 1 mm (0.05 inch); wetted parts shall be constructed of stainless steel. Operating power shall be nominal 24 VDC. Local instantaneous flow indicator shall be LED type in NEMA 4 enclosure with 3-1/2 digit display, for wall or panel mounting.
  1. Performance characteristics:
    - a. Ambient conditions: -40°C to 60°C (-40°F to 140°F), 5 to 100% humidity.
    - b. Operating conditions: 850 kPa (125 psig), 0°C to 120°C (30°F to 250°F), 0.15 to 12 m per second (0.5 to 40 feet per second) velocity.
    - c. Nominal range (turn down ratio): 10 to 1.
    - d. Preamplifier mounted on meter shall provide 4-20 ma divided pulse output or switch closure signal for units of volume or mass per a time base. Signal transmission distance shall be a minimum of 1,800 meters (6,000 feet). // Preamplifier for bi-directional flow measurement shall provide a directional contact closure from a relay mounted in the preamplifier //.
    - e. Pressure Loss: Maximum 1 percent of the line pressure in line sizes above 100 mm (4 inches).
    - f. Ambient temperature effects, less than 0.005 percent calibrated span per °C (°F) temperature change.
    - g. RFI effect - flow meter shall not be affected by RFI.
    - h. Power supply effect less than 0.02 percent of span for a variation of plus or minus 10 percent power supply.
- F. Flow switches:
  1. Shall be either paddle or differential pressure type.
    - a. Paddle-type switches (liquid service only) shall be UL Listed, SPDT snap-acting, adjustable sensitivity with NEMA 4 enclosure.
    - b. Differential pressure type switches (air or water service) shall be UL listed, SPDT snap acting, NEMA 4 enclosure, with scale range and differential suitable for specified application.
- G. Current Switches: Current operated switches shall be self powered, solid state with adjustable trip current as well as status, power, and relay command status LED indication. The switches shall be selected to match the current of the application and output requirements of the DDC systems.

## 2.12 CONTROL CABLES

### A. General:

1. Ground cable shields, drain conductors, and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments. Comply with Sections 27 05 26 and 26 05 26.
2. Cable conductors to provide protection against induction in circuits. Crosstalk attenuation within the System shall be in excess of -80 dB throughout the frequency ranges specified.
3. Minimize the radiation of RF noise generated by the System equipment so as not to interfere with any audio, video, data, computer main distribution frame (MDF), telephone customer service unit (CSU), and electronic private branch exchange (EPBX) equipment the System may service.
4. The as-installed drawings shall identify each cable as labeled, used cable, and bad cable pairs.
5. Label system's cables on each end. Test and certify cables in writing to the VA before conducting proof-of-performance testing. Minimum cable test requirements are for impedance compliance, inductance, capacitance, signal level compliance, opens, shorts, cross talk, noise, and distortion, and split pairs on all cables in the frequency ranges used. Make available all cable installation and test records at demonstration to the VA. All changes (used pair, failed pair, etc.) shall be posted in these records as the change occurs.
6. Power wiring shall not be run in conduit with communications trunk wiring or signal or control wiring operating at 100 volts or less.

### B. Analogue control cabling shall be not less than No. 18 AWG solid, with thermoplastic insulated conductors as specified in Section 26 05 21.

### C. Copper digital communication cable between the ECC and the B-BC and B-AAC controllers shall be 100BASE-TX Ethernet, Category 5e or 6, not less than minimum 24 American Wire Gauge (AWG) solid, Shielded Twisted Pair (STP) or Unshielded Twisted Pair (UTP), with thermoplastic insulated conductors, enclosed in a thermoplastic outer jacket, as specified in Section 27 15 00.

1. Other types of media commonly used within IEEE Std 802.3 LANs (e.g., 10Base-T and 10Base-2) shall be used only in cases to interconnect with existing media.

### D. Optical digital communication fiber, if used, shall be Multimode or Singlemode fiber, 62.5/125 micron for multimode or 10/125 micron for singlemode micron with SC or ST connectors as specified in TIA-568-C.1. Terminations, patch panels, and other hardware shall be compatible with the specified fiber and shall be as specified in Section 27 15 00. Fiber-optic cable shall be suitable for use with the 100Base-FX or the 100Base-SX standard (as applicable) as defined in IEEE Std 802.3.

## 2.13 THERMOSTATS AND HUMIDISTATS

- ### A. Room thermostats controlling unitary standalone heating and cooling devices not connected to the DDC system shall have three modes of operation (heating - null or dead band - cooling). Thermostats for patient bedrooms shall have capability of being adjusted to eliminate null or dead band. Wall mounted thermostats shall have polished or brushed aluminum finish, setpoint range and temperature display and external adjustment:

1. Electronic Thermostats: Solid-state, microprocessor based, programmable to daily, weekend, and holiday schedules.
  - a. Public Space Thermostat: Public space thermostat shall have a thermistor sensor and shall not have a visible means of set point adjustment. Adjustment shall be via the digital controller to which it is connected.
  - b. Patient Room Thermostats: thermistor with in-space User set point adjustment and an on-casing room temperature numerical temperature display.
  - c. Psychiatric Patient Room Sensors: Electronic duct sensor as noted under Article 2.4.
  - d. Battery replacement without program loss.
- B. Strap-on thermostats shall be enclosed in a dirt-and-moisture proof housing with fixed temperature switching point and single pole, double throw switch.
- C. Room Humidistats: Provide fully proportioning humidistat with adjustable throttling range for accuracy of settings and conservation. The humidistat shall have set point scales shown in percent of relative humidity located on the instrument. Systems showing moist/dry or high/low are not acceptable.

#### 2.14 FINAL CONTROL ELEMENTS AND OPERATORS

- A. Fail Safe Operation: Control valves and dampers shall provide "fail safe" operation in either the normally open or normally closed position as required for freeze, moisture, and smoke or fire protection.
- B. Power Operated Control Dampers (other than VAV Boxes): Factory fabricated, balanced type dampers. All modulating dampers shall be opposed blade type and gasketed. Blades for two-position, duct-mounted dampers shall be parallel, airfoil (streamlined) type for minimum noise generation and pressure drop.
  1. Leakage: Maximum leakage in closed position shall not exceed 7 L/S (15 CFMs) differential pressure for outside air and exhaust dampers and 200 L/S/ square meter (40 CFM/sq. ft.) at 50 mm (2 inches) differential pressure for other dampers.
  2. Frame shall be galvanized steel channel with seals as required to meet leakage criteria.
  3. Blades shall be galvanized steel or aluminum, 200 mm (8 inch) maximum width, with edges sealed as required.
  4. Bearing shall be nylon, bronze sleeve or ball type.
  5. Hardware shall be zinc-plated steel. Connected rods and linkage shall be non-slip. Working parts of joints shall be brass, bronze, nylon or stainless steel.
  6. Maximum air velocity and pressure drop through free area the dampers:
    - a. Smoke damper in air handling unit: 305 meter per minute (1000 fpm).
    - b. Duct mounted damper: 600 meter per minute (2000 fpm).
    - c. Maximum static pressure loss: 50 Pascal (0.20 inches water gage).

C. Smoke Dampers and Combination Fire/Smoke Dampers: Dampers and operators are specified in Section 23 31 00, HVAC DUCTS AND CASINGS. Control of these dampers is specified under this Section.

D. Control Valves:

1. Valves shall be rated for a minimum of 150 percent of system operating pressure at the valve location but not less than 900 kPa (125 psig).
2. Valves 50 mm (2 inches) and smaller shall be bronze body with threaded or flare connections.
3. Valves 60 mm (2 1/2 inches) and larger shall be bronze or iron body with flanged connections.
4. Brass or bronze seats except for valves controlling media above 100 degrees C (210 degrees F), which shall have stainless steel seats.
5. Flow characteristics:
  - a. Three way modulating valves shall be globe pattern. Position versus flow relation shall be linear relation for steam or equal percentage for water flow control.
  - b. Two-way modulating valves shall be globe pattern. Position versus flow relation shall be linear for steam and equal percentage for water flow control.
  - c. Two-way 2-position valves shall be ball, gate or butterfly type.
6. Maximum pressure drop:
  - a. Two position steam control: 20 percent of inlet gauge pressure.
  - b. Modulating Steam Control: 80 percent of inlet gauge pressure (acoustic velocity limitation).
  - c. Modulating water flow control, greater of 3 meters (10 feet) of water or the pressure drop through the apparatus.
7. Two position water valves shall be line size.

E. Damper and Valve Operators and Relays:

1. Electric operator shall provide full modulating control of dampers and valves. A linkage and pushrod shall be furnished for mounting the actuator on the damper frame internally in the duct or externally in the duct or externally on the duct wall, or shall be furnished with a direct-coupled design. Metal parts shall be aluminum, mill finish galvanized steel, or zinc plated steel or stainless steel. Provide actuator heads which allow for electrical conduit attachment. The motors shall have sufficient closure torque to allow for complete closure of valve or damper under pressure. Provide multiple motors as required to achieve sufficient close-off torque.
  - a. Minimum valve close-off pressure shall be equal to the system pump's dead-head pressure, minimum 50 psig for valves smaller than 4 inches.

2. Electronic damper operators: Metal parts shall be aluminum, mill finish galvanized steel, or zinc plated steel or stainless steel. Provide actuator heads which allow for electrical conduit attachment. The motors shall have sufficient closure torque to allow for complete closure of valve or damper under pressure. Provide multiple motors as required to achieve sufficient close-off torque.
  - a. VAV Box actuator shall be mounted on the damper axle or shall be of the air valve design, and shall provide complete modulating control of the damper. The motor shall have a closure torque of 35-inch pounds minimum with full torque applied at close off to attain minimum leakage.
3. See drawings for required control operation.

## 2.15 AIR FLOW CONTROL

- A. Airflow and static pressure shall be controlled via digital controllers with inputs from airflow control measuring stations and static pressure inputs as specified. Controller outputs shall be analog or pulse width modulating output signals. The controllers shall include the capability to control via simple proportional (P) control, proportional plus integral (PI), proportional plus integral plus derivative (PID), and on-off. The airflow control programs shall be factory-tested programs that are documented in the literature of the control manufacturer.
- B. Air Flow Measuring Station -- Electronic Thermal Type:
  1. Air Flow Sensor Probe:
    - a. Each air flow sensor shall contain two individual thermal sensing elements. One element shall determine the velocity of the air stream while the other element shall compensate for changes in temperature. Each thermal flow sensor and its associated control circuit and signal conditioning circuit shall be factory calibrated and be interchangeable to allow replacement of a sensor without recalibration of the entire flow station. The sensor in the array shall be located at the center of equal area segment of the duct and the number of sensors shall be adequate to accommodate the expected velocity profile and variation in flow and temperature. The airflow station shall be of the insertion type in which sensor support structures are inserted from the outside of the ducts to make up the complete electronic velocity array.
    - b. Thermal flow sensor shall be constructed of hermetically sealed thermistors or nickel chromium or reference grade platinum wire, wound over an epoxy, stainless steel or ceramic mandrel and coated with a material suitable for the conditions to be encountered. Each dual sensor shall be mounted in an extruded aluminum alloy strut.
  2. Air Flow Sensor Grid Array:
    - a. Each sensor grid shall consist of a lattice network of temperature sensors and linear integral controllers (ICs) situated inside an aluminum casing suitable for mounting in a duct. Each sensor shall be mounted within a strut facing downstream of the airflow and located so that it is protected on the upstream side. All wiring shall be encased (out of the air stream) to protect against mechanical damage.
    - b. The casing shall be made of welded aluminum of sufficient strength to prevent structural bending and bowing. Steel or iron composite shall not be acceptable in the casing material.

- c. Pressure drop through the flow station shall not exceed 4 Pascal (0.015" W.G.) at 1,000 meter per minute (3,000 FPM).

3. Electronics Panel:

- a. Electronics Panel shall consist of a surface mounted enclosure complete with solid-state microprocessor and software.
  - b. Electronics Panel shall be A/C powered 24 VAC and shall have the capability to transmit signals of 0-5 VDC, 0-10 VCD or 4-20 ma for use in control of the HVAC Systems. The electronic panel shall have the capability to accept user defined scaling parameters for all output signals.
  - c. Electronics Panel shall have the capability to digitally display airflow in CFM and temperature in degrees F. The displays shall be provided as an integral part of the electronics panel. The electronic panel shall have the capability to totalize the output flow in CFM for two or more systems, as required. A single output signal may be provided which will equal the sum of the systems totalized. Output signals shall be provided for temperature and airflow. Provide remote mounted air flow or temperature displays where indicated on the plans.
  - d. Electronics Panel shall have the following:
    - 1) Minimum of 12-bit A/D conversion.
    - 2) Field adjustable digital primary output offset and gain.
    - 3) Airflow analog output scaling of 100 to 10,000 FPM.
    - 4) Temperature analog output scaling from -45°C to 70°C (-50°F to 160°F).
    - 5) Analog output resolution (full scale output) of 0.025%.
  - e. All readings shall be in I.P. units.
4. Thermal flow sensors and its electronics shall be installed as per manufacturer's instructions. The probe sensor density shall be as follows:

| Probe Sensor Density |              |
|----------------------|--------------|
| Area (sq.ft.)        | Qty. Sensors |
| <=1                  | 2            |
| >1 to <4             | 4            |
| 4 to <8              | 6            |
| 8 to <12             | 8            |
| 12 to <16            | 12           |
| >=16                 | 16           |

- a. Complete installation shall not exhibit more than  $\pm 2.0\%$  error in airflow measurement output for variations in the angle of flow of up to 10 percent in any direction from its calibrated orientation. Repeatability of readings shall be within  $\pm 0.25\%$ .
- C. Static Pressure Measuring Station: shall consist of one or more static pressure sensors and transmitters along with relays or auxiliary devices as required for a complete functional system. The span of the transmitter shall not exceed two times the design static pressure at the point of measurement. The output of the transmitter shall be true representation of the input pressure with plus or minus 25 Pascal (0.1 inch) W.G. of the true input pressure:
  1. Static pressure sensors shall have the same requirements as Airflow Measuring Devices except that total pressure sensors are optional, and only multiple static pressure sensors positioned on an equal area basis connected to a network of headers are required.
  2. For systems with multiple major trunk supply ducts, furnish a static pressure transmitter for each trunk duct. The transmitter signal representing the lowest static pressure shall be selected and this shall be the input signal to the controller.
  3. The controller shall receive the static pressure transmitter signal and CU shall provide a control output signal to the supply fan capacity control device. The control mode shall be proportional plus integral (PI) (automatic reset) and where required shall also include derivative mode.
  4. In systems with multiple static pressure transmitters, provide a switch located near the fan discharge to prevent excessive pressure during abnormal operating conditions. High-limit switches shall be manually-reset.
- D. Constant Volume Control Systems shall consist of an air flow measuring station along with such relays and auxiliary devices as required to produce a complete functional system. The transmitter shall receive its air flow signal and static pressure signal from the flow measuring station and shall have a span not exceeding three times the design flow rate. The CU shall receive the transmitter signal and shall provide an output to the fan volume control device to maintain a constant flow rate. The CU shall provide proportional plus integral (PI) (automatic reset) control mode and where required also inverse derivative mode. Overall system accuracy shall be plus or minus the equivalent of 2 Pascal (0.008 inch) velocity pressure as measured by the flow station.
- E. Airflow Synchronization:
  1. Systems shall consist of an air flow measuring station for each supply and return duct, the CU and such relays, as required to provide a complete functional system that will maintain a constant flow rate difference between supply and return air to an accuracy of  $\pm 10\%$ . In systems where there is no suitable location for a flow measuring station that will sense total supply or return flow, provide multiple flow stations with a differential pressure transmitter for each station. Signals from the multiple transmitters shall be added through the CU such that the resultant signal is a true representation of total flow.
  2. The total flow signals from supply and return air shall be the input signals to the CU. This CU shall track the return air fan capacity in proportion to the supply air flow under all conditions.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

#### A. General:

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1. Examine project plans for control devices and equipment locations; and report any discrepancies, conflicts, or omissions to Resident Engineer for resolution before proceeding for installation.
2. Install equipment, piping, wiring /conduit parallel to or at right angles to building lines.
3. Install all equipment and piping in readily accessible locations. Do not run tubing and conduit concealed under insulation or inside ducts.
4. Mount control devices, tubing and conduit located on ducts and apparatus with external insulation on standoff support to avoid interference with insulation.
5. Provide sufficient slack and flexible connections to allow for vibration of piping and equipment.
6. Run tubing and wire connecting devices on or in control cabinets parallel with the sides of the cabinet neatly racked to permit tracing.
7. Install equipment level and plum.

**B. Electrical Wiring Installation:**

1. All wiring cabling shall be installed in conduits. Install conduits and wiring in accordance with Specification Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS. Conduits carrying control wiring and cabling shall be dedicated to the control wiring and cabling; these conduits shall not carry power wiring. Provide plastic end sleeves at all conduit terminations to protect wiring from burrs.
2. Install analog signal and communication cables in conduit and in accordance with Specification Section 26 05 21. Install digital communication cables in conduit and in accordance with Specification Section 27 15 00, Communications Horizontal Cabling.
3. Install conduit and wiring between operator workstation(s), digital controllers, electrical panels, indicating devices, instrumentation, miscellaneous alarm points, thermostats, and relays as shown on the drawings or as required under this section.
4. Install all electrical work required for a fully functional system and not shown on electrical plans or required by electrical specifications. Where low voltage (less than 50 volt) power is required, provide suitable Class B transformers.
5. Install all system components in accordance with local Building Code and National Electric Code.
  - a. Splices: Splices in shielded and coaxial cables shall consist of terminations and the use of shielded cable couplers. Terminations shall be in accessible locations. Cables shall be harnessed with cable ties.
  - b. Equipment: Fit all equipment contained in cabinets or panels with service loops, each loop being at least 300 mm (12 inches) long. Equipment for fiber optics system shall be rack mounted, as applicable, in ventilated, self-supporting, code gauge steel enclosure. Cables shall be supported for minimum sag.
  - c. Cable Runs: Keep cable runs as short as possible. Allow extra length for connecting to the terminal board. Do not bend flexible coaxial cables in a radius less than ten times the cable outside diameter.



- d. Use vinyl tape, sleeves, or grommets to protect cables from vibration at points where they pass around sharp corners, through walls, panel cabinets, etc.
  - 6. Conceal cables, except in mechanical rooms and areas where other conduits and piping are exposed.
  - 7. Permanently label or code each point of all field terminal strips to show the instrument or item served. Color-coded cable with cable diagrams may be used to accomplish cable identification.
  - 8. Grounding: ground electrical systems per manufacturer's written requirements for proper and safe operation.
- C. Install Sensors and Controls:
- 1. Temperature Sensors:
    - a. Install all sensors and instrumentation according to manufacturer's written instructions. Temperature sensor locations shall be readily accessible, permitting quick replacement and servicing of them without special skills and tools.
    - b. Calibrate sensors to accuracy specified, if not factory calibrated.
    - c. Use of sensors shall be limited to its duty, e.g., duct sensor shall not be used in lieu of room sensor.
    - d. Install room sensors permanently supported on wall frame. They shall be mounted at 1.5 meter (5.0 feet) above the finished floor.
    - e. Mount sensors rigidly and adequately for the environment within which the sensor operates. Separate extended-bulb sensors from contact with metal casings and coils using insulated standoffs.
    - f. Sensors used in mixing plenum, and hot and cold decks shall be of the averaging of type. Averaging sensors shall be installed in a serpentine manner horizontally across duct. Each bend shall be supported with a capillary clip.
    - g. All pipe mounted temperature sensors shall be installed in wells.
    - h. All wires attached to sensors shall be air sealed in their conduits or in the wall to stop air transmitted from other areas affecting sensor reading.
    - i. Permanently mark terminal blocks for identification. Protect all circuits to avoid interruption of service due to short-circuiting or other conditions. Line-protect all wiring that comes from external sources to the site from lightning and static electricity.
  - 2. Pressure Sensors:
    - a. Install duct static pressure sensor tips facing directly downstream of airflow.
    - b. Install high-pressure side of the differential switch between the pump discharge and the check valve.
    - c. Install snubbers and isolation valves on steam pressure sensing devices.

3. Actuators:

- a. Mount and link damper and valve actuators according to manufacturer's written instructions.
- b. Check operation of damper/actuator combination to confirm that actuator modulates damper smoothly throughout stroke to both open and closed position.
- c. Check operation of valve/actuator combination to confirm that actuator modulates valve smoothly in both open and closed position.

4. Flow Switches:

- a. Install flow switch according to manufacturer's written instructions.
- b. Mount flow switch a minimum of 5 pipe diameters up stream and 5 pipe diameters downstream or 600 mm (2 feet) whichever is greater, from fittings and other obstructions.
- c. Assure correct flow direction and alignment.
- d. Mount in horizontal piping-flow switch on top of the pipe.

D. Installation of network:

1. Ethernet:

- a. The network shall employ Ethernet LAN architecture, as defined by IEEE 802.3. The Network Interface shall be fully Internet Protocol (IP) compliant allowing connection to currently installed IEEE 802.3, Compliant Ethernet Networks.
  - b. The network shall directly support connectivity to a variety of cabling types. As a minimum provide the following connectivity: 100 Base TX (Category 5e cabling) for the communications between the ECC and the B-BC and the B-AAC controllers.
2. Third party interfaces: Contractor shall integrate real-time data from building systems by other trades and databases originating from other manufacturers as specified and required to make the system work as one system.

E. Installation of digital controllers and programming:

1. Provide a separate digital control panel for each major piece of equipment, such as air handling unit, chiller, pumping unit etc. Points used for control loop reset such as outdoor air, outdoor humidity, or space temperature could be located on any of the remote control units.
2. Provide sufficient internal memory for the specified control sequences and trend logging. There shall be a minimum of 25 percent of available memory free for future use.
3. System point names shall be modular in design, permitting easy operator interface without the use of a written point index.
4. Provide software programming for the applications intended for the systems specified, and adhere to the strategy algorithms provided.

5. Provide graphics for each piece of equipment and floor plan in the building. This includes each chiller, cooling tower, air handling unit, fan, terminal unit, boiler, pumping unit etc. These graphics shall show all points dynamically as specified in the point list.

### 3.2 SYSTEM VALIDATION AND DEMONSTRATION

- A. As part of final system acceptance, a system demonstration is required (see below). Prior to start of this demonstration, the contractor is to perform a complete validation of all aspects of the controls and instrumentation system.

- B. Validation

1. Prepare and submit for approval a validation test plan including test procedures for the performance verification tests. Test Plan shall address all specified functions of the ECC and all specified sequences of operation. Explain in detail actions and expected results used to demonstrate compliance with the requirements of this specification. Explain the method for simulating the necessary conditions of operation used to demonstrate performance of the system. Test plan shall include a test check list to be used by the Installer's agent to check and initial that each test has been successfully completed. Deliver test plan documentation for the performance verification tests to the owner's representative 30 days prior to start of performance verification tests. Provide draft copy of operation and maintenance manual with performance verification test.
2. After approval of the validation test plan, installer shall carry out all tests and procedures therein. Installer shall completely check out, calibrate, and test all connected hardware and software to insure that system performs in accordance with approved specifications and sequences of operation submitted. Installer shall complete and submit Test Check List.

- C. Demonstration

1. System operation and calibration to be demonstrated by the installer in the presence of the Architect or VA's representative on random samples of equipment as dictated by the Architect or VA's representative. Should random sampling indicate improper commissioning, the owner reserves the right to subsequently witness complete calibration of the system at no addition cost to the VA.
2. Demonstrate to authorities that all required safeties and life safety functions are fully functional and complete.
3. Make accessible, personnel to provide necessary adjustments and corrections to systems as directed by balancing agency.
4. Witnessed demonstration of ECC functions shall consist of:
  - a. Running each specified report.
  - b. Display and demonstrate each data entry to show site specific customizing capability. Demonstrate parameter changes.
  - c. Step through penetration tree, display all graphics, demonstrate dynamic update, and direct access to graphics.
  - d. Execute digital and analog commands in graphic mode.

- e. Demonstrate DDC loop precision and stability via trend logs of inputs and outputs (6 loops minimum).
- f. Demonstrate EMS performance via trend logs and command trace.
- g. Demonstrate scan, update, and alarm responsiveness.
- h. Demonstrate spreadsheet/curve plot software, and its integration with database.
- i. Demonstrate on-line user guide, and help function and mail facility.
- j. Demonstrate digital system configuration graphics with interactive upline and downline load, and demonstrate specified diagnostics.
- k. Demonstrate multitasking by showing dynamic curve plot, and graphic construction operating simultaneously via split screen.
- l. Demonstrate class programming with point options of beep duration, beep rate, alarm archiving, and color banding.

----- END -----

SECTION 232113  
HYDRONIC PIPING

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 pipe and fitting materials, joining methods, special-duty valves, and specialties for the following:
  - 1. Chilled-water piping.
  - 2. Makeup-water piping.
  - 3. Condensate-drain piping.
- B. Related Sections include the following:
  - 1. Division 23 Section "Hydronic Pumps" for pumps, motors, and accessories for hydronic piping.

1.3 DEFINITIONS

- A. PTFE: Polytetrafluoroethylene.
- B. RTRF: Reinforced thermosetting resin (fiberglass) fittings.
- C. RTRP: Reinforced thermosetting resin (fiberglass) pipe.

1.4 PERFORMANCE REQUIREMENTS

- A. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature:
  - 1. Chilled-Water Piping: 175 psig at 200 deg F.
  - 2. Makeup-Water Piping: 80 psig at 150 deg F.

1.5 SUBMITTALS

- A. Product Data: For each type of the following:

1. Valves. Include flow and pressure drop curves based on manufacturer's testing for calibrated-orifice balancing valves and automatic flow-control valves.
2. Air control devices.
3. Chemical treatment.
4. Hydronic specialties.

#### 1.6 QUALITY ASSURANCE

- A. Steel Support Welding: Qualify processes and operators according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX.
  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. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 01.

#### 1.7 EXTRA MATERIALS

- A. Water-Treatment Chemicals: Furnish enough chemicals for initial system startup and for preventive maintenance for one year from date of Substantial Completion.

### PART 2 - PRODUCTS

#### 2.1 COPPER TUBE AND FITTINGS

- A. Drawn-Temper Copper Tubing: ASTM B 88, Type L
- B. Wrought-Copper Fittings: ASME B16.22.
  1. Basis-of-Design Product: Subject to compliance with requirements, provide a comparable product by one of the following:
    - a. Anvil International, Inc.
    - b. S. P. Fittings; a division of Star Pipe Products.
    - c. Victaulic Company of America.
  2. Grooved-End Copper Fittings: ASTM B 75, copper tube or ASTM B 584, bronze casting.
  3. Grooved-End-Tube Couplings: Rigid pattern, unless otherwise indicated; gasketed fitting. Ductile-iron housing with keys matching pipe and fitting

grooves, prelubricated EPDM gasket rated for minimum 230 deg F for use with housing, and steel bolts and nuts.

- C. Wrought-Copper Unions: ASME B16.22.

## 2.2 STEEL PIPE AND FITTINGS

- A. Steel Pipe: ASTM A 53/A 53M, black steel with plain ends; type, grade, and wall thickness as indicated in Part 3 "Piping Applications" Article.
- B. Cast-Iron Pipe Flanges and Flanged Fittings: ASME B16.1, Classes 25, 125, and 250; raised ground face, and bolt holes spot faced as indicated in Part 3 "Piping Applications" Article.
- C. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
  - 1. Material Group: 1.1.
  - 2. End Connections: Butt welding.
  - 3. Facings: Raised face.
- D. Grooved Mechanical-Joint Fittings and Couplings:
  - 1. Basis-of-Design Product: Subject to compliance with requirements, provide a comparable product by one of the following:
    - a. Anvil International, Inc.
    - b. Central Sprinkler Company; a division of Tyco Fire & Building Products.
    - c. National Fittings, Inc.
    - d. S. P. Fittings; a division of Star Pipe Products.
    - e. Victaulic Company of America.
  - 2. Joint Fittings: ASTM A 536, Grade 65-45-12 ductile iron; ASTM A 47/A 47M, Grade 32510 malleable iron; ASTM A 53/A 53M, Type F, E, or S, Grade B fabricated steel; or ASTM A 106, Grade B steel fittings with grooves or shoulders constructed to accept grooved-end couplings; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.
  - 3. Couplings: Ductile- or malleable-iron housing and synthetic rubber gasket of central cavity pressure-responsive design; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.
- E. Steel Pipe Nipples: ASTM A 733, made of same materials and wall thicknesses as pipe in which they are installed.

## 2.3 JOINING MATERIALS

- A. 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.
- B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
- C. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for joining copper with copper; or BAg-1, silver alloy for joining copper with bronze or steel.
- D. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- E. Gasket Material: Thickness, material, and type suitable for fluid to be handled and working temperatures and pressures.

## 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:
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Capitol Manufacturing Company.
    - b. Central Plastics Company.
    - c. Hart Industries International, Inc.
    - d. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
    - e. Zurn Plumbing Products Group; AquaSpec Commercial Products Division.
  2. Factory-fabricated union assembly, for 250-psig minimum working pressure at 180 deg F.
- D. Dielectric Flanges:
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Capitol Manufacturing Company.
    - b. Central Plastics Company.
    - c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
  2. Factory-fabricated companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.



E. Dielectric-Flange Kits:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Advance Products & Systems, Inc.
  - b. Calpico, Inc.
  - c. Central Plastics Company.
  - d. Pipeline Seal and Insulator, Inc.
2. 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.
3. 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:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Calpico, Inc.
  - b. Lochinvar Corporation.
2. Galvanized-steel coupling with inert and noncorrosive thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.

G. Dielectric Nipples:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Perfection Corporation; a subsidiary of American Meter Company.
  - b. Precision Plumbing Products, Inc.
  - c. Sioux Chief Manufacturing Company, Inc.
  - d. Victaulic Company of America.
2. Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.

2.5 VALVES

- A. Gate, Globe, Check, Ball, and Butterfly Valves: Comply with requirements specified in Division 23 Section "General-Duty Valves for HVAC Piping."
- B. Automatic Temperature-Control Valves, Actuators, and Sensors: Comply with requirements specified in Division 23 Section "Instrumentation and Control for HVAC."
- C. Bronze, Calibrated-Orifice, Balancing Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Armstrong Pumps, Inc.
  - b. Bell & Gossett Domestic Pump; a division of ITT Industries.
  - c. Flow Design Inc.
  - d. Gerand Engineering Co.
  - e. Griswold Controls.
  - f. Taco.
2. Body: Bronze, ball or plug type with calibrated orifice or venturi.
3. Ball: Brass or stainless steel.
4. Plug: Resin.
5. Seat: PTFE.
6. End Connections: Threaded or socket.
7. Pressure Gage Connections: Integral seals for portable differential pressure meter.
8. Handle Style: Lever, with memory stop to retain set position.
9. CWP Rating: Minimum 125 psig.
10. Maximum Operating Temperature: 250 deg F.

D. Cast-Iron or Steel, Calibrated-Orifice, Balancing Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Armstrong Pumps, Inc.
  - b. Bell & Gossett Domestic Pump; a division of ITT Industries.
  - c. Flow Design Inc.
  - d. Gerand Engineering Co.
  - e. Griswold Controls.
  - f. Taco.
  - g. Tour & Andersson; available through Victaulic Company of America.
2. Body: Cast-iron or steel body, ball, plug, or globe pattern with calibrated orifice or venturi.
3. Ball: Brass or stainless steel.
4. Stem Seals: EPDM O-rings.
5. Disc: Glass and carbon-filled PTFE.
6. Seat: PTFE.
7. End Connections: Flanged or grooved.
8. Pressure Gage Connections: Integral seals for portable differential pressure meter.
9. Handle Style: Lever, with memory stop to retain set position.
10. CWP Rating: Minimum 125 psig.
11. Maximum Operating Temperature: 250 deg F.

E. Diaphragm-Operated, Pressure-Reducing Valves:

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

- a. Amtrol, Inc.
  - b. Armstrong Pumps, Inc.
  - c. Bell & Gossett Domestic Pump; a division of ITT Industries.
  - d. Conbraco Industries, Inc.
  - e. Spence Engineering Company, Inc.
  - f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
- 2. Body: Bronze or brass.
  - 3. Disc: Glass and carbon-filled PTFE.
  - 4. Seat: Brass.
  - 5. Stem Seals: EPDM O-rings.
  - 6. Diaphragm: EPT.
  - 7. Low inlet-pressure check valve.
  - 8. Inlet Strainer: stainless steel removable without system shutdown.
  - 9. Valve Seat and Stem: Noncorrosive.
  - 10. Valve Size, Capacity, and Operating Pressure: Selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.

F. Diaphragm-Operated Safety Valves:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Amtrol, Inc.
  - b. Armstrong Pumps, Inc.
  - c. Bell & Gossett Domestic Pump; a division of ITT Industries.
  - d. Conbraco Industries, Inc.
  - e. Spence Engineering Company, Inc.
  - f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
- 2. Body: Bronze or brass.
- 3. Disc: Glass and carbon-filled PTFE.
- 4. Seat: Brass.
- 5. Stem Seals: EPDM O-rings.
- 6. Diaphragm: EPT.
- 7. Wetted, Internal Work Parts: Brass and rubber.
- 8. Inlet Strainer: stainless steel removable without system shutdown.
- 9. Valve Seat and Stem: Noncorrosive.
- 10. Valve Size, Capacity, and Operating Pressure: Comply with ASME Boiler and Pressure Vessel Code: Section IV, and selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.

G. Automatic Flow-Control Valves:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Flow Design Inc.
  - b. Griswold Controls.
- 2. Body: Brass or ferrous metal.

3. Piston and Spring Assembly: Corrosion resistant, tamper proof, self cleaning, and removable.
4. Combination Assemblies: Include bronze or brass-alloy ball valve.
5. Identification Tag: Marked with zone identification, valve number, and flow rate.
6. Size: Same as pipe in which installed.
7. Performance: Maintain constant flow, plus or minus 5 percent over system pressure fluctuations.
8. Minimum CWP Rating 175 psig.
9. Maximum Operating Temperature: 200 deg F.

## 2.6 AIR CONTROL DEVICES

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  1. Amtrol, Inc.
  2. Armstrong Pumps, Inc.
  3. Bell & Gossett Domestic Pump; a division of ITT Industries.
  4. Taco.
- C. Manual Air Vents:
  1. Body: Bronze.
  2. Internal Parts: Nonferrous.
  3. Operator: Screwdriver or thumbscrew.
  4. Inlet Connection: NPS 1/2.
  5. Discharge Connection: NPS 1/8.
  6. CWP Rating: 150 psig.
  7. Maximum Operating Temperature: 225 deg F.
- D. Automatic Air Vents:
  1. Body: Bronze or cast iron.
  2. Internal Parts: Nonferrous.
  3. Operator: Noncorrosive metal float.
  4. Inlet Connection: NPS 1/2.
  5. Discharge Connection: NPS 1/4.
  6. CWP Rating: 150 psig.
  7. Maximum Operating Temperature: 240 deg F.
- E. Expansion Tanks:
  1. Tank: Welded steel, rated for 125-psig working pressure and 375 deg F maximum operating temperature, with taps in bottom of tank for tank fitting and taps in end of tank for gage glass. Tanks shall be factory tested with taps

fabricated and labeled according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

2. Air-Control Tank Fitting: Cast-iron body, copper-plated tube, brass vent tube plug, and stainless-steel ball check, 100-gal. unit only; sized for compression-tank diameter. Provide tank fittings for 125-psig working pressure and 250 deg F maximum operating temperature.
3. Tank Drain Fitting: Brass body, nonferrous internal parts; 125-psig working pressure and 240 deg F maximum operating temperature; constructed to admit air to compression tank, drain water, and close off system.
4. Gage Glass: Full height with dual manual shutoff valves, 3/4-inch diameter gage glass, and slotted-metal glass guard.

F. Bladder-Type Expansion Tanks:

1. Tank: Welded steel, rated for 125-psig working pressure and 375 deg F maximum operating temperature. Factory test with taps fabricated and supports installed and labeled according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
2. Bladder: Securely sealed into tank to separate air charge from system water to maintain required expansion capacity.
3. Air-Charge Fittings: Schrader valve, stainless steel with EPDM seats.

G. Tangential-Type Air Separators:

1. Tank: Welded steel; ASME constructed and labeled for 125-psig minimum working pressure and 375 deg F maximum operating temperature.
2. Air Collector Tube: Perforated stainless steel, constructed to direct released air into expansion tank.
3. Tangential Inlet and Outlet Connections: Threaded for NPS 2 and smaller; flanged connections for NPS 2-1/2 and larger.
4. Blowdown Connection: Threaded.
5. Size: Match system flow capacity.

H. Air Purgers:

1. Body: Cast iron with internal baffles that slow the water velocity to separate the air from solution and divert it to the vent for quick removal.
2. Maximum Working Pressure: 150 psig.
3. Maximum Operating Temperature: 250 deg F.

## 2.7 CHEMICAL TREATMENT

A. Bypass Chemical Feeder: Welded steel construction; 125-psig working pressure; 5-gal. capacity; with fill funnel and inlet, outlet, and drain valves.

1. Chemicals: Specially formulated, based on analysis of makeup water, to prevent accumulation of scale and corrosion in piping and connected equipment.

- B. Ethylene and Propylene Glycol: Industrial grade with corrosion inhibitors and environmental-stabilizer additives for mixing with water in systems indicated to contain antifreeze or glycol solutions.

## 2.8 HYDRONIC PIPING SPECIALTIES

### A. Y-Pattern Strainers:

1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
3. Strainer Screen: 40-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
4. CWP Rating: 125 psig.

### B. Basket Strainers:

1. Body: ASTM A 126, Class B, high-tensile cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
3. Strainer Screen: 60-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
4. CWP Rating: 125 psig.

### C. T-Pattern Strainers:

1. Body: Ductile or malleable iron with removable access coupling and end cap for strainer maintenance.
2. End Connections: Grooved ends.
3. Strainer Screen: 40-mesh startup strainer, and perforated stainless-steel basket with 57 percent free area.
4. CWP Rating: 750 psig.

### D. Stainless-Steel Bellow, Flexible Connectors:

1. Body: Stainless-steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket.
2. End Connections: Threaded or flanged to match equipment connected.
3. Performance: Capable of 3/4-inch misalignment.
4. CWP Rating: 150 psig.
5. Maximum Operating Temperature: 250 deg F.

### E. Spherical, Rubber, Flexible Connectors:

1. Body: Fiber-reinforced rubber body.
2. End Connections: Steel flanges drilled to align with Classes 150 and 300 steel flanges.
3. Performance: Capable of misalignment.

4. CWP Rating: 150 psig.
  5. Maximum Operating Temperature: 250 deg F.
- F. Expansion fittings are specified in Division 23 Section "Expansion Fittings and Loops for HVAC Piping."

## PART 3 - EXECUTION

### 3.1 PIPING APPLICATIONS

- A. Chilled-water piping, aboveground, NPS 2 and smaller, shall be the following:
1. Type L drawn-temper copper tubing, wrought-copper fittings, and brazed joints.
- B. Chilled-water piping, aboveground, NPS 2-1/2 and larger, shall be any of the following:
1. Type L, drawn-temper copper tubing, wrought-copper fittings, and brazed joints.
  2. Schedule 40 steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.
  3. Schedule 40 steel pipe; grooved, mechanical joint coupling and fittings; and grooved, mechanical joints.
- C. Makeup-water piping installed aboveground shall be the following:
1. Type L, drawn-temper copper tubing, wrought-copper fittings, and brazed joints.

### 3.2 VALVE APPLICATIONS

- A. Install shutoff-duty valves at each branch connection to supply mains, and at supply connection to each piece of equipment.
- B. Install balancing valves at each branch connection to return main.
- C. Install calibrated-orifice, balancing valves in the return pipe of each heating or cooling terminal.
- D. Install check valves at each pump discharge and elsewhere as required to control flow direction.
- E. Install pressure-reducing valves at makeup-water connection to regulate system fill pressure.

### 3.3 PIPING INSTALLATIONS

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicate piping locations and arrangements if such 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.

- B. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- C. 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.
- D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- E. Install piping to permit valve servicing.
- F. Install piping at indicated slopes.
- G. Install piping free of sags and bends.
- H. Install fittings for changes in direction and branch connections.
- I. Install piping to allow application of insulation.
- J. Select system components with pressure rating equal to or greater than system operating pressure.
- K. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.
- L. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.
- M. Install piping at a uniform grade of 0.2 percent upward in direction of flow.
- N. Reduce pipe sizes using eccentric reducer fitting installed with level side up.
- O. Install branch connections to mains using mechanically formed tee fittings in main pipe, with the branch connected to the bottom of the main pipe. For up-feed risers, connect the branch to the top of the main pipe.
- P. Install valves according to Division 23 Section "General-Duty Valves for HVAC Piping."
- Q. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.
- R. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.
- S. Install strainers on inlet side of each control valve, pressure-reducing valve, solenoid valve, in-line pump, and elsewhere as indicated. Install NPS 3/4 nipple and ball valve



in blowdown connection of strainers NPS 2 and larger. Match size of strainer blowoff connection for strainers smaller than NPS 2.

- T. Install expansion loops, expansion joints, anchors, and pipe alignment guides as specified in Division 23 Section "Expansion Fittings and Loops for HVAC Piping."
- U. Identify piping as specified in Division 23 Section "Identification for HVAC Piping and Equipment."

### 3.4 HANGERS AND SUPPORTS

- A. Hanger, support, and anchor devices are specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment." Comply with the following requirements for maximum spacing of supports.
- B. Seismic restraints are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."
- C. Install the following pipe attachments:
  - 1. Adjustable steel clevis hangers for individual horizontal piping less than 20 feet long.
  - 2. Adjustable roller hangers and spring hangers for individual horizontal piping 20 feet or longer.
  - 3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
  - 4. Spring hangers to support vertical runs.
  - 5. Provide copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.
  - 6. On plastic pipe, install pads or cushions on bearing surfaces to prevent hanger from scratching pipe.
- D. Install hangers for steel piping with the following maximum spacing and minimum rod sizes:
  - 1. NPS 3/4: Maximum span, 7 feet; minimum rod size, 3/8 inch.
  - 2. NPS 1: Maximum span, 7 feet; minimum rod size, 3/8 inch.
  - 3. NPS 1-1/4: Maximum span, 7 feet; minimum rod size, 3/8 inch.
  - 4. NPS 1-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
  - 5. NPS 2: Maximum span, 10 feet; minimum rod size, 3/8 inch.
  - 6. NPS 2-1/2: Maximum span, 11 feet; minimum rod size, 1/2 inch.
  - 7. NPS 3: Maximum span, 12 feet; minimum rod size, 1/2 inch.
  - 8. NPS 3-1/2: Maximum span, 13 feet; minimum rod size, 1/2 inch.
  - 9. NPS 4: Maximum span, 14 feet; minimum rod size, 5/8 inch.
  - 10. NPS 5: Maximum span, 16 feet; minimum rod size, 5/8 inch.
  - 11. NPS 6: Maximum span, 17 feet; minimum rod size, 3/4 inch.
  - 12. NPS 8: Maximum span, 19 feet; minimum rod size, 3/4 inch.
  - 13. NPS 10: Maximum span, 22 feet; minimum rod size, 7/8 inch.
  - 14. NPS 12: Maximum span, 23 feet; minimum rod size, 7/8 inch.
  - 15. NPS 14: Maximum span, 25 feet; minimum rod size, 1 inch.

16. NPS 16: Maximum span, 27 feet; minimum rod size, 1 inch.
  17. NPS 18: Maximum span, 28 feet; minimum rod size, 1 inch.
  18. NPS 20: Maximum span, 30 feet; minimum rod size, 1-1/4 inches.
- E. Install hangers for drawn-temper copper tubing with the following maximum spacing and minimum rod sizes:
1. NPS 3/4: Maximum span, 5 feet; minimum rod size, 3/8 inch.
  2. NPS 1: Maximum span, 6 feet; minimum rod size, 3/8 inch.
  3. NPS 1-1/4: Maximum span, 7 feet; minimum rod size, 3/8 inch.
  4. NPS 1-1/2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
  5. NPS 2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
  6. NPS 2-1/2: Maximum span, 9 feet; minimum rod size, 1/2 inch.
  7. NPS 3: Maximum span, 10 feet; minimum rod size, 1/2 inch.
- F. Support vertical runs at roof, at each floor, and at 10-foot intervals between floors.

### 3.5 PIPE 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. 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.
- E. 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.
- F. Welded Joints: Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.
- G. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
- H. Grooved Joints: Assemble joints with coupling and gasket, lubricant, and bolts. Cut or roll grooves in ends of pipe based on pipe and coupling manufacturer's written

instructions for pipe wall thickness. Use grooved-end fittings and rigid, grooved-end-pipe couplings.

### 3.6 HYDRONIC SPECIALTIES INSTALLATION

- A. Install tangential air separator in pump suction. Install blowdown piping with gate or full-port ball valve; extend full size to nearest floor drain.
- B. Install bypass chemical feeders in each hydronic system where indicated, in upright position with top of funnel not more than 48 inches above the floor. Install feeder in minimum NPS 3/4 bypass line, from main with full-size, full-port, ball valve in the main between bypass connections. Install NPS 3/4 pipe from chemical feeder drain, to nearest equipment drain and include a full-size, full-port, ball valve.
- C. Install expansion tanks above the air separator. Install tank fitting in tank bottom and charge tank. Use manual vent for initial fill to establish proper water level in tank.
  - 1. Install tank fittings that are shipped loose.
  - 2. Support tank from floor or structure above with sufficient strength to carry weight of tank, piping connections, fittings, plus tank full of water. Do not overload building components and structural members.
- D. Install expansion tanks on the floor. Vent and purge air from hydronic system, and ensure tank is properly charged with air to suit system Project requirements.

### 3.7 TERMINAL EQUIPMENT CONNECTIONS

- A. Sizes for supply and return piping connections shall be the same as or larger than equipment connections.
- B. Install control valves in accessible locations close to connected equipment.
- C. Install bypass piping with globe valve around control valve. If parallel control valves are installed, only one bypass is required.
- D. Install ports for pressure gages and thermometers at coil inlet and outlet connections according to Division 23 Section "Meters and Gages for HVAC Piping."

### 3.8 CHEMICAL TREATMENT

- A. General: All HVAC water piping systems shall be cleaned and treated as indicated below. Chemical compound identifications are from San Joaquin Chemicals, Inc. Equivalent formulations from Skasol may be submitted. Provide treatment as required to control scale, corrosion, biological fouling and foaming. Chemical treatments indicated below are general in nature. Actual formations, dosages and application shall be determined by analysis of the water to be treated with consideration for the type of treatment equipment and operating units. Initial cleaning, preparation and start-up shall be supervised by the water treatment company field service engineer.

B. Cleaning and Initial Preparations:

1. Initial Fill: As the first water is introduced, add not less than 10 gallons for each 1,000 gallons of contained water volume a liquid blend of alkaline detergent (SANASOLV6103) comprised of the following ingredients.
  - a. Soda Ash
  - b. Sodium Silicate Pentahydrate
  - c. Sodium Tri-Polyphosphate
  - d. Wetting Agent, Non-Ionic
2. Circulation: The above detergent shall be circulated for not less than 6 hours after which the system will be rapidly dumped with circulating pumps operating to provide maximum practical motion, and whenever possible, simultaneously adding or chasing with rinse water. In either case, the system shall be flushed until neutral to phenolphthalein. After flushing, all strainers shall be removed and cleaned.
3. Initial Treatment: As soon as possible after flushing, but in no case more than 24 hours later, and with clean water in the systems, introduce 500 to 1,000 parts per million of sodium nitrite (SANACOR 2301) and adjust Ph to 7.5-8.5. Maintain treatment concentration in all closed systems using bypass feeders. Introduce 250-500 parts per million SANACOR 2600 series inhibitor to open recirculating water systems. Allow this inhibitor to fall within control limits as recommended by the water treatment representative.

C. Certification Before Start-Up: Equipment shall not be started until the water has been cleaned and treated per the water treatment company's recommendations. The field service engineer shall prepare a letter and submit it to the Engineer indicating that all piping systems have been cleaned and treated and are ready to be put into operation.

D. Continuation of Supervision: Provide supervision of the water treatment program for a period of one year which shall consist of analysis of all systems treated and the submittal of a written report stating the current conditions and recommendations for maintaining optimal controls. This service shall be performed monthly.

E. Chemical Supply: Provide a 6-month supply of chemicals to maintain the following concentrations based on 10 hours operation per day, 7 days a week, at 75% capacity.

1. Chilled Closed System: Provide and maintain an excess nitrite concentration of 500-1,000 ppm by addition of SANACOR 2301.

F. Equipment and Accessories:

1. Bypass Feeder: Welded steel construction, rated at 175 psi working pressure. Capacity as indicated on drawings. 3"(min.) neck opening. Cast iron cap with Buna-N O-ring. 3/4" NPT fittings. 1/4" brass air vent in cap.
2. Controller: Controller shall continuously monitor the conductivity of a sample water stream via a remote sensor. As the conductivity rises above a set level, the controller shall signal a solenoid bleed valve to open and simultaneously signal a pump to introduce chemicals for treatment of the make-up water. The solenoid valve shall remain open until the conductivity drops to the set level. The

conductivity level shall be adjustable from 100-6,000 micromhos. Controller shall have operating mode indicator lights, connections for chemical pump, solenoid valve and conductivity sensor, and flange for wall mounting. Cambridge Scientific Industries, Hydac, Model E.

3. Chemical Pump: Positive displacement pump with variable stroke and frequency. 0.5-24 gpd. Acrylic head. Reinforced, thermoplastic housing. Provide foot valve with strainer and polyethylene tubing. Liquid Metronics, Inc., Model A-111.
4. Solenoid Bleed Valve: Normally closed, pilot operated, diaphragm valve. One inch pipe size. Griswold Controls, Model 4160.
5. Flow Control Valve: One-inch pipe size. Dole flow control valve.
6. Chemical Storage Tank: 10-gallon polyethylene chemical container.
7. Cooling Tower Float Valve: Griswold Controls, Model 4190. One-inch pipe size.

G. Installation: Install all equipment and accessories per the piping diagrams on drawings and the manufacturer's recommendations.

H. Fill systems indicated to have antifreeze or glycol solutions with the following concentrations:

1. Chilled-Water Piping: Minimum 10 percent ethylene glycol.

### 3.9 FIELD QUALITY CONTROL

A. Prepare hydronic piping according to ASME B31.9 and as follows:

1. Leave joints, including welds, uninsulated and exposed for examination during test.
2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
3. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.
4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
5. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.

B. Perform the following tests on hydronic piping:

1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.
3. Isolate expansion tanks and determine that hydronic system is full of water.
4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test.

Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times "SE" value in Appendix A in ASME B31.9, "Building Services Piping."

5. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
6. Prepare written report of testing.

C. Perform the following before operating the system:

1. Open manual valves fully.
2. Inspect pumps for proper rotation.
3. Set makeup pressure-reducing valves for required system pressure.
4. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
5. Set temperature controls so all coils are calling for full flow.
6. Inspect and set operating temperatures of hydronic equipment, such as boilers, chillers, cooling towers, to specified values.
7. Verify lubrication of motors and bearings.

END OF SECTION 232113

## SECTION 232123 HYDRONIC PUMPS

### 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. Separately coupled, base-mounted, end-suction centrifugal pumps.

#### 1.3 DEFINITIONS

- A. Buna-N: Nitrile rubber.
- B. EPT: Ethylene propylene terpolymer.

#### 1.4 SUBMITTALS

- A. Product Data: Include certified performance curves and rated capacities, operating characteristics, furnished specialties, final impeller dimensions, and accessories for each type of product indicated. Indicate pump's operating point on curves.
- B. Operation and Maintenance Data: For pumps to include in emergency, operation, and maintenance manuals.

#### 1.5 QUALITY ASSURANCE

- A. Source Limitations: Obtain hydronic pumps through one source from a single manufacturer.
- B. Product Options: Drawings indicate size, profiles, and dimensional requirements of hydronic pumps and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- D. UL Compliance: Comply with UL 778 for motor-operated water pumps.

## 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Manufacturer's Preparation for Shipping: Clean flanges and exposed machined metal surfaces and treat with anticorrosion compound after assembly and testing. Protect flanges, pipe openings, and nozzles with wooden flange covers or with screwed-in plugs.
- B. Store pumps in dry location.
- C. Retain protective covers for flanges and protective coatings during storage.
- D. Protect bearings and couplings against damage from sand, grit, and other foreign matter.
- E. Comply with pump manufacturer's written rigging instructions.

## 1.7 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.

## 1.8 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. Mechanical Seals: One mechanical seal(s) for each pump.

# 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 SEPARATELY COUPLED, BASE-MOUNTED, END-SUCTION CENTRIFUGAL PUMPS

- A. Available Manufacturers:
  - 1. Bell & Gossett; Div. of ITT Industries.
  - 2. Taco, Inc.



- B. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, separately coupled, end-suction pump as defined in Part 1.2; designed for base mounting, with pump and motor shafts horizontal. Rate pump for 125-psig minimum working pressure and a continuous water temperature 225 deg F.
- C. Pump Construction:
1. Casing: Radially split, cast iron, with replaceable bronze wear rings, threaded gage tappings at inlet and outlet, drain plug at bottom and air vent at top of volute, and flanged connections. Provide integral mount on volute to support the casing, and attached piping to allow removal and replacement of impeller without disconnecting piping or requiring the realignment of pump and motor shaft.
  2. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. Trim impeller to match specified performance.
  3. Pump Shaft: Steel, with copper-alloy shaft sleeve.
  4. Mechanical Seal: Carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N bellows and gasket.
  5. Packing Seal: Stuffing box, with a minimum of four rings of graphite-impregnated braided yarn with bronze lantern ring between center two graphite rings, and bronze packing gland.
  6. Pump Bearings: Grease-lubricated ball bearings contained in cast-iron housing with grease fittings.
- D. Shaft Coupling: Molded rubber insert and interlocking spider capable of absorbing vibration. Couplings shall be drop-out type to allow disassembly and removal without removing pump shaft or motor.
- E. Coupling Guard: Dual rated; ANSI B15.1, Section 8; OSHA 1910.219 approved; steel; removable; attached to mounting frame.
- F. Mounting Frame: Welded-steel frame and cross members, factory fabricated from ASTM A 36/A 36M channels and angles. Fabricate to mount pump casing, coupling guard, and motor.
- G. Motor: Single speed, with permanently lubricated ball bearings, unless otherwise indicated; secured to mounting frame, with adjustable alignment. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."
- H. Capacities and Characteristics:
1. As indicated on the Drawings

## 2.3 PUMP SPECIALTY FITTINGS

- A. Suction Diffuser: Angle pattern, 175 psig pressure rating, cast-iron body and end cap, pump-inlet fitting; with bronze startup and bronze or stainless-steel permanent strainers; bronze or stainless-steel straightening vanes; drain plug; and factory-fabricated support.

- B. Triple-Duty Valve: Angle or straight pattern, 175-psig pressure rating, cast-iron body, pump-discharge fitting; with drain plug and bronze-fitted shutoff, balancing, and check valve features. Brass gage ports with integral check valve, and orifice for flow measurement.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine equipment foundations and anchor-bolt locations for compliance with requirements for installation tolerances and other conditions affecting performance of work.
- B. Examine roughing-in for piping systems to verify actual locations of piping connections before pump installation.
- C. Examine foundations and inertia bases for suitable conditions where pumps are to be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PUMP INSTALLATION

- A. Install pumps with access for periodic maintenance including removal of motors, impellers, couplings, and accessories.
- B. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.
- C. Set base-mounted pumps on metal foundation. Disconnect coupling before setting. Do not reconnect couplings until alignment procedure is complete.
  - 1. Support pump baseplate on rectangular metal blocks and shims, or on metal wedges with small taper, at points near foundation bolts to provide a gap of 3/4 to 1-1/2 inches between pump base and foundation for grouting.
  - 2. Adjust metal supports or wedges until pump and driver shafts are level. Check coupling faces and suction and discharge flanges of pump to verify that they are level and plumb.

### 3.3 ALIGNMENT

- A. Align pump and motor shafts and piping connections after setting on foundation, foundation bolts have been tightened, and piping connections have been made.
- B. Comply with pump and coupling manufacturers' written instructions.

- C. After alignment is correct, tighten foundation bolts evenly but not too firmly. Completely fill baseplate with nonshrink, nonmetallic grout while metal blocks and shims or wedges are in place.

### 3.4 CONNECTIONS

- A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to machine to allow service and maintenance.
- C. Connect piping to pumps. Install valves that are same size as piping connected to pumps.
- D. Install suction and discharge pipe sizes equal to or greater than diameter of pump nozzles.
- E. Install check valve and throttling valve on discharge side of pumps.
- F. Install Y-type strainer and shutoff valve on suction side of pumps.
- G. Install flexible connectors on suction and discharge sides of base-mounted pumps between pump casing and valves.
- H. Install pressure gages on pump suction and discharge, at integral pressure-gage tapping, or install single gage with multiple input selector valve.
- I. Install check valve and gate or ball valve on each condensate pump unit discharge.
- J. Install electrical connections for power, controls, and devices.
- K. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- L. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

### 3.5 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
  - 1. Complete installation and startup checks according to manufacturer's written instructions.
  - 2. Check piping connections for tightness.
  - 3. Clean strainers on suction piping.
  - 4. Perform the following startup checks for each pump before starting:
    - a. Verify bearing lubrication.

- b. Verify that pump is free to rotate by hand and that pump for handling hot liquid is free to rotate with pump hot and cold. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.
  - c. Verify that pump is rotating in the correct direction.
- 5. Prime pump by opening suction valves and closing drains, and prepare pump for operation.
- 6. Start motor.
- 7. Open discharge valve slowly.

### 3.6 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain hydronic pumps. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION

## SECTION 233113

### METAL DUCTS

#### PART 1 - GENERAL

##### 1.1 SUMMARY

###### A. Section Includes:

1. Rectangular ducts and fittings.
2. Round ducts and fittings.
3. Sheet metal materials.
4. Sealants and gaskets.
5. Hangers and supports.
6. Seismic-restraint devices.

###### 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 "Air Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

##### 1.2 PERFORMANCE REQUIREMENTS

###### A. 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" and ASCE/SEI 7. 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.

###### B. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.

##### 1.3 SUBMITTALS

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

###### B. 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. Speakers.
  - d. Sprinklers.
  - e. Access panels.
  - f. Perimeter moldings.

C. Welding certificates.

#### 1.4 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum," for aluminum supports. 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. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1-2004, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-Up."
- D. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2004, Section 6.4.4 - "HVAC System Construction and Insulation."

### PART 2 - PRODUCTS

#### 2.1 RECTANGULAR DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.
- B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-4, "Transverse (Girth)

Joints," 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."

- C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-5, "Longitudinal Seams - Rectangular Ducts," 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."
- D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 2, "Fittings and Other Construction," 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 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. Spiral Manufacturing Co., Inc.
- B. 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.
- C. 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.
- D. 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."

## 2.3 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. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
  - 1. Galvanized Coating Designation: G60.
  - 2. Finishes for Surfaces Exposed to View: Mill phosphatized.
- C. 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.
- D. 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.
- E. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less.

## 2.4 DUCT LINER

- A. Fibrous-Glass Duct Liner: Comply with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."
  - 1. Manufacturers: Subject to compliance with requirements.
  - 2. Basis-of-Design Product: Subject to compliance with requirements, provide comparable product by one of the following:
    - a. CertainTeed Corporation; Insulation Group.
    - b. Johns Manville.
    - c. Knauf Insulation.
    - d. Owens Corning.
  - 3. Maximum Thermal Conductivity:
    - a. Type I, Flexible: 0.27 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
    - b. Type II, Rigid: 0.23 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.



4. Antimicrobial Erosion-Resistant Coating: Apply to the surface of the liner that will form the interior surface of the duct to act as a moisture repellent and erosion-resistant coating. Antimicrobial compound shall be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.
5. Solvent Based Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C 916.
  - a. For indoor applications, use adhesive that has a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Insulation Pins and Washers:

1. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
2. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick stainless steel; with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

C. Shop Application of Duct Liner: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-19, "Flexible Duct Liner Installation."

1. Adhere a single layer of indicated thickness of duct liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.
2. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.
3. Butt transverse joints without gaps, and coat joint with adhesive.
4. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.
5. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and dimensions of standard liner make longitudinal joints necessary.
6. Apply adhesive coating on longitudinal seams in ducts with air velocity of 2500 fpm.
7. Secure liner with mechanical fasteners 4 inches from corners and at intervals not exceeding 12 inches transversely; at 3 inches from transverse joints and at intervals not exceeding 18 inches longitudinally.
8. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or "Z" profiles or are integrally formed from duct wall. Fabricate edge facings at the following locations:
  - a. Fan discharges.
  - b. Intervals of lined duct preceding unlined duct.
  - c. Upstream edges of transverse joints in ducts where air velocities are higher than 2500 fpm or where indicated.
9. Secure insulation between perforated sheet metal inner duct of same thickness as specified for outer shell. Use mechanical fasteners that maintain inner duct at uniform distance from outer shell without compressing insulation.

- a. Sheet Metal Inner Duct Perforations: 3/32-inch diameter, with an overall open area of 23 percent.
- 10. Terminate inner ducts with buildouts attached to fire-damper sleeves, dampers, turning vane assemblies, or other devices. Fabricated buildouts (metal hat sections) or other buildout means are optional; when used, secure buildouts to duct walls with bolts, screws, rivets, or welds.

## 2.5 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. 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: 4-inches, 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.
- C. 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.
  - 6. For indoor applications, use sealant that has a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- D. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.
- E. 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 4-inch 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.

## 2.6 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.

## 2.7 SEISMIC-RESTRAINT DEVICES

- A. Manufacturers: Subject to compliance with requirements:
  - 1. Cooper B-Line, Inc.; a division of Cooper Industries.
  - 2. Mason Industries.
  - 3. TOLCO; a brand of NIBCO INC.
- B. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as defined in reports by.
  - 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: Steel tube or steel slotted-support-system sleeve with internally bolted connections 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 INSTALLATION OF EXPOSED DUCTWORK

- A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.
- B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.
- C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.
- D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.
- E. Repair or replace damaged sections and finished work that does not comply with these requirements.

### 3.3 DUCT SEALING

- A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- B. Seal ducts to the following seal classes according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":
  - 1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
  - 2. Outdoor, Supply-Air Ducts: Seal Class A.
  - 3. Outdoor, Exhaust Ducts: Seal Class C.
  - 4. Unconditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class B.
  - 5. Unconditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class A.
  - 6. Unconditioned Space, Exhaust Ducts: Seal Class C.
  - 7. Conditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class C.
  - 8. Conditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class B.
  - 9. Conditioned Space, Exhaust Ducts: Seal Class B.

### 3.4 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.

### 3.5 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 evaluation service member of the ICC Evaluation Service 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.

### 3.6 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.

### 3.7 DUCT CLEANING

- A. Clean new 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.

### 3.8 START UP

- A. Air Balance: Comply with requirements in Division 23 Section "Testing, Adjusting, and Balancing for HVAC."



### 3.9 DUCT SCHEDULE

- A. Fabricate ducts with galvanized sheet steel except as otherwise indicated and as follows:
  - 1. Operating Room Supply and Exhaust Ducts: Stainless Steel
- B. Supply Ducts:
  - 1. Ducts Connected to Constant-Volume Air-Handling Units
    - a. Pressure Class: Positive 2-inch wg.
    - b. Minimum SMACNA Seal Class: B.
    - c. SMACNA Leakage Class for Rectangular: 6.
    - d. SMACNA Leakage Class for Round and Flat Oval: 6.
  - 2. Ducts Connected to Equipment Not Listed Above:
    - a. Pressure Class: Positive 2-inch wg.
    - b. Minimum SMACNA Seal Class: B.
    - c. SMACNA Leakage Class for Rectangular: 3.
    - d. SMACNA Leakage Class for Round and Flat Oval: 3.
- C. Exhaust Ducts:
  - 1. Ducts Connected to Fans Exhausting (ASHRAE 62.1, Class 1 and 2) Air:
    - a. Pressure Class: Negative 3-inch wg.
    - b. Minimum SMACNA Seal Class: B if negative pressure, and A if positive pressure.
    - c. SMACNA Leakage Class for Rectangular: 12.
    - d. SMACNA Leakage Class for Round and Flat Oval: 12.
  - 2. Ducts Connected to Equipment Not Listed Above:
    - a. Pressure Class: Positive or negative 3-inch wg.
    - b. Minimum SMACNA Seal Class: B if negative pressure, and A if positive pressure.
    - c. SMACNA Leakage Class for Rectangular: 12.
    - d. SMACNA Leakage Class for Round and Flat Oval: 6.
- D. Intermediate Reinforcement:
  - 1. Galvanized-Steel Ducts: Galvanized steel.
  - 2. Stainless-Steel Ducts:
    - a. Exposed to Airstream: Match duct material.
    - b. Not Exposed to Airstream: Match duct material.

E. Elbow Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Elbows."
  - a. Velocity 1000 fpm or Lower:
    - 1) Radius Type RE 1 with minimum 0.5 radius-to-diameter ratio.
    - 2) Mitered Type RE 4 without vanes.
  - b. Velocity 1000 to 1500 fpm.
    - 1) Radius Type RE 1 with minimum 1.0 radius-to-diameter ratio.
    - 2) Radius Type RE 3 with minimum 0.5 radius-to-diameter ratio and two vanes.
    - 3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-3, "Vanes and Vane Runners," and Figure 2-4, "Vane Support in Elbows."
  - c. Velocity 1500 fpm or Higher:
    - 1) Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
    - 2) Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
    - 3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-3, "Vanes and Vane Runners," and Figure 2-4, "Vane Support in Elbows."
2. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Elbows."
  - a. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
  - b. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
  - c. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-3, "Vanes and Vane Runners," and Figure 2-4, "Vane Support in Elbows."
3. 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.
  - 4) Radius-to Diameter Ratio: 1.5.
- b. Round Elbows, 12 Inches and Smaller in Diameter: Stamped or pleated.
  - c. Round Elbows, 14 Inches and Larger in Diameter.

F. Branch Configuration:

- 1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-6, "Branch Connections."
  - a. Rectangular Main to Rectangular Branch: 45-degree entry.
  - b. Rectangular Main to Round Branch: Spin in.
- 2. Round: 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 233113

SECTION 233300  
AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Backdraft and pressure relief dampers.
2. Manual volume dampers.
3. Control dampers.
4. Fire dampers.
5. Smoke dampers.
6. Flange connectors.
7. Turning vanes.
8. Duct-mounted access doors.
9. Flexible connectors.
10. Flexible ducts.
11. Duct accessory hardware.

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Operation and maintenance data.

1.3 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. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.

1. Galvanized Coating Designation: G60 (Z180).
  2. Exposed-Surface Finish: Mill phosphatized.
- C. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304, and having a No. 2 finish for concealed ducts and finish for exposed ducts.
- 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, 6-mm minimum diameter for lengths 900 mm or less; 3/8-inch (10-mm) minimum diameter for lengths longer than 36 inches (900 mm).

## 2.2 BACKDRAFT AND PRESSURE RELIEF DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Air Balance Inc.; a division of Mestek, Inc.
  2. Cesco Products; a division of Mestek, Inc.
  3. Greenheck Fan Corporation.
  4. Ruskin Company.
- B. Description: Gravity balanced.
- C. Maximum Air Velocity: 3000 fpm (15 m/s).
- D. Maximum System Pressure: 2-inch wg (0.5 kPa).
- E. Frame: 0.052-inch- (1.3-mm-) thick, galvanized sheet steel 0.063-inch- (1.6-mm-) thick extruded aluminum.
- F. Blades: Multiple single-piece blades, center-pivoted, maximum 6-inch (150-mm) width, with sealed edges.
- G. Blade Action: Parallel.
- H. Blade Seals: Felt.
- I. Blade Axles:
1. Material: Galvanized steel.
  2. Diameter: 0.20 inch (5 mm).
- J. Tie Bars and Brackets: Galvanized steel.
- K. Return Spring: Adjustable tension.
- L. Bearings: Synthetic pivot bushings.
- M. Accessories:

1. Adjustment device to permit setting for varying differential static pressure.
2. Counterweights and spring-assist kits for vertical airflow installations.
3. 90-degree stops.

## 2.3 CONTROL DAMPERS

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

1. Ruskin Company.
2. Greenheck Fan Corporation.
3. McGill AirFlow LLC.

- B. Frames:

1. Hat or U or Angle shaped.
2. Stainless-steel channels, 0.064 inch (1.62 mm) thick.
3. Mitered and welded corners.

- C. Blades:

1. Multiple blade with maximum blade width of 8 inches (200 mm).
2. Opposed-blade design.
3. Stainless steel: 0.064 inch (1.62 mm) thick.
4. Blade Edging: Closed-cell neoprene edging.
5. Blade Edging: Inflatable seal blade edging, or replaceable rubber seals.

- D. Blade Axles: 1/2-inch- (13-mm-) diameter; stainless steel; blade-linkage hardware of zinc-plated steel and brass; ends sealed against blade bearings.

1. Operating Temperature Range: From minus 40 to plus 200 deg F (minus 40 to plus 93 deg C).

- E. Bearings:

1. Stainless-steel sleeve.
2. Dampers in ducts with pressure classes of 3-inch wg (750 Pa) or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
3. Thrust bearings at each end of every blade.

## 2.4 COMBINATION FIRE AND SMOKE DAMPERS

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

1. Air Balance Inc.; a division of Mestek, Inc.
2. Cesco Products; a division of Mestek, Inc.
3. Greenheck Fan Corporation.
4. Ruskin Company.

- B. Type: Static and dynamic; rated and labeled according to UL 555 and UL 555S by an NRTL.
- C. Closing rating in ducts up to 4-inch wg static pressure class and minimum 4000-fpm velocity.
- D. Fire Rating: 1-1/2 hours.
- E. Frame: Curtain type with blades inside airstream; fabricated with roll-formed, 0.034-inch-thick galvanized steel; with mitered and interlocking corners.
- F. Heat-Responsive Device: Replaceable, 165 deg F rated, fusible links.
- G. Heat-Responsive Device: Electric resettable link and switch package, factory installed, rated.
- H. Smoke Detector: Integral, factory wired for single-point connection.
- I. Frame: Curtain type with blades inside airstream; fabricated with roll-formed, 0.034-inch-thick galvanized steel; with mitered and interlocking corners.
- J. Blades: Roll-formed, horizontal, interlocking, 0.034-inch-thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch-thick, galvanized-steel blade connectors.
- K. Leakage: Class II.
- L. Rated pressure and velocity to exceed design airflow conditions.
- M. Mounting Sleeve: Factory-installed, 0.052-inch-thick, galvanized sheet steel; length to suit wall or floor application with factory-furnished silicone calking.
- N. Master control panel for use in dynamic smoke-management systems.
- O. Damper Motors: Two-position action.
- P. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."
  - 1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
  - 2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 23 Section "Instrumentation and Control for HVAC." Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.
  - 3. Spring-Return Motors: Equip with an integral spiral-spring mechanism where indicated. Enclose entire spring mechanism in a removable housing designed for service or adjustments. Size for running torque rating of 150 in. x lbf and breakaway torque rating of 150 in. x lbf.

4. Outdoor Motors and Motors in Outdoor-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 40 deg F.
5. Nonspring-Return Motors: For dampers larger than 25 sq. ft., size motor for running torque rating of 150 in. x lbf and breakaway torque rating of 300 in. x lbf.
6. Electrical Connection: 115 V, single phase, 60 Hz.

Q. Accessories:

1. Auxiliary switches for position indication.
2. Test and reset switches mounted.

## 2.5 FLANGE CONNECTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. Ductmate Industries, Inc.
  2. Nexus PDQ; Division of Shilco Holdings Inc.
  3. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Description: Add-on or roll-formed, factory-fabricated, slide-on transverse flange connectors, gaskets, and components.
- C. Material: Stainless steel.
- D. Gage and Shape: Match connecting ductwork.

## 2.6 TURNING VANES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. Ductmate Industries, Inc.
  2. Duro Dyne Inc.
  3. METALAIRE, Inc.
- B. Manufactured Turning Vanes for Metal Ducts: Curved blades of Stainless steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.
- C. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 2-3, "Vanes and Vane Runners," and 2-4, "Vane Support in Elbows."
- D. Vane Construction: Single wall for ducts up to 48 inches (1200 mm) wide and double wall for larger dimensions.



## 2.7 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. Greenheck Fan Corporation.
  - 5. McGill AirFlow LLC.
- 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. Stainless steel with insulation fill and thickness as indicated for duct pressure class.
    - c. Vision panel.
    - d. Hinges and Latches: 1-by-1-inch (25-by-25-mm) butt or piano hinge and cam latches.
    - e. Fabricate doors airtight and suitable for duct pressure class.
  - 2. Frame: Stainless steel, with bend-over tabs and foam gaskets.
  - 3. Number of Hinges and Locks:
    - a. Access Doors Less Than 12 Inches (300 mm) Square: No hinges and two sash locks.
    - b. Access Doors up to 18 Inches (460 mm) Square: Two hinges and two sash locks.
    - c. Access Doors up to 24 by 48 Inches (600 by 1200 mm): Three hinges and two compression latches with outside and inside handles.
    - d. Access Doors Larger Than 24 by 48 Inches (600 by 1200 mm): Four hinges and two compression latches with outside and inside handles.

## 2.8 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.
- B. Labeled according to UL 1978 by an NRTL.
- C. Panel and Frame: Minimum thickness 0.0528-inch (1.3-mm) 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 (1093 deg C).
- F. Minimum Pressure Rating: 10-inch wg (2500 Pa), positive or negative.

## 2.9 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.
- 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 3-1/2 inches (89 mm) wide attached to 2 strips of 2-3/4-inch- (70-mm-) wide, 0.028-inch- (0.7-mm-) thick, Stainless steel. 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. (880 g/sq. m).
  - 2. Tensile Strength: 480 lbf/inch (84 N/mm) in the warp and 360 lbf/inch (63 N/mm) in the filling.
  - 3. Service Temperature: Minus 40 to plus 200 deg F (Minus 40 to plus 93 deg C).
- F. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.
  - 1. Minimum Weight: 24 oz./sq. yd. (810 g/sq. m).
  - 2. Minimum Tensile Strength: 500 lbf/inch (88 N/mm) in the warp and 440 lbf/inch (77 N/mm) in the filling.
  - 3. Service Temperature: Minus 50 to plus 250 deg F (Minus 45 to plus 121 deg C).
- G. 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 (6-mm) movement at start and stop.

## 2.10 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. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.
  1. Install Stainless steel volume dampers in Stainless steel ducts.
- E. Set dampers to fully open position before testing, adjusting, and balancing.
- F. Install test holes at fan inlets and outlets and elsewhere as indicated.
- G. Install fire and smoke dampers according to UL listing.
- H. 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. Upstream from duct filters.

3. At outdoor-air intakes and mixed-air plenums.
  4. At drain pans and seals.
  5. Downstream from manual volume dampers, control dampers, backdraft dampers, and equipment.
  6. 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.
  7. At each change in direction and at maximum 50-foot (15-m) spacing.
  8. Upstream from turning vanes.
  9. Control devices requiring inspection.
  10. Elsewhere as indicated.
- I. Install access doors with swing against duct static pressure.
- J. Access Door Sizes:
1. One-Hand or Inspection Access: 8 by 5 inches (200 by 125 mm).
  2. Two-Hand Access: 12 by 6 inches (300 by 150 mm).
  3. Head and Hand Access: 18 by 10 inches (460 by 250 mm).
  4. Head and Shoulders Access: 21 by 14 inches (530 by 355 mm).
  5. Body Access: 25 by 14 inches (635 by 355 mm).
  6. Body plus Ladder Access: 25 by 17 inches (635 by 430 mm).
- K. Label access doors according to Division 23 Section "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.
- L. Install flexible connectors to connect ducts to equipment.
- M. For fans developing static pressures of 5-inch wg (1250 Pa) and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.
- N. Connect terminal units to supply ducts with maximum 12-inch (300-mm) lengths of flexible duct. Do not use flexible ducts to change directions.
- O. Connect diffusers or light troffer boots to ducts with maximum 60-inch (1500-mm) lengths of flexible duct clamped or strapped in place.
- P. Connect flexible ducts to metal ducts with adhesive plus sheet metal screws.
- Q. Install duct test holes where required for testing and balancing purposes.
- R. 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 (6-mm) 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 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.

END OF SECTION 233300

SECTION 233416  
CENTRIFUGAL HVAC FANS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
  - 1. Backward-inclined centrifugal fans.

1.2 SUBMITTALS

- A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated.
- B. Operation and maintenance data.

1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. 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 1.

PART 2 - PRODUCTS

2.1 BACKWARD-INCLINED CENTRIFUGAL FANS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Aerovent; a Twin City Fan Company.
  - 2. Greenheck Corporation.
  - 3. Loren Cook Company.
  - 4. New York Blower Company (The).
- B. Description: Factory-fabricated, -assembled, -tested, and -finished, belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor, drive assembly, and support structure.

- C. Housings: Formed panels to make curved-scroll housings with shaped cutoff; with doors or panels to allow access to internal parts and components.
  - 1. Panel Bracing: Steel angle- or channel-iron member supports for mounting and supporting fan scroll, wheel, motor, and accessories.
  - 2. Spun inlet cone with flange.
  - 3. Outlet flange.
- D. Backward-Inclined Wheels: Single-width-single-inlet construction with curved inlet flange, backplate, backward-inclined blades welded or riveted to flange and backplate; and fastened to shaft with set screws.
- E. Shafts: Statically and dynamically balanced and selected for continuous operation at maximum rated fan speed and motor horsepower, with final alignment and belt adjustment made after installation.
  - 1. Turned, ground, and polished hot-rolled steel with keyway. Ship with a protective coating of lubricating oil.
  - 2. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.
- F. Prelubricated and Sealed Shaft Bearings: Self-aligning, pillow-block-type ball bearings.
  - 1. Ball-Bearing Rating Life: ABMA 9, L10 at 100,000 hours.
- G. Belt Drives: Factory mounted, with final alignment and belt adjustment made after installation.
  - 1. Service Factor Based on Fan Motor Size: 1.5.
  - 2. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
  - 3. Motor Pulleys: Adjustable pitch for use with motors through 5 hp; fixed pitch for use with larger motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
  - 4. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
  - 5. Belt Guards: Fabricate to comply with OSHA and SMACNA requirements of diamond-mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short circuiting vibration isolation. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.
  - 6. Motor Mount: Adjustable for belt tensioning.
- H. Accessories:
  - 1. Scroll Access Doors: Shaped to conform to scroll, with quick-opening latches and gaskets.
  - 2. Scroll Drain Connection: NPS 1 steel pipe coupling welded to low point of fan scroll.
  - 3. Companion Flanges: Rolled flanges for duct connections of same material as housing.

4. Inlet Screens: Grid screen of same material as housing.
  5. Spark-Resistant Construction: AMCA 99.
  6. Shaft Seals: Airtight seals installed around shaft on drive side of single-width fans.
  7. Weather Cover: Enameled-steel sheet with ventilation slots, bolted to housing.
- I. Motors: Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."
1. Enclosure Type: Totally enclosed, fan cooled.

## 2.2 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 centrifugal fans level and plumb.
- B. Support floor-mounting units using base rails and having a static deflection of 1 inch.
- C. Install floor mounted unit on equipment platform as detailed.
- D. Install units with clearances for service and maintenance.
- E. Label fans 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 fans to allow service and maintenance.
- C. Install line-sized piping from scroll drain connection, with trap with seal equal to 1.5 times specified static pressure, to nearest floor drain.



- D. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- E. 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. Refer to Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing procedures.
  - 10. Remove and replace malfunctioning units and retest as specified above.
- B. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

END OF SECTION 233416

SECTION 233600  
AIR TERMINAL UNITS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
  - 1. Shutoff, single-duct air terminal units.

1.2 SUBMITTALS

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

1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1-2004, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-Up."

PART 2 - PRODUCTS

2.1 SHUTOFF, SINGLE-DUCT AIR TERMINAL UNITS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
  - 1. Environmental Technologies, Inc.
  - 2. Price Industries.
  - 3. Titus.
- B. Configuration: Volume-damper assembly inside unit casing with control components inside a protective metal shroud.
- C. Casing: **0.034-inch (0.85-mm)** steel double wall.
  - 1. Casing Lining: Adhesive attached, **3/4-inch- (19-mm)** thick, coated, fibrous-glass duct liner complying with ASTM C 1071, and having a maximum flame-spread index of 25 and a maximum smoke-developed index of 50, for both insulation and adhesive, when tested according to ASTM E 84.

- a. Cover liner with nonporous foil.
- 2. Air Inlet: Round stub connection or S-slip and drive connections for duct attachment.
- 3. Air Outlet: S-slip and drive connections.
- 4. Access: Removable panels for access to parts requiring service, adjustment, or maintenance; with airtight gasket.
- 5. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.
- D. Regulator Assembly: System-air-powered bellows section incorporating polypropylene bellows for volume regulation and thermostatic control. Bellows shall operate at temperatures from 0 to 140 deg F (minus 18 to plus 60 deg C), shall be impervious to moisture and fungus, shall be suitable for 10-inch wg (2500-Pa) static pressure, and shall be factory tested for leaks.
- E. Volume Damper: Galvanized steel with peripheral gasket and self-lubricating bearings.
  - 1. Maximum Damper Leakage: ARI 880 rated, 3 percent of nominal airflow at 3-inch wg (750-Pa) inlet static pressure.
  - 2. Damper Position: Normally open.
- F. Hydronic Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch (2.5 mm), and rated for a minimum working pressure of 200 psig (1380 kPa) and a maximum entering-water temperature of 220 deg F (104 deg C). Include manual air vent and drain valve.
- G. Direct Digital Controls: Single-package unitary controller and actuator specified in Division 23 Section "Instrumentation and Control for HVAC."

## 2.2 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. Air Terminal Unit Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
- D. Trapeze and Riser Supports: Steel shapes and plates for units with steel casings; aluminum for units with aluminum casings.

## 2.3 SOURCE QUALITY CONTROL

- A. Factory Tests: Test assembled air terminal units according to ARI 880.
  - 1. Label each air terminal unit with plan number, nominal airflow, maximum and minimum factory-set airflows, coil type, and ARI certification seal.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install air terminal units according to NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems."
- B. Install air terminal units level and plumb. Maintain sufficient clearance for normal service and maintenance.
- C. Install wall-mounted thermostats.

### 3.2 HANGER AND SUPPORT INSTALLATION

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Hangers and Supports."
- B. Hangers Exposed to View: Threaded rod and angle or channel supports.
- C. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

### 3.3 CONNECTIONS

- A. Install piping adjacent to air terminal unit to allow service and maintenance.
- B. Hot-Water Piping: In addition to requirements in Division 23 Section "Hydronic Piping," connect heating coils to supply with shutoff valve, strainer, control valve, and union or flange; and to return with balancing valve and union or flange.
- C. Connect ducts to air terminal units according to Division 23 Section "Metal Ducts."
- D. Make connections to air terminal units with flexible connectors complying with requirements in Division 23 Section "Air Duct Accessories."

### 3.4 IDENTIFICATION

- A. Label each air terminal unit with plan number, nominal airflow, and maximum and minimum factory-set airflows. Comply with requirements in Division 23 Section "Identification for HVAC Piping and Equipment" for equipment labels and warning signs and labels.

### 3.5 FIELD QUALITY CONTROL

- A. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:

1. After installing air terminal units and after electrical circuitry has been energized, test for compliance with requirements.
2. Leak Test: After installation, fill water coils and test for leaks. Repair leaks and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Air terminal unit will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

### 3.6 STARTUP SERVICE

A. Perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Verify that inlet duct connections are as recommended by air terminal unit manufacturer to achieve proper performance.
3. Verify that controls and control enclosure are accessible.
4. Verify that control connections are complete.
5. Verify that nameplate and identification tag are visible.
6. Verify that controls respond to inputs as specified.

END OF SECTION 233600

SECTION 236423  
SCROLL WATER CHILLERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes: Packaged, air-cooled, electric-motor-driven, scroll water chillers.

1.2 SUBMITTALS

- A. Product Data: Include refrigerant, rated capacities, operating characteristics, furnished specialties, and accessories.
- B. Operation and maintenance data.

1.3 QUALITY ASSURANCE

- A. ARI Certification: Certify chiller according to ARI 590 certification program.
- B. ARI Rating: Rate water chiller performance according to requirements in ARI 550/590, "Water Chilling Packages Using the Vapor Compression Cycle."
- C. ASHRAE Compliance: ASHRAE 15 for safety code for mechanical refrigeration.
- D. ASHRAE/IESNA 90.1-2004 Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2004, Section 6 - "Heating, Ventilating, and Air-Conditioning."
- E. ASME Compliance: Fabricate and stamp water chiller heat exchangers to comply with ASME Boiler and Pressure Vessel Code.
- F. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 PACKAGED AIR-COOLED WATER CHILLERS

- 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. Trane.
  - 2. York International Corporation.
  - 3. Or approved equal.

- B. Description: Factory-assembled and run-tested water chiller complete with base and frame, condenser casing, compressors, compressor motors and motor controllers, evaporator, condenser coils, condenser fans and motors, electrical power, controls, and accessories.
- C. Cabinet:
1. Base: Galvanized-steel base extending the perimeter of water chiller. Secure frame, compressors, and evaporator to base to provide a single-piece unit.
  2. Frame: Rigid galvanized-steel frame secured to base and designed to support cabinet, condenser, control panel, and other chiller components not directly supported from base.
  3. Casing: Galvanized steel.
  4. Finish: Coat base, frame, and casing with a corrosion-resistant coating capable of withstanding a 1000-hour salt-spray test according to ASTM B 117.
- D. Compressors:
1. Description: Positive-displacement direct drive with hermetically sealed casing.
  2. Each compressor provided with suction and discharge service valves, crankcase oil heater, and suction strainer.
  3. Operating Speed: Nominal 3600 rpm for 60-Hz applications.
  4. Oil Lubrication System: Automatic pump with strainer, sight glass, filling connection, filter with magnetic plug, and initial oil charge.
- E. Compressor Motors:
1. Hermetically sealed and cooled by refrigerant suction gas.
  2. High-torque, two-pole induction type with inherent thermal-overload protection on each phase.
- F. Compressor Motor Controllers:
1. Across the Line: NEMA ICS 2, Class A, full voltage, nonreversing.
- G. Refrigeration:
1. Refrigerant: R-410a. Classified as Safety Group A1 according to ASHRAE 34.
  2. Refrigerant Compatibility: Parts exposed to refrigerants shall be fully compatible with refrigerants, and pressure components shall be rated for refrigerant pressures.
  3. Refrigerant Circuit: Each circuit shall include a thermal-expansion valve, refrigerant charging connections, a hot-gas muffler, compressor suction and discharge shutoff valves, a liquid-line shutoff valve, a replaceable-core filter-dryer, a sight glass with moisture indicator, a liquid-line solenoid valve, and an insulated suction line.
- H. Evaporator:
1. Brazed-plate design, as indicated.

2. Brazed Plate:
  - a. Direct-expansion, single-pass, brazed-plate design.
  - b. Type 316 stainless-steel construction.
  - c. Code Compliance: Tested and stamped according to ASME Boiler and Pressure Vessel Code.
  - d. Fluid Nozzles: Terminate with mechanical-coupling end connections for connection to field piping.
3. Heater: Factory-installed and -wired electric heater with integral controls designed to protect the evaporator to **minus 20 deg F**.

I. Air-Cooled Condenser:

1. Plate-fin coil with integral subcooling on each circuit, rated at **650 psig**.
  - a. Construct coils of copper tubes mechanically bonded to aluminum fins.
  - b. Hail Protection: Provide condenser coils with louvers, baffles, or hoods to protect against hail damage.
2. Fans: Direct-drive propeller type with statically and dynamically balanced fan blades, arranged for vertical air discharge.
3. Fan Motors: Totally enclosed nonventilating (TENV) or totally enclosed air over (TEAO) enclosure, with permanently lubricated bearings, and having built-in overcurrent- and thermal-overload protection.
4. Fan Guards: Steel safety guards with corrosion-resistant coating.

J. Electrical Power:

1. Factory-installed and -wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point field power connection to water chiller.
2. House in a unit-mounted, NEMA 250, Type 3R enclosure with hinged access door with lock and key or padlock and key.
3. Wiring shall be numbered and color-coded to match wiring diagram.
4. Install factory wiring outside of an enclosure in a raceway.
5. Field power interface shall be to NEMA KS 1, heavy-duty, nonfused disconnect switch.
6. Provide branch power circuit to each motor and to controls with one of the following disconnecting means:
  - a. NEMA AB 1, motor-circuit protector (circuit breaker) with field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
7. Provide each motor with overcurrent protection.
8. Overload relay sized according to UL 1995, or an integral component of water chiller control microprocessor.
9. Phase-Failure and Undervoltage: Solid-state sensing with adjustable settings.
10. Transformer: Unit-mounted transformer with primary and secondary fuses and sized with enough capacity to operate electrical load plus spare capacity.



- a. Power unit-mounted controls where indicated.
- 11. Control Relays: Auxiliary and adjustable time-delay relays.
- 12. Indicate the following for water chiller electrical power supply:
  - a. Current, phase to phase, for all three phases.
  - b. Voltage, phase to phase and phase to neutral for all three phases.
  - c. Three-phase real power (kilowatts).
  - d. Three-phase reactive power (kilovolt amperes reactive).
  - e. Power factor.
  - f. Running log of total power versus time (kilowatt hours).
  - g. Fault log, with time and date of each.

K. Controls:

- 1. Stand-alone, microprocessor based.
- 2. Enclosure: Share enclosure with electrical power devices or provide a separate enclosure of matching construction.
- 3. Operator Interface: Keypad or pressure-sensitive touch screen. Multiple-character, backlit, liquid-crystal display or light-emitting diodes. Display the following:
  - a. Date and time.
  - b. Operating or alarm status.
  - c. Operating hours.
  - d. Outside-air temperature if required for chilled-water reset.
  - e. Temperature and pressure of operating set points.
  - f. Entering and leaving temperatures of chilled water.
  - g. Refrigerant pressures in evaporator and condenser.
  - h. Saturation temperature in evaporator and condenser.
  - i. No cooling load condition.
  - j. Elapsed time meter (compressor run status).
  - k. Pump status.
  - l. Antirecycling timer status.
  - m. Percent of maximum motor amperage.
  - n. Current-limit set point.
  - o. Number of compressor starts.
- 4. Control Functions:
  - a. Manual or automatic startup and shutdown time schedule.
  - b. Entering and leaving chilled-water temperatures, control set points, and motor load limit. Chilled-water leaving temperature shall be reset based on return-water temperature.
  - c. Current limit and demand limit.
  - d. External water chiller emergency stop.
  - e. Antirecycling timer.
  - f. Automatic lead-lag switching.
- 5. Manual-Reset Safety Controls: The following conditions shall shut down water chiller and require manual reset:

- a. Low evaporator pressure or high condenser pressure.
- b. Low chilled-water temperature.
- c. Refrigerant high pressure.
- d. High or low oil pressure.
- e. High oil temperature.
- f. Loss of chilled-water flow.
- g. Control device failure.

L. Insulation:

- 1. Material: Closed-cell, flexible elastomeric, thermal insulation complying with ASTM C 534, Type I, for tubular materials and Type II, for sheet materials.
- 2. Thickness: **3/4 inch**.
- 3. Apply protective coating to exposed surfaces of insulation.

M. Accessories:

- 1. Factory-furnished, chilled- and condenser-water flow switches for field installation.
- 2. Individual compressor suction and discharge pressure gages with shutoff valves for each refrigeration circuit.

N. Capacities and Characteristics:

- 1. As indicated on Drawings.

## 2.2 SOURCE QUALITY CONTROL

- A. Perform functional test of water chillers before shipping.
- B. Factory test and inspect evaporator according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1. Stamp with ASME label.
- C. For water chillers located outdoors, rate sound power level according to ARI 370 procedure.

## PART 3 - EXECUTION

### 3.1 WATER CHILLER INSTALLATION

- A. Install water chillers on support structure indicated.
- B. Equipment Mounting: Install water chiller on concrete bases.
  - 1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on **18-inch** centers around the full perimeter of concrete base.
  - 2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.

3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  4. Install anchor bolts to elevations required for proper attachment to supported equipment.
- C. Maintain manufacturer's recommended clearances for service and maintenance.
  - D. Charge water chiller with refrigerant if not factory charged and fill with oil if not factory installed.
  - E. Install separate devices furnished by manufacturer and not factory installed.

### 3.2 CONNECTIONS

- A. Comply with requirements in Division 23 Section "Hydronic Piping" Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to chiller to allow service and maintenance.
- C. Evaporator Fluid Connections: Connect to evaporator inlet with shutoff valve, strainer, flexible connector, thermometer, and plugged tee with pressure gage. Connect to evaporator outlet with shutoff valve, balancing valve, flexible connector, flow switch, thermometer, plugged tee with pressure gage, flow meter, and drain connection with valve. Make connections to water chiller with a union, flange, or mechanical coupling.
- D. Connect each drain connection with a union and drain pipe and extend pipe, full size of connection, to floor drain. Provide a shutoff valve at each connection if required.

### 3.3 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
- B. Inspect field-assembled components, equipment installation, and piping and electrical connections for proper assemblies, installations, and connections.
- C. Complete installation and startup checks according to manufacturer's written instructions and perform the following:
  1. Verify that refrigerant charge is sufficient and water chiller has been leak tested.
  2. Verify that pumps are installed and functional.
  3. Verify that thermometers and gages are installed.
  4. Operate water chiller for run-in period.
  5. Check bearing lubrication and oil levels.
  6. Verify proper motor rotation.
  7. Verify static deflection of vibration isolators, including deflection during water chiller startup and shutdown.
  8. Verify and record performance of chilled-water flow and low-temperature interlocks.
  9. Verify and record performance of water chiller protection devices.

10. Test and adjust controls and safeties. Replace damaged or malfunctioning controls and equipment.
- D. Prepare a written startup report that records results of tests and inspections.

END OF SECTION 236423

## SECTION 238413

### HUMIDIFIERS

#### PART 1 - GENERAL

##### 1.1 SUMMARY

- A. This Section includes self-contained humidifiers.

##### 1.2 SUBMITTALS

- A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories.
- B. Operation and maintenance data.

##### 1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with ARI 640, "Commercial and Industrial Humidifiers."

#### PART 2 - PRODUCTS

##### 2.1 SELF-CONTAINED HUMIDIFIERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Armstrong International, Inc.
  - 2. Carel USA, LLC.
  - 3. Nortec Industries Inc.
- B. Electric-Resistance Heater Container: Cleanable, ASTM A 666, Type 304 stainless steel. Comply with UL 499.
- C. Electrode Cylinder: Replaceable plastic assembly. Comply with UL 499.
- D. Cabinet: Sheet metal enclosure for housing heater cylinder, electrical wiring, components, controls, and control panel. Enclosure shall include baked-enamel finish,

hinged or removable access door, and threaded outlet in bottom of cabinet for drain piping.

E. Control Panel:

1. Factory-wired disconnect switch.
2. Liquid-crystal display.
3. Programmable keyboard.
4. Set-point adjustment.
5. Warning signal indicating end of replaceable cylinder[ **or ionic bed insert**] life.
6. Low-voltage, control circuit.
7. Diagnostic, maintenance, alarm, and status features.
8. High-water sensor to prevent overfilling.

F. Controls:

1. Microprocessor-based control system for modulating or cycling control, and start/stop and status monitoring for interface to central HVAC instrumentation and controls.
2. Solenoid-fill and automatic drain valves to maintain water level and temper hot drain water.
3. Field-adjustable timer to control drain cycle for flush duration and interval.
4. Controls shall drain tanks if no demand for humidification for more than 72 hours.
5. Conductivity-type level controls.

G. Accessories:

1. Humidistat: Wall-mounting, solid-state, electronic-sensor controller capable of full modulation or cycling control.
2. Duct-mounting, high-limit humidistat.
3. Airflow switch for preventing humidifier operation without airflow.

H. Capacities and Characteristics:

1. Humidification Rate: 33.0lb/h.
2. Maximum Absorption Distance: 36 inches.
3. Minimum Makeup Water Supply Pressure: 30 psi.
4. Electric-Resistance Heater Container or Electrode Cylinder:
  - a. Power Input per Container or Cylinder: 11.2 kilowatts.
  - b. Number of Containers or Cylinders: 1.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install humidifiers with required clearance for service and maintenance. Maintain path, downstream from humidifiers, clear of obstructions as required by ASHRAE 62.1-2004.

- B. Seal humidifier manifold duct or plenum penetrations with flange.
- C. Install humidifier manifolds in metal ducts and casings constructed according to SMACNA's "HVAC Duct Construction Standards, Metal and Flexible."
- D. Install stainless-steel drain pan under each manifold mounted in duct.
  - 1. Construct drain pans with connection for drain; insulated and complying with ASHRAE 62.1-2004.
  - 2. Connect to condensate trap and drainage piping.
  - 3. Extend drain pan upstream and downstream from manifold a minimum distance recommended by manufacturer but not less than required by ASHRAE 62.1-2004.
- E. Install manifold supply piping pitched to drain condensate back to humidifier.
- F. Piping installation requirements are per Manufacturer's recommendations. Drawings indicate general arrangement of piping, fittings, and specialties.
  - 1. Install piping adjacent to humidifiers to allow service and maintenance.
  - 2. Install shutoff valve, strainer, backflow preventer, and union in humidifier makeup line.
- G. Install electrical devices and piping specialties furnished by manufacturer but not factory mounted.
- H. Install piping from safety relief valves to nearest floor drain.
- I. Ground equipment according to Division 26.
- J. Connect wiring according to Division 26.

### 3.2 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
- B. Tests and Inspections:
  - 1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
  - 2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
  - 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Remove and replace malfunctioning units and retest as specified above.

### 3.3 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain humidifiers. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 238413



SECTION 260511  
REQUIREMENTS FOR ELECTRICAL INSTALLATIONS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section applies to all sections of Division 26.
- B. Furnish and install electrical systems, materials, equipment, and accessories in accordance with the specifications and drawings. Capacities and ratings of motors, transformers, conductors and cable, switchboards, switchgear, panelboards, motor control centers, generators, automatic transfer switches, and other items and arrangements for the specified items are shown on the drawings.
- C. Electrical service entrance equipment and arrangements for temporary and permanent connections to the electric utility company's system shall conform to the electric utility company's requirements. Coordinate fuses, circuit breakers and relays with the electric utility company's system, and obtain electric utility company approval for sizes and settings of these devices.
- D. Conductor ampacities specified or shown on the drawings are based on copper conductors, with the conduit and raceways sized per NEC. Aluminum conductors are prohibited.

1.2 MINIMUM REQUIREMENTS

- A. The International Building Code (IBC), National Electrical Code (NEC), Underwriters Laboratories, Inc. (UL), and National Fire Protection Association (NFPA) codes and standards are the minimum requirements for materials and installation.
- B. The drawings and specifications shall govern in those instances where requirements are greater than those stated in the above codes and standards.

1.3 TEST STANDARDS

- A. All materials and equipment shall be listed, labeled, or certified by a Nationally Recognized Testing Laboratory (NRTL) to meet Underwriters Laboratories, Inc. (UL), standards where test standards have been established. Materials and equipment which are not covered by UL standards will be accepted, providing that materials and equipment are listed, labeled, certified or otherwise determined to meet the safety requirements of a NRTL. Materials and equipment which no NRTL accepts, certifies, lists, labels, or determines to be safe, will be considered if inspected or tested in accordance with national industrial standards, such as ANSI, NEMA, and NETA. Evidence of compliance shall include certified test reports and definitive shop drawings.
- B. Definitions:

1. Listed: Materials and equipment included in a list published by an organization that is acceptable to the Authority Having Jurisdiction and concerned with evaluation of products or services, that maintains periodic inspection of production or listed materials and equipment or periodic evaluation of services, and whose listing states that the materials and equipment either meets appropriate designated standards or has been tested and found suitable for a specified purpose.
2. Labeled: Materials and equipment to which has been attached a label, symbol, or other identifying mark of an organization that is acceptable to the Authority Having Jurisdiction and concerned with product evaluation, that maintains periodic inspection of production of labeled materials and equipment, and by whose labeling the manufacturer indicates compliance with appropriate standards or performance in a specified manner.
3. Certified: Materials and equipment which:
  - a. Have been tested and found by a NRTL to meet nationally recognized standards or to be safe for use in a specified manner.
  - b. Are periodically inspected by a NRTL.
  - c. Bear a label, tag, or other record of certification.
4. Nationally Recognized Testing Laboratory: Testing laboratory which is recognized and approved by the Secretary of Labor in accordance with OSHA regulations.

#### 1.4 QUALIFICATIONS (PRODUCTS AND SERVICES)

- A. Manufacturer's Qualifications: The manufacturer shall regularly and currently produce, as one of the manufacturer's principal products, the materials and equipment specified for this project, and shall have manufactured the materials and equipment for at least three years.
- B. Product Qualification:
  1. Manufacturer's materials and equipment shall have been in satisfactory operation, on three installations of similar size and type as this project, for at least three years.
  2. The Government reserves the right to require the Contractor to submit a list of installations where the materials and equipment have been in operation before approval.
  3. Service Qualifications: There shall be a permanent service organization maintained or trained by the manufacturer which will render satisfactory service to this installation within four hours of receipt of notification that service is needed. Submit name and address of service organizations.

#### 1.5 APPLICABLE PUBLICATIONS

- A. Applicable publications listed in all Sections of Division 26 are the latest issue, unless otherwise noted.

- B. Products specified in all sections of Division 26 shall comply with the applicable publications listed in each section.

#### 1.6 MANUFACTURED PRODUCTS

- A. Materials and equipment furnished shall be of current production by manufacturers regularly engaged in the manufacture of such items, and for which replacement parts shall be available.
- B. When more than one unit of the same class or type of materials and equipment is required, such units shall be the product of a single manufacturer.
- C. Equipment Assemblies and Components:
  - 1. Components of an assembled unit need not be products of the same manufacturer.
  - 2. Manufacturers of equipment assemblies, which include components made by others, shall assume complete responsibility for the final assembled unit.
  - 3. Components shall be compatible with each other and with the total assembly for the intended service.
  - 4. Constituent parts which are similar shall be the product of a single manufacturer.
- D. Factory wiring and terminals shall be identified on the equipment being furnished and on all wiring diagrams.
- E. When Factory Testing Is Specified:
  - 1. The Government shall have the option of witnessing factory tests. The Contractor shall notify the Government through the //Resident Engineer// //COTR// a minimum of 15 working days prior to the manufacturer's performing the factory tests.
  - 2. Four copies of certified test reports shall be furnished to the //Resident Engineer// //COTR// two weeks prior to final inspection and not more than 90 days after completion of the tests.
  - 3. When materials and equipment fail factory tests, and re-testing and re-inspection is required, the Contractor shall be liable for all additional expenses for the Government to witness re-testing.

#### 1.7 VARIATIONS FROM CONTRACT REQUIREMENTS

- A. Where the Government or the Contractor requests variations from the contract requirements, the connecting work and related components shall include, but not be limited to additions or changes to branch circuits, circuit protective devices, conduits, wire, feeders, controls, panels and installation methods.

## 1.8 MATERIALS AND EQUIPMENT PROTECTION

- A. Materials and equipment shall be protected during shipment and storage against physical damage, vermin, dirt, corrosive substances, fumes, moisture, cold and rain.
  - 1. Store materials and equipment indoors in clean dry space with uniform temperature to prevent condensation.
  - 2. During installation, equipment shall be protected against entry of foreign matter, and be vacuum-cleaned both inside and outside before testing and operating. Compressed air shall not be used to clean equipment. Remove loose packing and flammable materials from inside equipment.
  - 3. Damaged equipment shall be repaired or replaced, as determined by the //Resident Engineer// //COTR//.
  - 4. Painted surfaces shall be protected with factory installed removable heavy kraft paper, sheet vinyl or equal.
  - 5. Damaged paint on equipment shall be refinished with the same quality of paint and workmanship as used by the manufacturer so repaired areas are not obvious.

## 1.9 WORK PERFORMANCE

- A. All electrical work shall comply with the requirements of NFPA 70 (NEC), NFPA 70B, NFPA 70E, OSHA Part 1910 subpart J – General Environmental Controls, OSHA Part 1910 subpart K – Medical and First Aid, and OSHA Part 1910 subpart S – Electrical, in addition to other references required by contract.
- B. Job site safety and worker safety is the responsibility of the Contractor.
- C. Electrical work shall be accomplished with all affected circuits or equipment de-energized. When an electrical outage cannot be accomplished in this manner for the required work, the following requirements are mandatory:
  - 1. Electricians must use full protective equipment (i.e., certified and tested insulating material to cover exposed energized electrical components, certified and tested insulated tools, etc.) while working on energized systems in accordance with NFPA 70E.
  - 2. Before initiating any work, a job specific work plan must be developed by the Contractor with a peer review conducted and documented by the //Resident Engineer// //COTR// and Medical Center staff. The work plan must include procedures to be used on and near the live electrical equipment, barriers to be installed, safety equipment to be used, and exit pathways.
  - 3. Work on energized circuits or equipment cannot begin until prior written approval is obtained from the //Resident Engineer// //COTR//.
- D. For work that affects existing electrical systems, arrange, phase and perform work to assure minimal interference with normal functioning of the facility. Refer to Article OPERATIONS AND STORAGE AREAS under Section 010000, GENERAL REQUIREMENTS.

- E. New work shall be installed and connected to existing work neatly, safely and professionally. Disturbed or damaged work shall be replaced or repaired to its prior conditions, as required by Section 010000, GENERAL REQUIREMENTS.
- F. Coordinate location of equipment and conduit with other trades to minimize interference.

#### 1.10 EQUIPMENT INSTALLATION AND REQUIREMENTS

- A. Equipment location shall be as close as practical to locations shown on the drawings.
- B. Working clearances shall not be less than specified in the NEC.
- C. Inaccessible Equipment:
  - 1. Where the Government determines that the Contractor has installed equipment not readily accessible for operation and maintenance, the equipment shall be removed and reinstalled as directed at no additional cost to the Government.
  - 2. "Readily accessible" is defined as being capable of being reached quickly for operation, maintenance, or inspections without the use of ladders, or without climbing or crawling under or over obstacles such as, but not limited to, motors, pumps, belt guards, transformers, piping, ductwork, conduit and raceways.

#### 1.11 EQUIPMENT IDENTIFICATION

- A. In addition to the requirements of the NEC, install an identification sign which clearly indicates information required for use and maintenance of items such as switchboards and switchgear, panelboards, cabinets, motor controllers, fused and non-fused safety switches, generators, automatic transfer switches, separately enclosed circuit breakers, individual breakers and controllers in switchboards, switchgear and motor control assemblies, control devices and other significant equipment.
- B. Identification signs for Normal Power System equipment shall be laminated black phenolic resin with a white core with engraved lettering. Identification signs for Essential Electrical System (EES) equipment, as defined in the NEC, shall be laminated red phenolic resin with a white core with engraved lettering. Lettering shall be a minimum of 12 mm (1/2 inch) high. Identification signs shall indicate equipment designation, rated bus amperage, voltage, number of phases, number of wires, and type of EES power branch as applicable. Secure nameplates with screws.
- C. Install adhesive arc flash warning labels on all equipment as required by NFPA 70E. Label shall indicate the arc hazard boundary (inches), working distance (inches), arc flash incident energy at the working distance (calories/cm<sup>2</sup>), required PPE category and description including the glove rating, voltage rating of the equipment, limited approach distance (inches), restricted approach distance (inches), prohibited approach distance (inches), equipment/bus name, date prepared, and manufacturer name and address.

## 1.12 SUBMITTALS

- A. Submit to the //Resident Engineer// //COTR// in accordance with Section 013323, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. The Government's approval shall be obtained for all materials and equipment before delivery to the job site. Delivery, storage or installation of materials and equipment which has not had prior approval will not be permitted.
- C. All submittals shall include six copies of adequate descriptive literature, catalog cuts, shop drawings, test reports, certifications, samples, and other data necessary for the Government to ascertain that the proposed materials and equipment comply with drawing and specification requirements. Catalog cuts submitted for approval shall be legible and clearly identify specific materials and equipment being submitted.
- D. Submittals for individual systems and equipment assemblies which consist of more than one item or component shall be made for the system or assembly as a whole. Partial submittals will not be considered for approval.
  - 1. Mark the submittals, "SUBMITTED UNDER SECTION\_\_\_\_\_".
  - 2. Submittals shall be marked to show specification reference including the section and paragraph numbers.
  - 3. Submit each section separately.
- E. The submittals shall include the following:
  - 1. Information that confirms compliance with contract requirements. Include the manufacturer's name, model or catalog numbers, catalog information, technical data sheets, shop drawings, manuals, pictures, nameplate data, and test reports as required.
  - 2. Submittals are required for all equipment anchors and supports. Submittals shall include weights, dimensions, center of gravity, standard connections, manufacturer's recommendations and behavior problems (e.g., vibration, thermal expansion, etc.) associated with equipment or piping so that the proposed installation can be properly reviewed. Include sufficient fabrication information so that appropriate mounting and securing provisions may be designed and attached to the equipment.//
  - 3. Elementary and interconnection wiring diagrams for communication and signal systems, control systems, and equipment assemblies. All terminal points and wiring shall be identified on wiring diagrams.
  - 4. Parts list which shall include information for replacement parts and ordering instructions, as recommended by the equipment manufacturer.
- F. Maintenance and Operation Manuals:
  - 1. Submit as required for systems and equipment specified in the technical sections. Furnish in hardcover binders or an approved equivalent.
  - 2. Inscribe the following identification on the cover: the words "MAINTENANCE AND OPERATION MANUAL," the name and location of the system, material, equipment, building, name of Contractor, and contract name and number. Include in the manual the names, addresses, and telephone numbers of each

subcontractor installing the system or equipment and the local representatives for the material or equipment.

3. Provide a table of contents and assemble the manual to conform to the table of contents, with tab sheets placed before instructions covering the subject. The instructions shall be legible and easily read, with large sheets of drawings folded in.
4. The manuals shall include:
  - a. Internal and interconnecting wiring and control diagrams with data to explain detailed operation and control of the equipment.
  - b. A control sequence describing start-up, operation, and shutdown.
  - c. Description of the function of each principal item of equipment.
  - d. Installation instructions.
  - e. Safety precautions for operation and maintenance.
  - f. Diagrams and illustrations.
  - g. Periodic maintenance and testing procedures and frequencies, including replacement parts numbers.
  - h. Performance data.
  - i. Pictorial "exploded" parts list with part numbers. Emphasis shall be placed on the use of special tools and instruments. The list shall indicate sources of supply, recommended spare and replacement parts, and name of servicing organization.
  - j. List of factory approved or qualified permanent servicing organizations for equipment repair and periodic testing and maintenance, including addresses and factory certification qualifications.

G. Approvals will be based on complete submission of shop drawings, manuals, test reports, certifications, and samples as applicable.

H. After approval and prior to installation, furnish the //Resident Engineer// //COTR// with one sample of each of the following:

1. A minimum 300 mm (12 inches) length of each type and size of wire and cable along with the tag from the coils or reels from which the sample was taken. The length of the sample shall be sufficient to show all markings provided by the manufacturer.
2. Each type of conduit coupling, bushing, and termination fitting.
3. Conduit hangers, clamps, and supports.
4. Duct sealing compound.
5. Each type of receptacle, toggle switch, lighting control sensor, outlet box, manual motor starter, device wall plate, engraved nameplate, wire and cable splicing and terminating material, and branch circuit single pole molded case circuit breaker.

#### 1.13 SINGULAR NUMBER

- A. Where any device or part of equipment is referred to in these specifications in the singular number (e.g., "the switch"), this reference shall be deemed to apply to as many such devices as are required to complete the installation as shown on the drawings.

#### 1.14 ACCEPTANCE CHECKS AND TESTS

- A. The Contractor shall furnish the instruments, materials, and labor for tests.
- B. Where systems are comprised of components specified in more than one section of Division 26, the Contractor shall coordinate the installation, testing, and adjustment of all components between various manufacturer's representatives and technicians so that a complete, functional, and operational system is delivered to the Government.
- C. When test results indicate any defects, the Contractor shall repair or replace the defective materials or equipment, and repeat the tests. Repair, replacement, and retesting shall be accomplished at no additional cost to the Government.

#### 1.15 WARRANTY

- A. All work performed and all equipment and material furnished under this Division shall be free from defects and shall remain so for a period of one year from the date of acceptance of the entire installation by the Contracting Officer for the Government.

#### 1.16 INSTRUCTION

- A. Instruction to designated Government personnel shall be provided for the particular equipment or system as required in each associated technical specification section.
- B. Furnish the services of competent instructors to give full instruction in the adjustment, operation, and maintenance of the specified equipment and system, including pertinent safety requirements. Instructors shall be thoroughly familiar with all aspects of the installation, and shall be trained in operating theory as well as practical operation and maintenance procedures.
- C. A training schedule shall be developed and submitted by the Contractor and approved by the //Resident Engineer// //COTR// at least 30 days prior to the planned training.

#### PART 2 - PRODUCTS (NOT USED)

#### PART 3 - EXECUTION (NOT USED)

END OF SECTION



SECTION 260519  
LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section specifies the furnishing, installation, connection, and testing of the electrical conductors and cables for use in electrical systems rated 600 V and below, indicated as cable(s), conductor(s), wire, or wiring in this section.

1.2 RELATED WORK

- A. Section 078400, FIRESTOPPING: Sealing around penetrations to maintain the integrity of fire-resistant rated construction.
- B. Section 260511, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: Requirements that apply to all sections of Division 26.
- C. Section 260526, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS: Requirements for personnel safety and to provide a low impedance path for possible ground fault currents.
- D. Section 260533, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS: Conduits for conductors and cables.

1.3 QUALITY ASSURANCE

- A. Refer to Paragraph, QUALIFICATIONS (PRODUCTS AND SERVICES), in Section 260511, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1.4 FACTORY TESTS

- A. Conductors and cables shall be thoroughly tested at the factory per NEMA to ensure that there are no electrical defects. Factory tests shall be certified.

1.5 SUBMITTALS

- A. Submit six copies of the following in accordance with Section 260511, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.
  - 1. Shop Drawings:
    - a. Submit sufficient information to demonstrate compliance with drawings and specifications.

- b. Submit the following data for approval:
    - 1) Electrical ratings and insulation type for each conductor and cable.
    - 2) Splicing materials and pulling lubricant.
- 2. Certifications: Two weeks prior to final inspection, submit the following.
  - a. Certification by the manufacturer that the conductors and cables conform to the requirements of the drawings and specifications.
  - b. Certification by the Contractor that the conductors and cables have been properly installed, adjusted, and tested.

## 1.6 APPLICABLE PUBLICATIONS

- A. Publications listed below (including amendments, addenda, revisions, supplements and errata) form a part of this specification to the extent referenced. Publications are reference in the text by designation only.
- B. American Society of Testing Material (ASTM):
  - D2301-10 Standard Specification for Vinyl Chloride Plastic Pressure-Sensitive Electrical Insulating Tape
  - D2304-10 Test Method for Thermal Endurance of Rigid Electrical Insulating Materials
  - D3005-10 Low-Temperature Resistant Vinyl Chloride Plastic Pressure-Sensitive Electrical Insulating Tape
- C. National Electrical Manufacturers Association (NEMA):
  - WC 70-09 Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy
- D. National Fire Protection Association (NFPA):
  - 70-11 National Electrical Code (NEC)
- E. Underwriters Laboratories, Inc. (UL):
  - 44-10 Thermoset-Insulated Wires and Cables
  - 83-08 Thermoplastic-Insulated Wires and Cables
  - 467-07 Grounding and Bonding Equipment
  - 486A-486B-03 Wire Connectors
  - 486C-04 Splicing Wire Connectors
  - 486D-05 Sealed Wire Connector Systems
  - 486E-09 Equipment Wiring Terminals for Use with Aluminum and/or Copper Conductors
  - 493-07 Thermoplastic-Insulated Underground Feeder and Branch Circuit Cables
  - 514B-04 Conduit, Tubing, and Cable Fittings

## PART 2 - PRODUCTS

### 2.1 CONDUCTORS AND CABLES

- A. Conductors and cables shall be in accordance with NEMA, UL, as specified herein, and as shown on the drawings.
- B. All conductors shall be copper.
- C. Single Conductor and Cable:
- No. 12 AWG: Minimum size, except where smaller sizes are specified herein or shown on the drawings.
  - No. 8 AWG and larger: Stranded.
  - No. 10 AWG and smaller: Solid; except shall be stranded for final connection to motors, transformers, and vibrating equipment.
  - Insulation: THHN-THWN and XHHW-2. XHHW-2 shall be used for isolated power systems.
- D. Color Code:
- No. 10 AWG and smaller: Solid color insulation or solid color coating.
  - No. 8 AWG and larger: Color-coded using one of the following methods:
    - Solid color insulation or solid color coating.
    - Stripes, bands, or hash marks of color specified.
    - Color using 19 mm (0.75 inches) wide tape.
  - For modifications and additions to existing wiring systems, color coding shall conform to the existing wiring system.
  - Conductors shall be color-coded as follows:

| 208/120 V  | Phase   | 480/277 V |
|--|---------|-----------|
| Black  | A       | Brown     |
| Red  | B       | Orange    |
| Blue   | C       | Yellow    |
| White  | Neutral | Gray *    |
| * or white with colored (other than green) tracer. |         |           |

- Lighting circuit "switch legs", and 3-way and 4-way switch "traveling wires," shall have color coding that is unique and distinct (e.g., pink and purple) from the color coding indicated above. The unique color codes shall be solid and in accordance with the NEC. Coordinate color coding in the field with the //Resident Engineer// //COTR//.
- Color code for isolated power system wiring shall be in accordance with the NEC.

### 2.2 SPLICES

- A. Splices shall be in accordance with NEC and UL.

B. Above Ground Splices for No. 10 AWG and Smaller:

1. Solderless, screw-on, reusable pressure cable type, with integral insulation, approved for copper and aluminum conductors.
2. The integral insulator shall have a skirt to completely cover the stripped conductors.
3. The number, size, and combination of conductors used with the connector, as listed on the manufacturer's packaging, shall be strictly followed.

C. Above Ground Splices for No. 8 AWG to No. 4/0 AWG:

1. Compression, hex screw, or bolt clamp-type of high conductivity and corrosion-resistant material, listed for use with copper and aluminum conductors.
2. Insulate with materials approved for the particular use, location, voltage, and temperature. Insulation level shall be not less than the insulation level of the conductors being joined.
3. Splice and insulation shall be product of the same manufacturer.
4. All bolts, nuts, and washers used with splices shall be //zinc-plated//cadmium-plated// steel.

D. Above Ground Splices for 250 kcmil and Larger:

1. Long barrel "butt-splice" or "sleeve" type compression connectors, with minimum of two compression indents per wire, listed for use with copper and aluminum conductors.
2. Insulate with materials approved for the particular use, location, voltage, and temperature. Insulation level shall be not less than the insulation level of the conductors being joined.
3. Splice and insulation shall be product of the same manufacturer.

E. Plastic electrical insulating tape: Per ASTM D2304, flame-retardant, cold and weather resistant.

## 2.3 CONNECTORS AND TERMINATIONS

- A. Mechanical type of high conductivity and corrosion-resistant material, listed for use with copper and aluminum conductors.
- B. Long barrel compression type of high conductivity and corrosion-resistant material, with minimum of two compression indents per wire, listed for use with copper and aluminum conductors.
- C. All bolts, nuts, and washers used to connect connections and terminations to bus bars or other termination points shall be //zinc-plated//cadmium-plated// steel.

## 2.4 CONTROL WIRING

- A. Unless otherwise specified elsewhere in these specifications, control wiring shall be as specified herein, except that the minimum size shall be not less than No. 14 AWG.

- B. Control wiring shall be sized such that the voltage drop under in-rush conditions does not adversely affect operation of the controls.

## 2.5 WIRE LUBRICATING COMPOUND

- A. Lubricating compound shall be suitable for the wire insulation and conduit, and shall not harden or become adhesive.
- B. Shall not be used on conductors for isolated power systems.

## PART 3 - EXECUTION

### 3.1 GENERAL

- A. Install conductors in accordance with the NEC, as specified, and as shown on the drawings.
- B. Install all conductors in raceway systems.
- C. Splice conductors only in outlet boxes, junction boxes, pullboxes, manholes, or handholes.
- D. Conductors of different systems (e.g., 120 V and 277 V) shall not be installed in the same raceway.
- E. Install cable supports for all vertical feeders in accordance with the NEC. Provide split wedge type which firmly clamps each individual cable and tightens due to cable weight.
- F. In panelboards, cabinets, wireways, switches, enclosures, and equipment assemblies, neatly form, train, and tie the conductors with non-metallic ties.
- G. For connections to motors, transformers, and vibrating equipment, stranded conductors shall be used only from the last fixed point of connection to the motors, transformers, or vibrating equipment.
- H. Use expanding foam or non-hardening duct-seal to seal conduits entering a building, after installation of conductors.
- I. Conductor and Cable Pulling:
  - 1. Provide installation equipment that will prevent the cutting or abrasion of insulation during pulling. Use lubricants approved for the cable.
  - 2. Use nonmetallic pull ropes.
  - 3. Attach pull ropes by means of either woven basket grips or pulling eyes attached directly to the conductors.
  - 4. All conductors in a single conduit shall be pulled simultaneously.
  - 5. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

- J. No more than three branch circuits shall be installed in any one conduit.
- K. When stripping stranded conductors, use a tool that does not damage the conductor or remove conductor strands.

### 3.2 SPLICE AND TERMINATION INSTALLATION

- A. Splices and terminations shall be mechanically and electrically secure, and tightened to manufacturer's published torque values using a torque screwdriver or wrench.
- B. Where the Government determines that unsatisfactory splices or terminations have been installed, replace the splices or terminations at no additional cost to the Government.

### 3.3 CONDUCTOR IDENTIFICATION

- A. When using colored tape to identify phase, neutral, and ground conductors larger than No. 8 AWG, apply tape in half-overlapping turns for a minimum of 75 mm (3 inches) from terminal points, and in junction boxes, pullboxes, and manholes. Apply the last two laps of tape with no tension to prevent possible unwinding. Where cable markings are covered by tape, apply tags to cable, stating size and insulation type.

### 3.4 FEEDER CONDUCTOR IDENTIFICATION

- A. In each interior pullbox and each underground manhole and handhole, install brass tags on all feeder conductors to clearly designate their circuit identification and voltage. The tags shall be the embossed type, 40 mm (1-1/2 inches) in diameter and 40 mils thick. Attach tags with plastic ties.

### 3.5 EXISTING CONDUCTORS

- A. Unless specifically indicated on the plans, existing conductors shall not be reused.

### 3.6 ACCEPTANCE CHECKS AND TESTS

- A. Perform in accordance with the manufacturer's recommendations. In addition, include the following:
  - 1. Visual Inspection and Tests: Inspect physical condition.
  - 2. Electrical tests:
    - a. After installation but before connection to utilization devices, such as fixtures, motors, or appliances, test conductors phase-to-phase and phase-to-ground resistance with an insulation resistance tester. Existing conductors to be reused shall also be tested.
    - b. Applied voltage shall be 500 V DC for 300 V rated cable, and 1000 V DC for 600 V rated cable. Apply test for one minute or until reading is constant

for 15 seconds, whichever is longer. Minimum insulation resistance values shall not be less than 25 megohms for 300 V rated cable and 100 megohms for 600 V rated cable.

- c. Perform phase rotation test on all three-phase circuits.

END OF SECTION

SECTION 260526  
GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. This section specifies the furnishing, installation, connection, and testing of grounding and bonding equipment, indicated as grounding equipment in this section.
- B. "Grounding electrode system" refers to grounding electrode conductors and all electrodes required or allowed by NEC, as well as made, supplementary, and lightning protection system grounding electrodes.
- C. The terms "connect" and "bond" are used interchangeably in this section and have the same meaning.

1.2 RELATED WORK

- A. Section 260511, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: Requirements that apply to all sections of Division 26.
- B. Section 260519, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES: Low-voltage conductors.
- C. Section 260533, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS: Conduit and boxes.

1.3 QUALITY ASSURANCE

- A. Refer to Paragraph, QUALIFICATIONS (PRODUCTS AND SERVICES), in Section 260511, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1.4 SUBMITTALS

- A. Submit six copies of the following in accordance with Section 260511, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.
  - 1. Shop Drawings:
    - a. Submit sufficient information to demonstrate compliance with drawings and specifications.
    - b. Submit plans showing the location of system grounding electrodes and connections, and the routing of aboveground and underground grounding electrode conductors.



2. Test Reports: Two weeks prior to the final inspection, submit ground resistance field test reports to the //Resident Engineer// //COTR//.
3. Certifications: Certification by the Contractor that the grounding equipment has been properly installed and tested.

## 1.5 APPLICABLE PUBLICATIONS

- A. Publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by designation only.
- B. American Society for Testing and Materials (ASTM):
 

|       |  |
|-------|--|
| B1-07 | Standard Specification for Hard-Drawn Copper Wire  |
| B3-07 | Standard Specification for Soft or Annealed Copper Wire  |
| B8-11 | Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft |
- C. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
 

|       |   |
|-------|---|
| 81-83 | IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System Part 1: Normal Measurements |
|-------|---|
- D. National Fire Protection Association (NFPA):
 

|        |                                 |
|--------|---------------------------------|
| 70-11  | National Electrical Code (NEC)  |
| 70E-12 | National Electrical Safety Code |
| 99-12  | Health Care Facilities          |
- E. Underwriters Laboratories, Inc. (UL):
 

|        |  |
|--------|--|
| 44-10  | Thermoset-Insulated Wires and Cables     |
| 83-08  | Thermoplastic-Insulated Wires and Cables |
| 467-07 | Grounding and Bonding Equipment          |

## PART 2 - PRODUCTS

### 2.1 GROUNDING AND BONDING CONDUCTORS

- A. Equipment grounding conductors shall be insulated stranded copper, except that sizes No. 10 AWG and smaller shall be solid copper. Insulation color shall be continuous green for all equipment grounding conductors, except that wire sizes No. 4 AWG and larger shall be identified per NEC.
- B. Bonding conductors shall be bare stranded copper, except that sizes No. 10 AWG and smaller shall be bare solid copper. Bonding conductors shall be stranded for final connection to motors, transformers, and vibrating equipment.

- C. Conductor sizes shall not be less than shown on the drawings, or not less than required by the NEC, whichever is greater.
- D. Insulation: THHN-THWN and XHHW-2. XHHW-2 shall be used for isolated power systems.
- E. Concrete encased electrode shall be No. 4 AWG bare copper wire, installed per NEC.

## 2.2 GROUND CONNECTIONS

- A. Above Grade:
  - 1. Bonding Jumpers: Listed for use with aluminum and copper conductors. For wire sizes No. 8 AWG and larger, use compression-type connectors. For wire sizes smaller than No. 8 AWG, use mechanical type lugs. Connectors or lugs shall use //zinc-plated//cadmium-plated// steel bolts, nuts, and washers. Bolts shall be torqued to the values recommended by the manufacturer.
  - 2. Connection to Building Steel: Exothermic-welded type connectors.
  - 3. Connection to Grounding Bus Bars: Listed for use with aluminum and copper conductors. Use mechanical type lugs, with //zinc-plated//cadmium-plated// steel bolts, nuts, and washers. Bolts shall be torqued to the values recommended by the manufacturer.

## 2.3 GROUND TERMINAL BLOCKS

- A. At any equipment mounting location (e.g., backboards and hinged cover enclosures) where rack-type ground bars cannot be mounted, provide mechanical type lugs, with //zinc-plated//cadmium-plated// steel bolts, nuts, and washers. Bolts shall be torqued to the values recommended by the manufacturer.

## PART 3 - EXECUTION

### 3.1 GENERAL

- A. Install grounding equipment in accordance with the NEC, as shown on the drawings, and as specified herein.
- B. Equipment Grounding: Metallic piping, building structural steel, electrical enclosures, raceways, junction boxes, outlet boxes, cabinets, machine frames, and other conductive items in close proximity with electrical circuits, shall be bonded and grounded.

### 3.2 INACCESSIBLE GROUNDING CONNECTIONS

- A. Make grounding connections, which are normally buried or otherwise inaccessible, by exothermic weld.

### 3.3 RACEWAY

#### A. Conduit Systems:

1. Ground all metallic conduit systems. All metallic conduit systems shall contain an equipment grounding conductor.
2. Non-metallic conduit systems, except non-metallic feeder conduits that carry a grounded conductor from exterior transformers to interior or building-mounted service entrance equipment, shall contain an equipment grounding conductor.
3. Metallic conduit that only contains a grounding conductor, and is provided for its mechanical protection, shall be bonded to that conductor at the entrance and exit from the conduit.
4. Metallic conduits which terminate without mechanical connection to an electrical equipment housing by means of locknut and bushings or adapters, shall be provided with grounding bushings. Connect bushings with a equipment grounding conductor to the equipment ground bus.

#### B. Feeders and Branch Circuits: Install equipment grounding conductors with all feeders, and power and lighting branch circuits.

#### C. Boxes, Cabinets, Enclosures, and Panelboards:

1. Bond the equipment grounding conductor to each pullbox, junction box, outlet box, device box, cabinets, and other enclosures through which the conductor passes (except for special grounding systems for intensive care units and other critical units shown).
2. Provide lugs in each box and enclosure for equipment grounding conductor termination.

#### D. Wireway Systems:

1. Bond the metallic structures of wireway to provide electrical continuity throughout the wireway system, by connecting a No. 6 AWG bonding jumper at all intermediate metallic enclosures and across all section junctions.
2. Install insulated No. 6 AWG bonding jumpers between the wireway system, bonded as required above, and the closest building ground at each end and approximately every 16 M (50 feet).
3. Use insulated No. 6 AWG bonding jumpers to ground or bond metallic wireway at each end for all intermediate metallic enclosures and across all section junctions.
4. Use insulated No. 6 AWG bonding jumpers to ground cable tray to column-mounted building ground plates (pads) at each end and approximately every 15 M (49 feet).

#### E. Receptacles shall not be grounded through their mounting screws. Ground receptacles with a jumper from the receptacle green ground terminal to the device box ground screw and a jumper to the branch circuit equipment grounding conductor.

#### F. Ground lighting fixtures to the equipment grounding conductor of the wiring system. Fixtures connected with flexible conduit shall have a green ground wire included with the power wires from the fixture through the flexible conduit to the first outlet box.

- G. Fixed electrical appliances and equipment shall be provided with a ground lug for termination of the equipment grounding conductor.

#### 3.4 CORROSION INHIBITORS

- A. When making grounding and bonding connections, apply a corrosion inhibitor to all contact surfaces. Use corrosion inhibitor appropriate for protecting a connection between the metals used.

#### 3.5 CONDUCTIVE PIPING

- A. Bond all conductive piping systems, interior and exterior, to the grounding electrode system. Bonding connections shall be made as close as practical to the equipment ground bus.
- B. In operating rooms and at intensive care and coronary care type beds, bond the medical gas piping and medical vacuum piping at the outlets directly to the patient ground bus.

#### 3.6 GROUND RESISTANCE

- A. Grounding system resistance to ground shall not exceed 5 ohms. Make any modifications or additions to the grounding electrode system necessary for compliance without additional cost to the Government. Final tests shall ensure that this requirement is met.
- B. Grounding system resistance shall comply with the electric utility company ground resistance requirements.

#### 3.7 ACCEPTANCE CHECKS AND TESTS

- A. Resistance of the grounding electrode system shall be measured using a four-terminal fall-of-potential method as defined in IEEE 81. Ground resistance measurements shall be made before the electrical distribution system is energized or connected to the electric utility company ground system, and shall be made in normally dry conditions not fewer than 48 hours after the last rainfall.
- B. Resistance measurements of separate grounding electrode systems shall be made before the systems are bonded together. The combined resistance of separate systems may be used to meet the required resistance, but the specified number of electrodes must still be provided.

END OF SECTION

SECTION 26 05 33  
RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section specifies the furnishing, installation, and connection of conduit, fittings, and boxes, to form complete, coordinated, grounded raceway systems. Raceways are required for all wiring unless shown or specified otherwise.
- B. Definitions: The term conduit, as used in this specification, shall mean any or all of the raceway types specified.

1.2 RELATED WORK

- A. Section 061000, ROUGH CARPENTRY: Mounting board for telephone closets.
- B. Section 076000, FLASHING AND SHEET METAL: Fabrications for the deflection of water away from the building envelope at penetrations.
- C. Section 078400, FIRESTOPPING: Sealing around penetrations to maintain the integrity of fire rated construction.
- D. Section 079200, JOINT SEALANTS: Sealing around conduit penetrations through the building envelope to prevent moisture migration into the building.
- E. Section 099100, PAINTING: Identification and painting of conduit and other devices.
- F. Section 130541, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS: Conduits bracing.
- G. Section 260511, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements and items that are common to more than one section of Division 26.
  - 1. Section 260526, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS: Requirements for personnel safety and to provide a low impedance path for possible ground fault currents.

1.3 QUALITY ASSURANCE

- A. Refer to Paragraph, QUALIFICATIONS, in Section 260511, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

#### 1.4 SUBMITTALS

- A. Submit six copies of the following in accordance with Section 260511, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1. Shop Drawings:

- a. Size and location of main feeders.
- b. Size and location of panels and pull-boxes.
- c. Layout of required conduit penetrations through structural elements.
- d. Submit the following data for approval:
  - 1) Raceway types and sizes.
  - 2) Conduit bodies, connectors and fittings.
  - 3) Junction and pull boxes, types and sizes.

2. Certifications: Two weeks prior to final inspection, submit the following:

- a. Certification by the manufacturer that raceways, conduits, conduit bodies, connectors, fittings, junction and pull boxes, and all related equipment conform to the requirements of the drawings and specifications.
- b. Certification by the Contractor that raceways, conduits, conduit bodies, connectors, fittings, junction and pull boxes, and all related equipment have been properly installed.

#### 1.5 APPLICABLE PUBLICATIONS

- A. Publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by designation only.

B. American National Standards Institute (ANSI):

|          |                                       |
|----------|---------------------------------------|
| C80.1-05 | Electrical Rigid Steel Conduit        |
| C80.3-05 | Steel Electrical Metal Tubing         |
| C80.6-05 | Electrical Intermediate Metal Conduit |

C. National Fire Protection Association (NFPA):

|       |                                |
|-------|--------------------------------|
| 70-11 | National Electrical Code (NEC) |
|-------|--------------------------------|

D. Underwriters Laboratories, Inc. (UL):

|         |  |
|---------|--|
| 1-05    | Flexible Metal Conduit                 |
| 5-11    | Surface Metal Raceway and Fittings     |
| 6-07    | Electrical Rigid Metal Conduit - Steel |
| 50-95   | Enclosures for Electrical Equipment    |
| 360-13  | Liquid-Tight Flexible Steel Conduit    |
| 467-13  | Grounding and Bonding Equipment        |
| 514A-13 | Metallic Outlet Boxes                  |
| 514B-12 | Conduit, Tubing, and Cable Fittings    |

|         |   |
|---------|---|
| 797-07  | Electrical Metallic Tubing                    |
| 1242-06 | Electrical Intermediate Metal Conduit - Steel |

E. National Electrical Manufacturers Association (NEMA):

|           |   |
|-----------|---|
| FB1-12    | Fittings, Cast Metal Boxes and Conduit Bodies for Conduit, Electrical Metallic Tubing and Cable   |
| FB2.10-13 | Selection and Installation Guidelines for Fittings for use with Non-Flexible Conduit or Tubing (Rigid Metal Conduit, Intermediate Metallic Conduit, and Electrical Metallic Tubing) |
| FB2.20-12 | Selection and Installation Guidelines for Fittings for use with Flexible Electrical Conduit and Cable   |

F. American Iron and Steel Institute (AISI):

|           |   |
|-----------|---|
| S100-2007 | North American Specification for the Design of Cold-Formed Steel Structural Members |
|-----------|---|

## PART 2 - PRODUCTS

### 2.1 MATERIAL

- A. Conduit Size: In accordance with the NEC, but not less than 13 mm (0.5-inch) unless otherwise shown. Where permitted by the NEC, 13 mm (0.5-inch) flexible conduit may be used for tap connections to recessed lighting fixtures.
- B. Conduit:
  - 1. Size: In accordance with the NEC, but not less than 13 mm (0.5-inch).
  - 2. Rigid Steel Conduit (RMC): Shall conform to UL 6 and ANSI C80.1.
  - 3. Rigid Intermediate Steel Conduit (IMC): Shall conform to UL 1242 and ANSI C80.6.
  - 4. Electrical Metallic Tubing (EMT): Shall conform to UL 797 and ANSI C80.3. Maximum size not to exceed 105 mm (4 inches) and shall be permitted only with cable rated 600 V or less.
  - 5. Flexible Metal Conduit: Shall conform to UL 1.
  - 6. Liquid-tight Flexible Metal Conduit: Shall conform to UL 360.
  - 7. Surface Metal Raceway: Shall conform to UL 5.
- C. Conduit Fittings:
  - 1. Rigid Steel and Intermediate Metallic Conduit Fittings:
    - a. Fittings shall meet the requirements of UL 514B and NEMA FB1.
    - b. Standard threaded couplings, locknuts, bushings, conduit bodies, and elbows: Only steel or malleable iron materials are acceptable. Integral retractable type IMC couplings are also acceptable.
    - c. Locknuts: Bonding type with sharp edges for digging into the metal wall of an enclosure.

- d. Bushings: Metallic insulating type, consisting of an insulating insert, molded or locked into the metallic body of the fitting. Bushings made entirely of metal or nonmetallic material are not permitted.
  - e. Erickson (Union-Type) and Set Screw Type Couplings: Approved for use in concrete are permitted for use to complete a conduit run where conduit is installed in concrete. Use set screws of case-hardened steel with hex head and cup point to firmly seat in conduit wall for positive ground. Tightening of set screws with pliers is prohibited.
  - f. Sealing Fittings: Threaded cast iron type. Use continuous drain-type sealing fittings to prevent passage of water vapor. In concealed work, install fittings in flush steel boxes with blank cover plates having the same finishes as that of other electrical plates in the room.
- 2. Electrical Metallic Tubing Fittings:
    - a. Fittings and conduit bodies shall meet the requirements of UL 514B, ANSI C80.3, and NEMA FB1.
    - b. Only steel or malleable iron materials are acceptable.
    - c. Compression Couplings and Connectors: Concrete-tight and rain-tight, with connectors having insulated throats.
  - 3. Flexible Metal Conduit Fittings:
    - a. Conform to UL 514B. Only steel or malleable iron materials are acceptable.
    - b. Clamp-type, with insulated throat.
  - 4. Liquid-tight Flexible Metal Conduit Fittings:
    - a. Fittings shall meet the requirements of UL 514B and NEMA FB1.
    - b. Only steel or malleable iron materials are acceptable.
    - c. Fittings must incorporate a threaded grounding cone, a steel or plastic compression ring, and a gland for tightening. Connectors shall have insulated throats.
  - 5. Surface Metal Raceway Fittings: As recommended by the raceway manufacturer. Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, conduit entry fittings, accessories, and other fittings as required for complete system.
  - 6. Expansion and Deflection Couplings:
    - a. Conform to UL 467 and UL 514B.
    - b. Accommodate a 19 mm (0.75-inch) deflection, expansion, or contraction in any direction, and allow 30 degree angular deflections.
    - c. Include internal flexible metal braid, sized to guarantee conduit ground continuity and a low-impedance path for fault currents, in accordance with UL 467 and the NEC tables for equipment grounding conductors.
    - d. Jacket: Flexible, corrosion-resistant, watertight, moisture and heat-resistant molded rubber material with stainless steel jacket clamps.

D. Conduit Supports:



1. Parts and Hardware: Zinc-coat or provide equivalent corrosion protection.
  2. Individual Conduit Hangers: Designed for the purpose, having a pre-assembled closure bolt and nut, and provisions for receiving a hanger rod.
  3. Multiple Conduit (Trapeze) Hangers: Not less than 38 mm x 38 mm (1.5 x 1.5 inches), 12-gauge steel, cold-formed, lipped channels; with not less than 9 mm(0.375-inch) diameter steel hanger rods.
  4. Solid Masonry and Concrete Anchors: Self-drilling expansion shields, or machine bolt expansion.
- E. Outlet, Junction, and Pull Boxes:
1. UL-50 and UL-514A.
  2. Rustproof cast metal where required by the NEC or shown on drawings.
  3. Sheet Metal Boxes: Galvanized steel, except where shown on drawings.
- F. Metal Wireways: Equip with hinged covers, except as shown on drawings. Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for a complete system.

## PART 3 - EXECUTION

### 3.1 PENETRATIONS

- A. Cutting or Holes:
1. Cut holes in advance where they should be placed in the structural elements, such as ribs or beams. Obtain the approval of the //Resident Engineer// //COR//prior to drilling through structural elements.
  2. Cut holes through concrete and masonry in new and existing structures with a diamond core drill or concrete saw. Pneumatic hammers, impact electric, hand, or manual hammer-type drills are not allowed, except when permitted by the//Resident Engineer// //COR//where working space is limited.
- B. Firestop: Where conduits, wire ways, and other electrical raceways pass through fire partitions, fire walls, smoke partitions, or floors, install a fire stop that provides an effective barrier against the spread of fire, smoke and gases as specified in Section 07 84 00, FIRESTOPPING.
- C. Waterproofing: At floor, exterior wall, and roof conduit penetrations, completely seal the gap around conduit to render it watertight, as specified in Section 07 92 00, JOINT SEALANTS.

### 3.2 INSTALLATION, GENERAL

- A. In accordance with UL, NEC, NEMA, as shown on drawings, and as specified herein.
- B. Raceway systems used for Essential Electrical Systems (EES) shall be entirely independent of other raceway systems.

C. Install conduit as follows:

1. In complete mechanically and electrically continuous runs before pulling in cables or wires.
2. Unless otherwise indicated on the drawings or specified herein, installation of all conduits shall be concealed within finished walls, floors, and ceilings.
3. Flattened, dented, or deformed conduit is not permitted. Remove and replace the damaged conduits with new conduits.
4. Assure conduit installation does not encroach into the ceiling height head room, walkways, or doorways.
5. Cut conduits square, ream, remove burrs, and draw up tight.
6. Independently support conduit at 2.4 M (8 feet) on centers with specified materials and as shown on drawings.
7. Do not use suspended ceilings, suspended ceiling supporting members, lighting fixtures, other conduits, cable tray, boxes, piping, or ducts to support conduits and conduit runs.
8. Support within 300 mm (12 inches) of changes of direction, and within 300 mm (12 inches) of each enclosure to which connected.
9. Close ends of empty conduits with plugs or caps at the rough-in stage until wires are pulled in, to prevent entry of debris.
10. Conduit installations under fume and vent hoods are prohibited.
11. Secure conduits to cabinets, junction boxes, pull-boxes, and outlet boxes with bonding type locknuts. For rigid steel and IMC conduit installations, provide a locknut on the inside of the enclosure, made up wrench tight. Do not make conduit connections to junction box covers.
12. Flashing of penetrations of the roof membrane is specified in Section 07 60 00, FLASHING AND SHEET METAL.
13. Conduit bodies shall only be used for changes in direction, and shall not contain splices.

D. Conduit Bends:

1. Make bends with standard conduit bending machines.
2. Conduit hickey may be used for slight offsets and for straightening stubbed out conduits.
3. Bending of conduits with a pipe tee or vise is prohibited.

E. Layout and Homeruns:

1. Install conduit with wiring, including homeruns, as shown on drawings.
2. Deviations: Make only where necessary to avoid interferences and only after drawings showing the proposed deviations have been submitted and approved by the //Resident Engineer// //COR//.

### 3.3 CONCEALED WORK INSTALLATION

A. Above Furred or Suspended Ceilings and in Walls:

1. Conduit for Conductors 600 V and Below: Rigid steel, IMC, or EMT. Mixing different types of conduits in the same system is prohibited.

2. Align and run conduit parallel or perpendicular to the building lines.
3. Tightening setscrews with pliers is prohibited.
4. For conduits running through metal studs, limit field cut holes to no more than 70% of web depth. Spacing between holes shall be at least 457 mm (18 inches). Cuts or notches in flanges or return lips shall not be permitted.

### 3.4 EXPOSED WORK INSTALLATION

- A. Unless otherwise indicated on drawings, exposed conduit is only permitted in mechanical and electrical rooms.
- B. Conduit for Conductors 600 V and Below: Rigid steel, IMC, or EMT. Mixing different types of conduits in the system is prohibited.
- C. Align and run conduit parallel or perpendicular to the building lines.
- D. Install horizontal runs close to the ceiling or beams and secure with conduit straps.
- E. Support horizontal or vertical runs at not over 2.4 M (8 feet) intervals.
- F. Surface Metal Raceways: Use only where shown on drawings.
- G. Painting:
  1. Paint exposed conduit as specified in Section 09 91 00, PAINTING.
  2. Paint all conduits containing cables rated over 600 V safety orange. Refer to Section 09 91 00, PAINTING for preparation, paint type, and exact color. In addition, paint legends, using 50 mm (2 inch) high black numerals and letters, showing the cable voltage rating. Provide legends where conduits pass through walls and floors and at maximum 6 M (20 feet) intervals in between.

### 3.5 HAZARDOUS LOCATIONS

- A. Use rigid steel conduit only.
- B. Install UL approved sealing fittings that prevent passage of explosive vapors in hazardous areas equipped with explosion-proof lighting fixtures, switches, and receptacles, as required by the NEC.

### 3.6 WET OR DAMP LOCATIONS

- A. Use rigid steel or IMC conduits unless as shown on drawings.
- B. Provide sealing fittings to prevent passage of water vapor where conduits pass from warm to cold locations, i.e., refrigerated spaces, constant-temperature rooms, air-conditioned spaces, building exterior walls, roofs, or similar spaces.
- C. Use rigid steel or IMC conduit within 1.5 M (5 feet) of the exterior and below concrete building slabs in contact with soil, gravel, or vapor barriers, unless as shown on

drawings. Conduit shall be half-lapped with 10 mil PVC tape before installation. After installation, completely recoat or retape any damaged areas of coating.

- D. Conduits run on roof shall be supported with integral galvanized lipped steel channel, attached to UV-inhibited polycarbonate or polypropylene blocks every 2.4 M (8 feet) with 9 mm (3/8-inch) galvanized threaded rods, square washer and locknut. Conduits shall be attached to steel channel with conduit clamps.

### 3.7 MOTORS AND VIBRATING EQUIPMENT

- A. Use flexible metal conduit for connections to motors and other electrical equipment subject to movement, vibration, misalignment, cramped quarters, or noise transmission.
- B. Use liquid-tight flexible metal conduit for installation in exterior locations, moisture or humidity laden atmosphere, corrosive atmosphere, water or spray wash-down operations, inside airstream of HVAC units, and locations subject to seepage or dripping of oil, grease, or water.
- C. Provide a green equipment grounding conductor with flexible and liquid-tight flexible metal conduit.

### 3.8 EXPANSION JOINTS

- A. Conduits 75 mm (3 inch) and larger that are secured to the building structure on opposite sides of a building expansion joint require expansion and deflection couplings. Install the couplings in accordance with the manufacturer's recommendations.
- B. Provide conduits smaller than 75 mm (3 inch) with junction boxes on both sides of the expansion joint. Connect flexible metal conduits to junction boxes with sufficient slack to produce a 125 mm (5 inch) vertical drop midway between the ends of the flexible metal conduit. Flexible metal conduit shall have a green insulated copper bonding jumper installed. In lieu of this flexible metal conduit, expansion and deflection couplings as specified above are acceptable.
- C. Install expansion and deflection couplings where shown.

### 3.9 CONDUIT SUPPORTS

- A. Safe working load shall not exceed one-quarter of proof test load of fastening devices.
- B. Use pipe straps or individual conduit hangers for supporting individual conduits.
- C. Support multiple conduit runs with trapeze hangers. Use trapeze hangers that are designed to support a load equal to or greater than the sum of the weights of the conduits, wires, hanger itself, and an additional 90 kg (200 lbs). Attach each conduit with U-bolts or other approved fasteners.

- D. Support conduit independently of junction boxes, pull-boxes, fixtures, suspended ceiling T-bars, angle supports, and similar items.
- E. Fasteners and Supports in Solid Masonry and Concrete:
  - 1. Existing Construction:
    - a. Steel expansion anchors not less than 6 mm (0.25-inch) bolt size and not less than 28 mm (1.125 inch) in embedment.
    - b. Power set fasteners not less than 6 mm (0.25-inch) diameter with depth of penetration not less than 75 mm (3 inch).
    - c. Use vibration and shock-resistant anchors and fasteners for attaching to concrete ceilings.
- F. Hollow Masonry: Toggle bolts.
- G. Bolts supported only by plaster or gypsum wallboard are not acceptable.
- H. Metal Structures: Use machine screw fasteners or other devices specifically designed and approved for the application.
- I. Attachment by wood plugs, rawl plug, plastic, lead or soft metal anchors, or wood blocking and bolts supported only by plaster is prohibited.
- J. Chain, wire, or perforated strap shall not be used to support or fasten conduit.
- K. Spring steel type supports or fasteners are prohibited for all uses except horizontal and vertical supports/fasteners within walls.
- L. Vertical Supports: Vertical conduit runs shall have riser clamps and supports in accordance with the NEC and as shown. Provide supports for cable and wire with fittings that include internal wedges and retaining collars.

### 3.10 BOX INSTALLATION

- A. Boxes for Concealed Conduits:
  - 1. Flush-mounted.
  - 2. Provide raised covers for boxes to suit the wall or ceiling, construction, and finish.
- B. In addition to boxes shown, install additional boxes where needed to prevent damage to cables and wires during pulling-in operations or where more than the equivalent of 4-90 degree bends are necessary.
- C. Locate pullboxes so that covers are accessible and easily removed. Coordinate locations with piping and ductwork where installed above ceilings.
- D. Remove only knockouts as required. Plug unused openings. Use threaded plugs for cast metal boxes and snap-in metal covers for sheet metal boxes.

- E. Outlet boxes mounted back-to-back in the same wall are prohibited. A minimum 600 mm (24 inch) center-to-center lateral spacing shall be maintained between boxes.
- F. Flush-mounted wall or ceiling boxes shall be installed with raised covers so that the front face of raised cover is flush with the wall. Surface-mounted wall or ceiling boxes shall be installed with surface-style flat or raised covers.
- G. Minimum size of outlet boxes for ground fault circuit interrupter (GFCI) receptacles is 100 mm (4 inches) square x 55 mm (2.125 inches) deep, with device covers for the wall material and thickness involved.
- H. Stencil or install phenolic nameplates on covers of the boxes identified on riser diagrams; for example "SIG-FA JB No. 1."
- I. On all branch circuit junction box covers, identify the circuits with black marker.

END OF SECTION

## SECTION 26 08 00

### COMMISSIONING OF ELECTRICAL SYSTEMS

#### PART 1 - GENERAL

##### 1.1 DESCRIPTION

- A. The requirements of this Section apply to all sections of Division 26.
- B. This project will have selected building systems commissioned. The complete list of equipment and systems to be commissioned is specified in Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS. The commissioning process, which the Contractor is responsible to execute, is defined in Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS. A Commissioning Agent (CxA) appointed by the VA will manage the commissioning process.

##### 1.2 RELATED WORK

- A. Section 01 00 00 GENERAL REQUIREMENTS.
- B. Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS.
- C. Section 01 33 23 SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

##### 1.3 SUMMARY

- A. This Section includes requirements for commissioning the Facility electrical systems, related subsystems and related equipment. This Section supplements the general requirements specified in Section 01 91 00 General Commissioning Requirements.
- B. Refer to Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS for more details regarding processes and procedures as well as roles and responsibilities for all Commissioning Team members.

##### 1.4 DEFINITIONS

- A. Refer to Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS for definitions.

##### 1.5 COMMISSIONED SYSTEMS

- A. Commissioning of a system or systems specified in Division 26 is part of the construction process. Documentation and testing of these systems, as well as training of the VA's Operation and Maintenance personnel in accordance with the requirements of Section 01 91 00 and of Division 26, is required in cooperation with the VA and the Commissioning Agent.
- B. The Facility electrical systems commissioning will include the systems listed in Section 01 19 00 General Commissioning Requirements:

## 1.6 SUBMITTALS

- A. The commissioning process requires review of selected Submittals that pertain to the systems to be commissioned. The Commissioning Agent will provide a list of submittals that will be reviewed by the Commissioning Agent. This list will be reviewed and approved by the VA prior to forwarding to the Contractor. Refer to Section 01 33 23 SHOP DRAWINGS, PRODUCT DATA, and SAMPLES for further details.
- B. The commissioning process requires Submittal review simultaneously with engineering review. Specific submittal requirements related to the commissioning process are specified in Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS.

## PART 2 - PRODUCTS (NOT USED)

## PART 3 - EXECUTION

### 3.1 CONSTRUCTION INSPECTIONS

- A. Commissioning of Electrical systems will require inspection of individual elements of the electrical systems construction throughout the construction period. The Contractor shall coordinate with the Commissioning Agent in accordance with Section 01 19 00 and the Commissioning plan to schedule electrical systems inspections as required to support the Commissioning Process.

### 3.2 PRE-FUNCTIONAL CHECKLISTS

- A. The Contractor shall complete Pre-Functional Checklists to verify systems, subsystems, and equipment installation is complete and systems are ready for Systems Functional Performance Testing. The Commissioning Agent will prepare Pre-Functional Checklists to be used to document equipment installation. The Contractor shall complete the checklists. Completed checklists shall be submitted to the VA and to the Commissioning Agent for review. The Commissioning Agent may spot check a sample of completed checklists. If the Commissioning Agent determines that the information provided on the checklist is not accurate, the Commissioning Agent will return the marked-up checklist to the Contractor for correction and resubmission. If the Commissioning Agent determines that a significant number of completed checklists for similar equipment are not accurate, the Commissioning Agent will select a broader sample of checklists for review. If the Commissioning Agent determines that a significant number of the broader sample of checklists is also inaccurate, all the checklists for the type of equipment will be returned to the Contractor for correction and resubmission. Refer to SECTION 01 91 00 GENERAL COMMISSIONING REQUIREMENTS for submittal requirements for Pre-Functional Checklists, Equipment Startup Reports, and other commissioning documents.



### 3.3 CONTRACTORS TESTS

- A. Contractor tests as required by other sections of Division 26 shall be scheduled and documented in accordance with Section 01 00 00 GENERAL REQUIREMENTS. All testing shall be incorporated into the project schedule. Contractor shall provide no less than 7 calendar days' notice of testing. The Commissioning Agent will witness selected Contractor tests at the sole discretion of the Commissioning Agent. Contractor tests shall be completed prior to scheduling Systems Functional Performance Testing.

### 3.4 SYSTEMS FUNCTIONAL PERFORMANCE TESTING

- A. The Commissioning Process includes Systems Functional Performance Testing that is intended to test systems functional performance under steady state conditions, to test system reaction to changes in operating conditions, and system performance under emergency conditions. The Commissioning Agent will prepare detailed Systems Functional Performance Test procedures for review and approval by the Resident Engineer. The Contractor shall review and comment on the tests prior to approval. The Contractor shall provide the required labor, materials, and test equipment identified in the test procedure to perform the tests. The Commissioning Agent will witness and document the testing. The Contractor shall sign the test reports to verify tests were performed. See Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS, for additional details.

### 3.5 TRAINING OF VA PERSONNEL

- A. Training of the VA operation and maintenance personnel is required in cooperation with the Resident Engineer and Commissioning Agent. Provide competent, factory authorized personnel to provide instruction to operation and maintenance personnel concerning the location, operation, and troubleshooting of the installed systems. Contractor shall submit training agendas and trainer resumes in accordance with the requirements of Section 01 19 00. The instruction shall be scheduled in coordination with the VA Resident Engineer after submission and approval of formal training plans. Refer to Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS and Division 26 Sections for additional Contractor training requirements.

END OF SECTION

SECTION 28 31 00  
FIRE ALARM SYSTEM

PART 1 – GENERAL

1.1 WORK INCLUDED

- A. General Conditions and requirements of Division 1 and Section 26 01 00 apply to work hereunder.
- B. Furnish and install extensions to the existing Fire Alarm System including all wiring and connections and other materials as shown on Plans and specified herein. It is the intent that a complete operating system conforming to all applicable codes be installed and that any power supplies, relays, resistors, cards, modules, programming, or other items required to achieve this end result shall be furnished whether or not such item or items are specified herein.
- C. Site and System Investigation: Fire Alarm System bidder shall visit site prior to bid and become thoroughly knowledgeable about existing system and work required to perform work of this section. Failure to discover the equipment, materials, and labor required to complete the extensions will not relieve the contractor from completing the work at no additional cost.

1.2 GENERAL REQUIREMENTS

- A. Code Requirements: System and all its components to meet requirements for local alarm system of National Fire Protection Association Standard 72, 2010 Edition, Americans with Disabilities Act (ADA), and Article 760, California Electrical Code, and to be approved by Division of the State Architect for use as school fire alarm system.
- B. System Requirements: All of various equipment components to be complete with all appurtenant accessories required to provide specified facilities and perform specified functions throughout presently planned construction and space; and provisions for expanding system to provide same facilities, and perform same functions in all future planned construction, including space and mountings in control panels and terminal cabinets.
- C. Interruption of Service: Existing fire alarm system must be kept operational during work of this contract. If operation of existing system or portion of existing system is disrupted for connections into system or cutoff for any reason by work of this project, Contractor must provide fire watch. Fire watch must occur 24 hours per day and every day system is down. Fire watch proposed by Contractor must be acceptable to local fire authority and Owner. All costs for fire watch shall be Contractor's responsibility.
- D. Instructions and Manuals:
  - 1. Equipment supplier of systems to demonstrate operation of systems to satisfaction of Owner and furnish Owner three (3) wiring schematics for all items of equipment, installation instructions, and details of all routine maintenance and

servicing which must be given systems by Owner. Manuals shall be provided in 3-ring binders, with title page, list of contents, and conspicuous label on cover and shall be delivered to the Owner. Refer to Section 26 01 00 for additional requirements. Submit copy to Architect for approval before delivering to Owner.

2. Supplier shall demonstrate operation of systems and provide training to all end users, administrative staff, and system administrator. Coordinate times of instruction with the Owner, at Owner's convenience. Supplier shall provide a minimum of 2 hours of user instructions to clerical staff and 4 hours of user/maintenance instructions to the Owner's maintenance personnel. Instruction periods shall not coincide and shall be scheduled with the Owner, not staff. Owner shall provide list of authorized personnel for training sessions.
  3. Furnish to Owner, a printed copy of the fire alarm control panel programming upon completion of final system programming.
- E. Installation of the fire alarm system and equipment shall not be started until submittals, including State Fire Marshal listing numbers for each component of the system, have been submitted to and approved by the Architect. Fire alarm submittals must be provided.
- F. Contractor Certifications:
1. Fire alarm system installer shall be State certified as a Fire/Life Safety Technician by the Division of Apprenticeship Standards.
  2. The contractor installing the fire alarm system must have NICET Certified Technicians on staff. There shall be at least one NICET Level III or IV fire alarm systems certified technician on staff at the local office to review the submittals and plans prior to submission. In addition, the on-site job supervisor for the installing contractor must be a Level II (or higher) NICET certified in fire alarm systems. A minimum of 30 percent of personnel on-site must be NICET certified.
  3. Certificates of all individuals must be included with the submittals. Failure to provide proof of certification will be cause for rejection of the submittals without further review. The rejection of the submittals for this reason will count as a submittal review/rejection.
- G. Submittals: Incomplete submittals (such as product data submitted without shop drawings, etc.) will be returned without review. Submittals shall be complete and include catalog data, shop drawings, one-line diagrams, scaled plan drawings, and certifications. Building plans shall be 1/8"=1'0", and site plans shall be no smaller than 1"=40'. Minimum text height shall be 3/32" high. Contractor shall also submit name of firm he proposes to do work under this Section, addresses, phone numbers, and name of firm's contact, for approval. Such firms shall be factory authorized representatives of the system specified and submittal shall include manufacturer's letter of confirmation. Proposed firm shall furnish all equipment and specialty cables, make all connections to same, and place the systems in operation. Such firms shall have offices and service departments within a 100 mile radius of project and shall have been in business of this type for at least five years. Also, refer to requirement for shop drawings, substitutions, materials, and submittals in Section 26 01 00, Electrical. Two submittal reviews will be

made by the Architect's representative. Subsequent reviews will be charged to the Contractor. A rejection of a submittal or review of a partially presented submittal constitutes one submittal review.

1. Fire alarm system design and products have been reviewed and approved by the Owner. Alterations to design and/or substitutions proposed by the contractor shall require the following to be included with the fire alarm submittal:
  - a. Riser diagram.
  - b. Point-to-Point diagram.
  - c. Mounting detail showing elevations of wall mounted devices.
  - d. List of system components, equipment, and devices, including manufacturer's model number(s) and California State Fire Marshal listing numbers.
  - e. Copies of manufacturer's specification sheets for equipment and devices indicated.
  - f. Voltage drop calculations -- include the following information for the worst case:
    - 1) Point-to-Point or ohms law calculations.
    - 2) Zone used in calculations.
    - 3) Voltage drop percent [not to exceed manufacturer's requirements].  
Note: If voltage drop exceeds 10%, indicate manufacturer's listed operating voltage range(s) for equipment and devices.
  - g. Battery type(s), amp hours, and load calculations -- include the following information:
    - 1) Normal Operation: 100% of applicable devices for 24 hours = control panel amps plus list of amps per device which draw power from the panel during standby power condition -- i.e.:
      - a) Zone modules.
      - b) Detectors.
      - c) Other devices [identify].
    - 2) Alarm Condition: 100% of applicable devices for 5 minutes = control panel amps plus list of amps per device which draw power from the panel during alarm condition -- i.e.:
      - a) Zone modules.
      - b) Signal modules.

- c) Detectors.
    - d) Signal devices
    - e) Annunciator.
    - f) Other devices [identify].
  - 3) Normal Operation + Alarm Condition:
    - a) Total amp hours required.
    - b) Total amp hours provided.
- H. Record Drawings: Refer to General Conditions. Final Inspection will not be made until drawings are received and approved. Record Drawings shall include "As-Built" one-line and wiring diagrams, with terminations identified, wire color coding schedule, pullbox locations, and conduit routing plans. Record drawings shall include FINAL addresses for all devices.
- I. Guarantee:
- 1. One firm to assume full responsibility for performance on all work of this section. Guarantee all equipment against defects in material and workmanship for one (1) year, and provide on-the-premises service during normal working hours for one year, at no cost to purchaser if trouble is not caused by misuse, abuse, or accident, or at current labor rates if so caused. Provide manufacturer's written one-year guarantee for equipment and parts.
  - 2. Service shall normally be available within 24 hours from service department of authorized distributor of manufacturer by factory trained servicemen.
  - 3. On-the-premises service at other than normal working hours to also be available, but labor charges for such calls to be paid by purchaser at current labor rates.

## PART 2 - DETAIL REQUIREMENTS AND PRODUCT

### 2.1 SYSTEM OPERATION

- A. Activation of any manual station or automatic detector shall cause the operation of all audible and visual signals. In addition to sounding local alarm signals, operation of manual stations or automatic detectors shall activate a digital communicator for telephone leased line reporting to remote SB575 compliant supervisory station. Telephone company leased lines monitoring contract shall be arranged by the Owner.

The system shall be electrically supervised against open circuits and grounds on the wiring to the alarm-initiating devices. An open or ground in the system shall cause a trouble signal to sound continuously until the system is restored to normal or until the signal is silenced by means of a cut-off switch. When the cut-off switch is thrown to the "off" position, a white pilot light shall be illuminated to show that the trouble signal

is off. When the system is restored to normal operation, the trouble signal shall sound again and shall be silenced only by restoring the cut-off switch to its normal position, thereby also extinguishing the pilot light. Open and grounded circuits in the system shall not cause the sounding of false alarms.

B. Contractor to ensure synchronization of visual devices where required by NFPA 72.

## 2.2 STANDARD PRODUCTS

A. Equipment and accessories furnished under the terms of these specifications shall be the standard products of manufacturers specified. All equipment shall be listed by U.L. and State Fire Marshal. Equipment shall be Simplex to match existing control panel, or equal, and Wheelock.

B. Refer to drawings for devices used.

C. Smoke Detectors: Shall be addressable, photoelectric type with test switch, LED status indicator, and tamperproof locking base, Simplex 4098-9714 with 4098-9792 base.

D. Monitor Modules: Shall provide an address for a group of normally open initiating devices. Simplex 4090-9101.

E. Control Modules: Shall provide a single Form-C (SPDT) dry contact. Simplex 4090-9002.

F. Audible/Visual Devices: All fire alarm devices shall be UL listed and meet ADA requirements. All devices shall have a red finish. All fire alarm audible devices shall have the same basic sound and "temporal" pattern (ANSI S3.41). Piezo horns and minihorns are not acceptable. Strobes shall be synchronized.

1. Combination Speaker/Visual Alarm Indicating Devices: Shall be semi-flush mounted, high intensity Xenon flasher type. Simplex 4906-9154. Refer to drawings for Candela settings.

2. Sync Module: Shall be Wheelock SM-12/24-R.

G. Signal Extender Panel Remote Power Supply (Field Charging Power Supply "FCPS"): Shall be power supply with four Class B notification appliance circuits. Fire-Lite FCPS-24FS6. Minimum battery size shall be 7.0 Ah. Label all power supplies "FCPS" with number shown on plans.

## PART 3 - EXECUTION

### 3.1 INSTALLATION REQUIREMENTS

A. Electrical Contractor shall retain the services of the duly appointed representative as specified hereinbefore, who shall furnish all equipment, make all connections to same, and place system in operation. Technician and workman employed shall be particularly skilled in this type of work. Technicians and workmen must have NICET certification as required hereinbefore. Fire alarm system contractor shall possess a

valid C10 California Electrical Contractors license. Only contractors holding a valid license may perform any fire alarm work.

- B. Existing system shall be tested as soon as possible after award of contract and prior to any demolition work and prior to preparing submittals. Contractor shall test entire system to insure proper operation. Any defects or deficiencies found shall be listed and presented to Owner in letter form. It will be assumed that existing equipment is fully functional unless identified otherwise by Contractor.

Testing shall be scheduled by the Contractor and shall be conducted at time least disruptive to school activities and as approved by District. Contractor shall provide technicians to conduct all testing (from same firm preparing submittals and performing fire alarm work). Testing shall be coordinated to include the Inspector of Record and a representative from Engineer's office.

At time of testing, Contractor shall insure that his submittal will reflect all materials and work necessary to make new equipment function properly with existing.

- C. Detector locations shown on drawings are approximate only. Exact locations shall be coordinated with lighting and mechanical equipment and shall be placed in accordance with NFPA 72 and manufacturer's recommendations (with respect to supply air diffusers, etc.).
- D. Coordinate installation of duct detectors with Division 23 contractor. Exact location shall be as required by Division 23.
- E. Fire alarm circuits shall be terminated on screw terminals. Terminal blocks shall be Allen-Bradley Bulletin 1492 with 600 volt screw terminals for #22 to #10 conductors, mounted to type N22 channel, or approved equal. Submittal shall show internal elevation of terminal cabinets or backboards with equipment laid out.
- F. All cables entering terminal cabinet shall be identified with Brady or E-Z Code wire markers. Upon completion of installation, six (6) copies of one-line "as-built" wiring diagram shall be furnished to Architect.
- G. Each cable run on wiring diagram shall be identified with exact wire marker code (numerical or alphabetical) as appears in terminal cabinets.
- H. Station locations shall be identified by the building's actual room numbers and system shall be programmed accordingly. Coordinate actual room numbers with the Owner. Coordinate final programming with the Owner. Contractor shall furnish a printed copy of final programming to the Owner.
- I. End-of-line resistors shall be installed in terminal cabinets, at backboards, or as noted on drawings.
- J. Color code wiring for the system to match existing scheme.

### 3.2 CONSTRUCTION MEETINGS

- A. The Contractor shall schedule construction meetings at the jobsite as follows:

1. Pre-rough-in meeting shall occur before installation of any boxes, raceways, etc. Exact locations of all detectors and strobes shall be established as recommended by Fire Alarm System subcontractor.
  2. Prewire meeting shall occur after raceways are installed and prior to pulling of any wire or cable.
  3. Pre-termination meeting shall occur after wire and cable has been installed and prior to termination.
- B. Meetings shall be scheduled by the Contractor on a building by building basis and shall include the Project Inspector, Owner's Representative, the electrical subcontractor, and the Fire Alarm System subcontractor as a minimum.

### 3.5 TESTS

- A. One-half to three-quarters of the way through project, Owner's Facilities will set up a meeting (preferably at the site) with decision makers from Facilities, Police Services, Maintenance, Maintenance Alarm Tech, General Contractor, Alarm Sub-contractor, and Owner's Administrator to review the alarm protocol and to identify responsible personnel and timelines for the items listed in paragraph D, which follows.
- B. After all equipment specified herein has been installed and is in operating condition, performance tests shall be conducted by Contractor in accordance with, but not limited to, Figure 14.4.2.2, NFPA 72, to verify that installation and components comply with these specifications. Contractor shall furnish competent personnel for these tests. Testing shall be scheduled with the Owner and shall occur after receipt by Architect of Contractor's written certification of completion, record one-line diagram, wiring diagrams, maintenance and operation manuals, and other "As-Built" data required by these specifications.
- C. Upon completion of the installation of the fire protective signaling equipment and after satisfactory performance tests have been conducted, a satisfactory demonstration of the entire system shall be made in the presence of the Project Inspector. Contractor shall coordinate with Project Inspector and Owner. Demonstration shall be completed prior to occupancy by School and prior to final testing with Owner.
- D. After system is completely tested, the Contractor shall take the following actions with the Owner:
1. The Contractor will schedule a meeting with the Alarm Sub-contractors and Owner's Representatives to determine alarm zone and device nomenclature. The Contractor shall insure that the alarm zone and device nomenclature matches the actual building and room numbers used by the building. Architectural numbering shall not be used. Once confirmed, the Contractor shall demonstrate this to Owner's Representatives.



2. The Contractor shall provide Owner's Representative with the location of the Master Fire Alarm Panel and provide training to include, but not limited to, how to silence the alarm.
3. The Contractor will insure that the buildings are identifiable with, at minimum, temporary ID's of the same size as specified, prior to the start of the one week familiarization period for Owner's Central Station and local fire authority.
4. Owner's Representatives, in conjunction with the Contractor, will test and remotely monitor the alarm system off-line for 48 hours.
5. The Owner's Representatives will review the off-line test report and make recommendation(s) for on-line activation or further testing to resolve any problems. If it is determined further testing is required, the Contractor shall participate and assist with the additional testing and perform all necessary corrective work.
6. The Contractor shall identify and provide to the Owner's Representative a competent 24 hour per day contact person who will respond to any problems with the alarm system during the first month of on-line operation. This shall be provided prior to the alarm system being activated.
7. The Contractor shall coordinate with the Owner's representative to determine a date when the alarm system is to be brought on-line. (No alarm system shall be placed on-line on a Friday, weekend, or Owner holiday.) This date will be scheduled a minimum of seven working days in advance of placing the system on-line, allowing for the one week familiarization period for Central Station and local fire authority personnel with the site and alarm system.
8. When project is phased, and the different phases are to be brought on-line for monitoring, paragraphs 1. through 7. above shall be performed for each phase.

### 3.6 FIRE ALARM SYSTEM CERTIFICATION

- A. Fire Alarm Certification: Written certification on the form found in Figure 10.18.2.1.1, NFPA 72 shall be submitted by the Contractor to Architect (with copies to Electrical Engineer and DSA) stating for himself and the equipment manufacturer that component parts are as LISTED AND APPROVED BY State Fire Marshal, that the installation conforms in all respects to requirements as set forth in the National Electrical Code, that acceptance testing has been performed in the presence of the Project Inspector. The certificate shall be signed by Contractor before submitting to Project Inspector.

END OF SECTION