

# PROJECT MANUAL

## REPLACE BUILDING 100 AHU-19

Project No. 640-15-138

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DEPARTMENT OF VETERANS AFFAIRS  
SPECIFICATIONS  
TABLE OF CONTENTS  
Section 00 01 10

	DIVISION 00 - SPECIAL SECTIONS
00 01 10	Table Of Contents
00 01 15	List of Drawing Sheets
	DIVISION 01 - GENERAL REQUIREMENTS
01 00 00	General Requirements
01 32 16.15	Project Schedules
01 33 23	Shop Drawings, Product Data, and Samples
01 35 26	Safety Requirements
01 40 50	Contractor Coordination Drawings
01 42 19	Reference Standards
01 45 29	Testing Laboratory Services
01 57 19	Temporary Environmental Controls
01 58 16	Temporary Interior Signage
01 74 19	Construction Waste Management
01 91 00	General Commissioning Requirements
	DIVISION 02 - EXISTING CONDITIONS
02 41 00	Demolition
	DIVISION 03 - CONCRETE
03 30 00	Cast-in-Place Concrete
	DIVISION 04 - MASONRY - NOT USED
	DIVISION 05 - METALS
05 12 00	Structural Steel Framing
	DIVISION 06 - WOOD, PLASTICS AND COMPOSITES - NOT USED
	DIVISION 07 - THERMAL AND MOISTURE PROTECTION
07 01 50.19	Preparation for Re-roofing
07 60 00	Flashing and Sheet Metal
07 92 00	Joint Sealants
	DIVISION 08 - OPENINGS - NOT USED
	DIVISION 09 - FINISHES - NOT USED

	DIVISION 10 - SPECIALTIES - NOT USED
	DIVISION 12 - FURNISHINGS - NOT USED
	DIVISION 13 - SPECIAL CONSTRUCTION
13 05 41	Seismic Restraint Requirements for Non-Structural Components
	DIVISION 14 - CONVEYING EQUIPMENT - NOT USED
	DIVISION 21- FIRE SUPPRESSION - NOT USED
	DIVISION 22 - PLUMBING - NOT USED
22 05 11	Common Work Results for Plumbing
22 05 23	General-Duty Values for Plumbing Piping
22 08 00	Commissioning of Plumbing Systems
22 11 00	Facility Water Distribution
22 13 00	Facility Sanitary and Vent Piping
	DIVISION 23 - HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)- NOT USED
23 05 11	Common Work Results For HVAC
23 05 12	General Motor Requirements for HVAC and Steam Generation Equipment
23 05 41	Noise and Vibration Control For HVAC Piping and Equipment
23 05 93	Testing Adjusting and Balancing for HVAC
23 07 11	HVAC and Boiler Plant Insulation
23 08 00	Commissioning of HVAC Systems
23 09 23	Direct-Digital Control System for HVAC
23 21 13	Hydronic Piping
23 21 23	Hydronic Pumps
23 22 13	Steam and Condensate Heating Piping
23 25 00	HVAC Water Treatment
23 31 00	HVAC Ducts and Casings
23 40 00	HVAC Air Cleaning Devices
23 72 00	Air to Air Energy Recovery Equipment
23 74 13	Packaged, Outdoor, Central-Station Air-Handling Units
23 82 16	Air Coils
	DIVISION 25 - INTEGRATED AUTOMATION
	DIVISION 26 - ELECTRICAL
26 05 11	Requirements for Electrical Installations
26 05 19	Low-Voltage Electrical Power Conductors and Cables
26 05 26	Grounding and Bonding for Electrical Systems
26 05 33	Raceway and Boxes for Electrical Systems
26 05 73	Overcurrent Protective Device Coordination Study
26 08 00	Commissioning of Electrical Systems

26 24 16	Panelboards
26 27 26	Wiring Devices
26 29 11	Motor Controllers
26 29 21	Enclosed Switches and Circuit Breakers
	DIVISION 27 - COMMUNICATIONS - NOT USED
	DIVISION 28 - ELECTRONIC SAFETY AND SECURITY - NOT USED



**SECTION 00 01 15**

**LIST OF DRAWINGS**

The drawings listed below accompanying this specification form a part of the contract.

<u>Drawing No.</u>	<u>Title</u>
<b>GENERAL</b>	
GI000	COVER SHEET
GI001	ABBREVIATIONS, SYMBOLS, INDEX OF DRAWINGS AND APPLICABLE STANDARDS
<b>ARCHITECTURAL</b>	
AE100	BUILDING 100 ROOF PLAN
AE101	ROOF DETAILS
<b>STRUCTURAL</b>	
SS-001	GENERAL NOTES, ABBREVIATIONS AND DRAWING LIST
SS-002	TYPICAL DETAILS
SS-200	PARTIAL ROOF FRAMING PLAN
SS-300	EQUIPMENT ANCHORAGE DETAILS
SS-309	EQUIPMENT ANCHORAGE DETAILS
<b>MECHANICAL</b>	
MH-001	ABBREVIATIONS AND LEGEND
MH-002	DRAWING INDEX AND MECHANICAL GENERAL NOTES
MH-201	LOCATION PLAN - FOURTH FLOOR
MH-202	LOCATION PLAN - ROOF
MH-401	PARTIAL ROOF PLAN
MP-401	PARTIAL FOURTH FLOOR PLAN
MP-402	PARTIAL ROOF PLAN
MH-501	DETAIL - AIR HANDLING UNIT NO. 19
MH-601	EQUIPMENT SCHEDULE
MH-701	PIPING DIAGRAM
MH-801	DETAILS
MH-802	DETAILS
MI-701	CONTROL DIAGRAM AND SEQUENCE OF OPERATION

<u>Drawing No.</u>	<u>Title</u>
<b>PLUMBING</b>	
PP-001	SCHEDULES, LEGENDS & ABBREVIATIONS
PP-201	FOURTH FLOOR PLAN
PP-202	ROOF PLAN
<b>ELECTRICAL</b>	
E-001	SYMBOLS & ABBREVIATIONS
E-002	FOURTH & ROOF FLOOR LOCATION PLAN
EP-201	PARTIAL ROOF PLAN
E-301	SINGLE LINE DIAGRAM - NORMAL POWER
E-301R	ELECTRICAL RISER DIAGRAM PART SERVICE 2
E-302	EMERGENCY POWER - SERVICE 2
E-501	DETAILS
E-601	PANEL SCHEDULES
<b>FIRE ALARM</b>	
FA-001	GENERAL NOTES, ABBREVIATIONS AND DRAWING LIST
FA-002	LOCATION PLANS AND PARTIAL ROOF PLAN

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**SECTION 01 00 00**  
**GENERAL REQUIREMENTS**

**TABLE OF CONTENTS**

1.1 GENERAL INTENTION.....	1
1.2 STATEMENT OF BID ITEM(S).....	2
1.3 SPECIFICATIONS AND DRAWINGS.....	2
1.4 ACCIDENT PREVENTION.....	2
1.5 CONSTRUCTION SECURITY REQUIREMENTS.....	4
1.5 FIRE SAFETY.....	6
1.6 OPERATIONS AND STORAGE AREAS.....	9
1.7 ALTERATIONS.....	13
1.8 INFECTION PREVENTION MEASURES.....	14
1.9 DISPOSAL AND RETENTION.....	17
1.10 PROTECTION OF EXISTING VEGETATION, STRUCTURES, EQUIPMENT, UTILITIES, AND IMPROVEMENTS.....	18
1.11 RESTORATION.....	18
1.12 PHYSICAL DATA.....	20
1.13 LAYOUT OF WORK.....	20
1.14 AS-BUILT DRAWINGS.....	20
1.15 USE OF ROADWAYS.....	21
1.16 TEMPORARY USE OF MECHANICAL AND ELECTRICAL EQUIPMENT.....	21
1.17 EXCLUSIVE TEMPORARY USE OF EXISTING ELEVATORS.....	22
1.18 TEMPORARY TOILETS.....	23
1.19 AVAILABILITY AND USE OF UTILITY SERVICES.....	23
1.20 NEW TELEPHONE EQUIPMENT.....	24
1.21 TESTS.....	24
1.22 INSTRUCTIONS.....	25
1.23 GOVERNMENT-FURNISHED PROPERTY.....	26
1.24 RELOCATED EQUIPMENT ITEMS.....	27

1.25 CONSTRUCTION SIGN.....	27
1.26 SAFETY SIGN.....	28
1.27 PHOTOGRAPHIC DOCUMENTATION .....	28
1.28 FINAL ELEVATION DIGITAL IMAGES - NOT USED.....	29
1.29 HISTORIC PRESERVATION.....	29

**SECTION 01 00 00**  
**GENERAL REQUIREMENTS**

**1.1 GENERAL INTENTION**

- A. Contractor shall completely prepare site for construction operations, and furnish all labor, equipment and materials and perform work for the expansion and modification of Air Handling Unit 19 for Building 100, VAPAHCS, as required by the drawings and specifications.
- B. Visits to the VA Campus site by Bidders may be made only by appointment with the Contracting Officer's Representative.
- C. Offices of The KPA Group, One Kaiser Plaza, Oakland, CA 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.
- D. Before placement and installation of work subject to tests by a testing laboratory approved by the COR and retained by the contractor, the Contractor shall notify the Contracting Officer's Representative and the testing laboratory in sufficient time to enable the COR and the testing laboratory personnel to be present at the site in time for proper taking and testing of specimens and field inspection. Such prior notice shall be not less than three work days unless otherwise designated by the Contracting Officer's Representative.
- E. All employees of the Contractor and subcontractors shall comply with the VA security management program and obtain permission for site entry from the VA police, be identified by project and employer, and be restricted from unauthorized access.
- F. The Contracting Officer's Representative will assign specific routes and times for pathways, corridors and elevators for transportation of personnel, materials and equipment. The Contractor will continually clean-up any dust, dirt or debris caused by their jobsite Ingress/egress.
- G. Dust and fume control will be exercised during all construction operations. Workers will be careful not to operate any vehicles, gas or diesel engines, or to perform any fume or dust generating process near a building air intake system. Noise will be held to a minimum at all times. Jack-hammering, core drilling and other noisy or disturbing

operations may have to be rescheduled or accomplished after hours to avoid interfering with surgery or patient care services.

#### **1.2 STATEMENT OF BID ITEM(S)**

- A. ITEM I, GENERAL: Work includes general demolition and replacement upgrade of select mechanical infrastructures at Building 100 VA Palo Alto Healthcare System.
- B. SCOPE OF WORK: This project provides for upgrade of Air Handling Unit 19 of Building 100, VA Palo Alto Healthcare System, as well as ancillary support systems. The intent of the project is to provide for a complete and functional system as shown on the construction documents.
- C. DEDUCTIVE ALTERNATES: NOT USED FOR THIS PROJECT

#### **1.3 SPECIFICATIONS AND DRAWINGS**

- A. After award of contract, specifications and drawings will be available for download from a link provided by the Contracting Officer's Representative
- B. The Contractor shall maintain on the job site one (1) printed set of specifications, one (1) printed set of drawings, one (1) printed copy of all RFI's and any documents that modify the original specifications and drawings.

#### **1.4 ACCIDENT PREVENTION**

- A. The Contractor shall provide and maintain work environments and procedures which will:
  - 1. Safeguard the public and Government personnel, property, materials, supplies, and equipment exposed to Contractor operations and activities;
  - 2. Avoid interruptions of Government operations and delays in project completion dates;
  - 3. Control costs in the performance of this contract; and
  - 4. Maintain a safe and healthy worksite to prevent adverse impacts to Contractor and subcontractor employees.
- B. The Contractor shall:
  - 1. Before commencing the work, submit a written Safety Plan for implementing actions to prevent accidents. The plan shall include an analysis of significant hazards to life, limb and property inherent in contract work performance and measures for controlling these hazards and avoiding personnel exposure. Meet with the Contracting Officer's Representative to discuss and develop a mutual understanding relative to administration of the overall safety

- program and obtain approval for the Contractor's Safety Plan from the Contracting Officer's Representative before work start.
2. Comply with the standards issued by the Secretary of Labor at 29 CFR Part 1926 and 29 CFR Part 1910 (OSHA); and Title 8, California Administrative Code - Construction Standards (CAL OSHA)
  3. Prior to commencing work, provide proof that an OSHA designated competent person (CP) per 29 CFR 1926.20(b)/ 1926.32(f)(2) will maintain a presence at the work site whenever the Contractor or subcontractors are present.
  4. Provide appropriate safety barricades, signs, signal lights and personal protective equipment (hard hats, goggles, protective shoes, gloves, masks or breathing apparatus, etc.).
  5. Ensure all Contractor and subcontractor employees have the 10-hour or 30-hour OSHA Construction Safety course and other relevant competency training, as determined by Contracting Officer's Representative. General Contractor shall maintain at least one person on site at all times who has completed the 30 hours OSHA Construction Safety Course (submittal of 30 hour training certificate required prior to start of work). Submit training records of all such employees for approval before the start of work.
  6. Ensure that any additional measures the Contracting Officer determines to be reasonably necessary for accident protection and safety of personnel are taken.
- C. Whenever the Contracting Officer becomes aware of any noncompliance with safety requirements or any condition which poses a serious or imminent danger to the health or safety of personnel, the Contracting Officer shall notify the Contractor orally, with written confirmation, and request immediate initiation of corrective action. After receiving the notice, the Contractor shall immediately take corrective action. If the Contractor fails or refuses to promptly take corrective action, the Contracting Officer may issue an order stopping all or part of the work until satisfactory corrective action has been taken. The Contractor shall not be entitled to any equitable adjustment of the contract price or extension of the performance schedule on any stop work order issued under this clause.
- D. The Contractor shall insert the above clause with appropriate changes in the designation of the parties in subcontracts.

### 1.5 CONSTRUCTION SECURITY REQUIREMENTS

- A. Security Plan (Submittal of Security Plan is required prior to mobilization):
  - 1. The Security Plan defines both physical and administrative security procedures that will remain effective for the entire duration of the project.
  - 2. The 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. Contractor and subcontractor employees shall not enter the project site without an appropriate badge. They will be subject to inspection of their personal effects when entering or leaving the project site.
  - 2. The Contractor shall create an Employee Daily Log of all personnel working on the site. The Employee Daily Log shall contain the employee's (a) Full Name, (b) Employer/Company Name and (c) Occupation/Trade. The Employee Daily Log shall be submitted with the Contractor's Daily Work Report.
- 3. Contractor's normal working hours shall be 7am to 4pm Monday through Friday excluding federally observed holidays. Contractor may be required to perform certain work activities outside of normal hours in the case of significant noise, dust or vibration that will disrupt hospital operations.
  - I. Contractor must observe Federal Holidays with no work allowed on such days. Refer to the OPM website [www.opm.gov](http://www.opm.gov) for the observed Federal Holidays and their dates for the applicable year.
  - a. Contractor must obtain written prior approval by the COR to work outside of normal working hours and weekends. This notice is separate from any notices required for utility shutdown described later in this specification.
- 4. No photography of VA premises is allowed without written permission of the VA Public Affairs Officer.
- 5. The VA Police are Federal Police Officers with full authority to make arrests, investigate crimes and issue traffic citations. Citations issued require an appearance in the Federal District Court and/or payment of a fine. Speed limits and other driving and parking codes are strictly enforced. Any vehicle left unattended for more than a few minutes may be cited by the VA Police.

6. Sexual harassment is strictly prohibited. This includes deliberate or unsolicited verbal comments or gestures of a sexual nature, unwelcome sexual advances, requests for sexual favors and/or other unwelcome verbal or physical conduct of a sexual nature.
7. Possession or use of non-prescription drugs or alcohol, including beer and wine, on the Health Care System grounds is strictly prohibited. Possession of firearms, knives with blades over 4", ammunition, explosive devices and any item that may be considered an offensive weapon is strictly prohibited. This includes carrying such items in vehicles.
8. The Health Care System does not have the equipment, facilities, or personnel trained to handle serious injuries. Call 911 for emergency medical assistance and notify the Contracting Officer's Representative and the VA Police.
9. Vehicle authorization requests shall be required for any contractor vehicle entering the site and such requests shall be submitted 24 hours before the date and time of access. Access shall be restricted to picking up and dropping off materials and supplies.
10. VA reserves the right to shut down the project site and order Contractor's employees and subcontractors off the premises in the event of a national emergency or local disaster. The Contractor may return to the site only with the written approval of the Contracting Officer's Representative.

C. Guards: NOT USED

D. Key Control:

1. The Contractor shall provide duplicate keys and lock combinations to the Contracting Officer's Representative for the purpose of security inspections and emergency actions for every area of the project site including tool boxes and parked machines.
2. The Contractor shall turn over all permanent lock cylinders to the VA locksmith for permanent installation.

E. Document Control:

1. Before mobilization, the Contractor shall submit to and receive acceptance by the COR, an electronic security memorandum describing the approach to following goals and maintaining confidentiality of "Sensitive Information".
2. The Contractor is responsible for safekeeping of all drawings, project manuals and other project information. This information shall

- be shared only with those with a specific need to accomplish the project.
3. Certain documents, sketches, videos or photographs and drawings may be marked "Law Enforcement Sensitive" or "Sensitive Unclassified". Secure such information in separate containers and limit access to only those who will need it for the project. Return the information to the Contracting Officer's Representative upon request.
  4. These security documents shall not be removed or transmitted from the project site without the written approval of Contracting Officer's Representative.
  5. All paper waste or electronic media shall be shredded, destroyed or erased in a manner acceptable to the VA.
  6. Notify Contracting Officer's Representative and Site Security Officer immediately when there is a loss or compromise of "Sensitive Information".
  7. All electronic information shall be stored in specified location following VA standards and procedures using an Engineering Document Management Software (EDMS).
    - a. Security, access and maintenance of all project drawings, both scanned and electronic shall be performed and tracked through the EDMS system.
    - b. "Sensitive Information" including drawings and other documents may be attached to e-mails provided all VA encryption procedures are followed.

#### **1.5 FIRE SAFETY**

A. Applicable Publications: Publications listed below form part of this Article.

1. American Society for Testing and Materials (ASTM):  
E84-13a.....Surface Burning Characteristics of Building  
Materials
2. National Fire Protection Association (NFPA):  
NFPA 10.....Standard for Portable Fire Extinguishers  
NFPA 30.....Flammable and Combustible Liquids Code  
NFPA 51.....Standard for Fire Prevention During Welding,  
Cutting and Other Hot Work  
NFPA 70/NEC.....National Electrical Code  
NFPA 241.....Standard for Safeguarding Construction,  
Alteration, and Demolition Operations



3. Occupational Safety and Health Administration (OSHA):

29 CFR 1910/1926.....Safety and Health Regulations for Construction

B. Fire Safety Plan (Submittal acceptance by COR of Fire Safety Plan is required prior to mobilization):

Establish and maintain a 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's Representative for review for compliance with contract requirements. Prior to any worker for the Contractor or subcontractors beginning work, they shall undergo a safety briefing provided by the Contractor's competent person per OSHA requirements. This briefing shall include information on the construction limits, VA safety guidelines, means of egress, break areas, work hours, locations of restrooms, use of VA equipment, etc. Documentation shall be provided to the Contracting Officer's Representative that individuals have undergone Contractor's safety briefings.

C. Site and Building Access: Maintain free and unobstructed access to facility emergency services and fire, police and other emergency response forces in accordance with NFPA 241. In the event of a fire or during a fire drill, the Contractor must vacate the construction site if within the zone affected.

D. 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 20 feet exposed overall length, separate by 10 feet.

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's Representative.

G. Egress Routes for Construction Workers: Maintain free and unobstructed egress. Inspect daily and report findings and corrective actions weekly to Contracting Officer's Representative.

H. Fire Extinguishers: Provide, maintain and show proof of extinguisher maintenance in construction areas and temporary storage areas in accordance with 29 CFR 1926, NFPA 241 and NFPA 10. Provide minimum of (2) 10 pound fire extinguishers at all times.

I. Flammable and Combustible Liquids: Store, dispense and use liquids in accordance with 29 CFR 1926, NFPA 241 and NFPA 30.

- J. Standpipes: Maintain standpipes at each floor in accordance with 29 CFR 1926 and NFPA 241. Do not charge wet standpipes subject to freezing until weather protected.
- K. Sprinklers: Install, test and activate new automatic sprinklers prior to removing existing sprinklers.
- L. Existing Fire Protection: Do not impair automatic sprinklers, smoke and heat detection and fire alarm systems except for portions immediately under construction or temporarily for connections. Provide fire watch for impairments more than 4 hours in a 24-hour period. If a Fire Alarm system or sprinkler system is out of service for more than 4 hours, then the Contractor shall implement Interim Life Safety Measures in accordance with VA Palo Alto Health Care System Memorandum SAFE 13-23. Request interruptions in accordance with Article, OPERATIONS AND STORAGE AREAS, and coordinate with Contracting Officer's Representative. All existing or temporary fire protection systems (fire alarms, sprinklers) located in construction areas shall be tested as coordinated with the Contracting Officer's Representative.
- M. Smoke Detectors: Prevent accidental operation. Remove temporary covers at end of work operations each day. Coordinate with Contracting Officer's Representative.
- N. Hot Work: Perform and safeguard hot work operations in accordance with NFPA 241 and NFPA 51. Any welding, cutting metal or other burning or spark producing operations require a hot work permit. Welding and/or burning operations are allowed only during normal working hours. Coordinate with Contracting Officer's Representative to obtain permits from the Facility Safety Officer at least 24 hours in advance. Evidence of training of all personnel assigned to be a fire watch shall be provided before Hot Work Permits will be issued. A fire watch is required for all hot work unless specified differently on the permit. The fire watch shall have fire extinguishing equipment readily available and be trained in its use and be familiar with facilities for sounding an alarm in the event of a fire. They shall watch for fires in all exposed areas, try to extinguish then otherwise sound the alarm. A fire watch shall be maintained for at least 30 minutes after completion of hot work.
- O. Fire Hazard Prevention and Safety Inspections: Inspect entire construction areas weekly. Coordinate with and report findings and corrective actions weekly to Contracting Officer's Representative.

- P. Smoking: Smoking is prohibited in all buildings and adjacent construction areas. Smoking is prohibited except in designated smoking areas.
- Q. Dispose of waste and debris in accordance with NFPA 241. Remove from buildings daily. Waste and debris will not be disposed of on station or in VA trash containers or dumpsters. The Contractor shall provide their own bin or dumpster; however, the use and location of such must be approved in writing by the Contracting Officer's Representative. Construction waste and debris will not be accumulated in corridors or other building areas where it might cause a fire or safety hazard. Contractor shall provide a monthly summary of construction and demolition debris diversion and disposal, quantifying all materials generated at the work site and disposed of or diverted from disposal through recycling per SECTION 01 74 19 CONSTRUCTION WASTE MANAGEMENT.
- R. Smoke/fire Barrier Penetrations: Any penetrations to smoke or fire barrier walls, ceilings or floor slabs shall be properly sealed immediately with Hilti Fire Stop 601 or 635 for walls and ceilings and Hilti Fire Stop 657 for floor penetrations or approved equal.
- S. Install one-hour temporary construction partitions as shown on drawings or as required to separate the work site from the occupied portion of the building and maintain integrity of existing exit stair enclosures, exit passageways, fire-rated enclosures of hazardous areas, horizontal exits, smoke barriers, vertical shafts and openings enclosures. Extend the partitions through suspended ceilings to floor slab deck or roof. Seal joints and penetrations. At door openings, install Class C, ¾ hour fire/smoke rated doors with self-closing devices.
- T. If required, submit documentation to the Contracting Officer's Representative that personnel have been trained in the fire safety aspects of working in areas with impaired structural or compartmentalization features.

#### **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's Representative. 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's Representative 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 their expense upon completion of the work. With the written consent of the Contracting Officer's Representative, the buildings and utilities may be abandoned and need not be removed.

- C. The Contractor shall, as prescribed by the Contracting Officer's Representative, use only established roadways, or use temporary roadways constructed by the Contractor when and as authorized by the Contracting Officer's Representative. 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, code 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.
- D. Working space and space available for storing materials shall be as determined by the Contracting Officer's Representative.
- E. Workmen are subject to rules of the VA Campus applicable to their conduct.
- F. Execute work so as to interfere as little as possible with normal functioning of the VA Campus as a whole, including operations of utility services, fire protection systems and any existing equipment, and with work being done by others.
  - 1. Do not store materials and equipment in other than assigned areas.
  - 2. Schedule delivery of materials and equipment to immediate construction working areas within buildings in use by the VA in quantities sufficient for not more than two work days. Provide unobstructed access to VA Campus areas required to remain in operation.
- G. Utilities Services: Provide temporary facilities, labor, materials, equipment, connections, and utilities to assure uninterrupted services. Where necessary to cut existing pipes, electrical wires, conduits, cables, etc., of utility services, or of fire protection systems or communications systems, they shall be cut and capped at suitable places where shown; or, in absence of such indication, where directed by Contracting Officer's Representative. All such actions shall be coordinated with any Utility Company involved:

- H. Construction Fence: Before construction operations begin, Contractor shall provide a chain link construction fence, six-foot minimum height, around the construction area, material storage areas and dumpsters/waste locations. Contractor shall provide and maintain visual screening fabric for all fencing. Contractor shall provide gates as required for access with necessary hardware including hasps and locks. All gates shall be locked when no workers are present. Contractor shall coordinate with the COR to assure VA access at any time. Contractor shall remove the fence when directed by Contracting Officer's Representative. Contractor shall place all applicable safety signs as required by 29 CFR 1926, securely attached to fence or approved surface. Contractor shall also place construction area signs on the exterior of the construction fence alerting campus and contractor personnel that the fence is enclosing a construction area. Sign shall indicate Construction Area, Authorized Personnel Only, Hard Hats and safety shoes required - Spacing of signs shall not exceed 50' on center, with a minimum of one safety sign on each direction of fence.
- I. Work areas will be vacated by Government and turned over to Contractor after date of Notice to Proceed and all pre-construction activities and submittals have been accepted by the COR.
- J. When a building/ area are turned over to Contractor, Contractor shall accept entire responsibility 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. In connection with fire alarm equipment, Contractor shall make arrangements for pre-inspection of site with Fire Department or Company (VA or municipal) whichever will be required to respond to an alarm from Contractor's employee or watchman.
- K. Utilities Services: Maintain existing utility services for the VA Campus at all times.
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 Contracting Officer's Representative. 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 the Contracting Officer's

- Representative prior knowledge and written approval. Refer to specification Sections 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, 27 05 11 REQUIREMENTS FOR COMMUNICATIONS INSTALLATIONS and 28 05 11, REQUIREMENTS FOR ELECTRONIC SAFETY AND SECURITY INSTALLATIONS for additional requirements.
2. Contractor shall submit a request to interrupt any such services to Contracting Officer's Representative, in writing, 4 weeks 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 the VA. Interruption time approved by Contracting Officer's Representative may occur at other than Contractor's normal working hours.
  4. Major interruptions of any system must be requested, in writing, at least 30 calendar days prior to the desired time and shall be performed as directed by the Contracting Officer's Representative.
  5. In case of a contract construction emergency, service will be interrupted on approval of Contracting Officer's Representative. Such approval will be confirmed in writing as soon as practical.
  6. Whenever it is required that a connection fee be paid to a public utility provider for new permanent service to the construction project, for such items as water, sewer, electricity, gas or steam, payment of such fee shall be the responsibility of the Contractor.
- L. 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. 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.
- M. To minimize interference of construction activities with flow of VA Campus traffic, comply with the following:
1. The Contractor shall not block any road or street, walkway or building egress without requesting in writing for approval from the Contracting Officer's Representative. Written requests shall be made at least (14) days prior to proposed interruption. 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. Wherever excavation for new work crosses existing roads, at least one lane must be open to traffic at all times.

2. Method and scheduling of required cutting, altering and removal of existing roads, walks and entrances must be approved by the Contracting Officer's Representative.

- N. Coordinate this contract with other construction operations as directed by Contracting Officer's Representative. This includes the scheduling of traffic and the use of roadways.

#### **1.7 ALTERATIONS**

- A. Survey: Before any work is started, the Contractor shall make a thorough survey with the Contracting Officer's Representative, of buildings areas in which alterations occur and areas which are anticipated routes of access, and furnish a signed report, to the Contracting Officer's Representative. 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 the building.
  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 Contracting Officer's Representative.
- 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 Contracting Officer's Representative 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: Thirty days before expected partial or final inspection date, the Contractor and Contracting Officer's Representative 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. 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 INFECTION PREVENTION MEASURES**

- A. Implement the requirements of VA's Infection Control Risk Assessment (ICRA) team. ICRA Group may monitor dust in the vicinity of the construction work and require the Contractor to take corrective action immediately if safe levels are exceeded.
- B. Establish and maintain a dust control program as part of the Contractor's infection preventive measures in accordance with the guidelines provided by ICRA Group. Prior to start of work, prepare a plan detailing project-specific dust protection measures, including periodic status reports, and submit to Contracting Officer's Representative and Facility ICRA team for review for compliance with contract requirements.
  1. All personnel involved in the construction or renovation activity shall be educated and trained in infection prevention measures established by the medical center.
- C. VA Infection Control personnel shall monitor for airborne disease (e.g. aspergillosis) as appropriate during construction. A baseline of conditions may be established by the Contracting Officer's Representative prior to the start of work and periodically during the



construction stage to determine impact of construction activities on indoor air quality. In addition in patient-care areas:

1. The Contractor, Contracting Officer's Representative and VA Infection Control personnel shall review pressure differential monitoring documentation to verify that pressure differentials in the construction zone and in patient-care areas are appropriate for their settings. The requirement for negative air pressure in the construction zone shall depend on the location and type of activity. Upon notification, the contractor shall implement corrective measures to restore proper pressure differentials as needed. The contractor shall install negative air machines as directed by the Contracting Officer's Representative and shall be required to add machines as directed.
  2. In case of a problem - the VA, with assistance from the contractor, shall conduct an environmental assessment to find and eliminate the source.
- D. In general, following preventive measures shall be adopted during construction to keep down dust and prevent mold.
1. Dampen debris to keep down dust and provide temporary construction partitions in existing structures where directed by Contracting Officer's Representative. Blank off ducts and diffusers to prevent circulation of dust into patient-occupied areas during construction.
  2. Do not perform dust producing tasks within patient-occupied areas without the approval of the Contracting Officer's Representative. For construction in any areas that will remain jointly occupied by the medical Center and Contractor's workers, the Contractor shall:
    - a. Provide dust proof temporary drywall construction barriers to completely separate construction from the operational areas of the hospital in order to contain dirt debris and dust. Construct the dust proof barrier with a one hour fire rating. Barriers shall be sealed and made presentable on hospital occupied side. Install a self-closing rated door in a metal frame, commensurate with the partition, to allow worker access. Maintain negative air at all times. A fire retardant polystyrene, 6-mil thick or greater plastic barrier meeting local fire codes may be used in certain circumstances where hard walls cannot be constructed and an agreement is reached with the Contracting Officer's Representative and VA Fire Protection Specialist.

- b. HEPA filtration is required. Contractor shall verify that construction exhaust to exterior is not reintroduced to the medical center through intake vents, or building openings. Install HEPA (High Efficiency Particulate Accumulator) filter vacuum system rated at 95% capture of 0.3 microns including pollen, mold spores and dust particles. Insure continuous negative air pressures occurring within the work area. HEPA filters should have ASHRAE 85 or other prefilter to extend the useful life of the HEPA. Provide both primary and secondary filtrations units. Exhaust hoses shall be heavy duty, flexible steel reinforced and exhausted so that dust is not reintroduced to the medical center.
- c. The contractor shall install a state of the art air pressure differential monitor. The monitor shall be placed at such a location that anyone entering or leaving the work site shall be able to determine if negative air pressure is being maintained.
- d. Adhesive Walk-off/Carpet Walk-off Mats, minimum 24" x 36", shall be used at all interior transitions from the construction area to occupied medical center area. A shop vacuum with HEPA filtration shall be placed at any exit from the work site. These shop vacuums shall be used to remove dust that has accumulated on workers clothing while working whenever they leave the work site. The mats shall be changed as directed by the Contracting Officer's Representative to maintain clean work areas directly outside construction area at all times.
- e. Vacuum and wet mop all transition areas from construction to the occupied medical center at the end of each workday. Shop vacuums and vacuum cleaners shall utilize HEPA filtration. Maintain surrounding area frequently. Remove debris as they are created. Transport these outside the construction area in containers with tightly fitting lids.
- f. The contractor shall not haul debris through patient-care areas without prior approval of the Contracting Officer's Representative. When, approved, debris shall be hauled in enclosed dust proof containers or wrapped in plastic and sealed with tape. No sharp objects should be allowed to cut through the plastic. Wipe down the wheel treads and 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. Wheels and tires shall not track debris on floors outside the work zone.

- g. Using a HEPA vacuum, clean inside the barrier and vacuum ceiling tile prior to replacement. Any ceiling access panels opened for investigation beyond sealed areas shall be sealed immediately when unattended.
- h. 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 4 hours. Remove and dispose of porous materials that remain damp for more than 24 hours.
- i. 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.

E. 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 and existing air ducts shall be cleaned prior to final inspection.

**1.9 DISPOSAL AND RETENTION**

A. Materials and equipment accruing from work removed 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 or in specifications as items to be stored. Items that remain property of the Government shall be removed from present locations in such a manner as to prevent damage. Store such items where directed by Contracting Officer's Representative.
- 2. Items not reserved shall become property of the Contractor and be removed by Contractor.
- 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 VA 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.

4. The Contractor is required to alert the VA immediately in the event any known or suspected hazardous materials are disturbed or will need to be disturbed before proceeding with work. Hazardous materials, such as PCB's, asbestos, lead paint, cleaning solutions and other harmful chemicals shall be disposed of in accordance with federal, state and local laws and regulations. In case of an accidental spill of hazardous materials, the Contractor shall take immediate action to contain the spill and notify the Contracting Officer's Representative. Washing cement, plaster, paint, oil or grease, solvents, etc. into any drains is strictly prohibited. **REPORT ANY ACCIDENTAL SPILLS THAT MAY RUN INTO STORM DRAINS IMMEDIATELY TO ENGINEERING SERVICE AT 650-493-5000 EXTENSION 62468.**

#### **1.10 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 as directed by the Contracting Officer's Representative.
- B. Contractor shall protect all irrigation equipment designated to remain within the limit of work and ensure the continued irrigation of all existing planting areas to remain in place.
- C. *The project construction may affect irrigation operations beyond the limit of work.* It shall be the responsibility of the Contractor to ensure the irrigation operations beyond the limit of work, affected by the project construction, remain operational during construction.
- D. The Contractor shall protect existing trees to remain by placing temporary fencing at the drip line of the trees. Provide 6' high tree protection fencing completely enclosing the tree(s). Avoid driving major fence posts or stakes into major roots.
  1. Treatment of roots exposed during construction. For roots over 1 inch in diameter damaged during construction, make a clean straight cut to

- remove damaged portion of the root. All exposed roots should be temporary covered with damp burlap and covered with soil or mulch as soon as possible to prevent drying.
2. No equipment or machinery shall be used within the tree protection zone. Work within the protection zone shall be done manually.
  3. No stockpiling of materials, vehicular traffic, or storage is allowed within the tree protection zone.
- E. 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's Representative may have the necessary work performed and charge the cost to the Contractor.

#### **1.11 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 Contracting Officer's Representative. Existing work to be altered or extended and that which is found to be defective in any way, shall be reported to the Contracting Officer's Representative 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, computer network, etc.) which are indicated on drawings or reasonably

discovered during execution of the work and which are not scheduled for discontinuance or abandonment.

- D. Expense of repairs to such utilities and systems not shown on drawings for which locations are unknown and not reasonably discovered will be considered for 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).

#### **1.12 PHYSICAL DATA**

- A. Data and information (test borings, hydrographic data, test pits, weather conditions, etc.) furnished or referred to is for the Contractor's information. The Government shall not be responsible for any interpretation of or conclusion drawn from the data or information by the Contractor. (FAR 52.236-4)

#### **1.13 LAYOUT OF WORK**

- A. The Contractor shall lay out the work and shall be responsible for all measurements in connection with the layout. The Contractor shall furnish, at Contractor's own expense, all templates, equipment, tools, materials, and labor required to lay out any part of the work. The Contractor shall be responsible for executing the work to the lines that may be established or indicated by the Contracting Officer's Representative. The Contractor shall also be responsible for maintaining and preserving all marks established by the Contracting Officer's Representative until authorized to remove them. If such marks are destroyed by the Contractor or through Contractor's negligence before their removal is authorized, the Contracting Officer's Representative may replace them and deduct the expense of the replacement from any amounts due or to become due to the Contractor. (FAR 52.236-17)

#### **1.14 AS-BUILT DRAWINGS**

- A. The Contractor shall maintain one full size set 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 Contracting Officer's Representative's review, as often as requested.
- C. Contractor shall deliver two approved completed sets of as-built drawings to the Contracting Officer's Representative within 15 calendar days after each completed phase and after the acceptance of the project by the Contracting Officer's Representative.

Contractor shall provide all final as-built drawings prepared in CAD software. An electronic copy shall be delivered to the COR in both DWG format and PDF along with the two hard copy sets. Drawing size, style, and fonts shall match construction drawings provided to the contractor by the contracting officer. Coordinate with COR for allowable version of DWG files.

#### **1.15 USE OF ROADWAYS**

- A. For hauling, use only established public roads and roads on the VA Campus and, when authorized by the Contracting Officer's Representative, such temporary roads which are necessary in the performance of contract work. Temporary roads shall be constructed by the Contractor at Contractor's expense. When necessary to cross curbing, sidewalks, or similar construction, they must be protected by well-constructed transitions.

#### **1.16 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 compliance with the following provisions:
  - 1. Permission to use each unit or system must be given by Contracting Officer's Representative. If the equipment is not installed and maintained in accordance with the following provisions, the Contracting Officer's Representative 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. 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 use 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. Boilers, pumps, feedwater heaters and auxiliary equipment must be operated as a complete system and be fully maintained by operating personnel. Boiler water must be given complete and continuous chemical treatment.
- 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.

**1.17 EXCLUSIVE TEMPORARY USE OF EXISTING ELEVATORS**

- A. Exclusive use of existing elevators for handling building materials and Contractor's personnel will be permitted subject to following provisions:
  1. Contractor shall coordinate all arrangements with the Contracting Officer's Representative for use of elevators. The Contracting Officer's Representative will ascertain that elevators are in proper condition. Personnel for operating elevators will not be provided by the VA.
  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.



4. If brake lining of elevators are excessively worn or damaged during temporary use, they shall be removed and replaced with new brake lining.
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, 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's Representative.

#### **1.18 TEMPORARY TOILETS**

- A. Provide where directed, (for use of all Contractor and subcontractor employees) ample temporary sanitary toilet accommodations with suitable sewer and water connections; or, when approved by Contracting Officer's Representative, provide suitable dry closets where directed. Keep such places clean and free from odor or flying insects, and all connections and appliances connected therewith are to be removed prior to completion of contract, and premises left perfectly clean.

#### **1.19 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. If applicable, 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 satisfactory to the Contracting Officer's Representative, shall install and maintain all necessary temporary connections and distribution lines, transformers and electrical panels, 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 equipment at contractor's own expense.
- C. Contractor shall install meters at Contractor's expense and furnish the Contracting Officer's Representative a monthly record of the Contractor's usage of electricity as required.
- 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 VA Campus electrical distribution system where practical. 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.
  - 2. Where Campus power is not practical or available for project power requirements, contractor shall provide portable power generators at contractor's own expense.
- F. Water (for Construction and Testing): Furnish temporary water service.
  - 1. Obtain water by connecting to the VA Campus water distribution system. Provide reduced pressure backflow preventer at each connection. 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 Contracting Officer's Representative's discretion) of use of water from VA Campus system at no cost.
  - 3. Provide drinking water for construction personnel at all times.
- G. Fuel: Natural and LP gas and burner fuel oil required for boiler cleaning, normal initial boiler-burner setup and adjusting, and for performing the specified boiler tests will be furnished by the Government. Fuel required for prolonged boiler burner setup, adjustments, or modifications due to improper design or operation of boiler, burner, or control devices shall be furnished or reimbursed by the Contractor at Contractor's expense.

#### **1.20 NEW TELEPHONE EQUIPMENT**

- A. The Contractor shall coordinate the work of installation of telephone equipment by others. This work shall be completed before the building is turned over to VA.

#### **1.21 TESTS**

- A. 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.

- B. Conduct final tests required in various sections of specifications in presence of the Contracting Officer's Representative. Contractor shall furnish all labor, materials, equipment, instruments, and forms, to conduct and record such tests, and re-tests as required.
- C. Mechanical and electrical systems shall be balanced, controlled and coordinated. A system is defined as the entire complex 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 complex 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.
- D. All related components shall be functioning when any system component is tested. Tests shall be completed within a reasonably short period of time during which operating and environmental conditions remain reasonably constant.
- E. 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.

#### **1.22 INSTRUCTIONS**

- A. Contractor shall furnish Maintenance and Operating Manuals and verbal instructions when required by the various sections of the specifications and as hereinafter specified.
- B. Manuals: Maintenance and Operating Manuals (two copies each plus pdf file) for each separate piece of equipment shall be delivered to the Contracting Officer's Representative 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 manufacturer representatives to give detailed instructions to assigned VA 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 Contracting Officer's Representative and shall be considered concluded only when the Contracting Officer's Representative is satisfied in regard to complete and thorough coverage. The VA reserves the right to request the removal of, and substitution for, any instructor who, in the opinion of the Contracting Officer's Representative, does not demonstrate sufficient qualifications in accordance with requirements for the above.

#### **1.23 GOVERNMENT-FURNISHED PROPERTY**

- A. The Government shall deliver to the Contractor, the Government-furnished property shown on the drawings.
- B. Equipment furnished by Government to be installed by Contractor will be furnished to Contractor at the building.
- C. Storage space for equipment will be provided by the Government and the Contractor shall be prepared to unload and store such equipment therein upon its receipt at the building.
- D. Notify Contracting Officer's Representative in writing, 60 days in advance, of date on which Contractor will be prepared to receive equipment furnished by Government. Arrangements will then be made by the Government for delivery of equipment.
1. Immediately upon delivery of equipment, Contractor shall arrange for a joint inspection thereof with the Contracting Officer's

- Representative. At such time the Contractor shall acknowledge receipt of equipment described, make notations, and immediately furnish the Contracting Officer's Representative with a written statement as to its condition or shortages.
2. Contractor thereafter is responsible for such equipment until such time as acceptance of contract work is made by the Contracting Officer's Representative.
- E. Equipment furnished by the Government will be delivered in a partially assembled (knock down) condition in accordance with existing standard commercial practices, complete with all fittings, fastenings, and appliances necessary for connections to respective services installed under contract. All fittings and appliances (i.e., couplings, ells, tees, nipples, piping, conduits, cables, and the like) necessary to make the connection between the Government furnished equipment item and the utility stub-up shall be furnished and installed by the Contractor at no additional cost to the Government.
- F. Completely assemble and install the Government furnished equipment in place ready for proper operation in accordance with specifications and drawings.
- G. Furnish supervision of installation of equipment at construction site by qualified factory trained technicians regularly employed by the equipment manufacturer.

#### **1.24 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 Contracting Officer's Representative.
- C. 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.

#### **1.25 CONSTRUCTION SIGN**

- A. Provide a Construction Sign where directed by the Contracting Officer's Representative. All wood members shall be of framing lumber. Cover sign frame with 24 gage galvanized sheet steel nailed securely around edges and on all bearings. Provide three 4 inch by 4 inch posts or equivalent round posts set four feet into ground. Set bottom of sign level at three feet above ground and secure to posts with through bolts. Make posts

full height of sign. Brace posts with two by four inch material. Minimum sign size shall be 48"x48".

- B. Paint all surfaces of sign and posts two coats of white gloss paint. Border and letters shall be of black gloss paint, except project title which shall be blue gloss paint.
- C. Maintain sign and remove it when directed by the Contracting Officer's Representative.
- D. Provide detailed drawing of proposed construction sign showing required legend and other characteristics of sign for approval by the Contracting Officer's Representative - COR may provide examples of previously approved signs.

#### **1.26 SAFETY SIGN**

- A. Provide a Safety Sign where directed by Contracting Officer's Representative. Face of sign shall be 3/4 inch thick exterior grade plywood. Provide two four by four inch posts extending full height of sign and three feet into ground. Set bottom of sign level at four feet above ground. Minimum sign size shall be 48"x48".
- B. Paint all surfaces of Safety Sign and posts with one prime coat and two coats of white gloss paint. Letters and design shall be painted with gloss paint of colors noted and approved by Contracting Officer's Representative.
- C. Maintain sign and remove it when directed by Contracting Officer's Representative.
- D. Provide detailed drawing of proposed sign showing required legend and other characteristics of sign for approval by the Contracting Officer's Representative - COR may provide examples of previously approved signs.
- E. Post the number of accident free days on a daily basis.

#### **1.27 PHOTOGRAPHIC DOCUMENTATION**

- A. Contractor to provide digital photographic exhibit of existing site and work performed. Digital color photos shall be taken from a digital camera with a minimum of 7.0 megapixels. Photos shall be transmitted to the COR by DVD in jpeg or tiff, and PDF formats. Each photo's electronic file size shall be a minimum of 300k with a maximum file size of 1.5meg.
- B. Photos shall document all phases of construction and shall be updated weekly until the project has been completed. Photos shall be submitted each month along with the project invoice for monthly payment.

**1.28 FINAL ELEVATION DIGITAL IMAGES - NOT USED**

**1.29 HISTORIC PRESERVATION**

- A. Where the Contractor or any of the Contractor's employees, prior to, or during the construction work, are advised of or discover any possible archeological, historical and/or cultural resources, the Contractor shall immediately notify the Contracting Officer's Representative verbally, and then with a written follow up.

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**SECTION 01 32 16.15**  
**PROJECT SCHEDULES**

**PART 1- GENERAL**

**1.1 DESCRIPTION:**

- A. The Contractor shall develop a Critical Path Method (CPM) plan and schedule demonstrating fulfillment of the contract requirements (Project Schedule), and shall keep the Project Schedule up-to-date in accordance with the requirements of this section and shall utilize the plan for scheduling, coordinating and monitoring work under this contract (including all activities of subcontractors, equipment vendors and suppliers). Conventional Critical Path Method (CPM) technique shall be utilized to satisfy both time and cost applications.

**1.2 CONTRACTOR'S REPRESENTATIVE:**

- A. The Contractor shall designate an authorized representative responsible for the Project Schedule including preparation, review and progress reporting with and to the Contracting Officer's Representative (COR).
- B. The Contractor's representative shall have direct project control and complete authority to act on behalf of the Contractor in fulfilling the requirements of this specification section.
- C. The Contractor's representative shall have the option of developing the project schedule within their organization or to engage the services of an outside consultant. If an outside scheduling consultant is utilized, Section 1.3 of this specification will apply.

**1.3 CONTRACTOR'S CONSULTANT:**

- A. The Contractor shall submit a qualification proposal to the COR, within 10 days of bid acceptance. The qualification proposal shall include:
  - 1. The name and address of the proposed consultant.
  - 2. Information to show that the proposed consultant has the qualifications to meet the requirements specified in the preceding paragraph.
  - 3. A representative sample of prior construction projects, which the proposed consultant has performed complete project scheduling services. These representative samples shall be of similar size and scope.
- B. The Contracting Officer has the right to approve or disapprove the proposed consultant, and will notify the Contractor of the VA decision within seven calendar days from receipt of the qualification proposal. In case of disapproval, the Contractor shall resubmit another consultant



within 10 calendar days for renewed consideration. The Contractor shall have their scheduling consultant approved prior to submitting any schedule for approval.

#### **1.4 COMPUTER PRODUCED SCHEDULES**

- A. The contractor shall provide monthly, to the Department of Veterans Affairs (VA), all computer-produced time/cost schedules and reports generated from monthly project updates. This monthly computer service will include: three copies of up to five different reports (inclusive of all pages) available within the user defined reports of the scheduling software approved by the Contracting Officer; a hard copy listing of all project schedule changes, and associated data, made at the update and an electronic file of this data; and the resulting monthly updated schedule in PDM format. These must be submitted with and substantively support the contractor's monthly payment request and the signed look ahead report. The COR shall identify the five different report formats that the contractor shall provide.
- B. The contractor shall be responsible for the correctness and timeliness of the computer-produced reports. The Contractor shall also responsible for the accurate and timely submittal of the updated project schedule and all CPM data necessary to produce the computer reports and payment request that is specified.
- C. The VA will report errors in computer-produced reports to the Contractor's representative within ten calendar days from receipt of reports. The Contractor shall reprocess the computer-produced reports and associated diskette(s), when requested by the Contracting Officer's representative, to correct errors which affect the payment and schedule for the project.

#### **1.5 THE COMPLETE PROJECT SCHEDULE SUBMITTAL**

- A. Within 45 calendar days after receipt of Notice to Proceed, the Contractor shall submit for the Contracting Officer's review; three blue line copies of the interim schedule on sheets of paper 765 x 1070 mm (30 x 42 inches) and an electronic file in the previously approved CPM schedule program. The submittal shall also include three copies of a computer-produced activity/event ID schedule showing project duration; phase completion dates; and other data, including event cost. Each activity/event on the computer-produced schedule shall contain as a minimum, but not limited to, activity/event ID, activity/event description, duration, budget amount, early start date, early finish date, late start date, late finish date and total float. Work

activity/event relationships shall be restricted to finish-to-start or start-to-start without lead or lag constraints. Activity/event date constraints, not required by the contract, will not be accepted unless submitted to and approved by the Contracting Officer. The contractor shall make a separate written detailed request to the Contracting Officer identifying these date constraints and secure the Contracting Officer's written approval before incorporating them into the network diagram. The Contracting Officer's separate approval of the Project Schedule shall not excuse the contractor of this requirement. Logic events (non-work) will be permitted where necessary to reflect proper logic among work events, but must have zero duration. The complete working schedule shall reflect the Contractor's approach to scheduling the complete project. The final Project Schedule in its original form shall contain no contract changes or delays which may have been incurred during the final network diagram development period and shall reflect the entire contract duration as defined in the bid documents. These changes/delays shall be entered at the first update after the final Project Schedule has been approved. The Contractor should provide their requests for time and supporting time extension analysis for contract time as a result of contract changes/delays, after this update, and in accordance with Article, ADJUSTMENT OF CONTRACT COMPLETION.

- D. Within 30 calendar days after receipt of the complete project interim Project Schedule and the complete final Project Schedule, the Contracting Officer or his representative, will do one or both of the following:
1. Notify the Contractor concerning his actions, opinions, and objections.
  2. A meeting with the Contractor at or near the job site for joint review, correction or adjustment of the proposed plan will be scheduled if required. Within 14 calendar days after the joint review, the Contractor shall revise and shall submit three blue line copies of the revised Project Schedule, three copies of the revised computer-produced activity/event ID schedule and a revised electronic file as specified by the Contracting Officer. The revised submission will be reviewed by the Contracting Officer and, if found to be as previously agreed upon, will be approved.
- E. The approved baseline schedule and the computer-produced schedule(s) generated there from shall constitute the approved baseline schedule until subsequently revised in accordance with the requirements of this section.

- F. The Complete Project Schedule shall contain approximately 40 work activities/events.

#### **1.6 WORK ACTIVITY/EVENT COST DATA**

- A. The Contractor shall cost load all work activities/events except procurement activities. The cumulative amount of all cost loaded work activities/events (including alternates) shall equal the total contract price. Prorate overhead, profit and general conditions on all work activities/events for the entire project length. The contractor shall generate from this information cash flow curves indicating graphically the total percentage of work activity/event dollar value scheduled to be in place on early finish, late finish. These cash flow curves will be used by the Contracting Officer to assist him in determining approval or disapproval of the cost loading. Negative work activity/event cost data will not be acceptable, except on VA issued contract changes.
- B. The Contractor shall cost load work activities/events for guarantee period services, test, balance and adjust various systems in accordance with the provisions in Article, FAR 52.232 - 5 (PAYMENT UNDER FIXED-PRICE CONSTRUCTION CONTRACTS) and VAAR 852.236 - 83 (PAYMENT UNDER FIXED-PRICE CONSTRUCTION CONTRACTS).
- C. In accordance with FAR 52.236 - 1 (PERFORMANCE OF WORK BY THE CONTRACTOR) and VAAR 852.236 - 72 (PERFORMANCE OF WORK BY THE CONTRACTOR), the Contractor shall submit, simultaneously with the cost per work activity/event of the construction schedule required by this Section, a responsibility code for all activities/events of the project for which the Contractor's forces will perform the work.
- D. The Contractor shall cost load work activities/events for all BID ITEMS including ASBESTOS ABATEMENT. The sum of each BID ITEM work shall equal the value of the bid item in the Contractors' bid.

#### **1.7 PROJECT SCHEDULE REQUIREMENTS**

- A. Show on the project schedule the sequence of work activities/events required for complete performance of all items of work. The Contractor Shall:
1. Show activities/events as:
    - a. Contractor's time required for submittal of shop drawings, templates, fabrication, delivery and similar pre-construction work.
    - b. Contracting Officer's and Architect-Engineer's review and approval of shop drawings, equipment schedules, samples, template, or similar items.

- c. Interruption of VA Facilities utilities, delivery of Government furnished equipment, and rough-in drawings, project phasing and any other specification requirements.
  - d. Test, balance and adjust various systems and pieces of equipment, maintenance and operation manuals, instructions and preventive maintenance tasks.
  - e. VA inspection and acceptance activity/event with a minimum duration of five work days at the end of each phase and immediately preceding any VA move activity/event required by the contract phasing for that phase.
- 2. Show not only the activities/events for actual construction work for each trade category of the project, but also trade relationships to indicate the movement of trades from one area, floor, or building, to another area, floor, or building, for at least five trades who are performing major work under this contract.
- 3. Break up the work into activities/events of a duration no longer than 20 work days each or one reporting period, except as to non-construction activities/events (i.e., procurement of materials, delivery of equipment, concrete and asphalt curing) and any other activities/events for which the COR may approve the showing of a longer duration. The duration for VA approval of any required submittal, shop drawing, or other submittals will not be less than 20 work days.
- 4. Describe work activities/events clearly, so the work is readily identifiable for assessment of completion. Activities/events labeled "start," "continue," or "completion," are not specific and will not be allowed. Lead and lag time activities will not be acceptable.
- 5. The schedule shall be generally numbered in such a way to reflect either discipline, phase or location of the work.
- B. The Contractor shall submit the following supporting data in addition to the project schedule:
  - 1. The appropriate project calendar including working days and holidays.
  - 2. The planned number of shifts per day.
  - 3. The number of hours per shift.Failure of the Contractor to include this data shall delay the review of the submittal until the Contracting Officer is in receipt of the missing data.
- C. To the extent that the Project Schedule or any revised Project Schedule shows anything not jointly agreed upon, it shall not be deemed to have been approved by the COR. Failure to include any element of work

required for the performance of this contract shall not excuse the Contractor from completing all work required within any applicable completion date of each phase regardless of the COR's approval of the Project Schedule.

- D. Compact Disk Requirements and CPM Activity/Event Record Specifications: Submit to the VA an electronic file(s) containing one file of the data required to produce a schedule, reflecting all the activities/events of the complete project schedule being submitted.

#### **1.8 PAYMENT TO THE CONTRACTOR:**

- A. Monthly, the contractor shall submit the AIA application and certificate for payment documents G702 & G703 reflecting updated schedule activities and cost data in accordance with the provisions of the following Article, PAYMENT AND PROGRESS REPORTING, as the basis upon which progress payments will be made pursuant to Article, FAR 52.232 - 5 (PAYMENT UNDER FIXED-PRICE CONSTRUCTION CONTRACTS) and VAAR 852.236 - 83 (PAYMENT UNDER FIXED-PRICE CONSTRUCTION CONTRACTS). The Contractor shall be entitled to a monthly progress payment upon approval of estimates as determined from the currently approved updated project schedule. Monthly payment requests shall include: a listing of all agreed upon project schedule changes and associated data; and an electronic file (s) of the resulting monthly updated schedule.
- B. Approval of the Contractor's monthly Application for Payment shall be contingent, among other factors, on the submittal of a satisfactory monthly update of the project schedule.

#### **1.9 PAYMENT AND PROGRESS REPORTING**

- A. Monthly schedule update meetings will be held on dates mutually agreed to by the COR and the Contractor. Contractor and their CPM consultant (if applicable) shall attend all monthly schedule update meetings. The Contractor shall accurately update the Project Schedule and all other data required and provide this information to the COR three work days in advance of the schedule update meeting. Job progress will be reviewed to verify:
1. Actual start and/or finish dates for updated/completed activities/events.
  2. Remaining duration for each activity/event started, or scheduled to start, but not completed.
  3. Logic, time and cost data for change orders, and supplemental agreements that are to be incorporated into the Project Schedule.

4. Changes in activity/event sequence and/or duration which have been made, pursuant to the provisions of following Article, ADJUSTMENT OF CONTRACT COMPLETION.
  5. Completion percentage for all completed and partially completed activities/events.
  6. Logic and duration revisions required by this section of the specifications.
  7. Activity/event duration and percent complete shall be updated independently.
- B. After completion of the joint review, the contractor shall generate an updated computer-produced calendar-dated schedule and supply the Contracting Officer's representative with reports in accordance with the Article, COMPUTER PRODUCED SCHEDULES, specified.
- C. After completing the monthly schedule update, the contractor's representative or scheduling consultant shall rerun all current period contract change(s) against the prior approved monthly project schedule. The analysis shall only include original workday durations and schedule logic agreed upon by the contractor and resident engineer for the contract change(s). When there is a disagreement on logic and/or durations, the Contractor shall use the schedule logic and/or durations provided and approved by the resident engineer. After each rerun update, the resulting electronic project schedule data file shall be appropriately identified and submitted to the VA in accordance to the requirements listed in articles 1.4 and 1.7. This electronic submission is separate from the regular monthly project schedule update requirements and shall be submitted to the resident engineer within fourteen (14) calendar days of completing the regular schedule update. Before inserting the contract changes durations, care must be taken to ensure that only the original durations will be used for the analysis, not the reported durations after progress. In addition, once the final network diagram is approved, the contractor must recreate all manual progress payment updates on this approved network diagram and associated reruns for contract changes in each of these update periods as outlined above for regular update periods. This will require detailed record keeping for each of the manual progress payment updates.
- D. Following approval of the CPM schedule, the VA, the General Contractor, its approved CPM Consultant, RE office representatives, and all subcontractors needed, as determined by the SRE, shall meet to discuss the monthly updated schedule. The main emphasis shall be to address work activities to avoid slippage of project schedule and to identify any

necessary actions required to maintain project schedule during the reporting period. The Government representatives and the Contractor should conclude the meeting with a clear understanding of those work and administrative actions necessary to maintain project schedule status during the reporting period. This schedule coordination meeting will occur after each monthly project schedule update meeting utilizing the resulting schedule reports from that schedule update. If the project is behind schedule, discussions should include ways to prevent further slippage as well as ways to improve the project schedule status, when appropriate.

#### **1.10 RESPONSIBILITY FOR COMPLETION**

- A. If it becomes apparent from the current revised monthly progress schedule that phasing or contract completion dates will not be met, the Contractor shall execute some or all of the following remedial actions:
  - 1. Increase construction manpower in such quantities and crafts as necessary to eliminate the backlog of work.
  - 2. Increase the number of working hours per shift, shifts per working day, working days per week, the amount of construction equipment, or any combination of the foregoing to eliminate the backlog of work.
  - 3. Reschedule the work in conformance with the specification requirements.
- B. Prior to proceeding with any of the above actions, the Contractor shall notify and obtain approval from the COR for the proposed schedule changes. If such actions are approved, the representative schedule revisions shall be incorporated by the Contractor into the Project Schedule before the next update, at no additional cost to the Government.

#### **1.11 CHANGES TO THE SCHEDULE**

- A. Within 30 calendar days after VA acceptance and approval of any updated project schedule, the Contractor shall submit a revised electronic file (s) and a list of any activity/event changes including predecessors and successors for any of the following reasons:
  - 1. Delay in completion of any activity/event or group of activities/events, which may be involved with contract changes, strikes, unusual weather, and other delays will not relieve the Contractor from the requirements specified unless the conditions are shown on the CPM as the direct cause for delaying the project beyond the acceptable limits.

2. Delays in submittals, or deliveries, or work stoppage are encountered which make rescheduling of the work necessary.
  3. The schedule does not represent the actual prosecution and progress of the project.
  4. When there is, or has been, a substantial revision to the activity/event costs regardless of the cause for these revisions.
- B. CPM revisions made under this paragraph which affect the previously approved computer-produced schedules for Government furnished equipment, vacating of areas by the VA Facility, contract phase(s) and sub phase(s), utilities furnished by the Government to the Contractor, or any other previously contracted item, shall be furnished in writing to the Contracting Officer for approval.
- C. Contracting Officer's approval for the revised project schedule and all relevant data is contingent upon compliance with all other paragraphs of this section and any other previous agreements by the Contracting Officer or the VA representative.
- D. The cost of revisions to the project schedule resulting from contract changes will be included in the proposal for changes in work as specified in FAR 52.243 - 4 (Changes) and VAAR 852.236 - 88 (Changes - Supplemental), and will be based on the complexity of the revision or contract change, man hours expended in analyzing the change, and the total cost of the change.
- E. The cost of revisions to the Project Schedule not resulting from contract changes is the responsibility of the Contractor.

#### **1.12 ADJUSTMENT OF CONTRACT COMPLETION**

- A. The contract completion time will be adjusted only for causes specified in this contract. Request for an extension of the contract completion date by the Contractor shall be supported with a justification, CPM data and supporting evidence as the COR may deem necessary for determination as to whether or not the Contractor is entitled to an extension of time under the provisions of the contract. Submission of proof based on revised activity/event logic, durations (in work days) and costs is obligatory to any approvals. The schedule must clearly display that the Contractor has used, in full, all the float time available for the work involved in this request. The Contracting Officer's determination as to the total number of days of contract extension will be based upon the current computer-produced calendar-dated schedule for the time period in question and all other relevant information.



- B. Actual delays in activities/events which, according to the computer-produced calendar-dated schedule, do not affect the extended and predicted contract completion dates shown by the critical path in the network, will not be the basis for a change to the contract completion date. The Contracting Officer will within a reasonable time after receipt of such justification and supporting evidence, review the facts and advise the Contractor in writing of the Contracting Officer's decision.
- C. The Contractor shall submit each request for a change in the contract completion date to the Contracting Officer in accordance with the provisions specified under FAR 52.243 - 4 (Changes) and VAAR 852.236 - 88 (Changes - Supplemental). The Contractor shall include, as a part of each change order proposal, a sketch showing all CPM logic revisions, duration (in work days) changes, and cost changes, for work in question and its relationship to other activities on the approved network diagram.
- D. All delays due to non-work activities/events such as RFI's, WEATHER, STRIKES, and similar non-work activities/events shall be analyzed on a month by month basis.

**PART 2 - PRODUCTS**

Not Used

**PART 3 - EXECUTION**

Not Used

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**SECTION 01 33 23**

**SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES**

**PART1 - GENERAL**

**1.1 RELATED WORK**

- A. 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 DEFINITIONS**

- B. For the purposes of this contract, samples (including laboratory samples to be tested), test reports, certificates, and manufacturers' literature and data shall also be subject to the referenced requirements. The following text refers to all items collectively as SUBMITTALS.

**1.3 SUBMITTAL PROCEDURES**

- A. 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:
1. Satisfactory written evidence is presented to, and approved by Contracting Officer's Representative, that manufacturer cannot make scheduled delivery of approved item or;
  2. Item delivered has been rejected and substitution of a suitable item is an urgent necessity or;
  3. Other conditions become apparent which indicates approval of such substitute item to be in best interest of the Government.
- B. 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.
- C. Submittals will be reviewed for compliance with contract requirements by Architect-Engineer, and action thereon will be taken by Contracting Officer's Representative on behalf of the Contracting Officer.
- D. 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.

- E. 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 therefore by Contracting Officer's Representative, 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.
- F. 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's Representative and Architect-Engineer assumes no responsibility for checking schedules or layout drawings for exact sizes, exact numbers and detailed positioning of items.
- G. Submittals must be submitted by Contractor only and shipped prepaid. Contracting Officer's Representative assumes no responsibility for checking quantities or exact numbers included in such submittals.
  - 1. Submit samples required by Section 09 06 00, SCHEDULE FOR FINISHES, in quadruplicate. Submit other 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.
  - 2. Submittals will receive consideration only when covered by a transmittal letter signed by Contractor. Letter shall be sent via first class 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.
    - a. 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.
    - b. 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.

- c. Required certificates shall be signed by an authorized representative of manufacturer or supplier of material, and by Contractor.
- H. In addition to complying with the applicable requirements specified in preceding Paragraph G, samples which are required to have Laboratory Tests (those preceded by symbol "LT" under the separate sections of the specification shall be tested, at the expense of Contractor, in a commercial laboratory approved by Contracting Officer's Representative.
  - 1. Laboratory shall furnish Contracting Officer's Representative with a certificate stating that it is fully equipped and qualified to perform intended work, is fully acquainted with specification requirements and intended use of materials and is an independent establishment in no way connected with organization of Contractor or with manufacturer or supplier of materials to be tested.
  - 2. Certificates shall also set forth a list of comparable projects upon which laboratory has performed similar functions during past five years.
  - 3. Samples and laboratory tests shall be sent directly to approved commercial testing laboratory.
  - 4. Contractor shall send a copy of transmittal letter to both Contracting Officer's Representative and to Architect-Engineer simultaneously with submission of material to a commercial testing laboratory.
  - 5. Laboratory test reports shall be sent directly to Contracting Officer's Representative for appropriate action.
  - 6. Laboratory reports shall list contract specification test requirements and a comparative list of the laboratory test results. When tests show that the material meets specification requirements, the laboratory shall also certify on test report.
  - 7. Laboratory test reports shall also include a recommendation for approval or disapproval of tested item.
- I. 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.
- J. Approved samples will be kept on file by the Contracting Officer's Representative 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.

K. 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 print ready PDF.  
Drawings submitted electronically.
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, fully formatted for printing.
6. One file 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 under one cover.

L. Samples (except laboratory samples), shop drawings, test reports, certificates and manufacturers' literature and data, shall be submitted for approval to:

The KPA Group  
1 Kaiser Plaza, Suite 445  
Oakland, California 94612

M. At the time of transmittal to the Architect-Engineer, the Contractor shall also send a copy of the complete submittal directly to the Contracting Officer's Representative.

## **PART 2 - PRODUCTS**

Not Used

## **PART 3 - EXECUTION**

Not Used

DEPARTMENT OF VETERANS AFFAIRS  
PALO ALTO HEALTH CARE SYSTEM  
REPLACE BUILDING 100 AHU-19

Project No.: 640-15-138

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**SECTION 01 35 26**  
**SAFETY REQUIREMENTS**

**TABLE OF CONTENTS**

1.1	APPLICABLE PUBLICATIONS .....	2
1.2	DEFINITIONS .....	3
1.3	REGULATORY REQUIREMENTS .....	4
1.4	ACCIDENT PREVENTION PLAN (APP) .....	4
1.5	ACTIVITY HAZARD ANALYSES (AHAs) .....	8
1.6	PRECONSTRUCTION CONFERENCE .....	10
1.7	"SITE SAFETY AND HEALTH OFFICER" (SSHO) and "COMPETENT PERSON" (CP) .....	10
1.8	TRAINING .....	11
1.9	INSPECTIONS .....	12
1.10	ACCIDENTS, OSHA 300 LOGS, AND MAN-HOURS .....	13
1.11	PERSONAL PROTECTIVE EQUIPMENT (PPE) .....	14
1.12	INFECTION CONTROL .....	14
1.13	TUBERCULOSIS SCREENING .....	21
1.14	FIRE SAFETY .....	21
1.15	ELECTRICAL .....	23
1.16	FALL PROTECTION .....	25
1.17	SCAFFOLDS AND OTHER WORK PLATFORMS .....	25
1.18	EXCAVATION AND TRENCHES .....	26
1.19	CRANES .....	27
1.20	CONTROL OF HAZARDOUS ENERGY (LOCKOUT/TAGOUT) .....	27
1.21	CONFINED SPACE ENTRY .....	27
1.22	WELDING AND CUTTING .....	28
1.23	LADDERS .....	28
1.24	FLOOR & WALL OPENINGS .....	28

**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-2010Guidelines 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 through 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.

#### **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:
- 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 be limited to procedures for addressing the risks associates 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. 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 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 as 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 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 Resident Engineer 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.
- B. A Certified Safety Professional (CSP) with specialized knowledge in construction safety or a certified Construction Safety and Health Technician (CSHT) shall randomly conduct a monthly site safety inspection. The CSP or CSHT can be a corporate safety professional or independently contracted. The CSP or CSHT will provide their certificate number on the required report for verification as necessary.
  - 1. Results of the inspection will be documented with tracking of the identified hazards to abatement.

2. The Contracting Officer Representative will be notified immediately prior to start of the inspection and invited to accompany the inspection.
3. Identified hazard and controls will be discussed to come to a mutual understanding to ensure abatement and prevent future reoccurrence.
4. A report of the inspection findings with status of abatement will be provided to the Contracting Officer Representative within one week of the onsite inspection.

**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 will determine 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 within 5 calendar days of the accident. The Contracting Officer Representative 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 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 as requested.

**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.
  - 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 creates 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)). The ICRA procedure found on the American Society for Healthcare Engineering (ASHE) website will be utilized. Risk classifications of Class II or lower will require approval by the Contracting Officer Representative before beginning any construction

work. Risk classifications of Class III or higher will require a permit before beginning any construction work. 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 [\_\_\_\_], 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:

a. During Construction Work:

- 1) Notify the Contracting Officer Representative
- 2) Execute work by methods to minimize raising dust from construction operations.
- 3) Ceiling tiles: Immediately replace a ceiling tiles displaced for visual inspection.

b. Upon Completion:

- 1) Clean work area upon completion of task
- 2) Notify the Contracting Officer Representative

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) Water mist work surfaces to control dust while cutting.
- 4) Seal unused doors with duct tape.
- 5) Block off and seal air vents.
- 6) Remove or isolate HVAC system in areas where work is being performed.

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) Upon completion, restore HVAC system where work was performed
  - 5) 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 within work site utilizing HEPA equipped air filtration units.
- 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.

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 Resident Engineer and 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 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 fire-rated 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 pre-filter 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 Resident Engineer 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 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. 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 Class C, ¾ hour fire/smoke rated doors with self-closing devices.
  - 2. Install fire-rated temporary construction partitions 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.

- L. 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 Resident Engineer.
- M. Smoke Detectors: Prevent accidental operation. Remove temporary covers at end of work operations each day. Coordinate with Contracting Officer Representative.
- N. Hot Work: Perform and safeguard hot work operations in accordance with NFPA 241 and NFPA 51B. Coordinate with Facility Safety Office. Obtain permits from Facility Safety Officer at least 36 hours in advance.
- O. Fire Hazard Prevention and Safety Inspections: Inspect entire construction areas weekly. Coordinate with, and report findings and corrective actions weekly to Contracting Officer Representative.
- P. 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.
- Q. 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 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). Working within the WLS does not require FP. 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 Facility Safety Officer prior to commencing work for the day. At the end of the day, the permit shall be closed out and provided to the Facility Safety Officer. 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 Contracting Officers Representative.

#### **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

toeboards 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.

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**SECTION 01 40 50**  
**CONTRACTOR COORDINATION DRAWINGS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section specifies specific requirements for the Contractor's coordination of the work of trades. Coordination will include all portions of the work.
- B. The Contractor is required to prepare coordination drawings for work that will occur above the finish ceiling of each floor, the roof deck(s), below grade both under the building(s), existing service and utility yards, general site, penetration through roof deck, floor deck, existing utility trench, and into adjacent existing buildings. These coordination drawings are in addition to those specified in particular in specific technical specification sections or required by notations on the drawings.
- C. Included:
  - 1. Required Drawings
  - 2. Schedule of sequence of each trade/subcontractor.

**1.2 RELATED WORK**

- A. Requirements and procedures set forth in the General Conditions: Section 01 00 00 GENERAL REQUIREMENTS.
- B. Preparation and format of submittals: Section 01 33 23 SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- C. Requirements and procedures set forth in all technical specifications.

**1.3 SCOPE OF COORDINATION DRAWINGS**

- A. Work above finish ceiling for each building and/or structure:
  - 1. Prior to the start of construction the contractor shall show on reproducible paper, the work of each trade including, but not limited to, pipe runs, mechanical ductwork, cable trays, conduit runs.
  - 2. Indicate locations of all dampers, valves, cleanouts and other devices requiring human access for maintenance and repair.
  - 3. Show the height above finish floor each item, demonstrating sufficient space for installation and maintenance.
  - 4. Layout of work shall be done in such a manner that avoids conflicts between the work of different trades, does not conflict finish

- ceiling heights, soffits, light fixtures or other finish work at ceilings and soffits.
5. Should conflicts occur that affect finish ceiling and soffit heights, methods of installations, methods of construction or means of accessibility, the contractor shall clearly identify each location(s) for review by the Architect.
- B. Work below grade for each building, structure and general site.
1. Prior to the start of construction the contractor shall show on reproducible paper the work for each trade that will be placed underground, including existing utility lines scheduled to remain.
  2. Show the below finish floor elevation of each item of work, indicate the horizontal distance between work of each trade.
  3. Where utility lines cross the contractor shall indicate the elevations of each utility line. Should conflicts occur between required elevations or minimum horizontal separations of work, including the sleeving of footings, pads, grade beams, footings for fences, walls, raised planters, etc. the contractor shall clearly identify each location(s) for review by the Architect.
- C. Existing Service & Utility Yards, Utility Trench, General Site and Buildings:
1. Prior to the start of construction the contractor shall show on reproducible paper the work of each trade both overhead and underground that will be installed, and existing work scheduled to remain.
  2. Show the finish elevations of all work, indicate the horizontal distances between work of each trade, show locations of all shut-off and isolation valves, cleanouts, filters and other devices requiring human access for maintenance and repair.
  3. Should conflicts occur between required elevations, horizontal clearances, sleeving requirements of concrete work the contractor shall clearly identify each location(s) for review by the Architect/Engineer.
- D. Roof:
1. Prior to the start of construction the contractor shall show on reproducible paper the work for each trade that will be placed on the roof. Show horizontal distance between all roof mounted equipment. Show the locations of roof penetrations indicate the

- horizontal distance between penetrations and roof mounted equipment.
2. Identify the means and methods of supports being used for pipe and conduit runs.
  3. Show all pipe and conduit runs for each trade.
  4. Show the relationship between all roof mounted equipment and all roof crickets, drains and cant strips.
  5. Show all penetrations through the roof. Show size of penetrations.

**1.4 SUBMITTAL REQUIREMENTS**

- A. Submit one reproducible and two prints of each coordination plan.
- B. Submit coordination drawings 30 days prior to the start of work for that area.
  1. The Architect/Engineer will review the coordination drawings and return a review copy within 10 working days after receipt.
  2. If required, resubmit within 7 working days after return of review copy.
- C. At completion of the project submit a record copy of these documents both in printed format and as electronic drawing file.

**PART 2 -PRODUCTS**

Not Used

**PART 3 - EXECUTION**

Not Used

- - - END - - -

**SECTION 01 42 19**

**REFERENCE STANDARDS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

This section specifies the availability and source of references and standards specified in the project manual under paragraphs APPLICABLE PUBLICATIONS and/or shown on the drawings.

**1.2 AVAILABILITY OF SPECIFICATIONS LISTED IN THE GSA INDEX OF FEDERAL SPECIFICATIONS, STANDARDS AND COMMERCIAL ITEM DESCRIPTIONS FPMR PART 101-29 (FAR 52.211-1) (AUG 1998)**

- A. The GSA Index of Federal Specifications, Standards and Commercial Item Descriptions, FPMR Part 101-29 and copies of specifications, standards, and commercial item descriptions cited in the solicitation may be obtained for a fee by submitting a request to - GSA Federal Supply Service, Specifications Section, Suite 8100, 470 East L'Enfant Plaza, SW, Washington, DC 20407, Telephone (202) 619-8925, Facsimile (202) 619-8978.
- B. If the General Services Administration, Department of Agriculture, or Department of Veterans Affairs issued this solicitation, a single copy of specifications, standards, and commercial item descriptions cited in this solicitation may be obtained free of charge by submitting a request to the addressee in paragraph (a) of this provision. Additional copies will be issued for a fee.

**1.3 AVAILABILITY FOR EXAMINATION OF SPECIFICATIONS NOT LISTED IN THE GSA INDEX OF FEDERAL SPECIFICATIONS, STANDARDS AND COMMERCIAL ITEM DESCRIPTIONS (FAR 52.211-4) (JUN 1988)**

The specifications and standards cited in this solicitation can be examined at the following location:

DEPARTMENT OF VETERANS AFFAIRS  
Office of Construction & Facilities Management  
Facilities Quality Service (00CFM1A)  
425 Eye Street N.W, (sixth floor)  
Washington, DC 20001  
Telephone Numbers: (202) 632-5249 or (202) 632-5178  
Between 9:00 AM - 3:00 PM

**1.4 AVAILABILITY OF SPECIFICATIONS NOT LISTED IN THE GSA INDEX OF FEDERAL SPECIFICATIONS, STANDARDS AND COMMERCIAL ITEM DESCRIPTIONS (FAR 52.211-3) (JUN 1988)**

The specifications cited in this solicitation may be obtained from the associations or organizations listed below.

AA	Aluminum Association Inc. <a href="http://www.aluminum.org">http://www.aluminum.org</a>
AABC	Associated Air Balance Council <a href="http://www.aabchg.com">http://www.aabchg.com</a>
AAMA	American Architectural Manufacturer's Association <a href="http://www.aamanet.org">http://www.aamanet.org</a>
AAN	American Nursery and Landscape Association <a href="http://www.anla.org">http://www.anla.org</a>
AASHTO	American Association of State Highway and Transportation Officials <a href="http://www.aashto.org">http://www.aashto.org</a>
AATCC	American Association of Textile Chemists and Colorists <a href="http://www.aatcc.org">http://www.aatcc.org</a>
ACGIH	American Conference of Governmental Industrial Hygienists <a href="http://www.acgih.org">http://www.acgih.org</a>
ACI	American Concrete Institute <a href="http://www.aci-int.net">http://www.aci-int.net</a>
ACPA	American Concrete Pipe Association <a href="http://www.concrete-pipe.org">http://www.concrete-pipe.org</a>
ACPPA	American Concrete Pressure Pipe Association <a href="http://www.acppa.org">http://www.acppa.org</a>
ADC	Air Diffusion Council <a href="http://flexibleduct.org">http://flexibleduct.org</a>
AGA	American Gas Association <a href="http://www.aga.org">http://www.aga.org</a>
AGC	Associated General Contractors of America <a href="http://www.agc.org">http://www.agc.org</a>
AGMA	American Gear Manufacturers Association, Inc. <a href="http://www.agma.org">http://www.agma.org</a>
AHAM	Association of Home Appliance Manufacturers <a href="http://www.aham.org">http://www.aham.org</a>
AISC	American Institute of Steel Construction <a href="http://www.aisc.org">http://www.aisc.org</a>



AISI	American Iron and Steel Institute <a href="http://www.steel.org">http://www.steel.org</a>
AITC	American Institute of Timber Construction <a href="http://www.aitc-glulam.org">http://www.aitc-glulam.org</a>
AMCA	Air Movement and Control Association, Inc. <a href="http://www.amca.org">http://www.amca.org</a>
ANLA	American Nursery & Landscape Association <a href="http://www.anla.org">http://www.anla.org</a>
ANSI	American National Standards Institute, Inc. <a href="http://www.ansi.org">http://www.ansi.org</a>
APA	The Engineered Wood Association <a href="http://www.apawood.org">http://www.apawood.org</a>
ARI	Air-Conditioning and Refrigeration Institute <a href="http://www.ari.org">http://www.ari.org</a>
ASAE	American Society of Agricultural Engineers <a href="http://www.asae.org">http://www.asae.org</a>
ASCE	American Society of Civil Engineers <a href="http://www.asce.org">http://www.asce.org</a>
ASHRAE	American Society of Heating, Refrigerating, and Air-Conditioning Engineers <a href="http://www.ashrae.org">http://www.ashrae.org</a>
ASME	American Society of Mechanical Engineers <a href="http://www.asme.org">http://www.asme.org</a>
ASSE	American Society of Sanitary Engineering <a href="http://www.asse-plumbing.org">http://www.asse-plumbing.org</a>
ASTM	American Society for Testing and Materials <a href="http://www.astm.org">http://www.astm.org</a>
AWI	Architectural Woodwork Institute <a href="http://www.awinet.org">http://www.awinet.org</a>
AWS	American Welding Society <a href="http://www.aws.org">http://www.aws.org</a>
AWWA	American Water Works Association <a href="http://www.awwa.org">http://www.awwa.org</a>
BHMA	Builders Hardware Manufacturers Association <a href="http://www.buildershardware.com">http://www.buildershardware.com</a>
BIA	Brick Institute of America <a href="http://www.bia.org">http://www.bia.org</a>
CAGI	Compressed Air and Gas Institute <a href="http://www.cagi.org">http://www.cagi.org</a>

CGA	Compressed Gas Association, Inc. <a href="http://www.cganet.com">http://www.cganet.com</a>
CI	The Chlorine Institute, Inc. <a href="http://www.chlorineinstitute.org">http://www.chlorineinstitute.org</a>
CISCA	Ceilings and Interior Systems Construction Association <a href="http://www.cisca.org">http://www.cisca.org</a>
CISPI	Cast Iron Soil Pipe Institute <a href="http://www.cispi.org">http://www.cispi.org</a>
CLFMI	Chain Link Fence Manufacturers Institute <a href="http://www.chainlinkinfo.org">http://www.chainlinkinfo.org</a>
CPMB	Concrete Plant Manufacturers Bureau <a href="http://www.cpmc.org">http://www.cpmc.org</a>
CRA	California Redwood Association <a href="http://www.calredwood.org">http://www.calredwood.org</a>
CRSI	Concrete Reinforcing Steel Institute <a href="http://www.crsi.org">http://www.crsi.org</a>
CTI	Cooling Technology Institute <a href="http://www.cti.org">http://www.cti.org</a>
DHI	Door and Hardware Institute <a href="http://www.dhi.org">http://www.dhi.org</a>
EGSA	Electrical Generating Systems Association <a href="http://www.egsa.org">http://www.egsa.org</a>
EEI	Edison Electric Institute <a href="http://www.eei.org">http://www.eei.org</a>
EPA	Environmental Protection Agency <a href="http://www.epa.gov">http://www.epa.gov</a>
ETL	ETL Testing Laboratories, Inc. <a href="http://www.etl.com">http://www.etl.com</a>
FAA	Federal Aviation Administration <a href="http://www.faa.gov">http://www.faa.gov</a>
FCC	Federal Communications Commission <a href="http://www.fcc.gov">http://www.fcc.gov</a>
FPS	The Forest Products Society <a href="http://www.forestprod.org">http://www.forestprod.org</a>
FM	Factory Mutual Insurance <a href="http://www.fmglobal.com">http://www.fmglobal.com</a>
GA	Gypsum Association <a href="http://www.gypsum.org">http://www.gypsum.org</a>
GANA	Glass Association of North America <a href="http://www.cssinfo.com/info/gana.html/">http://www.cssinfo.com/info/gana.html/</a>

GSA	General Services Administration <a href="http://www.gsa.gov">http://www.gsa.gov</a>
HI	Hydraulic Institute <a href="http://www.pumps.org">http://www.pumps.org</a>
HPVA	Hardwood Plywood & Veneer Association <a href="http://www.hpva.org">http://www.hpva.org</a>
ICBO	International Conference of Building Officials <a href="http://www.icbo.org">http://www.icbo.org</a>
ICEA	Insulated Cable Engineers Association Inc. <a href="http://www.icea.net">http://www.icea.net</a>
\ICAC	Institute of Clean Air Companies <a href="http://www.icac.com">http://www.icac.com</a>
IEEE	Institute of Electrical and Electronics Engineers <a href="http://www.ieee.org">http://www.ieee.org</a>
IMSA	International Municipal Signal Association <a href="http://www.imsasafety.org">http://www.imsasafety.org</a>
IPCEA	Insulated Power Cable Engineers Association
NBMA	Metal Buildings Manufacturers Association <a href="http://www.mbma.com">http://www.mbma.com</a>
MSS	Manufacturers Standardization Society of the Valve and Fittings Industry Inc. <a href="http://www.mss-hq.com">http://www.mss-hq.com</a>
NAAMM	National Association of Architectural Metal Manufacturers <a href="http://www.naamm.org">http://www.naamm.org</a>
NAPHCC	Plumbing-Heating-Cooling Contractors Association <a href="http://www.phccweb.org.org">http://www.phccweb.org.org</a>
NBS	National Bureau of Standards See - NIST
NBBPVI	National Board of Boiler and Pressure Vessel Inspectors <a href="http://www.nationboard.org">http://www.nationboard.org</a>
NEC	National Electric Code See - NFPA National Fire Protection Association
NEMA	National Electrical Manufacturers Association <a href="http://www.nema.org">http://www.nema.org</a>
NFPA	National Fire Protection Association <a href="http://www.nfpa.org">http://www.nfpa.org</a>
NHLA	National Hardwood Lumber Association <a href="http://www.natlhardwood.org">http://www.natlhardwood.org</a>
NIH	National Institute of Health <a href="http://www.nih.gov">http://www.nih.gov</a>

NIST	National Institute of Standards and Technology <a href="http://www.nist.gov">http://www.nist.gov</a>
NLMA	Northeastern Lumber Manufacturers Association, Inc. <a href="http://www.nelma.org">http://www.nelma.org</a>
NPA	National Particleboard Association 18928 Premiere Court Gaithersburg, MD 20879 (301) 670-0604
NSF	National Sanitation Foundation <a href="http://www.nsf.org">http://www.nsf.org</a>
NWWDA	Window and Door Manufacturers Association <a href="http://www.nwwda.org">http://www.nwwda.org</a>
OSHA	Occupational Safety and Health Administration Department of Labor <a href="http://www.osha.gov">http://www.osha.gov</a>
PCA	Portland Cement Association <a href="http://www.portcement.org">http://www.portcement.org</a>
PCI	Precast Prestressed Concrete Institute <a href="http://www.pci.org">http://www.pci.org</a>
PPI	The Plastic Pipe Institute <a href="http://www.plasticpipe.org">http://www.plasticpipe.org</a>
PEI	Porcelain Enamel Institute, Inc. <a href="http://www.porcelainenamel.com">http://www.porcelainenamel.com</a>
PTI	Post-Tensioning Institute <a href="http://www.post-tensioning.org">http://www.post-tensioning.org</a>
RFICI	The Resilient Floor Covering Institute <a href="http://www.rfci.com">http://www.rfci.com</a>
RIS	Redwood Inspection Service See - CRA
RMA	Rubber Manufacturers Association, Inc. <a href="http://www.rma.org">http://www.rma.org</a>
SCMA	Southern Cypress Manufacturers Association <a href="http://www.cypressinfo.org">http://www.cypressinfo.org</a>
SDI	Steel Door Institute <a href="http://www.steeldoor.org">http://www.steeldoor.org</a>
IGMA	Insulating Glass Manufacturers Alliance <a href="http://www.igmaonline.org">http://www.igmaonline.org</a>
SJI	Steel Joist Institute <a href="http://www.steeljoist.org">http://www.steeljoist.org</a>

SMACNA Sheet Metal and Air-Conditioning Contractors  
National Association, Inc.  
<http://www.smacna.org>

SSPC The Society for Protective Coatings  
<http://www.sspc.org>

STI Steel Tank Institute  
<http://www.steeltank.com>

SWI Steel Window Institute  
<http://www.steelwindows.com>

TCA Tile Council of America, Inc.  
<http://www.tileusa.com>

TEMA Tubular Exchange Manufacturers Association  
<http://www.tema.org>

TPI Truss Plate Institute, Inc.  
583 D'Onofrio Drive; Suite 200  
Madison, WI 53719  
(608) 833-5900

UBC The Uniform Building Code  
See ICBO

UL Underwriters' Laboratories Incorporated  
<http://www.ul.com>

ULC Underwriters' Laboratories of Canada  
<http://www.ulc.ca>

WCLIB West Coast Lumber Inspection Bureau  
6980 SW Varns Road, P.O. Box 23145  
Portland, OR 97223  
(503) 639-0651

WRCLA Western Red Cedar Lumber Association  
P.O. Box 120786  
New Brighton, MN 55112  
(612) 633-4334

WWPA Western Wood Products Association  
<http://www.wwpa.org>

**PART 2 - PRODUCTS**

**Not Used**

**PART 3 - EXECUTION**

**Not Used**

DEPARTMENT OF VETERANS AFFAIRS  
PALO ALTO HEALTH CARE SYSTEM  
REPLACE BUILDING 100 AHU-19

Project No.: 640-15-138

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**SECTION 01 45 29**  
**TESTING LABORATORY SERVICES**

**PART 1 - GENERAL**

**1.1 DESCRIPTION:**

This section specifies materials testing activities and inspection services required during project construction to be provided by a Testing Laboratory retained by the Contractor and approved by the Government.

**1.2 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 the basic designation only.
- B. American Association of State Highway and Transportation Officials (AASHTO):
  - T27-11.....Standard Method of Test for Sieve Analysis of Fine and Coarse Aggregates
  - T96-02 (R2006).....Standard Method of Test for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
  - T99-10.....Standard Method of Test for Moisture-Density Relations of Soils Using a 2.5 Kg (5.5 lb.) Rammer and a 305 mm (12 in.) Drop
  - T104-99 (R2007).....Standard Method of Test for Soundness of Aggregate by Use of Sodium Sulfate or Magnesium Sulfate
  - T180-10.....Standard Method of Test for Moisture-Density Relations of Soils using a 4.54 kg (10 lb.) Rammer and a 457 mm (18 in.) Drop
  - T191-02(R2006).....Standard Method of Test for Density of Soil In-Place by the Sand-Cone Method
- C. American Concrete Institute (ACI):
  - 318.....Building Code Requirements for Reinforced Concrete
  - 211.....Standard Practice for Selecting Proportions for Normal, Heavyweight and Mass Concrete
  - 212.....Chemical Admixtures for Concrete
  - 214.....Recommended Practice for Evaluation of Strength Test Results of Concrete

226.....Use of Fly Ash in Concrete

301.....Specifications for Structural Concrete for  
Buildings

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

A325-10.....Standard Specification for Structural Bolts,  
Steel, Heat Treated, 120/105 ksi Minimum Tensile  
Strength

A370-12.....Standard Test Methods and Definitions for  
Mechanical Testing of Steel Products

A490-12.....Standard Specification for Heat Treated Steel  
Structural Bolts, 150 ksi Minimum Tensile  
Strength

C31/C31M-10.....Standard Practice for Making and Curing Concrete  
Test Specimens in the Field

C33/C33M-11a.....Standard Specification for Concrete Aggregates

C39/C39M-12.....Standard Test Method for Compressive Strength of  
Cylindrical Concrete Specimens

C109/C109M-11b.....Standard Test Method for Compressive Strength of  
Hydraulic Cement Mortars

C136-06.....Standard Test Method for Sieve Analysis of Fine  
and Coarse Aggregates

C138/C138M-10b.....Standard Test Method for Density (Unit Weight),  
Yield, and Air Content (Gravimetric) of Concrete

C140-12.....Standard Test Methods for Sampling and Testing  
Concrete Masonry Units and Related Units

C143/C143M-10a.....Standard Test Method for Slump of Hydraulic  
Cement Concrete

C172/C172M-10.....Standard Practice for Sampling Freshly Mixed  
Concrete

C173/C173M-10b.....Standard Test Method for Air Content of freshly  
Mixed Concrete by the Volumetric Method

C780-11.....Standard Test Method for Pre-construction and  
Construction Evaluation of Mortars for Plain and  
Reinforced Unit Masonry

C1019-11.....Standard Test Method for Sampling and Testing  
Grout

C1064/C1064M-11.....Standard Test Method for Temperature of Freshly  
Mixed Portland Cement Concrete



C1077-11c.....Standard Practice for Agencies Testing Concrete  
and Concrete Aggregates for Use in Construction  
and Criteria for Testing Agency Evaluation

C1314-11a.....Standard Test Method for Compressive Strength of  
Masonry Prisms

D422-63(2007).....Standard Test Method for Particle-Size Analysis  
of Soils

D698-07e1.....Standard Test Methods for Laboratory Compaction  
Characteristics of Soil Using Standard Effort

D1140-00(2006).....Standard Test Methods for Amount of Material in  
Soils Finer than No. 200 Sieve

D1188-07e1.....Standard Test Method for Bulk Specific Gravity  
and Density of Compacted Bituminous Mixtures  
Using Coated Samples

D1556-07.....Standard Test Method for Density and Unit Weight  
of Soil in Place by the Sand-Cone Method

D1557-09.....Standard Test Methods for Laboratory Compaction  
Characteristics of Soil Using Modified Effort  
(56,000ft lbf/ft<sup>3</sup> (2,700 KNm/m<sup>3</sup>))

D2166-06.....Standard Test Method for Unconfined Compressive  
Strength of Cohesive Soil

D2167-08).....Standard Test Method for Density and Unit Weight  
of Soil in Place by the Rubber Balloon Method

D2216-10.....Standard Test Methods for Laboratory  
Determination of Water (Moisture) Content of  
Soil and Rock by Mass

D2974-07a.....Standard Test Methods for Moisture, Ash, and  
Organic Matter of Peat and Other Organic Soils

D3666-11.....Standard Specification for Minimum Requirements  
for Agencies Testing and Inspecting Road and  
Paving Materials

D3740-11.....Standard Practice for Minimum Requirements for  
Agencies Engaged in Testing and/or Inspection  
of Soil and Rock as used in Engineering Design  
and Construction

D6938-10.....Standard Test Method for In-Place Density and  
Water Content of Soil and Soil-Aggregate by  
Nuclear Methods (Shallow Depth)

E94-04(2010).....Standard Guide for Radiographic Examination

E164-08.....Standard Practice for Contact Ultrasonic Testing  
of Weldments  
E329-11c.....Standard Specification for Agencies Engaged in  
Construction Inspection, Testing, or Special  
Inspection  
E543-09.....Standard Specification for Agencies Performing  
Non-Destructive Testing  
E605-93(R2011).....Standard Test Methods for Thickness and Density  
of Sprayed Fire Resistive Material (SFRM)  
Applied to Structural Members  
E709-08.....Standard Guide for Magnetic Particle Examination  
E1155-96(R2008).....Determining FF Floor Flatness and FL Floor  
Levelness Numbers

E. American Welding Society (AWS):

D1.D1.1M-10.....Structural Welding Code-Steel

**1.3 REQUIREMENTS:**

A. Accreditation Requirements: Testing Laboratory retained by Contractor, must be accredited by one or more of the National Voluntary Laboratory Accreditation Program (NVLAP) programs acceptable in the geographic region for the project. Furnish to the Contracting Officer's Representative a copy of the Certificate of Accreditation and Scope of Accreditation. For testing laboratories that have not yet obtained accreditation by a NVLAP program, submit an acknowledgement letter from one of the laboratory accreditation authorities indicating that the application for accreditation has been received and the accreditation process has started, and submit to the Contracting Officer's Representative for approval, certified statements, signed by an official of the testing laboratory attesting that the proposed laboratory, meets or conforms to the ASTM standards listed below as appropriate to the testing field.

1. Laboratories engaged in testing of construction materials shall meet the requirements of ASTM E329.
2. Laboratories engaged in testing of concrete and concrete aggregates shall meet the requirements of ASTM C1077.
3. Laboratories engaged in testing of bituminous paving materials shall meet the requirements of ASTM D3666.
4. Laboratories engaged in testing of soil and rock, as used in engineering design and construction, shall meet the requirements of ASTM D3740.

5. Laboratories engaged in inspection and testing of steel, stainless steel, and related alloys will be evaluated according to ASTM A880.
  6. Laboratories engaged in non-destructive testing (NDT) shall meet the requirements of ASTM E543.
  7. Laboratories engaged in Hazardous Materials Testing shall meet the requirements of OSHA and EPA.
- B. Inspection and Testing: Testing laboratory shall inspect materials and workmanship and perform tests described herein and additional tests requested by Contracting Officer's Representative. When it appears materials furnished, or work performed by Contractor fail to meet construction contract requirements, Testing Laboratory shall direct attention of Contracting Officer's Representative to such failure.
- C. Written Reports: Testing laboratory shall submit test reports to Contracting Officer's Representative, Contractor, unless other arrangements are agreed to in writing by the Contracting Officer's Representative. Submit reports of tests that fail to meet construction contract requirements on colored paper.
- D. Verbal Reports: Give verbal notification to Contracting Officer's Representative immediately of any irregularity.

## **PART 2 - PRODUCTS**

NOT USED

## **PART 3 - EXECUTION**

### **3.1 EARTHWORK:**

- A. General: The Testing Laboratory shall provide qualified personnel, materials, equipment, and transportation as required to perform the services identified/required herein, within the agreed to schedule and/or time frame. The work to be performed shall be as identified herein and shall include but not be limited to the following:
1. Observe fill and subgrades during proof-rolling to evaluate suitability of surface material to receive fill or base course. Provide recommendations to the Contracting Officer's Representative regarding suitability or unsuitability of areas where proof-rolling was observed. Where unsuitable results are observed, witness excavation of unsuitable material and recommend to Contracting Officer's Representative extent of removal and replacement of unsuitable materials and observe proof-rolling of replaced areas until satisfactory results are obtained.

2. Provide part time observation of fill placement and compaction and field density testing in building areas and provide part time observation of fill placement and compaction and field density testing in pavement areas to verify that earthwork compaction obtained is in accordance with contract documents.
3. Provide supervised geotechnical technician to inspect excavation, subsurface preparation, and backfill for structural fill.

B. Testing Compaction:

1. Determine maximum density and optimum moisture content for each type of fill, backfill and subgrade material used.
2. Make field density tests in accordance with the primary testing method following ASTM D6938 wherever possible. Field density tests utilizing ASTM D1556 or ASTM D2167 shall be utilized on a case by case basis only if there are problems with the validity of the results from the primary method due to specific site field conditions. Should the testing laboratory propose these alternative methods, they should provide satisfactory explanation to the Contracting Officer's Representative before the tests are conducted.
  - a. Building Slab Subgrade: At least one test of subgrade for every 185 m<sup>2</sup> (2000 square feet) of building slab, but in no case fewer than three tests. In each compacted fill layer, perform one test for every 185 m<sup>2</sup> (2000 square feet) of overlaying building slab, but in no case fewer than three tests.
  - b. Foundation Wall Backfill: One test per 30 m (100 feet) of each layer of compacted fill but in no case fewer than two tests.
  - c. Pavement Subgrade: One test for each 335 m<sup>2</sup> (400 square yards), but in no case fewer than two tests.
  - d. Curb, Gutter, and Sidewalk: One test for each 90 m (300 feet), but in no case fewer than two tests.
  - e. Trenches: One test at maximum 30 m (100 foot) intervals per 1200 mm (4 foot) of vertical lift and at changes in required density, but in no case fewer than two tests.
  - f. Footing Subgrade: At least one test for each layer of soil on which footings will be placed. Subsequent verification and approval of each footing subgrade may be based on a visual comparison of each subgrade with related tested subgrade when acceptable to Contracting Officer's Representative. In each compacted fill layer below wall footings, perform one field density test for every 30 m (100 feet) of wall. Verify subgrade is level, all loose or disturbed soils have been removed, and

correlate actual soil conditions observed with those indicated by test borings.

- C. Fill and Backfill Material Gradation: One test of stockpiled or in-place source material. Gradation of fill and backfill material shall be determined in accordance with ASTM C136, ASTM D422 or ASTM D1140.
- D. Testing for Footing Bearing Capacity: Evaluate if suitable bearing capacity material is encountered in footing subgrade.
- E. Testing Materials: Test suitability of on-site and off-site borrow as directed by Contracting Officer's Representative.

### **3.2 LANDSCAPE**

- A. Not required.

### **3.3 ASPHALT CONCRETE PAVING**

- A. Aggregate Base Course:

- 1. Determine maximum density and optimum moisture content for aggregate base material in accordance with AASHTO T180, Method D, ASTM D1557, Method D.
- 2. Make a minimum of three field density tests on each day's final compaction on each aggregate course in accordance with AASHTO T191, ASTM D1556, AASHTO T238, ASTM D6938.
- 3. Sample and test aggregate as necessary to insure compliance with specification requirements for gradation, wear, and soundness as specified in the applicable state highway standards and specifications.

- B. Asphalt Concrete:

- 1. Aggregate: Sample and test aggregates in stock pile and hot-bins as necessary to insure compliance with specification requirements for gradation (AASHTO T27), wear (AASHTO T96), and soundness (AASHTO T104).
- 2. Temperature: Check temperature of each load of asphalt concrete at mixing plant and at site of paving operation.
- 3. Density: Make a minimum of two field density tests in accordance with ASTM D1188 of asphalt base and surface course for each day's paving operation.

### **3.4 SITE WORK CONCRETE**

Test site work concrete including materials for concrete as required in Article CONCRETE of this section.

### 3.5 CONCRETE:

#### A. Field Inspection and Materials Testing:

1. Provide a technician at site of placement at all times to perform concrete sampling and testing.
2. Review the delivery tickets of the ready-mix concrete trucks arriving on-site. Notify the Contractor if the concrete cannot be placed within the specified time limits or if the type of concrete delivered is incorrect. Reject any loads that do not comply with the Specification requirements. Rejected loads are to be removed from the site at the Contractor's expense. Any rejected concrete that is placed will be subject to removal.
3. Take concrete samples at point of placement in accordance with ASTM C172. Mold and cure compression test cylinders in accordance with ASTM C31. Make at least three cylinders for each 40 m<sup>3</sup> (50 cubic yards) or less of each concrete type, and at least three cylinders for any one day's pour for each concrete type. After good concrete quality control has been established and maintained as determined by Contracting Officer's Representative make three cylinders for each 80 m<sup>3</sup> (100 cubic yards) or less of each concrete type, and at least three cylinders from any one day's pour for each concrete type. Label each cylinder with an identification number. Contracting Officer's Representative may require additional cylinders to be molded and cured under job conditions.
4. Perform slump tests in accordance with ASTM C143. Test the first truck each day, and every time test cylinders are made. Test pumped concrete at the hopper and at the discharge end of the hose at the beginning of each day's pumping operations to determine change in slump.
5. Determine the air content of concrete per ASTM C173. For concrete required to be air-entrained, test the first truck and every 20 m<sup>3</sup> (25 cubic yards) thereafter each day. For concrete not required to be air-entrained, test every 80 m<sup>3</sup> (100 cubic yards) at random. For pumped concrete, initially test concrete at both the hopper and the discharge end of the hose to determine change in air content.
6. If slump or air content fall outside specified limits, make another test immediately from another portion of same batch.
7. Perform unit weight tests in compliance with ASTM C138 for normal weight concrete and ASTM C567 for lightweight concrete. Test the first truck and each time cylinders are made.

8. Notify laboratory technician at batch plant of mix irregularities and request materials and proportioning check.
9. Verify that specified mixing has been accomplished.
10. Environmental Conditions: Determine the temperature per ASTM C1064 for each truckload of concrete during hot weather and cold weather concreting operations:
  - a. When ambient air temperature falls below 4.4 degrees C (40 degrees F), record maximum and minimum air temperatures in each 24 hour period; record air temperature inside protective enclosure; record minimum temperature of surface of hardened concrete.
  - b. When ambient air temperature rises above 29.4 degrees C (85 degrees F), record maximum and minimum air temperature in each 24 hour period; record minimum relative humidity; record maximum wind velocity; record maximum temperature of surface of hardened concrete.
11. Inspect the reinforcing steel placement, including bar size, bar spacing, top and bottom concrete cover, proper tie into the chairs, and grade of steel prior to concrete placement. Submit detailed report of observations.
12. Observe conveying, placement, and consolidation of concrete for conformance to specifications.
13. Observe condition of formed surfaces upon removal of formwork prior to repair of surface defects and observe repair of surface defects.
14. Observe curing procedures for conformance with specifications, record dates of concrete placement, start of preliminary curing, start of final curing, end of curing period.
15. Observe preparations for placement of concrete:
  - a. Inspect handling, conveying, and placing equipment, inspect vibrating and compaction equipment.
  - b. Inspect preparation of construction, expansion, and isolation joints.
16. Observe preparations for protection from hot weather, cold weather, sun, and rain, and preparations for curing.
17. Observe concrete mixing:
  - a. Monitor and record amount of water added at project site.
  - b. Observe minimum and maximum mixing times.
18. Measure concrete flatwork for levelness and flatness as follows:
  - a. Perform Floor Tolerance Measurements  $F_F$  and  $F_L$  in accordance with ASTM E1155. Calculate the actual overall F- numbers using the inferior/superior area method.

- b. Perform all floor tolerance measurements within 48 hours after slab installation and prior to removal of shoring and formwork.
  - c. Provide the Contractor and the Contracting Officer's Representative with the results of all profile tests, including a running tabulation of the overall  $F_F$  and  $F_L$  values for all slabs installed to date, within 72 hours after each slab installation.
19. Other inspections:
- a. Grouting under base plates.
  - b. Epoxy grouting of anchor bolts and reinforcing steel in hardened concrete.

B. Laboratory Tests of Field Samples:

1. Test compression test cylinders for strength in accordance with ASTM C39. For each test series, test one cylinder at 7 days and one cylinder at 28 days. Use remaining cylinder as a spare tested as directed by Contracting Officer's Representative. Compile laboratory test reports as follows: Compressive strength test shall be result of one cylinder, except when one cylinder shows evidence of improper sampling, molding or testing, in which case it shall be discarded and strength of spare cylinder shall be used.
2. Make weight tests of hardened lightweight structural concrete in accordance with ASTM C567.
3. Furnish certified compression test reports (duplicate) to Contracting Officer's Representative. In test report, indicate the following information:
  - a. Cylinder identification number and date cast.
  - b. Specific location at which test samples were taken.
  - c. Type of concrete, slump, and percent air.
  - d. Compressive strength of concrete in MPa (psi).
  - e. Weight of lightweight structural concrete in  $\text{kg/m}^3$  (pounds per cubic feet).
  - f. Weather conditions during placing.
  - g. Temperature of concrete in each test cylinder when test cylinder was molded.
  - h. Maximum and minimum ambient temperature during placing.
  - i. Ambient temperature when concrete sample in test cylinder was taken.
  - j. Date delivered to laboratory and date tested.

**3.6 REINFORCEMENT**

- A. Review mill test reports furnished by Contractor.



- B. Make one tensile and one bend test in accordance with ASTM A370 from each pair of samples obtained.
- C. Written report shall include, in addition to test results, heat number, manufacturer, type and grade of steel, and bar size.
- D. Perform tension tests of mechanical and welded splices in accordance with ASTM A370.

### **3.7 STRUCTURAL STEEL**

- A. General: Provide shop and field inspection and testing services to certify structural steel work is done in accordance with contract documents. Welding shall conform to AWS D1.1 Structural Welding Code.
- B. Prefabrication Inspection:
  - 1. Review design and shop detail drawings for size, length, type and location of all welds to be made.
  - 2. Approve welder qualifications by certification or retesting.
  - 3. Approve procedure for control of distortion and shrinkage stresses.
  - 4. Approve procedures for welding in accordance with applicable sections of AWS D1.1.
- C. Fabrication and Erection:
  - 1. Weld Inspection:
    - a. Verify specified electrodes and handling and storage of electrodes in accordance with AWS D1.1.
    - b. Inspect preparation and assembly of materials to be welded for conformance with AWS D1.1.
    - c. Inspect preheating and interpass temperatures for conformance with AWS D1.1.
    - d. Measure 25 percent of fillet welds.
    - e. Welding Magnetic Particle Testing: Test in accordance with ASTM E709 for a minimum of:
      - 1) 20 percent of all shear plate fillet welds at random, final pass only.
      - 2) 20 percent of all continuity plate and bracing gusset plate fillet welds, at random, final pass only.
      - 3) 100 percent of tension member fillet welds (i.e., hanger connection plates and other similar connections) for root and final passes.
      - 4) 20 percent of length of built-up column member partial penetration and fillet welds at random for root and final passes.

- 5) 100 percent of length of built-up girder member partial penetration and fillet welds for root and final passes.
  - f. Welding Ultrasonic Testing: Test in accordance with ASTM E164 and AWS D1.1 for 100 percent of all full penetration welds, braced and moment frame column splices, and a minimum of 20 percent of all other partial penetration column splices, at random.
  - g. Verify that correction of rejected welds are made in accordance with AWS D1.1.
  - h. Testing and inspection do not relieve the Contractor of the responsibility for providing materials and fabrication procedures in compliance with the specified requirements.
2. Bolt Inspection:
- a. Inspect high-strength bolted connections in accordance AISC Specifications for Structural Joints Using ASTM A325 or A490 Bolts.
  - b. Slip-Critical Connections: Inspect 10 percent of bolts, but not less than 2 bolts, selected at random in each connection in accordance with AISC Specifications for Structural Joints Using ASTM A325 or A490 Bolts. Inspect all bolts in connection when one or more are rejected.
  - c. Fully Pre-tensioned Connections: Inspect 10 percent of bolts, but not less than 2 bolts, selected at random in 25 percent of connections in accordance with AISC Specification for Structural Joints Using ASTM A325 or A490 Bolts. Inspect all bolts in connection when one or more are rejected.
  - d. Bolts installed by turn-of-nut tightening may be inspected with calibrated wrench when visual inspection was not performed during tightening.
  - e. Snug Tight Connections: Inspect 10 percent of connections verifying that plies of connected elements have been brought into snug contact.
  - f. Inspect field erected assemblies; verify locations of structural steel for plumbness, level, and alignment.
- D. Submit inspection reports, record of welders and their certification, and identification, and instances of noncompliance to Contracting Officer's Representative.

### **3.8 STEEL DECKING**

- A. Provide field inspection of welds of metal deck to the supporting steel, and testing services to insure steel decking has been installed in accordance with contract documents and manufacturer's requirements.
- B. Qualification of Field Welding: Qualify welding processes and welding operators in accordance with "Welder Qualification" procedures of AWS D1.1. Refer to the "Plug Weld Qualification Procedure" in Part 3 "Field Quality Control."
- C. Submit inspection reports, certification, and instances of noncompliance to Contracting Officer's Representative.

### **3.9 SHEAR CONNECTOR STUDS**

- A. Provide field inspection and testing services required by AWS D.1 to insure shear connector studs have been installed in accordance with contract documents.
- B. Tests: Test 20 percent of headed studs for fastening strength in accordance with AWS D1.1.
- C. Submit inspection reports, certification, and instances of noncompliance to Contracting Officer's Representative.

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**SECTION 01 57 19**

**TEMPORARY ENVIRONMENTAL CONTROLS**

**PART 1 - GENERAL**

**1.1 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.

**1.2 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.

**1.3 REFERENCES**

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

**1.4 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 Contracting Officer's Representative 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 Contracting Officer's Representative 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.
- C. Submit SWPPP plan per City of Sunnyvale requirements.

#### **1.5 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

Contracting Officer's Representative. 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.
  - a. Sediment Basins: Trap sediment from construction areas in temporary or permanent sediment basins that accommodate the runoff of a local ten design year) storm. After each storm, pump the basins dry and remove the accumulated sediment. Control overflow/drainage with paved weirs or by vertical overflow pipes, draining from the surface.
  - b. Reuse or conserve the collected topsoil sediment as directed by the Contracting Officer's Representative. Topsoil use and requirements are specified in Section 31 20 00, EARTH MOVING.
  - c. Institute effluent quality monitoring programs as required by Federal, State, and local environmental agencies.

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 borrow areas on Government property to minimize erosion and to prevent sediment from entering nearby water courses or lakes.
  7. Manage and control spoil areas.
  8. Protect adjacent areas from despoilment by temporary excavations and embankments.
  9. 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.
  10. Store chemical waste away from the work areas in corrosion resistant containers and dispose of waste in accordance with Federal, State, and local regulations.
  11. Handle discarded materials other than those included in the solid waste category as directed by the Contracting Officer's Representative.
- 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 Fish and Wildlife Resources: Keep construction activities under surveillance, management, and control to minimize interference



with, disturbance of, or damage to fish and wildlife. Prior to beginning construction operations, list species that require specific attention along with measures for their protection.

- E. 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 State of California and State Air Pollution Statue, Rule, or Regulation 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.
- F. 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 Contracting Officer's Representative. 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 between 8:00 a.m. and 6:00 p.m unless otherwise permitted by local ordinance or the Contracting Officer's Representative. 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

- G. 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.
- H. 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 Contracting Officer's Representative. 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.

**PART 2 - PRODUCTS**

Not Used

**PART 3 - EXECUTION**

Not Used

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**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. Cut to 100 mm (4-inch) wide by 300 mm (12 inch) long size tag.
- C. 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.
- D. Reinforce hole on both sides with gummed cloth washer or other suitable material capable of preventing tie pulling through paper edge.
- E. 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.

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**SECTION 01 74 19**  
**CONSTRUCTION WASTE MANAGEMENT**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section specifies the requirements for the management of non-hazardous building construction and demolition waste.
- B. Waste disposal in landfills shall be minimized to the greatest extent possible. Of the inevitable waste that is generated, as much of the waste material as economically feasible shall be salvaged, recycled or reused.
- C. Contractor shall use all reasonable means to divert construction and demolition waste from landfills and incinerators, and facilitate their salvage and recycle not limited to the following:
  - 1. Waste Management Plan development and implementation.
  - 2. Techniques to minimize waste generation.
  - 3. Sorting and separating of waste materials.
  - 4. Salvage of existing materials and items for reuse or resale.
  - 5. Recycling of materials that cannot be reused or sold.
- D. At a minimum the following waste categories shall be diverted from landfills:
  - 1. Soil.
  - 2. Inerts (eg, concrete, masonry and asphalt).
  - 3. Clean dimensional wood and palette wood.
  - 4. Green waste (biodegradable landscaping materials).
  - 5. Engineered wood products (plywood, particle board and I-joists, etc).
  - 6. Metal products (eg, steel, wire, beverage containers, copper, etc).
  - 7. Cardboard, paper and packaging.
  - 8. Bitumen roofing materials.
  - 9. Plastics (eg, ABS, PVC).
  - 10. Carpet and/or pad.
  - 11. Gypsum board.
  - 12. Insulation.
  - 13. Paint.
  - 14. Fluorescent lamps.

## **1.2 RELATED WORK**

- A. All Sections listed in the Table of Contents are a Condition of this Section.

## **1.3 QUALITY ASSURANCE**

- A. Contractor shall practice efficient waste management when sizing, cutting and installing building products. Processes shall be employed to ensure the generation of as little waste as possible. Construction Demolition waste includes products of the following:
1. Excess or unusable construction materials.
  2. Packaging used for construction products.
  3. Poor planning and/or layout.
  4. Construction error.
  5. Over ordering.
  6. Weather damage.
  7. Contamination.
  8. Mishandling.
  9. Breakage.
- B. Establish and maintain the management of non-hazardous building construction and demolition waste set forth herein. Conduct a site assessment to estimate the types of materials that will be generated by demolition and construction.
- C. Contractor shall develop and implement procedures to recycle construction and demolition waste to a minimum of 50 percent.
- D. Contractor shall be responsible for implementation of any special programs involving rebates or similar incentives related to recycling. Any revenues or savings obtained from salvage or recycling shall accrue to the contractor.
- E. Contractor shall provide all demolition, removal and legal disposal of materials. Contractor shall ensure that facilities used for recycling, reuse and disposal shall be permitted for the intended use to the extent required by local, state, federal regulations. The Whole Building Design Guide website <http://www.cwm.wbdg.org> provides a Construction Waste Management Database that contains information on companies that haul, collect, and process recyclable debris from construction projects.
- F. Contractor shall assign a specific area to facilitate separation of materials for reuse, salvage, recycling, and return. Such areas are to

be kept neat and clean and clearly marked in order to avoid contamination or mixing of materials.

- G. Contractor shall provide on-site instructions and supervision of separation, handling, salvaging, recycling, reuse and return methods to be used by all parties during waste generating stages.
- H. Record on daily reports any problems in complying with laws, regulations and ordinances with corrective action taken.

#### **1.4 TERMINOLOGY**

- A. Class III Landfill: A landfill that accepts non-hazardous resources such as household, commercial and industrial waste resulting from construction, remodeling, repair and demolition operations.
- B. Clean: Untreated and unpainted; uncontaminated with adhesives, oils, solvents, mastics and like products.
- C. Construction and Demolition Waste: Includes all non-hazardous resources resulting from construction, remodeling, alterations, repair and demolition operations.
- D. Dismantle: The process of parting out a building in such a way as to preserve the usefulness of its materials and components.
- E. Disposal: Acceptance of solid wastes at a legally operating facility for the purpose of land filling (includes Class III landfills and inert fills).
- F. Inert Backfill Site: A location, other than inert fill or other disposal facility, to which inert materials are taken for the purpose of filling an excavation, shoring or other soil engineering operation.
- G. Inert Fill: A facility that can legally accept inert waste, such as asphalt and concrete exclusively for the purpose of disposal.
- H. Inert Solids/Inert Waste: Non-liquid solid resources including, but not limited to, soil and concrete that does not contain hazardous waste or soluble pollutants at concentrations in excess of water-quality objectives established by a regional water board, and does not contain significant quantities of decomposable solid resources.
- I. Mixed Debris: Loads that include commingled recyclable and non-recyclable materials generated at the construction site.
- J. Mixed Debris Recycling Facility: A solid resource processing facility that accepts loads of mixed construction and demolition debris for the purpose of recovering re-usable and recyclable materials and disposing non-recyclable materials.

- K. Permitted Waste Hauler: A company that holds a valid permit to collect and transport solid wastes from individuals or businesses for the purpose of recycling or disposal.
- L. Recycling: The process of sorting, cleansing, treating, and reconstituting materials for the purpose of using the altered form in the manufacture of a new product. Recycling does not include burning, incinerating or thermally destroying solid waste.
  - 1. On-site Recycling - Materials that are sorted and processed on site for use in an altered state in the work, i.e. concrete crushed for use as a sub-base in paving.
  - 2. Off-site Recycling - Materials hauled to a location and used in an altered form in the manufacture of new products.
- M. Recycling Facility: An operation that can legally accept materials for the purpose of processing the materials into an altered form for the manufacture of new products. Depending on the types of materials accepted and operating procedures, a recycling facility may or may not be required to have a solid waste facilities permit or be regulated by the local enforcement agency.
- N. Reuse: Materials that are recovered for use in the same form, on-site or off-site.
- O. Return: To give back reusable items or unused products to vendors for credit.
- P. Salvage: To remove waste materials from the site for resale or re-use by a third party.
- Q. Source-Separated Materials: Materials that are sorted by type at the site for the purpose of reuse and recycling.
- R. Solid Waste: Materials that have been designated as non-recyclable and are discarded for the purposes of disposal.
- S. Transfer Station: A facility that can legally accept solid waste for the purpose of temporarily storing the materials for re-loading onto other trucks and transporting them to a landfill for disposal, or recovering some materials for re-use or recycling.

#### **1.5 SUBMITTALS**

- A. In accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES, furnish the following:

B. Prepare and submit to the Contracting Officer's Representative a written demolition debris management plan. The plan shall include, but not be limited to, the following information:

1. Procedures to be used for debris management.
2. Techniques to be used to minimize waste generation.
3. Analysis of the estimated job site waste to be generated:
  - a. List of each material and quantity to be salvaged, reused, recycled.
  - b. List of each material and quantity proposed to be taken to a landfill.
4. Detailed description of the Means/Methods to be used for material handling.
  - a. On site: Material separation, storage, protection where applicable.
  - b. Off site: Transportation means and destination. Include list of materials.
    - 1) Description of materials to be site-separated and self-hauled to designated facilities.
    - 2) Description of mixed materials to be collected by designated waste haulers and removed from the site.
  - c. The names and locations of mixed debris reuse and recycling facilities or sites.
  - d. The names and locations of trash disposal landfill facilities or sites.
  - e. Documentation that the facilities or sites are approved to receive the materials.

C. Designated Manager responsible for instructing personnel, supervising, documenting and administer over meetings relevant to the Waste Management Plan.

D. Monthly summary of construction and demolition debris diversion and disposal, quantifying all materials generated at the work site and disposed of or diverted from disposal through recycling.

#### **1.6 APPLICABLE PUBLICATIONS**

A Publications listed below form a part of this specification to the extent referenced. Publications are referenced by the basic designation only. In the event that criteria requirements conflict, the most stringent requirements shall be met.



B. U.S. Green Building Council (USGBC):

LEED Green Building Rating System for New Construction

**1.7 RECORDS**

Maintain records to document the quantity of waste generated; the quantity of waste diverted through sale, reuse, or recycling; and the quantity of waste disposed by landfill or incineration. Records shall be kept in accordance with the LEED Reference Guide and LEED Template. Contractor shall submit all record keeping forms/templates to COR no later than five (5) days prior to the start of work and 30 days prior to substantial completion. COR shall issue written approval of the forms prior to the start of work.

**PART 2 - PRODUCTS**

Not Used

**PART 3 - EXECUTION**

**3.1 COLLECTION**

- A. Provide all necessary containers, bins and storage areas to facilitate effective waste management.
- B. Clearly identify containers, bins and storage areas so that recyclable materials are separated from trash and can be transported to respective recycling facility for processing.
- C. Hazardous wastes shall be separated, stored, disposed of according to local, state, federal regulations.

**3.2 DISPOSAL**

- A. Contractor shall be responsible for transporting and disposing of materials that cannot be delivered to a source-separated or mixed materials recycling facility to a transfer station or disposal facility that can accept the materials in accordance with state and federal regulations.
- B. Construction or demolition materials with no practical reuse or that cannot be salvaged or recycled shall be disposed of at a landfill or incinerator.

**3.3 REPORT**

- A. With each application for progress payment, submit a summary of construction and demolition debris diversion and disposal including beginning and ending dates of period covered.

- B. Quantify all materials diverted from landfill disposal through salvage or recycling during the period with the receiving parties, dates removed, transportation costs, weight tickets, manifests, invoices. Include the net total costs or savings for each salvaged or recycled material.
- C. Quantify all materials disposed of during the period with the receiving parties, dates removed, transportation costs, weight tickets, tipping fees, manifests, invoices. Quantity of materials shall be recorded and reported to COR in both volume (cubic yards) and weight (tons). Include the net total costs for each disposal.

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**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 22, Division 23, Division 26, Division 27, Division 28, and Division 31 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 22, Division 23, Division 26, Division 27, Division 28, and Division 31 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.

### 1.3 RELATED WORK

- A. Section 01 00 00 GENERAL REQUIREMENTS.
- B. Section 01 32.16.15 PROJECT SCHEDULES
- C. Section 01 33 23 SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES
- D. Section 01 81 11 SUSTAINABLE DESIGN REQUIREMENTS
- E. Section 01 81 13 LEED Requirements

### 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.
- C. The commissioning activities have been developed to support the United States Green Building Council's (USGBC) LEED™ rating program and to support delivery of project performance in accordance with the VA requirements developed for the project to support the following credits:
  - 1. Commissioning activities and documentation for the LEED™ section on "Energy and Atmosphere" and the prerequisite of "Fundamental Building Systems Commissioning."
  - 2. Commissioning activities and documentation for the LEED™ section on "Energy and Atmosphere" requirements for the "Enhanced Building System Commissioning" credit.

### 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

List of Acronyms	
Acronym	Meaning
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
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:
  - 1. Roofing, windows and other exterior penetrations
  - 2. All equipment of the heating ventilating and air conditioning systems both mechanical and plumbing and direct digital controls
  - 3. Life safety systems (smoke and fire alarm)
  - 4. Emergency power systems
  - 5. All electrical control systems, including but not limited to electrical distribution system, normal power system, emergency power, grounding/bonding, electrical monitoring, substations
  - 6. Noise and vibration control

#### **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. 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 completing prestart and startup checklists for systems, subsystems, and equipment to be verified and tested.
- 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 a 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. 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.
- G. 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.
- H. 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 60 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 60 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.

PALO ALTO HEALTH CARE SYSTEM  
REPLACE BUILDING 100 AHU-19

### 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 RE = Resident Engineer A/E = Design Arch/Engineer PC = Prime Contractor O&M = Gov't Facility O&M					L = Lead P = Participate A = Approve R = Review O = Optional
Commissioning Roles & Responsibilities							
Category	Task Description	CxA	RE	A/E	PC	O&M	Notes
Meetings	Construction Commissioning Kick Off meeting	L	A	P	P	O	
	Commissioning Meetings	L	A	P	P	O	
	Project Progress Meetings	P	A	P	L	O	
	Controls 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 the OPR and BOD.	L	A	P	P	N/A	
Cx Plan & Spec	Final Commissioning Plan	L	A	R	R	O	
Schedules	Duration Schedule for Commissioning Activities	L	A	R	R	N/A	

PALO ALTO HEALTH CARE SYSTEM  
REPLACE BUILDING 100 AHU-19

Construction Phase		CxA = Commissioning Agent RE = Resident Engineer A/E = Design Arch/Engineer PC = Prime Contractor O&M = Gov't Facility O&M					L = Lead P = Participate A = Approve R = Review 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	R	R	O	
	Maintain BOD/DID on behalf of Owner	L	A	R	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	P	A	L	R	N/A	
Site Observations	Witness Factory Testing	P	A	P	L	O	
	Construction Observation Site Visits	L	A	R	R	O	
Functional Test Protocols	Final Pre-Functional Checklists	L	A	R	R	O	
	Final Functional Performance Test Protocols	L	A	R	R	O	
Technical Activities	Issues Resolution Meetings	P	A	P	L	O	
	Status Reports	L	A	R	R	O	

PALO ALTO HEALTH CARE SYSTEM  
REPLACE BUILDING 100 AHU-19

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



PALO ALTO HEALTH CARE SYSTEM  
REPLACE BUILDING 100 AHU-19

Acceptance Phase		CxA = Commissioning Agent RE = Resident Engineer A/E = Design Arch/Engineer PC = Prime Contractor O&M = Gov't Facility O&M					L = Lead P = Participate A = Approve R = Review O = Optional
Commissioning Roles & Responsibilities							
Category	Task Description	CxA	RE	A/E	PC	O&M	Notes
Cx Plan & Spec	Maintain/Update Commissioning Plan	L	A	R	R	O	
Schedules	Prepare Functional Test Schedule	L	A	R	R	O	
OPR and BOD	Maintain OPR on behalf of Owner	L	A	R	R	O	
	Maintain BOD/DID on behalf of Owner	L	A	R	R	O	
Document Reviews	Review Completed Pre-Functional Checklists	L	A	R	R	O	
	Pre-Functional Checklist Verification	L	A	R	R	O	
	Review Operations & Maintenance Manuals	L	A	R	R	R	
	Training Plan Review	L	A	R	R	R	
	Warranty Review	L	A	R	R	O	
	Review TAB Report	L	A	R	R	O	
Site Observations	Construction Observation Site Visits	L	A	R	R	O	
	Witness Selected Equipment Startup	L	A	R	R	O	
Functional Test Protocols	TAB Verification	L	A	R	R	O	
	Systems Functional Performance Testing	L	A	P	P	P	
	Retesting	L	A	P	P	P	

PALO ALTO HEALTH CARE SYSTEM  
REPLACE BUILDING 100 AHU-19

Acceptance Phase		CxA = Commissioning Agent RE = Resident Engineer A/E = Design Arch/Engineer PC = Prime Contractor O&M = Gov't Facility O&M					L = Lead P = Participate A = Approve R = Review O = Optional
Commissioning Roles & Responsibilities							
Category	Task Description	CxA	RE	A/E	PC	O&M	Notes
Technical Activities	Issues Resolution Meetings	P	A	P	L	O	
	Systems Training	R	S	R	L	P	
Reports and Logs	Status Reports	L	A	R	R	O	
	Maintain Commissioning Issues Log	L	A	R	R	O	
	Final Commissioning Report	L	A	R	R	R	
	Prepare Systems Manuals	L	A	R	R	R	

PALO ALTO HEALTH CARE SYSTEM  
REPLACE BUILDING 100 AHU-19

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					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	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 22, Division 23, Division 26, Division 27, and Division 28 specifications.
  - b. All procedures used shall be fully documented on the point to point spreadsheets 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.

### **3.5 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.

VRV 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		
SA Temp	AI	15 Min	24 hours	3 days	C	±5°F from SP	10 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
Fire Alarm Status	DI	COV	24 hours	3 days	C	True	5 min



VRV Unit Trending and Alarms							
Point	Type	Trend Interval	Operationa l Trend Duration	Testing Trend Duration	Alarm Type	Alarm Range	Alarm Delay
Freeze Stat Level 1	DI	COV	24 hours	3 days	C	True	10 min
Exhaust Fan #1 Status	DI	COV	24 hours	3 days	C	Status <> Command	10 min
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
CO2 Alarm	DI	COV	24 hours	3 days	P	True	10 min
Power Failure	DI	COV	24 hours	3 days	P	True	1 min
AHU Energy	Calc	1 Hour	30 day	N/A	N/A		

Terminal Unit (VAV, CAV, etc.) Trending and Alarms							
Point	Type	Trend Interval	Operationa l 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
Damper Position	AO	15 Minutes	12 hours	3 days	N/A		

Domestic Hot Water Trending and Alarms							
Point	Type	Trend Interval	Operationa l 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 Hot Water Trending and Alarms							
Point	Type	Trend Interval	Operational Trend Duration	Testing Trend Duration	Alarm Type	Alarm Range	Alarm Delay
Domestic HW Temperature	AI	15 Minute	12 Hours	3 days	C	> 135 °F	10 Min
Dom. Circ. Pump #1 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		
Domestic HW 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 reference to 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.
- H. Cost of Retesting: The cost associated with expanded sample System Functional Performance Tests shall be solely the responsibility of the Contractor. Any required retesting by the Contractor shall not be considered a justified reason for a claim of delay or for a time extension by the Contractor.
- 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.
- C. Cost of Retesting: The cost to retest a System Functional Performance Test shall be solely the responsibility of the Contractor. Any



required retesting by the Contractor shall not be considered a justified reason for a claim of delay or for a time extension by the Contractor.

- 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 Performance 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 22, 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.
  - 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, , public address, mass evacuation, voice and data, and entertainment television equipment.
- 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: Contractor shall 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 -----



**SECTION 02 41 00**

**DEMOLITION**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section specifies demolition of portions of buildings, utilities, other structures and debris.

**1.2 RELATED WORK**

- A. All Sections listed in the Table of Contents are a Condition of this Section.

**1.3 PROTECTION**

- A. Perform demolition in such manner as to eliminate hazards to persons and property; to minimize interference with use of adjacent areas, utilities and structures or interruption of use of such utilities; and to provide free passage to and from such adjacent areas of structures. Comply with requirements of Section GENERAL REQUIREMENTS, Article, ACCIDENT PREVENTION.
- B. Provide safeguards, including warning signs, barricades, temporary fences, warning lights, and other similar items that are required for protection of all personnel during demolition and removal operations. Comply with requirements of Section 01010, GENERAL REQUIREMENTS, Article 1.9 PROTECTION OF EXISTING VEGETATION, STRUCTURES, EQUIPMENT, UTILITIES AND IMPROVEMENTS.
- C. Maintain fences, barricades, lights, and other similar items around exposed excavations until such excavations have been completely filled.
- D. Provide enclosed dust chutes with control gates from each floor to carry debris to truck beds and govern flow of material into truck. Provide overhead bridges of tight board or prefabricated metal construction at dust chutes to protect persons and property from falling debris.
- E. Prevent spread of flying particles and dust. Sprinkle rubbish and debris with water to keep dust to a minimum. Do not use water if it results in hazardous or objectionable condition. Vacuum and dust the work area daily.
- F. In addition to previously listed fire and safety rules to be observed in performance of work, include following:
  - 1. No wall or part of wall shall be permitted to fall outwardly from structures.

2. Maintain at least one stairway in each structure in usable condition to highest remaining floor. Keep stairway free of obstructions and debris until that level of structure has been removed.
  3. Wherever a cutting torch or other equipment that might cause a fire is used, provide and maintain fire extinguishers nearby ready for immediate use. Instruct all possible users in use of fire extinguishers.
  4. Keep hydrants clear and accessible at all times. Prohibit debris from accumulating within a radius of 4500 mm (15 feet) of fire hydrants.
- G. Before beginning any demolition work, the Contractor shall survey the site and examine the drawings and specifications to determine the extent of the work. The contractor shall take necessary precautions to avoid damages to existing items to remain in place, to be reused, or to remain the property of the VA Medical Center; any damaged items shall be repaired or replaced as approved by the the Contracting Officer's Representative. The Contractor shall coordinate the work of this section with all other work and shall construct and maintain shoring, bracing, and supports as required. The Contractor shall ensure that structural elements are not overloaded and shall be responsible for increasing structural supports or adding new supports as may be required as a result of any cutting, removal, or demolition work performed under this contract. Do not overload structural elements. Provide new supports and reinforcement for existing construction weakened by demolition or removal works. Repairs, reinforcement, or structural replacement must have the Contracting Officer's Representative approval.
- H. The work shall comply with the requirements of Section 01 57 19, ENVIRONMENTAL PROTECTION.
- I. The work shall comply with the requirements of Section 01 00 00, GENERAL REQUIREMENTS, Article 1.7 INFECTION PREVENTION MEASURES.

#### 1.4 UTILITY SERVICES

- A. Demolish and remove outside utility service lines shown to be removed.
- B. Remove abandoned outside utility lines that would interfere with installation of new utility lines and new construction

#### PART 2 - PRODUCTS

##### NOT USED

**PART 3 - EXECUTION**

**3.1 DEMOLITION**

- A. Completely demolish buildings components, including all appurtenances related or connected thereto, as noted below:
  - 1. As required for installation of new utility service lines.
  - 2. As required for construction of new equipment.
- B. Debris, including, concrete, stone, metals and similar materials shall become property of Contractor and shall be disposed of by the contractor daily, off the VA Campus to avoid accumulation at the demolition site. Materials that cannot be removed daily shall be stored in areas specified by the Contracting Officer's Representative. Contractor shall dispose debris in compliance with applicable federal, state or local permits, rules and/or regulations.
- C. Remove and legally dispose of all materials, other than earth to remain as part of project work. Materials removed shall become property of contractor and shall be disposed of compliance with applicable federal, state or local permits, rules and/or regulations. All materials including above surrounding grade and extending to a depth of 1500mm (5feet) below surrounding grade, shall be included as part of the lump sum compensation for the work of this section. Materials that are located beneath the surface of the surrounding ground more than 1500 mm (5 feet), or materials that are discovered to be hazardous, shall be handled as unforeseen. The removal of hazardous material shall be referred to Hazardous Materials specifications.
- D. Remove existing utilities as indicated or uncovered by work and terminate in a manner conforming to the nationally recognized code covering the specific utility and approved by the Contracting Officer's Representative. When Utility lines are encountered that are not indicated on the drawings, the Contracting Officer's Representative shall be notified prior to further work in that area.

**3.2 CLEAN-UP**

- A. On completion of work of this section and after removal of all debris, leave site in clean condition satisfactory to the Contracting Officer's Representative. Clean-up shall include off the Campus disposal of all items and materials not required to remain property of the Government as well as all debris and rubbish resulting from demolition operations.

- - - E N D - - -

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

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section specifies cast-in-place structural concrete materials, formwork and reinforcement.
- B. Material and mixes for other concrete.
- C. Grout for base plates and other uses as shown on the drawings.
- D. Epoxy for setting reinforcement or bolts in hardened concrete.

**1.2 RELATED WORK**

- A. All Sections listed in the Table of Contents are a Condition of this Section.

**1.3 TOLERANCES**

- A. Slab Finishes: F-number method in accordance with ASTM E1155. Value as indicated on drawings.

**1.4 REGULATORY REQUIREMENTS**

- A. Conform to American Concrete Institute (ACI).

**1.5 SUBMITTALS**

- A. In accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES, furnish the following:
- B. Concrete Mix Design.
- C. Shop Drawings: Reinforcing steel: Complete shop drawings.
- D. Manufacturer's Certificates: Air-entraining admixture, chemical admixtures, curing compounds.
- E. Test Reports: Certified copies of mill tests of reinforcement showing chemical and physical analyses of each heat or melt from which reinforcement was made.
- F. Manufacturer's Literature, Instructions and Code Approval Reports: Submit for Grout and epoxy adhesive.

**1.6 APPLICABLE PUBLICATIONS**

- A. Publications listed below form a part of this specification to extent referenced. Publications are referenced in text by basic designation only.
- B. American Concrete Institute (ACI):
  - 117R-90.....Standard Tolerances for Concrete Construction and Materials
  - 301-89.....Specification for Structural Concrete for Buildings
  - 305R-91.....Hot Weather Concreting

306R-88.....Cold Weather Concreting  
315-80(92).....Details and Detailing of Concrete Reinforcement  
318/318R-95.....Building Code Requirements for Reinforced Concrete  
347R-94.....Guide to Formwork for Concrete

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

C33/C33M-11a.....Standard Specification for Concrete Aggregates  
C94/C94M-12.....Standard Specification for Ready Mixed Concrete  
C143/C143M-10.....Standard Test Method for Slump of Hydraulic  
Cement Concrete  
C150-11.....Standard Specification for Portland Cement  
C260-10.....Standard Specification for Air-Entraining  
Admixtures for Concrete

D1751-04(R2008).....Standard Specification for Preformed Expansion  
Joint Fillers for Concrete Paving and Structural  
Construction (Non-extruding and Resilient  
Bituminous Types)

E1155-96(2008).....Standard Test Method for Determining  $F_F$  Floor  
Flatness and  $F_L$  Floor Levelness Numbers

D..Concrete Reinforcing Steel Institute (CRSI):  
Manual of Standard Practice

**1.7 TESTING AGENCY FOR CONCRETE MIX DESIGN**

- A. Testing agency retained and reimbursed by the Contractor and approved by Contracting Officer's Representative.
- B. Testing agency maintaining active participation in Program of Cement and Concrete Reference Laboratory (CCRL) of National Institute of Standards and Technology.
- C. Testing agency shall furnish equipment and qualified technicians to establish proportions of ingredients for concrete mixes.

**1.8 DELIVERY, STORAGE AND HANDLING**

A. Reinforcement:

- 1. Deliver reinforcement from the mill in securely tied bundles, each bundle limited to one size and grade of reinforcement. Identify each bundle with readily visible metal or plastic tags identifying the reinforcement by the same item marking as on the approved shop drawings; tags shall also identify the mill, heat or melt number, and the grade and size of reinforcement.

2. After bundles are broken, identify by segregating reinforcement by sizes and grades.
3. Store reinforcement off the ground, protected from the elements and foreign material which could adversely affect its bond with concrete.

B. Concrete Materials:

1. Deliver, store, and handle packaged materials in the manufacturers' original, sealed packages, each clearly identified with the manufacturer's name, and name and type of material.
2. Deliver, store, and handle materials subject to damage from dirt and moisture maintaining them clean and dry, off the ground, and suitably protected.
3. Store coarse and fine aggregates in separate, covered bins to prevent them from mixing, and to preserve moisture content of aggregate at batch plant.
4. Store bulk cement in covered bins.

**PART 2 - PRODUCTS**

**2.1 FORMS**

- A. Wood, plywood, metal or other materials, new at start of work and approved by the Contracting Officer's Representative, of grade or type suitable to obtain type of finish specified.
- B. Accessories:
  1. Accessories which will be entirely or partially embedded in concrete, such as ties and hangers, shall be of metal and of standard manufacture; wire ties are not acceptable.
  2. The portion of embedded accessories remaining in concrete shall have no metal within one inch of face of concrete, and shall have no fractures, spalls, depressions, or other surface disfigurements exceeding 3/4 inch in diameter.
  3. Spreader cones on ties shall not exceed one inch in diameter.
- C. Form Sealer: Sealer shall eliminate grain raise as a result of moisture, and shall not interfere with color, bond, or subsequent treatment of or application of finishes to concrete surface; Sonneborn Building Products, Inc. "Form Saver," Grace Construction Materials "Form Film," Burke "Form Sealer," or approved equal.
- D. Form Release Agents:
  1. For Concrete Exposed to View in the Finished Work or to Receive Applied Finishes: Use chemically-active types producing water-insoluble soaps.

Release agents shall contain no petroleum-based solvents such as creosote, paraffin, wax, or diesel oil.

2. For Unexposed Concrete: Any type that will not interfere with bond of finishes to be applied.

## 2.2 MATERIALS

- A. Portland Cement: ASTM C150, Type II.
- B. Coarse Aggregate: ASTM C33 Size 67. Size 67 may be used for footings and walls over 2 inches (1300 mm) thick. Coarse aggregate for applied topping and metal pan stair fill shall be Size 7.
- C. Fine Aggregate: ASTM C33.
- D. Mixing Water: Fresh, clean, and potable.
- E. Air-Entraining Admixture: ASTM C260.
- F. Vapor Barrier: ASTM D4397, 6 mil (150 um).
- G. Reinforcing Steel:
  1. Bars: ASTM A615, deformed, Grade 60. ASTM A706, deformed, Grade 60 for bars require welding.
  2. Wire for Ties: ASTM A82.
  3. Welded Wire Fabric: ASTM A185.
  4. Spacers, Bar Supports, and Other Accessories: In conformance with ACI 315. Where portions of accessories will be within 1/2 inch of concrete surfaces which will be exposed to the elements in the finished work, such accessories shall be of non-corrosive material or shall be corrosion-resistant treated; aluminum products will not be acceptable.
- I. Expansion Joint Filler: ASTM D1751.
- J. Sheet Materials for Curing Concrete: ASTM C171.
- K. Abrasive Aggregates: Aluminum oxide grains or emery grits.
- L. Liquid Hardener and Dustproofer: Fluosilicate solution or magnesium fluosilicate or zinc fluosilicate. Magnesium and zinc may be used separately or in combination as recommended by manufacturer.
- M. Grout: Non-shrinking, premixed, non-metallic grout shall be mixed and applied in accordance with manufacturer's recommendations. Grout shall show no settlement or vertical drying shrinkage at 3 days or thereafter based on initial measurement made at time of placement, and produce a compressive strength of at least 5,000 psi (35mpa) at 3 days.
- N. Epoxy Adhesive: Hilti "HIT-RE 500-SD" Adhesive Anchoring System, Simpson Strong-Tie "SET-XP" or approved equal.
- O. Patching Mortar: Mix in proportion by volume, one part cement to two parts fine aggregate.

## 2.3 CONCRETE MIXES

- A. Mix Designs: Proportioned in accordance with Section 5.3, "Proportioning on the Basis of Field Experience and/or Trial Mixtures" of ACI 318. If concrete will be pneumatically placed, mixes shall be specifically so designed and designated.
1. If trial mixes are used, make a set of at least 6 cylinders in accordance with ASTM C192 for test purposes from each trial mix; test three for compressive strength at 7 days and three at 28 days.
  2. Submit a report of results of each test series, include a detailed listing of the proportions of trial mix or mixes, including cement, fly ash, admixtures, weight of fine and coarse aggregate per m<sup>3</sup> (cubic yard) measured dry rodded and damp loose, specific gravity, fineness modulus, percentage of moisture, air content, water to cement-fly ash ratio, and consistency of each cylinder in terms of slump. Include dry unit weight of lightweight structural concrete.
  3. Prepare a curve showing relationship between water to cement-fly ash ratio at 7-day and 28-day compressive strengths. Plot each curve using at least three specimens.
  4. If the field experience method is used, submit complete standard deviation analysis.
- B. After approval of mixes no substitution in material or change in proportions of approval mixes may be made without additional tests and approval of Contracting Officer's Representative or as specified. Making and testing of preliminary test cylinders may be carried on pending approval of cement and fly ash, providing Contractor and manufacturer certify that ingredients used in making test cylinders are the same. Contracting Officer's Representative may allow Contractor to proceed with depositing concrete for certain portions of work, pending final approval of cement and fly ash and approval of design mix.
- C. Design of concrete mixes using materials specified shall be the responsibility of the Contractor as set forth under Option C of ASTM C94.
- D. Weight: Concrete fill, pads and curbs on metal decking shall be light weight (110 pounds per cubic foot). All other concrete shall be normal weight (145 pounds per cubic foot).
- E. Aggregate Size: Maximum aggregate to be 0.75 inch.
- E. Compressive strength:
1. Slabs, walls and foundations: Compressive strength at 28 days shall be not less than 28 mpa (4000 psi).
  2. Concrete fill, pads and curbs on metal decking: Compressive strength at 28 days shall be not less than 21 mpa (3000 psi).



- F. Maximum slump for vibrated concrete is 100 mm (4 inches) tested in accordance with ASTM C143.
- G. Cement and water factor:
  - 1. Non-Air-Entrained
    - a. Min. Cement 280 kg/m<sup>3</sup> (470 lbs./c. yd)
    - b. Max. Water Cement Ratio 0.55.
  - 2. Air-Entrained
    - a. Min. Cement 290 kg/m<sup>3</sup> (490 lbs./c. yd)
    - b. Max. Water Cement Ratio 0.45.
- H. Air-entrainment is required for all exterior concrete and as required for Section 32 05 23, CEMENT AND CONCRETE FOR EXTERIOR IMPROVEMENTS.

#### **2.4 REINFORCEMENT FABRICATION**

- A. Fabricate reinforcement in accordance with the requirements of ACI 315, where specific details are not shown or where Contract Documents are not more restrictive.
- B. Fabrication of reinforcement shall begin only after approval of Bar Mill Certificates, lists and shop drawings, with each item of reinforcement fabricated in conformance with such approved documents.
- C. Bend reinforcing steel cold; do not straighten or re-bend, doing damage to the material.

#### **2.5 BATCHING & MIXING**

- A. General: Concrete shall be "Ready-Mixed" and comply with ACI 318 and ASTM C94, except as specified. With each batch of concrete, furnish certified delivery tickets listing information in Paragraph 16.1 and 16.2 of ASTM C94. Maximum delivery temperature of concrete is 38°C (100 degrees Fahrenheit). Minimum delivery temperature is 15.6 degrees C (60 degrees F).

### **PART 3 - EXECUTION**

#### **3.1 FORMWORK CONSTRUCTION**

- A. General: Design in accordance with ACI 347 is the responsibility of the Contractor. Sufficiently tight to hold concrete without leakage, sufficiently braced to withstand vibration of concrete, and to carry, without appreciable deflection, all dead and live loads to which they may be subjected.
- B. Construction Tolerances: Contractor is responsible for setting and maintaining concrete formwork to assure erection of completed work within tolerances specified to accommodate installation or other rough and finish materials. Remedial work necessary for correcting excessive

tolerances is the responsibility of the Contractor. Erected work that exceeds specified tolerance limits shall be remedied or removed and replaced, at no additional cost to the Government.

C. Preparation:

1. Treat contact surface of plywood and board forms with a form sealer in accordance with the manufacturer's printed instructions.
2. Clean form surfaces and reseal before each use. The use of form oil will not be permitted.

D. Construction:

1. Coordinate design, construction, and installation of formwork to accommodate openings, sleeves, chases, pipes, nailers, anchors, ties, inserts, and other embedded items.
2. Whenever concrete bases and foundations are required for equipment furnished as part of the work of other Sections, verify equipment dimensions prior to placing concrete.
3. Formwork shall be clean and free of foreign material when concrete is placed.

E. Form Removal:

1. Do not remove forms until concrete has attained sufficient strength to support its own weight and anticipated construction live loads without damage, but in no case less than the following:
  - a. Walls: Four (4) days.
  - b. Footings, Curbs, Walks, Paving: Side forms may be removed 24 hours after concrete placement.

**3.2 REINFORCEMENT PLACEMENT**

A. General: Details of concrete reinforcement in accordance with ACI 318 and ACI 315, unless otherwise shown.

B. Placing: Place reinforcement conforming to CRSI DA4, unless otherwise shown.

1. At time of concrete placement, reinforcement shall be free of dirt, oil, scale, loose rust, and other foreign material that could adversely affect the bond with concrete.
2. Fasten reinforcement/support to prevent displacement beyond the tolerances specified in ACI 301, by construction loads and concrete placement. Sizes and dimensions of supports shall be as required to position the reinforcement as shown on the approved shop drawings and in conformance with the minimum concrete protective covering requirements of ACI 301.

3. Furnish reinforcing bars full length whenever possible; splices will be permitted only where shown or noted on the approved shop drawings, or as otherwise permitted by SFIA.
4. Splices may be made in horizontal reinforcement by lapping and placing ends of bars in contact and securely wiring; or bars may be separated sufficiently to permit the embedment of the entire surface of each bar in concrete:
  1. Locate all splices as per drawings. Lap bars 48 diameters minimum.
  2. Stagger splices in adjacent bars.
  3. Where threaded couplers are noted on Drawings, locate couplers in accordance with Drawings. Stagger coupler locations unless noted otherwise.
  4. Obstructions: Should items to be embedded in concrete interfere with placement of reinforcements, notify Contracting Officer's Representative to obtain written approval of procedure before starting.
  5. Concrete Cover: Install reinforcement to achieve the minimum concrete coverage shown or noted on the Drawings, unless otherwise specified.
  6. Welding: Reinforcing bars shall not have welded joints.
  7. Misplaced Reinforcing Bars:
    - a. If reinforcing bars are found to be misplaced after concrete placement, immediately notify Contracting Officer's Representative for recommendations for correcting the misplacement; perform no corrective measures without such prior recommendations.
    - b. Redesign, alterations, corrections, and replacement of concrete or reinforcing bars due to misplaced bars shall be performed at no additional expense to the Government.
  8. Maintenance of Reinforcement:
    - a. Continuously inspect/maintain reinforcement in proper position during concreting operations.
    - b. Where reinforcement cannot otherwise be kept properly aligned, provide additional bracing, ties, stirrups, and other items as necessary.

### **3.3 PLACING CONCRETE**

#### **A. Preparation:**

1. Remove hardened concrete, wood chips, shavings and other debris from forms. Thoroughly clean reinforcement and other items to be embedded

- in concrete of loose rust and other foreign matter which could inhibit bond with concrete.
2. Remove loose dirt/foreign material from excavations and forms and standing and saturated soil from excavations and cavities. Placing concrete in standing water is not permitted.
  3. Remove hardened concrete and foreign materials from interior surfaces of mixing and conveying equipment.
  3. Have subgrade, forms and reinforcement inspected and approved by Contracting Officer's Representative before depositing concrete.
  4. Provide runways for wheeling equipment to convey concrete to point of deposit. Keep equipment on runways which are not supported by or bear on reinforcement. Provide similar runways for protection of vapor barrier on coarse fill.
- B. Bonding: Before depositing new concrete on or against concrete which has been set, thoroughly roughen (1/4" +/- amplitude) and clean existing surfaces of laitance, foreign matter, and loose particles. Provide shear keys and prepare joints as per Drawings and Specifications. Apply bonding agent between existing and new concrete pours.
- C. Transporting:
1. Convey concrete from mixer to final place of deposit by method which will prevent segregation or loss of ingredients.
  2. Do not deposit in work concrete that has attained its initial set or has contained its water or cement more than 1 1/2 hours.
  3. Do not allow concrete to drop freely more than 1500 mm (5 feet) in unexposed work nor more than 900 mm (3 feet) in exposed work.
  4. Concrete may be pumped from the mixer to the place of deposit, provided that information on mix design adjustments, equipment, and procedures have received Contracting Officer's Representative prior review and written approval.
- D. Consolidation:
1. Thoroughly consolidate concrete by puddling with suitable tools during placement, and by thoroughly working around reinforcement and other embedded items, and into corners of forms.
  2. In addition to manual spading and tamping, internally vibrate concrete with high-speed mechanical vibrators of sufficient amplitude for thorough consolidation.
  3. Vertically insert and remove hand-held vibrators at points 18 to 30 inches apart, vibrating concrete the minimum amount required for consolidation.

- a. Do not use vibrators to transport concrete in forms.
- b. Do not secure vibrator to forms or reinforcement.
- c. Vibration shall be carried on continuously with placing of concrete.
- E. Hot weather placing of concrete: Follow recommendations of ACI to prevent problems in the manufacturing, placing, and curing of concrete that can adversely affect the properties and serviceability of the hardened concrete.
- F. Cold weather placing of concrete: follow recommendations of ACI 306, to prevent freezing of thin sections less than 12 inches (300 mm) and to permit concrete to gain strength properly, except that use of calcium chloride shall not be permitted without written approval from Contracting Officer's Representative.

### **3.4 PROTECTION AND CURING**

- A. General: Protect exposed surfaces of concrete from premature drying, wash by rain or running water, wind, mechanical injury, and excessively hot or cold temperature. Curing method shall be subject to approval by Contracting Officer's Representative.
- A. Protection:
  - 1. Maintain concrete temperature above 50 degrees F during curing.
  - 2. Protect concrete from sun and rain.
  - 3. Do not subject concrete to loads until it has completely cured and attained minimum 28-day strength.
  - 4. Water cure concrete continuously for minimum duration specified, including Saturdays, Sundays, and holidays; do not permit it to dry out until it has cured for the specified time.
  - 5. Protect concrete during/after curing from damage from construction operations.
  - 6. Cover traffic areas with kraft paper and plywood sheets; maintain protective covering in place and in good repair as long as necessary to protect concrete from damage.
  - 7. Keep finished areas free from traffic for a minimum of four days, or as long as necessary for concrete to have set sufficiently to prevent its being damaged.
- B. Curing: Curing shall immediately follow finishing, and shall be performed as follows:
  - 1. Wall Surfaces: Cure for a minimum of seven days by form-curing with forms thoroughly wetted a minimum of four times a day until forms

are removed; if for less than seven days, immediately follow with membrane curing.

2. Flatwork Surfaces: Membrane cure for a minimum of seven days.

### **3.5 FORM REMOVAL**

A. Forms remain in place until concrete has a sufficient strength to carry its own weight and loads supported. Removal of forms at any time is the Contractor's sole responsibility.

### **3.6 SURFACE PREPARATION**

A. Immediately after forms have been removed and work has been examined and approved by Contracting Officer's Representative, remove loose materials, and patch all stone pockets, surface honeycomb, or similar deficiencies with cement mortar made with 1 part portland cement and 2 parts sand.

1. Repair or replace defective concrete as instructed by Contracting Officer's Representative, and at no additional expense to the Government. Repair materials shall include, as necessary, cements, aggregates, admixtures, and epoxy.
2. With written approval of Contracting Officer's Representative, some minor defective work may be repaired by use of cement mortar; however, if the defects affect the strength of the structure, its appearance, or are otherwise detrimental, Contracting Officer's Representative may require the removal and replacement of that portion of the structure.
3. Immediately after form removal, inspect concrete surfaces for poor joints, voids, rock pockets, tie holes, and other defects. Prior to starting patching, SFIA will examine the defects, following which such defects shall be immediately patched upon SFIA's written approval of patching mixture and method proposed for use.
4. No metal will be accepted within one inch (1") of the face of exposed concrete. Cut nails and tie wires to remain concealed and leave surfaces clean and smooth.
5. Finish: Finish to match adjacent surfaces with no discernable or visible difference in appearance.

### **3.7 FINISHES**

A. Vertical and Overhead Surface Finishes:

1. Interior and Exterior Exposed Areas (Finished): Finished areas, unless otherwise shown, shall be given a grout finish of uniform color and shall have a smooth finish treated as follows:

- a. After concrete has hardened and laitance, fins and burrs have been removed, scrub concrete with wire brushes. Clean stained concrete surfaces by use of a hone or stone.
- b. Apply grout composed of 1 part portland cement and 1 part clean, fine sand (smaller than No. 30 sieve). Work grout into surface of concrete with cork floats or fiber brushes until all pits and honeycomb are filled.
- c. After grout has hardened, but still plastic, remove surplus grout with a sponge rubber float and by rubbing with clean burlap.
- d. In hot, dry weather use a fog spray to keep grout wet during setting period. Complete finish for any area in same day. Confine limits of finished areas to natural breaks in wall surface. Do not leave grout on concrete surface overnight.

B. Slab Finishes:

1. Scratch Finish: Slab surfaces to receive a bonded applied cementitious application shall all be thoroughly raked or wire broomed after partial setting (within 2 hours after placing) to roughen surface to insure a permanent bond between base slab and applied cementitious materials.
2. Floating: Allow water brought to surface by float used for rough finishing to evaporate before surface is again floated or troweled. Do not sprinkle dry cement on surface to absorb water.
3. Float Finish: Equipment pads, and slabs to receive non-cementitious materials, except as specified, shall be screened and floated to a smooth dense finish. After first floating, while surface is still soft, surfaces shall be checked for alignment using a straightedge or template. Correct high spots by cutting down with a trowel or similar tool and correct low spots by filling in with material of same composition as floor finish. Remove any surface projections on floated finish by rubbing or dry grinding. Refloat the slab to a uniform sandy texture.
4. Broom Finish: Finish all exterior slabs with a bristle brush moistened with clear water after the surfaces have been floated.

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**SECTION 05 12 00**  
**STRUCTURAL STEEL FRAMING**

**PART 1 - GENERAL**

**1.1 DESCRIPTION:**

- A. This section specifies structural steel shown and classified by Section 2, Code of Standard Practice for Steel Buildings and Bridges.

**1.2 RELATED WORK:**

- A. All Sections listed in the Table of Contents are a Condition of this Section.

**1.3 QUALITY ASSURANCE:**

- A. Fabricator and erector shall maintain a program of quality assurance in conformance with Section 8, Code of Standard Practice for Steel Buildings and Bridges. Work shall be fabricated in an AISC certified Category Std fabrication plant.
- B. Before authorizing the commencement of steel erection, the controlling contractor shall ensure that the steel erector is provided with the written notification required by 29 CFR 1926.752. Provide copy of this notification to the Contracting Officer's Representative.

**1.4 TOLERANCES:**

- A. Fabrication tolerances for structural steel shall be held within limits established by ASTM A6, by AISC 303, Sections 6 and 7, Code of Standard Practice for Buildings and Bridges, except as follows:
- B. Elevation tolerance for closure plates at the building perimeter and at slab openings prior to concrete placement is 6 mm (1/4 inch).

**1.5 REGULATORY REQUIREMENTS:**

- A. AISC 360: Specification for Structural Steel Buildings
- B. AISC 303: Code of Standard Practice for Steel Buildings and Bridges.

**1.6 SUBMITTALS:**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Shop and Erection Drawings: Complete
- C. Certificates:
  - 1. Structural steel.
  - 2. Steel for all connections.
  - 3. Welding materials.
  - 4. Shop coat primer paint.
- D. Test Reports:
  - 1. Welders' qualifying tests.



**1.7 APPLICABLE PUBLICATIONS:**

- A. Publications listed below form a part of this specification to extent referenced. Publications are referenced in text by basic designation only.
- B. American Institute of Steel Construction (AISC):
1. AISC 360-10 Specification for Structural Steel Buildings
  2. AISC 303-10 Code of Standard Practice for Steel Buildings and Bridges
- C. American National Standards Institute (ANSI):
- B18.22.1-65(R2008).....Plain Washers
- B18.22M-81(R2000).....Metric Plain Washers
- D. American Society for Testing and Materials (ASTM):
- A6/A6M-11.....Standard Specification for General Requirements  
for Rolled Structural Steel Bars, Plates,  
Shapes, and Sheet Piling
- A36/A36M-08.....Standard Specification for Carbon Structural  
Steel
- A53/A53M-10.....Standard Specification for Pipe, Steel, Black  
and Hot-Dipped, Zinc-Coated Welded and Seamless
- A123/A123M-09.....Standard Specification for Zinc (Hot-Dip  
Galvanized) Coatings on Iron and Steel Products
- A242/A242M-04(R2009)....Standard Specification for High-Strength Low-  
Alloy Structural Steel
- A283/A283M-03(R2007)....Standard Specification for Low and Intermediate  
Tensile Strength Carbon Steel Plates
- A307-10.....Standard Specification for Carbon Steel Bolts  
and Studs, 60,000 psi Tensile Strength
- A325-10.....Standard Specification for Structural Bolts,  
Steel, Heat Treated, 120/105 ksi Minimum Tensile  
Strength
- A490-12.....Standard Specification for Heat-Treated Steel  
Structural Bolts 150 ksi Minimum Tensile  
Strength
- A500/A500M-10a.....Standard Specification for Cold Formed Welded  
and Seamless Carbon Steel Structural Tubing in  
Rounds and Shapes
- A501-07.....Standard Specification for Hot-Formed Welded and  
Seamless Carbon Steel Structural Tubing
- A572/A572M-07.....Standard Specification for High-Strength  
Low-Alloy Columbium-Vanadium Structural Steel

A992/A992M-11.....Standard Specification for Structural Steel

Shapes

E. American Welding Society (AWS):

D1.1/D1.1M-10.....Structural Welding Code-Steel

F. Military Specifications (Mil. Spec.):

MIL-P-21035.....Paint, High Zinc Dust Content, Galvanizing,  
Repair

G. Occupational Safety and Health Administration (OSHA):

29 CFR Part 1926-2001...Safety Standards for Steel Erection

**PART 2 - PRODUCTS**

**2.1 MATERIALS:**

A. Structural Steel Shapes: ASTM A992 for W shapes.

B. Steel Plates: ASTM A572,  $F_y = 50\text{ksi}$ .

C. Channels and Angles: ASTM A36.

D. Structural Tubing: ASTM A500, Grade B or ASTM A501.

E. Steel Pipe: ASTM A53, Grade B.

F. Bolts, Nuts and Washers:

1. High-strength bolts, including nuts and washers: ASTM A325.

2. Machine bolts: ASTM A307.

3. Anchor bolts: ASTM F1554, grade 105.

G. Zinc Coating: ASTM A123.

H. Galvanizing Repair Paint: Mil. Spec. MIL-P-21035.

**PART 3 - EXECUTION**

**3.1 CONNECTIONS (SHOP AND FIELD):**

A. Welding: Welding in accordance with AWS D1.1. Welds shall be made only by welders and welding operators who have been previously qualified by tests as prescribed in AWS D1.1 to perform type of work required.

B. All framing bolts tightened to a bolt tension not less than 70% of their minimum tensile strength. Tightening done with use of direct tension indicators (bolts or washers) or with twist-off bolts.

**3.2 FABRICATION:**

A. Fabrication in accordance with Chapter M, AISC 360.

**3.3 SHOP PAINTING:**

A. General: Shop paint steel with primer in accordance with AISC 303, Section 6.

B. Shop paint for steel surfaces is specified in Section 09 91 00, PAINTING.

C. Do not apply paint to following:

1. Surfaces within 50 mm (2 inches) of joints to be welded in field.
2. Surfaces which will be encased in concrete.
3. Top flange of members which will have shear connector studs applied.

D. Zinc Coated (Hot Dip Galvanized) per ASTM A123 (after fabrication):

Touch-up after erection: Clean and wire brush any abraded and other spots worn through zinc coating, including threaded portions of bolts and welds and touch-up with galvanizing repair paint.

**3.4 ERECTION:**

- A. General: Erection in accordance with AISC 303, Section 7B. Temporary Supports: Temporary support of structural steel frames during erection in accordance with AISC 303, Section 7

**3.5 FIELD PAINTING:**

- A. After erection, touch-up steel surfaces specified to be shop painted. After welding is completed, clean and prime areas not painted due to field welding.
- B. Finish painting of steel surfaces is specified in Section 09 91 00, PAINTING.

**3.6 SURVEY:**

Upon completion of finish bolting or welding on any part of the work, and prior to start of work by other trades that may be supported, attached, or applied to the structural steel work, submit a certified report of survey to Contracting Officer's Representative for approval. Reports shall be prepared by Registered Land Surveyor or Registered Civil Engineer as specified in Section 01 00 00, GENERAL REQUIREMENTS. Report shall specify that location of structural steel is acceptable for plumbness, level and alignment within specified tolerances specified in the AISC Manual.

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**SECTION 07 01 50.19  
PREPARATION FOR RE-ROOFING**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. Partial roof tear-off, temporary roofing membrane, roof re-cover preparation, removal of base flashings on existing construction in preparation to receive new roofing membrane.
- B. Existing Membrane Roofing System: Field verify existing single ply or multi-ply roofing system.

**1.2 RELATED WORK**

- A. Use of the premises and phasing requirements: Section 01 00 00 GENERAL REQUIREMENTS.
- B. Temporary construction and environmental-protection measures for reroofing preparation: Section 01 00 00 GENERAL REQUIREMENTS
- C. HVAC equipment removal and reinstallation: Division 23 sections.
- D. Electrical equipment disconnection and reconnection: Division 26 sections.

**1.3 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. Editions of applicable publications current on date of issue of bidding documents apply unless otherwise indicated.
- B. American National Standards Institute/Single-Ply Roofing Institute (ANSI/SPRI):
  - ANSI/SPRI FX-1-01(R2006) Standard Field Test Procedure for  
Determining the Withdrawal Resistance of  
Roofing Fasteners.
- C. ASTM International (ASTM):
  - C208-08.....Cellulosic Fiber Insulating Board
  - C728-05.....Perlite Thermal Insulation Board
  - C1177/C1177M-08.....Standard Specification for Glass Mat Gypsum  
Substrate for Use as Sheathing
  - C1278/C1278M-07.....Standard Specification for Fiber-Reinforced  
Gypsum Panel
  - D1079-09.....Standard Terminology Relating to Roofing and  
Waterproofing
- D. FM Approvals: RoofNav Approved Roofing Assemblies and Products.

**PREPARATION FOR RE-ROOFING**

4450-89.....Approved Standard for Class 1 Insulated Steel  
Deck Roofs

4470-10.....Approved Standard for Class 1 Roof Coverings

1-28-09.....Loss Prevention Data Sheet: Design Wind Loads.

1-29-09.....Loss Prevention Data Sheet: Above-Deck Roof

Components

1-49-09.....Loss Prevention Data Sheet: Perimeter Flashing

E. National Roofing Contractors Association: Roofing and Waterproofing  
Manual

#### **1.4 MATERIALS OWNERSHIP**

A. Assume ownership of demolished materials and remove from Project site and dispose of legally, unless indicated to be reused, reinstalled, or otherwise to remain Government's property.

#### **1.5 DEFINITIONS**

A. Refer to ASTM D1079 and NRCA "The NRCA Roofing and Waterproofing Manual" for definition of terms.

#### **1.6 QUALITY CONTROL**

A. Requirements of Division 07 roofing section for qualifications of roofing system and roofing insulation Installer; work of this section shall be performed by same Installer.

1. Where Project requirements include removal of asbestos-containing material, Installer must be legally qualified to perform the required work.

2. Where Project requirements include work affecting existing roofing system to remain under warranty, Installer must be approved by warrantor of existing roofing system.

B. Regulatory Requirements: Comply with governing EPA notification regulations. Comply with hauling and disposal regulations of authorities having jurisdiction.

C. Reroofing Conference: Conduct conference at Project site.

1. Meet with Government; Architect-Engineer; testing and inspecting agency representative; roofing system manufacturer's representative; roofing Installer including project manager, superintendent, and foreman; and installers whose work interfaces with or affects reroofing.

2. Review methods and procedures related to roofing system tear-off and replacement

PREPARATION FOR RE-ROOFING

#### 1.7 SUBMITTALS

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Manufacturer's Literature and Data:
  - 1. Recover boards.
- C. List of proposed infill materials.
- D. List of proposed temporary roofing materials.
- E. Fastener pull-out test report.
- F. Photographs or Videotape: Document existing conditions of adjacent construction including site improvements.
- G. Landfill Records: Indicate receipt and acceptance of hazardous wastes by a licensed landfill facility.
- H. Qualification Data: For Installer.
  - 1. Certificate indicating Installer is licensed to perform asbestos abatement.
  - 2. Certificate indicating Installer is approved by warrantor of existing roofing system.

#### 1.8 PROJECT CONDITIONS

- A. Government will occupy portions of building below reroofing area. Conduct reroofing so Government's operations will not be disrupted.
  - 1. Coordinate work activities daily with Government.
  - 2. Provide Government with not less than 72 hours' notice of activities that may affect Government's operations.
- B. Protect building and landscaping from damage.
- C. Maintain access to existing walkways and adjacent occupied facilities.
- D. Available Information: The following are available for Contractor reference:
  - 1. Roof Moisture Survey of existing membrane roofing system.
  - 2. Analysis of test cores from existing membrane roofing system.
  - 3. Construction Drawings and Project Manual for existing roofing system.
  - 4. Contractor is responsible for interpretation and conclusions based upon available information.
- E. Weather Limitations: Proceed with reroofing preparation only when weather conditions permit Work to proceed without water entering existing roofing system or building.

F. Hazardous Materials: It is not expected that Contractor will encounter hazardous materials such as asbestos-containing materials.

1. Government will remove hazardous materials before start of the Work.
2. Do not disturb materials suspected of containing hazardous materials. Notify Architect-Engineer and Government. Hazardous materials will be removed by Government under a separate contract.

G. Hazardous Materials: A report on the presence of hazardous materials is available to Contractor for review and use.

1. Examine report to become aware of locations where hazardous materials are present.
2. Hazardous material remediation is specified elsewhere in the Contract Documents.

#### **1.9 WARRANTY**

A. Existing Warranties: Remove, replace, patch, and repair materials and surfaces affected by reroofing, by methods and with materials acceptable to warrantor.

1. Notify warrantor of existing roofing system before proceeding, and upon completion of reroofing.
2. Obtain documentation verifying that existing roofing system has been inspected by warrantor and warranty remains in effect. Submit documentation at Project closeout.

### **PART 2 - PRODUCTS**

#### **2.1 INFILL MATERIALS**

A. Use infill materials matching existing membrane roofing system materials.

#### **2.2 TEMPORARY ROOFING MATERIALS**

A. Design of temporary roofing and selection of materials are responsibilities of Contractor.

#### **2.3 RECOVER BOARDS**

A. Insulation Serving as Recover Board: Requirements are specified in Section 07 22 00 ROOF AND DECK INSULATION.

B. Recover Board: ASTM C1177/C1177M, glass-mat, water-resistant gypsum substrate or match existing type X, 16 mm (5/8 inch) thick.

C. Fasteners: Factory-coated steel fasteners, No. 12 or 14, and metal or plastic plates listed in FM Approval's "RoofNav."

## **2.4 AUXILIARY REROOFING MATERIALS**

- A. General: Auxiliary reroofing preparation materials recommended by roofing system manufacturer and compatible with components of existing and new membrane roofing system.
- B. Base Sheet Fasteners: Capped head, factory-coated steel fasteners, listed in FM Approval's "RoofNav."
- C. Metal Flashing Sheet: Metal flashing sheet is specified in Section 07 60 00 SHEET METAL FLASHING AND TRIM.

## **PART 3 - EXECUTION**

### **3.1 PREPARATION**

- A. Protect existing membrane roofing system that is indicated not to be reroofed.
  - 1. Limit traffic and material storage to areas of existing roofing membrane that have been protected.
  - 2. Maintain temporary protection and leave in place until replacement roofing has been completed. Remove temporary protection on completion of reroofing.
- B. Coordinate with Government to shut down air-intake equipment in the vicinity of the Work. Cover air-intake louvers before proceeding with reroofing work that could affect indoor air quality or activate smoke detectors in the ductwork.
  - 1. Comply with Government's requirements for maintaining fire watch when temporarily disabling smoke detectors.
- C. During removal operations, have sufficient and suitable materials on-site to facilitate rapid installation of temporary protection in the event of unexpected rain.
- D. Maintain roof drains in functioning condition to ensure roof drainage at end of each workday. Prevent debris from entering or blocking roof drains and conductors. Use roof-drain plugs specifically designed for this purpose. Remove roof-drain plugs at end of each workday, when no work is taking place, or when rain is forecast.
  - 1. If roof drains are temporarily blocked or unserviceable due to roofing system removal or partial installation of new membrane roofing system, provide alternative drainage method to remove water and eliminate ponding.
  - 2. Do not permit water to enter into or under existing membrane roofing system components that are to remain.



- E. Verify that rooftop utilities and service piping have been shut off before beginning the Work.

### **3.2 ROOF TEAR-OFF**

- A. General: Notify Government each day of extent of roof tear-off proposed for that day and obtain authorization to proceed.
- B. Remove aggregate ballast from roofing membrane.
- C. Remove loose aggregate from aggregate-surfaced built-up bituminous roofing using a power broom.
- D. Remove pavers and accessories from roofing membrane. Store and protect pavers and accessories for reuse. Discard cracked pavers.
- E. Remove protection mat and insulation from protected roofing membrane.
  - 1. Discard insulation.
- F. Partial Roof Tear-Off: Remove existing roofing membrane and other membrane roofing system components down to the deck.
  - 1. Dry bitumen and felts that are firmly bonded to concrete decks may remain. Remove wet or unadhered bitumen and felts.
  - 2. Comply with FM Approvals requirements for removal of excess asphalt from steel decks.
  - 3. Remove fasteners from.

### **3.3 DECK PREPARATION**

- A. Inspect deck after tear-off or partial tear-off of membrane roofing system.
- B. Verify that concrete substrate is visibly dry and free of moisture. Test for capillary moisture by plastic sheet method according to ASTM D 4263. Do not proceed with roofing work if moisture condenses under the plastic sheet.
- C. If deck surface is not suitable for receiving new roofing or if structural integrity of deck is suspect, immediately notify Architect-Engineer. Do not proceed with installation until directed by Architect-Engineer.

### **3.4 INFILL MATERIALS INSTALLATION**

- A. Immediately after removal of selected portions of existing membrane roofing system, and inspection and repair, if needed, of deck, fill in the tear-off areas to match existing membrane roofing system construction.
  - 1. Installation of infill materials shall match existing.

2. Install new roofing membrane patch over roof infill area. If new roofing membrane is installed the same day tear-off is made, roofing membrane patch is not required.

### **3.5 TEMPORARY ROOFING MEMBRANE**

- A. Install approved temporary roofing membrane over area to be reroofed.
- B. Remove temporary roofing membrane before installing new roofing membrane.
- C. Prepare the temporary roof to receive new roofing membrane according to approved temporary roofing membrane proposal. Restore temporary roofing membrane to watertight condition. Obtain approval for temporary roof substrate from roofing membrane manufacturer and Architect-Engineer before installing new roof.

### **3.6 EXISTING BASE FLASHINGS**

- A. Remove existing base flashings around parapets, curbs, walls, and penetrations.
  1. Clean substrates of contaminants such as asphalt, sheet materials, dirt, and debris.
- B. Do not damage metal counterflashings that are to remain. Replace metal counterflashings.
- C. Remove existing parapet sheathing and replace with.

### **3.7 FASTENER PULL-OUT TESTING**

- A. Retain independent testing and inspecting agency to conduct fastener pull-out tests according to SPRI FX-1, and submit test report to Architect-Engineer before installing new membrane roofing system.
  1. Obtain Architect-Engineer's approval to proceed with specified fastening pattern. Architect-Engineer may furnish revised fastening pattern commensurate with pull-out test results.

### **3.8 RECOVER BOARD INSTALLATION**

- A. Install recover boards over roof insulation with long joints in continuous straight lines and end joints staggered between rows. Loosely butt recover boards together and fasten to deck.
  1. Fasten recover boards to resist wind-uplift pressure at corners, perimeter, and field of roof.
  2. Install additional fasteners near board corners and edges as necessary to conform boards to substrate and to adjacent boards.

### 3.9 DISPOSAL

- A. Collect demolished materials and place in containers. Promptly dispose of demolished materials. Do not allow demolished materials to accumulate on-site.
  - 1. Storage or sale of demolished items or materials on-site is not permitted.
- B. Transport and legally dispose of demolished materials off Government's property.

- - - END OF SECTION - - -

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

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. Formed sheet metal work for wall and roof flashing/counterflashings, mechanical curb openings, copings, roof edge metal, drainage specialties, formed expansion joint covers and flexible and aluminum trim at openings (jambs, heads, sills) are specified in this section.

**1.2 RELATED WORK**

- A. All Sections listed in the Table of Contents are a Condition of this Section.

**1.3 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. Editions of applicable publications current on date of issue of bidding documents apply unless otherwise indicated.
- B. Aluminum Association (AA):  
AA-C22A41.....Aluminum Chemically etched medium matte, with  
clear anodic coating, Class I Architectural,  
0.7-mil thick
- C. American National Standards Institute/Single-Ply Roofing Institute  
(ANSI/SPRI):  
ANSI/SPRI ES-1-03.....Wind Design Standard for Edge Systems Used with  
Low Slope Roofing Systems
- D. American Architectural Manufacturers Association (AAMA):  
AAMA 620.....Voluntary Specification for High Performance  
Organic Coatings on Coil Coated Architectural  
Aluminum
- E. ASTM International (ASTM):  
B209-07.....Aluminum and Aluminum-Alloy Sheet and Plate
- F. National Association of Architectural Metal Manufacturers (NAAMM):  
AMP 500-06.....Metal Finishes Manual
- G. Federal Specification (Fed. Spec):  
A-A-1925A.....Shield, Expansion; (Nail Anchors)

H. International Code Commission (ICC): International Building Code,  
Current Edition

#### **1.4 PERFORMANCE REQUIREMENTS**

- A. Flashing and sheet metal shall be design to resist Wind Uplift Forces.
- B. Wind Design Standard: Fabricate and install copings roof-edge flashings, tested per ANSI/SPRI ES-1 as indicated on Drawings.

#### **1.5 SUBMITTALS**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Shop Drawings: For all specified items, including:
  - 1. Flashings
  - 2. Copings
  - 3. Gravel Stop-Fascia
  - 4. Scuppers and Conductors
  - 5. Expansion joints
  - 6. Fascia-cant
  - 7. Aluminum flashings at openings, including flexible flashings.
  - 8. Flashing dams at opening corners and penetrations through exterior walls systems for electrical and other exterior boxes.
- C. Manufacturer's Literature and Data: For all specified items, including:
  - 1. Two-piece counterflashing
  - 2. Expansion joint cover, each type
  - 3. Fascia-cant
- D. Certificates: Indicating compliance with specified finishing requirements, from applicator and contractor.

### **PART 2 - PRODUCTS**

#### **2.1 FLASHING AND SHEET METAL MATERIALS**

- A. Aluminum Sheet: ASTM B209, alloy 3003-H14 except alloy used for color anodized aluminum shall be as required to produce specified color.  
Alloy required to produce specified color shall have the same structural properties as alloy 3003-H14.

#### **2.2 FLASHING ACCESSORIES**

- A. Fasteners:
  - 1. Use stainless steel for aluminum alloy.
  - 2. Nails:

- a. Minimum diameter for stainless steel nails: 2 mm (0.095 inch) and annular threaded.
- b. Length to provide not less than 22 mm (7/8 inch) penetration into anchorage.
- 3. Expansion Shields: Fed Spec A-A-1925A.
- B. Sealant: As specified in Section 07 92 00, JOINT SEALANTS for exterior locations.
- C. Flexible Flashing: .9 mm (35 mils) self-adhering, vapor permeable, SBS rubberized asphalt compound with integral cross-laminated polyethylene film. Impermeable to air, moisture and water vapor. Self-sealing when penetrate with self-tapping screws or nails. Peel and stick, no flame applications.
- D. Fabricated sheet metal flashings at openings and penetrations.

### **2.3 SHEET METAL THICKNESS**

- A. Except as otherwise shown or specified use thickness or weight of sheet metal as follows:
- B. Exposed Locations:
  - 1. Stainless steel: 0.4 mm (0.015 inch).
- C. Thickness of aluminum or galvanized steel is specified with each item.

### **2.4 FABRICATION, GENERAL**

- A. Jointing:
  - 1. In general, stainless steel joints, except expansion and contraction joints, shall be locked and soldered.
  - 2. Jointing of stainless steel over 0.45 mm (0.018 inch) thick shall be done by lapping, riveting and soldering.
  - 3. Joints shall conform to following requirements:
    - a. Flat-lock joints shall finish not less than 19 mm (3/4 inch) wide.
    - b. Lap joints subject to stress shall finish not less than 25 mm (one inch) wide and shall be soldered and riveted.
    - c. Lap joints shall finish not less than 100 mm (4 inches) wide.
  - 4. Flat and lap joints shall be made in direction of flow.
- B. Expansion and Contraction Joints:
  - 1. Fabricate in accordance with the Architectural Sheet Metal Manual recommendations for expansion and contraction of sheet metal work in continuous runs.

2. Fabricate joint covers of same thickness material as sheet metal served.

C. Cleats:

1. Fabricate cleats to secure flashings and sheet metal work over 300 mm (12 inches) wide and where specified.
2. Provide continuous cleats.
3. Form cleats of same metal and weights or thickness as the sheet metal being installed unless specified otherwise.
4. Fabricate cleats from 50 mm (2 inch) wide strip. Form end with not less than 19 mm (3/4 inch) wide loose lock to item for anchorage. Form other end of length to receive nails free of item to be anchored and end edge to be folded over and cover nail heads.

D. Edge Strips or Continuous Cleats:

1. Fabricate continuous edge strips where shown and specified to secure loose edges of the sheet metal work.
2. Fabricate edge strips or minimum 1.25 mm (0.050 inch) thick aluminum.
3. Use material compatible with sheet metal to be secured by the edge strip.
4. Fabricate in 3000 mm (10 feet) maximum lengths with not less than 19 mm (3/4 inch) loose lock into metal secured by edge strip.
5. Fabricate Strips for fascia anchorage to extend below the supporting wood construction to form a drip and to allow the flashing to be hooked over the lower edge at least 19 mm (3/4-inch).
6. Fabricate anchor edge maximum width of 75 mm (3 inches) or of sufficient width to provide adequate bearing area to insure a rigid installation using 1.6 mm (0.0625 inch) thick aluminum.

E. Drips:

1. Form drips at lower edge of sheet metal counter-flashings (cap flashings), fascias, gravel stops, wall copings, by folding edge back 13 mm (1/2 inch) and bending out 45 degrees from vertical to carry water away from the wall.
2. Form drip to provide hook to engage cleat or edge strip for fastening for not less than 19 mm (3/4 inch) loose lock where shown.

F. Edges:

1. Finish exposed edges of flashing with a 6 mm (1/4 inch) hem formed by folding edge of flashing back on itself when not hooked to edge

strip or cleat. Use 6 mm (1/4 inch) minimum penetration beyond wall face with drip for through-wall flashing exposed edge.

2. All metal roof edges shall meet requirements of IBC, current edition.

G. Metal Options:

1. Where options are permitted for different metals use only one metal throughout.
2. Stainless steel may be used in concealed locations for fasteners of other metals exposed to view.

## 2.5 FINISHES

- A. Use same finish on adjacent metal or components and exposed metal surfaces unless specified or shown otherwise.
- B. In accordance with NAAMM Metal Finishes Manual AMP 500, unless otherwise specified.
- C. Finish exposed metal surfaces as follows, unless specified otherwise:
  1. Stainless Steel: Finish No. 2B or 2D.
  2. Aluminum:
    - a. Clear Finish: AA-C22A41 medium matte, clear anodic coating, Class 1 Architectural, 18 mm (0.7 mils) thick.
    - b. Colors per Section 09 06 00, Schedule for Finishes.

## 2.6 BASE FLASHING

- A. Use metal base flashing at vertical surfaces intersecting built-up roofing without cant strips or where shown.
  1. Use stainless steel at aluminum roof curbs where flashing contacts the aluminum.
  2. Use stainless steel at pipe flashings.
- B. Fabricate metal base flashing up vertical surfaces not less than 200 mm (8 inch) nor more than 400 mm (16 inch).
- C. Fabricate roof flange not less than 100 mm (4 inches) wide unless shown otherwise. When base flashing length exceeds 2400 mm (8 feet) form flange edge with 13 mm (1/2 inch) hem to receive cleats.
- D. Form base flashing bent from strip except pipe flashing. Fabricate ends for riveted soldered lap seam joints. Fabricate expansion joint ends as specified.
- E. Pipe Flashing: (Other than engine exhaust or flue stack)
  1. Fabricate roof flange not less than 100 mm (4 inches) beyond sleeve on all sides.



2. Extend sleeve up and around pipe and flange out at bottom not less than 13 mm (1/2 inch) and solder to flange and sleeve seam to make watertight.

## **2.7 COUNTERFLASHING (CAP FLASHING OR HOODS)**

- A. Fabricate to lap base flashing a minimum of 100 mm (4 inches) with drip:
  1. Form lock seams for outside corners. Allow for lap joints at ends and inside corners.
  2. In general, form flashing in lengths not less than 2400 mm (8 feet) and not more than 3000 mm (10 feet).
  3. Manufactured assemblies may be used.
  4. Where counterflashing is installed at existing work use surface applied type, formed to provide a space for the application of sealant at the top edge.
- B. One-piece Counterflashing:
  1. Back edge turned up and fabricated to lock into reglet in concrete.
  2. Upper edge formed to extend full depth of masonry unit in mortar joint with back edge turned up 6 mm (1/4 inch).
- C. Surface Mounted Counterflashing; one or two piece:
  1. Use at existing or new surfaces where flashing can not be inserted in vertical surface.
  2. One piece fabricate upper edge folded double for 65 mm (2 1/2 inches) with top 19 mm (3/4 inch) bent out to form "V" joint sealant pocket with vertical surface. Perforate flat double area against vertical surface with horizontally slotted fastener holes at 400 mm (16 inch) centers between end holes. Option: One piece surface mounted counter-flashing (cap flashing) may be used. Fabricate as detailed on Plate 51 of SMACNA Architectural Sheet Metal Manual.
- D. Pipe Counterflashing:
  1. Form flashing for water-tight umbrella with upper portion against pipe to receive a draw band and upper edge to form a "V" joint sealant receiver approximately 19 mm (3/4 inch) deep.
  2. Fabricate 100 mm (4 inch) over lap at end.
  3. Fabricate draw band of same metal as counter flashing. Use 0.6 Kg (24 oz) copper or 0.33 mm (0.013 inch) thick stainless steel or copper coated stainless steel.
  4. Use stainless steel bolt on draw band tightening assembly.

5. Vent pipe counter flashing may be fabricated to omit draw band and turn down 25 mm (one inch) inside vent pipe.

## **2.8 GRAVEL STOPS**

### **A. General:**

1. Fabricate in lengths not less than 2400 mm (8 feet) long and maximum of 3000 mm (10 feet).
2. Fabricate internal and external corners as one-piece with legs not less than 600 mm (2 feet) or more than 1200 mm (4 feet) long.
3. Fabricate roof flange not less than 100 mm (4 inches) wide.
4. Fabricate top edge to extend above roof not less than 25 mm (one inch) for embedded gravel aggregate and not less than 100 mm (4 inches) for loose laid ballast.
5. Fabricate lower edge outward at an angle of 45 degrees to form drip and as fascia or as counter flashing as shown:
  - a. Fabricate of one-piece material of suitable width for fascia height of 250 mm (10 inch) maximum or counterflashing lap of not less than 100 mm (4 inch) over base flashing.
  - b. Fabricate bottom edge of formed fascia to receive edge strip.
  - c. When fascia bottom edge forms counter flashing over roofing lap roofing not less than 150 mm (6 inches).

### **B. Formed Flat Sheet Metal Gravel Stops and Fascia:**

1. Fabricate as shown of 1.25 mm (0.050 inch) thick aluminum.
2. When fascia exceeds 150 mm (6 inches) in depth, form one or more horizontal stops not less than 13 mm (1/2 inch) high in the fascia.
3. Fabricate as two-piece fascia when fascia depth exceeds 250 mm (10 inches).
4. At joint between ends of sheets, provide a concealed clip soldered or welded near one end of each sheet to hold the adjoining sheet in lapped position. The clip shall be approximately 100 mm (4 inches) wide and shall be the full depth of the fascia less 25 mm (one inch) at top and bottom. Clip shall be of the same thickness as the fascia.
5. Provide edge strip as specified with lower hooked edge bent outward at an angle of 45 degrees.

### **C. Formed Sheet Metal Gravel Stops and Fascia:**

1. Factory fabricate prepackaged system, complete with fastenings.

2. Provide concealed flashing splice plate at joints not less than 150 mm (6 inches) long and continuous edge strip at lower edge of fascia made from same metal.
3. Fabricate as two-piece fascia when fascia depth exceeds 175 mm (7 inches).

## **2.9 EXPANSION JOINT COVERS**

- A. Unless otherwise indicated in drawings, expansion joint covers shall have factory fabricated mitered corners, crossing tees, and other necessary accessories. Furnish in the longest available lengths.

## **2.10 FLASHINGS AT ROOF PENETRATIONS**

- A. Flashing at penetrations through roofing shall consist of a metal collar, sheet metal flashing sleeve and hood.
- B. Fabricate collar with roof flange of 1.2 mm (0.047 inch) minimum thick black iron or galvanized steel sheet.
  1. Fabricate inside diameter of collar 100 mm (4 inches) larger than the outside diameter of the item penetration the roofing.
  2. Extend collar height from structural roof deck to not less than 350 mm (14 inches) above roof surface.
  3. Fabricate collar roof flange not less than 100 mm (4 inches) wide.
- C. Fabricate sleeve base flashing with roof flange of stainless steel.
  1. Fabricate sleeve roof flange not less than 100 mm (4 inches) wide.
  2. Extend sleeve around collar up to top of collar.
  3. Flange bottom of sleeve out not less than 13 mm (1/24 inch) and soldered to 100 mm (4 inch) wide flange to make watertight.
  4. Fabricate interior diameter 50 mm (2 inch) greater than collar.
- D. Fabricate hood counter flashing from same material and thickness as sleeve.
  1. Fabricate the same as pipe counter flashing except allow not less than 100 mm (4 inch) lap below top of sleeve and to form vent space minimum of 100 mm (4 inch) wide.
  2. Hem bottom edge of hood 13 mm (1/2 inch).
  3. Provide a 50 mm (2 inch) deep drawband.

## **2.11 PRE-FINISHED ALUMINUM FLASHINGS**

- A. Formed Sheet Metal Corners and Sills:
- B. Use flexible base flashing at vertical and horizontal surfaces extending membrane waterproofing intersections.

- C. Form flashing bent from strip. Fabricate ends for riveted soldered lap seam joints. Fabricate expansion joint ends as specified.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

A. General:

1. Install flashing and sheet metal items as shown in Sheet Metal and Air Conditioning Contractors National Association, Inc., publication, ARCHITECTURAL SHEET METAL MANUAL, except as otherwise shown or specified.
2. Apply Sealant as specified in Section 07 92 00, JOINT SEALANTS.
3. Apply sheet metal and other flashing material to surfaces which are smooth, sound, clean, dry and free from defects that might affect the application.
4. Remove projections which would puncture the materials and fill holes and depressions with material compatible with the substrate. Cover holes or cracks in wood wider than 6 mm (1/4 inch) with sheet metal compatible with the roofing and flashing material used.
5. Confine direct nailing of sheet metal to strips 300 mm (12 inch) or less wide. Nail flashing along one edge only. Space nail not over 100 mm (4 inches) on center unless specified otherwise.
6. Install bolts, rivets, and screws where indicated, specified, or required in accordance with the SMACNA Sheet Metal Manual. Space rivets at 75 mm (3 inch) on centers in two rows in a staggered position. Use neoprene washers under fastener heads when fastener head is exposed.
7. Coordinate with roofing work for the installation of metal base flashings and other metal items having roof flanges for anchorage and watertight installation.
8. Nail continuous cleats on 75 mm (3 inch) on centers in two rows in a staggered position.
9. Nail individual cleats with two nails and bend end tab over nail heads. Lock other end of cleat into hemmed edge.
10. Install flashings in conjunction with other trades so that flashings are inserted in other materials and joined together to provide a water tight installation.

11. Where required to prevent galvanic action between dissimilar metal isolate the contact areas of dissimilar metal with sheet lead, waterproof building paper, or a coat of bituminous paint.
12. Isolate aluminum in contact with dissimilar metals others than stainless steel, white bronze or other metal compatible with aluminum by:
  - a. Paint dissimilar metal with a prime coat of zinc-chromate or other suitable primer, followed by two coats of aluminum paint.
  - b. Paint dissimilar metal with a coat of bituminous paint.
  - c. Apply an approved caulking material between aluminum and dissimilar metal.
13. Paint aluminum in contact with mortar, concrete, plaster, or other masonry materials with a coat of bituminous paint.
14. Paint aluminum in contact with absorptive materials that may become repeatedly wet with two coats of bituminous paint or two coats of aluminum paint.

### **3.2 BASE FLASHING**

- A. Install where roof membrane type base flashing is not used and where shown.
  1. Install flashing at intersections of roofs with vertical surfaces or at penetrations through roofs, to provide watertight construction.
  2. Install metal flashings and accessories having flanges extending out on top of the built-up roofing before final bituminous coat and roof aggregate is applied.
  3. Set flanges in heavy trowel coat of roof cement and nail through flanges into wood nailers over bituminous roofing.
  4. Secure flange by nailing through roofing into wood blocking with nails spaced 75 mm (3 inch) on centers or, when flange over 100 mm (4 inch) wide terminate in a 13 mm (1/2 inch) folded edge anchored with cleats spaced 200 mm (8 inch) on center. Secure one end of cleat over nail heads. Lock other end into the seam.
- B. For long runs of base flashings install in lengths of not less than 2400 mm (8 feet) nor more than 3000 mm (ten feet). Install a 75 mm (3 inch) wide slip type, loose lock expansion joint filled with sealant in joints of base flashing sections over 2400 mm (8 feet) in length. Lock and solder corner joints at corners.

- C. Extend base flashing up under counter flashing of roof specialties and accessories or equipment not less than 75 mm (3 inch).

### **3.3 COUNTERFLASHING (CAP FLASHING OR HOODS)**

#### **A. General:**

1. Install counterflashing over and in conjunction with installation of base flashings, except as otherwise specified or shown.
2. Install counterflashing to lap base flashings not less than 100 mm (4 inch).
3. Install upper edge or top of counterflashing not less than 225 mm (9 inch) above top of the roofing.
4. Lap joints not less than 100 mm (4 inch). Stagger joints with relation to metal base flashing joints.
5. Use surface applied counterflashing on existing surfaces and new work where not possible to integrate into item.
6. When fastening to concrete or masonry, use screws driven in expansion shields set in concrete or masonry. Use screws to wood and sheet metal. Set fasteners in mortar joints of masonry work.

#### **B. One Piece Counterflashing:**

1. Where flashing is installed in reglet in concrete insert upper edge into reglet. Hold flashing in place with lead wedges spaced not more than 200 mm (8 inch) apart. Fill joint with sealant.
2. Where flashing is surface mounted on flat surfaces.
  - a. When top edge is double folded anchor flat portion below sealant "V" joint with fasteners spaced not over 400 mm (16 inch) on center:
    - 1) Locate fasteners in masonry mortar joints.
    - 2) Use screws to sheet metal or wood.
  - b. Fill joint at top with sealant.
3. Where flashing or hood is mounted on pipe.
  - a. Secure with draw band tight against pipe.
  - b. Set hood and secure to pipe with a one by 25 mm x 3 mm (1 x 1/8 inch) bolt on stainless steel draw band type clamp, or a stainless worm gear type clamp.
  - c. Completely fill joint at top with sealant.

#### **C. Two-Piece Counterflashing:**

1. Where receiver is installed at new masonry coordinate to insure proper height, embed in mortar, and lap.

2. Surface applied type receiver:

- a. Secure to face construction in accordance, with manufacturers instructions.
  - b. Completely fill space at the top edge of receiver with sealant.
3. Insert counter flashing in receiver in accordance with fabricator or manufacturer's instructions and to fit tight against base flashing.
- D. Where vented edge occur install so lower edge of counterflashing is against base flashing.
- E. When counter flashing is a component of other flashing install as shown.

**3.4 REGLETS**

- A. Install reglets where indicated in drawings, in a manner to provide a watertight installation.
- B. Butt and align end joints on each section of reglet and securely hold in position until concrete or mortar are hardened:
1. Coordinate reglets for anchorage into construction.

**3.5 GRAVEL STOPS**

A. General:

1. Install gravel stops and fascias with allowance for expansion at each joint; minimum of 6 mm (1/4 inch).
2. Extend roof flange of gravel stop and splice plates not less than four inches out over roofing and nail or screw to wood nailers. Space fasteners on 75 mm (3 inch) centers in staggered pattern.
3. Install continuous cleat for fascia drip edge. Secure with fasteners as close to lower edge as possible on 75 mm (3 inch) centers.
4. Where ends of gravel stops and fascias abut a vertical wall, provide a watertight, flashed and sealant filled joint.
5. Set flange in roof cement when installed over built-up roofing.
6. Edge securement for low-slope roofs: Low-slope membrane roof systems metal edge securement, except gutters, shall be designed in accordance with ANSI/SPRI ES-1, except the basic wind speed shall be determined from Figure 1609, of IBC 2003.

B. Sheet metal gravel stops and fascia:

1. Install with end joints of splice plates sheets lapped three inches.
2. Hook the lower edge of fascia into a continuous edge strip.
3. Lock top section to bottom section for two piece fascia.

C. Scuppers:

1. Install scupper where occurs, with flange behind gravel stops; leave 6 mm (1/4 inch) joint to gravel stop.
2. Set scupper at roof as indicated in drawings and fasten to wood blocking.
3. Use sealant to seal joint with fascia gravel stops at ends.
4. Coordinate to lap over conductor head and to discharge water into conductor head.

### **3.6 COPINGS**

- A. Install ends adjoining existing construction so as to form space for installation of sealants. Sealant is specified in Section 07 92 00, JOINT SEALANTS.
- B. Aluminum Coping:
  1. Install with 6 mm (1/4 inch) joint between ends of coping sections.
  2. Install joint covers, centered at each joint, and securely lock in place.

### **3.7 EXPANSION JOINT COVERS, INSULATED**

- A. Install expansion joint covers at locations shown above roof surface.
- B. Install continuous edge strips of same metal as expansion joint flange, nailed at not less than 75 mm (3 inch) centers.
- C. Install expansion joint covers in accordance with manufacturer's directions locking edges to edge strips.
- D. At transition between horizontal and vertical expansion joint, continue joint cover up the vertical face of the wall. Cover joint cover with edge strip.

- - - E N D - -



**SECTION 07 92 00**

**JOINT SEALANTS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. Section covers all sealant and caulking materials and their application, wherever required for complete installation of building materials or systems.

**1.2 RELATED WORK**

- A. All Sections listed in the Table of Contents are a Condition of this Section.

**1.3 QUALITY CONTROL**

- A. Installer Qualifications: An experienced installer who has specialized in installing joint sealants similar in material, design, and extent to those indicated for this Project and whose work has resulted in joint-sealant installations with a record of successful in-service performance.
- B. Source Limitations: Obtain each type of joint sealant through one source from a single manufacturer.
- C. Product Testing: Obtain test results from a qualified testing agency based on testing current sealant formulations within a 12-month period.
  - 1. Testing Agency Qualifications: An independent testing agency qualified according to ASTM C1021.
  - 2. Test elastomeric joint sealants for compliance with requirements specified by reference to ASTM C920, and where applicable, to other standard test methods.
  - 3. Test other joint sealants for compliance with requirements indicated by referencing standard specifications and test methods.
- D. Preconstruction Field-Adhesion Testing: Before installing elastomeric sealants, field test their adhesion to joint substrates in accordance with sealant manufacturer's recommendations:
  - 1. Locate test joints where indicated or, if not indicated, as directed by Contracting Officer.
  - 3. Notify COR seven days in advance of dates and times when test joints will be erected.
  - 4. Arrange for tests to take place with joint sealant manufacturer's technical representative present.

- E. VOC: Acrylic latex and Silicon sealants shall have less than 50g/l VOC content.
- F. Mockups: Before installing joint sealants, apply elastomeric sealants as follows to verify selections made under sample Submittals and to demonstrate aesthetic effects and qualities of materials and execution. Joints in Sections that are indicated to receive elastomeric joint sealants, which are specified by reference to this section.

#### **1.4 SUBMITTALS**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Manufacturer's installation instructions for each product used.
- C. Cured samples of exposed sealants for each color where required to match adjacent material.
- D. Manufacturer's Literature and Data:
  - 1. Caulking compound
  - 2. Primers
  - 3. Sealing compound, each type, including compatibility when different sealants are in contact with each other.

#### **1.5 PROJECT CONDITIONS**

- A. Environmental Limitations:
  - 1. Do not proceed with installation of joint sealants under following conditions:
    - a. When ambient and substrate temperature conditions are outside limits permitted by joint sealant manufacturer or are below 4.4 °C (40 °F).
    - b. When joint substrates are wet.
- B. Joint-Width Conditions:
  - 1. Do not proceed with installation of joint sealants where joint widths are less than those allowed by joint sealant manufacturer for applications indicated.
- C. Joint-Substrate Conditions:
  - 1. Do not proceed with installation of joint sealants until contaminants capable of interfering with adhesion are removed from joint substrates.

#### **1.6 DELIVERY, HANDLING, AND STORAGE**

- A. Deliver materials in manufacturers' original unopened containers, with brand names, date of manufacture, shelf life, and material designation clearly marked thereon.
- B. Carefully handle and store to prevent inclusion of foreign materials.
- C. Do not subject to sustained temperatures exceeding 32° C (90° F) or less than 5° C (40° F).

#### **1.7 DEFINITIONS**

- A. Definitions of terms in accordance with ASTM C717 and as specified.
- B. Back-up Rod: A type of sealant backing.
- C. Bond Breakers: A type of sealant backing.
- D. Filler: A sealant backing used behind a back-up rod.

#### **1.8 WARRANTY**

- A. Warranty exterior sealing against leaks, adhesion, and cohesive failure, and subject to terms of "Warranty of Construction", FAR clause 52.246-21, except that warranty period shall be extended to two years.
- B. General Warranty: Special warranty specified in this Article shall not deprive Government of other rights Government may have under other provisions of Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of Contract Documents.

#### **1.9 APPLICABLE PUBLICATIONS**

- A. Publications listed below form a part of this specification to extent referenced. Publications are referenced in text by basic designation only.
- B. American Society for Testing and Materials (ASTM):
  - C834-10.....Latex Sealants.
  - C920-10.....Elastomeric Joint Sealants.

### **PART 2 - PRODUCTS**

#### **2.1 SEALANTS**

- A. S-1:
  - 1. ASTM C920, polyurethane or polysulfide.
  - 2. Type M.
  - 3. Class 25.
  - 4. Grade P.
  - 5. Shore A hardness of 25-40.

B. S-2:

1. ASTM C920, silicone, neutral cure.
2. Type S.
3. Class: Joint movement range of plus 100 percent to minus 50 percent.
4. Grade NS.
5. Shore A hardness of 15-20.
6. Minimum elongation of 1200 percent.

C. S-3:

1. ASTM C920 silicone.
2. Type S.
3. Class 25.
4. Grade NS.
5. Shore A hardness of 25-30.
6. Non-yellowing, mildew resistant.

D. S-4:

1. ASTM C920, coal tar extended fuel resistance polyurethane.
2. Type M/S.
3. Class 25.
4. Grade P/NS.
5. Shore A hardness of 15-20.

E. S-5:

1. ASTM C920, polyurethane.
2. Type M/S.
3. Class 25, joint movement range of plus or minus 50 percent.
4. Grade P/NS.
5. Shore A hardness of 25 to 50.

## **2.2 CAULKING COMPOUND**

- A. C-1: ASTM C834, acrylic latex.
- B. C-2: One component acoustical caulking, non drying, non hardening, synthetic rubber.

## **2.3 COLOR**

- A. Sealants shall match color of adjacent surface.
- B. Color of sealants for other locations shall be light gray or aluminum, unless specified otherwise.
- C. Caulking shall be light gray or white, unless specified otherwise.

## **2.4 JOINT SEALANT BACKING**

- A. General: Provide sealant backings of material and type 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.
- B. Cylindrical Sealant Backings: ASTM C1330, of type indicated below and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance:
  - 1. Type C: Closed-cell material with a surface skin.
- C. Elastomeric Tubing Sealant Backings: Neoprene, butyl, EPDM, or silicone tubing complying with ASTM D1056, nonabsorbent to water and gas, and capable of remaining resilient at temperatures down to minus 32° C (minus 26° F). Provide products with low compression set and of size and shape to provide a secondary seal, to control sealant depth, and otherwise contribute to optimum sealant performance.
- D. 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 where such adhesion would result in sealant failure. Provide self-adhesive tape where applicable.

## **2.5 FILLER**

- A. Mineral fiber board: ASTM C612, Class 1.
- B. Thickness same as joint width.
- C. Depth to fill void completely behind back-up rod.

## **2.6 PRIMER**

- A. As recommended by manufacturer of caulking or sealant material.
- B. Stain free type.

## **2.7 CLEANERS-NON POUROUS SURFACES**

- A. Chemical cleaners acceptable to manufacturer of sealants and sealant backing material, free of oily residues and other substances capable of staining or harming joint substrates and adjacent non-porous surfaces and formulated to promote adhesion of sealant and substrates.

# **PART 3 - EXECUTION**

## **3.1 INSPECTION**

- A. Inspect substrate surface for bond breaker contamination and unsound materials at adherent faces of sealant.

- B. Coordinate for repair and resolution of unsound substrate materials.
- C. Inspect for uniform joint widths and that dimensions are within tolerance established by sealant manufacturer.

### **3.2 PREPARATIONS**

- A. Prepare joints in accordance with manufacturer's instructions and SWRI.
- B. Clean surfaces of joint to receive caulking or sealants leaving joint dry to the touch, free from frost, moisture, grease, oil, wax, lacquer paint, or other foreign matter that would tend to destroy or impair adhesion.
  - 1. Clean porous joint substrate surfaces by brushing, grinding, blast cleaning, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants.
  - 2. Remove loose particles remaining from above cleaning operations by vacuuming or blowing out joints with oil-free compressed air. Porous joint surfaces include concrete and masonry materials.
  - 3. Remove laitance and form-release agents from concrete.
  - 4. Clean nonporous surfaces, including metals, with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants.
- C. Do not cut or damage joint edges.
- D. Apply masking tape to face of surfaces adjacent to joints before applying primers, caulking, or sealing compounds.
  - 1. Do not leave gaps between ends of sealant backings.
  - 2. Do not stretch, twist, puncture, or tear sealant backings.
  - 3. Remove absorbent sealant backings that have become wet before sealant application and replace them with dry materials.
- E. Apply primer to sides of joints wherever required by compound manufacturer's printed instructions.
  - 1. Apply primer prior to installation of back-up rod or bond breaker tape.
  - 2. Use brush or other approved means that will reach all parts of joints.
- F. Take all necessary steps to prevent three sided adhesion of sealants.

### **3.3 BACKING INSTALLATION**

- A. Install back-up material, to form joints enclosed on three sides as required for specified depth of sealant.

- B. Where deep joints occur, install filler to fill space behind the back-up rod and position the rod at proper depth.
- C. Cut fillers installed by others to proper depth for installation of back-up rod and sealants.
- D. Install back-up rod, without puncturing the material, to a uniform depth, within plus or minus 3 mm (1/8 inch) for sealant depths specified.
- E. Where space for back-up rod does not exist, install bond breaker tape strip at bottom (or back) of joint so sealant bonds only to two opposing surfaces.
- F. Take all necessary steps to prevent three sided adhesion of sealants.

### **3.4 SEALANT DEPTHS AND GEOMETRY**

- A. At widths up to 6 mm (1/4 inch), sealant depth equal to width.
- B. At widths over 6 mm (1/4 inch), sealant depth 1/2 of width up to 13 mm (1/2 inch) maximum depth at center of joint with sealant thickness at center of joint approximately 1/2 of depth at adhesion surface.

### **3.5 INSTALLATION**

- A. General:
  - 1. Apply sealants and caulking only when ambient temperature is between 5° C and 38° C (40° and 100° F).
  - 2. Do not use polysulfide base sealants where sealant may be exposed to fumes from bituminous materials, or where water vapor in continuous contact with cementitious materials may be present.
  - 3. Do not use sealant type listed by manufacture as not suitable for use in locations specified.
  - 4. Apply caulking and sealing compound in accordance with manufacturer's printed instructions.
  - 5. Avoid dropping or smearing compound on adjacent surfaces.
  - 6. Fill joints solidly with compound and finish compound smooth.
  - 7. Tool joints to concave surface unless shown or specified otherwise.
  - 8. Finish paving or floor joints flush unless joint is otherwise detailed.
  - 9. Apply compounds with nozzle size to fit joint width.
  - 10. Test sealants for compatibility with each other and substrate. Use only compatible sealant.
- B. For application of sealants, follow requirements of ASTM C1193 unless specified otherwise.

C. Where gypsum board partitions are of sound rated, fire rated, or smoke barrier construction, follow requirements of ASTM C919 only to seal all cut-outs and intersections with the adjoining construction unless specified otherwise.

1. Apply a 6 mm (1/4 inch) minimum bead of sealant each side of runners (tracks), including those used at partition intersections with dissimilar wall construction.
2. Coordinate with application of gypsum board to install sealant immediately prior to application of gypsum board.
3. Partition intersections: Seal edges of face layer of gypsum board abutting intersecting partitions, before taping and finishing or application of veneer plaster-joint reinforcing.
4. Openings: Apply a 6 mm (1/4 inch) bead of sealant around all cut-outs to seal openings of electrical boxes, ducts, pipes and similar penetrations. To seal electrical boxes, seal sides and backs.
5. Control Joints: Before control joints are installed, apply sealant in back of control joint to reduce flanking path for sound through control joint.

### **3.6 FIELD QUALITY CONTROL**

A. Field-Adhesion Testing:

1. Field-test joint-sealant adhesion to joint substrates as recommended by sealant manufacturer.
2. Perform one test for first 30 m (100 feet) of joint length for each type of elastomeric sealant and joint substrate per elevation..

B. Inspect joints for complete fill, for absence of voids, and for joint configuration complying with specified requirements. Record results in a field adhesion test log.

C. Inspect tested joints and report on following:

1. 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 type of product and joint substrate.
2. Compare these results to determine if adhesion passes sealant manufacturer's field-adhesion hand-pull test criteria.
3. Whether sealants filled joint cavities and are free from voids.
4. Whether sealant dimensions and configurations comply with specified requirements.



- D. Repair sealants pulled from test area by applying new sealants following same procedures used to originally seal joints. Ensure that original sealant surfaces are clean and new sealant contacts original sealant.
- E. Evaluation of Field-Test Results: Sealants not evidencing adhesive failure from testing or noncompliance with other indicated requirements, will be considered satisfactory. Remove sealants that fail to adhere to joint substrates during testing or to comply with other requirements. Retest failed applications until test results prove sealants comply with indicated requirements.

### 3.7 CLEANING

- A. Fresh compound accidentally smeared on adjoining surfaces: Scrape off immediately and rub clean with a solvent as recommended by the caulking or sealant manufacturer.
- B. After filling and finishing joints, remove masking tape.
- C. Leave adjacent surfaces in a clean and unstained condition.

### 3.8 LOCATIONS

- A. Exterior Building Joints, Horizontal and Vertical:
  - 1. Metal to Metal: Type S-1, S-2
- B. Metal Reglets and Flashings:
  - 1. Flashings to Wall: Type S-6
  - 2. Metal to Metal: Type S-6
- C. Sanitary Joints:
  - 1. Walls to Plumbing Fixtures: Type S-9
  - 2. Pipe Penetrations: Type S-9
- D. Horizontal Traffic Joints:
  - 1. Concrete Paving: Type S-11 or S-12
- E. Interior Caulking:
  - 1. Typical Narrow Joint 6 mm, (1/4 inch) or less at Walls and Adjacent Components: Types C-1 and C-2.
  - 2. Perimeter of Doors, Windows, Access Panels which Adjoin Concrete: Types C-1 and C-2.
  - 3. Exposed Isolation Joints at top of full height walls: Types C-1 and C-2.

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**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: suspended ceiling.
  - 2. Electrical Elements: Power and lighting systems; selector and controller panels; fire protection and alarm systems; and telephone and communication systems.
  - 3. Mechanical Elements: Heating, ventilating, and air-conditioning systems; roof drainage piping; sprinkler systems.

**1.2 RELATED WORK**

- A. All Sections listed in the Table of Contents are a Condition of this Section.

**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 California.
  - 2. Submit design tables and information used for the design-force levels, stamped and signed by a professional structural engineer registered in California
- 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.

- C. Seismic Certification: Permanent equipments and components are to have Special Seismic Certification in accordance with requirements of section 13.2.2 of ASCE 7, and shall comply with section 13.2.6 of ASCE 7.

#### **1.4 SUBMITTALS**

- A. In accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES, furnish the following:
- B. 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.
- C. 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.
- D. 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.
- E. Submit design calculations prepared and sealed by the registered structural engineer specified above in paragraph 1.3A.

#### **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 Society of Civil Engineers (ASCE 7) Latest Edition.
- C. International Building Code (IBC) Latest Edition
- D. VA Seismic Design Requirements, H-18-8, February 2011
- E. National Uniform Seismic Installation Guidelines (NUSIG)
- F. Sheet Metal and Air Conditioning Contractors National Association (SMACNA): Seismic Restraint Manual - Guidelines for Mechanical Systems, 1998 Edition and Addendum

#### **1.6 REGULATORY REQUIREMENT**

- A. IBC, current edition.
- 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 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**

Not Used

## **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.

### **3.2 EQUIPMENT RESTRAINT AND BRACING**

- A. See drawings for equipment to be restrained or braced.

### **3.3 MECHANICAL DUCTWORK AND PIPING; ELECTRICAL BUSWAYS, CONDUITS, AND CABLE TRAYS; AND TELECOMMUNICATION WIRES AND CABLE TRAYS**

- A. Support and brace mechanical ductwork and piping; conduits and cable trays; and telecommunication wires and cable trays 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. 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 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.

### **3.5 FACADES**

- 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.

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**SECTION 22 05 11**  
**COMMON WORK RESULTS FOR PLUMBING**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. The requirements of this Section shall apply to all sections of Division 22.
- B. Definitions:
  - 1. Exposed: Piping and equipment exposed to view in finished rooms.
  - 2. Option or optional: Contractor's choice of an alternate material or method.

**1.2 RELATED WORK**

- A. Section 01 00 00, GENERAL REQUIREMENTS.
- B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- C. Section 05 36 00, COMPOSITE METAL DECKING: Building Components for Attachment of Hangers.
- D. Section 05 50 00, METAL FABRICATIONS.
- E. Section 07 84 00, FIRESTOPPING.
- F. Section 07 92 00, JOINT SEALANTS.
- G. Section 09 91 00, PAINTING.
- H. Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS
- I. SECTION 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS. Requirements for commissioning, systems readiness checklist, and training.
- J. Section 23 07 11, HVAC, PLUMBING, AND BOILER PLANT INSULATION.
- K. Section 23 09 23, DIRECT DIGITAL CONTROLS FOR HVAC.
- L. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS
- M. Section 26 29 11, LOW-VOLTAGE MOTOR STARTERS.

**1.3 QUALITY ASSURANCE**

- A. Products Criteria:
  - 1. Standard Products: Material and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of the products for at least 3 years. However, digital electronics devices, software and systems such as controls, instruments, computer work station, shall be the current generation of technology and basic design that has a proven satisfactory service record of at least three years.

2. Equipment Service: There shall be permanent service organizations, authorized and trained by manufacturers of the equipment supplied, located within 160 km (100 miles) of the project. These organizations shall come to the site and provide acceptable service to restore operations within four hours of receipt of notification by phone, e-mail or fax in event of an emergency, such as the shut-down of equipment; or within 24 hours in a non-emergency. Names, mail and e-mail addresses and phone numbers of service organizations providing service under these conditions for (as applicable to the project): pumps, critical instrumentation, computer workstation and programming shall be submitted for project record and inserted into the operations and maintenance manual.
3. All items furnished shall be free from defects that would adversely affect the performance, maintainability and appearance of individual components and overall assembly.
4. The products and execution of work specified in Division 22 shall conform to the referenced codes and standards as required by the specifications. Local codes and amendments enforced by the local code official shall be enforced, if required by local authorities such as the natural gas supplier. If the local codes are more stringent, then the local code shall apply. Any conflicts shall be brought to the attention of the Resident Engineer (RE)/Contracting Officers Technical Representative (COTR).
5. Multiple Units: When two or more units of materials or equipment of the same type or class are required, these units shall be products of one manufacturer.
6. Assembled Units: Manufacturers of equipment assemblies, which use components made by others, assume complete responsibility for the final assembled product.
7. Nameplates: Nameplate bearing manufacturer's name or identifiable trademark shall be securely affixed in a conspicuous place on equipment, or name or trademark cast integrally with equipment, stamped or otherwise permanently marked on each item of equipment.
8. Asbestos products or equipment or materials containing asbestos shall not be used.



- B. Welding: Before any welding is performed, contractor shall submit a certificate certifying that welders comply with the following requirements:
1. Qualify welding processes and operators for piping according to ASME "Boiler and Pressure Vessel Code", Section IX, "Welding and Brazing Qualifications".
  2. Comply with provisions of ASME B31 series "Code for Pressure Piping".
  3. Certify that each welder has passed American Welding Society (AWS) qualification tests for the welding processes involved, and that certification is current.
  4. All welds shall be stamped according to the provisions of the American Welding Society.
- C. Manufacturer's Recommendations: Where installation procedures or any part thereof are required to be in accordance with the recommendations of the manufacturer of the material being installed, printed copies of these recommendations shall be furnished to the Resident Engineer prior to installation. Installation of the item will not be allowed to proceed until the recommendations are received. Failure to furnish these recommendations can be cause for rejection of the material.
- D. Execution (Installation, Construction) Quality:
1. All items shall be applied and installed in accordance with manufacturer's written instructions. Conflicts between the manufacturer's instructions and the contract drawings and specifications shall be referred to the RE/COTR for resolution. Written hard copies or computer files of manufacturer's installation instructions shall be provided to the RE/COTR at least two weeks prior to commencing installation of any item.
  2. Complete layout drawings shall be required by Paragraph, SUBMITTALS. Construction work shall not start on any system until the layout drawings have been approved.
- E. Guaranty: Warranty of Construction, FAR clause 52.246-21.
- F. Plumbing Systems: IPC, International Plumbing Code.

#### **1.4 SUBMITTALS**

- A. Submittals shall be submitted in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.

- B. Information and material submitted under this section shall be marked "SUBMITTED UNDER SECTION 22 05 11, COMMON WORK RESULTS FOR PLUMBING", with applicable paragraph identification.
- C. Contractor shall make all necessary field measurements and investigations to assure that the equipment and assemblies will meet contract requirements.
- D. If equipment is submitted which differs in arrangement from that shown, provide drawings that show the rearrangement of all associated systems. Approval will be given only if all features of the equipment and associated systems, including accessibility, are equivalent to that required by the contract.
- E. Prior to submitting shop drawings for approval, contractor shall certify in writing that manufacturers of all major items of equipment have each reviewed drawings and specifications, and have jointly coordinated and properly integrated their equipment and controls to provide a complete and efficient installation.
- F. Upon request by Government, lists of previous installations for selected items of equipment shall be provided. Contact persons who will serve as references, with telephone numbers and e-mail addresses shall be submitted with the references.
- G. Manufacturer's Literature and Data: Manufacturer's literature shall be submitted under the pertinent section rather than under this section.
  - 1. Electric motor data and variable speed drive data shall be submitted with the driven equipment.
  - 2. Equipment and materials identification.
  - 4. Hangers, inserts, supports and bracing. Provide load calculations for variable spring and constant support hangers.
  - 5. Wall, floor, and ceiling plates.
- H. Coordination Drawings: Complete consolidated and coordinated layout drawings shall be submitted for all new systems, and for existing systems that are in the same areas. The drawings shall include plan views, elevations and sections of all systems and shall be on a scale of not less than 1:32 (3/8-inch equal to one foot). Clearly identify and dimension the proposed locations of the principal items of equipment. The drawings shall clearly show the proposed location and adequate clearance for all equipment, piping, pumps, valves and other items. All valves, trap primer valves, water hammer arrestors,

strainers, and equipment requiring service shall be provided with an access door sized for the complete removal of plumbing device, component, or equipment. Equipment foundations shall not be installed until equipment or piping until layout drawings have been approved. Detailed layout drawings shall be provided for all piping systems. In addition, details of the following shall be provided.

1. Mechanical equipment rooms.
2. Hangers, inserts, supports, and bracing.
3. Pipe sleeves.
4. Equipment penetrations of floors, walls, ceilings, or roofs.

I. Maintenance Data and Operating Instructions:

1. Maintenance and operating manuals in accordance with Section 01 00 00, GENERAL REQUIREMENTS, Article, INSTRUCTIONS, for systems and equipment.
2. Listing of recommended replacement parts for keeping in stock supply, including sources of supply, for equipment shall be provided.
3. The listing shall include belts for equipment: Belt manufacturer, model number, size and style, and distinguished whether of multiple belt sets.

**1.5 DELIVERY, STORAGE AND HANDLING**

A. Protection of Equipment:

1. Equipment and material placed on the job site shall remain in the custody of the Contractor until phased acceptance, whether or not the Government has reimbursed the Contractor for the equipment and material. The Contractor is solely responsible for the protection of such equipment and material against any damage.
2. Damaged equipment shall be replaced with an identical unit as determined and directed by the RE/COTR. Such replacement shall be at no additional cost to the Government.
3. Interiors of new equipment and piping systems shall be protected against entry of foreign matter. Both inside and outside shall be cleaned before painting or placing equipment in operation.
4. Existing equipment and piping being worked on by the Contractor shall be under the custody and responsibility of the Contractor and shall be protected as required for new work.

B. Cleanliness of Piping and Equipment Systems:

1. Care shall be exercised in the storage and handling of equipment and piping material to be incorporated in the work. Debris arising from cutting, threading and welding of piping shall be removed.
2. Piping systems shall be flushed, blown or pigged as necessary to deliver clean systems.
3. Contractor shall be fully responsible for all costs, damage, and delay arising from failure to provide clean systems.

#### **1.6 APPLICABLE PUBLICATIONS**

- A. The publications listed below shall 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 for Testing and Materials (ASTM):
- A36/A36M-2008.....Standard Specification for Carbon Structural Steel
  - A575-96 (R 2007).....Standard Specification for Steel Bars, Carbon, Merchant Quality, M-Grades R (2002)
  - E84-2005.....Standard Test Method for Surface Burning Characteristics of Building Materials
  - E119-2008a.....Standard Test Methods for Fire Tests of Building Construction and Materials
- C. Manufacturers Standardization Society (MSS) of the Valve and Fittings Industry, Inc:
- SP-58-02.....Pipe Hangers and Supports-Materials, Design and Manufacture
  - SP 69-2003 (R 2004).....Pipe Hangers and Supports-Selection and Application
- D. National Electrical Manufacturers Association (NEMA):
- MG1-2003, Rev. 1-2007...Motors and Generators
- E. International Code Council, (ICC):
- IBC-06, (R2012).....International Building Code
  - IPC-06, (R2012).....International Plumbing Code

#### **PART 2 - PRODUCTS**

##### **2.1 FACTORY-ASSEMBLED PRODUCTS**

- A. STANDARDIZATION OF COMPONENTS SHALL BE MAXIMIZED TO REDUCE SPARE PART requirements.

B. Manufacturers of equipment assemblies that include components made by others shall assume complete responsibility for final assembled unit.

1. All components of an assembled unit need not be products of same manufacturer.
2. Constituent parts that are alike shall be products of a single manufacturer.
3. Components shall be compatible with each other and with the total assembly for intended service.
4. Contractor shall guarantee performance of assemblies of components, and shall repair or replace elements of the assemblies as required to deliver specified performance of the complete assembly.

C. Components of equipment shall bear manufacturer's name and trademark, model number, serial number and performance data on a name plate securely affixed in a conspicuous place, or cast integral with, stamped or otherwise permanently marked upon the components of the equipment.

D. Major items of equipment, which serve the same function, shall be the same make and model

## **2.2 COMPATIBILITY OF RELATED EQUIPMENT**

A. Equipment and materials installed shall be compatible in all respects with other items being furnished and with existing items so that the result will be a complete and fully operational system that conforms to contract requirements.

## **2.3 SAFETY GUARDS**

A. Pump shafts and couplings shall be fully guarded by a sheet steel guard, covering coupling and shaft but not bearings. Material shall be minimum 16-gage sheet steel; ends shall be braked and drilled and attached to pump base with minimum of four 6 mm (1/4-inch) bolts. Reinforce guard as necessary to prevent side play forcing guard onto couplings.

B. All Equipment shall have moving parts protected from personal injury.

## **2.4 ELECTRIC MOTORS, MOTOR CONTROL, CONTROL WIRING**

A. All material and equipment furnished and installation methods shall conform to the requirements of Section 22 05 12, GENERAL MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT; Section 26 29 11, LOW-VOLTAGE MOTOR STARTERS; and, Section 26 05 21, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW). All electrical wiring, conduit, and devices necessary for the proper connection, protection

and operation of the systems shall be provided. Premium efficient motors shall be provided. Unless otherwise specified for a particular application, electric motors shall have the following requirements.

B. Special Requirements:

1. Wire and cable materials specified in the electrical division of the specifications shall be modified as follows:
  - a. Wiring material located where temperatures can exceed 71° C (160° F) shall be stranded copper with Teflon FEP insulation with jacket. This includes wiring on the boilers.
  - b. Other wiring at boilers and to control panels shall be NFPA 70 designation THWN.
  - c. Shielded conductors or wiring in separate conduits for all instrumentation and control systems shall be provided where recommended by manufacturer of equipment.

**2.5 EQUIPMENT AND MATERIALS IDENTIFICATION**

- A. Use symbols, nomenclature and equipment numbers specified, shown on the drawings, or shown in the maintenance manuals. Identification for piping is specified in Section 09 91 00, PAINTING.
- B. Interior (Indoor) Equipment: Engraved nameplates, with letters not less than 48 mm (3/16-inch) high of brass with black-filled letters, or rigid black plastic with white letters specified in Section 09 91 00, PAINTING shall be permanently fastened to the equipment. Unit components such as water heaters, tanks, coils, filters, fans, etc. shall be identified.
- C. Exterior (Outdoor) Equipment: Brass nameplates, with engraved black filled letters, not less than 48 mm (3/16-inch) high riveted or bolted to the equipment.
- D. Control Items: All temperature, pressure, and controllers shall be labeled and the component's function identified. Identify and label each item as they appear on the control diagrams.
- E. Valve Tags and Lists:
  1. Plumbing: All valves shall be provided with valve tags and listed on a valve list (Fixture stops not included).
  2. Valve tags: Engraved black filled numbers and letters not less than 13 mm (1/2-inch) high for number designation, and not less than 6.4 mm(1/4-inch) for service designation on 19 gage, 38 mm (1-1/2

- inches) round brass disc, attached with brass "S" hook or brass chain.
3. Valve lists: Valve lists shall be created using a word processing program and printed on plastic coated cards. The plastic coated valve list card(s), sized 216 mm (8-1/2 inches) by 280 mm (11 inches) shall show valve tag number, valve function and area of control for each service or system. The valve list shall be in a punched 3-ring binder notebook. A copy of the valve list shall be mounted in picture frames for mounting to a wall.
  4. A detailed plan for each floor of the building indicating the location and valve number for each valve shall be provided. Each valve location shall be identified with a color coded sticker or thumb tack in ceiling.

## **2.7 GALVANIZED REPAIR COMPOUND**

- A. Mil. Spec. DOD-P-21035B, paint.

## **2.8 PIPE AND EQUIPMENT SUPPORTS AND RESTRAINTS**

- A. In lieu of the paragraph which follows, suspended equipment support and restraints may be designed and installed in accordance with the International Building Code (IBC), latest edition, and SECTION 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS. Submittals based on the International Building Code (IBC), latest edition, SECTION 13 05 41 requirements, or the following paragraphs of this Section shall be stamped and signed by a professional engineer registered in a state where the project is located. The Support system of suspended equipment over 227 kg (500 pounds) shall be submitted for approval of the Resident Engineer in all cases. See these specifications for lateral force design requirements.
- B. Type Numbers Specified: MSS SP-58. For selection and application refer to MSS SP-69. Refer to Section 05 50 00, METAL FABRICATIONS, for miscellaneous metal support materials and prime coat painting.
- C. For Attachment to Concrete Construction:
  1. Concrete insert: Type 18, MSS SP-58.
  2. Self-drilling expansion shields and machine bolt expansion anchors: Permitted in concrete not less than 102 mm (4 inches) thick when approved by the Resident Engineer for each job condition.

3. Power-driven fasteners: Permitted in existing concrete or masonry not less than 102 mm (4 inches) thick when approved by the Resident Engineer for each job condition.
- D. For Attachment to Steel Construction: MSS SP-58.
  1. Welded attachment: Type 22.
  2. Beam clamps: Types 20, 21, 28 or 29. Type 23 C-clamp may be used for individual copper tubing up to 23 mm (7/8-inch) outside diameter.
- E. Attachment to Metal Pan or Deck: As required for materials specified in Section 05 31 00, STEEL DECKING.
- F. Hanger Rods: Hot-rolled steel, ASTM A36 or A575 for allowable load listed in MSS SP-58. For piping, provide adjustment means for controlling level or slope. Types 13 or 15 turn-buckles shall provide 38 mm (1-1/2 inches) minimum of adjustment and incorporate locknuts. All-thread rods are acceptable.
- G. Multiple (Trapeze) Hangers: Galvanized, cold formed, lipped steel channel horizontal member, not less than 41 mm by 41 mm (1-5/8 inches by 1-5/8 inches), 2.7 mm (No. 12 gage), designed to accept special spring held, hardened steel nuts. Trapeze hangers are not permitted for steam supply and condensate piping.
  1. Allowable hanger load: Manufacturers rating less 91kg (200 pounds).
  2. Guide individual pipes on the horizontal member of every other trapeze hanger with 6 mm (1/4-inch) U-bolt fabricated from steel rod. Provide Type 40 insulation shield, secured by two 13 mm (1/2-inch) galvanized steel bands, or insulated calcium silicate shield for insulated piping at each hanger.
- H. Pipe Hangers and Supports: (MSS SP-58), use hangers sized to encircle insulation on insulated piping. Refer to Section 23 07 11, HVAC, PLUMBING, and BOILER PLANT INSULATION for insulation thickness. To protect insulation, provide Type 39 saddles for roller type supports or insulated calcium silicate shields. Provide Type 40 insulation shield or insulated calcium silicate shield at all other types of supports and hangers including those for insulated piping.
  1. General Types (MSS SP-58):
    - a. Standard clevis hanger: Type 1; provide locknut.
    - b. Riser clamps: Type 8.
    - e. Saddle support: Type 36, 37 or 38.
    - g. U-bolt clamp: Type 24.



h. Copper Tube:

- 1) Hangers, clamps and other support material in contact with tubing shall be painted with copper colored epoxy paint, plastic coated or taped with isolation tape to prevent electrolysis.
- 2) For vertical runs use epoxy painted or plastic coated riser clamps.
- 3) For supporting tube to strut: Provide epoxy painted pipe straps for copper tube or plastic inserted vibration isolation clamps.
- 4) Insulated Lines: Provide pre-insulated calcium silicate shields sized for copper tube.

i. Spring hangers are required on all plumbing system pumps one horsepower and greater.

2. Plumbing Piping (Other Than General Types):

- a. Horizontal piping: Type 1, 5, 7, 9, and 10.
- b. Chrome plated piping: Chrome plated supports.
- c. Hangers and supports in pipe chase: Prefabricated system ABS self-extinguishing material, not subject to electrolytic action, to hold piping, prevent vibration and compensate for all static and operational conditions.
- d. Blocking, stays and bracing: Angle iron or preformed metal channel shapes, 1.3 mm (18 gage) minimum.

J. Seismic Restraint of Piping: Refer to Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.

**2.9 PIPE PENETRATIONS**

- A. Pipe penetration sleeves shall be installed for all pipe other than rectangular blocked out floor openings for risers in mechanical bays.
- B. Pipe penetration sleeve materials shall comply with all fire stopping requirements for each penetration.
- C. To prevent accidental liquid spills from passing to a lower level, provide the following:
  1. For sleeves: Extend sleeve 25 mm (1 inch) above finished floor and provide sealant for watertight joint.
  2. For blocked out floor openings: Provide 40 mm (1-1/2 inch) angle set in silicone adhesive around opening.

3. For drilled penetrations: Provide 40 mm (1-1/2 inch) angle ring or square set in silicone adhesive around penetration.
- C. Penetrations are not allowed through beams or ribs, but may be installed in concrete beam flanges. Any deviation from these requirements must receive prior approval of Resident Engineer.
- D. Sheet metal, plastic, or moisture resistant fiber sleeves shall be provided for pipe passing through floors, interior walls, and partitions, unless brass or steel pipe sleeves are specifically called for below.
- E. Cast iron or zinc coated pipe sleeves shall be provided for pipe passing through exterior walls below grade. The space between the sleeve and pipe shall be made watertight with a modular or link rubber seal. The link seal shall be applied at both ends of the sleeve.
- F. Galvanized steel or an alternate black iron pipe with asphalt coating sleeves shall be for pipe passing through concrete beam flanges, except where brass pipe sleeves are called for. A galvanized steel Sleeve shall be provided for pipe passing through floor of mechanical rooms, laundry work rooms, and animal rooms above basement. Except in mechanical rooms, sleeves shall be connected with a floor plate.
- G. Brass Pipe Sleeves shall be provided for pipe passing through quarry tile, terrazzo or ceramic tile floors. The sleeve shall be connected with a floor plate.
- H. Sleeve clearance through floors, walls, partitions, and beam flanges shall be 25 mm (1 inch) greater in diameter than external diameter of pipe. Sleeve for pipe with insulation shall be large enough to accommodate the insulation plus 25 mm (1 inch) in diameter. Interior openings shall be caulked tight with fire stopping material and sealant to prevent the spread of fire, smoke, and gases.
- I. Sealant and Adhesives: Shall be as specified in Section 07 92 00, JOINT SEALANTS.

#### **2.10 WALL, FLOOR AND CEILING PLATES**

- A. Material and Type: Chrome plated brass or chrome plated steel, one piece or split type with concealed hinge, with set screw for fastening to pipe, or sleeve. Use plates that fit tight around pipes, cover openings around pipes and cover the entire pipe sleeve projection.

- B. Thickness: Not less than 2.4 mm (3/32-inch) for floor plates. For wall and ceiling plates, not less than 0.64 mm (0.025-inch) for up to 80 mm (3 inch) pipe, 0.89 mm (0.035-inch) for larger pipe.
- C. Locations: Use where pipe penetrates floors, walls and ceilings in exposed locations, in finished areas only. Wall plates shall be used where insulation ends on exposed water supply pipe drop from overhead. A watertight joint shall be provided in spaces where brass or steel pipe sleeves are specified.

## **2.11 ASBESTOS**

Materials containing asbestos are not permitted.

## **PART 3 - EXECUTION**

### **3.1 ARRANGEMENT AND INSTALLATION OF EQUIPMENT AND PIPING**

- A. Location of piping, sleeves, inserts, hangers, and equipment, access provisions shall be coordinated with the work of all trades. Piping, sleeves, inserts, hangers, and equipment shall be located clear of windows, doors, openings, light outlets, and other services and utilities. Equipment layout drawings shall be prepared to coordinate proper location and personnel access of all facilities. The drawings shall be submitted for review.  
Manufacturer's published recommendations shall be followed for installation methods not otherwise specified.
- B. Operating Personnel Access and Observation Provisions: All equipment and systems shall be arranged to provide clear view and easy access, without use of portable ladders, for maintenance and operation of all devices including, but not limited to: all equipment items, valves, filters, strainers, transmitters, sensors, control devices. All gages and indicators shall be clearly visible by personnel standing on the floor or on permanent platforms. Maintenance and operating space and access provisions that are shown on the drawings shall not be changed nor reduced.
- C. Structural systems necessary for pipe and equipment support shall be coordinated to permit proper installation.
- D. Location of pipe sleeves, trenches and chases shall be accurately coordinated with equipment and piping locations.
- E. Cutting Holes:
  - 1. Holes through concrete and masonry shall be cut by rotary core drill. Pneumatic hammer, impact electric, and hand or manual hammer

- type drill will not be allowed, except as permitted by RE/COTR where working area space is limited.
2. Holes shall be located to avoid interference with structural members such as beams or grade beams. Holes shall be laid out in advance and drilling done only after approval by RE/COTR. If the Contractor considers it necessary to drill through structural members, this matter shall be referred to RE/COTR for approval.
- F. Interconnection of Instrumentation or Control Devices: Generally, electrical and pneumatic interconnections are not shown but must be provided.
- G. Minor Piping: Generally, small diameter pipe runs from drips and drains, water cooling, and other service are not shown but must be provided.
- H. Protection and Cleaning:
1. Equipment and materials shall be carefully handled, properly stored, and adequately protected to prevent damage before and during installation, in accordance with the manufacturer's recommendations and as approved by the Resident Engineer. Damaged or defective items in the opinion of the Resident Engineer, shall be replaced.
  2. Protect all finished parts of equipment, such as shafts and bearings where accessible, from rust prior to operation by means of protective grease coating and wrapping. Close pipe openings with caps or plugs during installation. Pipe openings, equipment, and plumbing fixtures shall be tightly covered against dirt or mechanical injury. At completion of all work thoroughly clean fixtures, exposed materials and equipment.
- I. Interconnection of Controls and Instruments: Electrical interconnection is generally not shown but shall be provided. This includes interconnections of sensors, transmitters, transducers, control devices, control and instrumentation panels, instruments and computer workstations. Comply with NFPA-70.
- J. Many plumbing systems interface with the HVAC control system. See the HVAC control points list and section 23 09 23 DIRECT DIGITAL CONTROLS FOR HVAC
- K. Work in Existing Building:
1. Perform as specified in Article, OPERATIONS AND STORAGE AREAS, Article, ALTERATIONS, and Article, RESTORATION of the Section 01 00

00, GENERAL REQUIREMENTS for relocation of existing equipment, alterations and restoration of existing building(s).

2. As specified in Section 01 00 00, GENERAL REQUIREMENTS, Article, OPERATIONS AND STORAGE AREAS, make alterations to existing service piping at times that will cause the least interfere with normal operation of the facility.

N. Inaccessible Equipment:

1. Where the Government determines that the Contractor has installed equipment not conveniently accessible for operation and maintenance, equipment shall be removed and reinstalled or remedial action performed as directed at no additional cost to the Government.
2. The term "conveniently accessible" is defined as capable of being reached without the use of ladders, or without climbing or crawling under or over obstacles such as electrical conduit, motors, fans, pumps, belt guards, transformers, high voltage lines, piping, and ductwork.

**3.2 TEMPORARY PIPING AND EQUIPMENT**

- A. Continuity of operation of existing facilities may require temporary installation or relocation of equipment and piping. Temporary equipment or pipe installation or relocation shall be provided to maintain continuity of operation of existing facilities.
- B. The Contractor shall provide all required facilities in accordance with the requirements of phased construction and maintenance of service. All piping and equipment shall be properly supported, sloped to drain, operate without excessive stress, and shall be insulated where injury can occur to personnel by contact with operating facilities. The requirements of Para. 3.1 shall apply.
- C. Temporary facilities and piping shall be completely removed and any openings in structures sealed. Necessary blind flanges and caps shall be provided to seal open piping remaining in service.

**3.3 RIGGING**

- A. Openings in building structures shall be planned to accommodate design scheme.
- B. Alternative methods of equipment delivery may be offered and will be considered by Government under specified restrictions of phasing and service requirements as well as structural integrity of the building.

- C. All openings in the building shall be closed when not required for rigging operations to maintain proper environment in the facility for Government operation and maintenance of service.
- D. Contractor shall provide all facilities required to deliver specified equipment and place on foundations. Attachments to structures for rigging purposes and support of equipment on structures shall be Contractor's full responsibility.
- E. Contractor shall check all clearances, weight limitations and shall provide a rigging plan designed by a Registered Professional Engineer. All modifications to structures, including reinforcement thereof, shall be at Contractor's cost, time and responsibility.
- F. Rigging plan and methods shall be referred to RE/COTR for evaluation prior to actual work.

#### **3.4 PIPE AND EQUIPMENT SUPPORTS**

- A. Where hanger spacing does not correspond with joist or rib spacing, use structural steel channels secured directly to joist and rib structure that will correspond to the required hanger spacing, and then suspend the equipment and piping from the channels. Holes shall be drilled or burned in structural steel ONLY with the prior written approval of the Resident Engineer.
- B. The use of chain pipe supports, wire or strap hangers; wood for blocking, stays and bracing, or hangers suspended from piping above shall not be permitted. Rusty products shall be replaced.
- C. Hanger rods shall be used that are straight and vertical. Turnbuckles for vertical adjustments may be omitted where limited space prevents use. A minimum of 15 mm (1/2-inch) clearance between pipe or piping covering and adjacent work shall be provided.
- D. For horizontal and vertical plumbing pipe supports, refer to the International Plumbing Code (IPC), latest edition, and these specifications.
- E. Overhead Supports:
  - 1. The basic structural system of the building is designed to sustain the loads imposed by equipment and piping to be supported overhead.
  - 2. Provide steel structural members, in addition to those shown, of adequate capability to support the imposed loads, located in accordance with the final approved layout of equipment and piping.
  - 3. Tubing and capillary systems shall be supported in channel troughs.

F. Floor Supports:

2. Bases and supports shall not be located and installed until equipment mounted thereon has been approved. Bases shall be sized to match equipment mounted thereon plus 50 mm (2 inch) excess on all edges. Structural drawings shall be reviewed for additional requirements. Bases shall be neatly finished and smoothed, shall have chamfered edges at the top, and shall be suitable for painting.
3. All equipment shall be shimmed, leveled, firmly anchored, and grouted with epoxy grout. Anchor bolts shall be placed in sleeves, anchored to the bases. Fill the annular space between sleeves and bolts with a grout material to permit alignment and realignment.
4. For seismic anchoring, refer to Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.

**3.5 PLUMBING SYSTEMS DEMOLITION**

- A. Rigging access, other than indicated on the drawings, shall be provided after approval for structural integrity by the RE/COTR. Such access shall be provided without additional cost or time to the Government. Where work is in an operating plant, approved protection from dust and debris shall be provided at all times for the safety of plant personnel and maintenance of plant operation and environment of the plant.
- B. In an operating plant, cleanliness and safety shall be maintained. The plant shall be kept in an operating condition. Government personnel will be carrying on their normal duties of operating, cleaning and maintaining equipment and plant operation. Work shall be confined to the immediate area concerned; maintain cleanliness and wet down demolished materials to eliminate dust. Dust and debris shall not be permitted to accumulate in the area to the detriment of plant operation. All flame cutting shall be performed to maintain the fire safety integrity of this plant. Adequate fire extinguishing facilities shall be available at all times. All work shall be performed in accordance with recognized fire protection standards. Inspections will be made by personnel of the VA Medical Center, and the Contractor shall follow all directives of the RE or COTR with regard to rigging, safety, fire safety, and maintenance of operations.
- C. Unless specified otherwise, all piping, wiring, conduit, and other devices associated with the equipment not re-used in the new work shall be completely removed from Government property. This includes all

concrete equipment pads, pipe, valves, fittings, insulation, and all hangers including the top connection and any fastenings to building structural systems. All openings shall be sealed after removal of equipment, pipes, ducts, and other penetrations in roof, walls, floors, in an approved manner and in accordance with plans and specifications where specifically covered. Structural integrity of the building system shall be maintained. Reference shall also be made to the drawings and specifications of the other disciplines in the project for additional facilities to be demolished or handled.

D. All valves including gate, globe, ball, butterfly and check, all pressure gages and thermometers with wells shall remain Government property and shall be removed and delivered to RE/COTR and stored as directed. The Contractor shall remove all other material and equipment, devices and demolition debris under these plans and specifications. Such material shall be removed from Government property expeditiously and shall not be allowed to accumulate.

E. Asbestos Insulation Removal: Conform to Section 02 82 11, TRADITIONAL ASBESTOS ABATEMENT.

### **3.6 CLEANING AND PAINTING**

A. Prior to final inspection and acceptance of the plant and facilities for beneficial use by the Government, the plant facilities, equipment and systems shall be thoroughly cleaned and painted. Refer to Section 09 91 00, PAINTING.

B. In addition, the following special conditions apply:

1. Cleaning shall be thorough. Solvents, cleaning materials and methods recommended by the manufacturers shall be used for the specific tasks. All rust shall be removed prior to painting and from surfaces to remain unpainted. Scratches, scuffs, and abrasions shall be repaired prior to applying prime and finish coats.
2. The following Material And Equipment shall NOT be painted::
  - a. Control and interlock devices.
  - b. Regulators.
  - c. Pressure reducing valves.
  - d. Control valves and thermostatic elements.
  - e. Copper, brass, aluminum, stainless steel and bronze surfaces.
  - f. Valve stems and rotating shafts.
  - g. Pressure gages and thermometers.



- h. Glass.
- i. Name plates.
- 3. Control and instrument panels shall be cleaned and damaged surfaces repaired. Touch-up painting shall be made with matching paint obtained from manufacturer or computer matched.
- 4. Pumps, motors, steel and cast iron bases, and coupling guards shall be cleaned, and shall be touched-up with the same color as utilized by the pump manufacturer
- 5. Temporary Facilities: Apply paint to surfaces that do not have existing finish coats.
- 6. The final result shall be a smooth, even-colored, even-textured factory finish on all items. The entire piece of equipment shall be repainted, if necessary, to achieve this.

### **3.7 IDENTIFICATION SIGNS**

- A. Laminated plastic signs, with engraved lettering not less than 5 mm (3/16-inch) high, shall be provided that designates equipment function, for all equipment, switches, motor controllers, relays, meters, control devices, including automatic control valves. Nomenclature and identification symbols shall correspond to that used in maintenance manual, and in diagrams specified elsewhere. Attach by chain, adhesive, or screws.
- B. Factory Built Equipment: Metal plate, securely attached, with name and address of manufacturer, serial number, model number, size, performance shall be placed on factory built equipment.
- C. Pipe Identification: Refer to Section 09 91 00, PAINTING.

### **3.8 STARTUP AND TEMPORARY OPERATION**

- A. Start up of equipment shall be performed as described in the equipment specifications. Vibration within specified tolerance shall be verified prior to extended operation. Temporary use of equipment is specified in Section 01 00 00, GENERAL REQUIREMENTS, Article, TEMPORARY USE OF MECHANICAL AND ELECTRICAL EQUIPMENT.

### **3.9 OPERATING AND PERFORMANCE TESTS**

- A. Prior to the final inspection, all required tests shall be performed as specified in Section 01 00 00, GENERAL REQUIREMENTS, Article, TESTS and Section 22 08 00 Commissioning of Plumbing Systems, and submit the test reports and records to the Resident Engineer.

- B. Should evidence of malfunction in any tested system, or piece of equipment or component part thereof, occur during or as a result of tests, make proper corrections, repairs or replacements, and repeat tests at no additional cost to the Government.
- C. When completion of certain work or system occurs at a time when final control settings and adjustments cannot be properly made to make performance tests, then make performance tests such systems respectively during first actual seasonal use of respective systems following completion of work.

### **3.10 OPERATION AND MAINTENANCE MANUALS**

- A. Provide four bound copies. The Operations and maintenance manuals shall be delivered to RE/COTR not less than 30 days prior to completion of a phase or final inspection.
- B. All new and temporary equipment and all elements of each assembly shall be included.
- C. Data sheet on each device listing model, size, capacity, pressure, speed, horsepower, impeller size, and other information shall be included.
- D. Manufacturer's installation, maintenance, repair, and operation instructions for each device shall be included. Assembly drawings and parts lists shall also be included. A summary of operating precautions and reasons for precautions shall be included in the Operations and Maintenance Manual.
- E. Lubrication instructions, type and quantity of lubricant shall be included.
- F. Schematic diagrams and wiring diagrams of all control systems corrected to include all field modifications shall be included.
- G. Set points of all interlock devices shall be listed.
- H. Trouble-shooting guide for the control system troubleshooting guide shall be inserted into the Operations and Maintenance Manual.
- I. The combustion control system sequence of operation corrected with submittal review comments shall be inserted into the Operations and Maintenance Manual.
- J. Emergency procedures.

### **3.11 INSTRUCTIONS TO VA PERSONNEL**

Instructions shall be provided in accordance with Article,  
INSTRUCTIONS, of Section 01 00 00, GENERAL REQUIREMENTS.

DEPARTMENT OF VETERANS AFFAIRS  
PALO ALTO HEALTH CARE SYSTEM  
REPLACE BUILDING 100 AHU-19

Project No.: 640-15-138

- - - E N D - - -

**SECTION 22 05 23**  
**GENERAL-DUTY VALVES FOR PLUMBING PIPING**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section describes the requirements for general-duty valves for domestic water and sewer systems.

**1.2 RELATED WORK**

- A. Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING.

**1.3 SUBMITTALS**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- B. Manufacturer's Literature and Data:
1. Valves.
  2. Backflow Preventers.
  3. Pressure Reducing Valves.
  5. All items listed in Part 2 - Products.

**1.4 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 for Testing and Materials (ASTM):A536-84(R 2004)  
Standard Specification for Ductile Iron Castings
- C. American Society of Sanitary Engineering (ASSE)  
ASSE 1003-01 (R 2003)...Performance Requirements for Water Pressure Reducing Valves  
ASSE 1013-05.....Reduced Pressure Principle Backflow Preventers and Reduced Pressure Fire Protection Principle Backflow Preventers
- D. International Code Council (ICC)  
IPC-06 (R2012).....International Plumbing Code
- E. Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS):  
SP-25-98.....Standard Marking System for Valves, Fittings, Flanges and Unions  
SP-67-02a (R 2004) Butterfly Valve of the Single flange Type (Lug Wafer)  
SP-72-99.....Ball Valves With Flanged or Butt Welding For General Purpose

SP-80-03.....Bronze Gate, Globe, Angle and Check Valves.

SP-110-96.....Ball Valve Threaded, Socket Welding, Solder  
Joint, Grooved and Flared Ends

### **1.5 DELIVERY, STORAGE, AND HANDLING**

A. Valves shall be prepared for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, grooves, and weld ends.
3. Set angle, gate, and globe valves closed to prevent rattling.
4. Set ball and plug valves open to minimize exposure of functional surfaces
6. Block check valves in either closed or open position.

B. Valves shall be prepared for storage as follows:

1. Maintain valve end protection.
2. Store valves indoors and maintain at higher than ambient dew point temperature.

C. A sling shall be used for large valves. The sling shall be rigged to avoid damage to exposed parts. Hand wheels or stems shall not be used as lifting or rigging points.

## **PART 2 - PRODUCTS**

### **2.1 VALVES**

A. Asbestos packing and gaskets are prohibited.

B. Bronze valves shall be made with dezincification resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc shall not be permitted.

E. Ball valves, pressure regulating valves, gate valves, globe valves, and plug valves used to supply potable water shall meet the requirements of NSF 61.

F. Shut-off:

1. Cold Water:

- a. 50 mm or DN50 (2 inches) and smaller: Ball, MSS SP-72, SP-110, Ball valve shall be lead-free, full port three piece or two piece with a union design with adjustable stem package. Threaded stem designs are not allowed. The ball valve shall have a SWP rating of 1035 kPa (150 psig) and a CWP rating of 4140 kPa (600 psig). The body material shall be Bronze ASTM B584, Alloy C844. The ends shall be solder,

2. Reagent Grade Water: Valves for reagent grade, reverse osmosis, or deionized water service shall be ball type of same material as used for pipe.

D. Check:

1. Check valves less than 80 mm or DN80 (3 inches) and smaller) shall be class 125, bronze swing check valves with non metallic Buna-N disc. The check valve shall meet MSS SP-80 Type 4 standard. The check valve shall have a CWP rating of 1380 kPa (200 psig). The check valve shall have a Y pattern horizontal body design with bronze body material conforming to ASTM B 62, solder joints, and PTFE or TFE disc.

E. Globe:

1. 80 mm or DN80 (3 inches) or smaller: Class 150, bronze globe valve with non metallic disc. The globe valve shall meet MSS SP-80, Type 2 standard. The globe valve shall have a CWP rating of 2070 kPa (300 psig). The valve material shall be bronze with integral seal and union ring bonnet conforming to ASTM B 62 with solder ends, copper-silicon bronze stem, TPFE or TFE disc, malleable iron hand wheel.

### **PART 3 - EXECUTION**

#### **3.1 EXAMINATION**

- A. Valve interior shall be examined for cleanliness, freedom from foreign matter, and corrosion. Special packing materials shall be removed, such as blocks, used to prevent disc movement during shipping and handling.
- B. Valves shall be operated in positions from fully open to fully closed. Guides and seats shall be examined and made accessible by such operations.
- C. Threads on valve and mating pipe shall be examined for form and cleanliness.
- D. 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. Valves shall be located for easy access and shall be provide with separate support. Valves shall be accessible with access doors when installed inside partitions or above hard ceilings.
- C. Valves shall be installed in horizontal piping with stem at or above center of pipe.
- D. Valves shall be installed in a position to allow full stem movement and valve handle operation.
- E. Check valves shall be installed for proper direction of flow and as follows:
  - 1. Swing Check Valves: In horizontal position with hinge pin level.

### **3.3 ADJUSTING**

- A. Valve packing shall be adjusted or replaced after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves shall be replaced if persistent leaking occurs.

- - E N D - - -

**SECTION 22 08 00**  
**COMMISSIONING OF PLUMBING SYSTEMS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. The requirements of this Section apply to all sections of Division 22.
- B. This project will have selected building systems commissioned. The complete list of equipment and systems to be commissioned are 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 Department of Veterans Affairs 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 plumbing systems, subsystems and equipment. This Section supplements the general requirements specified in Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS.
- B. The commissioning activities have been developed to support the VA requirements to meet guidelines for Federal Leadership in Environmental, Energy, and Economic Performance.
- C. The commissioning activities have been developed to support the United States Green Building Council (USGBC) LEED™ rating program and to support delivery of project performance in accordance with the Contract Documents developed with the approval of the VA.
  - 1. Commissioning activities and documentation for the LEED™ section on "Energy and Atmosphere" prerequisite of "Fundamental Building Systems Commissioning".
  - 2. Commissioning activities and documentation for the LEED™ section on "Energy and Atmosphere" requirements for the "Enhanced Building System Commissioning" credit.
  - 3. Activities and documentation for the LEED™ section on "Measurement and Verification" requirements for the Measurement and Verification credit.



- D. Refer to Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS for more specifics 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 this Division 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 Plumbing systems will be commissioned:
  - 2. Domestic Water Filtration and Deionized Water Systems (Tanks and casings, gages and instruments, controls, pumps and motors - if applicable, packaged piping, alarms).

#### **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 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.

### **3.2 CONTRACTORS TESTS**

- A. Contractor tests as required by other sections of Division 22 shall be scheduled and documented in accordance with Section 01 00 00 GENERAL REQUIREMENTS. The Commissioning Agent will witness selected Contractor tests. Contractor tests shall be completed prior to scheduling Systems Functional Performance Testing.

### **3.3 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.

### **3.4 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. The instruction shall be scheduled in coordination with the Resident Engineer after submission and approval of formal training plans. Refer to Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS and Division 22 Sections for additional Contractor training requirements.

----- END -----

**SECTION 22 11 00**  
**FACILITY WATER DISTRIBUTION**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. Domestic water systems, including piping, equipment and all necessary accessories as designated in this section.

**1.2 RELATED WORK**

- A. Section 07 84 00, FIRESTOPPING: Penetrations in rated enclosures
- B. Section 09 91 00, PAINTING: Preparation and finish painting and identification of piping systems.
- C. Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING.
- E. SECTION 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS: Requirements for commissioning, systems readiness checklist, and training.

**1.3 SUBMITTALS**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Manufacturer's Literature and Data:
  - 1. All items listed in Part 2 - Products.

**1.4 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 National Standards Institute (ANSI):
  - American Society of Mechanical Engineers (ASME): (Copyrighted Society)
  - A13.1-2007.....Scheme for Identification of Piping Systems
  - B16.12-2009 .....Cast Iron Threaded Drainage Fittings ANSI/ASME
  - B16.15-2006 .....Cast Bronze Threaded Fittings Classes 125 and 250 ANSI/ASME
  - B16.18-01 (R2005).....Cast Copper Alloy Solder-Joint Pressure Fittings ANSI/ASME
  - B16.22-01 (R2005).....Wrought Copper and Copper Alloy Solder Joint Pressure Fittings ANSI/ASME Element ANSI/ASME
- C. American Society for Testing and Materials (ASTM):
  - A183-03(2009).....Carbon Steel Track Bolts and Nuts

- A269-10.....Standard Specification for Seamless and Welded  
Austenitic Stainless Steel Tubing for General  
Service
- A312/A312M-09.....Seamless, Welded, and Heavily Cold Worked  
Austenitic Stainless Steel Pipes
- A403/A403M-10a.....Standard Specification for Wrought Austenitic  
Stainless Steel Piping Fittings
- A733-03(2009).....Welded and Seamless Carbon Steel and Austenitic  
Stainless Steel Pipe Nipples
- B32-08.....Solder Metal
- B61-08.....Steam or Bronze Castings
- B62-09.....Composition Bronze or Ounce Metal Castings
- B88-09.....Seamless Copper Water Tube
- B300-10.....AWWA Standard for Hypochlorites
- B301-10.....AWWA Standard for Liquid Chlorine
- B584-09a.....Copper Alloy Sand Castings for General  
Applications Revision A
- B687-99(2005) e1.....Brass, Copper, and Chromium-Plated Pipe Nipples
- E1120-08.....Standard Specification For Liquid Chlorine
- E1229-08.....Standard Specification For Calcium Hypochlorite
- D. American Water Works Association (AWWA):
  - C651-05.....Disinfecting Water Mains
- E. American Welding Society (AWS):
  - A5.8/A5.8M:2004.....Filler Metals for Brazing
- F. International Plumbing Code
  - International Plumbing Code - 2012
- G. American Society of Sanitary Engineers (ASSE):
  - ANSI/ASSE (Plumbing)
    - 1001-2008.....Pipe Applied Atmospheric Type Vacuum Breakers
    - ANSI/ASSE 1010-2004.....Water Hammer Arresters
    - ANSI/ASSE 1018-2001.....Performance for trap seal primer valves -  
potable water supplied.
  - ANSI/ASSE (Plumbing)
    - 1020-2004.....Pressure Vacuum Breaker Assembly
- I. Plumbing and Drainage Institute (PDI):
  - PDI WH-201 2007.....Water Hammer Arrestor

### **1.5 QUALITY ASSURANCE**

- A. Submit prior to welding of steel piping a certificate of Welder's certification. The certificate shall be current and more than one year old.
- E. All castings used for coupling housings, fittings, valve bodies, etc., shall be date stamped for quality assurance and traceability.

### **1.6 SPARE PARTS**

- A. For mechanical pressed sealed fittings provide tools required for each pipe size used at the facility.

## **PART 2 - PRODUCTS**

### **2.1 MATERIALS**

- A. Material or equipment containing a weighted average of greater than 0.25 percent lead shall not be used in any potable water system intended for human consumption, and shall be certified in accordance with NSF/ANSI 61 or NSF 372.

### **2.2 ABOVE GROUND (INTERIOR) WATER PIPING**

- A. Pipe: For 20 to 50 mm (1/2 to 2 inches) Copper tube, ASTM B88, Type K or L, drawn.
- B. Fittings for Copper Tube:
  - 1. Wrought copper or bronze castings conforming to ANSI B16.18 and B16.22. Unions shall be bronze, MSS SP72 & SP 110, Solder or braze joints. Use lead-free 95/5 tin and antimony for all soldered joints.
- C. Piping and Fittings for Stainless Steel:
  - 1. ASTM 312, Schedule 10S IPS, annealed type 316L, welded seamless austenitic stainless steel piping.
  - 2. Double ferrule fitting for sizes 1" and smaller, compression type fitting. For 32 mm (1 1/4 inches) and larger, ASTM 403, type 316L wrought austenitic stainless steel short radius, IPS, butt-welding fitting for sizes 1-1/4" and larger.
- D. Adapters: Provide adapters for joining screwed pipe to copper tubing.
- E. Solder: ASTM B32 Composition Sb5 HA or HB. Provide non-corrosive flux.
- F. Brazing alloy: AWS A5.8, Classification BCuP.

### **2.4 TRAP PRIMER WATER PIPING:**

- A. Pipe: Copper tube, ASTM B88, type K, hard drawn.
- B. Fittings: Bronze castings conforming to ANSI B16.18 Solder joints.
- C. Solder: ASTM B32 composition Sb5. Provide non-corrosive flux.

## **2.5 STRAINERS**

- A. Provide on high pressure side of pressure reducing valves, on suction side of pumps, on inlet side of indicating and control instruments and equipment subject to sediment damage and where shown on drawings. Strainer element shall be removable without disconnection of piping.
- B. Water: Basket or "Y" type with easily removable cover and brass strainer basket.
- C. Body: Smaller than 80 mm (3 inches), brass or bronze; 80 mm (3 inches) and larger, cast iron or semi-steel.

## **2.6 DIELECTRIC FITTINGS**

- A. Provide dielectric couplings or unions between ferrous and non-ferrous pipe.

## **2.7 STERILIZATION CHEMICALS**

- A. Hypochlorites ANSI/AWWA B300-10
- B. Liquid Chlorine ANSI/AWWA B301-10

## **2.8 WATER HAMMER ARRESTER:**

- A. Closed copper tube chamber with permanently sealed 410 kPa (60 psig) air charge above a Double O-ring piston. Two high heat Buna-N O-rings pressure packed and lubricated with FDA approved silicone compound. All units shall be designed in accordance with ASSE 1010 for sealed wall installations without an access panel. Size and install in accordance with Plumbing and Drainage Institute requirements (PDI WH 201). Provide water hammer arrestors at:
  - 1. All solenoid valves.
  - 3. All quick opening or closing valves.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. General: Comply with the International Plumbing Code and the following:
  - 1. Install branch piping for water from the piping system and connect to all valves, outlets, including those furnished by the Government or specified in other sections.
  - 2. Pipe shall be round and straight. Cutting shall be done with proper tools. Pipe, except for plastic and glass, shall be reamed to full size after cutting.
  - 3. All pipe runs shall be laid out to avoid interference with other work.

4. Install union and shut-off valve on pressure piping at connections to equipment.
5. Pipe Hangers, Supports and Accessories:
  - a. All piping shall be supported per the International Plumbing Code, Chapter No. 3.
  - b. Shop Painting and Plating: Hangers, supports, rods, inserts and accessories used for pipe supports shall be shop coated with red lead or zinc chromate primer paint. Electroplated copper hanger rods, hangers and accessories may be used with copper tubing.
  - c. Floor, Wall and Ceiling Plates, Supports, galvanized finish Hangers:
    - 1) Solid or split unplated cast iron.
    - 2) All plates shall be provided with set screws.
    - 3) Pipe Hangers: Height adjustable clevis type.
    - 4) Adjustable Floor Rests and Base Flanges: Steel.
    - 5) Concrete Inserts: "Universal" or continuous slotted type.
    - 6) Hanger Rods: Mild, low carbon steel, fully threaded or Threaded at each end with two removable nuts at each end for positioning rod and hanger and locking each in place.
    - 7) Riser Clamps: Malleable iron or steel.
    - 8) Self-drilling type expansion shields shall be "Phillips" type, with case hardened steel expander plugs.
    - 09) Hangers and supports utilized with insulated pipe and tubing shall have 180 degree (min.) metal protection shield Centered on and welded to the hanger and support. The shield shall be 4 inches in length and be 16 gauge steel. The shield shall be sized for the insulation.
    - 10) Miscellaneous Materials: As specified, required, directed or as noted on the drawings for proper installation of hangers, supports and accessories. If the vertical distance exceeds 6 m (20 feet) for cast iron pipe additional support shall be provided in the center of that span. Provide all necessary auxiliary steel to provide that support.
    - 11) With the installation of each flexible expansion joint, provide piping restraints for the upstream and downstream section of the piping at the flexible expansion joint. Provide



calculations supporting the restraint length design and type of selected restraints.

6. Install chrome plated cast brass escutcheon with set screw at each wall, floor and ceiling penetration in exposed finished locations and within cabinets and millwork.

7. Penetrations:

- a. Fire Stopping: Where pipes 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. Completely fill and seal clearances between raceways and openings with the fire stopping materials.
- b. Waterproofing: At floor penetrations, completely seal clearances around the pipe and make watertight with sealant as specified in Section 07 92 00, JOINT SEALANTS.

B. Piping shall conform to the following:

1. Domestic Water:

- a. Grade all lines to facilitate drainage. Provide drain valves at bottom of risers and all low points in system. Design domestic hot water circulating lines with no traps.
- b. Connect branch lines at bottom of main serving fixtures below and pitch down so that main may be drained through fixture. Connect branch lines to top of main serving only fixtures located on floor above.

**3.2 TESTS**

- A. General: Test system either in its entirety or in sections.
- B. Potable Water System: Test after installation of piping and domestic water heaters, but before piping is concealed, before covering is applied, and before plumbing fixtures are connected. Fill systems with water and maintain hydrostatic pressure of 690 kPa (100 psi) gage for two hours. No decrease in pressure is allowed. Provide a pressure gage with a shutoff and bleeder valve at the highest point of the piping being tested.
- C. Reagent Grade Water Systems: Fill system with water and maintain hydrostatic pressure of 690 kPa (100 psi) gage during inspection and prove tight.

- D. All Other Piping Tests: Test new installed piping under 1 1/2 times actual operating conditions and prove tight.

### **3.3 STERILIZATION**

- A. After tests have been successfully completed, thoroughly flush and sterilize the interior domestic water distribution system in accordance with AWWA C651.
- B. Use liquid chlorine or hypochlorites for sterilization.

### **3.4 COMMISSIONING**

- A. Provide commissioning documentation accordance with the requirements of Section 22 08 00 - COMMISSIONING OF PLUMBING SYSTEMS for all inspection, startup, and contractor testing required above and required by the System Readiness Checklist provided by the Commissioning Agent.
- B. Components provided under this section of the specification will be tested as part of a larger system. Refer to Section 22 08 00 - COMMISSIONING OF PLUMBING SYSTEMS and related sections for contractor responsibilities for system commissioning.

- - - E N D - - -

**SECTION 22 13 00**  
**FACILITY SANITARY AND VENT PIPING**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section pertains to sanitary sewer and vent systems, including piping, equipment and all necessary accessories as designated in this section.

**1.2 RELATED WORK**

- A. Section 07 84 00, FIRESTOPPING: Penetrations in rated enclosures.
- B. Section 09 91 00, PAINTING: Preparation and finish painting and identification of piping systems.
- C. Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING: Pipe Hangers and Supports, Materials Identification.
- E. Section 07 92 00 Joint Sealants: Sealant products.

**1.3 SUBMITTALS**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- B. Manufacturer's Literature and Data:
  - 1. Piping.
  - 2. Floor Drains.
  - 4. Cleanouts.
  - 5. All items listed in Part 2 - Products.
- C. Detailed shop drawing of clamping device and extensions when required in connection with the waterproofing membrane or the floor drain.

**1.4 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 Mechanical Engineers (ASME): (Copyrighted Society)
  - A112.6.3-01 (R 2007)....Standard for Floor and Trench Drains
  - A13.1-07.....Scheme for Identification of Piping Systems
  - B16.3-06.....Malleable Iron Threaded Fittings, Classes 150 and 300.
  - B16.12-98 (R 2006).....Cast Iron Threaded Drainage Fittings
  - B16.15-06.....Cast Bronze Threaded Fittings, Classes 125 and 250

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

A53/A53M-07.....Standard Specification for Pipe, Steel, Black  
And Hot-Dipped, Zinc-coated, Welded and  
Seamless  
A74-06.....Standard Specification for Cast Iron Soil Pipe  
and Fittings  
A183-03.....Standard Specification for Carbon Steel Track  
Bolts and Nuts  
B32-08.....Standard Specification for Solder Metal  
B75-02.....Standard Specification for Seamless Copper Tube  
B306-02.....Standard Specification for Copper Drainage Tube  
(DWV)  
B584-06a.....Standard Specification for Copper Alloy Sand  
Castings for General Applications  
C564-03a.....Standard Specification for Rubber Gaskets for  
Cast Iron Soil Pipe and Fittings  
D2000-08.....Standard Classification System for Rubber  
Products in Automotive Applications

D. International Code Council:

IPC-2012.....International Plumbing Code

E. Cast Iron Soil Pipe Institute (CISPI):

301-05.....Hubless Cast Iron Soil Pipe and Fittings for  
Sanitary and Storm Drain, Waste, and Vent  
Piping Applications  
310-04.....Coupling for Use in Connection with Hubless  
Cast Iron Soil Pipe and Fittings for Sanitary  
and Storm Drain, Waste, and Vent Piping  
Applications

F. American Society of Sanitary Engineers (ASSE):

1018-01.....Trap Seal Primer Valves - Potable, Water  
Supplied

G. Plumbing and Drainage Institute (PDI):

PDI WH-201.....Water Hammer Arrestor

**PART 2 - PRODUCTS**

**2.1 SANITARY WASTE, DRAIN, AND VENT PIPING**

A. Cast iron waste, drain, and vent pipe and fittings

1. Cast iron waste, drain, and vent pipe and fittings shall be used for the following applications:
  - a. Interior waste and vent piping above grade.
3. The material for all pipe and fittings shall be cast iron soil pipe and fittings and shall conform to the requirements of CISPI Standard 301, and ASTM A-888.
4. Joints for hubless pipe and fittings shall conform to the manufacturer's installation instructions. Couplings for hubless joints shall conform to CISPI 310. Joints for hub and spigot pipe shall be installed with compression gaskets conforming to the requirements of ASTM Standard C-564 or be installed with lead and oakum.

B. Copper Tube, (DWV):

1. Copper DWV tube sanitary waste, drain and vent pipe may be used for piping above ground, except for urinal drains.
2. The copper DWV tube shall be drainage type, drawn temper conforming to ASTM B306.
3. The copper drainage fittings shall be cast copper or wrought copper conforming to ASME B16.23 or ASME 16.29.
4. The joints shall be lead free, using a water flushable flux, and conforming to ASTM B32.C. Pressure fitting copper tube:
5. Copper tubing shall be ASTM B88, Type M.
6. Fitting shall be pressure fitting with EPDM sealing element and smart connection, conform with ASME B16.51.

**2.2 EXPOSED WASTE PIPING**

- A. Full iron pipe size chrome plated brass piping shall be used in finished rooms for exposed waste piping connecting fixtures, casework, cabinets, equipment and reagent racks when not concealed by apron including those furnished by the Government or specified in other sections.
1. The Pipe shall meet Fed. Spec. WW-P-351, standard weight.
  2. The Fittings shall conform to ANSI B16.15, cast bronze threaded fittings with chrome finish, (125 and 250).
  3. Nipples shall conform to ASTM B 687, Chromium-plated.
  4. Unions shall be brass or bronze with chrome finish. Unions 65 mm (2-1/2 inches) and larger shall be flange type with approved gaskets.

- B. In unfinished Rooms such as mechanical Rooms and Kitchens, Chrome-plated brass piping is not required. The pipe materials specified under the paragraph "Sanitary Waste, Drain, and Vent Piping" can be used. The sanitary pipe in unfinished rooms shall be painted as specified in Section 09 91 00, PAINTING.

### **2.3 SPECIALTY PIPE FITTINGS**

- A. Transition pipe couplings shall join piping with small differences in outside diameters or different materials. End connections shall be of the same size and compatible with the pipes being joined. The transition coupling shall be elastomeric, sleeve type reducing or transition pattern and include shear and corrosion resistant metal, tension band and tightening mechanism on each end. The transition coupling sleeve coupling shall be of the following material:
1. For cast iron soil pipes, the sleeve material shall be rubber conforming to ASTM C564.
  2. For dissimilar pipes, the sleeve material shall be PVC conforming to ASTM D5926, or other material compatible with the pipe materials being joined.
- B. The dielectric fittings shall conform to ASSE 1079 with a pressure rating of 860 kPa (125 psig) at a minimum temperature of 82°C (180°F). The end connection shall be solder joint copper alloy and threaded ferrous.
- C. Dielectric flange insulating kits shall be of non conducting materials for field assembly of companion flanges with a pressure rating of 1035 kPa (150 psig). The gasket shall be neoprene or phenolic. The bolt sleeves shall be phenolic or polyethylene. The washers shall be phenolic with steel backing washers.
- D. The di-electric nipples shall be electroplated steel nipple complying with ASTM F 1545 with a pressure ratings of 2070 kPa (300 psig) at 107°C (225°F). The end connection shall be male threaded. The lining shall be inert and noncorrosive propylene.

### **2.4 CLEANOUTS**

- A. Cleanouts shall be the same size as the pipe, up to 100 mm (4 inches); and not less than 100 mm (4 inches) for larger pipe. Cleanouts shall be easily accessible and shall be gastight and watertight. Minimum clearance of 600 mm (24 inches) shall be provided for clearing a clogged sanitary line.

- C. Cleanouts shall be provided at or near the base of the vertical stacks with the cleanout plug located approximately 600 mm (24 inches) above the floor. If there are no fixtures installed on the lowest floor, the cleanout shall be installed at the base of the stack. The cleanouts shall be extended to the wall access cover. Cleanout shall consist of sanitary tees. Nickel-bronze square frame and stainless steel cover with minimum opening of 150 by 150 mm (6 by 6 inches) shall be furnished at each wall cleanout. Where the piping is concealed, a fixture trap or a fixture with integral trap, readily removable without disturbing concealed pipe, shall be accepted as a cleanout equivalent providing the opening to be used as a cleanout opening is the size required.
- D. In horizontal runs above grade, cleanouts shall consist of cast brass tapered screw plug in fitting or caulked/hubless cast iron ferrule. Plain end (hubless) piping in interstitial space or above ceiling may use plain end (hubless) blind plug and clamp.

## **2.5 FLOOR DRAINS**

- A. Type A (FD-A) floor drain shall comply with ANSI A112.6.3. A caulking flange, inside gasket, or hubless connection shall be provided for connection to cast iron pipe, screwed or no hub outlets for connection to steel pipe. The drain connection shall be bottom outlet. A membrane clamp and extensions shall be provided, if required, where installed in connection with waterproof membrane. Puncturing membrane other than for drain opening will not be permitted. Double drainage pattern floor drains shall have integral seepage pan for embedding into floor construction, and weep holes to provide adequate drainage from pan to drain pipe. For drains not installed in connection with a waterproof membrane, a 2.2 kg (16-ounce) soft copper membrane, 600 mm (24 inches) square or another approved waterproof membrane shall be provided.

## **2.6 TRAPS**

- A. Traps shall be provided on all sanitary branch waste connections from fixtures or equipment not provided with traps. Exposed brass shall be polished brass chromium plated with nipple and set screw escutcheons. Concealed traps may be rough cast brass or same material as pipe connected to. Slip joints are not permitted on sewer side of trap.

Traps shall correspond to fittings on cast iron soil pipe or steel pipe respectively, and size shall be as required by connected service or fixture.

## **2.7 TRAP SEAL PRIMER VALVES AND TRAP SEAL PRIMER SYSTEMS**

- A. Trap Primer (TP-1): The trap seal primer system shall be electronic type conforming to ASSE 1044.
1. The controller shall have a 24 hour programmable timer, solid state, 6 outlet zones, minimum adjustable run time of 1 minute for each zone, 12 hour program battery backup, manual switch for 120VAC power, 120VAC to 24VAC internal transformer, fuse protected circuitry, UL listed, 120VAC input-24VAC output, constructed of enameled steel or plastic.
  2. The cabinet shall be recessed mounting with a stainless steel cover.
  3. The solenoid valve shall have a brass body, Buna "N" seats, normally closed, 5.98 kPa (125 psi) rated, 24VAC.
  4. The control wiring shall be copper in accordance with the latest edition of the National Electric Code, Article 725 and not less than 18 gauge. All wiring shall be in conduit and in accordance with Division 26 of the specifications.
  5. The vacuum breaker shall conform to ASSE 1001.
- B. Trap Primer (TP-2): The trap seal primer valve shall be hydraulic, supply type with a pressure rating of 5.98 kPa (125 psig) and conforming to standard ASSE 1018.
1. The inlet and outlet connections shall be 15 mm or DN15 (NPS ½ inch)
  2. The trap seal primer valve shall be fully automatic with an all brass or bronze body.
  3. The trap seal primer valve shall be activated by a drop in building water pressure, no adjustment required.
  4. The trap seal primer valve shall include a manifold when serving two, three, or four traps.
  5. The manifold shall be omitted when serving only one trap.

## **2.9 WATERPROOFING**

- A. A sleeve flashing device shall be provided at points where pipes pass through membrane waterproofed floors or walls. The sleeve flashing device shall be manufactured, cast iron fitting with clamping device that forms a sleeve for the pipe floor penetration of the floor membrane. A galvanized steel pipe extension shall be included in the



top of the fitting that will extend 50 mm (2 inches) above finished floor and galvanized steel pipe extension in the bottom of the fitting that will extend through the floor slab. A waterproof caulked joint shall be provided at the top hub.

B. Walls: See detail shown on drawings.

### **PART 3 - EXECUTION**

#### **3.1 PIPE INSTALLATION**

- A. The pipe installation shall comply with the requirements of the International Plumbing Code (IPC) and these specifications.
- B. Branch piping shall be installed for waste from the respective piping systems and connect to all fixtures, valves, cocks, outlets, casework, cabinets and equipment, including those furnished by the Government or specified in other sections.
- C. Pipe shall be round and straight. Cutting shall be done with proper tools. Pipe shall be reamed to full size after cutting.
- D. All pipe runs shall be laid out to avoid interference with other work.
- E. The piping shall be installed above accessible ceilings where possible.
- F. The piping shall be installed to permit valve servicing or operation.
- G. Unless specifically indicated on the drawings, the minimum slope shall be 2% slope.
- H. The piping shall be installed free of sags and bends.
- I. Seismic restraint shall be installed where required by code.
- J. Changes in direction for soil and waste drainage and vent piping shall be made using appropriate branches, bends and long sweep bends. Sanitary tees and short sweep quarter bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Long turn double wye branch and eighth bend fittings shall be used if two fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Proper size of standard increaser and reducers shall be used if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.
- L. Cast iron piping shall be installed according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings"

- M. Aboveground copper tubing shall be installed according to CDA's "Copper Tube Handbook".
- N. Aboveground PVC piping shall be installed according to ASTM D2665.  
Underground PVC piping shall be installed according to ASTM D2321.

### **3.2 JOINT CONSTRUCTION**

- C. Hubless or No-hub, cast iron piping shall be joined in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless piping coupling joints.
- D. For threaded joints, thread pipe with tapered pipe threads according to ASME B1.20.1. The threads shall be cut full and clean using sharp disc cutters. Threaded pipe ends shall be reamed to remove burrs and restored to full pipe inside diameter. Pipe fittings and valves shall be joined as follows:
  - 1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is required by the pipe service
  - 2. Pipe sections with damaged threads shall be replaced with new sections of pipe.
- E. Copper tube and fittings with soldered joints shall be joined according to ASTM B828. A water flushable, lead free flux conforming to ASTM B813 and a lead free alloy solder conforming to ASTM B32 shall be used.
- F. Copper tubing for condensate drainage shall be jointed with copper pressure fitting, and conforming ASME B16.51

### **3.3 SPECIALTY PIPE FITTINGS**

- A. Transition coupling shall be installed at pipe joints with small differences in pipe outside diameters.
- B. Dielectric fittings shall be installed at connections of dissimilar metal piping and tubing.

### **3.4 PIPE HANGERS, SUPPORTS AND ACCESSORIES:**

- A. All piping shall be supported according to the International Plumbing Code (IPC), Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING, and these specifications. Where conflicts arise between these the code and Section 22 05 11, the most restrictive or the requirement that specifies supports with highest loading or shortest spacing shall apply.
- B. Hangers, supports, rods, inserts and accessories used for pipe supports shall be shop coated with zinc chromate primer paint. Electroplated

copper hanger rods, hangers and accessories may be used with copper tubing.

- C. Horizontal piping and tubing shall be supported within 300 mm (12 inches) of each fitting or coupling.
- D. Horizontal cast iron piping shall be supported with the following maximum horizontal spacing and minimum hanger rod diameters:
  - 1. 40 mm or DN40 to 50 mm or DN50 (NPS 1-1/2 inch to NPS 2 inch): 1500 mm (60 inches) with 10 mm (3/8 inch) rod.
  - 2. 80 mm or DN 80 (NPS 3 inch): 1500 mm (60 inches) with 13 mm (1/2 inch) rod.
  - 3. 100 mm or DN100 to 125 mm or DN125 (NPS 4 to NPS 5): 1500 mm (60 inches) with 16 mm (5/8 inch) rod.
  - 4. 150 mm or DN150 to 200 mm or DN200 (NPS 6 inch to NPS 8 inch): 1500 mm (60 inches) with 19 mm (3/4 inch) rod.
  - 5. 250 mm or DN250 to 300 mm or DN 300 (NPS 10 inch to NPS 12 inch): 1500 mm (60 inch) with 22 mm (7/8 inch) rod.
- F. Vertical piping and tubing shall be supported at the base, at each floor, and at intervals no greater than 4.57 m (15 feet).
- G. In addition to the requirements in Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING, floor, Wall and Ceiling Plates, Supports, Hangers shall have the following characteristics:
  - 1. Solid or split unplated cast iron.
  - 2. All plates shall be provided with set screws.
  - 3. Height adjustable clevis type pipe hangers.
  - 4. Adjustable floor rests and base flanges shall be steel.
  - 5. Hanger rods shall be low carbon steel, fully threaded or threaded at each end with two removable nuts at each end for positioning rod and hanger and locking each in place.
  - 7. Riser clamps shall be malleable iron or steel.
  - 9. See Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING, for requirements on insulated pipe protective shields at hanger supports.
- H. Miscellaneous materials shall be provided as specified, required, directed or as noted on the drawings for proper installation of hangers, supports and accessories. If the vertical distance exceeds 6 m (20 feet) for cast iron pipe additional support shall be provided in

the center of that span. All necessary auxiliary steel shall be provided to provide that support.

- I. Cast escutcheon with set screw shall be provided at each wall, floor and ceiling penetration in exposed finished locations and within cabinets and millwork.

J. Penetrations:

1. Fire Stopping: Where pipes pass through fire partitions, fire walls, smoke partitions, or floors, a fire stop shall be installed that provides an effective barrier against the spread of fire, smoke and gases as specified in Section 07 84 00, FIRESTOPPING. Clearances between raceways and openings shall be completely filled and sealed with the fire stopping materials.
2. Water proofing: At floor penetrations, clearances shall be completely sealed around the pipe and make watertight with sealant as specified in Section 07 92 00, JOINT SEALANTS.

K. Piping shall conform to the following:

1. Waste and Vent Drain to main stacks:

Pipe Size	Minimum Pitch
80 mm or DN 80 (3 inches) and smaller	2%
100 mm or DN 100 (4 inches) and larger	1%

2. Exhaust vents shall be extended separately through roof. Sanitary vents shall not connect to exhaust vents.

### 3.5 TESTS

- A. Sanitary waste and drain systems shall be tested either in its entirety or in sections.
- B. Waste System tests shall be conducted before trenches are backfilled or fixtures are connected. A water test or air test shall be conducted, as directed.
1. If entire system is tested for a water test, tightly close all openings in pipes except highest opening, and fill system with water to point of overflow. If the waste system is tested in sections, tightly plug each opening except highest opening of section under test, fill each section with water and test with at least a 3 m (10 foot) head of water. In testing successive sections, test at least

- upper 3 m (10 feet) of next preceding section so that each joint or pipe except upper most 3 m (10 feet) of system has been submitted to a test of at least a 3 m (10 foot) head of water. Water shall be kept in the system, or in portion under test, for at least 15 minutes before inspection starts. System shall then be tight at all joints.
2. For an air test, an air pressure of 35 kPa (5 psig) gage shall be maintained for at least 15 minutes without leakage. A force pump and mercury column gage shall be used for the air test.
  3. After installing all fixtures and equipment, open water supply so that all p-traps can be observed. For 15 minutes of operation, all p-traps shall be inspected for leaks and any leaks found shall be corrected.
  3. Final Tests: Either one of the following tests may be used.
    - a. Smoke Test: After fixtures are permanently connected and traps are filled with water, fill entire drainage and vent systems with smoke under pressure of 1.3 kPa (1 inch of water) with a smoke machine. Chemical smoke is prohibited.
    - b. Peppermint Test: Introduce (2 ounces) of peppermint into each line or stack.

- - - E N D - - -

**SECTION 23 05 11  
COMMON WORK RESULTS FOR HVAC**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. The requirements of this Section apply to all sections of Division 23.
- B. Definitions:
  - 1. Exposed: Piping, ductwork, and equipment exposed to view in finished rooms.
  - 2. Option or optional: Contractor's choice of an alternate material or method.
  - 3. COR: Contracting Officer's Representative

**1.2 RELATED WORK**

- A. Sustainable design requirements and procedures including submittal requirements: Section 01 81 11, SUSTAINABLE DESIGN REQUIREMENTS.
- B. Procedures and requirements for managing and disposing construction and demolition waste: Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- C. Section 00 72 00, GENERAL CONDITIONS
- D. Section 01 00 00, GENERAL REQUIREMENTS
- E. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES
- F. Section 03 30 00, CAST-IN-PLACE CONCRETE: Concrete and Grout
- G. Section 05 50 00, METAL FABRICATIONS
- H. Section 07 84 00, FIRESTOPPING
- I. Section 07 60 00, FLASHING AND SHEET METAL: Flashing for Wall and Roof Penetrations
- J. Section 07 92 00, JOINT SEALANTS
- K. Section 09 91 00, PAINTING
- L. Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS
- M. Section 23 05 12, GENERAL MOTOR REQUIREMENTS FOR HVAC and STEAM GENERATION

- N. Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING and EQUIPMENT
- O. Section 23 05 93, TESTING, ADJUSTING, and BALANCING FOR HVAC
- P. Section 23 07 11, HVAC, PLUMBING, and Boiler Plant Insulation
- Q. Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC
- R. Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS: Requirements for commissioning, systems readiness checklists, and training
- S. Section 23 21 13, HYDRONIC PIPING
- T. Section 23 21 23, HYDRONIC PUMPS
- U. Section 23 22 13, STEAM and CONDENSATE HEATING PIPING
- V. Section 23 25 00, HVAC WATER TREATMENT
- W. Section 23 31 00, HVAC DUCTS and CASINGS
- X. Section 23 34 00, HVAC FANS
- Y. Section 23 40 00, HVAC AIR CLEANING DEVICES
- Z. Section 23 72 00, AIR-TO-AIR ENERGY RECOVERY EQUIPMENT
- AA. Section 23 74 13, PACKAGED, OUTDOOR, CENTRAL-STATION AIR-HANDLING UNITS
- BB. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS
- CC. Section 26 29 11, LOW-VOLTAGE MOTOR STARTERS

### **1.3 QUALITY ASSURANCE**

- A. Mechanical, electrical and associated systems shall be safe, reliable, efficient, durable, easily and safely operable and maintainable, easily and safely accessible, and in compliance with applicable codes as specified. The systems shall be comprised of high quality institutional-class and industrial-class products of manufacturers that are experienced specialists in the required product lines. All construction firms and personnel shall be experienced and qualified specialists in industrial and institutional HVAC
- B. Flow Rate Tolerance for HVAC Equipment: Section 23 05 93, TESTING, ADJUSTING, AND BALANCING FOR HVAC.
- C. Equipment Vibration Tolerance:
  - 1. Refer to Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING and EQUIPMENT. Equipment shall be factory-balanced to this tolerance and re-balanced on site, as necessary.

2. After HVAC air balance work is completed and permanent drive sheaves are in place, perform field mechanical balancing and adjustments required to meet the specified vibration tolerance.

D. Products Criteria:

1. Standard Products: Material and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of the products for at least 3 years (or longer as specified elsewhere). The design, model and size of each item shall have been in satisfactory and efficient operation on at least three installations for approximately three years. However, digital electronics devices, software and systems such as controls, instruments, computer work station, shall be the current generation of technology and basic design that has a proven satisfactory service record of at least three years. See other specification sections for any exceptions and/or additional requirements.
2. All items furnished shall be free from defects that would adversely affect the performance, maintainability and appearance of individual components and overall assembly.
3. Conform to codes and standards as required by the specifications. Conform to local codes, if required by local authorities such as the natural gas supplier, if the local codes are more stringent than those specified. Refer any conflicts to the Contracting Officer's Representative.
4. Multiple Units: When two or more units of materials or equipment of the same type or class are required, these units shall be products of one manufacturer.
5. Assembled Units: Manufacturers of equipment assemblies, which use components made by others, assume complete responsibility for the final assembled product.
6. Nameplates: Nameplate bearing manufacturer's name or identifiable trademark shall be securely affixed in a conspicuous place on equipment, or name or trademark cast integrally with equipment, stamped or otherwise permanently marked on each item of equipment.
7. Asbestos products or equipment or materials containing asbestos shall not be used.

E. Equipment Service Organizations:

1. HVAC: Products and systems shall be supported by service organizations that maintain a complete inventory of repair parts and are located within 50 miles to the site.

F. HVAC Mechanical Systems Welding: Before any welding is performed, contractor shall submit a certificate certifying that welders comply with the following requirements:

1. Qualify welding processes and operators for piping according to ASME "Boiler and Pressure Vessel Code", Section IX, "Welding and Brazing Qualifications".



2. Comply with provisions of ASME B31 series "Code for Pressure Piping".
3. Certify that each welder has passed American Welding Society (AWS) qualification tests for the welding processes involved, and that certification is current.

G. Execution (Installation, Construction) Quality:

1. Apply and install all items in accordance with manufacturer's written instructions. Refer conflicts between the manufacturer's instructions and the contract drawings and specifications to the Contracting Officer's Representative for resolution. Provide written hard copies or computer files of manufacturer's installation instructions to the Contracting Officer's Representative at least two weeks prior to commencing installation of any item. Installation of the item will not be allowed to proceed until the recommendations are received. Failure to furnish these recommendations is a cause for rejection of the material.
2. Provide complete layout drawings required by Paragraph, SUBMITTALS. Do not commence construction work on any system until the layout drawings have been approved.

- H. Upon request by Government, provide lists of previous installations for selected items of equipment. Include contact persons who will serve as references, with telephone numbers and e-mail addresses.

**1.4 SUBMITTALS**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES, and with requirements in the individual specification sections.
- B. Contractor shall make all necessary field measurements and investigations to assure that the equipment and assemblies will meet contract requirements.
- C. If equipment is submitted which differs in arrangement from that shown, provide drawings that show the rearrangement of all associated systems. Approval will be given only if all features of the equipment and associated systems, including accessibility, are equivalent to that required by the contract.
- D. Prior to submitting shop drawings for approval, contractor shall certify in writing that manufacturers of all major items of equipment have each reviewed drawings and specifications, and have jointly coordinated and properly integrated their equipment and controls to provide a complete and efficient installation.
- E. Submittals and shop drawings for interdependent items, containing applicable descriptive information, shall be furnished together and complete in a group. Coordinate and properly integrate materials and equipment in each group to provide a completely compatible and efficient.

- F. Samples: Samples will not be required, except for insulation or where materials offered differ from specification requirements. Samples shall be accompanied by full description of characteristics different from specification. The Government, at the Government's expense, will perform evaluation and testing if necessary. The Contractor may submit samples of additional material at the Contractor's option; however, if additional samples of materials are submitted later, pursuant to Government request, adjustment in contract price and time will be made as provided under Article CHANGES of Section 00 72 00, GENERAL CONDITIONS.
- G. Layout Drawings:
1. Submit complete consolidated and coordinated layout drawings for all new systems, and for existing systems that are in the same areas. Refer to Section 00 72 00, GENERAL CONDITIONS, Article, SUBCONTRACTS AND WORK COORDINATION.
  2. The drawings shall include plan views, elevations and sections of all systems and shall be on a scale of not less than 1:32 (3/8-inch equal to one foot). Clearly identify and dimension the proposed locations of the principal items of equipment. The drawings shall clearly show locations and adequate clearance for all equipment, piping, valves, control panels and other items. Show the access means for all items requiring access for operations and maintenance. Provide detailed layout drawings of all piping and duct systems.
  3. Do not install equipment foundations, equipment or piping until layout drawings have been approved.
  4. In addition, for HVAC systems, provide details of the following:
    - a. Mechanical equipment rooms.
    - b. Interstitial space.
    - c. Hangers, inserts, supports, and bracing.
    - d. Pipe sleeves.
    - e. Duct or equipment penetrations of floors, walls, ceilings, or roofs.
- H. Manufacturer's Literature and Data: Submit under the pertinent section rather than under this section.
1. Submit belt drive with the driven equipment. Submit selection data for specific drives when requested by the Contracting Officer's Representative.
  2. Submit electric motor data and variable speed drive data with the driven equipment.
  3. Equipment and materials identification.
  4. Fire-stopping materials.
  5. Hangers, inserts, supports and bracing. Provide load calculations for variable spring and constant support hangers.
  6. Wall, floor, and ceiling plates.

I. HVAC Maintenance Data and Operating Instructions:

1. Maintenance and operating manuals in accordance with Section 01 00 00, GENERAL REQUIREMENTS, Article, INSTRUCTIONS, for systems and equipment.
2. Provide a listing of recommended replacement parts for keeping in stock supply, including sources of supply, for equipment. Include in the listing belts for equipment: Belt manufacturer, model number, size and style, and distinguished whether of multiple belt sets.

J. Provide copies of approved HVAC equipment submittals to the Testing, Adjusting and Balancing Subcontractor.

**1.5 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. Air Conditioning, Heating and Refrigeration Institute (AHRI):

1. 430-2009 Central Station Air-Handling Units

C. American National Standard Institute (ANSI):

1. B31.1-2007 Power Piping

D. Rubber Manufacturers Association (ANSI/RMA):

1. IP-20-2007 Specifications for Drives Using Classical V-Belts and Sheaves
2. IP-21-2009 Specifications for Drives Using Double-V (Hexagonal) Belts
3. IP-22-2007 Specifications for Drives Using Narrow V-Belts and Sheaves

E. Air Movement and Control Association (AMCA):

1. 410-96 Recommended Safety Practices for Air Moving Devices

F. American Society of Mechanical Engineers (ASME):

1. Boiler and Pressure Vessel Code (BPVC):
  - a. Section I-2007 Power Boilers
  - b. Section IX-2007 Welding and Brazing Qualifications

G. Code for Pressure Piping:

1. B31.1-2007 Power Piping

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

1. A36/A36M-08 Standard Specification for Carbon Structural Steel
2. A575-96(2007) Standard Specification for Steel Bars, Carbon, Merchant Quality, M-Grades

3. E84-10 Standard Test Method for Surface Burning Characteristics of Building Materials
  4. E119-09c Standard Test Methods for Fire Tests of Building Construction and Materials
- I. Manufacturers Standardization Society (MSS) of the Valve and Fittings Industry, Inc:
1. SP-58-2009 Pipe Hangers and Supports-Materials, Design and Manufacture, Selection, Application, and Installation
  2. SP 69-2003 Pipe Hangers and Supports-Selection and Application
  3. SP 127-2001 Bracing for Piping Systems, Seismic - Wind - Dynamic, Design, Selection, Application
- J. National Electrical Manufacturers Association (NEMA):
1. MG-1-2009 Motors and Generators
- K. National Fire Protection Association (NFPA):
1. 31-06 Standard for Installation of Oil-Burning Equipment
  2. 54-09 National Fuel Gas Code
  3. 70-08 National Electrical Code
  4. 85-07 Boiler and Combustion Systems Hazards Code
  5. 90A-09 Standard for the Installation of Air Conditioning and Ventilating Systems
  6. 101-09 Life Safety Code

#### **1.6 DELIVERY, STORAGE AND HANDLING**

- A. Protection of Equipment:
1. Equipment and material placed on the job site shall remain in the custody of the Contractor until phased acceptance, whether or not the Government has reimbursed the Contractor for the equipment and material. The Contractor is solely responsible for the protection of such equipment and material against any damage.
  2. Place damaged equipment in first class, new operating condition; or, replace same as determined and directed by the Contracting Officer's Representative. Such repair or replacement shall be at no additional cost to the Government.
  3. Protect interiors of new equipment and piping systems against entry of foreign matter. Clean both inside and outside before painting or placing equipment in operation.
  4. Existing equipment and piping being worked on by the Contractor shall be under the custody and responsibility of the Contractor and shall be protected as required for new work.

B. Cleanliness of Piping and Equipment Systems:

1. Exercise care in storage and handling of equipment and piping material to be incorporated in the work. Remove debris arising from cutting, threading and welding of piping.
2. Piping systems shall be flushed, blown or pigged as necessary to deliver clean systems.
3. Clean interior of all tanks prior to delivery for beneficial use by the Government.
4. Boilers shall be left clean following final internal inspection by Government insurance representative or inspector.
5. Contractor shall be fully responsible for all costs, damage, and delay arising from failure to provide clean systems.

1.7 **JOB CONDITIONS ON WORK IN EXISTING BUILDING**

- A. Building Operation: Government employees will be continuously operating and managing all facilities, including temporary facilities that serve the medical center.
- B. Maintenance of Service: Schedule all work to permit continuous service as required by the medical center.
- C. Steam and Condensate Service Interruptions: Limited steam and condensate service interruptions, as required for interconnections of new and existing systems, will be permitted by the Resident Engineer during periods when the demands are not critical to the operation of the medical center. These non-critical periods are limited to between 8 pm and 5 am in the appropriate off-season (if applicable). Provide at least one week advance notice to the Resident Engineer.
- D. Phasing of Work: Comply with all requirements shown on drawings or specified.
- E. Building Working Environment: Maintain the architectural and structural integrity of the building and the working environment at all times. Maintain the interior of building at 18 degrees C (65 degrees F) minimum. Limit the opening of doors, windows or other access openings to brief periods as necessary for rigging purposes. No storm water or ground water leakage permitted. Provide daily clean-up of construction and demolition debris on all floor surfaces and on all equipment being operated by VA.
- F. Acceptance of Work for Government Operation: As new facilities are made available for operation and these facilities are of beneficial use to the Government, inspections will be made and tests will be performed. Based on the inspections, a list of contract deficiencies will be issued to the Contractor. After correction of deficiencies as necessary for beneficial use, the Contracting Officer will process necessary acceptance and the equipment will then be under the control and operation of Government personnel.

- G. Temporary Facilities: Refer to Article, TEMPORARY PIPING AND EQUIPMENT in this section.

## **PART 2 - PRODUCTS**

### **2.1 FACTORY-ASSEMBLED PRODUCTS**

- A. Provide maximum standardization of components to reduce spare part requirements.
- B. Manufacturers of equipment assemblies that include components made by others shall assume complete responsibility for final assembled unit.
  - 1. All components of an assembled unit need not be products of same manufacturer.
  - 2. Constituent parts that are alike shall be products of a single manufacturer.
  - 3. Components shall be compatible with each other and with the total assembly for intended service.
  - 4. Contractor shall guarantee performance of assemblies of components, and shall repair or replace elements of the assemblies as required to deliver specified performance of the complete assembly.
- C. Components of equipment shall bear manufacturer's name and trademark, model number, serial number and performance data on a name plate securely affixed in a conspicuous place, or cast integral with, stamped or otherwise permanently marked upon the components of the equipment.
- D. Major items of equipment, which serve the same function, must be the same make and model. Exceptions will be permitted if performance requirements cannot be met.

### **2.2 COMPATIBILITY OF RELATED EQUIPMENT**

- A. Equipment and materials installed shall be compatible in all respects with other items being furnished and with existing items so that the result will be a complete and fully operational plant that conforms to contract requirements.

### **2.3 BELT DRIVES**

- A. Type: ANSI/RMA standard V-belts with proper motor pulley and driven sheave. Belts shall be constructed of reinforced cord and rubber.
- B. Dimensions, rating and selection standards: ANSI/RMA IP-20 and IP-21.
- C. Minimum Horsepower Rating: Motor horsepower plus recommended ANSI/RMA service factor (not less than 20 percent) in addition to the ANSI/RMA allowances for pitch diameter, center distance, and arc of contact.

- D. Maximum Speed: 25 m/s (5000 feet per minute).
- E. Adjustment Provisions: For alignment and ANSI/RMA standard allowances for installation and take-up.
- F. Drives may utilize a single V-Belt (any cross section) when it is the manufacturer's standard.
- G. Multiple Belts: Matched to ANSI/RMA specified limits by measurement on a belt measuring fixture. Seal matched sets together to prevent mixing or partial loss of sets. Replacement, when necessary, shall be an entire set of new matched belts.
- H. Sheaves and Pulleys:
  - 1. Material: Pressed steel, or close grained cast iron.
  - 2. Bore: Fixed or bushing type for securing to shaft with keys.
  - 3. Balanced: Statically and dynamically.
  - 4. Groove spacing for driving and driven pulleys shall be the same.
- I. Drive Types, Based on ARI 435:
  - 1. Provide adjustable-pitch drive as follows:
    - a. Fan horse power: 2.2 kW (3 horsepower) and smaller.
  - 2. Provide fixed-pitch drives for drives larger than those listed above.
  - 3. The final fan speeds required to just meet the system CFM and pressure requirements, without throttling, shall be determined by adjustment of a temporary adjustable-pitch motor sheave or by fan law calculation if a fixed-pitch drive is used initially.

## **2.4 DRIVE GUARDS**

- A. For machinery and equipment, provide guards as shown in AMCA 410 for belts, chains, couplings, pulleys, sheaves, shafts, gears and other moving parts regardless of height above the floor to prevent damage to equipment and injury to personnel. Drive guards may be excluded where motors and drives are inside factory fabricated air handling unit casings.
- B. Pump shafts and couplings shall be fully guarded by a sheet steel guard, covering coupling and shaft but not bearings. Material shall be minimum 16-gage sheet steel; ends shall be braked and drilled and attached to pump base with minimum of four 6 mm (1/4-inch) bolts. Reinforce guard as necessary to prevent side play forcing guard onto couplings.
- C. V-belt and sheave assemblies shall be totally enclosed, firmly mounted, non-resonant. Guard shall be an assembly of minimum 22-gage sheet steel and expanded or perforated metal to permit observation of belts. 25 mm (one-inch) diameter hole shall be provided at each shaft centerline to permit speed measurement.

- D. Materials: Sheet steel, cast iron, expanded metal or wire mesh rigidly secured so as to be removable without disassembling pipe, duct, or electrical connections to equipment.
- E. Access for Speed Measurement: 25 mm (One inch) diameter hole at each shaft center.

## **2.5 LIFTING ATTACHMENTS**

- A. Provide equipment with suitable lifting attachments to enable equipment to be lifted in its normal position. Lifting attachments shall withstand any handling conditions that might be encountered, without bending or distortion of shape, such as rapid lowering and braking of load.

## **2.6 ELECTRIC MOTORS**

- A. All material and equipment furnished and installation methods shall conform to the requirements of Section 23 05 12, GENERAL MOTOR REQUIREMENTS FOR HVAC AND STEAM GENERATION EQUIPMENT; Section 26 29 11, LOW-VOLTAGE MOTOR STARTERS; and, Section 26 05 21, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW). Provide all electrical wiring, conduit, and devices necessary for the proper connection, protection and operation of the systems. Provide special energy efficient premium efficiency type motors as scheduled.

## **2.7 VARIABLE SPEED MOTOR CONTROLLERS**

- A. Refer to Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS and Section 26 29 11, LOW-VOLTAGE MOTOR STARTERS for specifications.
- B. The combination of controller and motor shall be provided by the manufacturer of the driven equipment, such as pumps and fans, and shall be rated for 100 percent output performance. Multiple units of the same class of equipment, i.e. air handlers, fans, pumps, shall be product of a single manufacturer.
- C. Motors shall be inverter duty, premium efficiency type and be approved by the motor controller manufacturer. The controller-motor combination shall be guaranteed to provide full motor nameplate horsepower in variable frequency operation. Both driving and driven motor/fan sheaves shall be fixed pitch.
- D. Controller shall not add any current or voltage transients to the input AC power distribution system, DDC controls, sensitive medical equipment, etc., nor shall be affected from other devices on the AC power system.
- E. Controller shall be provided with the following operating features and accessories:
  - 1. Suitable for variable torque load.
  - 2. Provide thermal magnetic circuit breaker or fused switch with external operator and incoming line fuses. Unit shall be rated



for minimum **30,000** AIC. Provide AC input **line reactors (3% impedance)** on incoming power line. Provide output line reactors on line between drive and motor **for motors over 50 HP or** where the distance between the breaker and motor exceeds 50 feet.

## **2.8 EQUIPMENT AND MATERIALS IDENTIFICATION**

- A. Use symbols, nomenclature and equipment numbers specified, shown on the drawings and shown in the maintenance manuals. Identification for piping is specified in Section 09 91 00, PAINTING.
- B. Use symbols, nomenclature and equipment numbers specified, shown on the drawings and shown in the maintenance manuals. In addition, provide bar code identification nameplate for all equipment which will allow the equipment identification code to be scanned into the system for maintenance and inventory tracking. Identification for piping is specified in Section 09 91 00, PAINTING.
- C. Interior (Indoor) Equipment: Engraved nameplates, with letters not less than 48 mm (3/16-inch) high of brass with black-filled letters, or rigid black plastic with white letters specified in Section 09 91 00, PAINTING permanently fastened to the equipment. Identify unit components such as coils, filters, fans, etc.
- D. Exterior (Outdoor) Equipment: Brass nameplates, with engraved black filled letters, not less than 48 mm (3/16-inch) high riveted or bolted to the equipment.
- E. Control Items: Label all temperature and humidity sensors, controllers and control dampers. Identify and label each item as they appear on the control diagrams.
- F. Valve Tags and Lists:
  - 1. HVAC: Provide for all valves other than for equipment in Section 23 82 00, CONVECTION HEATING AND COOLING UNITS.
  - 2. Valve tags: Engraved black filled numbers and letters not less than 13 mm (1/2-inch) high for number designation, and not less than 6.4 mm (1/4-inch) for service designation on 19 gage 38 mm (1-1/2 inches) round brass disc, attached with brass "S" hook or brass chain.
  - 3. Valve lists: Typed or printed plastic coated card(s), sized 216 mm(8-1/2 inches) by 280 mm (11 inches) showing tag number, valve function and area of control, for each service or system. Punch sheets for a 3-ring notebook.
  - 4. Provide detailed plan for each floor of the building indicating the location and valve number for each valve. Identify location of each valve with a color coded thumb tack in ceiling.

## **2.9 FIRESTOPPING**

- A. Section 07 84 00, FIRESTOPPING specifies an effective barrier against the spread of fire, smoke and gases where penetrations occur for

pipings and ductwork. Refer to Section 23 07 11, HVAC, PLUMBING, AND BOILER PLANT INSULATION, for firestop pipe and duct insulation.

**2.10 GALVANIZED REPAIR COMPOUND**

- A. Mil. Spec. DOD-P-21035B, paint form.

**2.11 HVAC PIPE AND EQUIPMENT SUPPORTS AND RESTRAINTS**

- A. Vibration Isolators: Refer to Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING AND EQUIPMENT.
- B. Supports for Roof Mounted Items (unless noted as Type 304 stainless steel on the construction drawings):
1. Equipment: Equipment rails shall be galvanized steel, minimum 1.3 mm (18 gauge), with integral baseplate, continuous welded corner seams, factory installed 50 mm by 100 mm (2 by 4) treated wood nailer, 1.3 mm (18 gauge) galvanized steel counter flashing cap with screws, built-in cant strip, (except for gypsum or tectum deck), minimum height 280 mm (11 inches). For surface insulated roof deck, provide raised cant strip to start at the upper surface of the insulation.
  2. Pipe/duct pedestals: Provide a galvanized Unistrut channel welded to U-shaped mounting brackets which are secured to side of rail with galvanized lag bolts.
- C. Pipe Supports: Comply with MSS SP-58. Type Numbers specified refer to this standard. For selection and application comply with MSS SP-69. Refer to Section 05 50 00, METAL FABRICATIONS, for miscellaneous metal support materials and prime coat painting requirements.
- D. Attachment to Concrete Building Construction:
1. Concrete insert: MSS SP-58, Type 18.
  2. Self-drilling expansion shields and machine bolt expansion anchors: Permitted in concrete not less than 102 mm (four inches) thick when approved by the Contracting Officer's Representative for each job condition.
  3. Power-driven fasteners: Permitted in existing concrete or masonry not less than 102 mm (four inches) thick when approved by the Contracting Officer's Representative for each job condition.
- E. Attachment to Steel Building Construction:
1. Welded attachment: MSS SP-58, Type 22.
  2. Beam clamps: MSS SP-58, Types 20, 21, 28 or 29. Type 23 C-clamp may be used for individual copper tubing up to 23mm (7/8-inch) outside diameter.
- F. Attachment to Metal Pan or Deck: As required for materials specified in **Section 05 31 00, STEEL DECKING**.

- G. Attachment to existing structure: Support from existing floor/roof frame.
- H. Hanger Rods: Hot-rolled steel, ASTM A36 or A575 for allowable load listed in MSS SP-58. For piping, provide adjustment means for controlling level or slope. Types 13 or 15 turn-buckles shall provide 38 mm (1-1/2 inches) minimum of adjustment and incorporate locknuts. All-thread rods are acceptable.
- I. Hangers Supporting Multiple Pipes (Trapeze Hangers): Galvanized, cold formed, lipped steel channel horizontal member, not less than 41 mm by 41 mm (1-5/8 inches by 1-5/8 inches), 2.7 mm (No. 12 gage), designed to accept special spring held, hardened steel nuts. Not permitted for steam supply and condensate piping.
  - 1. Allowable hanger load: Manufacturers rating less 91kg (200 pounds).
  - 2. Guide individual pipes on the horizontal member of every other trapeze hanger with 6 mm (1/4-inch) U-bolt fabricated from steel rod. Provide Type 40 insulation shield, secured by two 13mm (1/2-inch) galvanized steel bands, or preinsulated calcium silicate shield for insulated piping at each hanger.
- J. Supports for Piping Systems:
  - 1. Select hangers sized to encircle insulation on insulated piping. Refer to Section 23 07 11, HVAC, PLUMBING, AND BOILER PLANT INSULATION for insulation thickness. To protect insulation, provide Type 39 saddles for roller type supports or preinsulated calcium silicate shields. Provide Type 40 insulation shield or preinsulated calcium silicate shield at all other types of supports and hangers including those for preinsulated piping.
  - 2. Piping Systems except High and Medium Pressure Steam (MSS SP-58):
    - a. Standard clevis hanger: Type 1; provide locknut.
    - b. Riser clamps: Type 8.
    - c. Wall brackets: Types 31, 32 or 33.
    - d. Roller supports: Type 41, 43, 44 and 46.
    - e. Saddle support: Type 36, 37 or 38.
    - f. Turnbuckle: Types 13 or 15. Preinsulate.
    - g. U-bolt clamp: Type 24.
    - h. Copper Tube:
      - 1) Hangers, clamps and other support material in contact with tubing shall be painted with copper colored epoxy paint, plastic coated or taped with non adhesive isolation tape to prevent electrolysis.
      - 2) For vertical runs use epoxy painted or plastic coated riser clamps.
      - 3) For supporting tube to strut: Provide epoxy painted pipe straps for copper tube or plastic inserted vibration isolation clamps.
      - 4) Insulated Lines: Provide pre-insulated calcium silicate shields sized for copper tube.

- i. Supports for plastic piping: As recommended by the pipe manufacturer with black rubber tape extending one inch beyond steel support or clamp.
  3. High and Medium Pressure Steam (MSS SP-58):
    - a. Provide eye rod or Type 17 eye nut near the upper attachment.
    - b. Piping 50 mm (2 inches) and larger: Type 43 roller hanger. For roller hangers requiring seismic bracing provide a Type 1 clevis hanger with Type 41 roller attached by flat side bars.
    - c. Piping with Vertical Expansion and Contraction:
      - 1) Movement up to 20 mm (3/4-inch): Type 51 or 52 variable spring unit with integral turn buckle and load indicator.
      - 2) Movement more than 20 mm (3/4-inch): Type 54 or 55 constant support unit with integral adjusting nut, turn buckle and travel position indicator.
- K. Pre-insulated Calcium Silicate Shields:
  1. Provide 360 degree water resistant high density 965 kPa (140 psi) compressive strength calcium silicate shields encased in galvanized metal.
  2. Pre-insulated calcium silicate shields to be installed at the point of support during erection.
  3. Shield thickness shall match the pipe insulation.
  4. The type of shield is selected by the temperature of the pipe, the load it must carry, and the type of support it will be used with.
    - a. Shields for supporting chilled or cold water shall have insulation that extends a minimum of 1 inch past the sheet metal. Provide for an adequate vapor barrier in chilled lines.
    - b. The pre-insulated calcium silicate shield shall support the maximum allowable water filled span as indicated in MSS-SP 69. To support the load, the shields may have one or more of the following features: structural inserts 4138 kPa (600 psi) compressive strength, an extra bottom metal shield, or formed structural steel (ASTM A36) wear plates welded to the bottom sheet metal jacket.
  5. Shields may be used on steel clevis hanger type supports, roller supports or flat surfaces.
- L. Seismic Restraint of Piping and Ductwork: Refer to Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS. Comply with MSS SP-127.

## **2.12 PIPE PENETRATIONS**

- A. Install sleeves during construction for other than blocked out floor openings for risers in mechanical bays.

- B. To prevent accidental liquid spills from passing to a lower level, provide the following:
  - 1. For sleeves: Extend sleeve 25 mm (one inch) above finished floor and provide sealant for watertight joint.
  - 2. For blocked out floor openings: Provide 40 mm (1-1/2 inch) angle set in silicone adhesive around opening.
  - 3. For drilled penetrations: Provide 40 mm (1-1/2 inch) angle ring or square set in silicone adhesive around penetration.
- C. Penetrations are not allowed through beams or ribs. Any deviation from these requirements must receive prior approval of Contracting Officer's Representative.
- D. Sheet Metal, Plastic, or Moisture-resistant Fiber Sleeves: Provide for pipe passing through floors, interior walls, and partitions, unless brass or steel pipe sleeves are specifically called for below.
- E. Cast Iron or Zinc Coated Pipe Sleeves: Provide for pipe passing through exterior walls below grade. Make space between sleeve and pipe watertight with a modular or link rubber seal. Seal shall be applied at both ends of sleeve.
- F. Galvanized Steel or an alternate Black Iron Pipe with asphalt coating Sleeves: Provide for pipe passing through concrete beam flanges, except where brass pipe sleeves are called for. Provide sleeve for pipe passing through floor of mechanical rooms, laundry work rooms, and animal rooms above basement. Except in mechanical rooms, connect sleeve with floor plate.
- G. Brass Pipe Sleeves: Provide for pipe passing through quarry tile, terrazzo or ceramic tile floors. Connect sleeve with floor plate.
- H. Sleeves are not required for wall hydrants for fire department connections or in drywall construction.
- I. Sleeve Clearance: Sleeve through floors, walls, partitions, and beam flanges shall be one inch greater in diameter than external diameter of pipe. Sleeve for pipe with insulation shall be large enough to accommodate the insulation. Interior openings shall be caulked tight with fire stopping material and sealant to prevent the spread of fire, smoke, and gases.
- J. Sealant and Adhesives: Shall be as specified in Section 07 92 00, JOINT SEALANTS.

## **2.13 DUCT PENETRATIONS**

- A. Provide curbs for roof mounted piping, ductwork and equipment. Curbs shall be 18 inches high with continuously welded seams, built-in cant strip, interior baffle with acoustic insulation, curb bottom, hinged curb adapter.

- B. Provide firestopping for openings through fire and smoke barriers, maintaining minimum required rating of floor, ceiling or wall assembly. See section 07 84 00, FIRESTOPPING.

#### **2.14 SPECIAL TOOLS AND LUBRICANTS**

- A. Furnish, and turn over to the Contracting Officer's Representative, tools not readily available commercially, that are required for disassembly or adjustment of equipment and machinery furnished.
- B. Grease Guns with Attachments for Applicable Fittings: One for each type of grease required for each motor or other equipment.
- C. Refrigerant Tools: Provide system charging/Evacuation equipment, gauges, fittings, and tools required for maintenance of furnished equipment.
- D. Tool Containers: Hardwood or metal, permanently identified for intended service and mounted, or located, where directed by the Contracting Officer's Representative.
- E. Lubricants: A minimum of 0.95 L (one quart) of oil, and 0.45 kg (one pound) of grease, of equipment manufacturer's recommended grade and type, in unopened containers and properly identified as to use for each different application.

#### **2.15 WALL, FLOOR AND CEILING PLATES**

- A. Material and Type: Chrome plated brass or chrome plated steel, one piece or split type with concealed hinge, with set screw for fastening to pipe, or sleeve. Use plates that fit tight around pipes, cover openings around pipes and cover the entire pipe sleeve projection.
- B. Thickness: Not less than 2.4 mm (3/32-inch) for floor plates. For wall and ceiling plates, not less than 0.64 mm (0.025-inch) for up to 80 mm (3-inch pipe), 0.89 mm (0.035-inch) for larger pipe.
- C. Locations: Use where pipe penetrates floors, walls and ceilings in exposed locations, in finished areas only. Provide a watertight joint in spaces where brass or steel pipe sleeves are specified.

#### **2.16 ASBESTOS**

- A. Materials containing asbestos are not permitted.

### **PART 3 - EXECUTION**

#### **3.1 ARRANGEMENT AND INSTALLATION OF EQUIPMENT AND PIPING**

- A. Coordinate location of piping, sleeves, inserts, hangers, ductwork and equipment. Locate piping, sleeves, inserts, hangers, ductwork and equipment clear of windows, doors, openings, light outlets, and other services and utilities. Prepare equipment layout drawings to

coordinate proper location and personnel access of all facilities. Submit the drawings for review as required by Part 1. Follow manufacturer's published recommendations for installation methods not otherwise specified.

- B. Operating Personnel Access and Observation Provisions: Select and arrange all equipment and systems to provide clear view and easy access, without use of portable ladders, for maintenance and operation of all devices including, but not limited to: all equipment items, valves, filters, strainers, transmitters, sensors, control devices. All gages and indicators shall be clearly visible by personnel standing on the floor or on permanent platforms. Do not reduce or change maintenance and operating space and access provisions that are shown on the drawings.
- C. Equipment and Piping Support: Coordinate structural systems necessary for pipe and equipment support with pipe and equipment locations to permit proper installation. Patch fire proofing on structural components that are removed or damaged by this Division installation work.
- D. Location of pipe sleeves, trenches and chases shall be accurately coordinated with equipment and piping locations.
- E. Cutting Holes:
  - 1. Cut holes through concrete and masonry by rotary core drill. Pneumatic hammer, impact electric, and hand or manual hammer type drill will not be allowed, except as permitted by Contracting Officer's Representative where working area space is limited.
  - 2. Locate holes to avoid interference with structural members such as beams or grade beams. Holes shall be laid out in advance and drilling done only after approval by Contracting Officer's Representative. If the Contractor considers it necessary to drill through structural members, this matter shall be referred to Contracting Officer's Representative for approval.
  - 3. Do not penetrate membrane waterproofing.
- F. Interconnection of Instrumentation or Control Devices: Generally, electrical and pneumatic interconnections are not shown but must be provided.
- G. Minor Piping: Generally, small diameter pipe runs from drips and drains, water cooling, and other service are not shown but must be provided.
- H. Electrical Interconnection of Controls and Instruments: This generally not shown but must be provided. This includes interconnections of sensors, transmitters, transducers, control devices, control and instrumentation panels, instruments and computer workstations. Comply with NFPA-70.

I. Protection and Cleaning:

1. Equipment and materials shall be carefully handled, properly stored, and adequately protected to prevent damage before and during installation, in accordance with the manufacturer's recommendations and as approved by the Contracting Officer's Representative. Damaged or defective items in the opinion of the Contracting Officer's Representative, shall be replaced.
2. Protect all finished parts of equipment, such as shafts and bearings where accessible, from rust prior to operation by means of protective grease coating and wrapping. Close pipe openings with caps or plugs during installation. Tightly cover and protect fixtures and equipment against dirt, water chemical, or mechanical injury. At completion of all work thoroughly clean fixtures, exposed materials and equipment.

J. Concrete and Grout: Use concrete and shrink compensating grout 25 MPa (3000 psi) minimum, specified in Section 03 30 00, CAST-IN-PLACE CONCRETE.

K. Install gages, thermometers, valves and other devices with due regard for ease in reading or operating and maintaining said devices. Locate and position thermometers and gages to be easily read by operator or staff standing on floor or walkway provided. Servicing shall not require dismantling adjacent equipment or pipe work.

L. Work in Existing Building:

1. Perform as specified in Article, OPERATIONS AND STORAGE AREAS, Article, ALTERATIONS, and Article, RESTORATION of the Section 01 00 00, GENERAL REQUIREMENTS for relocation of existing equipment, alterations and restoration of existing building(s).
2. As specified in Section 01 00 00, GENERAL REQUIREMENTS, Article, OPERATIONS AND STORAGE AREAS, make alterations to existing service piping at times that will least interfere with normal operation of the facility.
3. Cut required openings through existing masonry and reinforced concrete using diamond core drills. Use of pneumatic hammer type drills, impact type electric drills, and hand or manual hammer type drills, will be permitted only with approval of the Resident Engineer. Locate openings that will least effect structural slabs, columns, ribs or beams. Refer to the Resident Engineer for determination of proper design for openings through structural sections and opening layouts approval, prior to cutting or drilling into structure. After Resident Engineer's approval, carefully cut opening through construction no larger than absolutely necessary for the required installation.

M. Switchgear/Electrical Equipment Drip Protection: Every effort shall be made to eliminate the installation of pipe above electrical and telephone switchgear. If this is not possible, encase pipe in a second pipe with a minimum of joints. Installation of piping, ductwork, leak protection apparatus or other installations foreign to the electrical installation shall be located in the space equal to the width and



depth of the equipment and extending from to a height of 1.8 m (6 ft.) above the equipment of to ceiling structure, whichever is lower (NFPA 70).

N. Inaccessible Equipment:

1. Where the Government determines that the Contractor has installed equipment not conveniently accessible for operation and maintenance, equipment shall be removed and reinstalled or remedial action performed as directed at no additional cost to the Government.
2. The term "conveniently accessible" is defined as capable of being reached without the use of ladders, or without climbing or crawling under or over obstacles such as motors, fans, pumps, belt guards, transformers, high voltage lines, piping, and ductwork.

**3.2 TEMPORARY PIPING AND EQUIPMENT**

- A. Continuity of operation of existing facilities will generally require temporary installation or relocation of equipment and piping.
- B. The Contractor shall provide all required facilities in accordance with the requirements of phased construction and maintenance of service. All piping and equipment shall be properly supported, sloped to drain, operate without excessive stress, and shall be insulated where injury can occur to personnel by contact with operating facilities. The requirements of Paragraph 3.1 apply.
- C. Temporary facilities and piping shall be completely removed and any openings in structures sealed. Provide necessary blind flanges and caps to seal open piping remaining in service.

**3.3 RIGGING**

- A. Design is based on application of available equipment. Openings in building structures are planned to accommodate design scheme.
- B. Alternative methods of equipment delivery may be offered by Contractor and will be considered by Government under specified restrictions of phasing and maintenance of service as well as structural integrity of the building.
- C. Close all openings in the building when not required for rigging operations to maintain proper environment in the facility for Government operation and maintenance of service.
- D. Contractor shall provide all facilities required to deliver specified equipment and place on foundations. Attachments to structures for rigging purposes and support of equipment on structures shall be Contractor's full responsibility. Upon request, the Government will check structure adequacy and advise Contractor of recommended restrictions.

- E. Contractor shall check all clearances, weight limitations and shall offer a rigging plan designed by a Registered Professional Engineer. All modifications to structures, including reinforcement thereof, shall be at Contractor's cost, time and responsibility.
- F. Rigging plan and methods shall be referred to Contracting Officer's Representative for evaluation prior to actual work.
- G. Restore building to original condition upon completion of rigging work.

### **3.4 PIPE AND EQUIPMENT SUPPORTS**

- A. Where hanger spacing does not correspond with joist or rib spacing, use structural steel channels secured directly to joist and rib structure that will correspond to the required hanger spacing, and then suspend the equipment and piping from the channels. Drill or burn holes in structural steel only with the prior approval of the Contracting Officer's Representative.
- B. Use of chain, wire or strap hangers; wood for blocking, stays and bracing; or, hangers suspended from piping above will not be permitted. Replace or thoroughly clean rusty products and paint with zinc primer.
- C. Use hanger rods that are straight and vertical. Turnbuckles for vertical adjustments may be omitted where limited space prevents use. Provide a minimum of 15 mm (1/2-inch) clearance between pipe or piping covering and adjacent work.
- D. HVAC Horizontal Pipe Support Spacing: Refer to MSS SP-69. Provide additional supports at valves, strainers, in-line pumps and other heavy components. Provide a support within one foot of each elbow.
- E. HVAC Vertical Pipe Supports:
  - 1. Up to 150 mm (6-inch pipe), 9 m (30 feet) long, bolt riser clamps to the pipe below couplings, or welded to the pipe and rests supports securely on the building structure.
  - 2. Vertical pipe larger than the foregoing, support on base elbows or tees, or substantial pipe legs extending to the building structure.
- F. Overhead Supports:
  - 1. The basic structural system of the building is designed to sustain the loads imposed by equipment and piping to be supported overhead.
  - 2. Provide steel structural members, in addition to those shown, of adequate capability to support the imposed loads, located in accordance with the final approved layout of equipment and piping.
  - 3. Tubing and capillary systems shall be supported in channel troughs.

G. Floor Supports:

1. Provide concrete bases, concrete anchor blocks and pedestals, and structural steel systems for support of equipment and piping. Anchor and dowel concrete bases and structural systems to resist forces under operating and seismic conditions (if applicable) without excessive displacement or structural failure.
2. Do not locate or install bases and supports until equipment mounted thereon has been approved. Size bases to match equipment mounted thereon plus 50 mm (2 inch) excess on all edges. Boiler foundations shall have horizontal dimensions that exceed boiler base frame dimensions by at least 150 mm (6 inches) on all sides. Refer to structural drawings. Bases shall be neatly finished and smoothed, shall have chamfered edges at the top, and shall be suitable for painting.
3. All equipment shall be shimmed, leveled, firmly anchored, and grouted with epoxy grout. Anchor bolts shall be placed in sleeves, anchored to the bases. Fill the annular space between sleeves and bolts with a granular material to permit alignment and realignment.
4. For seismic anchoring, refer to Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.

**3.5 MECHANICAL DEMOLITION**

- A. Rigging access, other than indicated on the drawings, shall be provided by the Contractor after approval for structural integrity by the Resident Engineer. Such access shall be provided without additional cost or time to the Government. Where work is in an operating plant, provide approved protection from dust and debris at all times for the safety of plant personnel and maintenance of plant operation and environment of the plant.
- B. In an operating facility, maintain the operation, cleanliness and safety. Government personnel will be carrying on their normal duties of operating, cleaning and maintaining equipment and plant operation. Confine the work to the immediate area concerned; maintain cleanliness and wet down demolished materials to eliminate dust. Do not permit debris to accumulate in the area to the detriment of plant operation. Perform all flame cutting to maintain the fire safety integrity of this plant. Adequate fire extinguishing facilities shall be available at all times. Perform all work in accordance with recognized fire protection standards. Inspection will be made by personnel of the VA Medical Center, and Contractor shall follow all directives of the RE or COTR with regard to rigging, safety, fire safety, and maintenance of operations.
- C. Completely remove all piping, wiring, conduit, and other devices associated with the equipment not to be re-used in the new work. This includes all pipe, valves, fittings, insulation, and all hangers including the top connection and any fastenings to building structural systems. Seal all openings, after removal of equipment, pipes, ducts, and other penetrations in roof, walls, floors, in an approved manner and in accordance with plans and specifications where specifically

covered. Structural integrity of the building system shall be maintained. Reference shall also be made to the drawings and specifications of the other disciplines in the project for additional facilities to be demolished or handled.

- D. All valves including gate, globe, ball, butterfly and check, all pressure gages and thermometers with wells shall remain Government property and shall be removed and delivered to Resident Engineer and stored as directed. The Contractor shall remove all other material and equipment, devices and demolition debris under these plans and specifications. Such material shall be removed from Government property expeditiously and shall not be allowed to accumulate.

### **3.6 CLEANING AND PAINTING**

- A. Prior to final inspection and acceptance of the plant and facilities for beneficial use by the Government, the plant facilities, equipment and systems shall be thoroughly cleaned and painted. Refer to Section 09 91 00, PAINTING.
- B. In addition, the following special conditions apply:
1. Cleaning shall be thorough. Use solvents, cleaning materials and methods recommended by the manufacturers for the specific tasks. Remove all rust prior to painting and from surfaces to remain unpainted. Repair scratches, scuffs, and abrasions prior to applying prime and finish coats.
  2. Material And Equipment Not To Be Painted Includes:
    - a. Motors, controllers, control switches, and safety switches.
    - b. Control and interlock devices.
    - c. Regulators.
    - d. Pressure reducing valves.
    - e. Control valves and thermostatic elements.
    - f. Lubrication devices and grease fittings.
    - g. Copper, brass, aluminum, stainless steel and bronze surfaces.
    - h. Valve stems and rotating shafts.
    - i. Pressure gauges and thermometers.
    - j. Glass.
    - k. Name plates.
  3. Control and instrument panels shall be cleaned, damaged surfaces repaired, and shall be touched-up with matching paint obtained from panel manufacturer.
  4. Pumps, motors, steel and cast iron bases, and coupling guards shall be cleaned, and shall be touched-up with the same color as utilized by the pump manufacturer
  5. Temporary Facilities: Apply paint to surfaces that do not have existing finish coats.
  6. Paint shall withstand the following temperatures without peeling or discoloration:

- a. Condensate and feedwater -- 38 degrees C (100 degrees F) on insulation jacket surface and 120 degrees C (250 degrees F) on metal pipe surface.
  - b. Steam -- 52 degrees C (125 degrees F) on insulation jacket surface and 190 degrees C (375 degrees F) on metal pipe surface.
7. Final result shall be smooth, even-colored, even-textured factory finish on all items. Completely repaint the entire piece of equipment if necessary to achieve this.

### **3.7 IDENTIFICATION SIGNS**

- A. Provide laminated plastic signs, with engraved lettering not less than 5 mm (3/16-inch) high, designating functions, for all equipment, switches, motor controllers, relays, meters, control devices, including automatic control valves. Nomenclature and identification symbols shall correspond to that used in maintenance manual, and in diagrams specified elsewhere. Attach by chain, adhesive, or screws.
- B. Factory Built Equipment: Metal plate, securely attached, with name and address of manufacturer, serial number, model number, size, performance.
- C. Pipe Identification: Refer to Section 09 91 00, PAINTING.

### **3.8 MOTOR AND DRIVE ALIGNMENT**

- A. Belt Drive: Set driving and driven shafts parallel and align so that the corresponding grooves are in the same plane.
- B. Direct-connect Drive: Securely mount motor in accurate alignment so that shafts are free from both angular and parallel misalignment when both motor and driven machine are operating at normal temperatures.

### **3.9 LUBRICATION**

- A. Lubricate all devices requiring lubrication prior to initial operation. Field-check all devices for proper lubrication.
- B. Equip all devices with required lubrication fittings or devices. Provide a minimum of one liter (one quart) of oil and 0.5 kg (one pound) of grease of manufacturer's recommended grade and type for each different application; also provide 12 grease sticks for lubricated plug valves. Deliver all materials to Contracting Officer's Representative in unopened containers that are properly identified as to application.
- C. Provide a separate grease gun with attachments for applicable fittings for each type of grease applied.
- D. All lubrication points shall be accessible without disassembling equipment, except to remove access plates.

**3.10 COMMISSIONING**

- A. Provide commissioning documentation in accordance with the requirements of Section 23 08 00 - COMMISSIONING OF HVAC SYSTEMS for all inspection, start up, and contractor testing required above and required by the System Readiness Checklist provided by the Commissioning Agent.
- B. Components provided under this section of the specifications will be tested as part of a larger system. Refer to Section 23 08 00 - COMMISSIONING OF HVAC SYSTEMS and related sections for contractor responsibilities for system commissioning.

**3.11 STARTUP AND TEMPORARY OPERATION**

- A. Start up equipment as described in equipment specifications. Verify that vibration is within specified tolerance prior to extended operation. Temporary use of equipment is specified in Section 01 00 00, GENERAL REQUIREMENTS, Article, TEMPORARY USE OF MECHANICAL AND ELECTRICAL EQUIPMENT.

**3.12 OPERATING AND PERFORMANCE TESTS**

- A. Prior to the final inspection, perform required tests as specified in Section 01 00 00, GENERAL REQUIREMENTS and submit the test reports and records to the Contracting Officer's Representative.
- B. Should evidence of malfunction in any tested system, or piece of equipment or component part thereof, occur during or as a result of tests, make proper corrections, repairs or replacements, and repeat tests at no additional cost to the Government.
- C. When completion of certain work or system occurs at a time when final control settings and adjustments cannot be properly made to make performance tests, then make performance tests for heating systems and for cooling systems respectively during first actual seasonal use of respective systems following completion of work.

**3.13 INSTRUCTIONS TO VA PERSONNEL**

- A. Provide in accordance with Article, INSTRUCTIONS, of Section 01 00 00, GENERAL REQUIREMENTS, and Section 23 08 11, DEMONSTRATIONS AND TESTS FOR BOILER PLANT.

**3.14 CONSTRUCTION WASTE MANAGEMENT**

- A. General: Comply with Contractor's Waste Management Plan and Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- B. To the greatest extent possible, separate reusable and recyclable products from contaminated waste and debris in accordance with the Contractor's Waste Management Plan. Place recyclable and reusable products in designated containers and protect from moisture and contamination.

DEPARTMENT OF VETERANS AFFAIRS  
PALO ALTO HEALTH CARE SYSTEM  
REPLACE BUILDING 100 AHU-19

Project No.: 640-15-138

- - - E N D - - -

**SECTION 23 05 12**  
**GENERAL MOTOR REQUIREMENTS FOR HVAC AND STEAM GENERATION EQUIPMENT**

**PART 1 - GENERAL**

**1.1 DESCRIPTION:**

- A. This section specifies the furnishing, installation and connection of motors for HVAC and steam generation equipment.

**1.2 RELATED WORK:**

- A. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements common to more than one Section of Division 26.
- B. Section 26 29 11, LOW-VOLTAGE MOTOR STARTERS: Starters, control and protection for motors.
- C. Section 26 24 19, MOTOR-CONTROL CENTERS: Multiple motor control assemblies, which include motor starters.
- D. Section 23 05 11, COMMON WORK RESULTS FOR HVAC.
- E. Section 23 21 23, HYDRONIC PUMPS.
- F. Section 23 72 00, AIR-TO-AIR ENERGY RECOVERY EQUIPMENT.
- G. Section 23 74 13, PACKAGED, OUTDOOR, CENTRAL-STATION AIR-HANDLING UNITS.
- H. Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS: Requirements for commissioning, systems readiness checklists, and training.

**1.3 SUBMITTALS:**

- A. In accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, submit the following:
- B. Shop Drawings:
  - 1. Provide documentation to demonstrate compliance with drawings and specifications.
  - 2. Include electrical ratings, efficiency, bearing data, power factor, frame size, dimensions, mounting details, materials, horsepower, voltage, phase, speed (RPM), enclosure, starting characteristics, torque characteristics, code letter, full load and locked rotor current, service factor, and lubrication method.
- C. Manuals:
  - 1. Submit simultaneously with the shop drawings, companion copies of complete installation, maintenance and operating manuals, including technical data sheets and application data.
- D. Certification: Two weeks prior to final inspection, unless otherwise noted, submit four copies of the following certification to the Resident Engineer:



1. Certification that the motors have been applied, installed, adjusted, lubricated, and tested according to manufacturer published recommendations.

E. Completed System Readiness Checklists provided by the Commissioning Agent and completed by the contractor, signed by a qualified technician and dated on the date of completion, in accordance with the requirements of Section 23 08 00 COMMISSIONING OF HVAC SYSTEMS.

#### **1.4 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. National Electrical Manufacturers Association (NEMA):

MG 1-2006 Rev. 1 2009 ..Motors and Generators

MG 2-2001 Rev. 1 2007...Safety Standard for Construction and Guide for  
Selection, Installation and Use of Electric  
Motors and Generators

C. National Fire Protection Association (NFPA):

70-2008.....National Electrical Code (NEC)

D. Institute of Electrical and Electronics Engineers (IEEE):

112-04.....Standard Test Procedure for Polyphase Induction  
Motors and Generators

E. American Society of Heating, Refrigerating and Air-Conditioning  
Engineers (ASHRAE):

90.1-2007.....Energy Standard for Buildings Except Low-Rise  
Residential Buildings

## **PART 2 - PRODUCTS**

### **2.1 MOTORS:**

A. For alternating current, fractional and integral horsepower motors, NEMA Publications MG 1 and MG 2 shall apply.

B. All material and equipment furnished and installation methods shall conform to the requirements of Section 26 29 11, LOW-VOLTAGE MOTOR STARTERS; and Section 26 05 21, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW). Provide all electrical wiring, conduit, and devices necessary for the proper connection, protection and operation of the systems. Provide premium efficiency type motors as scheduled. Unless otherwise specified for a particular application, use electric motors with the following requirements.

- C. Single-phase Motors: Motors for centrifugal fans and pumps may be split phase or permanent split capacitor (PSC) type. Provide capacitor-start type for hard starting applications.
- D. Poly-phase Motors: NEMA Design B, Squirrel cage, induction type.
  - 1. Two Speed Motors: Each two-speed motor shall have two separate windings. Provide a time- delay (20 seconds minimum) relay for switching from high to low speed.
- E. Voltage ratings shall be as follows:
  - 1. Single phase:
    - a. Motors connected to 120-volt systems: 115 volts.
    - b. Motors connected to 208-volt systems: 200 volts.
    - c. Motors connected to 240 volt or 480 volt systems: 230/460 volts, dual connection.
  - 2. Three phase:
    - a. Motors connected to 208-volt systems: 200 volts.
    - b. Motors, less than 100 HP, connected to 240 volt or 480 volt systems: 208-230/460 volts, dual connection.
    - c. Motors, 100 HP or larger, connected to 240-volt systems: 230 volts.
    - d. Motors, 100 HP or larger, connected to 480-volt systems: 460 volts.
    - e. Motors connected to high voltage systems (Over 600V): Shall conform to NEMA Standards for connection to the nominal system voltage shown on the drawings.
- F. Number of phases shall be as follows:
  - 1. Motors, less than 1/2 HP: Single phase.
  - 2. Motors, 1/2 HP and larger: 3 phase.
  - 3. Exceptions:
    - a. Hermetically sealed motors.
    - b. Motors for equipment assemblies, less than 746 W (one HP), may be single phase provided the manufacturer of the proposed assemblies cannot supply the assemblies with three phase motors.
- G. Motors shall be designed for operating the connected loads continuously in a 40°C (104°F) environment, where the motors are installed, without exceeding the NEMA standard temperature rises for the motor insulation. If the motors exceed 40°C (104°F), the motors shall be rated for the actual ambient temperatures.
- H. Motor designs, as indicated by the NEMA code letters, shall be coordinated with the connected loads to assure adequate starting and running torque.

I. Motor Enclosures:

1. Shall be the NEMA types as specified and/or shown on the drawings.
2. Where the types of motor enclosures are not shown on the drawings, they shall be the NEMA types, which are most suitable for the environmental conditions where the motors are being installed.  
Enclosure requirements for certain conditions are as follows:
  - a. Motors located outdoors, indoors in wet or high humidity locations, or in unfiltered airstreams shall be totally enclosed type.
  - b. Where motors are located in an NEC 511 classified area, provide TEFC explosion proof motor enclosures.
  - c. Where motors are located in a corrosive environment, provide TEFC enclosures with corrosion resistant finish.
3. Enclosures shall be primed and finish coated at the factory with manufacturer's prime coat and standard finish.

J. Special Requirements:

1. Where motor power requirements of equipment furnished deviate from power shown on plans, provide electrical service designed under the requirements of NFPA 70 without additional time or cost to the Government.
2. Assemblies of motors, starters, controls and interlocks on factory assembled and wired devices shall be in accordance with the requirements of this specification.
3. Wire and cable materials specified in the electrical division of the specifications shall be modified as follows:
  - a. Wiring material located where temperatures can exceed 71 degrees C (160 degrees F) shall be stranded copper with Teflon FEP insulation with jacket. This includes wiring on the boilers.
  - b. Other wiring at boilers and to control panels shall be NFPA 70 designation THWN.
  - c. Provide shielded conductors or wiring in separate conduits for all instrumentation and control systems where recommended by manufacturer of equipment.
4. Select motor sizes so that the motors do not operate into the service factor at maximum required loads on the driven equipment. Motors on pumps shall be sized for non-overloading at all points on the pump performance curves.
5. Motors utilized with variable frequency drives shall be rated "inverter-duty" per NEMA Standard, MG1, Part 31.4.4.2. Provide motor

shaft grounding apparatus that will protect bearings from damage from stray currents.

- K. Additional requirements for specific motors, as indicated in the other sections listed in Article 1.2, shall also apply.
- L. Energy-Efficient Motors (Motor Efficiencies): All permanently wired polyphase motors of 746 Watts (1 HP) or more shall meet the minimum full-load efficiencies as indicated in the following table. Motors of 746 Watts or more with open, drip-proof or totally enclosed fan-cooled enclosures shall be NEMA premium efficiency type, unless otherwise indicated. Motors provided as an integral part of motor driven equipment are excluded from this requirement if a minimum seasonal or overall efficiency requirement is indicated for that equipment by the provisions of another section. Motors not specified as "premium efficiency" shall comply with the Energy Policy Act of 2005 (EPACT).

Minimum Premium Efficiencies Open Drip-Proof				Minimum Premium Efficiencies Totally Enclosed Fan-Cooled			
Rating kW (HP)	1200 RPM	1800 RPM	3600 RPM	Rating kW (HP)	1200 RPM	1800 RPM	3600 RPM
0.746 (1)	82.5%	85.5%	77.0%	0.746 (1)	82.5%	85.5%	77.0%
1.12 (1.5)	86.5%	86.5%	84.0%	1.12 (1.5)	87.5%	86.5%	84.0%
1.49 (2)	87.5%	86.5%	85.5%	1.49 (2)	88.5%	86.5%	85.5%
2.24 (3)	88.5%	89.5%	85.5%	2.24 (3)	89.5%	89.5%	86.5%
3.73 (5)	89.5%	89.5%	86.5%	3.73 (5)	89.5%	89.5%	88.5%
5.60 (7.5)	90.2%	91.0%	88.5%	5.60 (7.5)	91.0%	91.7%	89.5%
7.46 (10)	91.7%	91.7%	89.5%	7.46 (10)	91.0%	91.7%	90.2%
11.2 (15)	91.7%	93.0%	90.2%	11.2 (15)	91.7%	92.4%	91.0%
14.9 (20)	92.4%	93.0%	91.0%	14.9 (20)	91.7%	93.0%	91.0%
18.7 (25)	93.0%	93.6%	91.7%	18.7 (25)	93.0%	93.6%	91.7%
22.4 (30)	93.6%	94.1%	91.7%	22.4 (30)	93.0%	93.6%	91.7%
29.8 (40)	94.1%	94.1%	92.4%	29.8 (40)	94.1%	94.1%	92.4%
37.3 (50)	94.1%	94.5%	93.0%	37.3 (50)	94.1%	94.5%	93.0%
44.8 (60)	94.5%	95.0%	93.6%	44.8 (60)	94.5%	95.0%	93.6%
56.9 (75)	94.5%	95.0%	93.6%	56.9 (75)	94.5%	95.4%	93.6%
74.6 (100)	95.0%	95.4%	93.6%	74.6 (100)	95.0%	95.4%	94.1%
93.3 (125)	95.0%	95.4%	94.1%	93.3 (125)	95.0%	95.4%	95.0%
112 (150)	95.4%	95.8%	94.1%	112 (150)	95.8%	95.8%	95.0%
149.2 (200)	95.4%	95.8%	95.0%	149.2 (200)	95.8%	96.2%	95.4%

- M. Minimum Power Factor at Full Load and Rated Voltage: 90 percent at 1200 RPM, 1800 RPM and 3600 RPM.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION:**

Install motors in accordance with manufacturer's recommendations, the NEC, NEMA, as shown on the drawings and/or as required by other sections of these specifications.

#### **3.2 FIELD TESTS**

- A. Perform an electric insulation resistance Test using a megohmmeter on all motors after installation, before start-up. All shall test free from grounds.
- B. Perform Load test in accordance with ANSI/IEEE 112, Test Method B, to determine freedom from electrical or mechanical defects and compliance with performance data.
- C. Insulation Resistance: Not less than one-half meg-ohm between stator conductors and frame, to be determined at the time of final inspection.

#### **3.3 STARTUP AND TESTING**

- A. The Commissioning Agent will observe startup and contractor testing of selected equipment. Coordinate the startup and contractor testing schedules with Resident Engineer and Commissioning Agent. Provide a minimum of 7 days prior notice.

#### **3.4 COMMISSIONING**

- A. Provide commissioning documentation in accordance with the requirements of Section 23 08 00 - COMMISSIONING OF HVAC SYSTEMS for all inspection, start up, and contractor testing required above and required by the System Readiness Checklist provided by the Commissioning Agent.
- B. Components provided under this section of the specification will be tested as part of a larger system. Refer to Section 23 08 00 - COMMISSIONING OF HVAC SYSTEMS and related sections for contractor responsibilities for system commissioning.

#### **3.5 DEMONSTRATION AND TRAINING**

- A. Provide services of manufacturer's technical representative for four hours to instruct VA personnel in operation and maintenance of units.
- B. Submit training plans and instructor qualifications in accordance with the requirements of Section 23 08 00 - COMMISSIONING OF HVAC SYSTEMS.

- - - E N D - - -

**SECTION 23 05 41**  
**NOISE AND VIBRATION CONTROL FOR HVAC PIPING AND EQUIPMENT**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. Noise criteria, seismic restraints for equipment, vibration tolerance and vibration isolation for HVAC and plumbing work.

**1.2 RELATED WORK**

- A. Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS: Seismic requirements for non-structural equipment
- B. Section 23 05 11, COMMON WORK RESULTS FOR HVAC: General mechanical requirements and items, which are common to more than one section of Division 23.
- C. Section 23 22 13, STEAM and CONDENSATE HEATING PIPING: Requirements for flexible pipe connectors to reciprocating and rotating mechanical equipment.
- D. Section 23 31 00, HVAC DUCTS and CASINGS: requirements for flexible duct connectors, sound attenuators and sound absorbing duct lining.
- E. SECTION 23 05 93, TESTING, ADJUSTING, and BALANCING FOR HVAC: requirements for sound and vibration tests.
- F. SECTION 23 21 23, HYDRONIC PUMPS: vibration isolation requirements for pumps.
- G. Section 23 74 13, PACKAGED, OUTDOOR CENTRAL STATION AIR HANDLING UNITS
- H. Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS: Requirements for commissioning, systems readiness checklists, and training.

**1.3 QUALITY ASSURANCE**

- A. Refer to article, QUALITY ASSURANCE in specification Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.
- B. Noise Criteria:
1. Noise levels in all 8 octave bands due to equipment and duct systems shall not exceed following NC levels:

TYPE OF ROOM	NC LEVEL
Bathrooms and Toilet Rooms	40
Conference Rooms	35
Corridors (Nurse Stations)	40
Corridors(Public)	40
Examination Rooms	35

Gymnasiums	50
Lobbies, Waiting Areas	40
Locker Rooms	45
Offices, Large Open	40
Offices, Small Private	35
Operating Rooms	40
Patient Rooms	35
Recreation Rooms	40-45
SPD (Decontamination and Clean Preparation)	45
Therapeutic Pools	45
Treatment Rooms	35
X-Ray and General Work Rooms	40

2. For equipment which has no sound power ratings scheduled on the plans, the contractor shall select equipment such that the foregoing noise criteria, local ordinance noise levels, and OSHA requirements are not exceeded. Selection procedure shall be in accordance with ASHRAE Fundamentals Handbook, Chapter 7, Sound and Vibration.
3. An allowance, not to exceed 5db, may be added to the measured value to compensate for the variation of the room attenuating effect between room test condition prior to occupancy and design condition after occupancy which may include the addition of sound absorbing material, such as, furniture. This allowance may not be taken after occupancy. The room attenuating effect is defined as the difference between sound power level emitted to room and sound pressure level in room.
4. In absence of specified measurement requirements, measure equipment noise levels three feet from equipment and at an elevation of maximum noise generation.

C. Seismic Restraint Requirements:

1. Equipment:
  - a. All mechanical equipment not supported with isolators external to the unit shall be securely anchored to the structure. Such mechanical equipment shall be properly supported to resist a horizontal force of 50 percent of the weight of the equipment furnished.

- b. All mechanical equipment mounted on vibration isolators shall be provided with seismic restraints capable of resisting a horizontal force of 100 percent of the weight of the equipment furnished.
- 2. Piping: Refer to specification Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.
- 3. Ductwork: Refer to specification Section 23 31 00, HVAC DUCTS AND CASINGS.
- D. Allowable Vibration Tolerances for Rotating, Non-reciprocating Equipment: Not to exceed a self-excited vibration maximum velocity of 5 mm per second (0.20 inch per second) RMS, filter in, when measured with a vibration meter on bearing caps of machine in vertical, horizontal and axial directions or measured at equipment mounting feet if bearings are concealed. Measurements for internally isolated fans and motors may be made at the mounting feet.

#### 1.4 SUBMITTALS

- A. Submit in accordance with specification Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- B. Manufacturer's Literature and Data:
  - 1. Vibration isolators:
    - a. Floor mountings
    - b. Hangers
    - c. Snubbers
    - d. Thrust restraints
  - 2. Bases.
  - 3. Seismic restraint provisions and bolting.
- C. Isolator manufacturer shall furnish with submittal load calculations for selection of isolators, including supplemental bases, based on lowest operating speed of equipment supported.
- D. Seismic Requirements: Submittals are required for all equipment anchors, supports and seismic restraints. Submittals shall include weights, dimensions, standard connections, and manufacturer's certification that all specified equipment will withstand seismic Lateral Force requirements as shown on drawings.



## 1.5 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, Inc. (ASHRAE):  
2009 .....Fundamentals Handbook, Chapter 7, Sound and Vibration
- C. American Society for Testing and Materials (ASTM):  
A123/A123M-09.....Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products  
A307-07b.....Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength  
D2240-05(2010).....Standard Test Method for Rubber Property - Durometer Hardness
- D. Manufacturers Standardization (MSS):  
SP-58-2009.....Pipe Hangers and Supports-Materials, Design and Manufacture
- E. Occupational Safety and Health Administration (OSHA):  
29 CFR 1910.95.....Occupational Noise Exposure
- F. American Society of Civil Engineers (ASCE):  
ASCE 7-10 .....Minimum Design Loads for Buildings and Other Structures.
- G. American National Standards Institute / Sheet Metal and Air Conditioning Contractor's National Association (ANSI/SMACNA):  
001-2008.....Seismic Restraint Manual: Guidelines for Mechanical Systems, 3rd Edition.
- H. International Code Council (ICC):  
2009 IBC.....International Building Code.
- I. Department of Veterans Affairs (VA):  
H-18-8 2010.....Seismic Design Requirements.

## PART 2 - PRODUCTS

### 2.1 GENERAL REQUIREMENTS

- A. Type of isolator, base, and minimum static deflection shall be as required for each specific equipment application as recommended by isolator or equipment manufacturer but subject to minimum requirements indicated herein and in the schedule on the drawings.

- B. Elastometric Isolators shall comply with ASTM D2240 and be oil resistant neoprene with a maximum stiffness of 60 durometer and have a straight-line deflection curve.
- C. Exposure to weather: Isolator housings to be either hot dipped galvanized or powder coated to ASTM B117 salt spray testing standards. Springs to be powder coated or electro galvanized. All hardware to be electro galvanized. In addition provide limit stops to resist wind velocity. Velocity pressure established by wind shall be calculated in accordance with section 1609 of the International Building Code. A minimum wind velocity of 75 mph shall be employed.
- D. Uniform Loading: Select and locate isolators to produce uniform loading and deflection even when equipment weight is not evenly distributed.
- E. Color code isolators by type and size for easy identification of capacity.

## **2.2 SEISMIC RESTRAINT REQUIREMENTS FOR EQUIPMENTS**

- A. Bolt pad mounted equipment, without vibration isolators, to the floor or other support using ASTM A307 standard bolting material.
- B. Floor mounted equipment, with vibration Isolators: Type SS. Where Type N isolators are used provide channel frame base horizontal restraints bolted to the floor, or other support, on all sides of the equipment. Size and material required for the base shall be as recommended by the isolator manufacturer.
- C. On all sides of suspended equipment, provide bracing for rigid supports and provide restraints for resiliently supported equipment.

## **2.3 VIBRATION ISOLATORS**

- A. Floor Mountings:
  - 1. Spring Isolators (Type S): Shall be free-standing, laterally stable and include acoustical friction pads and leveling bolts. Isolators shall have a minimum ratio of spring diameter-to-operating spring height of 1.0 and an additional travel to solid equal to 50 percent of rated deflection.
  - 2. Captive Spring Mount for Seismic Restraint (Type SS):
    - a. Design mounts to resiliently resist seismic forces in all directions. Snubbing shall take place in all modes with adjustment to limit upward, downward, and horizontal travel to a maximum of 6 mm (1/4-inch) before contacting snubbers. Mountings shall have a

- minimum rating of one G coefficient of gravity as calculated and certified by a registered structural engineer.
- b. All mountings shall have leveling bolts that must be rigidly bolted to the equipment. Spring diameters shall be no less than 0.8 of the compressed height of the spring at rated load. Springs shall have a minimum additional travel to solid equal to 50 percent of the rated deflection. Mountings shall have ports for spring inspection. Provide an all directional neoprene cushion collar around the equipment bolt.
  3. Spring Isolators with Vertical Limit Stops (Type SP): Similar to spring isolators noted above, except include a vertical limit stop to limit upward travel if weight is removed and also to reduce movement and spring extension due to wind loads. Provide clearance around restraining bolts to prevent mechanical short circuiting.
  4. Pads (Type D), Washers (Type W), and Bushings (Type L): Pads shall be natural rubber or neoprene waffle, neoprene and steel waffle, or reinforced duct and neoprene. Washers and bushings shall be reinforced duct and neoprene. Size pads for a maximum load of 345 kPa (50 pounds per square inch).
  5. Seismic Pad (Type DS): Pads shall be natural rubber / neoprene waffle with steel top plate and drilled for an anchor bolt. Washers and bushings shall be reinforced duct and neoprene. Size pads for a maximum load of 345 kPa (50 pounds per square inch).
- B. Hangers: Shall be combination neoprene and springs unless otherwise noted and shall allow for expansion of pipe.
1. Combination Neoprene and Spring (Type H): Vibration hanger shall contain a spring and double deflection neoprene element in series. Spring shall have a diameter not less than 0.8 of compressed operating spring height. Spring shall have a minimum additional travel of 50 percent between design height and solid height. Spring shall permit a 15 degree angular misalignment without rubbing on hanger box.
  2. Neoprene (Type HN): Vibration hanger shall contain a double deflection type neoprene isolation element. Hanger rod shall be separated from contact with hanger bracket by a neoprene grommet.
  3. Spring (Type HS): Vibration hanger shall contain a coiled steel spring in series with a neoprene grommet. Spring shall have a

- diameter not less than 0.8 of compressed operating spring height. Spring shall have a minimum additional travel of 50 percent between design height and solid height. Spring shall permit a 15 degree angular misalignment without rubbing on hanger box.
4. Hanger supports for piping 50 mm (2 inches) and larger shall have a pointer and scale deflection indicator.
  5. Hangers used in seismic applications shall be provided with a neoprene and steel rebound washer installed  $\frac{1}{4}$ ' clear of bottom of hanger housing in operation to prevent spring from excessive upward travel
- C. Snubbers: Each spring mounted base shall have a minimum of four all-directional or eight two directional (two per side) seismic snubbers that are double acting. Elastomeric materials shall be shock absorbent neoprene bridge quality bearing pads, maximum 60 durometer, replaceable and have a minimum thickness of 6 mm (1/4 inch). Air gap between hard and resilient material shall be not less than 3 mm (1/8 inch) nor more than 6 mm (1/4 inch). Restraints shall be capable of withstanding design load without permanent deformation.

#### **2.4 BASES**

- A. Integral Structural Steel Base (Type B): Design base with isolator brackets to reduce mounting height of equipment which require a complete supplementary rigid base. To assure adequate stiffness, height of members shall be a minimum of 1/12 of longest base dimension, but not less than 100 mm (four inches).

#### **2.4 SOUND ATTENUATING UNITS**

- A. Refer to specification Section 23 31 00, HVAC DUCTS and CASINGS.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

- A. Vibration Isolation:
  1. No metal-to-metal contact will be permitted between fixed and floating parts.
  2. Connections to Equipment: Allow for deflections equal to or greater than equipment deflections. Electrical, drain, piping connections, and other items made to rotating or reciprocating equipment (pumps, compressors, etc.) which rests on vibration isolators, shall be isolated from building structure for first three hangers or supports with a deflection equal to that used on the corresponding equipment.

3. Common Foundation: Mount each electric motor on same foundation as driven machine. Hold driving motor and driven machine in positive rigid alignment with provision for adjusting motor alignment and belt tension. Bases shall be level throughout length and width. Provide shims to facilitate pipe connections, leveling, and bolting.
  4. Provide heat shields where elastomers are subject to temperatures over 38 degrees C (100 degrees F).
  5. Extend bases for pipe elbow supports at discharge and suction connections at pumps. Pipe elbow supports shall not short circuit pump vibration to structure.
  6. Non-rotating equipment such as heat exchangers and convertors shall be mounted on isolation units having the same static deflection as the isolation hangers or support of the pipe connected to the equipment.
- B. Inspection and Adjustments: Check for vibration and noise transmission through connections, piping, ductwork, foundations, and walls. Adjust, repair, or replace isolators as required to reduce vibration and noise transmissions to specified levels.

### **3.2 ADJUSTING**

- A. Adjust vibration isolators after piping systems are filled and equipment is at operating weight.
- B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.
- C. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4inch (6-mm) movement during start and stop.
- D. Adjust active height of spring isolators.
- E. Adjust snubbers according to manufacturer's recommendations.
- F. Adjust seismic restraints to permit free movement of equipment within normal mode of operation.
- G. Torque anchor bolts according to equipment manufacturer's recommendations to resist seismic forces.

### **3.3 COMMISSIONING**

- A. Provide commissioning documentation in accordance with the requirements of section 23 08 00 - COMMISSIONING OF HVAC SYSTEMS for all inspection, start up, and contractor testing required above and required by the System Readiness Checklist provided by the Commissioning Agent.

B. Components provided under this section of the specification will be tested as part of a larger system. Refer to section 23 08 00 - COMMISSIONING OF HVAC SYSTEMS and related sections for contractor responsibilities for system commissioning.

- - - E N D - - -

**SELECTION GUIDE FOR VIBRATION ISOLATORS**

EQUIPMENT		ON GRADE			20FT FLOOR SPAN			30FT FLOOR SPAN			40FT FLOOR SPAN			50FT FLOOR SPAN		
		BASE TYPE	ISOL TYPE	MIN DEFL	BASE TYPE	ISOL TYPE	MIN DEFL	BASE TYPE	ISOL TYPE	MIN DEFL	BASE TYPE	ISOL TYPE	MIN DEFL	BASE TYPE	ISOL TYPE	MIN DEFL
<b>PUMPS</b>																
CLOSE COUPLED	UP TO 1-1/2 HP	---	---	---	---	D,L, W	---	---	D,L, W	---	---	D,L, W	---	---	D,L, W	---
	2 HP & OVER	---	---	---	---	SS	0.8	---	SS	1.5	---	SS	1.5	---	SS	2.0
BASE MOUNTED	UP TO 10 HP	---	---	---	---	D,L, W	---	---	D,L, W	---	---	D,L, W	---	---	D,L, W	---
	15 HP THRU 40 HP	---	---	---	I	S	1.0	I	S	2.0	I	S	2.0	I	S	2.0
<b>ROOF FANS</b>																
ABOVE OCCUPIED AREAS:																
5 HP & OVER		---	---	---	CB	S	1.0	CB	S	1.0	CB	S	1.0	CB	S	1.0
<b>CENTRIFUGAL FANS</b>																

EQUIPMENT	ON GRADE			20FT FLOOR SPAN			30FT FLOOR SPAN			40FT FLOOR SPAN			50FT FLOOR SPAN		
	BASE TYPE	ISOL TYPE	MIN DEFL	BASE TYPE	ISOL TYPE	MIN DEFL	BASE TYPE	ISOL TYPE	MIN DEFL	BASE TYPE	ISOL TYPE	MIN DEFL	BASE TYPE	ISOL TYPE	MIN DEFL
UP TO 50 HP:															
UP TO 200 RPM	B	N	0.3	B	S	2.5	B	S	2.5	B	S	3.5	B	S	3.5
201 - 300 RPM	B	N	0.3	B	S	2.0	B	S	2.5	B	S	2.5	B	S	3.5
301 - 500 RPM	B	N	0.3	B	S	2.0	B	S	2.0	B	S	2.5	B	S	3.5
501 RPM & OVER	B	N	0.3	B	S	2.0	B	S	2.0	B	S	2.0	B	S	2.5

**NOTES:**

1. Edit the Table above to suit where isolator, other than those shown, are used, such as for seismic restraints and position limit stops.
2. For suspended floors lighter than 100 mm (4 inch) thick concrete, select deflection requirements from next higher span.
3. For separate chiller building on grade, pump isolators may be omitted.
4. Direct bolt fire pumps to concrete base. Provide pads (D) for domestic water booster pump package.
5. For projects in seismic areas, use only SS & DS type isolators and snubbers.
6. For floor mounted in-line centrifugal blowers (ARR 1): use "B" type in lieu of "R" type base.
7. Suspended: Use "H" isolators of same deflection as floor mounted.



**SECTION 23 05 93**  
**TESTING, ADJUSTING, AND BALANCING FOR HVAC**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

A. Testing, adjusting, and balancing (TAB) of heating, ventilating and air conditioning (HVAC) systems. TAB includes the following:

1. Planning systematic TAB procedures.
2. Design Review Report.
3. Systems Inspection report.
4. Duct Air Leakage test report.
5. Systems Readiness Report.
6. Balancing air and water distribution systems; adjustment of total system to provide design performance; and testing performance of equipment and automatic controls.
7. Vibration and sound measurements.
8. Recording and reporting results.

B. Definitions:

1. Basic TAB used in this Section: Chapter 37, "Testing, Adjusting and Balancing" of 2007 ASHRAE Handbook, "HVAC Applications".
2. TAB: Testing, Adjusting and Balancing; the process of checking and adjusting HVAC systems to meet design objectives.
3. AABC: Associated Air Balance Council.
4. NEBB: National Environmental Balancing Bureau.
5. Hydronic Systems: Includes chilled water, heating hot water and heat recovery water systems.
6. Air Systems: Includes all outside air, supply air, return air, and exhaust air systems.
7. Flow rate tolerance: The allowable percentage variation, minus to plus, of actual flow rate from values (design) in the contract documents.

**1.2 RELATED WORK**

- A. Section 23 05 11, COMMON WORK RESULTS FOR HVAC: General Mechanical Requirements.
- B. Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING AND EQUIPMENT: Noise and Vibration Requirements.
- C. Section 23 07 11, HVAC, PLUMBING, AND BOILER PLANT INSULATION: Piping and Equipment Insulation.

- D. Section 23 31 00, HVAC DUCTS AND CASINGS: Duct Leakage.
- E. Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC: Controls and Instrumentation Settings.
- F. Section 23 82 16, AIR COILS
- G. Section 23 74 13, PACKAGED, OUTDOOR, CENTRAL-STATION AIR-HANDLING UNITS
- H. Section 23 21 23, HYDRONIC PUMPS
- I. Section 23 21 13, HYDRONIC PIPING
- J. Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS. Requirements for commissioning, systems readiness checklists, and training
- K. Section 23 05 12 GENERAL MOTOR REQUIREMENTS FOR HVAC AND STEAM GENERATION EQUIPMENT

### **1.3 QUALITY ASSURANCE**

- A. Refer to Articles, Quality Assurance and Submittals, in Section 23 05 11, COMMON WORK RESULTS FOR HVAC, Section 23 05 10, COMMON WORK RESULTS FOR BOILER PLANTS and STEAM GENERATION, and Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.
- B. Qualifications:
  - 1. TAB Agency: The TAB agency shall be a subcontractor of the General Contractor and shall report to and be paid by the General Contractor.
  - 2. The TAB agency shall be either a certified member of AABC or certified by the NEBB to perform TAB service for HVAC, water balancing and vibrations and sound testing of equipment. The certification shall be maintained for the entire duration of duties specified herein. If, for any reason, the agency loses subject certification during this period, the General Contractor shall immediately notify the Resident Engineer and submit another TAB firm for approval. Any agency that has been the subject of disciplinary action by either the AABC or the NEBB within the five years preceding Contract Award shall not be eligible to perform any work related to the TAB. All work performed in this Section and in other related Sections by the TAB agency shall be considered invalid if the TAB agency loses its certification prior to Contract completion, and the successor agency's review shows unsatisfactory work performed by the predecessor agency.
  - 3. TAB Specialist: The TAB specialist shall be either a member of AABC or an experienced technician of the Agency certified by NEBB. The

- certification shall be maintained for the entire duration of duties specified herein. If, for any reason, the Specialist loses subject certification during this period, the General Contractor shall immediately notify the Resident Engineer and submit another TAB Specialist for approval. Any individual that has been the subject of disciplinary action by either the AABC or the NEBB within the five years preceding Contract Award shall not be eligible to perform any duties related to the HVAC systems, including TAB. All work specified in this Section and in other related Sections performed by the TAB specialist shall be considered invalid if the TAB Specialist loses its certification prior to Contract completion and must be performed by an approved successor.
4. TAB Specialist shall be identified by the General Contractor within 60 days after the notice to proceed. The TAB specialist will be coordinating, scheduling and reporting all TAB work and related activities and will provide necessary information as required by the Resident Engineer. The responsibilities would specifically include:
- a. Shall directly supervise all TAB work.
  - b. Shall sign the TAB reports that bear the seal of the TAB standard. The reports shall be accompanied by report forms and schematic drawings required by the TAB standard, AABC or NEBB.
  - c. Would follow all TAB work through its satisfactory completion.
  - d. Shall provide final markings of settings of all HVAC adjustment devices.
  - e. Permanently mark location of duct test ports.
5. All TAB technicians performing actual TAB work shall be experienced and must have done satisfactory work on a minimum of 3 projects comparable in size and complexity to this project. Qualifications must be certified by the TAB agency in writing. The lead technician shall be certified by AABC or NEBB
- C. Test Equipment Criteria: The instrumentation shall meet the accuracy/calibration requirements established by AABC National Standards or by NEBB Procedural Standards for Testing, Adjusting and Balancing of Environmental Systems and instrument manufacturer. Provide calibration history of the instruments to be used for test and balance purpose.
- D. Tab Criteria:

1. One or more of the applicable AABC, NEBB or SMACNA publications, supplemented by ASHRAE Handbook "HVAC Applications" Chapter 36, and requirements stated herein shall be the basis for planning, procedures, and reports.
2. Flow rate tolerance: Following tolerances are allowed. For tolerances not mentioned herein follow ASHRAE Handbook "HVAC Applications", Chapter 36, as a guideline. Air Filter resistance during tests, artificially imposed if necessary, shall be at least 100 percent of manufacturer recommended change over pressure drop values for pre-filters and after-filters.
  - a. Air handling unit and all other fans, cubic meters/min (cubic feet per minute): Minus 0 percent to plus 10 percent.
  - b. Air terminal units (maximum values): Minus 2 percent to plus 10 percent.
  - c. Minimum outside air: 0 percent to plus 10 percent.
  - d. Individual room air outlets and inlets, and air flow rates not mentioned above: Minus 5 percent to plus 10 percent except if the air to a space is 100 CFM or less the tolerance would be minus 5 to plus 5 percent.
  - e. Heating hot water and heat recovery pumps, and hot water heat recovery coils: Minus 5 percent to plus 5 percent.
  - f. Chilled water pumps: Minus 0 percent to plus 5 percent.
  - g. Chilled water coils: Minus 0 percent to plus 5 percent.
3. Systems shall be adjusted for energy efficient operation as described in PART 3.
4. Typical TAB procedures and results shall be demonstrated to the Resident Engineer for one air distribution system (including all fans, three terminal units, three rooms randomly selected by the Resident Engineer) and one hydronic system (pumps and three coils) as follows:
  - a. When field TAB work begins.
  - b. During each partial final inspection and the final inspection for the project if requested by VA.

#### **1.4 SUBMITTALS**

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

- B. Submit names and qualifications of TAB agency and TAB specialists within 60 days after the notice to proceed. Submit information on three recently completed projects and a list of proposed test equipment.
- C. For use by the Resident Engineer staff, submit one complete set of applicable AABC or NEBB publications that will be the basis of TAB work.
- D. Submit Following for Review and Approval:
  - 1. Design Review Report within 90 days for conventional design projects after the system layout on air and water side is completed by the Contractor.
  - 2. Systems inspection report on equipment and installation for conformance with design.
  - 3. Duct Air Leakage Test Report.
  - 4. Systems Readiness Report.
  - 5. Intermediate and Final TAB reports covering flow balance and adjustments, performance tests, vibration tests and sound tests.
  - 6. Include in final reports uncorrected installation deficiencies noted during TAB and applicable explanatory comments on test results that differ from design requirements.
- E. Prior to request for Final or Partial Final inspection, submit completed Test and Balance report for the area.

#### **1.5 APPLICABLE PUBLICATIONS**

- A. The following publications form a part of this specification to the extent indicated by the reference thereto. In text the publications are referenced to by the acronym of the organization.
- B. American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc. (ASHRAE):
  - 2007 .....HVAC Applications ASHRAE Handbook, Chapter 37, Testing, Adjusting, and Balancing and Chapter 47, Sound and Vibration Control
- C. Associated Air Balance Council (AABC):
  - 2002.....AABC National Standards for Total System Balance
- D. National Environmental Balancing Bureau (NEBB):
  - 7<sup>th</sup> Edition 2005 .....Procedural Standards for Testing, Adjusting, Balancing of Environmental Systems

2nd Edition 2006 .....Procedural Standards for the Measurement of  
Sound and Vibration

3<sup>rd</sup> Edition 2009 .....Procedural Standards for Whole Building Systems  
Commissioning of New Construction

E. Sheet Metal and Air Conditioning Contractors National Association  
(SMACNA):

3<sup>rd</sup> Edition 2002 .....HVAC SYSTEMS Testing, Adjusting and Balancing

## **PART 2 - PRODUCTS**

### **2.1 PLUGS**

A. Provide plastic plugs to seal holes drilled in ductwork for test purposes.

### **2.2 INSULATION REPAIR MATERIAL**

A. See Section 23 07 11, HVAC and BOILER PLANT INSULATION Provide for repair of insulation removed or damaged for TAB work.

## **PART 3 - EXECUTION**

### **3.1 GENERAL**

- A. Refer to TAB Criteria in Article, Quality Assurance.
- B. Obtain applicable contract documents and copies of approved submittals for HVAC equipment and automatic control systems.

### **3.2 DESIGN REVIEW REPORT**

A. The TAB Specialist shall review the Contract Plans and specifications and advise the Resident Engineer of any design deficiencies that would prevent the HVAC systems from effectively operating in accordance with the sequence of operation specified or prevent the effective and accurate TAB of the system. The TAB Specialist shall provide a report individually listing each deficiency and the corresponding proposed corrective action necessary for proper system operation.

### **3.3 SYSTEMS INSPECTION REPORT**

- A. Inspect equipment and installation for conformance with design.
- B. The inspection and report is to be done after air distribution equipment is on site and duct installation has begun, but well in advance of performance testing and balancing work. The purpose of the inspection is to identify and report deviations from design and ensure that systems will be ready for TAB at the appropriate time.
- C. Reports: Follow check list format developed by AABC, NEBB or SMACNA, supplemented by narrative comments, with emphasis on air handling units and fans. Check for conformance with submittals. Verify that diffuser

and register sizes are correct. Check air terminal unit installation including their duct sizes and routing.

### **3.4 DUCT AIR LEAKAGE TEST REPORT**

- A. TAB Agency shall perform the leakage test as outlined in "Duct leakage Tests and Repairs" in Section 23 31 00, HVAC DUCTS and CASINGS for TAB agency's role and responsibilities in witnessing, recording and reporting of deficiencies.

### **3.5 SYSTEM READINESS REPORT**

- A. The TAB Contractor shall measure existing air and water flow rates associated with existing systems utilized to serve renovated areas as indicated on drawings. Submit report of findings to resident engineer.
- B. Inspect each System to ensure that it is complete including installation and operation of controls. Submit report to RE in standard format and forms prepared and or approved by the Commissioning Agent.
- C. Verify that all items such as ductwork piping, ports, terminals, connectors, etc., that is required for TAB are installed. Provide a report to the Resident Engineer.

### **3.6 TAB REPORTS**

- A. Submit an intermediate report for 50 percent of systems and equipment tested and balanced to establish satisfactory test results.
- B. The TAB contractor shall provide raw data immediately in writing to the Resident Engineer if there is a problem in achieving intended results before submitting a formal report.
- C. If over 20 percent of readings in the intermediate report fall outside the acceptable range, the TAB report shall be considered invalid and all contract TAB work shall be repeated and re-submitted for approval at no additional cost to the owner.
- D. Do not proceed with the remaining systems until intermediate report is approved by the Resident Engineer.

### **3.7 TAB PROCEDURES**

- A. Tab shall be performed in accordance with the requirement of the Standard under which TAB agency is certified by either AABC or NEBB.
- B. General: During TAB all related system components shall be in full operation. Fan and pump rotation, motor loads and equipment vibration shall be checked and corrected as necessary before proceeding with TAB. Set controls and/or block off parts of distribution systems to simulate

design operation of variable volume air or water systems for test and balance work.

- C. Coordinate TAB procedures with existing systems and any phased construction completion requirements for the project. Provide TAB reports for pre construction air and water flow rate and for each phase of the project prior to partial final inspections of each phase of the project. Return existing areas outside the work area to pre constructed conditions.
- D. Allow 15 days time in construction schedule for TAB and submission of all reports for an organized and timely correction of deficiencies.
- E. Air Balance and Equipment Test: Include air handling units, fans, terminal units, and room diffusers/outlets/inlets.
  - 1. Artificially load air filters by partial blanking to produce air pressure drop of manufacturer's recommended pressure drop.
  - 2. Adjust fan speeds to provide design air flow. V-belt drives, including fixed pitch pulley requirements, are specified in Section 23 05 11, COMMON WORK RESULTS FOR HVAC.
  - 3. Test and balance systems in all specified modes of operation, including variable volume, economizer, and fire emergency modes. Verify that dampers and other controls function properly.
  - 4. Variable air volume (VAV) systems:
    - a. Coordinate TAB, including system volumetric controls, with Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC.
    - b. Section 23 36 00, AIR TERMINAL UNITS, specifies that maximum and minimum flow rates for air terminal units (ATU) be factory set. Check and readjust ATU flow rates if necessary. Balance air distribution from ATU on full cooling maximum scheduled cubic meters per minute (cubic feet per minute). Reset room thermostats and check ATU operation from maximum to minimum cooling, to the heating mode, and back to cooling. Record and report the heating coil leaving air temperature when the ATU is in the maximum heating mode. Record and report outdoor air flow rates under all operating conditions (The test shall demonstrate that the minimum outdoor air ventilation rate shall remain constant under all operating conditions).
    - c. Adjust operating pressure control setpoint to maintain the design flow to each space with the lowest setpoint.



5. Record final measurements for air handling equipment performance data sheets.
- F. Water Balance and Equipment Test: Include circulating pumps, and coils:
  1. Coordinate water chiller flow balancing with Section 23 64 00, PACKAGED WATER CHILLERS.
  2. Adjust flow rates for equipment. Set coils and evaporator to values on equipment submittals, if different from values on contract drawings.
  3. Primary only variable volume systems: Coordinate TAB with Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC. Balance systems at design water flow and then verify that variable flow controls function as designed.
  4. Record final measurements for hydronic equipment on performance data sheets. Include entering and leaving water temperatures for heating and cooling coils, and for convertors. Include entering and leaving air temperatures (DB/WB for cooling coils) for air handling units and reheat coils. Make air and water temperature measurements at the same time.

### **3.8 VIBRATION TESTING**

- A. Furnish instruments and perform vibration measurements as specified in Section 23 05 41, NOISE and VIBRATION CONTROL FOR HVAC PIPING and EQUIPMENT. Field vibration balancing is specified in Section 23 05 11, COMMON WORK RESULTS FOR HVAC. Provide measurements for all rotating HVAC equipment of 373 watts (1/2 horsepower) and larger, including centrifugal/screw compressors, cooling towers, pumps, fans and motors.
- B. Record initial measurements for each unit of equipment on test forms and submit a report to the Resident Engineer. Where vibration readings exceed the allowable tolerance Contractor shall be directed to correct the problem. The TAB agency shall verify that the corrections are done and submit a final report to the Resident Engineer.

### **3.9 SOUND TESTING**

- A. Perform and record required sound measurements in accordance with Paragraph, QUALITY ASSURANCE in Section 23 05 41, NOISE and VIBRATION CONTROL FOR HVAC PIPING and EQUIPMENT.
  1. Take readings in rooms, approximately ten percent of all rooms. The Resident Engineer may designate the specific rooms to be tested.

- B. Take measurements with a calibrated sound level meter and octave band analyzer of the accuracy required by AABC or NEBB.
- C. Sound reference levels, formulas and coefficients shall be according to ASHRAE Handbook, "HVAC Applications", Chapter 46, SOUND AND VIBRATION CONTROL.
- D. Determine compliance with specifications as follows:
  - 1. When sound pressure levels are specified, including the NC Criteria in Section 23 05 41, NOISE and VIBRATION CONTROL FOR HVAC PIPING and EQUIPMENT:
    - a. Reduce the background noise as much as possible by shutting off unrelated audible equipment.
    - b. Measure octave band sound pressure levels with specified equipment "off."
    - c. Measure octave band sound pressure levels with specified equipment "on."
    - d. Use the DIFFERENCE in corresponding readings to determine the sound pressure due to equipment.

DIFFERENCE:	0	1	2	3	4	5 to 9	10 or More
FACTOR:	10	7	4	3	2	1	0

Sound pressure level due to equipment equals sound pressure level with equipment "on" minus FACTOR.

- e. Plot octave bands of sound pressure level due to equipment for typical rooms on a graph which also shows noise criteria (NC) curves.
- 2. When sound power levels are specified:
  - a. Perform steps 1.a. thru 1.d., as above.
  - b. For indoor equipment: Determine room attenuating effect, i.e., difference between sound power level and sound pressure level. Determined sound power level will be the sum of sound pressure level due to equipment plus the room attenuating effect.
  - c. For outdoor equipment: Use directivity factor and distance from noise source to determine distance factor, i.e., difference between sound power level and sound pressure level. Measured sound power level will be the sum of sound pressure level due to equipment plus the distance factor. Use 10 meters (30 feet) for sound level location.

3. Where sound pressure levels are specified in terms of dB(A), measure sound levels using the "A" scale of meter. Single value readings will be used instead of octave band analysis.

- E. Where measured sound levels exceed specified level, the installing contractor or equipment manufacturer shall take remedial action approved by the Resident Engineer and the necessary sound tests shall be repeated.
- F. Test readings for sound testing could go higher than 15 percent if determination is made by the Resident Engineer based on the recorded sound data.

### **3.10 MARKING OF SETTINGS**

- A. Following approval of Tab final Report, the setting of all HVAC adjustment devices including valves, splitters and dampers shall be permanently marked by the TAB Specialist so that adjustment can be restored if disturbed at any time. Style and colors used for markings shall be coordinated with the Resident Engineer.

### **3.11 IDENTIFICATION OF TEST PORTS**

- A. The TAB Specialist shall permanently and legibly identify the location points of duct test ports. If the ductwork has exterior insulation, the identification shall be made on the exterior side of the insulation. All penetrations through ductwork and ductwork insulation shall be sealed to prevent air leaks and maintain integrity of vapor barrier.

### **3.12 PHASING**

- A. Phased Projects: Testing and Balancing Work to follow project with areas shall be completed per the project phasing. Upon completion of the project all areas shall have been tested and balanced per the contract documents.
- B. Existing Areas: Systems that serve areas outside of the project scope shall not be adversely affected. Measure existing parameters where shown to document system capacity.

### **3.13 COMMISSIONING**

- A. Provide commissioning documentation in accordance with the requirements of Section 23 08 00 - COMMISSIONING OF HVAC SYSTEMS for all inspection, start up, and contractor testing required above and required by the System Readiness Checklist provided by the Commissioning Agent.
- B. Components provided under this section of the specification will be tested as part of a larger system. Refer to Section 23 08 00 -

DEPARTMENT OF VETERANS AFFAIRS  
PALO ALTO HEALTH CARE SYSTEM  
REPLACE BUILDING 100 AHU-19

Project No.: 640-15-138

COMMISSIONING OF HVAC SYSTEMS and related sections for contractor  
responsibilities for system commissioning.

- - E N D - - -

**SECTION 23 07 11**  
**HVAC AND BOILER PLANT INSULATION**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

A. Field applied insulation for thermal efficiency and condensation control for

1. HVAC piping, ductwork and equipment.

B. Definitions

1. ASJ: All service jacket, white finish facing or jacket.

2. Air conditioned space: Space having air temperature and/or humidity controlled by mechanical equipment.

3. Cold: Equipment, ductwork or piping handling media at design temperature of 16 degrees C (60 degrees F) or below.

4. Concealed: Ductwork and piping above ceilings and in chases, and pipe spaces.

5. Exposed: Piping, ductwork, and equipment exposed to view in finished areas including mechanical or exposed to outdoor weather. Attics and crawl spaces where air handling units are located are considered to be mechanical rooms. Shafts, chases, and pipe basements are not considered finished areas.

6. FSK: Foil-scrim-kraft facing.

7. Hot: HVAC Ductwork handling air at design temperature above 16 degrees C (60 degrees F); HVAC equipment or piping handling media above 41 degrees C (105 degrees F).

8. Density: kg/m<sup>3</sup> - kilograms per cubic meter (Pcf - pounds per cubic foot).

9. Runouts: Branch pipe connections up to 25-mm (one-inch) nominal size to fan coil units or reheat coils for terminal units.

10. Thermal conductance: Heat flow rate through materials.

a. Flat surface: Watt per square meter (BTU per hour per square foot).

b. Pipe or Cylinder: Watt per square meter (BTU per hour per linear foot).

11. Thermal Conductivity (k): Watt per meter, per degree C (BTU per inch thickness, per hour, per square foot, per degree F temperature difference).

12. Vapor Retarder (Vapor Barrier): A material which retards the transmission (migration) of water vapor. Performance of the vapor retarder is rated in terms of permeance (perms). For the purpose of this specification, vapor retarders shall have a maximum published permeance of 0.1 perms and vapor barriers shall have a maximum published permeance of 0.001 perms.
13. HPS: High pressure steam (415 kPa [60 psig] and above).
14. HPR: High pressure steam condensate return.
15. MPS: Medium pressure steam (110 kPa [16 psig] thru 414 kPa [59 psig]).
16. MPR: Medium pressure steam condensate return.
17. LPS: Low pressure steam (103 kPa [15 psig] and below).
18. LPR: Low pressure steam condensate gravity return.
19. HWH: Hot water heating supply.
20. HWHR: Hot water heating return.
21. CW: Cold water.
22. SW: Soft water.
23. HW: Hot water.
24. CH: Chilled water supply.
25. CHR: Chilled water return.
26. PVDC: Polyvinylidene chloride vapor retarder jacketing, white.

## **1.2 RELATED WORK**

- A. Section 07 84 00, FIRESTOPPING: Mineral fiber and bond breaker behind sealant.
- B. Section 23 05 11, COMMON WORK RESULTS FOR HVAC: General mechanical requirements and items, which are common to more than one section of Division 23.
- C. Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING and EQUIPMENT
- D. Section 23 21 23, HYDRONIC PUMPS
- E. Section 23 22 13, STEAM and CONDENSATE HEATING PIPING
- F. Section 23 21 13, HYDRONIC PIPING and Section 23 22 13, STEAM and CONDENSATE HEATING PIPING: Piping and equipment.
- G. Section 23 21 13, HYDRONIC PIPING: Hot water, and chilled water.
- H. Section 23 31 00, HVAC DUCTS AND CASINGS: Ductwork, plenum and fittings.

I. Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS. Requirements for commissioning, systems readiness checklists, and training.

### 1.3 QUALITY ASSURANCE

A. Refer to article QUALITY ASSURANCE, in Section 23 05 11, COMMON WORK RESULTS FOR HVAC and Section 23 05 10, COMMON WORK RESULTS FOR BOILER PLANT and STEAM GENERATION.

B. Criteria:

1. Comply with NFPA 90A, particularly paragraphs 4.3.3.1 through 4.3.3.6, 4.3.10.2.6, and 5.4.6.4, parts of which are quoted as follows:

**4.3.3.1** Pipe insulation and coverings, duct coverings, duct linings, vapor retarder facings, adhesives, fasteners, tapes, and supplementary materials added to air ducts, plenums, panels, and duct silencers used in duct systems, unless otherwise provided for in 4.3.3.1.1 or 4.3.3.1.2., shall have, in the form in which they are used, a maximum flame spread index of 25 without evidence of continued progressive combustion and a maximum smoke developed index of 50 when tested in accordance with NFPA 255, Standard Method of Test of Surface Burning Characteristics of Building Materials.

**4.3.3.1.1** Where these products are to be applied with adhesives, they shall be tested with such adhesives applied, or the adhesives used shall have a maximum flame spread index of 25 and a maximum smoke developed index of 50 when in the final dry state. (See 4.2.4.2.)

**4.3.3.1.2** The flame spread and smoke developed index requirements of 4.3.3.1.1 shall not apply to air duct weatherproof coverings where they are located entirely outside of a building, do not penetrate a wall or roof, and do not create an exposure hazard.

**4.3.3.2** Closure systems for use with rigid and flexible air ducts tested in accordance with UL 181, Standard for Safety Factory-Made Air Ducts and Air Connectors, shall have been tested, listed, and used in accordance with the conditions of their listings, in accordance with one of the following:

(1) UL 181A, Standard for Safety Closure Systems for Use with Rigid Air Ducts and Air Connectors

(2) UL 181B, Standard for Safety Closure Systems for Use with Flexible Air Ducts and Air Connectors

**4.3.3.3** Air duct, panel, and plenum coverings and linings, and pipe insulation and coverings shall not flame, glow, smolder, or smoke when tested in accordance with a similar test for pipe covering, ASTM C 411, Standard Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation, at the temperature to which they are exposed in service.

**4.3.3.3.1** In no case shall the test temperature be below 121°C (250°F).

4.3.3.4 Air duct coverings shall not extend through walls or floors that are required to be fire stopped or required to have a fire resistance rating, unless such coverings meet the requirements of 5.4.6.4.

4.3.3.5\* Air duct linings shall be interrupted at fire dampers to prevent interference with the operation of devices.

4.3.3.6 Air duct coverings shall not be installed so as to conceal or prevent the use of any service opening.

4.3.10.2.6 Materials exposed to the airflow shall be noncombustible or limited combustible and have a maximum smoke developed index of 50 or comply with the following.

4.3.10.2.6.1 Electrical wires and cables and optical fiber cables shall be listed as noncombustible or limited combustible and have a maximum smoke developed index of 50 or shall be listed as having a maximum peak optical density of 0.5 or less, an average optical density of 0.15 or less, and a maximum flame spread distance of 1.5 m (5 ft) or less when tested in accordance with NFPA 262, Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces.

//4.3.10.2.6.2 Pneumatic tubing for control systems shall be listed as having a maximum peak optical density of 0.5 or less, an average optical density of 0.15 or less, and a maximum flame spread distance of 1.5 m (5 ft) or less when tested in accordance with UL 1820, Standard for Safety Fire Test of Pneumatic Tubing for Flame and Smoke Characteristics. //

4.3.10.2.6.4 Optical-fiber and communication raceways shall be listed as having a maximum peak optical density of 0.5 or less, an average optical density of 0.15 or less, and a maximum flame spread distance of 1.5 m (5 ft) or less when tested in accordance with UL 2024, Standard for Safety Optical-Fiber Cable Raceway.

4.3.10.2.6.6 Supplementary materials for air distribution systems shall be permitted when complying with the provisions of 4.3.3.

5.4.6.4 Where air ducts pass through walls, floors, or partitions that are required to have a fire resistance rating and where fire dampers are not required, the opening in the construction around the air duct shall be as follows:

(1) Not exceeding a 25.4 mm (1 in.) average clearance on all sides

(2) Filled solid with an approved material capable of preventing the passage of flame and hot gases sufficient to ignite cotton waste when subjected to the time-temperature fire conditions required for fire barrier penetration as specified in NFPA 251, *Standard Methods of Tests of Fire Endurance of Building Construction and Materials*

2. Test methods: ASTM E84, UL 723, or NFPA 255.

3. Specified k factors are at 24 degrees C (75 degrees F) mean temperature unless stated otherwise. Where optional thermal insulation material is used, select thickness to provide thermal



conductance no greater than that for the specified material. For pipe, use insulation manufacturer's published heat flow tables. For domestic hot water supply and return, run out insulation and condensation control insulation, no thickness adjustment need be made.

4. All materials shall be compatible and suitable for service temperature, and shall not contribute to corrosion or otherwise attack surface to which applied in either the wet or dry state.

- C. Every package or standard container of insulation or accessories delivered to the job site for use must have a manufacturer's stamp or label giving the name of the manufacturer and description of the material.

#### **1.4 SUBMITTALS**

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

- B. Shop Drawings:

1. All information, clearly presented, shall be included to determine compliance with drawings and specifications and ASTM, federal and military specifications.
  - a. Insulation materials: Specify each type used and state surface burning characteristics.
  - b. Insulation facings and jackets: Each type used. Make it clear that white finish will be furnished for exposed ductwork, casings and equipment.
  - c. Insulation accessory materials: Each type used.
  - d. Manufacturer's installation and fitting fabrication instructions for flexible unicellular insulation.
  - e. Make reference to applicable specification paragraph numbers for coordination.

- C. Samples:

1. Each type of insulation: Minimum size 100 mm (4 inches) square for board/block/ blanket; 150 mm (6 inches) long, full diameter for round types.
2. Each type of facing and jacket: Minimum size 100 mm (4 inches square).
3. Each accessory material: Minimum 120 ML (4 ounce) liquid container or 120 gram (4 ounce) dry weight for adhesives / cement / mastic.

### 1.5 STORAGE AND HANDLING OF MATERIAL

Store materials in clean and dry environment, pipe covering jackets shall be clean and unmarred. Place adhesives in original containers. Maintain ambient temperatures and conditions as required by printed instructions of manufacturers of adhesives, mastics and finishing cements.

### 1.6 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 basic designation only.
- B. Federal Specifications (Fed. Spec.):
  - L-P-535E (2)- 99.....Plastic Sheet (Sheeting): Plastic Strip; Poly (Vinyl Chloride) and Poly (Vinyl Chloride - Vinyl Acetate), Rigid.
- C. Military Specifications (Mil. Spec.):
  - MIL-A-3316C (2)-90.....Adhesives, Fire-Resistant, Thermal Insulation
  - MIL-A-24179A (1)-87.....Adhesive, Flexible Unicellular-Plastic Thermal Insulation
  - MIL-C-19565C (1)-88.....Coating Compounds, Thermal Insulation, Fire-and Water-Resistant, Vapor-Barrier
  - MIL-C-20079H-87.....Cloth, Glass; Tape, Textile Glass; and Thread, Glass and Wire-Reinforced Glass
- D. American Society for Testing and Materials (ASTM):
  - A167-99(2004).....Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
  - B209-07.....Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
  - C411-05.....Standard test method for Hot-Surface Performance of High-Temperature Thermal Insulation
  - C449-07.....Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement
  - C533-09.....Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation

- C534-08.....Standard Specification for Preformed Flexible  
Elastomeric Cellular Thermal Insulation in  
Sheet and Tubular Form
- C547-07.....Standard Specification for Mineral Fiber pipe  
Insulation
- C552-07.....Standard Specification for Cellular Glass  
Thermal Insulation
- C553-08.....Standard Specification for Mineral Fiber  
Blanket Thermal Insulation for Commercial and  
Industrial Applications
- C585-09.....Standard Practice for Inner and Outer Diameters  
of Rigid Thermal Insulation for Nominal Sizes  
of Pipe and Tubing (NPS System) R (1998)
- C612-10.....Standard Specification for Mineral Fiber Block  
and Board Thermal Insulation
- C1126-04.....Standard Specification for Faced or Unfaced  
Rigid Cellular Phenolic Thermal Insulation
- C1136-10.....Standard Specification for Flexible, Low  
Permeance Vapor Retarders for Thermal  
Insulation
- D1668-97a (2006).....Standard Specification for Glass Fabrics (Woven  
and Treated) for Roofing and Waterproofing
- E84-10.....Standard Test Method for Surface Burning  
Characteristics of Building  
Materials
- E119-09c.....Standard Test Method for Fire Tests of Building  
Construction and Materials
- E136-09b.....Standard Test Methods for Behavior of Materials  
in a Vertical Tube Furnace at 750 degrees C  
(1380 F)
- E. National Fire Protection Association (NFPA):
- 90A-09.....Standard for the Installation of Air  
Conditioning and Ventilating Systems
- 96-08.....Standards for Ventilation Control and Fire  
Protection of Commercial Cooking Operations
- 101-09.....Life Safety Code

251-06.....Standard methods of Tests of Fire Endurance of  
Building Construction Materials

255-06.....Standard Method of tests of Surface Burning  
Characteristics of Building Materials

F. Underwriters Laboratories, Inc (UL):

723.....UL Standard for Safety Test for Surface Burning  
Characteristics of Building Materials with  
Revision of 09/08

G. Manufacturer's Standardization Society of the Valve and Fitting  
Industry (MSS):

SP58-2009.....Pipe Hangers and Supports Materials, Design,  
and Manufacture

## **PART 2 - PRODUCTS**

### **2.1 MINERAL FIBER OR FIBER GLASS**

- A. ASTM C612 (Board, Block), Class 1 or 2, density 48 kg/m<sup>3</sup> (3 pcf), k = 0.037 (0.26) at 24 degrees C (75 degrees F), external insulation for temperatures up to 204 degrees C (400 degrees F) with foil scrim (FSK) facing.
- B. ASTM C553 (Blanket, Flexible) Type I, // Class B-3, Density 16 kg/m<sup>3</sup> (1 pcf), k = 0.045 (0.31) at 24 degrees C (75 degrees F), for use at temperatures up to 204 degrees C (400 degrees F) with foil scrim (FSK) facing.
- C. ASTM C547 (Pipe Fitting Insulation and Preformed Pipe Insulation), Class 1, k = 0.037 (0.26) at 24 degrees C (75 degrees F), for use at temperatures up to 230 degrees C (450 degrees F) with an all service vapor retarder jacket with polyvinyl chloride premolded fitting covering.

### **2.2 MINERAL WOOL**

- A. Comply with Standard ASTM C612, Class 3, 450 degrees C (850 degrees F).

### **2.3 RIGID CELLULAR PHENOLIC FOAM**

- A. Preformed (molded) pipe insulation, ASTM C1126, type III, grade 1, k = 0.021(0.15) at 10 degrees C (50 degrees F), for use at temperatures up to 121 degrees C (250 degrees F) with all service vapor retarder jacket with polyvinyl chloride premolded fitting covering.
- B. Equipment and Duct Insulation, ASTM C 1126, type II, grade 1, k = 0.021 (0.15) at 10 degrees C (50 degrees F), for use at temperatures up to

121 degrees C (250 degrees F) with rigid cellular phenolic insulation and covering, and all service vapor retarder jacket.

#### **2.4 POLYISOCYANURATE CLOSED-CELL RIGID**

- A. Preformed (fabricated) pipe insulation, ASTM C591, type IV,  $K=0.027(0.19)$  at 24 degrees C (75 degrees F), flame spread not over 25, smoke developed not over 50, for use at temperatures up to 149 degree C (300 degree F) with factory applied PVDC or all service vapor retarder jacket with polyvinyl chloride premolded fitting covers.
- B. Equipment and duct insulation, ASTM C 591, type IV,  $K=0.027(0.19)$  at 24 degrees C (75 degrees F), for use at temperatures up to 149 degrees C (300 degrees F) with PVDC or all service jacket vapor retarder jacket.

#### **2.5 FLEXIBLE ELASTOMERIC CELLULAR THERMAL**

- A. ASTM C177, C518,  $k = 0.039 (0.27)$  at 24 degrees C (75 degrees F), flame spread not over 25, smoke developed not over 50, for temperatures from minus 4 degrees C (40 degrees F) to 93 degrees C (200 degrees F). No jacket required.

#### **2.6 CALCIUM SILICATE**

- A. Preformed pipe Insulation: ASTM C533, Type I and Type II with indicator denoting asbestos-free material.
- B. Premolded Pipe Fitting Insulation: ASTM C533, Type I and Type II with indicator denoting asbestos-free material.
- C. Equipment Insulation: ASTM C533, Type I and Type II

D. Characteristics:

Insulation Characteristics		
ITEMS	TYPE I	TYPE II
Temperature, maximum degrees C (degrees F)	649 (1200)	927 (1700)
Density (dry), Kg/m <sup>3</sup> (lb/ ft <sup>3</sup> )	232 (14.5)	288 (18)
Thermal conductivity: Min W/ m K (Btu in/h ft <sup>2</sup> degrees F)@ mean temperature of 93 degrees C (200 degrees F)	0.059 (0.41)	0.078 (0.540)
Surface burning characteristics: Flame spread Index, Maximum	0	0
Smoke Density index, Maximum	0	0

## 2.7 INSULATION FACINGS AND JACKETS

- A. Vapor Retarder, higher strength with low water permeance  $\leq 0.02$  or less perm rating, Beach puncture 50 units for insulation facing on exposed ductwork, casings and equipment, and for pipe insulation jackets. Facings and jackets shall be all service type (ASJ) or PVDC Vapor Retarder jacketing.
- B. ASJ jacket shall be white kraft bonded to 0.025 mm (1 mil) thick aluminum foil, fiberglass reinforced, with pressure sensitive adhesive closure. Comply with ASTM C1136. Beach puncture 50 units, Suitable for painting without sizing. Jackets shall have minimum 40 mm (1-1/2 inch) lap on longitudinal joints and minimum 75 mm (3 inch) butt strip on end joints. Butt strip material shall be same as the jacket. Lap and butt strips shall be self-sealing type with factory-applied pressure sensitive adhesive.
- C. Vapor Retarder medium strength with low water vapor permeance of 0.02 or less perm rating), Beach puncture 25 units: Foil-Scrim-Kraft (FSK) or PVDC vapor retarder jacketing type for concealed ductwork and equipment.
- D. Field applied vapor barrier jackets shall be provided, in addition to the specified facings and jackets, on all exterior piping and ductwork. The vapor barrier jacket shall consist of a multi-layer laminated

cladding with a maximum water vapor permeance of 0.001 perms. The minimum puncture resistance shall be 35 cm-kg (30 inch-pounds) for interior locations and 92 cm-kg (80 inch-pounds) for exterior or exposed locations or where the insulation is subject to damage.

- E. Glass Cloth Jackets: Presized, minimum 0.18 kg per square meter (7.8 ounces per square yard), 2000 kPa (300 psig) bursting strength with integral vapor retarder where required or specified. Weather proof if utilized for outside service.
- F. Factory composite materials may be used provided that they have been tested and certified by the manufacturer.
- G. Pipe fitting insulation covering (jackets): Fitting covering shall be premolded to match shape of fitting and shall be polyvinyl chloride (PVC) conforming to Fed Spec L-P-335, composition A, Type II Grade GU, and Type III, minimum thickness 0.7 mm (0.03 inches). Provide color matching vapor retarder pressure sensitive tape.
- H. Aluminum Jacket-Piping systems: ASTM B209, 3003 alloy, H-14 temper, 0.6 mm (0.023 inch) minimum thickness with locking longitudinal joints. Jackets for elbows, tees and other fittings shall be factory-fabricated to match shape of fitting and of 0.6 mm (0.024) inch minimum thickness aluminum. Fittings shall be of same construction as straight run jackets but need not be of the same alloy. Factory-fabricated stainless steel bands shall be installed on all circumferential joints. Bands shall be 13 mm (0.5 inch) wide on 450 mm (18 inch) centers. System shall be weatherproof if utilized for outside service.
- I. Aluminum jacket for unlined supply duct exposed outdoors: ASTM B209, 3003 alloy, H-14 temper, 0.5 mm (0.020 inches) thick with 32 mm (1-1/4 inch) corrugations or 0.8 mm (0.032 inches) thick with no corrugations. System shall be weatherproof if used for outside service.

## **2.8 REMOVABLE INSULATION JACKETS**

- A. Insulation and Jacket:
  - 1. Non-Asbestos Glass mat, type E needled fiber.
  - 2. Temperature maximum of 450°F, Maximum water vapor transmission of 0.00 perm, and maximum moisture absorption of 0.2 percent by volume.
  - 3. Jacket Material: Silicon/fiberglass and LFP 2109 pure PTFE.
  - 4. Construction: One piece jacket body with three-ply braided pure Teflon or Kevlar thread and insulation sewn as part of jacket. Belt fastened.

## 2.9 PIPE COVERING PROTECTION SADDLES

- A. Cold pipe support: Premolded pipe insulation 180 degrees (half-shells) on bottom half of pipe at supports. Material shall be cellular glass or high density Polyisocyanurate insulation of the same thickness as adjacent insulation. Density of Polyisocyanurate insulation shall be a minimum of 48 kg/m<sup>3</sup> (3.0 pcf).

Nominal Pipe Size and Accessories Material (Insert Blocks)	
Nominal Pipe Size mm (inches)	Insert Blocks mm (inches)
Up through 125 (5)	150 (6) long
150 (6)	150 (6) long
200 (8), 250 (10), 300 (12)	225 (9) long
350 (14), 400 (16)	300 (12) long
450 through 600 (18 through 24)	350 (14) long

- B. Warm or hot pipe supports: Premolded pipe insulation (180 degree half-shells) on bottom half of pipe at supports. Material shall be high density Polyisocyanurate (for temperatures up to 149 degrees C [300 degrees F]), cellular glass or calcium silicate. Insulation at supports shall have same thickness as adjacent insulation. Density of Polyisocyanurate insulation shall be a minimum of 48 kg/m<sup>3</sup> (3.0 pcf).

## 2.10 ADHESIVE, MASTIC, CEMENT

- A. Mil. Spec. MIL-A-3316, Class 1: Jacket and lap adhesive and protective finish coating for insulation.
- B. Mil. Spec. MIL-A-3316, Class 2: Adhesive for laps and for adhering insulation to metal surfaces.
- C. Mil. Spec. MIL-A-24179, Type II Class 1: Adhesive for installing flexible unicellular insulation and for laps and general use.
- D. Mil. Spec. MIL-C-19565, Type I: Protective finish for outdoor use.
- E. Mil. Spec. MIL-C-19565, Type I or Type II: Vapor barrier compound for indoor use.
- F. ASTM C449: Mineral fiber hydraulic-setting thermal insulating and finishing cement.
- G. Other: Insulation manufacturers' published recommendations.

## 2.11 MECHANICAL FASTENERS

- A. Pins, anchors: Welded pins, or metal or nylon anchors with galvanized steel-coated or fiber washer, or clips. Pin diameter shall be as recommended by the insulation manufacturer.



- B. Staples: Outward clinching // monel or // galvanized steel.
- C. Wire: 1.3 mm thick (18 gage) soft annealed galvanized or 1.9 mm (14 gage) copper clad steel or nickel copper alloy.
- D. Bands: 13 mm (0.5 inch) nominal width, brass, galvanized steel, aluminum or stainless steel.

## **2.12 REINFORCEMENT AND FINISHES**

- A. Glass fabric, open weave: ASTM D1668, Type III (resin treated) and Type I (asphalt treated).
- B. Glass fiber fitting tape: Mil. Spec MIL-C-20079, Type II, Class 1.
- C. Tape for Flexible Elastomeric Cellular Insulation: As recommended by the insulation manufacturer.
- D. Hexagonal wire netting: 25 mm (one inch) mesh, 0.85 mm thick (22 gage) galvanized steel.
- E. Corner beads: 50 mm (2 inch) by 50 mm (2 inch), 0.55 mm thick (26 gage) galvanized steel; or, 25 mm (1 inch) by 25 mm (1 inch), 0.47 mm thick (28 gage) aluminum angle adhered to 50 mm (2 inch) by 50 mm (2 inch) Kraft paper.
- F. PVC fitting cover: Fed. Spec L-P-535, Composition A, 11-86 Type II, Grade GU, with Form B Mineral Fiber insert, for media temperature 4 degrees C (40 degrees F) to 121 degrees C (250 degrees F). Below 4 degrees C (40 degrees F) and above 121 degrees C (250 degrees F). Provide double layer insert. Provide color matching vapor barrier pressure sensitive tape.

## **2.13 FIRESTOPPING MATERIAL**

- A. Other than pipe and duct insulation, refer to Section 07 84 00 FIRESTOPPING.

## **2.14 FLAME AND SMOKE**

- A. Unless shown otherwise all assembled systems shall meet flame spread 25 and smoke developed 50 rating as developed under ASTM, NFPA and UL standards and specifications. See paragraph 1.3 "Quality Assurance".

## **PART 3 - EXECUTION**

### **3.1 GENERAL REQUIREMENTS**

- A. Required pressure tests of duct and piping joints and connections shall be completed and the work approved by the Resident Engineer for application of insulation. Surface shall be clean and dry with all foreign materials, such as dirt, oil, loose scale and rust removed.

- B. Except for specific exceptions, insulate entire specified equipment, piping (pipe, fittings, valves, accessories), and duct systems. Insulate each pipe and duct individually. Do not use scrap pieces of insulation where a full length section will fit.
- C. Insulation materials shall be installed in a first class manner with smooth and even surfaces, with jackets and facings drawn tight and smoothly cemented down at all laps. Insulation shall be continuous through all sleeves and openings, except at fire dampers and. Vapor retarders shall be continuous and uninterrupted throughout systems with operating temperature 16 degrees C (60 degrees F) and below. Lap and seal vapor retarder over ends and exposed edges of insulation. Anchors, supports and other metal projections through insulation on cold surfaces shall be insulated and vapor sealed for a minimum length of 150 mm (6 inches).
- D. Install vapor stops at all insulation terminations on either side of valves, pumps and equipment and particularly in straight lengths of pipe insulation.
- E. Construct insulation on parts of equipment such as chilled water pumps and heads of chillers, convertors and heat exchangers that must be opened periodically for maintenance or repair, so insulation can be removed and replaced without damage. Install insulation with bolted 1 mm thick (20 gage) galvanized steel or aluminum covers as complete units, or in sections, with all necessary supports, and split to coincide with flange/split of the equipment.
- F. Insulation on hot piping and equipment shall be terminated square at items not to be insulated, access openings and nameplates. Cover all exposed raw insulation with white sealer or jacket material.
- G. Protect all insulations outside of buildings with aluminum jacket using lock joint or other approved system for a continuous weather tight system. Access doors and other items requiring maintenance or access shall be removable and sealable.
- H. Insulate PRVs, flow meters, and steam traps with specified removable insulation.
- I. HVAC work not to be insulated:
  - 1. Internally insulated ductwork and air handling units.
  - 2. Relief air ducts (Economizer cycle exhaust air).
  - 3. Exhaust air ducts and plenums, and ventilation exhaust air shafts.

4. Equipment: Expansion tanks. -Expansion Tanks exposed outdoors must be insulated.
5. In hot piping: Unions, flexible connectors, control valves. Insulate piping to within approximately 75 mm (1 inches) of uninsulated items.
- J. Apply insulation materials subject to the manufacturer's recommended temperature limits. Apply adhesives, mastic and coatings at the manufacturer's recommended minimum coverage.
- K. Elbows, flanges and other fittings shall be insulated with the same material as is used on the pipe straights. // The elbow/ fitting insulation shall be field-fabricated, mitered or factory prefabricated to the necessary size and shape to fit on the elbow/ fitting.// Use of polyurethane spray-foam to fill a PVC elbow jacket is prohibited on cold applications.
- L. Firestop Pipe and Duct insulation:
  1. Provide firestopping insulation at fire and smoke barriers through penetrations. Fire stopping insulation shall be UL listed as defines in Section 07 84 00, FIRESTOPPING.
  2. Pipe and duct penetrations requiring fire stop insulation including, but not limited to the following:
    - a. Pipe risers through floors
    - b. Pipe or duct chase walls and floors
    - c. Smoke partitions
    - d. Fire partitions
- M. Provide vapor barrier jackets over insulation as follows:
  1. All piping and ductwork exposed to outdoor weather.
- N. Provide metal jackets over insulation as follows:
  1. All piping and ducts exposed to outdoor weather.
  2. Piping exposed in building, within 1800 mm (6 feet) of the floor, that connects to sterilizers. Jackets may be applied with pop rivets. Provide aluminum angle ring escutcheons at wall, ceiling or floor penetrations.
  3. A 50 mm (2 inch) overlap is required at longitudinal and circumferential joints.

### **3.2 INSULATION INSTALLATION**

- A. Mineral Fiber Board:

1. Faced board: Apply board on pins spaced not more than 300 mm (12 inches) on center each way, and not less than 75 mm (3 inches) from each edge of board. In addition to pins, apply insulation bonding adhesive to entire underside of horizontal metal surfaces. Butt insulation edges tightly and seal all joints with laps and butt strips. After applying speed clips cut pins off flush and apply vapor seal patches over clips.
2. Plain board:
  - a. Insulation shall be scored, beveled or mitered to provide tight joints and be secured to equipment with bands spaced 225 mm (9 inches) on center for irregular surfaces or with pins and clips on flat surfaces. Use corner beads to protect edges of insulation.
  - b. For hot equipment: Stretch 25 mm (1 inch) mesh wire, with edges wire laced together, over insulation and finish with insulating and finishing cement applied in one coat, 6 mm (1/4 inch) thick, trowel led to a smooth finish.
  - c. For cold equipment: Apply meshed glass fabric in a tack coat 1.5 to 1.7 square meter per liter (60 to 70 square feet per gallon) of vapor mastic and finish with mastic at 0.3 to 0.4 square meter per liter (12 to 15 square feet per gallon) over the entire fabric surface.
  - d. Chilled water pumps: Insulate with removable and replaceable 1 mm thick (20 gage) aluminum or galvanized steel covers lined with insulation. Seal closure joints/flanges of covers with gasket material. Fill void space in enclosure with flexible mineral fiber insulation.
3. Exposed, unlined ductwork and equipment in unfinished areas, mechanical and electrical equipment rooms and attics and duct work exposed to outdoor weather:
  - a. 50 mm (2 inch) thick insulation faced with ASJ (white all service jacket): Supply air duct and afterfilter housing.
  - b. 40 mm (1-1/2 inch) thick insulation faced with ASJ: Return air duct, mixed air plenums and prefilter housing.
  - c. Exposed, unlined supply and return ductwork exposed to outdoor weather: 50 mm (2 inch) thick insulation faced with a reinforcing membrane and two coats of vapor barrier mastic or multi-layer

vapor barrier with a maximum water vapor permeability of 0.001 perms.

4. Cold equipment: 40 mm (1-1/2 inch) thick insulation faced with ASJ.
  - a. Chilled water pumps, water filter, chemical feeder pot or tank.
5. Hot equipment: 40 mm (1-1/2 inch) thick insulation faced with ASJ.
  - a. Reheat coil casing.

B. Flexible Mineral Fiber Blanket:

1. Adhere insulation to metal with 75 mm (3 inch) wide strips of insulation bonding adhesive at 200 mm (8 inches) on center all around duct. Additionally secure insulation to bottom of ducts exceeding 600 mm (24 inches) in width with pins welded or adhered on 450 mm (18 inch) centers. Secure washers on pins. Butt insulation edges and seal joints with laps and butt strips. Staples may be used to assist in securing insulation. Seal all vapor retarder penetrations with mastic. Sagging duct insulation will not be acceptable. Install firestop duct insulation where required.
2. Supply air ductwork to be insulated includes main and branch ducts from AHU discharge to room supply outlets, and the bodies of ceiling outlets to prevent condensation. Insulate sound attenuator units, coil casings and damper frames. To prevent condensation insulate trapeze type supports and angle iron hangers for flat oval ducts that are in direct contact with metal duct.
3. Concealed supply air ductwork.
  - a. Above ceilings at a roof level, in attics, and duct work exposed to outdoor weather: 50 mm (2 inch) thick insulation faced with FSK.
  - b. Above ceilings for other than roof level: 40 mm (1 ½ inch) thick insulation faced with FSK.
4. Concealed return air duct:
  - a. All duct above ceilings unconditioned areas, and in chases with external wall or containing steam piping; 40 mm (1-1/2 inch) thick, insulation faced with FSK.

C. Molded Mineral Fiber Pipe and Tubing Covering:

1. Fit insulation to pipe or duct, aligning longitudinal joints. Seal longitudinal joint laps and circumferential butt strips by rubbing hard with a nylon sealing tool to assure a positive seal. Staples may be used to assist in securing insulation. Seal all vapor

- retarder penetrations on cold piping with a generous application of vapor barrier mastic. Provide inserts and install with metal insulation shields at outside pipe supports. Install freeze protection insulation over heating cable.
2. Contractor's options for fitting, flange and valve insulation:
    - a. Insulating and finishing cement for sizes less than 100 mm (4 inches) operating at surface temperature of 16 degrees C (61 degrees F) or more.
    - b. Factory premolded, one piece PVC covers with mineral fiber, (Form B), inserts. Provide two insert layers for pipe temperatures below 4 degrees C (40 degrees F), or above 121 degrees C (250 degrees F). Secure first layer of insulation with twine. Seal seam edges with vapor barrier mastic and secure with fitting tape.
    - c. Factory molded, ASTM C547 or field mitered sections, joined with adhesive or wired in place. For hot piping finish with a smoothing coat of finishing cement. For cold fittings, 16 degrees C (60 degrees F) or less, vapor seal with a layer of glass fitting tape imbedded between two 2 mm (1/16 inch) coats of vapor barrier mastic.
    - d. Fitting tape shall extend over the adjacent pipe insulation and overlap on itself at least 50 mm (2 inches).
  3. Nominal thickness in millimeters and inches specified in the schedule at the end of this section.
- D. Rigid Cellular Phenolic Foam:
1. 1. Note the NFPA 90A burning characteristics requirements of 25/50 in paragraph 1.3.B
  2. Provide secure attachment facilities such as welding pins.
  3. Apply insulation with joints tightly drawn together
  4. Apply adhesives, coverings, neatly finished at fittings, and valves.
  5. Final installation shall be smooth, tight, neatly finished at all edges.
  6. Minimum thickness in millimeters (inches) specified in the schedule at the end of this section.
  7. Exposed, unlined supply and return ductwork exposed to outdoor weather: 50 mm (2 inch) thick insulation faced with a multi-layer vapor barrier with a maximum water vapor permeance of 0.00 perms.

8. Condensation control insulation: Minimum 25 mm (1.0 inch) thick for all pipe sizes.

a. HVAC: Cooling coil condensation piping to waste piping fixture or drain inlet. Omit insulation on plastic piping in mechanical rooms.

E. Polyisocyanurate Closed-Cell Rigid Insulation:

1. Polyisocyanurate closed-cell rigid insulation (PIR) may be provided for exterior piping, equipment and ductwork for temperature up to 149 degree C (300 degree F).
2. Install insulation, vapor barrier and jacketing per manufacturer's recommendations. Particular attention should be paid to recommendations for joint staggering, adhesive application, external hanger design, expansion/contraction joint design and spacing and vapor barrier integrity.
3. Install insulation with all joints tightly butted (except expansion joints in hot applications).
4. If insulation thickness exceeds 63 mm (2.5 inches), install as a double layer system with longitudinal (lap) and butt joint staggering as recommended by manufacturer.
5. For cold applications, vapor barrier shall be installed in a continuous manner. No staples, rivets, screws or any other attachment device capable of penetrating the vapor barrier shall be used to attach the vapor barrier or jacketing. No wire ties capable of penetrating the vapor barrier shall be used to hold the insulation in place. Banding shall be used to attach PVC or metal jacketing.
6. Elbows, flanges and other fittings shall be insulated with the same material as is used on the pipe straights. The elbow/ fitting insulation shall be field-fabricated, mitered or factory prefabricated to the necessary size and shape to fit on the elbow/ fitting. Use of polyurethane spray-foam to fill PVC elbow jacket is prohibited on cold applications.
7. For cold applications, the vapor barrier on elbows/fittings shall be either mastic-fabric-mastic or 2 mil thick PVDC vapor barrier adhesive tape.

8. All PVC and metal jacketing shall be installed so as to naturally shed water. Joints shall point down and shall be sealed with either adhesive or caulking (except for periodic slip joints).
  9. Exposed, unlined supply and return ductwork exposed to outdoor weather: 50 mm (2 inch) thick insulation faced with a multi-layer vapor barrier with a water vapor permeance of 0.00 perms.
  10. Note the NFPA 90A burning characteristic requirements of 25/50 in paragraph 1.3B. Refer to paragraph 3.1 for items not to be insulated.
  11. Minimum thickness in millimeter (inches) specified in the schedule at the end of this section.
- F. Flexible Elastomeric Cellular Thermal Insulation:
1. Apply insulation and fabricate fittings in accordance with the manufacturer's installation instructions and finish with two coats of weather resistant finish as recommended by the insulation manufacturer.
  2. Pipe and tubing insulation:
    - a. Use proper size material. Do not stretch or strain insulation.
    - b. To avoid undue compression of insulation, provide cork stoppers or wood inserts at supports as recommended by the insulation manufacturer. Insulation shields are specified under Section 23 05 11, COMMON WORK RESULTS FOR HVAC.
    - c. Where possible, slip insulation over the pipe or tubing prior to connection, and seal the butt joints with adhesive. Where the slip-on technique is not possible, slit the insulation and apply it to the pipe sealing the seam and joints with contact adhesive. Optional tape sealing, as recommended by the manufacturer, may be employed. Make changes from mineral fiber insulation in a straight run of pipe, not at a fitting. Seal joint with tape.
  3. Apply sheet insulation to flat or large curved surfaces with 100 percent adhesive coverage. For fittings and large pipe, apply adhesive to seams only.
  4. Pipe insulation: nominal thickness in millimeters (inches as specified in the schedule at the end of this section.
  5. Minimum 20 mm (0.75 inch) thick insulation for pneumatic control lines for a minimum distance of 6 m (20 feet) from discharge side of the refrigerated dryer.



6. Use Class S (Sheet), 20 mm (3/4 inch) thick for the following:
  - a. Chilled water pumps
  - b. Chillers, insulate any cold chiller surfaces subject to condensation which has not been factory insulated.
  - c. Piping inside refrigerators and freezers: Provide heat tape under insulation.
7. Exposed, unlined supply and return ductwork exposed to outdoor weather: 50 mm (2 inch) thick insulation faced with a multi-layer vapor barrier with a water vapor permeance of 0.00 perms.

G. Calcium Silicate:

1. Minimum thickness in millimeter (inches) specified in the schedule at the end of this section for piping other than in boiler plant.

**3.4 PIPE INSULATION SCHEDULE**

Provide insulation for piping systems as scheduled below:

Insulation Thickness Millimeters (Inches)					
		Nominal Pipe Size Millimeters (Inches)			
Operating Temperature Range/Service	Insulation Material	Less than 25 (1)	25 - 32 (1 - 1¼)	38 - 75 (1½ - 3)	100 (4) and Above
122-177 degrees C (251-350 degrees F) (HPS, MPS)	Mineral Fiber (Above ground piping only)	75 (3)	100 (4)	113 (4.5)	113 (4.5)
93-260 degrees C (200-500 degrees F) (HPS, HPR)	Calcium Silicate	100 (4)	125 (5)	150 (6)	150 (6)
100-121 degrees C (212-250 degrees F) (HPR, MPR, LPS, including the humidifier steam piping)	Mineral Fiber (Above ground piping only)	62 (2.5)	62 (2.5)	75 (3.0)	75 (3.0)
100-121 degrees C (212-250 degrees F) (HPR, MPR, LPS including the humidifier steam	Rigid Cellular Phenolic Foam	50 (2.0)	50 (2.0)	75 (3.0)	75 (3.0)

<p>                     piping, vent piping                      from PRV Safety                      Valves, Condensate                      receivers and flash                      tanks)                 </p>					
<p>                     38-94 degrees C                      (100-200 degrees F)                      (LPR including the                      humidifier                      dispersion to be                      return, PC, HWH,                      HWHR)                 </p>	<p>                     Mineral Fiber                      (Above ground                      piping only)                 </p>	<p>                     38                      (1.5)                 </p>	<p>                     38 (1.5)                 </p>	<p>                     50 (2.0)                 </p>	<p>                     50 (2.0)                 </p>
<p>                     38-99 degrees C                      (100-211 degrees F)                      (LPR including the                      humidifier                      dispersion to be                      return, PC, HWH,                      HWHR)                 </p>	<p>                     Rigid Cellular                      Phenolic Foam                 </p>	<p>                     38                      (1.5)                 </p>	<p>                     38 (1.5)                 </p>	<p>                     50 (2.0)                 </p>	<p>                     50 (2.0)                 </p>
<p>                     39-99 degrees C                      (100-211 degrees F)                      (LPR including the                      humidifier                      dispersion to be                      return, PC, HWH,                      HWHR)                 </p>	<p>                     Polyiso-                      cyanurate                      Closed-Cell                      Rigid                      (Exterior                      Locations                      only)                 </p>	<p>                     38                      (1.5)                 </p>	<p>                     38 (1.5)                 </p>	<p>                     ----                 </p>	<p>                     ----                 </p>
<p>                     4-16 degrees C                      (40-60 degrees F)                      (CH, CHR)                 </p>	<p>                     Rigid Cellular                      Phenolic Foam                 </p>	<p>                     38                      (1.5)                 </p>	<p>                     38 (1.5)                 </p>	<p>                     38 (1.5)                 </p>	<p>                     38 (1.5)                 </p>
<p>                     4-16 degrees C                      (40-60 degrees F)                      (CH, CHR)                 </p>	<p>                     Polyiso-                      cyanurate                      Closed-Cell                      Rigid                      (Exterior                      Locations                      only)                 </p>	<p>                     38                      (1.5)                 </p>	<p>                     38 (1.5)                 </p>	<p>                     38 (1.5)                 </p>	<p>                     38 (1.5)                 </p>
<p>                     (40-60 degrees F)                      (CH, CHR)                 </p>	<p>                     Flexible                      Elastomeric                      Cellular                      Thermal (Above                      ground piping                      only)                 </p>	<p>                     38                      (1.5)                 </p>	<p>                     38 (1.5)                 </p>	<p>                     38 (1.5)                 </p>	<p>                     38 (1.5)                 </p>

DEPARTMENT OF VETERANS AFFAIRS  
PALO ALTO HEALTH CARE SYSTEM  
REPLACE BUILDING 100 AHU-19

Project No.: 640-15-138

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**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 the Facility exterior closure, 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 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.
- B. The Facility exterior closure 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 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

DEPARTMENT OF VETERANS AFFAIRS  
PALO ALTO HEALTH CARE SYSTEM  
REPLACE BUILDING 100 AHU-19

Project No.: 640-15-138

91 00 GENERAL COMMISSIONING REQUIREMENTS and Division 23 Sections for  
additional Contractor training requirements.

----- END -----

**SECTION 23 09 23**  
**DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. Provide (a) direct-digital control system(s) as indicated on the project documents, point list, interoperability tables, drawings and as described in these specifications. Include a complete and working direct-digital control system. Include all engineering, programming, controls and installation materials, installation labor, commissioning and start-up, training, final project documentation and warranty.
1. The direct-digital control system(s) shall consist of high-speed, peer-to-peer network of DDC controllers, a control system server, and an Engineering Control Center. Provide a remote user using a standard web browser to access the control system graphics and change adjustable setpoints with the proper password.
  2. The direct-digital control system(s) shall be native BACnet. All new controllers, devices and components shall be listed by BACnet Testing Laboratories. All new controller, devices and components shall be accessible using a Web browser interface and shall communicate exclusively using the ASHRAE Standard 135 BACnet communications protocol without the use of gateways, unless otherwise allowed by this Section of the technical specifications, specifically shown on the design drawings and specifically requested otherwise by the VA.
    - a. If used, gateways shall support the ASHRAE Standard 135 BACnet communications protocol.
  3. 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.



4. 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. 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. Chiller controls. These controls, if not native BACnet, will require a BACnet Gateway.
3. Terminal units' velocity sensors
4. Variable frequency drives. These controls, if not native BACnet, will require a BACnet Gateway.
5. The following systems have limited control (as individually noted below) from the ECC:
  - a. New Medical gas systems (if not bottled at point of use): low pressure and status alarms.
  - b. See control drawings for additional requirements.
  - c. Operating and isolation rooms: pressure outside of acceptable limit alarms.

E. Responsibility Table:

Work/Item/System	Furnish	Install	Low Voltage Wiring	Line Power
Control system low voltage and communication wiring	23 09 23	23 09 23	23 09 23	N/A
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
Interface with chiller/boiler controls	23 09 23	23 09 23	23 09 23	26
Chiller/boiler controls interface with control	23	23	23 09 23	26

Work/Item/System	Furnish	Install	Low Voltage Wiring	Line Power
system				
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
VFDs	23 09 23	26	23 09 23	26
Medical gas panels	23	23	26	26
Control system monitoring of fire alarm smoke control relay	28	28	23 09 23	28
Oxygen depletion	23 09 23	23 09 23	23 09 23	26
Steam to steam humidifier	23	23	23 09 23	26
Starters, HOA switches	23	23	N/A	26

Note: (1) Electrical to provide line voltage power to the main temperature control panels and control power junction boxes located in selected areas above the ceiling. This section shall obtain line voltage control power from this location and extend as required.

F. This facility's existing direct-digital control system is manufactured by Siemens (apogee DDC system), and its ECC is located at Building 100. The existing system's top-end communications is via Ethernet. The existing system's ECC and top-end controllers were installed in 1984. 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. //Provide a new BACnet ECC, communications network, and controllers within the project area. Provide a programmable internetworking gateway allowing for real-time communication between the existing direct-digital control system and the new BACnet control system. Real-time communication shall provide all object properties and read/write services shown on VA-approved interoperability schedules.

The contractor administered by this Section of the technical specifications shall provide all necessary investigation and site-specific programming to execute the interoperability schedules.

- a. The combined system shall operate and function as one complete system including one database of control point objects and global control logic capabilities. Facility operators shall have complete operations and control capability over all systems, new and existing including; monitoring, trending, graphing, scheduling, alarm management, global point sharing, global strategy deployment, graphical operations interface and custom reporting as specified.
- 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 09 23 contractor	Control system 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		

Unitary standalone systems 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. 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.

**1.2 SEISMIC PERFORMANCE REQUIREMENTS**

- A. Seismic performance: Equipment shall have special seismic certification in accordance with the requirements in Section 13.2.2 of ASCE 7-10.
- B. Equipment with OSHPD OSP certification is acceptable.

**1.3 RELATED WORK**

- A. Sustainable design requirements and procedures including submittal requirements: Section 01 81 11, SUSTAINABLE DESIGN REQUIREMENTS.
- B. Procedures and requirements for managing and disposing construction and demolition waste: Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- C. Section 23 21 13, Hydronic Piping.

- D. Section 23 22 13, Steam and Condensate Heating Piping.
- E. Section 23 31 00, HVAC Ducts and Casings.
- F. Section 23 34 00, HVAC Fans
- G. Section 23 74 13, Packaged, Outdoor, Central-Station Air-Handling Units.
- H. Section 26 05 11, Requirements for Electrical Installations.
- I. Section 26 05 21, Low-Voltage Electrical Power Conductors and Cables (600 Volts and Below).
- J. Section 26 05 26, Grounding and Bonding for Electrical Systems.
- K. Section 26 05 33, Raceway and Boxes for Electrical Systems.
- L. Section 26 09 23, Lighting Controls.
- M. Section 26 22 21, Specialty Transformers.
- N. Section 26 27 26, Wiring Devices.
- O. Section 26 29 11, Motor Starters.
- P. Section 27 15 00, Communications Horizontal Cabling
- Q. Section 28 31 00, Fire Detection and Alarm.

### 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. ARCNET: ANSI/ATA 878.1 - Attached Resource Computer Network. ARCNET is a deterministic LAN technology; meaning it's possible to determine the maximum delay before a device is able to transmit a message.
- C. Analog: A continuously varying signal value (e.g., temperature, current, velocity etc.
- D. 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.
- E. 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.
- F. BACnet Internetwork: Two or more BACnet networks connected with routers. The two networks may sue different LAN technologies.

- G. 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.
- H. BACnet Segment: One or more physical segments of BACnet devices on a BACnet network, connected at the physical layer by repeaters.
- I. 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.
- J. 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.
- K. BACnet Testing Laboratories (BTL). The organization responsible for testing products for compliance with the BACnet standard, operated under the direction of BACnet International.
- L. 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).
- M. 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.
- N. 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.
- O. Bus Topology: A network topology that physically interconnects workstations and network devices in parallel on a network segment.
- P. 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
- Q. 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).
- R. Device: a control system component that contains a BACnet Device Object and uses BACnet to communicate with other devices.
- S. 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.

- T. 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.
- U. 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.
- V. 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.
- W. 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.
- X. 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.
- Y. DXF: An AutoCAD 2-D graphics file format. Many CAD systems import and export the DXF format for graphics interchange.
- Z. 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.



- AA. 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.
- BB. 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.
- CC. Ethernet: A trademark for a system for exchanging messages between computers on a local area network using coaxial, fiber optic, or twisted-pair cables.
- DD. Firmware: Firmware is software programmed into read only memory (ROM) chips. Software may not be changed without physically altering the chip.
- EE. 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.
- FF. GIF: Abbreviation of Graphic interchange format.
- GG. 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.
- HH. Graphic Sequence of Operation: It is a graphical representation of the sequence of operation, showing all inputs and output logical blocks.
- II. 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.
- JJ. 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.

- KK. JPEG: A standardized image compression mechanism stands for Joint Photographic Experts Group, the original name of the committee that wrote the standard.
- LL. Local Area Network (LAN): A communication bus that interconnects operator workstation and digital controllers for peer-to-peer communications, sharing resources and exchanging information.
- MM. Network Repeater: A device that receives data packet from one network and rebroadcasts to another network. No routing information is added to the protocol.
- NN. MS/TP: Master-slave/token-passing (ISO/IEC 8802, Part 3). It is not an acceptable LAN option for VA health-care facilities. It uses twisted-pair wiring for relatively low speed and low cost communication.
- OO. 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.
- PP. 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.
- QQ. Object: The concept of organizing BACnet information into standard components with various associated properties. Examples include analog input objects and binary output objects.
- RR. Object Identifier: An object property used to identify the object, including object type and instance. Object Identifiers must be unique within a device.
- SS. 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.
- TT. Operating system (OS): Software, which controls the execution of computer application programs.
- UU. 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.
- VV. Peripheral: Different components that make the control system function as one unit. Peripherals include monitor, printer, and I/O unit.

- WW. 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.
- XX. PICS: Protocol Implementation Conformance Statement, describing the BACnet capabilities of a device. All BACnet devices have published PICS.
- YY. PID: Proportional, integral, and derivative control, used to control modulating equipment to maintain a setpoint.
- ZZ. Repeater: A network component that connects two or more physical segments at the physical layer.
- AAA. 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.
- BBB. Sensors: devices measuring state points or flows, which are then transmitted back to the DDC system.
- CCC. 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.
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
Carbon Monoxide (CO)	$\pm 5\%$ of reading

Carbon Dioxide (CO <sub>2</sub> )	±50 ppm
Air pressure (ducts)	±25 Pa [±0.1"w.c.]
Air pressure (space)	±0.3 Pa [±0.001"w.c.]
Water pressure	±2% of full scale *Note 1
Electrical Power	±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	±50 Pa (±0.2 in. w.g.)	0-1.5 kPa (0-6 in. w.g.)
Air Pressure	±3 Pa (±0.01 in. w.g.)	-25 to 25 Pa (-0.1 to 0.1 in. w.g.)
Airflow	±10% of full scale	
Space Temperature	±1.0°C (±2.0°F)	
Duct Temperature	±1.5°C (±3°F)	
Humidity	±5% RH	
Fluid Pressure	±10 kPa (±1.5 psi)	0-1 MPa (1-150 psi)
Fluid Pressure	±250 Pa (±1.0 in. w.g.)	0-12.5 kPa (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 Contracting Officer's Representative 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.
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 16 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 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. New control system shall be compatible with and capable of communicating with the existing campus DDC control system without the use of a gateway.

### **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 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
3. All necessary telephone lines, ISDN lines and internet Service Provider services and connections to the main network controller are existing. Communications between building unit and device controllers shall be wired as part of the Building DDC system architecture.

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. Servers are existing.
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.
  3. The MS/TP data link / physical layer protocol is not acceptable to the VA in any new BACnet network or sub-network in its healthcare or lab facilities.
- B. Each controller shall have a communication port for connection to an operator interface.
- C. 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.
- D. 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.

- E. 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 is existing.

B. ECC Software:

1. Upgrade the existing ECC software with the newest version.
2. 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.
3. 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.
4. Provide a method of configuring the system. This shall allow for future system changes or additions by users with proper clearance.
5. 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.
6. 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.
7. 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.
  8. 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.
  9. 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.
  10. 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.
  11. 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.
  12. 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.
13. 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.
  14. 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.
  15. 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.

16. 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.
- 17. 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.
- 18. 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 inlet and outlet temperature
  - b. Chilled water flow
  - c. Chilled water inlet and outlet pressures
  - d. Motor amperes per phase
  - e. Motor volts per phase
  - f. Ambient temperature (dry-bulb and wet-bulb)
  - g. Date and time logged
- 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.

22. 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.

23. 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.

24. 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 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.

## **2.6 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.

### 2.7 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.

## **2.8 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. Economizer: An economizer program shall be provided for VAV systems. This program shall control the position of air handler relief, return, and outdoors dampers. If the outdoor air dry bulb temperature falls below changeover set point the energy control center will modulate the dampers to provide 100 percent outdoor air. The operator shall be able to override the economizer cycle and return to minimum outdoor air operation at any time.
    - b. Night Setback/Morning Warm up Control: The system shall provide the ability to automatically adjust set points for this mode of operation.

- c. Optimum Start/Stop (OSS): Optimum start/stop program shall automatically be coordinated with event scheduling. The OSS program shall start HVAC equipment at the latest possible time that will allow the equipment to achieve the desired zone condition by the time of occupancy, and it shall also shut down HVAC equipment at the earliest possible time before the end of the occupancy period and still maintain desired comfort conditions. The OSS program shall consider both outside weather conditions and inside zone conditions. The program shall automatically assign longer lead times for weekend and holiday shutdowns. The program shall poll all zones served by the associated AHU and shall select the warmest and coolest zones. These shall be used in the start time calculation. It shall be possible to assign occupancy start times on a per air handler unit basis. The program shall meet the local code requirements for minimum outdoor air while the building is occupied. Modification of assigned occupancy start/stop times shall be possible via the ECC.
- d. Event Scheduling: Provide a comprehensive menu driven program to automatically start and stop designated points or a group of points according to a stored time. This program shall provide the capability to individually command a point or group of points. When points are assigned to one common load group it shall be possible to assign variable time advances/delays between each successive start or stop within that group. Scheduling shall be calendar based and advance schedules may be defined up to one year in advance. Advance schedule shall override the day-to-day schedule. The operator shall be able to define the following information:
- 1) Time, day.
  - 2) Commands such as on, off, auto.
  - 3) Time delays between successive commands.
  - 4) Manual overriding of each schedule.
  - 5) Allow operator intervention.
- f. 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.

- g. 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.
- h. 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.
- i. 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) Variable Primary chilled water pumps and controls.
  - 3) Generate chilled water plant load profiles for different seasons for use in forecasting efficient operating schedule.
  - 4) The chilled water plant program shall display the following as a minimum:
    - a) Outdoor air dry bulb temperature.
    - b) Outdoor air wet bulb temperature.
    - c) Ton-hours of chilled water per day/month/year.

- d) On-off status for each chiller.
- e) Chilled water flow rate.
- f) Chilled water supply and return temperature.
- g) Operating set points-temperature and pressure.
- h) Kilowatts and power factor.
- i) Current limit set point.
- j) Date and time.
- k) Operating or alarm status.
- l) Operating hours.

## **2.9 SPECIAL CONTROLLERS**

A. Room Differential Pressure Controller: The differential pressure in operating rooms and isolation 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

## **2.10 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.
- d. Outdoor air temperature sensors shall have watertight inlet fittings and be shielded from direct sunlight.
- e. Wire: Twisted, shielded-pair cable.
- f. 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: 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 minute 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).
- 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.

E. CO2 Sensors:

- 1. For use to measure return air or room CO2 concentration. Unit shall be suitable for return duct application, have 0-2000 or 0-5000 ppm selectable ranges, and have an output signal suitable for use by the Facilities Monitoring and Control System. Provide necessary power/power supply needed by the sensor.
  - a. Provide necessary pre-mixed concentrations of calibration gases for calibration and testing of control and alarm points. Also, provide the gases for use in the commissioning process.

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.

## **2.11 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.

## **2.12 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 manufacturer's recommendation 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. 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. Freezestats shall have a minimum of 300 mm (one linear foot) of sensing element for each 0.093 square meter (one square foot) of coil area. A freezing condition at any increment of 300 mm (one foot) anywhere along the sensing element shall be sufficient to operate the thermostatic element. Freezestats shall be manually-reset.

- D. 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.

## **2.13 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. Spring Ranges: Range as required for system sequencing and to provide tight shut-off.
- 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. Liquid Differential-Pressure Transmitters
  - 1. The transmitter shall be FM approved smart indicating type capable of transmitting a linear 4-20mA dc output signal proportional to the liquid differential pressure being measured. The 4-20mA dc signal shall be converted to a 0-5V dc output signal if required. Transmitters shall have a display 13mm high 3 1/2 digit liquid crystal type.
  - 2. The transmitter shall be of the 2-wire design with micropressure based electronics and shall meet the following requirements:
    - a. Accuracy: +0.25% of calibrated span.
    - b. Repeatability: +0.10% of full scale.
    - c. Zero and Span: Adjustable.
    - d. Zero and Span: Adjustable.
    - e. Damping: Adjustable.
    - f. Humidity Limits: 0-100% relative humidity.
    - g. Operating Temperature: -20°F to 200°F.
    - h. Output: 4-20 mA dc converted to 0-5v dc if required.
    - i. Materials of Construction:
      - 1) Isolating Diaphragms - Type 316 stainless steel.
      - 2) Flanges - Type 316 stainless.
      - 3) Drains/Vent Valves - Type 316 stainless steel.
      - 4) Wetted O-Rings - Viton.
      - 5) Fill fluid - Silicon oil.
      - 6) Bolts - Cadmium plated carbon steel.
      - 7) Electronics housing - NEMA 4x.
      - 8) Cover O-Rings - Buna-N.
      - 9) Paint - epoxy polyester.
    - j. Range: Suitable for the application, 0-300 psi minimum.
    - k. Power Supply: 12 to 45 v dc with no load.
- F. Oxygen Depletion Sensor/Alarm System
  - 1. System shall be capable of indicating, alarming, shutting, down equipment, and automation/ventilation interface.

2. Monitor shall be capable of applying multiple sensor technology, CMOS (refrigerants), and/or electrochemical (oxygen, O<sub>2</sub>), within one system.
3. System Configuration: System shall conform to the design specifications as follows:
  - a. Description: Multi-sensor/Multi-gas monitor shall consist of controller and remote sensors. Controller shall activate an alarm and mechanical equipment room ventilation at less than the TLV-TWA.
  - b. Controller Configuration: The controller shall be wall mount type for continuous monitoring.
    - 1) Enclosure type: The enclosure shall be NEMA 12/13, IP65 design type.
    - 2) Enclosure shall be no more than 12 inches in any dimension.
    - 3) Mounting points shall be integral to enclosure.
    - 4) Controls: All adjustments shall be accessible from front panel. Functions shall include LCD display of refrigerant concentration and type; power On/Off; high alarm, low alarm, off scale alarm, fault and rest condition LED's, NO/NC relays, and optional analog output. Relay termination strip shall be isolated junction box, rigidly attached to control enclosure.
    - 5) Sensors: Controller shall be capable of monitoring up to six (6) points using CMOS sensor, or oxygen sensor, in any combination.
    - 6) There shall be no other gas inlet or outlet such as zero or compensation gas inlet.
    - 7) Operating temperature: 0°F to 120°F, non-condensing.
  - c. Sensor Configuration: Sensors shall be located in an area where refrigerants from a leak will concentrate.
    - 1) Oxygen sensor shall employ a long-life galvanic cell with electrolyte and shall be able to transmit percent oxygen value up to 300 ft. from controller.
    - 2) Sensitivity: Range of 0-25% oxygen. Accuracy +/- 1/2%.
    - 3) Operating temperature: 40°F to 110°F non-condensing.
  - d. Controller Requirements:
    - 1) Display: A 2-line LCD display shall be provided for display of sensor location, gas type and concentration, sensor type,

- alarm type (Malfunction codes are not permitted. All error codes are to be plain language.), malfunction, set-up information, diagnostics, and calibration.
- 2) Alarm set points: Three (3) levels of alarm shall be provided for each sensor (High, Low, and Off Scale). Alarm set points for each sensor shall be independently user-adjustable at value less than full scale. Relays shall be user selectable: Latching or Non-latching.
  - 3) Visual alarm indication: LED shall energize for each level or alarm, fault or malfunction.
  - 4) Relay outputs: Alarm set point signal shall activate relay. Four (4) dry contracts shall be provided to initiate output signal for three (3) level alarms and malfunction, at local panel, interface with both the DDC or BMS and the machine room ventilation system. Contract ratings 3 amps at 120 VAC, single pole, double throw, Form C.
  - 5) AutoCalibration: System shall automatically re-zero to compensate for changes. Any alarm condition or malfunction shall override automatic re-zero.
  - 6) Audible alarm: An audible alarm (110dB) shall energize when alarm condition or fault condition occurs. Audible alarm shall pulse at variable frequency to indicate type of alarm.
  - 7) Visual indication: An amber strobe light alarm shall energize when high alarm or off-scale alarm condition occurs.
- e. Power Requirements: System shall operate on 115-230 VAC, 50 Hz/60 Hz.
- f. Multi-channel Capability: The system shall be capable of adding up to six (6) sampling points, in any combination of technology (CMOS, electrochemical, O<sub>2</sub>).
- 1) System shall be capable of allowing user to add additional sensors in the field.
  - 2) System shall be capable of monitoring multiple refrigerants (CFC's, HCFC's, and HFC's) or oxygen with one controller.
  - 3) The scanner must be integral to the controller. Scanning time between channels shall be adjustable 0 to 10 seconds.

- 4) Scanner operation: Manual override push button shall be provided to hold and display any sensor reading for two minutes.
  4. Maintenance: System shall require no periodic adjustments other than checking against a clean air source, every 6 to 12 months.
- G. 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.
  4. See drawings for required control operation.

#### **2.14 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 120 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.

## **2.15 OCCUPANCY SENSORS**

### **A. Low voltage 360° dual technology.**

#### **1. Occupancy Sensors**

- a. The Dual Technology sensor shall be capable of detecting presence in the control area by detecting doppler shifts in transmitted ultrasound and passive infrared heat changes.
- b. Sensors shall use patent pending ultrasonic diffusion technology that spreads coverage to a wider area.
- c. Sensor shall utilize Dual Sensing Verification Principle for coordination between ultrasonic and PIR technologies. Detection verification of both technologies must occur in order to activate lighting systems. Upon verification, detection by either shall hold lighting on.
- d. Sensor shall have a retrigger feature in which detection by either technology shall retrigger the lighting system on within 5 seconds of being switched off.
- e. Sensors shall be ceiling mounted with a flat, unobtrusive appearance and provide 360° coverage.
- f. Ultrasonic sensing shall be volumetric in coverage with a frequency of 40 KHz. It shall utilize Advanced Signal Processing that automatically adjusts the detection threshold dynamically to compensate for changing levels of activity and airflow throughout controlled space.
- g. To avoid false ON activations and to provide immunity to RFI and EMI, Detection Signature Analysis shall be used to examine the frequency, duration, and amplitude of a signal, to respond only to those signals caused by human motion.
- h. The PIR technology shall utilize a temperature compensated, dual element sensor and a multi-element Fresnel lens. The lens shall be Poly IR4 material to offer superior performance in the infrared wavelengths and filter short wavelength IR, such as those emitted by the sun and other visible light sources. The lens shall have grooves facing in to avoid dust and residue build up which affects IR reception.
- i. Sensors shall optimize time delay and sensitivity settings to fit occupant usage patterns. The use of SmartSet shall be selectable with a DIP switch.
- j. Sensors shall have a time delay that is adjusted automatically (with the SmartSet setting) or shall have a fixed time delay of 5 to 30 minutes, set by DIP switch.
- k. Sensors shall feature a walk-through mode, where lights turn off 3 minutes after the area is initially occupied if no motion is detected after the first 30 seconds.

- l. Sensors shall have eight occupancy logic options that give the ability to customize control to meet application needs.
- m. The sensors shall feature terminal style wiring, which makes installation easier.
- n. Sensor shall have an additional single-pole, double throw isolated relay with normally open, normally closed and common outputs. The isolated relay is for use with HVAC control, data logging, and other control options.
- o. Each sensing technology shall have an LED indicator that remains active at all times in order to verify detection within the area to be controlled. The LED can be disabled for applications that require less sensor visibility.
- p. To ensure quality and reliability, sensor shall be manufactured by an ISO 9002 certified manufacturing facility and shall have a defect rate of less than 1/3 of 1%.
- q. Sensors shall have standard 5 year warranty and shall be UL and CUL listed.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

##### **A. General:**

1. Examine project plans for control devices and equipment locations; and report any discrepancies, conflicts, or omissions to Contracting Officer's Representative 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.
9. Obtain 120V power from the temperature control power junction boxes or at the main temperature control panel as indicated on the electrical drawings. Line voltage wiring shall be in conduit. Install per Division 16 requirements. Extend 120V power to the field devices or control panels as required.

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. Oxygen Depletion Monitoring and Alarm System

1. Provide and install sampling modules as indicated on the Mechanical drawings, and recommend by the unit manufacturer.
2. Install controller as indicated and recommended by the unit manufacturer.
3. Install all wiring in conduit per Division 16 requirements.
4. Program, calibrate, and test the unit to meet the control sequence as indicated.

E. Occupancy Sensors:

1. Provide where indicated and where lighting occupancy sensors with HVAC interface are not provided.

2. Provide number of sensors per manufacturer's recommendations for a full room coverage. Submit proposed layout with calculations.
3. Install and power per the manufacturer's recommendations.

F. 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.

G. 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. The following witnessed demonstrations of field control equipment shall be included:

- a. Observe HVAC systems in shut down condition. Check dampers and valves for normal position.
  - b. Test application software for its ability to communicate with digital controllers, operator workstation, and uploading and downloading of control programs.
  - c. Demonstrate the software ability to edit the control program off-line.
  - d. Demonstrate reporting of alarm conditions for each alarm and ensure that these alarms are received at the assigned location, including operator workstations.
  - e. Demonstrate ability of software program to function for the intended applications-trend reports, change in status etc.
  - f. Demonstrate via graphed trends to show the sequence of operation is executed in correct manner, and that the HVAC systems operate properly through the complete sequence of operation, e.g., seasonal change, occupied/unoccupied mode, and warm-up condition.
  - g. Demonstrate hardware interlocks and safeties functions, and that the control systems perform the correct sequence of operation after power loss and resumption of power loss.
  - h. Prepare and deliver to the VA graphed trends of all control loops to demonstrate that each control loop is stable and the set points are maintained.
  - i. Demonstrate that each control loop responds to set point adjustment and stabilizes within one (1) minute. Control loop trend data shall be instantaneous and the time between data points shall not be greater than one (1) minute.
5. 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.

### **3.3 CONSTRUCTION WASTE MANAGEMENT**

- A. General: Comply with Contractor's Waste Management Plan and Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- B. To the greatest extent possible, separate reusable and recyclable products from contaminated waste and debris in accordance with the Contractor's Waste Management Plan. Place recyclable and reusable products in designated containers and protect from moisture and contamination.

----- END -----

**SECTION 23 21 13**  
**HYDRONIC PIPING**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. Water piping to connect HVAC equipment, including the following:
  - 1. Chilled water, heat recovery water, heating hot water and drain piping.
  - 2. Extension of domestic water make-up piping.

**1.2 RELATED WORK**

- A. Section 01 00 00, GENERAL REQUIREMENTS.
- B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- C. Section 31 20 00, EARTH MOVING: Excavation and backfill.
- D. Section 03 30 00, CAST-IN-PLACE CONCRETE.
- E. Section 07 12 00, BUILT-UP BITUMINOUS WATERPROOFING, and Section 07 13 52, MODIFIED BITUMINOUS SHEET WATERPROOFING.
- F. Section 33 10 00, WATER UTILITIES: Underground piping.
- G. Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS: Seismic restraints for piping.
- H. Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION: General mechanical requirements and items, which are common to more than one section of Division 23.
- I. Section 23 21 23, HYDRONIC PUMPS: Pumps.
- J. Section 23 07 11, HVAC, PLUMBING, and BOILER PLANT INSULATION: Piping insulation.
- K. Section 23 25 00, HVAC WATER TREATMENT: Water treatment for open and closed systems.
- L. Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC: Temperature and pressure sensors and valve operators.
- M. Section 23 74 13, PACKAGED, OUTDOOR, CENTRAL STATION AIR HANDLING UNITS

**1.3 QUALITY ASSURANCE**

- A. Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION, which includes welding qualifications.
- B. Submit prior to welding of steel piping a certificate of Welder's certification. The certificate shall be current and not more than one year old.

C. All grooved joint couplings, fittings, valves, and specialties shall be the products of a single manufacturer. Grooving tools shall be the same manufacturer as the grooved components.

1. All castings used for coupling housings, fittings, valve bodies, etc., shall be date stamped for quality assurance and traceability.

#### **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. Pipe and equipment supports.
2. Pipe and tubing, with specification, class or type, and schedule.
3. Pipe fittings, including miscellaneous adapters and special fittings.
4. Flanges, gaskets and bolting.
5. Grooved joint couplings and fittings.
6. Valves of all types.
7. Strainers.
8. Flexible connectors for water service.
9. Pipe alignment guides.
10. All specified hydronic system components.
11. Water flow measuring devices.
12. Gages.
13. Thermometers and test wells.
14. Design and calculations for new and existing (within the 3rd floor project area) piping systems supports and bracings. See Specification Section 13 05 41 for requirements.

C. Manufacturer's certified data report, Form No. U-1, for ASME pressure vessels.

D. Submit the welder's qualifications in the form of a current (less than one year old) and formal certificate.

E. Coordination Drawings: Refer to Article, SUBMITTALS of Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.

F. As-Built Piping Diagrams: Provide drawing as follows for chilled water, condenser water, and heating hot water system and other piping systems and equipment.

- ## 1.5 APPLICABLE PUBLICATIONS

- HYDRONIC PIPING  
23 21 13 - 3

- B16.42-06.....Ductile Iron Pipe Flanges and Flanged Fittings  
B31.1-08.....Power Piping
- E. American Society for Testing and Materials (ASTM):
- A47/A47M-99 (2004).....Ferritic Malleable Iron Castings  
A53/A53M-07.....Standard Specification for Pipe, Steel, Black  
and Hot-Dipped, Zinc-Coated, Welded and  
Seamless  
A106/A106M-08.....Standard Specification for Seamless Carbon  
Steel Pipe for High-Temperature Service  
A126-04.....Standard Specification for Gray Iron Castings  
for Valves, Flanges, and Pipe Fittings  
A183-03 ..... Standard Specification for Carbon Steel Track  
Bolts and Nuts  
A216/A216M-08 ..... Standard Specification for Steel Castings,  
Carbon, Suitable for Fusion Welding, for High  
Temperature Service  
A234/A234M-07 ..... Piping Fittings of Wrought Carbon Steel and  
Alloy Steel for Moderate and High Temperature  
Service  
A307-07 ..... Standard Specification for Carbon Steel Bolts  
and Studs, 60,000 PSI Tensile Strength  
A536-84 (2004) ..... Standard Specification for Ductile Iron Castings  
A615/A615M-08 ..... Deformed and Plain Carbon Steel Bars for  
Concrete Reinforcement  
A653/A 653M-08 ..... Steel Sheet, Zinc-Coated (Galvanized) or Zinc-  
Iron Alloy Coated (Galvannealed) By the Hot-Dip  
Process  
B32-08 ..... Standard Specification for Solder Metal  
B62-02 ..... Standard Specification for Composition Bronze or  
Ounce Metal Castings  
B88-03 ..... Standard Specification for Seamless Copper Water  
Tube  
B209-07 ..... Aluminum and Aluminum Alloy Sheet and Plate  
C177-04 ..... Standard Test Method for Steady State Heat Flux  
Measurements and Thermal Transmission Properties  
by Means of the Guarded Hot Plate Apparatus  
C478-09 ..... Precast Reinforced Concrete Manhole Sections

- C533-07 ..... Calcium Silicate Block and Pipe Thermal  
Insulation
- C552-07 ..... Cellular Glass Thermal Insulation
- D3350-08 ..... Polyethylene Plastics Pipe and Fittings  
Materials
- C591-08 ..... Unfaced Preformed Rigid Cellular  
Polyisocyanurate Thermal Insulation
- D1784-08 ..... Rigid Poly (Vinyl Chloride) (PVC) Compounds and  
Chlorinated Poly (Vinyl Chloride) (CPVC)  
Compound
- D1785-06 ..... Poly (Vinyl Chloride) (PVC) Plastic Pipe,  
Schedules 40, 80 and 120
- D2241-05 ..... Poly (Vinyl Chloride) (PVC) Pressure Rated Pipe  
(SDR Series)
- F439-06 ..... Standard Specification for Chlorinated Poly  
(Vinyl Chloride) (CPVC) Plastic Pipe Fittings,  
Schedule 80
- F441/F441M-02 ..... Standard Specification for Chlorinated Poly  
(Vinyl Chloride) (CPVC) Plastic Pipe, Schedules  
40 and 80
- F477-08 ..... Elastomeric Seals Gaskets) for Joining Plastic  
Pipe
- F. American Water Works Association (AWWA):
  - C110-08.....Ductile Iron and Grey Iron Fittings for Water
  - C203-02.....Coal Tar Protective Coatings and Linings for  
Steel Water Pipe Lines Enamel and Tape Hot  
Applied
- G. American Welding Society (AWS):
  - B2.1-02.....Standard Welding Procedure Specification
- H. Copper Development Association, Inc. (CDA):
  - CDA A4015-06.....Copper Tube Handbook
- I. Expansion Joint Manufacturer's Association, Inc. (EJMA):
  - EMJA-2003.....Expansion Joint Manufacturer's Association  
Standards, Ninth Edition
- J. Manufacturers Standardization Society (MSS) of the Valve and Fitting  
Industry, Inc.:
  - SP-67-02a.....Butterfly Valves



SP-70-06.....Gray Iron Gate Valves, Flanged and Threaded  
Ends

SP-71-05.....Gray Iron Swing Check Valves, Flanged and  
Threaded Ends

SP-80-08.....Bronze Gate, Globe, Angle and Check Valves

SP-85-02.....Cast Iron Globe and Angle Valves, Flanged and  
Threaded Ends

SP-110-96.....Ball Valves Threaded, Socket-Welding, Solder  
Joint, Grooved and Flared Ends

SP-125-00.....Gray Iron and Ductile Iron In-line, Spring  
Loaded, Center-Guided Check Valves

K. National Sanitation Foundation/American National Standards Institute,  
Inc. (NSF/ANSI):

14-06.....Plastic Piping System Components and Related  
Materials

50-2009a.....Equipment for Swimming Pools, Spas, Hot Tubs  
and other Recreational Water Facilities -  
Evaluation criteria for materials, components,  
products, equipment and systems for use at  
recreational water facilities

61-2008.....Drinking Water System Components - Health  
Effects

L. Tubular Exchanger Manufacturers Association: TEMA 9th Edition, 2007

## **PART 2 - PRODUCTS**

### **2.1 PIPE AND EQUIPMENT SUPPORTS, PIPE SLEEVES, AND WALL AND CEILING PLATES**

A. Provide in accordance with Section 23 05 11, COMMON WORK RESULTS FOR  
HVAC and STEAM GENERATION.

### **2.2 PIPE AND TUBING**

A. Chilled Water, Heat Recovery Water, Heating Hot Water, and Vent Piping:

1. Steel: ASTM A53 Grade B, seamless or ERW, Schedule 40.

2. Copper water tube option: ASTM B88, Type L, hard drawn.

B. Extension of Domestic Water Make-up Piping: ASTM B88, Type K or L, hard  
drawn copper tubing.

C. Cooling Coil Condensate Drain Piping:

1. From air handling units: Copper water tube, ASTM B88, Type M,  
piping.

- D. Pipe supports, including insulation shields, for above ground piping:  
Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.

### **2.3 FITTINGS FOR STEEL PIPE**

- A. 50 mm (2 inches) and Smaller: Screwed or welded joints.
1. Butt welding: ASME B16.9 with same wall thickness as connecting piping.
  2. Forged steel, socket welding or threaded: ASME B16.11.
  3. Screwed: 150 pound malleable iron, ASME B16.3. 125 pound cast iron, ASME B16.4, may be used in lieu of malleable iron. Bushing reduction of a single pipe size, or use of close nipples, is not acceptable.
  4. Unions: ASME B16.39.
  5. Water hose connection adapter: Brass, pipe thread to 20 mm (3/4 inch) garden hose thread, with hose cap nut.
- B. 65 mm (2-1/2 inches) and Larger: Welded or flanged joints. Contractor's option: Grooved mechanical couplings and fittings are acceptable for chilled water and Heat Recovery Water piping only.
1. Butt welding fittings: ASME B16.9 with same wall thickness as connecting piping. Elbows shall be long radius type, unless otherwise noted.
  2. Welding flanges and bolting: ASME B16.5:
    - a. Water service: Weld neck or slip-on, plain face, with 6 mm (1/8 inch) thick full face neoprene gasket suitable for 104 degrees C (220 degrees F).
      - 1) Contractor's option: Convolute, cold formed 150 pound steel flanges, with teflon gaskets, may be used for water service.
    - b. Flange bolting: Carbon steel machine bolts or studs and nuts, ASTM A307, Grade B.
- C. Welded Branch and Tap Connections: Forged steel weldolets, or branchlets and threadolets may be used for branch connections up to one pipe size smaller than the main. Forged steel half-couplings, ASME B16.11 may be used for drain, vent and gage connections.
- D. Grooved Mechanical Pipe Couplings and Fittings (for chilled water and heat recovery water piping only): Grooved Mechanical Pipe Couplings and Fittings may be used, with cut or roll grooved pipe, in water service up to 110 degrees C (230 degrees F) in lieu of welded, screwed or flanged connections. All joints must be rigid type.

1. Grooved mechanical couplings: Malleable iron, ASTM A47 or ductile iron, ASTM A536, fabricated in two or more parts, securely held together by two or more track-head, square, or oval-neck bolts, ASTM A449 and A183.
2. Gaskets: Rubber product recommended by the coupling manufacturer for the intended service.
3. Grooved end fittings: Malleable iron, ASTM A47; ductile iron, ASTM A536; or steel, ASTM A53 or A106, designed to accept grooved mechanical couplings. Tap-in type branch connections are acceptable.

#### **2.4 FITTINGS FOR COPPER TUBING**

##### **A. Joints:**

1. Solder Joints: Joints shall be made up in accordance with recommended practices of the materials applied. Apply 95/5 tin and antimony on all copper piping.
2. Mechanically formed tee connection in water and drain piping: Form mechanically extracted collars in a continuous operation by drilling pilot hole and drawing out tube surface to form collar, having a height of not less than three times the thickness of tube wall. Adjustable collaring device shall insure proper tolerance and complete uniformity of the joint. Notch and dimple joining branch tube in a single process to provide free flow where the branch tube penetrates the fitting.

##### **B. Bronze Flanges and Flanged Fittings: ASME B16.24.**

##### **C. Fittings: ANSI/ASME B16.18 cast copper or ANSI/ASME B16.22 solder wrought copper.**

#### **2.5 FITTINGS FOR PLASTIC PIPING**

##### **A. Schedule 40, socket type for solvent welding.**

#### **2.6 DIELECTRIC FITTINGS**

- A. Provide where copper tubing and ferrous metal pipe are joined.
- B. 50 mm (2 inches) and Smaller: Threaded dielectric union, ASME B16.39.
- C. 65 mm (2 1/2 inches) and Larger: Flange union with dielectric gasket and bolt sleeves, ASME B16.42.
- D. Temperature Rating, 99 degrees C (210 degrees F).
- E. Contractor's option: On pipe sizes 2" and smaller, minimum 6" long screwed or dielectric nipples may be used in lieu of dielectric unions.

#### **2.7 SCREWED JOINTS**

##### **A. Pipe Thread: ANSI B1.20.**

- B. Lubricant or Sealant: Oil and graphite or other compound approved for the intended service.

## **2.8 VALVES**

- A. Asbestos packing is not acceptable.
- B. All valves of the same type shall be products of a single manufacturer.
- C. Provide chain operators for valves 150 mm (6 inches) and larger when the centerline is located 2400 mm (8 feet) or more above the floor or operating platform.
- D. Shut-Off Valves
  - 1. Ball Valves (Pipe sizes 2-1/2" and smaller): MSS-SP 110, screwed or solder connections, brass or bronze body with chrome-plated ball with full port and Teflon seat at 2760 kPa (400 psig) working pressure rating. Provide stem extension to allow operation without interfering with pipe insulation.
  - 2. Butterfly Valves (Pipe Sizes 3" and larger): Provide stem extension to allow 50 mm (2 inches) of pipe insulation without interfering with valve operation. MSS-SP 67, flange lug type or grooved end rated 1205 kPa (175 psig) working pressure at 93 degrees C (200 degrees F). Valves shall be ANSI Leakage Class VI and rated for bubble tight shut-off to full valve pressure rating. Valve shall be rated for dead end service and bi-directional flow capability to full rated pressure. Not permitted for direct buried pipe applications.
    - a. Body: Cast iron, ASTM A126, Class B. Malleable iron, ASTM A47 electro-plated, or ductile iron, ASTM A536, Grade 65-45-12 electro-plated.
    - b. Trim: Bronze, aluminum bronze, or 300 series stainless steel disc, bronze bearings, 316 stainless steel shaft and manufacturer's recommended resilient seat. Resilient seat shall be field replaceable, and fully line the body to completely isolate the body from the product. A phosphate coated steel shaft or stem is acceptable, if the stem is completely isolated from the product.
    - c. Actuators: Field interchangeable. Valves for balancing service shall have adjustable memory stop to limit open position.

- 1) Valves 150 mm (6 inches) and smaller: Lever actuator with minimum of seven locking positions, except where chain wheel is required.
- 2) Valves 200 mm (8 inches) and larger: Enclosed worm gear with handwheel, and where required, chain-wheel operator.

E. Globe Valves

1. Globe Valves

- a. 50 mm (2 inches) and smaller: MSS-SP 80, bronze, 1034 kPa (150 lb.) Globe valves shall be union bonnet with metal plug type disc.
- b. 65 mm (2 1/2 inches) and larger: 861 kPa (125 psig), flanged, iron body, bronze trim, MSS-SP-85 for globe valves.

F. Check Valves

1. Swing Check Valves:

- a. 50 mm (2 inches) and smaller: MSS-SP 80, bronze, 1034 kPa (150 lb.), 45 degree swing disc.
- b. 65 mm (2 1/2 inches) and larger: 861 kPa (125 psig), flanged, iron body, bronze trim, MSS-SP-71 for check valves.

2. Non-Slam or Silent Check Valve: Spring loaded double disc swing check or internally guided flat disc lift type check for bubble tight shut-off. Provide where check valves are shown in chilled water and hot water piping. Check valves incorporating a balancing feature may be used.

- a. Body: MSS-SP 125 cast iron, ASTM A126, Class B, or steel, ASTM A216, Class WCB, or ductile iron, ASTM 536, flanged, grooved, or wafer type.
- b. Seat, disc and spring: 18-8 stainless steel, or bronze, ASTM B62. Seats may be elastomer material.

G. Water Flow Balancing Valves: For flow regulation and shut-off. Valves shall be line size rather than reduced to control valve size.

1. Ball or Globe style valve.
2. A dual purpose flow balancing valve and adjustable flow meter, with bronze or cast iron body, calibrated position pointer, valved pressure taps or quick disconnects with integral check valves and preformed polyurethane insulating enclosure.
3. Provide a readout kit including flow meter, readout probes, hoses, flow charts or calculator, and carrying case.

H. Automatic Balancing Control Valves: Factory calibrated to maintain constant flow (plus or minus five percent) over system pressure fluctuations of at least 10 times the minimum required for control. Provide standard pressure taps and four sets of capacity charts. Valves shall be line size and be one of the following designs:

1. Gray iron (ASTM A126) or brass body rated 1205 kPa (175 psig) at 93 degrees C (200 degrees F), with stainless steel piston and spring.
2. Brass or ferrous body designed for 2067 kPa (300 psig) service at 121 degrees C (250 degrees F), with corrosion resistant, tamper proof, self-cleaning piston/spring assembly that is easily removable for inspection or replacement.
3. Combination assemblies containing ball type shut-off valves, unions, flow regulators, strainers with blowdown valves and pressure temperature ports shall be acceptable.
4. Provide a readout kit including flow meter, probes, hoses, flow charts and carrying case.

## **2.9 WATER FLOW MEASURING DEVICES**

- A. Minimum overall accuracy plus or minus three percent over a range of 70 to 110 percent of design flow. Select devices for not less than 110 percent of design flow rate.
- B. Insertion Turbine Type Sensor: Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC.
- C. Flow Measuring Device Identification:
  1. Metal tag attached by chain to the device.
  2. Include meter or equipment number, manufacturer's name, meter model, flow rate factor and design flow rate in l/m (gpm).

## **2.10 STRAINERS**

- A. Basket or Y Type.
  1. Screens: Bronze, monel metal or 18-8 stainless steel, free area not less than 2-1/2 times pipe area, with perforations as follows: 1.1 mm (0.045 inch) diameter perforations for 100 mm (4 inches) and larger: 3.2 mm (0.125 inch) diameter perforations.
- B. Suction Diffusers: Specified in Section 23 21 23, HYDRONIC PUMPS.

## **2.11 FLEXIBLE CONNECTORS FOR WATER SERVICE**

- A. Flanged Spool Connector (for chilled water and heat recovery water system only):

1. Single arch or multiple arch type. Tube and cover shall be constructed of chlorobutyl elastomer with full faced integral flanges to provide a tight seal without gaskets. Connectors shall be internally reinforced with high strength synthetic fibers impregnated with rubber or synthetic compounds as recommended by connector manufacturer, and steel reinforcing rings.
2. Working pressures and temperatures shall be as follows:
  - a. Connector sizes 50 mm to 100 mm (2 inches to 4 inches), 1137 kPa (165psig) at 121 degrees C (250 degrees F).
  - b. Connector sizes 125 mm to 300 mm (5 inches to 12 inches), 965 kPa (140 psig) at 121 degrees C (250 degrees F).
3. Provide ductile iron retaining rings and control units.

**B. Mechanical Pipe Couplings:**

See other fittings specified under Part 2, PRODUCTS.

**2.12 HYDRONIC SYSTEM COMPONENTS**

- A. Bladder Type Pre-Pressurized Expansion Tank: ASME Pressure Vessel Code construction for 861 kPa (125 psig) working pressure, welded steel shell, rust-proof coated, with a flexible elastomeric diaphragm suitable for a maximum operating temperature of 116 degrees C (240 degrees F). Provide Form No. U-1. Tank shall be equipped with system connection, drain connection, standard air fill valve and be factory pre-charged to a minimum of 83 kPa (12 psig).
- B. Pressure Reducing Valve (Water): Diaphragm or bellows operated, spring loaded type, with minimum adjustable range of 28 kPa (4 psig) above and below set point. Bronze, brass or iron body and bronze, brass or stainless steel trim, rated 861 kPa (125 psig) working pressure at 107 degrees C (225 degrees F).
- C. Pressure Relief Valve: Bronze or iron body and bronze or stainless steel trim, with testing lever. Comply with ASME Code for Pressure Vessels, Section 8, and bear ASME stamp.
- D. Automatic Air Vent Valves (where shown): Cast iron or semi-steel body, 1034 kPa (150 psig) working pressure, stainless steel float, valve, valve seat and mechanism, minimum 15 mm (1/2 inch) water connection and 6 mm (1/4 inch) air outlet. Air outlet shall be piped to the nearest floor drain.

**2.13 POT CHEMICAL FEEDERS**

See section 23 25 00, HVAC WATER TREATMENT, Article 2.2, CHEMICAL

TREATMENT FOR CLOSED LOOP SYSTEMS.

**2.14 GAGES, PRESSURE AND COMPOUND**

- A. ASME B40.100, Accuracy Grade 1A, (pressure, vacuum, or compound for air, oil or water), initial mid-scale accuracy 1 percent of scale (Qualify grade), metal or phenolic case, 115 mm (4-1/2 inches) in diameter, 6 mm (1/4 inch) NPT bottom connection, white dial with black graduations and pointer, clear glass or acrylic plastic window, suitable for board mounting. Provide red "set hand" to indicate normal working pressure.
- B. Provide brass lever handle union cock. Provide brass/bronze pressure snubber for gages in water service.
- C. Range of Gages: Provide range equal to at least 130 percent of normal operating range.
  - 1. For condenser water suction (compound): Minus 100 kPa (30 inches Hg) to plus 700 kPa (100 psig).

**2.15 PRESSURE/TEMPERATURE TEST PROVISIONS**

- A. Pete's Plug: 6 mm (1/4 inch) MPT by 75 mm (3 inches) long, brass body and cap, with retained safety cap, nordel self-closing valve cores, permanently installed in piping where shown, or in lieu of pressure gage test connections shown on the drawings.
- B. Provide one each of the following test items to the Resident Engineer:
  - 1. 6 mm (1/4 inch) FPT by 3 mm (1/8 inch) diameter stainless steel pressure gage adapter probe for extra long test plug. PETE'S 500 XL is an example.
  - 2. 90 mm (3-1/2 inch) diameter, one percent accuracy, compound gage, -- 100 kPa (30 inches) Hg to 700 kPa (100 psig) range.
  - 3. 0 - 104 degrees C (220 degrees F) pocket thermometer one-half degree accuracy, 25 mm (one inch) dial, 125 mm (5 inch) long stainless steel stem, plastic case.

**2.16 THERMOMETERS**

- A. Mercury or organic liquid filled type, red or blue column, clear plastic window, with 150 mm (6 inch) brass stem, straight, fixed or adjustable angle as required for each in reading.
- B. Case: Chrome plated brass or aluminum with enamel finish.
- C. Scale: Not less than 225 mm (9 inches), range as described below, two degree graduations.



D. Separable Socket (Well): Brass, extension neck type to clear pipe insulation.

E. Scale ranges:

1. Chilled Water and Heat Recovery-Water: 0-38 degrees C (32-100 degrees F).
2. Hot Water: -1 - 116 degrees C (30-240 degrees F).

## **2.16 FIRESTOPPING MATERIAL**

Refer to Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.

## **PART 3 - EXECUTION**

### **3.1 GENERAL**

- A. The drawings show the general arrangement of pipe and equipment but do not show all required fittings and offsets that may be necessary to connect pipes to equipment, fan-coils, coils, radiators, etc., and to coordinate with other trades. Provide all necessary fittings, offsets and pipe runs based on field measurements and at no additional cost to the government. Coordinate with other trades for space available and relative location of HVAC equipment and accessories to be connected on ceiling grid. Pipe location on the drawings shall be altered by contractor where necessary to avoid interferences and clearance difficulties.
- B. Store materials to avoid excessive exposure to weather or foreign materials. Keep inside of piping relatively clean during installation and protect open ends when work is not in progress.
- C. Support piping securely. Refer to PART 3, Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION. D. Install piping generally parallel to walls and column center lines, unless shown otherwise on the drawings. Space piping, including insulation, to provide 25 mm (one inch) minimum clearance between adjacent piping or other surface. Unless shown otherwise, slope drain piping down in the direction of flow not less than 25 mm (one inch) in 12 m (40 feet). Provide eccentric reducers to keep bottom of sloped piping flat.
- D. Locate and orient valves to permit proper operation and access for maintenance of packing, seat and disc. Generally locate valve stems in overhead piping in horizontal position. Provide a union adjacent to one end of all threaded end valves. Control valves usually require reducers to connect to pipe sizes shown on the drawing. Install butterfly valves

with the valve open as recommended by the manufacturer to prevent binding of the disc in the seat.

- E. Offset equipment connections to allow valving off for maintenance and repair with minimal removal of piping. Provide flexibility in equipment connections and branch line take-offs with 3-elbow swing joints where noted on the drawings.
- F. Tee water piping runouts or branches into the side of mains or other branches. Avoid bull-head tees, which are two return lines entering opposite ends of a tee and exiting out the common side.
- G. Provide manual or automatic air vent at all piping system high points and drain valves at all low points. Install piping to floor drains from all automatic air vents.
- H. Connect piping to equipment as shown on the drawings. Install components furnished by others such as:
  - 1. Water treatment pot feeders and condenser water treatment systems.
  - 2. Flow elements (orifice unions), control valve bodies, flow switches, pressure taps with valve, and wells for sensors.
- I. Thermometer Wells: In pipes 65 mm (2-1/2 inches) and smaller increase the pipe size to provide free area equal to the upstream pipe area.
- J. Firestopping: Fill openings around uninsulated piping penetrating floors or fire walls, with firestop material. For firestopping insulated piping refer to Section 23 07 11, HVAC, PLUMBING, and BOILER PLANT INSULATION.
- K. Where copper piping is connected to steel piping, provide dielectric connections.

### **3.2 PIPE JOINTS**

- A. Welded: Beveling, spacing and other details shall conform to ASME B31.1 and AWS B2.1. See Welder's qualification requirements under "Quality Assurance" in Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.
- B. Screwed: Threads shall conform to ASME B1.20; joint compound shall be applied to male threads only and joints made up so no more than three threads show. Coat exposed threads on steel pipe with joint compound, or red lead paint for corrosion protection.
- C. Mechanical Joint: Pipe grooving shall be in accordance with joint manufacturer's specifications. Lubricate gasket exterior including lips, pipe ends and housing interiors to prevent pinching the gasket

during installation. Lubricant shall be as recommended by coupling manufacturer.

- D. 125 Pound Cast Iron Flange (Plain Face): Mating flange shall have raised face, if any, removed to avoid overstressing the cast iron flange.

### **3.3 SUPPORTS AND SEISMIC BRACING ABOVEGROUND PIPING**

A. Provide supports and bracing for new piping. Provide additional support and bracing on the existing piping within the 3rd Floor project area. Provide in accordance with Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.

### **3.4 LEAK TESTING ABOVEGROUND PIPING**

- A. Inspect all joints and connections for leaks and workmanship and make corrections as necessary, to the satisfaction of the Resident Engineer. Tests may be either of those below, or a combination, as approved by the Resident Engineer.
- B. An operating test at design pressure, and for hot systems, design maximum temperature.
- C. A hydrostatic test at 1.5 times design pressure (minimum 100 psig). For water systems the design maximum pressure would usually be the static head, or expansion tank maximum pressure, plus pump head. Factory tested equipment (convertors, exchangers, coils, etc.) need not be field tested. Isolate equipment where necessary to avoid excessive pressure on mechanical seals and safety devices.

### **3.5 FLUSHING AND CLEANING PIPING SYSTEMS**

- A. Water Piping: Clean systems as recommended by the suppliers of chemicals specified in Section 23 25 00, HVAC WATER TREATMENT.
  - 1. Initial flushing: Remove loose dirt, mill scale, metal chips, weld beads, rust, and like deleterious substances without damage to any system component. Provide temporary piping or hose to bypass coils, control valves, exchangers and other factory cleaned equipment unless acceptable means of protection are provided and subsequent inspection of hide-out areas takes place. Isolate or protect clean system components, including pumps and pressure vessels, and remove any component which may be damaged. Open all valves, drains, vents and strainers at all system levels. Remove plugs, caps, spool pieces, and components to facilitate early debris discharge from system. Sectionalize system to obtain debris carrying velocity of

- 1.8 m/S (6 feet per second), if possible. Connect dead-end supply and return headers as necessary. Flush bottoms of risers. Install temporary strainers where necessary to protect down-stream equipment. Supply and remove flushing water and drainage by various type hose, temporary and permanent piping and Contractor's booster pumps. Flush until clean as approved by the Resident Engineer.
2. Cleaning: Using products supplied in Section 23 25 00, HVAC WATER TREATMENT, circulate systems at normal temperature to remove adherent organic soil, hydrocarbons, flux, pipe mill varnish, pipe joint compounds, iron oxide, and like deleterious substances not removed by flushing, without chemical or mechanical damage to any system component. Removal of tightly adherent mill scale is not required. Keep isolated equipment which is "clean" and where dead-end debris accumulation cannot occur. Sectionalize system if possible, to circulate at velocities not less than 1.8 m/S (6 feet per second). Circulate each section for not less than four hours. Blow-down all strainers, or remove and clean as frequently as necessary. Drain and prepare for final flushing.
3. Final Flushing: Return systems to conditions required by initial flushing after all cleaning solution has been displaced by clean make-up. Flush all dead ends and isolated clean equipment. Gently operate all valves to dislodge any debris in valve body by throttling velocity. Flush for not less than one hour.

### **3.6 WATER TREATMENT**

- A. Install water treatment equipment and provide water treatment system piping.
- B. Close and fill system as soon as possible after final flushing to minimize corrosion.
- C. Charge systems with chemicals specified in Section 23 25 00, HVAC WATER TREATMENT.
- D. Utilize this activity, by arrangement with the Resident Engineer, for instructing VA operating personnel.

### **3.7 OPERATING AND PERFORMANCE TEST AND INSTRUCTION**

- A. Refer to PART 3, Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.
- B. Adjust red set hand on pressure gages to normal working pressure.

- - - E N D - - -

**23 21 23**  
**HYDRONIC PUMPS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. Hydronic pumps for Heating, Ventilating and Air Conditioning.

**1.2 RELATED WORK**

- A. Section 01 00 00, GENERAL REQUIREMENTS.
- B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- C. Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.
- D. Section 23 05 11, COMMON WORK RESULTS FOR HVAC.
- E. Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING and EQUIPMENT.
- F. Section 23 21 13, HYDRONIC PIPING.
- G. Section 23 05 12, GENERAL MOTOR REQUIREMENTS FOR HVAC and STEAM GENERATION EQUIPMENT.
- H. Section 26 29 11, LOW-VOLTAGE MOTOR STARTERS.

**1.3 QUALITY ASSURANCE**

- A. Refer to Paragraph, QUALITY ASSURANCE, in Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.
- B. Design Criteria:
  - 1. Pumps design and manufacturer shall conform to Hydraulic Institute Standards.
  - 2. Pump sizes, capacities, pressures, operating characteristics and efficiency shall be as scheduled.
  - 3. Head-capacity curves shall slope up to maximum head at shut-off. Curves shall be relatively flat for closed systems. Select pumps near the midrange of the curve, so the design capacity falls to the left of the best efficiency point, to allow a cushion for the usual drift to the right in operation, without approaching the pump curve end point and possible cavitation and unstable operation. Select pumps for open systems so that required net positive suction head (NPSHR) does not exceed the net positive head available (NPSHA).

4. Pump Driver: Furnish with pump. Size shall be non-overloading at any point on the head-capacity curve, including in a parallel or series pumping installation with one pump in operation.
5. Provide all pumps with motors, impellers, drive assemblies, bearings, coupling guard and other accessories specified. Statically and dynamically balance all rotating parts.
6. Furnish each pump and motor with a nameplate giving the manufacturers name, serial number of pump, capacity in GPM and head in feet at design condition, horsepower, voltage, frequency, speed and full load current and motor efficiency.
7. Test all pumps before shipment. The manufacturer shall certify all pump ratings.
8. After completion of balancing, provide replacement of impellers or trim impellers to provide specified flow at actual pumping head, as installed.

C. Allowable Vibration Tolerance for Pump Units: Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING and EQUIPMENT.

#### **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. Pumps and accessories.
  2. Motors and drives.
  3. Variable speed motor controllers.
- C. Manufacturer's installation, maintenance and operating instructions, in accordance with Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.
- D. Characteristic Curves: Head-capacity, efficiency-capacity, brake horsepower-capacity, and NPSHR-capacity for each pump and for combined pumps in parallel or series service. Identify pump and show fluid pumped, specific gravity, pump speed and curves plotted from zero flow

to maximum for the impeller being furnished and at least the maximum diameter impeller that can be used with the casing.

### 1.5 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 Iron and Steel Institute (AISI):

AISI 1045.....Cold Drawn Carbon Steel Bar, Type 1045

AISI 416.....Type 416 Stainless Steel

C. American National Standards Institute (ANSI):

ANSI B15.1-00(R2008)..... Safety Standard for Mechanical Power  
Transmission Apparatus

ANSI B16.1-05.....Cast Iron Pipe Flanges and Flanged Fittings,  
Class 25, 125, 250 and 800

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

A48-03 (2008).....Standard Specification for Gray Iron Castings

B62-2009.....Standard Specification for Composition Bronze or  
Ounce Metal Castings

E. Maintenance and Operating Manuals in accordance with Section 01 00 00,  
General Requirements.

### 1.6 DEFINITIONS

A. Capacity: Gallons per minute (GPM) of the fluid pumped.

B. Head: Total dynamic head in feet of the fluid pumped.

C. Flat head-capacity curve: Where the shutoff head is less than 1.16 times the head at the best efficiency point.

### 1.7 SPARE MATERIALS

A. Furnish one spare seal and casing gasket for each pump to the Project Manager.

**PART 2 - PRODUCTS**

**2.1 CENTRIFUGAL PUMPS, BRONZE FITTED**

A. General:

1. Provide pumps that will operate continuously without overheating bearings or motors at every condition of operation on the pump curve, or produce noise audible outside the room or space in which installed.
2. Provide pumps of size, type and capacity as indicated, complete with electric motor and drive assembly, unless otherwise indicated. Design pump casings for the indicated working pressure and factory test at 1½ times the designed pressure.
3. Provide pumps of the same type, the product of a single manufacturer, with pump parts of the same size and type interchangeable.
4. General Construction Requirements
  - a. Balance: Rotating parts, statically and dynamically.
  - b. Construction: To permit servicing without breaking piping or motor connections.
  - c. Pump Motors: Provide premium efficiency motors, inverter duty for variable speed service. Refer to Section 23 05 12, GENERAL MOTOR REQUIREMENTS FOR HVAC and STEAM GENERATION EQUIPMENT. Motors shall be Totally Enclosed Fan Cooled (TEFC) and operate at 1750 rpm unless noted otherwise.
  - e. Provide coupling guards that meet ANSI B15.1, Section 8 and OSHA requirements.
  - f. Pump Connections: Flanged.
  - g. Pump shall be factory tested.
  - h. Performance: As scheduled on the Contract Drawings.
5. Variable Speed Pumps:
  - a. The pumps shall be the type shown on the drawings and specified herein flex coupled to an open drip-proof motor.



- b. Variable Speed Motor Controllers: Refer to Section 26 29 11, LOW-VOLTAGE MOTOR STARTERS and to Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION paragraph, Variable Speed Motor Controllers. Furnish controllers with pumps and motors.
  - c. Pump operation and speed control shall be as shown on the drawings.
- B. In-Line and Base Mounted End Suction Type:
- 1. Casing and Bearing Housing: Close-grained cast iron, ASTM A48.
  - 2. Casing Wear Rings: Bronze.
  - 3. Suction and Discharge: Plain face flange, 850 kPa (125 psig), ANSI B16.1.
  - 4. Casing Vent: Manual brass cock at high point.
  - 5. Casing Drain and Gage Taps: 15 mm (1/2-inch) plugged connections minimum size.
  - 6. Impeller: Bronze, ASTM B62, enclosed type, keyed to shaft.
  - 7. Shaft: Steel, AISI Type 1045 or stainless steel.
  - 8. Shaft Seal: Manufacturer's standard mechanical type to suit pressure and temperature and fluid pumped.
  - 9. Shaft Sleeve: Bronze or stainless steel.
  - 10. Motor: Furnish with pump. Refer to Section 23 05 12, GENERAL MOTOR REQUIREMENTS FOR HVAC AND STEAM GENERATION EQUIPMENT.
  - 11. Base Mounted Pumps:
    - a. Designed for disassembling for service or repair without disturbing the piping or removing the motor.
    - b. Impeller Wear Rings: Bronze.
    - c. Shaft Coupling: Non-lubricated steel flexible type or spacer type with coupling guard, ANSI B15.1, bolted to the baseplate.
    - d. Bearings (Double-Suction pumps): Regreaseable ball or roller type. Provide lip seal and slinger outboard of each bearing.

- e. Base: Cast iron or fabricated steel for common mounting to a concrete base.
- 12. Provide line sized shut-off valve and suction strainer, maintain manufacturer recommended straight pipe length on pump suction (with blow down valve). Contractor option: Provide suction diffuser as follows:
  - a. Body: Cast iron with steel inlet vanes and combination diffuser-strainer-orifice cylinder with 5 mm (3/16-inch) diameter openings for pump protection. Provide taps for strainer blowdown and gage connections.
  - b. Provide adjustable foot support for suction piping.
  - c. Strainer free area: Not less than five times the suction piping.
  - d. Provide disposable start-up strainer.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

- A. Follow manufacturer's written instructions for pump mounting and start-up. Access/Service space around pumps shall not be less than minimum space recommended by pumps manufacturer.
- B. Provide drains for bases and seals for base mounted pumps, piped to and discharging into floor drains.
- C. Coordinate location of thermometer and pressure gauges as per Section 23 21 13, HYDRONIC PIPING.

#### **3.2 START-UP**

- A. Verify that the piping system has been flushed, cleaned and filled.
- B. Lubricate pumps before start-up.
- C. Prime the pump, vent all air from the casing and verify that the rotation is correct. To avoid damage to mechanical seals, never start or run the pump in dry condition.
- D. Verify that correct size heaters-motor over-load devices are installed for each pump controller unit.

- E. Field modifications to the bearings and or impeller (including trimming) are not permitted. If the pump does not meet the specified vibration tolerance send the pump back to the manufacturer for a replacement pump. All modifications to the pump shall be performed at the factory.
- F. Ensure the disposable strainer is free of debris prior to testing and balancing of the hydronic system.
- G. After several days of operation, replace the disposable start-up strainer with a regular strainer in the suction diffuser.

- - - E N D - - -

**SECTION 23 22 13**  
**STEAM AND CONDENSATE HEATING PIPING**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. Steam, condensate and vent piping inside buildings.
- B. Steam to Steam Humidifier.

**1.2 RELATED WORK**

- A. Seismic restraints for piping: Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS
- B. General mechanical requirements and items, which are common to more than one section of Division 23: Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION.
- C Piping insulation: Section 23 07 11, HVAC, PLUMBING, AND BOILER PLANT INSULATION.
- D. Heating Coils and Humidifiers: Section 23 74 13, PACKAGED, OUTDOOR, CENTRAL STATION AIR HANDLING UNITS and SECTION 23 31 00, HVAC DUCTS AND CASING.
- E. Heating coils: Section 23 82 16, AIR COILS.
- F. Temperature and pressure sensors and valve operators: Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC.

**1.3 QUALITY ASSURANCE**

- A. Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION, which includes welding qualifications.

**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. Pipe and equipment supports.
  - 2. Pipe and tubing, with specification, class or type, and schedule.
  - 3. Pipe fittings, including miscellaneous adapters and special fittings.
  - 4. Flanges, gaskets and bolting.
  - 5. Valves of all types.
  - 6. Strainers.
  - 7. All specified steam system components.
  - 8. Gages.
  - 9. Thermometers and test wells.
  - 10. Steam to steam humidifier.

11.Design and calculations for new and existing (within the 3rd floor project area) piping systems supports and bracings. See Specification Section 13 05 41 for requirements.

C. Coordination Drawings: Refer to Article, SUBMITTALS of Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION.

#### 1.5 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 Mechanical Engineers/American National Standards Institute (ASME/ANSI):

B1.20.1-83(R2006).....Pipe Threads, General Purpose (Inch)

B16.4-2006.....Gray Iron Threaded Fittings

C. American Society of Mechanical Engineers (ASME):

B16.1-2005.....Gray Iron Pipe Flanges and Flanged Fittings

B16.3-2006.....Malleable Iron Threaded Fittings

B16.9-2007.....Factory-Made Wrought Buttwelding Fittings

B16.11-2005.....Forged Fittings, Socket-Welding and Threaded

B16.14-91.....Ferrous Pipe Plugs, Bushings, and Locknuts with  
Pipe Threads

B16.22-2001.....Wrought Copper and Copper Alloy Solder-Joint  
Pressure Fittings

B16.23-2002.....Cast Copper Alloy Solder Joint Drainage Fittings

B16.24-2006.....Cast Copper Alloy Pipe Flanges and Flanged  
Fittings, Class 150, 300, 400, 600, 900, 1500  
and 2500

B16.39-98.....Malleable Iron Threaded Pipe Unions, Classes  
150, 250, and 300

B31.1-2007.....Power Piping

B31.9-2008.....Building Services Piping

B40.100-2005.....Pressure Gauges and Gauge Attachments

Boiler and Pressure Vessel Code: SEC VIII D1-2001, Pressure Vessels,  
Division 1

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

A47-99.....Ferritic Malleable Iron Castings

A53-2007.....Pipe, Steel, Black and Hot-Dipped, Zinc-Coated,  
Welded and Seamless

A106-2008.....Seamless Carbon Steel Pipe for High-Temperature  
Service

- A126-2004.....Standard Specification for Gray Iron Castings  
for Valves, Flanges, and Pipe Fittings
- A181-2006.....Carbon Steel Forgings, for General-Purpose  
Piping
- A183-2003 ..... Carbon Steel Track Bolts and Nuts
- A216-2008 ..... Standard Specification for Steel Castings,  
Carbon, Suitable for Fusion Welding, for High  
Temperature Service
- A285-01 ..... Pressure Vessel Plates, Carbon Steel, Low-and-  
Intermediate-Tensile Strength
- A307-2007 ..... Carbon Steel Bolts and Studs, 60,000 PSI Tensile  
Strength
- A516-2006 ..... Pressure Vessel Plates, Carbon Steel, for  
Moderate-and- Lower Temperature Service
- A536-84(2004)e1 ..... Standard Specification for Ductile Iron Castings
- B32-2008 ..... Solder Metal
- B61-2008 ..... Steam or Valve Bronze Castings
- B62-2009 ..... Composition Bronze or Ounce Metal Castings
- B88-2003 ..... Seamless Copper Water Tube
- E. American Welding Society (AWS):
  - A5.8-2004.....Filler Metals for Brazing and Braze Welding
  - B2.1-00.....Welding Procedure and Performance Qualifications
- F. Manufacturers Standardization Society (MSS) of the Valve and Fitting  
Industry, Inc.:
  - SP-67-95.....Butterfly Valves
  - SP-70-98.....Cast Iron Gate Valves, Flanged and Threaded Ends
  - SP-71-97.....Gray Iron Swing Check Valves, Flanged and  
Threaded Ends
  - SP-72-99.....Ball Valves with Flanged or Butt-Welding Ends  
for General Service
  - SP-78-98.....Cast Iron Plug Valves, Flanged and Threaded Ends
  - SP-80-97.....Bronze Gate, Globe, Angle and Check Valves
  - SP-85-94.....Cast Iron Globe and Angle Valves, Flanged and  
Threaded Ends
- G. Military Specifications (Mil. Spec.):
  - MIL-S-901D-1989.....Shock Tests, H.I. (High Impact) Shipboard  
Machinery, Equipment, and Systems

H. National Board of Boiler and Pressure Vessel Inspectors (NB): Relieving Capacities of Safety Valves and Relief Valves

I. Tubular Exchanger Manufacturers Association: TEMA 18th Edition, 2000

## **PART 2 - PRODUCTS**

### **2.1 PIPE AND EQUIPMENT SUPPORTS, PIPE SLEEVES, AND WALL AND CEILING PLATES**

A. Provide in accordance with Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION.

### **2.2 PIPE AND TUBING**

A. Steam Piping: Steel, ASTM A53, Grade B, seamless or ERW; A106 Grade B, Seamless; Schedule 40.

B. Steam Condensate and Pumped Condensate Piping:

1. Concealed above ceiling, in wall or chase: Copper water tube ASTM B88, Type K, hard drawn.
2. All other locations: Copper water tube ASTM B88, Type K, hard drawn; or steel, ASTM A53, Grade B, Seamless or ERW, or A106 Grade B Seamless, Schedule 80.

C. Vent Piping: Steel, ASTM A53, Grade B, seamless or ERW; A106 Grade B, Seamless; Schedule 40, galvanized.

### **2.3 FITTINGS FOR STEEL PIPE**

A. 50 mm (2 inches) and Smaller: Screwed or welded.

1. Butt welding: ASME B16.9 with same wall thickness as connecting piping.
2. Forged steel, socket welding or threaded: ASME B16.11.
3. Screwed: 150 pound malleable iron, ASME B16.3. 125 pound cast iron, ASME B16.4, may be used in lieu of malleable iron, except for steam and steam condensate piping. Provide 300 pound malleable iron, ASME B16.3 for steam and steam condensate piping. Cast iron fittings or piping is not acceptable for steam and steam condensate piping. Bushing reduction of a single pipe size, or use of close nipples, is not acceptable.
4. Unions: ASME B16.39.
5. Steam line drip station and strainer quick-couple blowdown hose connection: Straight through, plug and socket, screw or cam locking type for 15 mm (1/2 inch) ID hose. No integral shut-off is required.

B. 65 mm (2-1/2 inches) and Larger: Welded or flanged joints.

1. Butt welding fittings: ASME B16.9 with same wall thickness as connecting piping. Elbows shall be long radius type, unless otherwise noted.
2. Welding flanges and bolting: ASME B16.5:

- a. Steam service: Weld neck or slip-on, raised face, with non-asbestos gasket. Non-asbestos gasket shall either be stainless steel spiral wound strip with flexible graphite filler or compressed inorganic fiber with nitrile binder rated for saturated and superheated steam service 750 degrees F and 1500 psi.
- b. Flange bolting: Carbon steel machine bolts or studs and nuts, ASTM A307, Grade B.
- C. Welded Branch and Tap Connections: Forged steel weldolets, or branchlets and threadolets may be used for branch connections up to one pipe size smaller than the main. Forged steel half-couplings, ASME B16.11 may be used for drain, vent and gage connections.

#### **2.4 FITTINGS FOR COPPER TUBING**

- A. Solder Joint:
  - 1. Joints shall be made up in accordance with recommended practices of the materials applied. Apply 95/5 tin and antimony on all copper piping.
- B. Bronze Flanges and Flanged Fittings: ASME B16.24.
- C. Fittings: ANSI/ASME B16.18 cast copper or ANSI/ASME B16.22 solder wrought copper.

#### **2.5 DIELECTRIC FITTINGS**

- A. Provide where copper tubing and ferrous metal pipe are joined.
- B. 50 mm (2 inches) and Smaller: Threaded dielectric union, ASME B16.39.
- C. 65 mm (2 1/2 inches) and Larger: Flange union with dielectric gasket and bolt sleeves, ASME B16.42.
- D. Temperature Rating, 121 degrees C (250 degrees F) for steam condensate and as required for steam service.
- E. Contractor's option: On pipe sizes 2" and smaller, screwed end brass gate valves or dielectric nipples may be used in lieu of dielectric unions.

#### **2.6 SCREWED JOINTS**

- A. Pipe Thread: ANSI B1.20.
- B. Lubricant or Sealant: Oil and graphite or other compound approved for the intended service.

#### **2.7 VALVES**

- A. Asbestos packing is not acceptable.
- B. All valves of the same type shall be products of a single manufacturer.
- C. Provide chain operators for valves 150 mm (6 inches) and larger when the centerline is located 2100 mm (7 feet) or more above the floor or operating platform.



D. Shut-Off Valves

1. Gate Valves:

- a. 50 mm (2 inches) and smaller: MSS-SP80, Bronze, 1034 kPa (150 lb.), wedge disc, rising stem, union bonnet.
- b. 65 mm (2 1/2 inches) and larger: Flanged, outside screw and yoke.
  - 1) High pressure steam 413 kPa (60 psig) and above nominal MPS system): Cast steel body, ASTM A216 grade WCB, 1034 kPa (150 psig) at 260 degrees C (500 degrees F), 11-1/2 to 13 percent chrome stainless steel solid disc and seats. Provide 25 mm (1 inch) factory installed bypass with globe valve on valves 100 mm (4 inches) and larger.
  - 2) All other services: MSS-SP 70, iron body, bronze mounted, 861 kPa (125 psig) wedge disc.

E. Globe and Angle Valves:

1. Globe Valves:

- a. 50 mm (2 inches) and smaller: MSS-SP 80, bronze, 1034 kPa (150 lb.) Globe valves shall be union bonnet with metal plug type disc.
- b. 65 mm (2 1/2 inches) and larger:
  - 1) Globe valves for high pressure steam 413 kPa (60 psig) and above nominal MPS system): Cast steel body, ASTM A216 grade WCB, flanged, OS&Y, 1034 kPa (150 psig) at 260 degrees C (500 degrees F), 11-1/2 to 13 percent chrome stainless steel disc and renewable seat rings.
  - 2) All other services: 861 kPa (125 psig), flanged, iron body, bronze trim, MSS-SP-85 for globe valves.

F. Swing Check Valves

- 1. 50 mm (2 inches) and smaller: MSS-SP 80, bronze, 1034 kPa (150 psig), 45 degree swing disc.
- 2. 65 mm (2-1/2 inches) and Larger:
  - a Check valves for high pressure steam 413 kPa (60 psig) and above nominal MPS system: Cast steel body, ASTM A216 grade WCB, flanged, OS&Y, 1034 kPa (150 psig) at 260 degrees C (500 degrees F), 11-1/2 to 13 percent chrome stainless steel disc and renewable seat rings.
  - b. All other services: 861 kPa (125 psig), flanged, iron body, bronze trim, MSS-SP-71 for check valves.

**2.8 STRAINERS**

- A. Basket or Y Type. Tee type is acceptable for gravity flow and pumped steam condensate service.

- B. High Pressure Steam: Rated 1034 kPa (150 psig) saturated steam.
  - 1. 50 mm (2 inches) and smaller: Iron, ASTM A116 Grade B, or bronze, ASTM B-62 body with screwed connections (250 psig).
  - 2. 65 mm (2-1/2 inches) and larger: Flanged cast steel or 1723 kPa (250 psig) cast iron.
- C. All Other Services: Rated 861 kPa (125 psig) saturated steam.
  - 1. 50 mm (2 inches) and smaller: Cast iron or bronze.
  - 2. 65 mm (2-1/2 inches) and larger: Flanged, iron body.
- D. Screens: Bronze, monel metal or 18-8 stainless steel, free area not less than 2-1/2 times pipe area, with perforations as follows:
  - 1. 75 mm (3 inches) and smaller: 20 mesh for steam and 1.1 mm (0.045 inch) diameter perforations for liquids.
  - 2. 100 mm (4 inches) and larger: 1.1 mm (0.045) inch diameter perforations for steam and 3.2 mm (0.125 inch) diameter perforations for liquids.

## **2.9 STEAM SYSTEM COMPONENTS**

- A. Safety Valves and Accessories: Comply with ASME Boiler and Pressure Vessel Code, Section VIII. Capacities shall be certified by National Board of Boiler and Pressure Vessel Inspectors, maximum accumulation 10 percent. Provide lifting lever. Provide drip pan elbow where shown.
- B. Steam PRV for Individual Equipment: Cast iron or bronze body, screwed or flanged ends, rated 861 kPa (125 psig) working pressure. Single-seated, diaphragm operated, spring loaded, adjustable range, all parts renewable.
- C. Steam Trap: Each type of trap shall be the product of a single manufacturer. Provide trap sets at all low points and at 200 feet intervals on the horizontal main lines.
  - 1. Floats and linkages shall provide sufficient force to open trap valve over full operating pressure range available to the system. Unless otherwise indicated on the drawings, traps shall be sized for capacities indicated at minimum pressure drop as follows:
    - a. For equipment with modulating control valve: 1/4 psig, based on a condensate leg of 300 mm (12 inches) at the trap inlet and gravity flow to the receiver.
    - b. For main line drip trap sets and other trap sets at steam pressure: Up to 70 percent of design differential pressure. Condensate may be lifted to the return line.
  - 2. Trap bodies: Bronze, cast iron, or semi-steel, constructed to permit ease of removal and servicing working parts without disturbing

- connecting piping. For systems without relief valve traps shall be 5  
Mechanism: Brass, stainless steel or corrosion resistant alloy. rated  
for the pressure upstream of the PRV supplying the system.
3. Balanced pressure thermostatic elements: Phosphor bronze, stainless  
steel or monel metal.
  4. Valves and seats: Suitable hardened corrosion resistant alloy.
  6. Floats: Stainless steel.
  7. Inverted bucket traps: Provide bi-metallic thermostatic element for  
rapid release of non-condensables.

## **2.10 STEAM-TO-STEAM EVAPORATIVE HUMIDIFICATION SYSTEM**

- A. Seismic performance requirements:
  1. Seismic performance: Equipment shall have special seismic  
certification in accordance with the requirements of Section 13.2.2  
of ASCE 7-10.
  2. Equipment with OSHPD OSP certification is acceptable.
- B. Fabrication requirements:
  1. Tank and cover: 14-gauge, 304-stainless steel with Heli-arch welded  
seams.
  2. Removable cover with 1/4" screws (M6).
  3. Easily accessible cleanout plate.
  4. Steam outlet on top of tank configured to connect to hose, pipe, or  
flange connection.
  5. Tubular copper heat exchanger and header with nickel coating.
- C. Mounting:
  1. Humidifier shall be mounted on painted H-legs.
  2. Four support legs with bracings shall provide a minimum of 24"  
between underside of humidifier and floor.
- D. Water requirements: The humidifier shall be capable of generating steam  
from DI water.
- E. Drain: An electric operated drain valve shall be mounted on the  
humidifier assembly to allow tank to drain automatically at the end of a  
humidification season.
- F. Steam trap and strainer: Humidifier shall include a float/thermostatic  
steam trap and steam supply line strainer.
- G. Humidifier Options:
  1. Fabrication Options:
    - a. Tank and cover shall be 316 stainless steel with Heli-arc welded  
seams.

- b. Factory insulation: Humidifier shall be covered with 1" thick rigid, foil-faced fiberglass insulation. All surfaces except front face panel shall have insulation.
  - c. Humidifier shall have a tubular 316 stainless steel heat exchanger and header with no coating.
2. Options for use with DI water:
- a. Humidifier shall have a stainless steel manually operated drain valve and a stainless steel float operated fill valve.
  - b. Humidifier shall have a stainless steel electric operated drain valve and a stainless steel float operated fill valve with an electric solenoid to prevent tank from filling when the tank drains automatically at the end of a humidification season.
  - c. Low water float switch. Humidifier shall have a field-wired float switch to provide water level indication for building management systems.
3. Outdoor enclosure system:
- a. Factory assembled and tested with the humidifier installed to provide complete weather protection and to operate within the following temperature limits: -40 to 120 °F
  - b. Humidifier and outdoor enclosure shall be shipped as one unit.
  - c. Frame construction: 5", 12-gauge, G-90 galvanized steel formed frame, suitably reinforced and braced to permit loading, shipping, unloading and rigging to the unit destination without damage to external or internal components. The base frame shall be corrosion resistant without painting or further coating.
  - d. Housing construction: 16-gauge, G-90 galvanized steel panels fabricated into self-framing, double standing seam-type construction. All joints shall be caulked weather-tight with a silicone sealant. All interior surfaces shall be insulated with 1", 2.2 lbs/sq ft rigid, noncombustible glass fiber insulation. No exposed insulation shall be permitted on the top-wearing surface of the floor of the unit. The floor shall be insulated from underneath. The floor shall have a drain connection.
  - e. Access door construction: Access door shall provide access to all internal components, be constructed of 16-gauge, G-90 galvanized steel with a gasket around the full perimeter of the doorframe, with heavy-duty stainless steel hinges, and latches.
  - f. Ventilation fans: wired to a thermostat to ventilate the control cabinet and the enclosure.

- g. Heaters:
  - 1) Thermostatically-controlled heaters to ensure proper operation during cold weather.
- H. Humidifier Controls:
  - 1. Steam valve: Modulating electronic control valve: Valve shall be a normally closed modulating type with an electronic actuator. Actuator to respond to a variable electronic signal. Available signal inputs 4 to 20 mA and 2 to 10 VDC.
  - 2. Control cabinet: Control cabinet shall be shipped loose and shall be a UL/CSA listed JIC enclosure. Control devices shall be mounted on a subpanel within the cabinet. A wiring diagram shall be included in the control cabinet.
  - 3. Microprocessor controller with the following features or functions:
    - a. Web interface and server, included standard on all models:
      - 1) Web interface shall have same functionality as the controller keypad/display.
      - 2) Web interface shall allow multiple remotely located users to simultaneously view system operation and/or change system parameters.
      - 3) Web interface shall have password-protected secure access.
      - 4) Web interface shall be compatible with standard Internet browsers.
      - 5) Web interface shall connect directly to a personal computer or through a system network via Ethernet cable.
        - a) Automatic cable configuration shall allow straight-through or crossover cables.
    - b. Interoperability using BACnet, MSTP compliant integration.
    - c. Fully modulating (0% to 100%) control of humidifier outputs.
    - d. PID control capability with field-adjustable settings.
    - e. Water level control for DI water:
      - 1) System shall provide for continuous control of water level and will accommodate the use of deionized or reverse osmosis water with resistance up to 18 M-ohm/cm.
      - 2) System shall:
        - a) Have a water level sensing unit comprised of a float operated stainless steel valve for water makeup.
        - b) Have a low water cutoff float switch.
        - c) Operate within inlet water pressure range of 25 to 80 psi.

- f. Temperature sensor: A factory mounted sensor, with a temperature range of -40 to 248 °F (-40 to 120 °C) mounted on the humidifier to enable the following functions:
  - 1) Maintain the evaporating chamber water temperature above freezing.
  - 2) Maintain a user-defined preset evaporating chamber water temperature.
  - 3) Allow rapid warm-up of water in evaporating chamber after a call for humidity, providing 100% operation until steam production occurs.
- g. USB port on the control board for software updates, data backups, and data restoration.
- h. Up-time optimizer function to keep humidifier(s) operating through conditions such as fill, drain, or run-time faults, as long as safety conditions are met, minimizing production down-time.
- i. Real-time clock to allow time-stamped alarm/message tracking, and scheduled events.
- j. Factory commissioning of humidifier and control board, including system configuration as-ordered.
- k. Keypad/display operable within a temperature range of 32 to 158 °F (0 to 70 °C), and that provides backlighting for viewing in low light.
- l. Alarms, unit configuration, and usage timer values shall remain in nonvolatile memory indefinitely during a power outage.
- m. The capability to monitor, control, and/or adjust the following parameters:
  - 1) Relative humidity (RH) set point, actual conditions in the space (from humidity transmitter), RH offset.
  - 2) Dew point set point, actual conditions in the space (from dew point transmitter), dew point offset.
  - 3) Relative humidity (RH) duct high limit set point (switch) and actual conditions.
  - 4) Relative humidity (RH) duct high limit set point, actual conditions (from transmitter), high limit span, and high limit offset.
  - 5) Total system demand in % of humidifier capacity.
  - 6) Total system output in lbs/hour (kg/h).
  - 7) Drain/flush duration

- 8) End-of-season drain status (on standard water systems and if ordered as a DI water option) and hours humidifier is idle before end of season draining occurs.
- 9) System alarms and system messages, current and previous.
- 10) Adjustable water skim duration.
- 11) Programmable outputs for remote signaling of alarms and/or messages, device activation (such as a fan), or for signaling tank heating and/or steam production.
- 12) System diagnostics that include:
  - a) Test outputs function to verify component operation.
  - b) Test humidifier function, by simulating demand to validate performance.
  - c) Data collection of RH, air temperature, water use, energy use, alarms, and service messages for viewing from the keypad/display or Web interface.
- 13) Service notification scheduling.
- 14) Password-protected system parameters.
- 15) Keypad/display or Web interface displays in English, French, or German languages.
- 16) Numerical units displayed in inch-pound or SI units.

I. Humidifier Control Options:

1. Control cabinet mounted: Control cabinet shall be a UL/CSA listed NEMA-12 enclosure. Control devices shall be mounted on a subpanel within the cabinet. A wiring diagram shall be included in the control cabinet. Control cabinet shall be factory attached to the side of humidifier with all wiring between cabinet and humidifier completed at factory.
2. Microprocessor water level controller with the following features or functions:
  - a. Makeup water valve control and low water safety shutdown.
  - b. Field adjustable autodrain and flush sequence whereby microprocessor activates autodrain and flush sequence after a user-defined run time.
  - c. Self-diagnostic test at start-up.
  - d. Water level sensing unit comprised of three metallic probes screwed into a threaded probe head.
  - e. Probe head mounted on the vaporizing chamber.
  - f. A solenoid operated water fill valve factory mounted on humidifier.

3. Keypad mounted on cabinet: The keypad shall be factory-mounted on the side of the control cabinet.
4. Cabinet door interlock switch: The control cabinet shall have an interlock control switch with manual override to remove control voltage when door is opened.
5. Control cabinet door lock: Control cabinet shall have a lock with keys provided.
6. Freeze protection: A factory-mounted aquastat shall be mounted on the front of humidifier to sense and maintain the evaporating chamber water temperature above freezing. Set point adjustable from 40 to 180°F.

J. Humidifier Accessories

1. Drane-kooler™: A thermostatically controlled water valve shall meter an amount of cold water into a stainless steel mixing chamber to temper 212 °F (100 °C) water with a 6 gpm in-flow rate to a 140 °F discharge temperature to sanitary system.

K. Humidifier Dispersion Panel

1. Dispersion Panel:
  - a. Each tube bank shall consist of a horizontal header/separator and designated quantity of vertical dispersion tubes necessary to achieve the required steam capacity and absorption distance.
  - b. The dispersion panel shall provide absorption characteristics that preclude water accumulation on any in-duct surface within 18" of the dispersion panel while maintaining conditions of 90% maximum relative humidity in the duct airstream.
  - c. Header/separator shall span the width of the duct, be constructed of stainless steel, and be fitted with connections for dispersion tubes.
    - 1) The dispersion tubes shall extend the height of the duct, shall be fitted with two rows of tubelets on the diametric centerline, and spaced 1½" (38 mm) apart.
    - 2) Each tubelet shall be made of a thermal-resin material designed for high steam temperatures.
    - 3) Each tubelet shall extend through the wall of and into the center of the dispersion tube and contain a steam orifice sized for its required steam capacity.
    - 4) For securing the upper ends of the tubes, a ¾" × 2" (19 mm × 51 mm) stainless steel L-bracket shall be furnished, which the installer shall attach to the duct or housing.



d. Option: High-efficiency dispersion tubes

- 1) Dispersion tubes shall be insulated with a plenum-approved insulating material for in-duct installation and have an R-value not less than 0.5 at a thickness not more than 0.125" (3.2 mm), for minimal increase in dispersion tube diameter.
- 2) Airstream heat gain shall not exceed the values as scheduled; the values shall be supported by the manufacturer's published data.
- 3) Insulating material shall meet the following criteria at 0.125" (3.2 mm) thickness:
  - a) Fire/smoke index shall be 0/0 per any of the following test procedures:
    - i. UL 723 fire/smoke index (Test for Surface Burning Characteristics of Building Materials).
    - ii. NFPA 255 (Standard Method of Test of Surface Burning Characteristics of Building Materials).
    - iii. ASTM E84 (Surface Burning Characteristics for Materials Used in Plenums).
  - b) Stable up to 300 °F (148 °C) continuous – to prevent material degradation, hardening, or crumbling at high temperatures.
  - c) Closed-cell construction does not absorb water or support microbial growth – to negate the need for vapor barriers and jackets.
  - d) Non-toxic and pure as documented in manufacturer's data – to prevent off-gassing and to facilitate use in clean rooms, pharmaceutical applications, and food industries.
  - e) Will not degrade when exposed to UVC light – to negate the need for UV wraps.
  - f) Continuous, seam-welded, and held in place without bands or clamps – to minimize surfaces for the accumulation of particulate matter.

**2.11 GAGES, PRESSURE AND COMPOUND**

- A. ASME B40.1, Accuracy Grade 1A, (pressure), initial mid-scale accuracy 1 percent of scale (Qualify grade), metal or phenolic case, 4-1/2 inches in diameter, 1/4 inch NPT bottom connection, white dial with black graduations and pointer, clear glass or acrylic plastic window, suitable for board mounting. Provide red "set hand" to indicate normal working pressure.

- B. Provide brass, lever handle union cock. Provide brass/bronze pressure snubber for gages in water service. Provide brass pigtail syphon for steam gages.
- C. Range of Gages: For services not listed provide range equal to at least 130 percent of normal operating range:

Low pressure steam and steam condensate to 103 kPa(15 psig)	0 to 207 kPa (30 psig).
Medium pressure steam and steam condensate nominal 413 kPa (60 psig)	0 to 689 kPa (100 psig).

## **2.12 FIRESTOPPING MATERIAL**

- A. Refer to Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION.

## **PART 3 - EXECUTION**

### **3.1 GENERAL**

- A. The drawings show the general arrangement of pipe and equipment but do not show all required fittings and offsets that may be necessary to connect pipes to equipment, fan-coils, coils, radiators, etc., and to coordinate with other trades. Provide all necessary fittings, offsets and pipe runs based on field measurements and at no additional cost to the government. Coordinate with other trades for space available and relative location of HVAC equipment and accessories to be connected on ceiling grid. Pipe location on the drawings shall be altered by contractor where necessary to avoid interferences and clearance difficulties.
- B. Store materials to avoid excessive exposure to weather or foreign materials. Keep inside of piping relatively clean during installation and protect open ends when work is not in progress.
- C. Support piping securely. Refer to PART 3, Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION. Install convertors and other heat exchangers at height sufficient to provide gravity flow of condensate to the flash tank and condensate pump.
- D. Install piping generally parallel to walls and column center lines, unless shown otherwise on the drawings. Space piping, including insulation, to provide 25 mm (one inch) minimum clearance between adjacent piping or other surface. Unless shown otherwise, slope steam, condensate and drain piping down in the direction of flow not less than 25 mm (one inch) in 12 m (40 feet). Provide eccentric reducers to keep bottom of sloped piping flat.

- E. Locate and orient valves to permit proper operation and access for maintenance of packing, seat and disc. Generally locate valve stems in overhead piping in horizontal position. Provide a union adjacent to one end of all threaded end valves. Control valves usually require reducers to connect to pipe sizes shown on the drawing. Install butterfly valves with the valve open as recommended by the manufacturer to prevent binding of the disc in the seat.
- F. Offset equipment connections to allow valving off for maintenance and repair with minimal removal of piping. Provide flexibility in equipment connections and branch line take-offs with 3-elbow swing joints where noted on the drawings.
- G. Tee water piping runouts or branches into the side of mains or other branches. Avoid bull-head tees, which are two return lines entering opposite ends of a tee and exiting out the common side.
- H. Connect piping to equipment as shown on the drawings. Install components furnished by others such as:
  - 1. Flow elements (orifice unions), control valve bodies, flow switches, pressure taps with valve, and wells for sensors.
- I. Firestopping: Fill openings around uninsulated piping penetrating floors or fire walls, with firestop material. For firestopping insulated piping refer to Section 23 07 11, HVAC, PLUMBING, and BOILER PLANT INSULATION.
- J. Where copper piping is connected to steel piping, provide dielectric connections.
- K. Pipe vents to the exterior. Where a combined vent is provided, the cross sectional area of the combined vent shall be equal to sum of individual vent areas. Slope vent piping one inch in 40 feet (0.25 percent) in direction of flow. Provide a drip trap elbow on relief valve outlets if the vent rises to prevent backpressure. Terminate vent minimum 0.3 M (12 inches) above the roof or through the wall minimum 2.5 M (8 feet) above grade with down turned elbow.

### **3.2 PIPE JOINTS**

- A. Welded: Beveling, spacing and other details shall conform to ASME B31.1 and AWS B2.1. See Welder's qualification requirements under "Quality Assurance" in Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.
- B. Screwed: Threads shall conform to ASME B1.20; joint compound shall be applied to male threads only and joints made up so no more than three threads show. Coat exposed threads on steel pipe with joint compound, or red lead paint for corrosion protection.

- C. 125 Pound Cast Iron Flange (Plain Face): Mating flange shall have raised face, if any, removed to avoid overstressing the cast iron flange.

### **3.3 STEAM TRAP PIPING**

- A. Install to permit gravity flow to the trap. Provide gravity flow (avoid lifting condensate) from the trap where modulating control valves are used. Support traps weighing over 11 kg (25 pounds) independently of connecting piping.

### **3.4 SUPPORTS AND SEISMIC BRACING**

- A. Provide supports and bracings for new piping. Provide additional supports and bracings on existing piping within the 3rd Floor project area. Provide in accordance with Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS

### **3.5 LEAK TESTING**

- A. Inspect all joints and connections for leaks and workmanship and make corrections as necessary, to the satisfaction of the Resident Engineer in accordance with the specified requirements. Testing shall be performed in accordance with the specification requirements.
- B. An operating test at design pressure, and for hot systems, design maximum temperature.
- C. A hydrostatic test at 1.5 times design pressure. For water systems the design maximum pressure would usually be the static head, or expansion tank maximum pressure, plus pump head. Factory tested equipment (convertors, exchangers, coils, etc.) need not be field tested. Avoid excessive pressure on mechanical seals and safety devices.

### **3.6 FLUSHING AND CLEANING PIPING SYSTEMS**

- A. Steam, Condensate and Vent Piping: No flushing or chemical cleaning required. Accomplish cleaning by pulling all strainer screens and cleaning all scale/dirt legs during start-up operation.

### **3.7 OPERATING AND PERFORMANCE TEST AND INSTRUCTION**

- A. Refer to PART 3, Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.
- B. Adjust red set hand on pressure gages to normal working pressure.

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**SECTION 23 25 00**  
**HVAC WATER TREATMENT**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section specifies cleaning and treatment of circulating HVAC water systems, including the following.
  - 1. Cleaning compounds.
  - 2. Chemical treatment for closed loop heat transfer systems.

**1.2 RELATED WORK**

- A. Test requirements and instructions on use of equipment/system: Section 01 00 00, GENERAL REQUIREMENTS.
- B. General mechanical requirements and items, which are common to more than one section of Division 23: Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.
- C. Piping and valves: Section 23 21 13, HYDRONIC PIPING and Section 23 22 13, STEAM and CONDENSATE HEATING PIPING.

**1.3 QUALITY ASSURANCE**

- A. Refer to paragraph, QUALITY ASSURANCE in Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.
- B. Technical Services: Provide the services of an experienced water treatment chemical engineer or technical representative to direct flushing, cleaning, pre-treatment, training, debugging, and acceptance testing operations; direct and perform chemical limit control during construction period and monitor systems for a period of 12 months after acceptance, including not less than 6 service calls and written status reports. Emergency calls are not included. Minimum service during construction/start-up shall be 6 hours.
- C. Chemicals: Chemicals shall be non-toxic approved by local authorities and meeting applicable EPA requirements.

**1.4 SUBMITTALS**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- B. Manufacturer's Literature and Data including:
  - 1. Cleaning compounds and recommended procedures for their use.
  - 2. Chemical treatment for closed systems, including installation and operating instructions.
  - 3. Glycol-water system materials, equipment, and installation.

- C. Water analysis verification.
- D. Materials Safety Data Sheet for all proposed chemical compounds, based on U.S. Department of Labor Form No. L5B-005-4.
- E. Maintenance and operating instructions in accordance with Section 01 00 00, GENERAL REQUIREMENTS.

#### **1.5 APPLICABLE PUBLICATIONS**

- A. The publication 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. National Fire Protection Association (NFPA):  
70-2008.....National Electric Code (NEC)
- C. American Society for Testing and Materials (ASTM):  
F441/F441M-02 (2008) ... Standard Specification for Chlorinated Poly  
(Vinyl Chloride) (CPVC) Plastic Pipe, Schedules  
40 and 80

### **PART 2 - PRODUCTS**

#### **2.1 CLEANING COMPOUNDS**

- A. Alkaline phosphate or non-phosphate detergent/surfactant/specific to remove organic soil, hydrocarbons, flux, pipe mill varnish, pipe compounds, iron oxide, and like deleterious substances, with or without inhibitor, suitable for system wetted metals without deleterious effects.
- B. All chemicals to be acceptable for discharge to sanitary sewer.
- C. Refer to Section 23 21 13, HYDRONIC PIPING and Section 23 22 13, STEAM and CONDENSATE HEATING PIPING, PART 3, for flushing and cleaning procedures.

#### **2.2 CHEMICAL TREATMENT FOR CLOSED LOOP SYSTEMS**

- A. Inhibitor: Provide sodium nitrite/borate, molybdate-based inhibitor or other approved compound suitable for make-up quality and make-up rate and which will cause or enhance bacteria/corrosion problems or mechanical seal failure due to excessive total dissolved solids. Shot feed manually. Maintain inhibitor residual as determined by water treatment laboratory, taking into consideration residual and temperature effect on pump mechanical seals.
- B. pH Control: Inhibitor formulation shall include adequate buffer to maintain pH range of 8.0 to 10.5.

- C. Performance: Protect various wetted, coupled, materials of construction including ferrous, and red and yellow metals. Maintain system essentially free of scale, corrosion, and fouling. Corrosion rate of following metals shall not exceed specified mills per year penetration; ferrous, 0-2; brass, 0-1; copper, 0-1. Inhibitor shall be stable at equipment skin surface temperatures and bulk water temperatures of not less than 121 degrees C (250 degrees F) and 52 degrees C (125 degrees Fahrenheit) respectively. Heat exchanger fouling and capacity reduction shall not exceed that allowed by fouling factor 0.0005.
- D. Pot Feeder: By-pass type, complete with necessary shut off valves, drain and air release valves, and system connections, for introducing chemicals into system, cast iron or steel tank with funnel or large opening on top for easy chemical addition. Feeders shall be 18.9 L (five gallon) minimum capacity at 860 kPa (125 psig) minimum working pressure.

## **2.3 EQUIPMENT AND MATERIALS IDENTIFICATION**

- A. Refer to Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. Delivery and Storage: Deliver all chemicals in manufacturer's sealed shipping containers. Store in designated space and protect from deleterious exposure and hazardous spills.
- B. Install equipment furnished by the chemical treatment supplier and charge systems according to the manufacturer's instructions and as directed by the Technical Representative.
- C. Refer to Section 23 21 13 HYDRONIC PIPING for chemical treatment piping, installed as follows:
1. Provide a by-pass line around water meters and bleed off piping assembly. Provide ball valves to allow for bypassing, isolation, and servicing of components.
  2. Bleed off water piping with bleed off piping assembly shall be piped from pressure side of circulating water piping to a convenient drain. Bleed off connection to main circulating water piping shall be upstream of chemical injection nozzles.
  3. Provide installation supervision, start-up and operating instruction by manufacturer's technical representative.

- D. Before adding cleaning chemical to the closed system, all air handling coils and fan coil units should be isolated by closing the inlet and outlet valves and opening the bypass valves. This is done to prevent dirt and solids from lodging the coils.
- E. Do not valve in or operate system pumps until after system has been cleaned.
- F. After chemical cleaning is satisfactorily completed, open the inlet and outlet valves to each coil and close the by-pass valves. Also, clean all strainers.
- G. Perform tests and report results in accordance with Section 01 00 00, GENERAL REQUIREMENTS.
- H. After cleaning is complete, and water PH is acceptable to manufacturer of water treatment chemical, add manufacturer-recommended amount of chemicals to systems.
- I. Instruct VA personnel in system maintenance and operation in accordance with Section 01 00 00, GENERAL REQUIREMENTS.

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**SECTION 23 31 00**  
**HVAC DUCTS AND CASINGS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. Ductwork and accessories for HVAC including the following:
  - 1. Supply air, return air, outside air, exhaust, make-up air, and relief systems.
  - 2. Exhaust duct with HEPA filters for Negative Pressure Isolation Room.
  - 3. Wet exhaust ducts.
- B. Definitions:
  - 1. SMACNA Standards as used in this specification means the HVAC Duct Construction Standards, Metal and Flexible.
  - 2. Seal or Sealing: Use of liquid or mastic sealant, with or without compatible tape overlay, or gasketing of flanged joints, to keep air leakage at duct joints, seams and connections to an acceptable minimum.
  - 3. Duct Pressure Classification: SMACNA HVAC Duct Construction Standards, Metal and Flexible.
  - 4. Exposed Duct: Exposed to view in a finished room, and exposed to weather.

**1.2 RELATED WORK**

- A. Fire Stopping Material: Section 07 84 00, FIRESTOPPING.
- B. Seismic Reinforcing: Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.
- C. General Mechanical Requirements: Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.
- D. Noise Level Requirements: Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING and EQUIPMENT.
- E. Duct Insulation: Section 23 07 11, HVAC, PLUMBING, and BOILER PLANT INSULATION
- F. Plumbing Connections: Section 22 11 00, FACILITY WATER DISTRIBUTION
- G. Duct Mounted Coils: Section 23 82 16, AIR COILS.
- H. Air Filters and Filters' Efficiencies: Section 23 40 00, HVAC AIR CLEANING DEVICES.
- I. Duct Mounted Instrumentation: Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC.
- J. Testing and Balancing of Air Flows: Section 23 05 93, TESTING, ADJUSTING, and BALANCING FOR HVAC.
- K. Smoke Detectors: Section 28 31 00, FIRE DETECTION and ALARM.

### **1.3 QUALITY ASSURANCE**

- A. Refer to article, QUALITY ASSURANCE, in Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.
- B. Fire Safety Code: Comply with NFPA 90A.
- C. Duct System Construction and Installation: Referenced SMACNA Standards are the minimum acceptable quality.
- D. Duct Sealing, Air Leakage Criteria, and Air Leakage Tests: Ducts shall be sealed as per duct sealing requirements of SMACNA HVAC Air Duct Leakage Test Manual for duct pressure classes shown on the drawings.
- E. Duct accessories exposed to the air stream, such as dampers of all types (except smoke dampers) and access openings, shall be of the same material as the duct or provide at least the same level of corrosion resistance.

### **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. Rectangular ducts:
    - a. Schedules of duct systems, materials and selected SMACNA construction alternatives for joints, sealing, gage and reinforcement.
    - b. Duct liner.
    - c. Sealants and gaskets.
    - d. Access doors.
  - 2. Round duct construction details:
    - a. Manufacturer's details for duct fittings.
    - b. Duct liner.
    - c. Sealants and gaskets.
    - d. Access sections.
    - e. Installation instructions.
  - 3. Volume dampers, back draft dampers.
  - 4. Upper hanger attachments.
  - 5. Fire dampers, and smoke dampers with installation instructions.
  - 6. Sound attenuators, including pressure drop and acoustic performance.
  - 7. Flexible ducts and clamps, with manufacturer's installation instructions.
  - 8. Flexible connections.
  - 9. Instrument test fittings.

- C. Design and calculations for the supports and bracings of the ductwork distribution, including the air terminal units and reheat coils. See Specification Section 13 05 41 for requirements.
- D. Coordination Drawings: Refer to article, SUBMITTALS, in Section 23 05 11 - Common Work Results for HVAC and Steam Generation.

#### 1.5 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 Civil Engineers (ASCE):
  - ASCE7-05.....Minimum Design Loads for Buildings and Other Structures
- C. American Society for Testing and Materials (ASTM):
  - A167-99(2009).....Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
  - A653-09.....Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy coated (Galvannealed) by the Hot-Dip process
  - A1011-09a.....Standard Specification for Steel, Sheet and Strip, Hot rolled, Carbon, structural, High-Strength Low-Alloy, High Strength Low-Alloy with Improved Formability, and Ultra-High Strength
  - B209-07.....Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
  - C1071-05e1.....Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material)
  - E84-09a.....Standard Test Method for Surface Burning Characteristics of Building Materials
- D. National Fire Protection Association (NFPA):
  - 90A-09.....Standard for the Installation of Air Conditioning and Ventilating Systems
  - 96-08.....Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations
- E. Sheet Metal and Air Conditioning Contractors National Association (SMACNA):
  - 2nd Edition - 2005.....HVAC Duct Construction Standards, Metal and Flexible

1st Edition - 1985.....HVAC Air Duct Leakage Test Manual

6th Edition - 2003.....Fibrous Glass Duct Construction Standards

F. Underwriters Laboratories, Inc. (UL):

181-08.....Factory-Made Air Ducts and Air Connectors

555-06 .....Standard for Fire Dampers

555S-06 .....Standard for Smoke Dampers

## **PART 2 - PRODUCTS**

### **2.1 DUCT MATERIALS AND SEALANTS**

- A. General: Except for systems specified otherwise, construct ducts, casings, and accessories of galvanized sheet steel, ASTM A653, coating G90; or, aluminum sheet, ASTM B209, alloy 1100, 3003 or 5052.
- B. Specified Corrosion Resistant Systems: Stainless steel sheet, ASTM A167, Class 302 or 304, Condition A (annealed) Finish No. 4 for exposed ducts and Finish No. 2B for concealed duct or ducts located in mechanical rooms.
- C. Joint Sealing: Refer to SMACNA HVAC Duct Construction Standards, paragraph S1.9.
  - 1. Sealant: Elastomeric compound, gun or brush grade, maximum 25 flame spread and 50 smoke developed (dry state) compounded specifically for sealing ductwork as recommended by the manufacturer. Generally provide liquid sealant, with or without compatible tape, for low clearance slip joints and heavy, permanently elastic, mastic type where clearances are larger. Oil base caulking and glazing compounds are not acceptable because they do not retain elasticity and bond.
  - 2. Tape: Use only tape specifically designated by the sealant manufacturer and apply only over wet sealant. Pressure sensitive tape shall not be used on bare metal or on dry sealant.
  - 3. Gaskets in Flanged Joints: Soft neoprene.
- D. Approved factory made joints may be used.

### **2.2 DUCT CONSTRUCTION AND INSTALLATION**

- A. Regardless of the pressure classifications outlined in the SMACNA Standards, fabricate and seal the ductwork in accordance with the following pressure classifications:
- B. Duct Pressure Classification:
  - 1. Low Pressure: 50 mm to 75 mm (2 inch to 3 inch). Ductwork downstream of supply and upstream or return/exhaust air terminal units, and general exhaust/return for AHU-8 and 9 systems.

2. 75 mm to 150 mm (3 inch to 6 inch). Upstream of supply and downstream of return/exhaust air terminal units, all supply and return and exhaust duct risers, and all duct on roof.
- C. Seal Class: All ductwork shall receive Class A Seal
- D. Operating Room/Cystoscopy Room and PACU Supply Air: All supply air ductwork on the downstream side of the final HEPA filter serving an operating room/cystoscopy and PACU rooms shall be fabricated from welded Type 304 stainless steel, including all components of the air distribution system up to and including the supply air outlet.
- E. Wet Air Exhaust Ducts and Accessories: Ducts steam sterilizer hoods and orthotics hoods shall be 1.3 mm (18 gage) Type 304 stainless steel made liquid tight with continuous external weld for all seams and joints. Provide neoprene gaskets at flanged connections. Where ducts are not self draining back to the equipment, provide low point drain pocket with copper drain pipe to sanitary sewer. Provide access door in side of duct at drain pockets.
- F. Duct for Negative Pressure Up to 1000 Pa (4 inch W.G.): Provide for exhaust duct between HEPA filters and exhaust fan inlet.
  1. Round Duct: Galvanized steel, spiral lock seam construction with standard slip joints.
  2. Rectangular Duct: Galvanized steel, minimum 1.0 mm (20 gage), Pittsburgh lock seam, companion angle joints 32 mm by 3.2 mm (1-1/4 by 1/8 inch) minimum at not more than 2.4 m (8 feet) spacing. Approved pre-manufactured joints are acceptable in lieu of companion angles.
- G. Round Ducts: Furnish duct and fittings made by the same manufacturer to insure good fit of slip joints. When submitted and approved in advance, round duct, with size converted on the basis of equal pressure drop, may be furnished in lieu of rectangular duct design shown on the drawings.
  1. Elbows: Diameters 80 through 200 mm (3 through 8 inches) shall be two sections die stamped, all others shall be gored construction, maximum 18 degree angle, with all seams continuously welded or standing seam. Coat galvanized areas of fittings damaged by welding with corrosion resistant aluminum paint or galvanized repair compound.
  2. Provide bell mouth, conical tees or taps, laterals, reducers, and other low loss fittings as shown in SMACNA HVAC Duct Construction Standards.
  3. Ribbed Duct Option: Lighter gage round/oval duct and fittings may be furnished provided certified tests indicating that the rigidity and

- performance is equivalent to SMACNA standard gage ducts are submitted.
- a. Ducts: Manufacturer's published standard gage, G90 coating, spiral lock seam construction with an intermediate standing rib.
  - b. Fittings: May be manufacturer's standard as shown in published catalogs, fabricated by spot welding and bonding with neoprene base cement or machine formed seam in lieu of continuous welded seams.
4. Provide flat side reinforcement of oval ducts as recommended by the manufacturer and SMACNA HVAC Duct Construction Standard S3.13. Because of high pressure loss, do not use internal tie-rod reinforcement unless approved by the Contracting Officer.
- H. Casings and Plenums: Construct in accordance with SMACNA HVAC Duct Construction Standards Section 6, including curbs, access doors, pipe penetrations, eliminators and drain pans. Access doors shall be hollow metal, insulated, with latches and door pulls, 500 mm (20 inches) wide by 1200 - 1350 mm (48 - 54 inches) high. Provide view port in the doors where shown. Provide drain for outside air louver plenum. Outside air plenum shall have exterior insulation. Drain piping shall be routed to the nearest floor drain.
- I. Volume Dampers: Single blade or opposed blade, multi-louver type as detailed in SMACNA Standards. Refer to SMACNA Detail Figure 2-12 for Single Blade and Figure 2.13 for Multi-blade Volume Dampers.
- J. Duct Hangers and Supports: Refer to SMACNA Standards Section IV. Avoid use of trapeze hangers for round duct.

### **2.3 DUCT LINER (WHERE INDICATED ON DRAWINGS)**

- A. Duct sizes shown on drawings for lined duct are clear opening inside lining.
- B. Duct liner is only permitted to be used for return, relief and general exhaust ducts. Duct liner is not permitted for outside air ducts, supply air ducts or any other positive pressure ductwork (provide exterior insulation only).
- C. Rectangular Duct or Casing Liner: ASTM C1071, Type I (flexible), or Type II (board), 25 mm (one inch) minimum thickness, applied with mechanical fasteners and 100 percent coverage of adhesive in conformance with SMACNA, Duct Liner Application Standard.
- D. Round Duct Liner: Factory fabricated double-walled with // one inch thick sound insulation and inner perforated galvanized metal liner. Construction shall comply with flame and smoke rating required by NFPA

90A. Metal liner shall be 1.0 to 0.60 mm (20 to 24 gage) having perforations not exceeding 2.4 mm (3/32 inch) diameter and approximately 22 percent free area. Metal liner for fittings need not be perforated. Assemblies shall be complete with continuous sheet Mylar liner, 2 mil thickness, between the perforated liner and the insulation to prevent erosion of the insulation. Provide liner couplings/spacer for metal liner. At the end of insulated sections, provide insulation end fittings to reduce outer shell to liner size. Provide liner spacing/concentricity leaving airway unobstructed.

#### **2.4 DUCT ACCESS DOORS, PANELS AND SECTIONS**

- A. Provide access doors, sized and located for maintenance work, upstream, in the following locations:
  - 1. Each duct mounted coil.
  - 2. Each fire damper (for link service), smoke damper and automatic control damper.
  - 3. Each duct mounted smoke detector.
  - 4. For cleaning operating room supply air duct and exhaust duct, locate access doors at 6 m (20 feet) intervals and at each change in duct direction.
- B. Openings shall be as large as feasible in small ducts, 300 mm by 300 mm (12 inch by 12 inch) minimum where possible. Access sections in insulated ducts shall be double-wall, insulated. Transparent shatterproof covers are preferred for uninsulated ducts.
  - 1. For rectangular ducts: Refer to SMACNA HVAC Duct Construction Standards (Figure 2-12).
  - 2. For round duct: Refer to SMACNA HVAC duct Construction Standards (Figure 2-11).

#### **2.5 FIRE DAMPERS**

- A. Galvanized steel, interlocking blade type, UL listing and label, 1-1/2 hour rating, 70 degrees C (160 degrees F) fusible line, 100 percent free opening with no part of the blade stack or damper frame in the air stream.
- B. Fire dampers in wet air exhaust shall be of stainless steel construction, all others may be galvanized steel.
- C. Minimum requirements for fire dampers:
  - 1. The damper frame may be of design and length as to function as the mounting sleeve, thus eliminating the need for a separate sleeve, as allowed by UL 555. Otherwise provide sleeves and mounting angles,

minimum 1.9 mm (14 gage), required to provide installation equivalent to the damper manufacturer's UL test installation.

2. Submit manufacturer's installation instructions conforming to UL rating test.

## **2.6 SMOKE DAMPERS**

- A. Maximum air velocity, through free area of open damper, and pressure loss: Low pressure and medium pressure duct (supply, return, exhaust, outside air): 450 m/min (1500 fpm). Maximum static pressure loss: 32 Pa (0.13 inch W.G.).
- B. Maximum air leakage, closed damper: 0.32 cubic meters /min/square meter (4.0 CFM per square foot) at 750 Pa (3 inch W.G.) differential pressure.
- C. Minimum requirements for dampers:
  1. Shall comply with requirements of Table 6-1 of UL 555S, except for the Fire Endurance and Hose Stream Test.
  2. Frame: Galvanized steel channel with side, top and bottom stops or seals.
  3. Blades: Galvanized steel, parallel type preferably, 300 mm (12 inch) maximum width, edges sealed with neoprene, rubber or felt, if required to meet minimum leakage. Airfoil (streamlined) type for minimum noise generation and pressure drop are preferred for duct mounted dampers.
  4. Shafts: Galvanized steel.
  5. Bearings: Nylon, bronze sleeve or ball type.
  6. Hardware: Zinc plated.
  7. Operation: Automatic open/close. No smoke damper that requires manual reset or link replacement after actuation is acceptable. See drawings for required control operation.
- D. Motor operator (actuator): Provide 120V electric as required by the automatic control system, externally mounted on stand-offs to allow complete insulation coverage.

## **2.7 COMBINATION FIRE AND SMOKE DAMPERS**

- A. Combination fire and smoke dampers: Multi-blade type units meeting all requirements of both fire dampers and smoke dampers shall be used where shown and may be used at the Contractor's option where applicable.

## **2.8 FLEXIBLE AIR DUCT**

- A. General: Factory fabricated, complying with NFPA 90A for connectors not passing through floors of buildings. Flexible ducts shall not penetrate any fire or smoke barrier which is required to have a fire resistance rating of one hour or more. Flexible duct length shall not exceed 1.5 m



(5 feet). Provide insulated acoustical air duct connectors in supply air duct systems and elsewhere as shown.

- B. Flexible ducts shall be listed by Underwriters Laboratories, Inc., complying with UL 181. Ducts larger than 200 mm (8 inches) in diameter shall be Class 1. Ducts 200 mm (8 inches) in diameter and smaller may be Class 1 or Class 2.
- C. Insulated Flexible Air Duct: Factory made including mineral fiber insulation with maximum C factor of 0.25 at 24 degrees C (75 degrees F) mean temperature, encased with a low permeability moisture barrier outer jacket, having a puncture resistance of not less than 50 Beach Units. Acoustic insertion loss shall not be less than 3 dB per 300 mm (foot) of straight duct, at 500 Hz, based on 150 mm (6 inch) duct, of 750 m/min (2500 fpm).
- D. Application Criteria:
1. Temperature range: -18 to 93 degrees C (0 to 200 degrees F) internal.
  2. Maximum working velocity: 1200 m/min (4000 feet per minute).
  3. Minimum working pressure, inches of water gage: 2500 Pa (10 inches) positive, 500 Pa (2 inches) negative.
- E. Duct Clamps: 100 percent nylon strap, 80 kg (175 pounds) minimum loop tensile strength manufactured for this purpose or stainless steel strap with cadmium plated worm gear tightening device. Apply clamps with sealant and as approved for UL 181, Class 1 installation.
- F. Medical Grade Flexible Acoustical Duct:
1. Provide medical grade flexible acoustical duct in surgical suite and PACU areas. Flexible duct shall be constructed of triple locked aluminum perforated core, 20-25% open area protected from the air stream with a UL approved acoustical polyethylene sleeve, outside thermal insulation (R6 minimum), and reinforced metalized polyester vapor barrier. Unit shall inhibit the growth of mold and mildew.
  2. Unit shall have 25/50 flame and smoke rating, and shall be UL-181 class 1 rated, and conform to NFPA-90A.
  3. Pressure rating: -2" w.g. to +6" w.g.
  4. Temperature rating: -20°F to +250°F.
  5. Noise Reduction (based on 5 ft length, 10" diameter).

Hz	125	250	500	1000	2000	4000
Octave Band	2	3	4	5	6	7
Noise Reduction (db)	15.8	24.6	25.8	27.9	18.2	10

## **2.9 FLEXIBLE DUCT CONNECTIONS**

- A. Where duct connections are made to fans, air terminal units, and air handling units, install a non-combustible flexible connection of 822 g (29 ounce) neoprene coated fiberglass fabric approximately 150 mm (6 inches) wide. For connections exposed to sun and weather provide hypalon coating in lieu of neoprene. Burning characteristics shall conform to NFPA 90A. Securely fasten flexible connections to round ducts with stainless steel or zinc-coated iron draw bands with worm gear fastener. For rectangular connections, crimp fabric to sheet metal and fasten sheet metal to ducts by screws 50 mm (2 inches) on center. Fabric shall not be stressed other than by air pressure. Allow at least 25 mm (one inch) slack to insure that no vibration is transmitted.

## **2.10 SOUND ATTENUATING UNITS**

- A. Casing, not less than 1.0 mm (20 gage) galvanized sheet steel, or 1.3 mm (18 gage) aluminum fitted with suitable flanges to make clean airtight connections to ductwork. Sound-absorbent material faced with glass fiber cloth and covered with not less than 0.6 mm (24 gage) or heavier galvanized perforated sheet steel, or 0.85 mm (22 gage) or heavier perforated aluminum. Perforations shall not exceed 4 mm (5/32-inch) diameter, approximately 25 percent free area. Sound absorbent material shall be long glass fiber acoustic blanket meeting requirements of NFPA 90A.
- B. Entire unit shall be completely air tight and free of vibration and buckling at internal static pressures up to 2000 Pa (8 inches W.G.) at operating velocities.
- C. Pressure drop through each unit: Not to exceed indicated value at design air quantities indicated.
- D. Submit complete independent laboratory test data showing pressure drop and acoustical performance.
- E. Cap open ends of attenuators at factory with plastic, heavy duty paper, cardboard, or other appropriate material to prevent entrance of dirt, water, or any other foreign matter to inside of attenuator. Caps shall not be removed until attenuator is installed in duct system.

## **2.11 FIRESTOPPING MATERIAL**

- A. Refer to Section 07 84 00, FIRESTOPPING.

## **2.12 SEISMIC RESTRAINT FOR DUCTWORK**

- A. Refer to Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.

### **2.13 DUCT MOUNTED THERMOMETER (AIR)**

- A. Stem Type Thermometers: ASTM E1, 7 inch scale, red appearing mercury, lens front tube, cast aluminum case with enamel finish and clear glass or polycarbonate window, brass stem, 2 percent of scale accuracy to ASTM E77 scale calibrated in degrees Fahrenheit.
- B. Thermometer Supports:
  - 1. Socket: Brass separable sockets for thermometer stems with or without extensions as required, and with cap and chain.
  - 2. Flange: 3 inch outside diameter reversible flange, designed to fasten to sheet metal air ducts, with brass perforated stem.

### **2.14 DUCT MOUNTED TEMPERATURE SENSOR (AIR)**

Refer to Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC.

### **2.15 INSTRUMENT TEST FITTINGS**

- A. Manufactured type with a minimum 50 mm (two inch) length for insulated duct, and a minimum 25 mm (one inch) length for duct not insulated. Test hole shall have a flat gasket for rectangular ducts and a concave gasket for round ducts at the base, and a screw cap to prevent air leakage.
- B. Provide instrument test holes at each duct or casing mounted temperature sensor or transmitter, and at entering and leaving side of each heating coil, cooling coil, and heat recovery unit.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. Comply with provisions of Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION, particularly regarding coordination with other trades and work in existing buildings.
- B. Fabricate and install ductwork and accessories in accordance with referenced SMACNA Standards:
  - 1. Drawings show the general layout of ductwork and accessories but do not show all required fittings and offsets that may be necessary to connect ducts to equipment, boxes, diffusers, grilles, etc., and to coordinate with other trades. Fabricate ductwork based on field measurements. Provide all necessary fittings and offsets at no additional cost to the government. Coordinate with other trades for space available and relative location of HVAC equipment and accessories on ceiling grid. Duct sizes on the drawings are inside dimensions which shall be altered by Contractor to other dimensions with the same air handling characteristics where necessary to avoid interferences and clearance difficulties.

2. Provide duct transitions, offsets and connections to dampers, coils, and other equipment in accordance with SMACNA Standards, Section II. Provide streamliner, when an obstruction cannot be avoided and must be taken in by a duct. Repair galvanized areas with galvanizing repair compound.
  3. Provide bolted construction and tie-rod reinforcement in accordance with SMACNA Standards.
  4. Construct casings, eliminators, and pipe penetrations in accordance with SMACNA Standards, Chapter 6. Design casing access doors to swing against air pressure so that pressure helps to maintain a tight seal.
- C. Install duct hangers and supports in accordance with SMACNA Standards, Chapter 4.
- D. Install fire dampers, smoke dampers and combination fire/smoke dampers in accordance with the manufacturer's instructions to conform to the installation used for the rating test. Install fire dampers, smoke dampers and combination fire/smoke dampers at locations indicated and where ducts penetrate fire rated and/or smoke rated walls, shafts and where required by the Resident Engineer. Install with required perimeter mounting angles, sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings and hinges per UL and NFPA. Demonstrate re-setting of fire dampers and operation of smoke dampers to the Resident Engineer.
- E. Seal openings around duct penetrations of floors and fire rated partitions with fire stop material as required by NFPA 90A.
- F. Flexible duct installation: Refer to SMACNA Standards, Chapter 3. Ducts shall be continuous, single pieces not over 1.5 m (5 feet) long (NFPA 90A), as straight and short as feasible, adequately supported. Centerline radius of bends shall be not less than two duct diameters. Make connections with clamps as recommended by SMACNA. Clamp per SMACNA with one clamp on the core duct and one on the insulation jacket. Flexible ducts shall not penetrate floors, or any chase or partition designated as a fire or smoke barrier, including corridor partitions fire rated one hour or two hour. Support ducts SMACNA Standards.
- G. Where diffusers, registers and grilles cannot be installed to avoid seeing inside the duct, paint the inside of the duct with flat black paint to reduce visibility.
- H. Air Flow Measuring Devices (AFMD): Install units with minimum straight run distances, upstream and downstream as recommended by the manufacturer.

- I. Low Pressure Duct Liner: Install in accordance with SMACNA, Duct Liner Application Standard.
- J. Protection and Cleaning: Adequately protect equipment and materials against physical damage. Place equipment in first class operating condition, or return to source of supply for repair or replacement, as determined by Resident Engineer. Protect equipment and ducts during construction against entry of foreign matter to the inside and clean both inside and outside before operation and painting. When new ducts are connected to existing ductwork, clean both new and existing ductwork by mopping and vacuum cleaning inside and outside before operation.

### **3.2 DUCT LEAKAGE TESTS AND REPAIR**

- A. Ductwork leakage testing shall be performed by the Testing and Balancing Contractor directly contracted by the General Contractor and independent of the Sheet Metal Contractor.
- B. Ductwork leakage testing shall be performed for the entire air distribution system (including all supply, return, exhaust and relief ductwork), section by section, including fans, coils and filter sections. Based upon satisfactory initial duct leakage test results, the scope of the testing may be reduced by the Contracting Officer on ductwork constructed to the 750 Pa (3" WG) duct pressure classification. In no case shall the leakage testing of ductwork constructed above the 750 Pa (3" WG) duct pressure classification or ductwork located in shafts or other inaccessible areas be eliminated.
- C. Test procedure, apparatus and report shall conform to SMACNA Leakage Test manual. The maximum leakage rate allowed is 4 percent of the design air flow rate.
- D. All ductwork shall be leak tested first before enclosed in a shaft or covered in other inaccessible areas.
- E. All tests shall be performed in the presence of the Resident Engineer and the Test and Balance agency. The Test and Balance agency shall measure and record duct leakage and report to the Resident Engineer and identify leakage source with excessive leakage.
- F. If any portion of the duct system tested fails to meet the permissible leakage level, the Contractor shall rectify sealing of ductwork to bring it into compliance and shall retest it until acceptable leakage is demonstrated to the Resident Engineer.
- G. All tests and necessary repairs shall be completed prior to insulation or concealment of ductwork.

- H. Make sure all openings used for testing flow and temperatures by TAB Contractor are sealed properly.

**3.3 SUPPORTS AND SEISMIC BRACING**

- A. Provide supports and bracings for new ductwork. Provide supports and bracing on existing ductwork within the 3rd Floor project area. Provide in accordance with Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.

**3.4 TESTING, ADJUSTING AND BALANCING (TAB)**

- A. Refer to Section 23 05 93, TESTING, ADJUSTING, and BALANCING FOR HVAC.

**3.5 OPERATING AND PERFORMANCE TESTS**

- A. Refer to Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION

- - - E N D - - -

**SECTION 23 40 00**  
**HVAC AIR CLEANING DEVICES**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. Air filters for heating, ventilating and air conditioning.
- B. Definitions: Refer to ASHRAE Standard 52.2 for definitions of face velocity, net effective filtering area, media velocity, initial resistance (pressure drop), MERV (Minimum Efficiency Reporting Value), PSE (Particle Size Efficiency), particle size ranges for each MERV number, dust holding capacity and explanation of electrostatic media based filtration products versus mechanical filtration products. Refer to ASHRAE Standard 52.2 Appendix J for definition of MERV-A.

**1.2 RELATED WORK**

- A. Sustainable design requirements and procedures including submittal requirements: Section 01 81 11, SUSTAINABLE DESIGN REQUIREMENTS.
- B. Procedures and requirements for managing and disposing construction and demolition waste: Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- C. Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION: General mechanical requirements and items, which are common to more than one section of Division 23.
- E. Section 23 74 13, PACKAGED, OUTDOOR, CENTRAL-STATION AIR-HANDLING UNITS: Filter housing and racks.
- F. Section 23 08 00 - COMMISSIONING OF HVAC SYSTEMS: Requirements for commissioning, systems readiness checklists, and training.

**1.3 QUALITY ASSURANCE**

- A. Air Filter Performance Report for Extended Surface Filters:
  - 1. Submit a test report for each Grade of filter being offered. The report shall not be more than three (3) years old and prepared by using test equipment, method and duct section as specified by ASHRAE Standard 52.2 for type filter under test and acceptable to Contracting Officer's Representative, indicating that filters comply with the requirements of this specification. Filters utilizing partial or complete synthetic media will be tested in compliance with pre-conditioning steps as stated in Appendix J. All testing is to be conducted on filters with a nominal 24 inch by 24 inch face dimension. Test for 150 m/min (500 fpm) will be accepted for lower velocity rated filters provided the test report of an independent testing laboratory complies with all the requirements of this specification.

2. Guarantee Performance: The manufacturer shall supply ASHRAE 52.2 test reports on each filter type submitted. Any filter supplied will be required to maintain the minimum efficiency shown on the ASHRAE Standard 52.2 report throughout the time the filter is in service.
- B. Filter Warranty for Extended Surface Filters: Guarantee the filters against leakage, blow-outs, and other deficiencies during their normal useful life, up to the time that the filter reaches the final pressure drop. Defective filters shall be replaced at no cost to the Government.
- C. Comply with UL Standard 900 for flame test.
- D. Nameplates: Each filter shall bear a label or name plate indicating manufacturer's name, filter size, rated efficiency.

#### 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. Extended surface filters.
  2. Holding frames. Identify locations.
  3. Side access housings. Identify locations, verify insulated doors.
  4. HEPA filters.
  5. Magnehelic gages.
- C. Air Filter performance reports.
- D. Suppliers warranty.
- E. Field test results for HEPA filters as per paragraph 2.3.E.3.

#### 1.5 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 basic designation only.
- B. American Society of Heating, Refrigerating and Air-conditioning Engineers, Inc. (ASHRAE):  
52.2-2007.....Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size, including Appendix J
- C. American Society of Mechanical Engineers (ASME):  
NQA-1-2008.....Quality Assurance Requirements for Nuclear Facilities Applications
- D. Underwriters Laboratories, Inc. (UL):  
900;Revision 15 July 2009      Test Performance of Air Filter Units



## PART 2 - PRODUCTS

### 2.1 REPLACEMENT FILTER ELEMENTS TO BE FURNISHED

- A. To allow temporary use of HVAC systems for testing and in accordance with Paragraph, TEMPORARY USE OF MECHANICAL AND ELECTRICAL SYSTEMS in Section 01 00 00, GENERAL REQUIREMENTS, provide one complete set of additional filters to the Contracting Officer.
- B. The Contracting Officer will direct whether these additional filters will either be installed as replacements for dirty units or turned over to VA for future use as replacements.

### 2.2 EXTENDED SURFACE AIR FILTERS

- A. Use factory assembled air filters of the extended surface type with supported or non-supported cartridges for removal of particulate matter in air conditioning, heating and ventilating systems. Filter units shall be of the extended surface type fabricated for disposal when the contaminant load limit is reached as indicated by maximum (final) pressure drop.
- B. Filter Classification: UL listed and approved conforming to UL Standard 900.
- C. HVAC Filter Types

HVAC Filter Types Table 2.2C				
MERV Value ASHRAE 52.2	MERV-A Value ASHRAE 62.2 Appendix J	Application	Particle Size	Thickness /Type
8	8-A	Pre-Filter	3 to 10 Microns	50 mm (2-inch) Throwaway
11	11-A	After-Filter	1 to 3 Microns	300 mm (4-inch) Throwaway
13	13-A	After-Filter	0.3 to 1 Microns	300 mm (12-inch) Rigid Cartridge
14	14-A	After-Filter	0.3 to 1 Microns	300 mm (12-inch) Rigid Cartridge

#### D. HEPA Filters

HEPA Filters Table 2.2D				
Efficiency at 0.3 Micron	Application	Initial Resistance (inches w.g.)	Rated CFM	Construction
99.97	Final Filter	1.00	2000	Aluminum Frame V-Bank

### 2.3 MEDIUM EFFICIENCY PLEATED PANEL PRE-FILTERS (2" / MERV 8 AND 4" / MERV 11; UL 900 CLASS 2):

- A. Construction: Air filters shall be medium efficiency ASHRAE pleated panels consisting of cotton and synthetic or 100% virgin synthetic

media, self supporting media with required media stabilizers, and beverage board enclosing frame. Filter media shall be lofted to a uniform depth and formed into a uniform radial pleat. The media stabilizers shall be bonded to the downstream side of the media to maintain radial pleats and prevent media oscillation. An enclosing frame of no less than 28-point high wet-strength beverage board shall provide a rigid and durable enclosure. The frame shall be bonded to the media on all sides to prevent air bypass. Integral diagonal support members on the air entering and air exiting side shall be bonded to the apex of each pleat to maintain uniform pleat spacing in varying airflows.

- B. Performance: The filter shall have a Minimum Efficiency Reporting Value of MERV 8 or 11 as indicated when evaluated under the guidelines of ASHRAE Standard 52.2. The media shall maintain or increase in efficiency over the life of the filter. Pertinent tolerances specified in Section 7.4 of the Air-Conditioning and Refrigeration Institute (ARI) Standard 850-93 shall apply to the performance ratings. All testing is to be conducted on filters with a nominal 24" x 24" face dimension.

Minimum Efficiency Reporting (MERV)	8	11
Media Area (Square Feet)	17.3	27.1
Dust Holding Capacity (Grams)	---	---
Nominal Size (Width x Height x Depth)	24x24x2	24x24x4
Rated Air Flow Capacity (Cubic Feet per Minute)	2,000	2,000
Rated Air Flow Rate (Feet per Minute)	500	500
Final Resistance (Inches w.g.)	1.0	1.0
Maximum Recommended Change-Out Resistance (Inches w.g.)	0.66	0.66
Rated Initial Resistance (Inches w.g.)	0.20	0.22

- C. The filters shall be approved and listed by Underwriters' Laboratories, Inc. as Class 2 when tested according to U. L. Standard 900 and CAN 4-5111.

#### **2.4 HIGH EFFICIENCY EXTENDED SURFACE (INTERMEDIATE/AFTER (FINAL)) CARTRIDGE FILTERS (12"; MERV 14/13; UL 900 CLASS 2):**

- A. Construction: Air filters shall consist of 8 pleated media packs assembled into 4 V-banks within a totally plastic frame. The filters shall be capable of operating at temperatures up to 80 degrees C (176 degrees F). The filters must either fit without modification or be adaptable to the existing holding frames. The molded end panels are to be made of high impact polystyrene plastic. The center

support members shall be made of ABS plastic. No metal components are to be used.

- B. Media: The media shall be made of micro glass fibers with a water repellent binder. The media shall be a dual density construction, with coarser fibers on the air entering side and finer fibers on the air leaving side. The media shall be pleated using separators made of continuous beads of low profile thermoplastic material. The media packs shall be bonded to the structural support members at all points of contact, this improves the rigidity as well as eliminates potential air bypass in the filter
- C. Performance: Filters of the size, air flow capacity and nominal efficiency (MERV) shall meet the following rated performance specifications based on the ASHRAE 52.2-1999 test method. Where applicable, performance tolerance specified in Section 7.4 of the Air-Conditioning and Refrigeration Institute (ARI) Standard 850-93 shall apply to the performance ratings. All testing is to be conducted on filters with a nominal 24"x24" header dimension.

Minimum Efficiency Reporting Value (MERV)	14	13
Gross Media Area (Sq. Ft.)	196	196
Dust Holding Capacity (Grams)	486	430
Nominal Size (Width x Height x Depth)	24x24x12	24x24x12
Rated Air Flow Capacity (cubic feet per minute)	2,000	2,000
Rated Air Flow Rate (feet per minute)	500	500
Final Resistance (inches w.g.)	2.0	2.0
Maximum Recommended Change-Out Resistance (Inches w.g.)	0.74	0.68
Rated Initial Resistance (inches w.g.)	0.36	0.27

**2.5 HEPA FILTERS HIGH CAPACITY V-BANK HIGH CAPACITY FILTERS (FINAL FILTER APPLICATION)**

- A. Air filters shall be absolute grade HEPA filters consisting of pleated media packs assembled in a V-bank configuration, polyurethane sealant, anodized aluminum enclosure and seamless fluid sealing gasket. Sizes shall be as noted on enclosed drawings or other supporting materials.
- B. Construction: Filter media shall be micro fiber glass formed into mini-pleat pleat-in-pleat V-bank design. The media packs shall be potted into the enclosing frame with fire retardant polyurethane sealant. An enclosing frame of anodized extruded aluminum shall form a rugged and

durable enclosure. A seamless sealing gasket shall be included on the downstream side of the filter to form a positive seal upon installation.

- C. Performance: Filter efficiency at 0.3 micron shall be 99.99% when evaluated according to the IEST Recommended Practice for applicable type. Each filter shall be labeled as to tested performance. Initial resistance target shall not exceed 1.0" w.g. at rated airflow.

HEPA Performance V-Bank Style (High Capacity) Table 2.5B		
Nominal Size (inches)	Airflow Capacity (cfm)	Media Area (Square Feet)
24H by 24W by 12D	2000 at 1.0" w.g.	390
24H by 12W by 12D	900 at 1.0" w.g.	174
Follow manufacturers' recommendation for change out resistance, typically double the initial.		

- D. Supporting Data: The filter shall be labeled as to tested efficiency, rated/tested cfm, pressure drop and shall be serialized for identification. The manufacturer shall supply a Certificate of Conformance for each HEPA filter supplied to the facility.
- E. Filter must be listed as UL 586 and UL 900 per Underwriters Laboratories. Manufacturer shall provide evidence of facility certification to ISO 9001:2000.

## 2.6 FILTER HOUSINGS/SUPPORT FRAMES

- A. Side-Access Housing (HEPA Grade)
1. Filter housing shall be two-stage filter system consisting of 14-gauge galvanized steel enclosure, spring-loaded crank-type sealing assembly for gasket seal type final filters, insulated dual-access doors with gasketing and positive sealing doorknobs. In-line housing depth shall not exceed 25". Sizes shall be as noted on enclosed drawings or other supporting materials.
  2. Construction: The housing shall be constructed of 14-gauge galvanized steel with mating flanges to facilitate attachment to other system components. All pressure boundaries shall be of all welded construction. The housing shall be weatherproof and suitable for rooftop/outdoor installation. A prefilter track to accommodate nominal 2" deep prefilters, shall be an integral component of the housing. The housing shall incorporate a spring-loaded crank-type final filter sealing mechanism. The mechanism shall be geared to exert 700 pounds of pressure against each filter. The clamping frame shall have a continuous flat surface seal to compress all four downstream gasketed surfaces of the downstream seal filter. The final filter locking mechanism shall include a 3/4" socket adapter to

facilitate opening or closing the mechanism. Insulated dual access doors shall include high-memory sponge neoprene gasket to facilitate a door-to-filter seal. Each door shall be equipped with adjustable and replaceable UV-resistant positive sealing knobs. The access doors shall be both hinged for swing open operation or designed to be completely removable. The housing shall include static pressure ports (1/8" NPT male) to facilitate pressure drop measurements across prefilter, final filter, or combination thereof.

3. Performance: Manufacturer shall provide evidence of facility certification to ISO 9001:2008.

## **2.7 INSTRUMENTATION**

- A. Magnehelic Differential Pressure Filter Gages: Nominal 100 mm (four inch) diameter, zero to 500 Pa (zero to two inch water gage), three inch for HEPA) range, //except for MERV 17 HEPA Final Filters, where the range shall be zero to 750 Pa (zero to three inch water gage)// Gauges shall be flush-mounted in aluminum panel board, complete with static tips, copper or aluminum tubing, and accessory items to provide zero adjustment.
- B. DDC static (differential) air pressure measuring station. Refer to Specification Section 23 09 23 DIRECT DIGITAL CONTROL SYSTEM FOR HVAC
- C. Provide one DDC sensor across each extended surface filter. Provide Petcocks for each gauge or sensor.
- D. Provide one common filter gauge for two-stage filter banks with isolation valves to allow differential pressure measurement.

## **2.8 HVAC EQUIPMENT FACTORY FILTERS**

- A. Manufacturer standard filters within fabricated packaged equipment should be specified with the equipment and should adhere to industry standard.
- B. Cleanable filters are not permitted.
- C. Automatic Roll Type filters are not permitted.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. Install supports, filters and gages in accordance with manufacturer's instructions.

### **3.2 START-UP AND TEMPORARY USE**

- A. Clean and vacuum air handling units and plenums prior to starting air handling systems.
- B. Replace Pre-filters and install clean filter units prior to final inspection as directed by the Resident Engineer.

### **3.3 COMMISSIONING**

- A. Provide commissioning documentation in accordance with the requirements of Section 23 08 00 - COMMISSIONING OF HVAC SYSTEMS for all inspection, start up, and contractor testing required above and required by the System Readiness Checklist provided by the Commissioning Agent.
- B. Components provided under this section of the specification will be tested as part of a larger system. Refer to Section 23 08 00 - COMMISSIONING OF HVAC SYSTEMS and related sections for contractor responsibilities for system commissioning.

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**SECTION 23 72 00**  
**AIR-TO-AIR ENERGY RECOVERY EQUIPMENT**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This Section specifies run-around heat recovery systems as an integral part of the air handling units.

**1.2 RELATED WORK**

- A. Section 01 00 00, GENERAL REQUIREMENTS: Requirements for pre-test of equipment.
- B. Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS: Seismic requirements for non-structural equipment.
- C. Section 23 05 11, COMMON WORK RESULTS FOR HVAC: General mechanical requirements and items, which are common to more than one section of Division 23.
- D. Section 23 21 23, HYDRONIC PUMPS: Requirements for pumping equipment.
- E. Section 23 07 11, HVAC and BOILER PLANT INSULATION: Requirements for piping insulation.
- F. Section 23 21 13, HYDRONIC PIPING: Requirements for piping for expansion tanks.
- G. Section 23 82 16, AIR COILS: Requirements for run-around system coils.
- H. Section 23 31 00, HVAC DUCTS and CASINGS: Requirements for sheet metal ducts and fittings.
- I. Section 23 40 00, HVAC AIR CLEANING DEVICES: Requirements for filters used before heat recovery coils.
- J. Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC: Requirements for controls and instrumentation.
- K. Section 23 05 93, TESTING, ADJUSTING and BALANCING FOR HVAC: Requirements for testing, adjusting and balancing of HVAC system.
- L. Section 23 08 00 - COMMISSIONING OF HVAC SYSTEMS: Requirements for commissioning, systems readiness checklists, and training.
- M. Section 01 91 00 - GENERAL COMMISSIONING REQUIREMENTS
- N. Section 23 74 13 - PACKAGED, OUTDOOR, CENTRAL STATION AIR-HANDLING UNITS

**1.3 QUALITY ASSURANCE**

- A. Refer to paragraph, GUARANTEE in specification Section 00 72 00, GENERAL CONDITIONS.
- B. Refer to specification Section 01 00 00, GENERAL REQUIREMENTS for performance tests and instructions to VA personnel.

- C. Refer to paragraph QUALITY ASSURANCE in specification Section 23 05 11, COMMON WORK RESULTS FOR HVAC.
- D. Performance Criteria: Heat recovery equipment shall be provided by a manufacturer who has been manufacturing such equipment and the equipment has a good track record for at least 3 years.
- E. Performance Test: In accordance with PART 3.

#### 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. Run-Around Energy Recovery System
- C. Certificate: Submit, simultaneously with shop drawings, an evidence of satisfactory service of the equipment on three similar installations.
- D. Submit type, size, arrangement and performance details. Present application ratings in the form of tables, charts or curves.
- E. Provide installation, operating and maintenance instructions, in accordance with Article, INSTRUCTIONS, in Section 01 00 00, GENERAL REQUIREMENTS.
- F. Completed System Readiness Checklists provided by the Commissioning Agent and completed by the contractor, signed by a qualified technician and dated on the date of completion, in accordance with the requirements of Section 23 08 00 COMMISSIONING OF HVAC SYSTEMS.

#### 1.5 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. Air Conditioning, Heating, and Refrigeration Institute (AHRI)  
AHRI 1060-2005.....Performance Rating of Air-to-Air Heat Exchangers  
for Energy Recovery Ventilation Equipment
- C. American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE):
  - 15-10.....Safety Standard for Refrigeration Systems (ANSI)
  - 52.1-92.....Gravimetric and Dust-Spot Procedures for Testing  
Air-Cleaning Devices Used in General Ventilation  
for Removing Particulate Matter
  - 52.2-07.....Method of Testing General Ventilation Air-  
Cleaning Devices for Removal Efficiency by  
Particle Size



84-08.....Method of Testing Air-to-Air Heat/Energy  
Exchangers

D. American Society for Testing and materials (ASTM)

D635-10.....Standard Test Method for Rate of Burning and/or  
Extent and Time of Burning of Plastics in a  
Horizontal Position

E84-10.....Standard Test Method for Surface Burning  
Characteristics of Building Materials

E. American Society of Civil Engineers (ASCE)

ASCE 7-10.....Minimum Design Loads for Buildings and Other  
Structures

F. Underwriters Laboratories, Inc (UL)

1812-2009.....Standard for Ducted Heat Recovery Ventilators

1815-2009.....Standard for Nonducted Heat Recovery Ventilators

## **PART 2 - PRODUCTS**

### **2.1 RUN-AROUND ENERGY RECOVERY SYSTEM**

A. System shall be field fabricated, as shown, containing coils (integral part of the air handling unit), piping, pumps, insulation, and accessories.

B. Automatic Temperature Controls and Sequence of Operations: As shown on drawings and as specified in Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC. C. Components shall comply with requirements in the following specification sections:

1. Pumps: Section 23 21 23, HYDRONIC PUMPS
2. Insulation: Section 23 07 11, HVAC AND BOILER PLANT INSULATION
3. Pipes, Fittings, and Specialties: Section 23 21 13, HYDRONIC PIPING
4. Coils: Section 23 82 16, AIR COILS
5. Controls: Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC

### **2.2 AIR FILTERS**

See drawings requirements in specification Section 23 40 00, HVAC AIR CLEANING DEVICES.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

A. Follow the equipment manufacturer's instructions for handling and installation, and setting up of ductwork for makeup and exhaust air steamers for maximum efficiency.

D. Install units with adequate spacing and access for cleaning and maintenance of heat recovery coils as well as filters.

- E. Brace heat recovery equipment installed in projects in the Seismic area according to specification Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.

### **3.2 FIELD QUALITY CONTROL**

- A. Operational Test: Perform tests as per manufacturer's written instructions for proper and safe operation of the heat recovery system.
  - 1. After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
  - 2. Adjust seals and purge.
  - 3. Test and adjust controls and safeties.
- B. Replace damaged and malfunctioning controls and equipment.
- C. Set initial temperature and humidity set points. Set field-adjustable switches and circuit-breaker trip ranges as indicated.
- D. Prepare test and inspection reports to the Senior Resident Engineer in accordance with specification Section 01 00 00, GENERAL REQUIREMENTS.

### **3.3 INSTRUCTIONS**

- A. Provide services of manufacturer's technical representative for four hours to instruct VA personnel in operation and maintenance of heat recovery equipment.

### **3.4 STARTUP AND TESTING**

- A. The Commissioning Agent will observe startup and contractor testing of selected equipment. Coordinate the startup and contractor testing schedules with the Resident Engineer and Commissioning Agent. Provide a minimum of 7 days prior notice.

### **3.5 COMMISSIONING**

- A. Provide commissioning documentation in accordance with the requirements of Section 23 08 00 - COMMISSIONING OF HVAC SYSTEMS for all inspection, start up, and contractor testing required above and required by the System Readiness Checklist provided by the Commissioning Agent.
- B. Components provided under this section of the specification will be tested as part of a larger system. Refer to Section 23 08 00 - COMMISSIONING OF HVAC SYSTEMS and related sections for contractor responsibilities for system commissioning.

### **3.6 DEMONSTRATION AND TRAINING**

- A. Provide services of manufacturer's technical representative for four hours to instruct VA personnel in operation and maintenance of units.
- B. Submit training plans and instructor qualifications in accordance with the requirements of Section 23 08 00 - COMMISSIONING OF HVAC SYSTEMS.

DEPARTMENT OF VETERANS AFFAIRS  
PALO ALTO HEALTH CARE SYSTEM  
REPLACE BUILDING 100 AHU-19

Project No.: 640-15-138

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**SECTION 23 74 13**  
**PACKAGED, OUTDOOR, CENTRAL-STATION AIR-HANDLING UNITS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. Roof top air handling units including integral components specified herein.
- B. Definitions: Roof Top Air Handling Unit(Roof Top Units, RTU): A factory fabricated assembly consisting of fan, coils, filters, and other necessary equipment to perform one or more of the following functions of circulating, cleaning, heating, cooling, humidifying, heat recovery, and mixing of air. Design capacities of units shall be as scheduled on the drawings.

**1.2 RELATED WORK**

- A. Sustainable design requirements and procedures including submittal requirements: Section 01 81 11, SUSTAINABLE DESIGN REQUIREMENTS.
- B. Procedures and requirements for managing and disposing construction and demolition waste: Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- C. Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS: Seismic restraints for equipment.
- D. Section 23 05 11, COMMON WORK RESULTS FOR HVAC: General mechanical requirements and items, which are common to more than one section of Division 23.
- E. Section 23 05 41, NOISE and VIBRATION CONTROL FOR HVAC PIPING and EQUIPMENT: Sound and vibration requirements.
- F. Section 23 07 11, HVAC and BOILER PLANT INSULATION: Piping and duct insulation.
- G. Section 23 21 13, HYDRONIC PIPING and Section 23 22 13, STEAM and CONDENSATE HEATING PIPING: Piping and valves, and humidifiers.
- H. Section 23 82 16, AIR COILS: Heating and cooling coils and pressure requirements.
- I. Section 23 31 00, HVAC DUCTS and CASINGS: Requirements for flexible duct connectors, sound attenuators and sound absorbing duct lining.
- J. Section 23 40 00, HVAC AIR CLEANING DEVICES: Air filters and filters' efficiency.
- K. Section 23 72 00, AIR TO AIR ENERGY RECOVERY EQUIPMENT.

- L. Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC: HVAC controls.
- M. Section 23 05 93, TESTING, ADJUSTING, and BALANCING FOR HVAC: Testing, adjusting and balancing of air and water flows.
- N. Section 23 05 12, GENERAL MOTOR REQUIREMENTS FOR HVAC and STEAM GENERATION EQUIPMENT: Types of motors.
- O. Section 26 29 11, LOW-VOLTAGE MOTOR STARTERS: Variable speed motor controllers.
- P. Section 01 91 00, GENERAL COMMISSIONING REQUIREMENTS:
- Q. Section 23 08 00 - COMMISSIONING OF HVAC SYSTEMS: Requirements for commissioning, systems readiness checklists, and training.

### **1.3 SEISMIC PERFORMANCE REQUIREMENTS**

- A. Seismic Performance: Equipment shall have special seismic certification in accordance with the requirements in Section 13.2.2 of ASCE 7-10.
- B. Equipment with OSHPD OSP certification is acceptable.

### **1.4 QUALITY ASSURANCE**

- A. Refer to Article, Quality Assurance, in Section 23 05 11, COMMON WORK RESULTS FOR HVAC.
- B. Air Handling Units Certification
  - 1. Air Handling Units with Plenum Fans:
    - a. Air handling Units with Multiple Fans in an Array shall be tested and rated in accordance with AHRI 430 and AHRI 260.
- C. Heating, Cooling, and Air Handling Capacity and Performance Standards: AHRI 430, AHRI 410, ASHRAE 51, and AMCA 211.
- D. Performance Criteria:
  - 1. The fan BHP shall include all system effects for all fans.
  - 2. The fan motor shall be selected within the rated nameplate capacity, without relying upon NEMA Standard Service Factor.
  - 3. Select the fan operating point as follows:
    - a. Air Foil, Backward Inclined, Including Plenum Fans: At or near the peak static efficiency but at an appropriate distance from the stall line.
  - 4. Operating Limits: AMCA 99 and Manufacturer's Recommendations.
- E. Units shall be factory-fabricated, assembled, and tested by a manufacturer, in business of manufacturing similar air-handling units for at least five (5) years.

- F. Fan performance shall be based on test runs in an AMCA certified laboratory as administered in accordance with AMCA Standard 210. Each fan shall be sized to perform as indicated in the equipment schedules.**

**1.5 SUBMITTALS:**

- A. The contractor shall, in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES, furnish a complete submission for all roof top units covered in the project. The submission shall include all information listed below. Partial and incomplete submissions shall be rejected without reviews.
- B. Manufacturer's Literature and Data:
1. Submittals for RTUs shall include fans, drives, motors, coils, humidifiers, sound attenuators, heat recovery, mixing box with outside/return air dampers, filter housings, blender sections, and all other related accessories. The contractor shall provide custom drawings showing total air handling unit assembly including dimensions, operating weight, access sections, flexible connections, door swings, controls penetrations, electrical disconnect, lights, duplex receptacles, switches, wiring, utility connection points, unit support system, vibration isolators, drain pan, pressure drops through each component (filter, coil etc) and rigging points.
  2. Submittal drawings of section or component only, will not be acceptable. Contractor shall also submit performance data including performance test results, charts, curves or certified computer selection data; data sheets; fabrication and insulation details; if the unit cannot be shipped in one piece, the contractor shall indicate the number of pieces that each unit will have to be broken into to meet shipping and job site rigging requirements. This data shall be submitted in hard copies and in electronic version compatible to AutoCAD version used by the VA at the time of submission.
  3. Submit sound power levels in each octave band for fan and at entrance and discharge of RTUs at scheduled conditions. Include sound attenuator capacities and itemized internal component attenuation. Internal lining of supply air ductwork with sound absorbing material is not permitted. In absence of sound power ratings refer to Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING AND EQUIPMENT.
  4. Provide fan curves showing cubic feet per minute, static pressure, efficiency, and horsepower for design point of operation and at maximum design cubic feet per minute and 110 percent of design static pressure.
  5. Submit total fan static pressure, external static pressure, for RTU including total, inlet and discharge pressures, and itemized specified internal losses and unspecified internal losses. Refer to air handling unit schedule on drawings.
- C. Maintenance and operating manuals in accordance with Section 01 00 00, GENERAL REQUIREMENTS. Include instructions for lubrication, filter

replacement, motor and drive replacement, spare part lists, and wiring diagrams.

- D. Submit written test procedures two weeks prior to factory testing. Submit written results of factory tests for approval prior to shipping.
- E. Completed System Readiness Checklists provided by the Commissioning Agent and completed by the contractor, signed by a qualified technician and dated on the date of completion, in accordance with the requirements of Section 23 08 00 COMMISSIONING OF HVAC SYSTEMS.
- F. Submit shipping information that clearly indicates how the units will be shipped in compliance with the descriptions below.
  - 1. Units shall be shipped in one (1) piece where possible and in shrink wrapping to protect the unit from dirt, moisture and/or road salt.
  - 2. If not shipped in one (1) piece, provide manufacturer approved shipping splits where required for installation or to meet shipping and/or job site rigging requirements in modular sections. Indicate clearly that the shipping splits shown in the submittals have been verified to accommodate the construction constraints for rigging as required to complete installation and removal of any section for replacement through available access without adversely affecting other sections.
  - 3. If shipping splits are provided, each component shall be individually shrink wrapped to protect the unit and all necessary hardware (e.g. bolts, gaskets etc.) will be included to assemble unit on site (see section 2.1.A4).
  - 4. Lifting lugs will be provided to facilitate rigging on shipping splits and joining of segments. If the unit cannot be shipped in one piece, the contractor shall indicate the number of pieces that each unit will have to be broken into to meet shipping and job site rigging requirements.

#### **1.6 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. Air-Conditioning, Heating, and Refrigeration Institute (AHRI):
  - 1. 260-01 Sound Rating of Ducted Air Moving and Conditioning Equipment
  - 2. 410-01 Standard for Forced-Circulation Air-Heating and Air-Cooling Coils
  - 3. 430-09 Standard for Central Station Air Handling Units
  - 4. AHRI-DCAACP Directory of Certified Applied Air Conditioning Products
- C. Air Moving and Conditioning Association (AMCA):

1. 210-07 Laboratory Methods of Testing Fans for Rating
- D. Anti-Friction Bearing Manufacturer's Association, Inc. (AFBMA):
  1. 9-90 (R2008) Load Ratings and Fatigue life for Ball Bearings
- E. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE):
  1. 51-2007 Laboratory Methods of Testing Fans for Rating
- F. American Society for Testing and Materials (ASTM):
  1. A653/653M-02 Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
  2. B117-07a Salt Spray (Fog) Testing
  3. C1071-05e1 Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material)
  4. D1654-08 Standard Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments
  5. D1735-08 Water Resistance of Coatings Using Water Fog Apparatus
  6. D3359-08 Standard Test Methods for Measuring Adhesion by Tape Test
  7. E84-10 Standard Test Method for Surface Burning Characteristics of Building Materials
- G. Anti-Friction Bearing Manufacturer's Association, Inc. (AFBMA):
  1. 9-90 Load Ratings and Fatigue life for Ball Bearings
- H. Military Specifications (Mil. Spec.):
  1. DOD-P-21035A-2003 Paint, High Zinc Dust Content, Galvanizing Repair
- I. National Fire Protection Association (NFPA):
  1. NFPA 90A Standard for Installation of Air Conditioning and Ventilating Systems, 2009
- J. Energy Policy Act of 2005 (P.L.109-58)

## **PART 2 - PRODUCTS**

### **2.1 ROOF TOP AIR HANDLING UNITS**

- A. General:
  1. Furnish rooftop air handling units with fan wall technology fans, manufactured by Hunt Air, Climate Craft, Temtrol, or Energy Lab.
  2. Roof top units (RTU) shall be fabricated from insulated, solid double-wall powder coated galvanized steel outer casing and interior liner, except provide solid type 304 stainless steel

PACKAGED, OUTDOOR, CENTRAL-STATION AIR HANDLING UNITS



liner in the humidifier and cooling coil sections, and all supply air section downstream of the HEPA filter section, and where indicated. Galvanizing shall be hot dipped conforming to ASTM A525 and shall provide a minimum of 0.275 kg of zinc per square meter (0.90 oz. of zinc per square foot) (G90).

3. The contractor and the RTU manufacturer shall be responsible for insuring that the unit will not exceed the allocated space shown on the drawings, including required clearances for service and future overhaul or removal of unit components. All structural, piping, wiring, and ductwork alterations of units, which are dimensionally different than those specified, shall be the responsibility of the contractor at no additional cost to the government.
4. RTUs shall be fully assembled by the manufacturer in the factory in accordance with the arrangement shown on the drawings. The unit shall be assembled into the largest sections possible subject to shipping and rigging restrictions. The correct fit of all components and casing sections shall be verified in the factory for all units prior to shipment. All units shall be fully assembled, tested and then split to accommodate shipment and job site rigging. On units not shipped fully assembled, the manufacturer shall tag each section and include air flow direction to facilitate assembly at the job site. Lifting lugs or shipping skids shall be provided for each section to allow for field rigging and final placement of unit.
5. The RTU manufacturer shall provide the necessary gasketing, caulking, and all screws, nuts, and bolts required for assembly. The manufacturer shall provide a local representative at the job site to supervise the assembly and to assure the units are assembled to meet manufacturer's recommendations and requirements noted on the drawings. Provide documentation that this representative has provided this service on similar jobs to the Contracting Officer. If a local representative cannot be provided, the manufacturer shall provide a factory representative.
6. Gaskets: All door and casing and panel gaskets and gaskets between air handling unit components, if joined in the field, shall be high quality which seal air tight and retain their structural integrity and sealing capability after repeated assembly and disassembly of bolted panels and opening and closing of hinged components. Bolted sections may use a more permanent gasketing method provided they are not disassembled.
7. Structural Rigidity: Provide structural reinforcement when required by span or loading so that the deflection of the assembled structure shall not exceed 1/200 of the span based on a differential static pressure of 1991 Pa (8 inches water gage) or higher.
8. Corrosion Protection:
  - a. Casing Surfaces (Exterior and Interior): Except where noted as stainless steel, all wall, roof, interior liner, interior divider walls, racks, blank-offs and the Base Structure shall be coated with a Dry Powder - Baked Polyester coating which

is both lead and cadmium free. Each cabinet panel, panel liner and interior partition component is to be individually coated & baked following shearing, notching, punching, and forming to provide 100% powder coverage over the entire finished piece to include the interior, exterior and all metal edges. The coating process is completed prior to assembly of the unit too ensure all joined surfaces (panel to panel joints), are covered. Spray or brush applied coatings on the exterior of the cabinet only are not acceptable. Powder Paint to have passed Salt Spray Resistance Test ASTM B 117-97 Minimum **7000** Hours, Impact Test ASTM D 2794-90 up to 160 lbs and Humidity Resistance Test ASTM D 2247-87 Minimum 1500-hour test with maximum blister 1/16 in/1 mm. Powder Coated unit to be wet white. Stainless steel interior liner shall not be coated.

B. Base:

1. Provide a heavy duty solid welded steel base for supporting all major RTU components. Bases shall be constructed of 6 inch minimum structural tubular steel base rails. Welded cross members shall be provided as required for lateral stability. Contractor shall provide supplemental steel supports as required to obtain proper operation heights for cooling coil condensate drain trap and humidifier condensate drain trap.
2. RTUs shall be completely self supporting for installation on roof support frame or concrete pads.
3. The RTU bases not constructed of galvanized material shall be cleaned, primed with a rust inhibiting primer, and finished with rust inhibiting exterior enamel.
4. Base shall be insulated with 6 lb insulation under the base skin and covered with a minimum 16 galvanized steel liner. Insulation to meet same criteria as explained under the cabinet casing requirements.
5. Provide a perimeter collar around the entire unit and around each opening to insure unit is watertight. The entire base shall act as a secondary drain pan to hold up to 1" of water.

C. Casing (including wall, floor and roof):

1. General: RTU casing shall be entirely double wall insulated panels, integral of or attached to a structural frame. Construction shall be such that removal of any panel shall not affect the structural integrity of the unit. Casing finished shall meet salt-spray test as specified. All casing and panel sections shall be tightly butted and gasketed. No gaps of double wall construction will be allowed where panels bolt to air handling unit structural member. Structural members, not covered by the double wall panels, shall have equivalent insulated double wall construction.
2. Walls and roof shall be 4" "Double Wall" construction for each section of the unit. Cabinet is with a minimum 16-gauge A60 galvanized outer panel and a minimum 20-gauge G90 galvanized inner liner. The humidifiers, cooling coil, and other sections,

where indicated shall have Type 304 stainless steel liner. Panels to have of standing seam construction with seams turned outward to provide a smooth flush interior. Panels to be screwed together on maximum 8" centers with minimum 5/16" zinc plated screws sealed with a continuous bead of 3M540 Silicone caulking applied between the matching panel seams prior to assembly, and with a final bead following assembly on both the exterior and interior panel seams to produce an air tight unit. Wall to base skin and wall to roof panel seams shall be continuously caulked to assure leak-proof integrity of the unit housing. AHU unit housing shall be constructed to prevent conditioned air bypass or mitigation through unit walls, roof and floor around any interior partition or component blank-off walls such as for filters, coils or fan bulkheads, , roof and floor deflection shall not exceed an L/100 ratio when the unit casing is pressurized to 1.5X the operating pressure. Deflection shall be measured at the midpoint of the panel height. Total housing leakage shall not exceed 0.5% of rated cfm when the unit casing is pressurized to 1.5X the operating pressure. Insulation: Wall & Ceiling panels to be insulated as follows:

- a. Solid liner: 4" fiberglass board or batt unfaced insulation which meets or exceeds 3.0 PCF density rating.
- b. Perforated Liner: Glass Matte or fiberglass board or batt with Mylar insulation which meets or exceeds 3.0 PCF density rating.
- c. Insulation to meet NFPA 90A, NFPA 90B and ASTM E 84 requirements for Flame Spread of 25 or less and Smoke Development of 50 or less. Insulation shall have a thermal conductivity K factor of .26 Btu/hr/Sq. ft/degree F @ 75 F mean and provide the following sound attenuation characteristics (per ASTM C 423 - Type "A" Mounting):

Octave bands	125	250	500	1k	2k	4k	8k
Absorption Coefficient	.18	.64	.99	1.02	1.01	1.04	1.05

(for 2" - 3 pcf)

All cut edges of the board insulation shall be completely enclosed by the unit panels.

A finish bead of caulking will be applied over all foil to panel seams and/or inner liners to main panel seams to completely encapsulate the insulation.

3. Interior liners: Minimum 20-gauge G90 exposed solid or perforated metal as indicated throughout the unit for the walls and roof except in the cooling coil section, humidifier section and its immediate downstream plenum which will have solid 304 SS inner liners. A finish bead of caulking will be applied between the liner and the interior panel seams to completely seal the panel.
4. Roof panels: on indoor units shall be flat with smooth exteriors the same as the side panels. Weatherproof units shall be constructed with raised seams. Raised Roof seams to be sealed between sandwiched panels with a bead of silicone caulking. The top of each roof panel seam is to receive a final bead of caulking and be sealed with a 16-gauge roof cleat mechanically formed to enclose the standing seam at the roof panel to panel joint. Roof to slope from center axis of roof to sides a minimum

PACKAGED, OUTDOOR, CENTRAL-STATION AIR HANDLING UNITS

- 1/8" per foot to allow complete water drainage and preclude standing water. Roof panels to overlap the side panels a minimum 1" all around unit creating an overhang to reduce direct runoff from the roof down over the side panels. All doors and louvers shall have a formed rain shield extending a minimum of 1" from the wall to direct water away from the door and louver openings.
5. Stiffeners of angle steel shall be supplied as required to maintain a casing deflection criteria of 1/100 at 1.5 times the working pressure
  6. Blank-Off: Provide blank-offs as required to prevent air bypass between the AHU sections, around coils, and filters.
  7. The thickness of insulation, mode of application, and thermal breaks shall be such that there is no visible condensation on the exterior panels of the AHU.
  8. Casing panels shall be secured to the support structure with stainless steel screws and gaskets installed around the panel perimeter. The exterior wall panel shall be smooth. No screws shall be on the exterior side of the unit. Panels shall be completely removable to allow removal of fan, coils, and other internal components for future maintenance, repair, or modifications. Welded exterior panels are not acceptable.
  9. Access Doors: Provide in each access section and where shown on drawings. Show double-sided access doors with door swings on the floor plans. Door inner liner for the cooling coil, humidifier, downstream of the HEPA filter section and where indicated shall be Type 304 stainless steel. Doors shall be a minimum of 2 inches thick with same double wall construction as the unit casing. Doors shall be a minimum of 24 inches wide, unless shown of different size on drawings, and shall be the full casing height up to a maximum of 6 feet. Doors shall be gasketed, hinged, and latched to provide an airtight seal. The access doors for fan section, mixing box, humidifier coil section shall include a minimum (12 inch x 12 inch) thermal break double thickness, with air space between glass panes tightly sealed, reinforced glass or Plexiglas window in a gasketed frame.
    - a. Hinges: Manufacturers standard, designed for door size, weight and pressure classifications. Hinges shall hold door completely rigid with minimum 45 kg (100 pound) weight hung on latch side of door.
    - b. Latches: Doors shall be provided with a minimum (2) dual acting heavy duty key locking composite latches through 48" high, (3) latches through 72" high. Latches shall be operable from both the interior and exterior of the unit. Door latches on doors into fan sections shall be provided with a hasp or other mechanism to facilitate locking of the doors. Door hinge shall be heavy duty Stainless Steel..
    - c. Gaskets: Doors shall be provided with double high performance closed cell replaceable neoprene bulb type gasket seals around the entire perimeter of the door / frame..
    - d. Doors shall open against static pressure unless obstructed by internal components. If obstructed by internal components on the positive sections requiring access, the doors shall open

with pressure and shall be provided with a safety restraining mechanism. Doors used to access rotating equipment shall be provided with an OSHA approved safety latching mechanism requiring a tool to open and shall also have a highly visible, permanently fixed, caution sign on the exterior of the door. Doors with access to moving parts must also have locking hardware and meet current UL mechanical protection guidelines.

10. Provide sealed sleeves, metal or plastic escutcheons or grommets for penetrations through casing for power and temperature control wiring and pneumatic tubing. Coordinate with electrical and temperature control subcontractors for number and location of penetrations. Coordinate lights, switches, and duplex receptacles and disconnect switch location and mounting. All penetrations and equipment mounting may be provided in the factory or in the field. All field penetrations shall be performed neatly by drilling or saw cutting. No cutting by torches will be allowed. Neatly seal all openings airtight.
  11. Roof of the unit shall be sloped to have a minimum pitch of 1/4 inch per foot. The roof shall overhang the side panels by a minimum of three inches to prevent precipitation drainage from streaming down the unit side panels.
- D. Unit floor shall be level without offset space or gap and designed to support a minimum of 100 pounds per square foot distributed load without permanent deformation or crushing of internal insulation. Provide adequate structural base members beneath floor in service access sections to support typical service foot traffic and to prevent damage to unit floor or internal insulation. Unit floors in casing sections, which may contain water or condensate, shall be watertight with drain pan.
- E. Condensate Drain Pan: Drain pan shall be designed to extend entire length of the humidifier section, cooling coils including headers and return bends, and outside air or economizer sections. Depth of drain pan shall be at least 2 inches and shall handle all condensate without overflowing. Drain pan shall be double wall construction, Type 304 stainless steel and have a minimum of 2 inch insulation, and shall be sloped to drain. Drain pan shall be continuous metal or welded watertight. No mastic sealing of joints exposed to water will be permitted. Drain pan shall be placed on top of casing floor or integrated into casing floor assembly. Drain pan shall be pitched in all directions to drain line.
1. An intermediate condensate drip pan shall be provided on stacked cooling coils and shall be constructed of type 304 stainless steel with copper downspouts factory piped to main condensate pan. Use of intermediate condensate drain channel on upper casing of lower coil is permissible provided it is readily cleanable. Design of intermediate condensate drain shall prevent upper coil condensate from flowing across face of lower coil.
  2. Drain pan shall be piped to the exterior of the unit or under the unit as indicated. Drain pan shall be readily cleanable.

3. Installation, including frame, shall be designed and sealed to prevent blow-by.
4. Drain outlet for the outside air or economizer section shall be piped to the exterior of the unit and plugged with removable cap.
5. Provide removable grating over the entire drain pan section.

F. Fan Wall Technology

1. Fans shall be aluminum airfoil, Class III, direct drive arrangement and shall be individually housed. Fans shall be certified by AMCA for performance. Fan shall be housed in a "cell".
2. Fan housing or "cell" shall be constructed of **20 gauge aluminum** with perforated inner liner, melamine insulation, with either solid or perforated **16 gauge aluminum** outer panels as required by applications.
3. Fan/motor shall be mounted within the housing on an adjustable slide rail base. Fan/motor assembly must be capable of either horizontal or vertical application.
4. Each fan/motor assembly shall be dynamically balanced to meet AMCA standard 204-96, for fan application class BV-5, to meet or exceed a rotational imbalance Grade .55, producing a maximum rotational imbalance of .022" per second peak, filter in (.55mm per second peak, filter in). "Filter in" measurement indicates that the specified balance grade must be achieved at the submitted design operating speed for the fan(s). Fan and motor assemblies submitted for approval incorporating larger than 215T frame shall be balanced in three orthogonal planes to demonstrate compliance with the G.55 requirement with a maximum rotational imbalance of .022" per second peak filter in (.55 mm per second peak, filter in).
5. Fan and motor assemblies shall be designed for application in multiple fan arrays.
6. Fan Backdraft Dampers:
  - a. Each fan applied in multiple fan applications shall be provided with an integral back flow prevention device that prohibits recirculation of air in the event a fan, or multiple fans, become disabled. The system effect for the submitted back flow prevention device shall be included in the calculation to determine the fan TSP for fan selection purposes, and shall be indicated as a separate line item SP loss in the submitted fan selection data. Manufacturers other than the basis of design being submitted must provide independent lab certification of fan testing that indicates the system effects attributed to the submitted back flow prevention device in the submitted close coupled mounting arrangement at the inlet of the fan. Fans submitted with discharge dampers will not be approved.
  - b. Back Draft Damper performance data that is based on an AMCA ducted inlet and ducted discharge mounting configuration will not be accepted. Submitted Back flow prevention device data must be reflective of close coupled mounting at the intake of

the fan(s) per the project design documents. Motorized dampers or other motorized devices submitted for back flow prevention are not acceptable.

7. Fan Airflow Monitoring:

- a. Fans shall have non invasive, zero pressure drop flow a/o pressure sensing taps installed in the fan inlet cone of each fan for airflow monitoring capability as specified.

8. Motors:

- a. All motors shall be standard foot mounted type, TEFC motors selected at the specified operating voltage, RPM, and efficiency as specified in Section 23 05 12.
- b. Motors shall meet the requirements of NEMA MG-1 Part 30 and 31, section 4.4.2.
- c. Provide permanent magnet (PM) motors. The motor running off a VFD motor shall have tested performance efficiencies equal to those listed in the FANWALL PM motor columns in the table below.

	Motor efficiency at		Motor efficiency at reduced speed on system curve					
	Nominal speed		67% speed		50% speed		33% speed	
Motor HP	FANWALL PM motor	NEMA Premium induction motor	FANWALL PM motor	NEMA Premium induction motor	FANWALL PM motor	NEMA Premium	FANWALL PM motor	NEMA Premium induction motor
3	93.0%	89.0%	92.5%	84.0%	90.5%	75.0%	84.0%	58.0%
5	92.0%	89.0%	93.0%	86.0%	91.5%	79.0%	87.0%	62.0%
7.5	91.0%	89.0%	93.5%	87.0%	92.0%	81.0%	88.5%	64.0%

The motor shall incorporate conical rotor and stator geometry to concentrate axial flux paths and utilize all ferrite magnets. The motor shall have compact bobbin-type windings (end-turns on the windings are not permitted). The motor shall have NEMA T frame foot mounting and comply with NEMA MG1 dimensional requirements. External rotor motors are not permitted. The motor shall be UL Listed and authorized to apply the UL mark. The motor windings shall have a minimum voltage spike resistance rating of 2400V. Each motor in the Fan Array shall be driven off a dedicated variable frequency drive that is programmed and tested at the factory. The motor shall have permanently lubricated sealed or double-shielded ball bearings. The motor shall incorporate a means to mitigate induced shaft currents to prevent electrical arcing across bearing races and balls via a contacting grounding stick. Fiber type grounding devices are not permitted. Motors with hybrid ceramic bearings, to protect motor bearing from electrical discharge machining are acceptable.

9. Multiple Fan Arrays:

- a. Fan Arrays shall be selected such that in the event of one fan fails the remaining fans shall be able to provide the required airflow.
  - b. The fan array shall consist of multiple housed fans or "cells", spaced in the air way tunnel cross section to provide a uniform air flow and velocity profile across the entire air tunnel cross section and components therein. **The minimum number of fans shall be as scheduled.**
  - c. Each fan and motor assembly shall be removable through a 24" wide, free area, access door located on the discharge side of the fan wall array without removing the fan wheel from the motor.
  - d. All fans in multiple fan arrays shall be AMCA certified for performance per AMCA arrangement "A" testing configuration. The submitted fan performance shall be inclusive of system effects attributed to the fan mounting arrangement, fan enclosures, backdraft dampers, and other fan appurtenances not considered when AMCA certified performance per AMCA arr. "A" is determined. Submitted AHU/fan performance that does not indicate allowances for system effects for the back flow prevention device(s), wheel enclosures, safety screens, bearing pedestals, belt guards, or the fan motor enclosure in which each fan is mounted, will be returned to the contractor disapproved and will need to be resubmitted with all the requested information included for approval. Added system effects for acoustic attenuators, or other devices required to meet specified fan performance and sound power levels must be indicated in the submitted fan selection data.
- G. By-pass damper blades shall be galvanized steel or aluminum type. Dampers shall have metal compressible jamb seals and extruded vinyl or metal blade edge seals. Dampers shall rotate on stainless steel bearings or bronze bushings. Leakage rate shall not exceed 2.5 cubic meters/minute/square meter (8 cfm per sq. foot) at 1 inch water. Dampers and operators shall be furnished and factory installed by RTU manufacturer. Damper operators shall be furnished under Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC.
- H. Economizer Section: Economizer Section shall consist of casing and outdoor air, return air and exhaust air dampers in opposed blade arrangement with damper linkage for automatic operation. Coordinate damper operator with Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC. Dampers shall be of ultra-low leak design with metal compressible bronze jamb seals and extruded vinyl edge seals on all blades. Blades shall rotate on stainless steel sleeve bearings or bronze bushings. Leakage rate shall not exceed 1.6 cubic meters/min/square meter (5 cfm per square foot) at 1 inch water gage and 2.8 cubic meters/min/square meter (9 cfm per square foot) at 4 inches water gage) Electronic damper operators shall be furnished and mounted in an accessible and easily serviceable location by the air handling unit manufacturer at the factory. Damper operators shall be furnished under Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC.



- I. Filter Section: Refer to Section 23 40 00, HVAC AIR CLEANING DEVICES, for filter requirements.
  - 1. Filters including one complete set for temporary use at site shall be provided independent of the RTU. The RTU manufacturer shall install filter housings and racks in filter section compatible with filters furnished. The RTU manufacturer shall be responsible for furnishing temporary filters (pre-filters and after-filters, as shown on drawings) required for RTU testing.
  - 2. Factory-fabricated filter section shall be of the same construction and finish as the RTU casing including filter racks and hinged double wall access doors. Filter housings shall be constructed in accordance with side service or holding frame housing requirements in Section 23 40 00, HVAC AIR CLEANING DEVICES.
- J. Coils: Coils shall be mounted on Type 304 stainless steel supports to assure proper anchoring of coil and future maintenance. Coils shall be face or side removable for future replacement thru the access doors or removable panels. Each coil shall be removable without disturbing adjacent coil. Cooling coils exhaust heat recovery coils shall be designed and installed to insure no condensate carry over. Provide factory installed extended supply, return, drain, and vent piping connections. Refer to Drawings and Section 23 82 16, AIR COILS, for additional coil requirements.
  - 1. Water Coils, including heat recovery coils.
  - 2. Steam Distributing Tube Coils.
- K. Humidifier: Coordinate the humidification requirements with section 23 22 13 Humidifiers. Provide humidification section with stainless steel drain pan of adequate length to allow complete absorption of water vapor. Provide stainless steel dispersion panel or distributors as indicated, with stainless steel supports and hardware.
- L. Sound Attenuators: Each plenum fan shall be housed in an acoustical attenuating enclosure that reduces the base fan discharge sound power level by a minimum of 15 db re 10<sup>-12</sup> watts throughout the eight octave band.
- M. Sound Power Levels: The sound power level at the air handling unit discharge, air intake (return air and/or OSA intake), and casing radiated shall not exceed the values the unit is operating at maximum design airflow and static Pressure as indicated on the schedule.
- N. Discharge Section: Provide aerodynamically designed framed discharge openings or spun bellmouth fittings to minimize pressure loss.
- O. Electrical and Lighting: Wiring and equipment specifications shall conform to Division 26, ELECTRICAL.
  - 1. Vapor-proof lights using cast aluminum base style with glass globe and cast aluminum guard shall be installed in access sections for fan, mixing box, humidifier and any section over 300mm (12 inch) wide. A switch shall control the lights in each compartment with pilot light mounted outside the respective

compartment access door. Wiring between switches and lights shall be factory installed. All wiring shall run in neatly installed electrical conduits and terminate in a junction box for field connection to the building system. Provide single point 115 volt - one phase connection at junction box for lighting and receptacles.

2. Install compatible 100 watt bulb in each light fixture.
3. Provide a convenience duplex weatherproof receptacle next to the light switch.
4. Provide panel(s) for the building FMCS controllers. Include conduit knockouts for external power and communications connection.
5. AHU-7 and 19 only: Provide panel with motor starters for the heat recovery pumps (one primary and one back up). See Specification Section 26 29 11 for motor starter requirements. Include power wiring and circuit protection. Provide knockouts for separate external power and controls connections
6. Disconnect switch and power wiring: Provide factory or field mounted disconnect switch. Coordinate with Division 26, ELECTRICAL.
7. Provide a complete electrical and control system required to run the air handling including all equipment, material, electrical enclosure, electrical components and electrical labor. Designs shall be in accordance with specific system requirements. Designs shall be in accordance with the NEC, UL 508A. Provide single point of connection for 460V/3 phase unit power.
  - a. Motor Circuit Protection:
    - 1) All motors in the Fan array shall be provided with individual Motor Protection for thermal overload protection. All motor circuit protectors shall be located in main enclosure.
  - b. Fan Wall with Variable Frequency Drive Control:
    - 1) Provide a single Variable Frequency Drive for each fan cube wired to an individual VFD to start and each motors in the fan array. The Variable Frequency Drives shall be sized accordingly to start and hold each motors in the fan array.
    - 2) Each motor in the fan array unit shall be driven off a dedicated variable frequency drive that is programmed and tested at the factory.
    - 3) Provide factory installed fully-integrated pressure transducer, MCP disconnect, wiring, pressure tubing and communication cabling for each fan cube.
    - 4) All Variable Frequency Drives shall be mounted in a remote electrical panel and be factory wired to the cube motor and to the motor circuit protection panel.
    - 5) Motor circuit protectors shall be used for each motor in the fan array. Motor circuit protectors mounted in a remote enclosure that is separate from the VFD.

- 6) Provide three phase power distribution wiring and control wiring as required. All three phase power components shall have a rating listed for Short Circuit Current Rating. Provide control wiring and components required for complete operation of the FANWALL system.
- c. Fan Array Optimization Control:
- 1) Means for monitoring and controlling individual fan and motor status for each of the multiple fans and motors in the array shall be provided. There shall be a controller provided as an integral part of the fan system electrical panel that automatically reconfigures the number of active fans in the array to achieve substantially peak operating efficiency for the fan array at any fan system operating point.
  - 2) System optimization shall be achieved by enabling and disabling fans, either manually or automatically, in the active array while the controller varies the enabled fans operating speeds at the concurrent system flow and pressure demands of the system.
  - 3) The fan array controller shall be provided with a BAS System interface as indicated or specified that is compatible with the building automation system and which shall allow remote monitoring and/or control of the array.
  - 4) The multiple fan array control panel shall be provided with a means to indicate fan and motor status, operating mode, system flow rate and fan total static pressure, as well as connected and required HP at the current system flow and pressure conditions. Status shall be displayed at the control panel and/or at the remote location of the building automation system.
  - 5) The system optimization controller and main electrical panels shall be provided by the AHU unit manufacturer, assuring single source responsibility for the fan system operation.
- d. Input Line Filters: As required by electrical design, when using variable frequency drives provide Input Line reactors with three percent impedance mounted externally if not already internal to variable frequency drive.
- e. Output Filters: When using variable frequency drives where distance and filtering is an issue, provide output line reactors as required. Size output filter accordingly to manufactures recommendations.
- f. Shaft Grounding: When using variable frequency drives provide an AEGIS SGR shaft grounding system for each AC motor to prevent electrical damage to motor bearings and to extend motor life by safely channeling harmful shaft currents to ground. The AEGIS SGR Conductive MicroFiber Brush system is installed by sliding a ring over the end of the motor shaft and locking it in place with screw on mounting brackets. The AGEGIS system is frictionless, has no wear and requires no maintenance or additional service during the life of the motor.

g. All electrical wiring in the unit shall be in conduits.

P. Louvers:

1. Furnish wind driven resistant outside air louver.
  - a. Louvers shall possess stationary vertical blades designed to prevent the penetration of wind driven rain. Louver blades shall be contained within a 6" frame. Louvers components (heads, jambs, sill and blades) shall be factory assembled by the louver manufacturer. Louvers shall be constructed of extruded 6063T6 aluminum alloy construction as follows:
    - 1) Material:
      - a) Frame: .125" wall thickness, caulking surfaces provided.
      - b) Blades: .081" nominal wall thickness. Blades are mounted vertically.
    - 2) Structural Design:
      - a) Integral structural supports shall be designed and furnished by the louver manufacturer to carry a wind load of not less than 20 PSF (an equivalent of a 90 mph wind)
  - b. AHU-2 Louver:
    - 1) Louvers shall be provided with outside airflow Pressure Transducer conforming to EMC standards EN50082-1/EN5014/EN60730-1. Transducer to be capable of reading pressures as low as  $\pm 0.5$ " wc ( $\pm 12.5$  pa) and shall handle up to 10 PSID overpressure without zero shift. Transducer output be in either two temperature compensated versions: 4-20 mA 2-wire or field selectable 0-5 VDC/0-10 VDC. Transducer shall incorporate glass-on-silicone (Gi-Si) capacitance sensor and shall be housed in a NEMA 4 enclosure.
    - 2) Provide two section louvers. One for minimum outside air and the other for economizer control.
2. Exhaust Louver. Not required. Exhaust air opening shall be provided with support framing for attachment of field installed external exhaust duct. See Drawings.

Q. Dampers:

1. Control Dampers:
  - a. Furnish and install, at locations shown on plans, or in accordance with schedules, Low Leak Dampers with published leakage data certified under the AMCA certified ratings program. Low Leak Dampers shall be rated less than 6.2 cfm per sq. ft. of area at 4-in. w.g. pressure difference through a 48" x 48" damper. Published leakage data shall include leakage information for all available damper sizes at pressure differences from 1 in w.g. through 13 w.g. Standard Control. Low leak dampers shall be fabricated of minimum 5" x 1" x .125" 6063T5 extruded aluminum hat channel with hat mounting flanges on both sides of the frame. Blades shall be airfoil type extruded aluminum (maximum 6" depth) with integral structural reinforcing tube running the full length

PACKAGED, OUTDOOR, CENTRAL-STATION AIR HANDLING UNITS

of each blade. Blade edge seals shall be extruded vinyl double edge design with inflatable pocket that enables air pressure from either direction to assist in blade to blade seal. Blades shall be mechanically locked in extruded blade slots, yet be easily replaceable in the field. Adhesive or clip-on type blade seals are not acceptable. Bearings shall be non-corrosive molded synthetic. Axles shall be square or hexagonal (round is not acceptable) to provide positive locking connection to blades and linkage. Linkage shall be concealed in the frame.

- b. Smoke Dampers: Furnish and install, at locations shown on plans, or in accordance with the schedules a Low Leak Damper classified as a UL555S Leakage Class I smoke damper, the lowest leakage class applicable for HVAC smoke control systems. The damper shall bear the UL Label attesting to the same. As part of the UL qualification, the damper shall have demonstrated a capacity to operate (to open & close) under HVAC system operating conditions, with pressures up to 4" w.g. in the closed position, and 4,000-fpm air velocity in the open position. The damper also fulfills the requirements for smoke dampers per NFPA90A and NFPA92A. Damper must be equipped with the appropriate electric or pneumatic actuator and be rated as an assembly to elevated temperatures of 250 degrees F, 350 degrees F, or 450 degrees F. depending upon the actuator selected. In addition, the damper must be factory furnished with the appropriate damper actuator to provide fail-safe operation (the damper automatically goes to the desired fail-safe position as fire interrupts power). The damper frame shall be a minimum .125" wall thickness 5" x 1" 6063T5 aluminum extruded into a structural hat channel shape. The blades shall be a maximum 6" wide; airfoil shaped 6063T5 heavy gauge single piece extruded aluminum. Bearings shall be stainless steel sleeve turning in an extruded hole in the frame for long life. Blade seals shall be silicone rubber mechanically locked into the blade edge (adhesive or clip fastened seals are not acceptable) and shall be designed to withstand 450 degrees F. Jambs shall be non-corrosive aluminum compression type to further enhance smoke management. Smoke damper downstream of the HEPA filter section shall be constructed of Type 304 stainless steel.

2. Supports for Interior Piping:

- a. Provide support framing inside the air handling unit for pipe support and bracing attachments. Coordinate work/pipe layout with the Contractor. Support framing shall be designed to be integral to the unit and shall comply with Specification Section 13 05 41. Submit design and calculation stamp and signed by a registered Structural Engineer for review.

**PART 3 - EXECUTION**

**3.1 INSTALLATION**

- A. Install roof top unit in conformance with ARI 435.

- B. Assemble roof top unit components following manufacturer's instructions for handling, testing and operation. Repair damaged galvanized areas with paint in accordance with Military Spec. DOD-P-21035A. Repair painted units by touch up of all scratches with finish paint material. Vacuum the interior of air-handling units clean prior to operation.
- C. Install unit on concrete curb. See Specification Section 23 05 41 and detail drawing. Refer to specification Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.
- D. Leakage and test requirements for roof top units shall be the same as specified for ductwork in Specification Section 23 31 00, HVAC DUCTS AND CASINGS except leakage shall not exceed Leakage Class ( $C_L$ ) 12 listed in SMACNA HVAC Air Duct Leakage Test Manual when tested at 1.5 times the design static pressure. Repair casing air leaks that can be heard or felt during normal operation and to meet test requirements.
- E. Perform field mechanical (vibration) balancing in accordance with Section 23 05 41, NOISE and VIBRATION CONTROL FOR HVAC PIPING and EQUIPMENT.
- F. Seal and/or fill all openings between the casing and RTU components and utility connections to prevent air leakage or bypass.

### **3.2 STARTUP SERVICES**

- A. The air handling unit shall not be operated for any purpose, temporary or permanent, until ductwork is clean, filters are in place, bearings are lubricated and fan has been test run under observation.
- B. After the air handling unit is installed and tested, provide startup and operating instructions to VA personnel.
- C. An authorized factory representative should start up, test and certify the final installation and application specific calibration of control components. Items to be verified include fan performance over entire operating range, noise and vibration testing, verification of proper alignment, overall inspection of the installation, Owner/Operator training, etc.

### **3.3 COMMISSIONING**

- A. Provide commissioning documentation in accordance with the requirements of Section 23 08 00 - COMMISSIONING OF HVAC SYSTEMS for all inspection, start up, and contractor testing required above and required by the System Readiness Checklist provided by the Commissioning Agent.
- B. Components provided under this section of the specification will be tested as part of a larger system. Refer to Section 23 08 00 - COMMISSIONING OF HVAC SYSTEMS and related sections for contractor responsibilities for system commissioning.

**3.4 CONSTRUCTION WASTE MANAGEMENT**

- A. General: Comply with Contractor's Waste Management Plan and Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- B. To the greatest extent possible, separate reusable and recyclable products from contaminated waste and debris in accordance with the Contractor's Waste Management Plan. Place recyclable and reusable products in designated containers and protect from moisture and contamination.

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**SECTION 23 82 16**  
**AIR COILS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. Heating and cooling coils for air handling unit and duct applications

**1.2 RELATED WORK**

- A. Section 23 05 11, COMMON WORK RESULTS FOR HVAC.
- B. Section 23 31 00, HVAC DUCTS AND CASINGS
- C. Section 23 74 13, PACKAGED, OUTDOOR, CENTRAL-STATION AIR-HANDLING UNITS
- D. Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS: Requirements for commissioning, systems readiness checklists, and training.
- E. Section 01 91 00, GENERAL COMMISSIONING REQUIREMENTS

**1.3 QUALITY ASSURANCE**

- A. Refer to paragraph, QUALITY ASSURANCE, Section 23 05 11, COMMON WORK RESULTS FOR HVAC, Section 23 05 10, COMMON WORK RESULTS FOR BOILER PLANT and STEAM GENERATION.
- B. Unless specifically exempted by these specifications, heating and cooling coils shall be tested, rated, and certified in accordance with AHRI Standard 410 and shall bear the AHRI certification label.

**1.4 SUBMITTALS**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- B. Manufacturer's Literature and Data for Heating and Cooling Coils: Submit type, size, arrangements and performance details. Present application ratings in the form of tables, charts or curves.
- C. Provide installation, operating and maintenance instructions.
- D. Certification Compliance: Evidence of listing in current ARI Directory of Certified Applied Air Conditioning Products.
- E. Coils may be submitted with Section 23 74 13, PACKAGED, OUTDOOR, CENTRAL-STATION AIR-HANDLING UNITS, and Section 23 36 00, AIR TERMINAL UNITS.
- F. Completed System Readiness Checklists provided by the Commissioning Agent and completed by the contractor, signed by a qualified technician and dated on the date of completion, in accordance with the requirements of Section 23 08 00 COMMISSIONING OF HVAC SYSTEMS.

**1.5 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. Air Conditioning and Refrigeration Institute (AHRI):  
Directory of Certified Applied Air Conditioning Products  
AHRI 410-01.....Forced-Circulation Air-Cooling and Air-Heating  
Coils
- C. American Society for Testing and Materials (ASTM):  
B75/75M-02.....Standard Specifications for Seamless Copper Tube
- D. National Fire Protection Association (NFPA):  
70-11.....National Electric Code
- E. National Electric Manufacturers Association (NEMA):  
250-11.....Enclosures for Electrical Equipment (1,000 Volts  
Maximum)
- F. Underwriters Laboratories, Inc. (UL):  
1996-09.....Electric Duct Heaters

## **PART 2 - PRODUCTS**

### **2.1 HEATING AND COOLING COILS**

- A. Conform to ASTM B75 and AHRI 410.
- B. Surgical Suites - All Locations: All coils installed in the air handling units serving surgical suites, duct-mounted reheat coils, and air terminal unit-mounted reheat coils, and all reheat coils in PACU areas shall be equipped with copper fins.
- C. Tubes: Minimum 0.625 inch tube diameter; Seamless copper tubing.
- D. Fins: 0.1397 mm (0.0055 inch) aluminum or 0.1143 mm (0.0045 inch) copper mechanically bonded or soldered or helically wound around tubing.
- E. Headers: Copper, welded steel or cast iron. Provide seamless copper tubing or resistance welded steel tube for volatile refrigerant coils.
- F. "U" Bends, Where Used: Machine die-formed, silver brazed to tube ends.
- G. Coil Casing: 16 gage Type 304 stainless steel with tube supports at 48 inch maximum spacing. Construct casing to eliminate air bypass and moisture carry-over. Provide duct connection flanges.
- H. Pressures kPa (PSIG):

Pressure	Water Coil	Steam Coil	Refrigerant Coil
Test	2070 (300)	1725 (250)	2070 (300)
Working	1380 (200)	520 (75)	1725 (250)

- I. Protection: Unless protected by the coil casing, provide cardboard, plywood, or plastic material at the factory to protect tube and finned surfaces during shipping and construction activities.

J. Vents and Drain: Coils that are not vented or drainable by the piping system shall have capped vent/drain connections extended through coil casing.

K. Cooling Coil Condensate Drain Pan: Section 23 74 13, PACKAGED, OUTDOOR, CENTRAL-STATION AIR-HANDLING UNITS.

L. Steam Distributing Coils: Conform to ASTM B75 and ARI 410. Minimum 9.5 mm (3/8-inch) steam distributing tubing installed concentrically in 25 mm (one-inch) OD condensing coil tubes.

## **2.2 REHEAT COILS, DUCT MOUNTED**

A. The coils shall be continuous circuit booster type for steam or hot water as shown on drawings. Use the same coil material as listed in Paragraphs 2.1.

## **2.3 WATER COILS**

A. Use the same coil material as listed in Paragraphs 2.1.

B. Drainable Type (Self Draining, Self Venting); Manufacturer standard:

1. Cooling, all types.

2. Heating or preheat.

3. Runaround energy recovery. ARI certification of capacity adjustment is waived. See Section 23 72 00, AIR-TO-AIR ENERGY RECOVERY EQUIPMENT.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

A. Follow coil manufacturer's instructions for handling, cleaning, installation and piping connections.

B. Comb fins, if damaged. Eliminate air bypass or leakage at coil sections.

### **3.2 STARTUP AND TESTING**

A. The Commissioning Agent will observe startup and contractor testing of selected equipment. Coordinate the startup and contractor testing schedules with the Resident Engineer and Commissioning Agent. Provide a minimum of 7 days prior notice.

### **3.3 COMMISSIONING**

A. Provide commissioning documentation in accordance with the requirements of Section 23 08 00 - COMMISSIONING OF HVAC SYSTEMS for all inspection, start up, and contractor testing required above and required by the System Readiness Checklist provided by the Commissioning Agent.

B. Components provided under this section of the specification will be tested as part of a larger system. Refer to Section 23 08 00 - COMMISSIONING OF HVAC SYSTEMS and related sections for contractor responsibilities for system commissioning.

**3.4 DEMONSTRATION AND TRAINING**

- A. Provide services of manufacturer's technical representative for four hours to instruct VA personnel in operation and maintenance of units.
- B. Submit training plans and instructor qualifications in accordance with the requirements of Section 23 08 00 - COMMISSIONING OF HVAC SYSTEMS.

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**SECTION 26 05 11  
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. 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.

- C. 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 COR 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 COR 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 COR.
  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 COR 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 COR.
- 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 01 00 00, 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 01 00 00, 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.

D.

#### **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, 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 COR in accordance with Section 01 33 23, 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 COR 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 COR at least 30 days prior to the planned training.

**PART 2 - PRODUCTS (NOT USED)**

**PART 3 - EXECUTION (NOT USED)**

---END---

**SECTION 26 05 19**  
**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 07 84 00, FIRESTOPPING: Sealing around penetrations to maintain the integrity of fire-resistant rated construction.
- B. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: Requirements that apply to all sections of Division 26.
- C. Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS: Requirements for personnel safety and to provide a low impedance path for possible ground fault currents.
- D. Section 26 05 33, 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 26 05 11, 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 26 05 11, 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:
1. No. 12 AWG: Minimum size, except where smaller sizes are specified herein or shown on the drawings.
  2. No. 8 AWG and larger: Stranded.
  3. No. 10 AWG and smaller: Solid; except shall be stranded for final connection to motors, transformers, and vibrating equipment.
  4. Insulation: THHN-THWN and XHHW-2. XHHW-2 shall be used for isolated power systems.
- D. Color Code:
1. No. 10 AWG and smaller: Solid color insulation or solid color coating.
  2. No. 8 AWG and larger: Color-coded using one of the following methods:
    - a. Solid color insulation or solid color coating.
    - b. Stripes, bands, or hash marks of color specified.
    - c. Color using 19 mm (0.75 inches) wide tape.
  4. For modifications and additions to existing wiring systems, color coding shall conform to the existing wiring system.
  5. 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.		

6. 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 COR.

7. 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 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 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.

## **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 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. Perform cable pulling calculations for all cable pulls that cannot be pulled by hand.
6. 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 CONTROL WIRING INSTALLATION**

- A. Unless otherwise specified in other sections, install control wiring and connect to equipment to perform the required functions as specified or as shown on the drawings.
- B. Install a separate power supply circuit for each system, except where otherwise shown on the drawings.

### **3.7 CONTROL WIRING IDENTIFICATION**

- A. Install a permanent wire marker on each wire at each termination.
- B. Identifying numbers and letters on the wire markers shall correspond to those on the wiring diagrams used for installing the systems.
- C. Wire markers shall retain their markings after cleaning.

### **3.8 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---

**SECTION 26 05 26**  
**GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- 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 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: Requirements that apply to all sections of Division 26.
- B. Section 26 05 19, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES: Low-voltage conductors.
- C. Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS: Conduit and boxes.
- D. Section 26 22 00, LOW-VOLTAGE TRANSFORMERS: Low-voltage transformers.
- E. Section 26 24 13, DISTRIBUTION SWITCHBOARDS: Low-voltage distribution switchboards.
- F. Section 26 24 16, PANELBOARDS: Low-voltage panelboards.
- G. Section 26 36 23, AUTOMATIC TRANSFER SWITCHES: Automatic transfer switches.

**1.3 QUALITY ASSURANCE**

- A. Refer to Paragraph, QUALIFICATIONS (PRODUCTS AND SERVICES), in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

**1.4 SUBMITTALS**

- A. Submit six copies of the following in accordance with Section 26 05 11, 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:
  - a. Two weeks prior to the final inspection, submit ground resistance field test reports to the COR.
- 3. Certifications:
  - a. 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.

### **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 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 steel bolts, nuts, and washers. Bolts shall be torqued to the values recommended by the manufacturer.
- 4. Connection to Equipment Rack and Cabinet Ground Bars: Listed for use with aluminum and copper conductors. Use mechanical type lugs, with zinc-plated steel bolts, nuts, and washers. Bolts shall be torqued to the values recommended by the manufacturer.

### **2.3 EQUIPMENT RACK AND CABINET GROUND BARS**

- A. Provide solid copper ground bars designed for mounting on the framework of open or cabinet-enclosed equipment racks. Ground bars shall have minimum dimensions of 6.3 mm (0.25 inch) thick x 19 mm (0.75 inch)

wide, with length as required or as shown on the drawings. Provide insulators and mounting brackets.

#### **2.4 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 steel bolts, nuts, and washers. Bolts shall be torqued to the values recommended by the manufacturer.

#### **2.5 GROUNDING BUS BAR**

- A. Pre-drilled rectangular copper bar with stand-off insulators, minimum 6.3 mm (0.25 inch) thick x 100 mm (4 inches) high in cross-section, length as shown on the drawings, with hole size, quantity, and spacing per detail shown on the drawings. Provide insulators and mounting brackets.

### **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. System Grounding:
  - 1. Secondary service neutrals: Ground at the supply side of the secondary disconnecting means and at the related transformer.
  - 2. Separately derived systems (transformers downstream from the service entrance): Ground the secondary neutral.
  - 3. Isolation transformers and isolated power systems shall not be system grounded.
- C. 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.
- D. For patient care area electrical power system grounding, conform to NFPA 99 and NEC.

#### **3.2 INACCESSIBLE GROUNDING CONNECTIONS**

- A. Make grounding connections, which are normally buried or otherwise inaccessible, by exothermic weld.



### 3.3 SECONDARY VOLTAGE EQUIPMENT AND CIRCUITS

A. Metallic Piping, Building Structural Steel, and Supplemental  
Electrode(s):

1. Provide a grounding electrode conductor sized per NEC between the service equipment ground bus and all metallic water pipe systems, building structural steel, and supplemental or made electrodes. Provide jumpers across insulating joints in the metallic piping.
2. Provide a supplemental ground electrode as shown on the drawings and bond to the grounding electrode system.

B. Switchboards, , Panelboards, Automatic Transfer Switches, and other  
electrical equipment:

1. Connect the equipment grounding conductors to the ground bus.
2. Connect metallic conduits by grounding bushings and equipment grounding conductor to the equipment ground bus.

C. Transformers:

1. Separately derived systems (transformers downstream from service equipment): Ground the secondary neutral at the transformer. Provide a grounding electrode conductor from the transformer to the nearest component of the grounding electrode system.

### 3.4 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.

H. Panelboard Bonding in Patient Care Areas: The equipment grounding terminal buses of the normal and essential branch circuit panel boards serving the same individual patient vicinity shall be bonded together with an insulated continuous copper conductor not less than No. 10 AWG, installed in rigid metal conduit.

### **3.5 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.

### **3.6 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.

### **3.7 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.

### **3.8 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.
- C. Below-grade connections shall be visually inspected by the COR prior to backfilling. The Contractor shall notify the Resident Engineer 24 hours before the connections are ready for inspection.

---END---

**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 06 10 00, ROUGH CARPENTRY: Mounting board for telephone closets.
- B. Section 07 60 00, FLASHING AND SHEET METAL: Fabrications for the deflection of water away from the building envelope at penetrations.
- C. Section 07 84 00, FIRESTOPPING: Sealing around penetrations to maintain the integrity of fire rated construction.
- D. Section 07 92 00, JOINT SEALANTS: Sealing around conduit penetrations through the building envelope to prevent moisture migration into the building.
- E. Section 09 91 00, PAINTING: Identification and painting of conduit and other devices.
- F. Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS: Conduits bracing.
- G. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements and items that are common to more than one section of Division 26.
- H. Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS: Requirements for personnel safety and to provide a low impedance path for possible ground fault currents.
- I. Section 26 05 41, UNDERGROUND ELECTRICAL CONSTRUCTION: Underground conduits.
- J. Section 31 20 00, EARTHWORK: Bedding of conduits.

**1.3 QUALITY ASSURANCE**

Refer to Paragraph, QUALIFICATIONS, in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

#### 1.4 SUBMITTALS

A. Submit six copies of the following in accordance with Section 26 05 11, 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
- 514C-07.....Nonmetallic Outlet Boxes, Flush-Device Boxes  
and Covers
- 651-11.....Schedule 40 and 80 Rigid PVC Conduit and  
Fittings
- 651A-11.....Type EB and A Rigid PVC Conduit and HDPE  
Conduit
- 797-07.....Electrical Metallic Tubing
- 1242-06.....Electrical Intermediate Metal Conduit - Steel
- E. National Electrical Manufacturers Association (NEMA):
  - TC-2-13.....Electrical Polyvinyl Chloride (PVC) Tubing and  
Conduit
  - TC-3-13.....PVC Fittings for Use with Rigid PVC Conduit and  
Tubing
  - 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. Setscrew Couplings and Connectors: Use setscrews of case-hardened steel with hex head and cup point, to firmly seat in wall of conduit for positive grounding.
  - d. Indent-type connectors or couplings are prohibited.
  - e. Die-cast or pressure-cast zinc-alloy fittings or fittings made of "pot metal" are prohibited.
4. Flexible Metal Conduit Fittings:
- a. Conform to UL 514B. Only steel or malleable iron materials are acceptable.
  - b. Clamp-type, with insulated throat.
5. 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.
6. Direct Burial Plastic Conduit Fittings: Fittings shall meet the requirements of UL 514C and NEMA TC3.
7. 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.
8. 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 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 COR where working space is limited.

B. Firestop: Where conduits, wireways, 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 COR.

### **3.3 CONCEALED WORK INSTALLATION**

A. In Concrete:

1. Conduit: Rigid steel, IMC, or EMT. Do not install EMT in concrete slabs that are in contact with soil, gravel, or vapor barriers.
2. Align and run conduit in direct lines.
3. Install conduit through concrete beams only:
  - a. Where shown on the structural drawings.
  - b. As approved by the COR prior to construction, and after submittal of drawing showing location, size, and position of each penetration.
4. Installation of conduit in concrete that is less than 75 mm (3 inches) thick is prohibited.
  - a. Conduit outside diameter larger than one-third of the slab thickness is prohibited.
  - b. Space between conduits in slabs: Approximately six conduit diameters apart, and one conduit diameter at conduit crossings.
  - c. Install conduits approximately in the center of the slab so that there will be a minimum of 19 mm (0.75-inch) of concrete around the conduits.
5. Make couplings and connections watertight. Use thread compounds that are UL approved conductive type to ensure low resistance ground continuity through the conduits. Tightening setscrews with pliers is prohibited.

B. 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. Connect recessed lighting fixtures to conduit runs with maximum 1.8 M (6 feet) of flexible metal conduit extending from a junction box to the fixture.
4. Tightening set screws with pliers is prohibited.
5. 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.
- C. Conduit for Conductors 600 V and Below: Rigid steel, IMC, or EMT. Mixing different types of conduits in the system is prohibited.
- D. Align and run conduit parallel or perpendicular to the building lines.
- E. Install horizontal runs close to the ceiling or beams and secure with conduit straps.
- F. Support horizontal or vertical runs at not over 2.4 M (8 feet) intervals.
- G. Surface Metal Raceways: Use only where shown on drawings.
- H. 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 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.

### **3.6 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.

### **3.7 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.

- D. Seismic Areas: In seismic areas, provide conduits rigidly secured to the building structure on opposite sides of a building expansion joint with junction boxes on both sides of the joint. Connect conduits to junction boxes with 375 mm (15 inches) of slack flexible conduit. Flexible conduit shall have a copper bonding jumper installed.

### 3.8 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. New Construction: Use steel or malleable iron concrete inserts set in place prior to placing the concrete.
  2. 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.

### 3.9 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.

- - - E N D - - -

**SECTION 26 05 73**  
**OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section specifies the overcurrent protective device coordination study, indicated as the study in this section.
- B. A short-circuit and selective coordination study shall be prepared for the electrical overcurrent devices to be installed under this project.
- C. The study shall present a well-coordinated time-current analysis of each overcurrent protective device from the individual device up to the utility source and the on-site generator sources.

**1.2 RELATED WORK**

- A. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements that are common to more than one section of Division 26.
- B. Section 26 23 00, LOW-VOLTAGE SWITCHGEAR: Low-voltage switchgear.
- C. Section 26 24 13, DISTRIBUTION SWITCHBOARDS: Low-voltage distribution switchboards.
- D. Section 26 24 16, PANELBOARDS: Low-voltage panelboards.
- E. Section 26 36 23, AUTOMATIC TRANSFER SWITCHES: Automatic transfer switches.

**1.3 QUALITY ASSURANCE**

- A. Refer to Paragraph, QUALIFICATIONS (PRODUCTS AND SERVICES), in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.
- B. The study shall be prepared by the equipment manufacturer.

**1.4 SUBMITTALS**

- A. Submit six copies of the following in accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.
  - 1. Product data on the software program to be used for the study.  
Software shall be in mainstream use in the industry, shall provide device settings and ratings, and shall show selective coordination by time-current drawings.
  - 2. Complete study as described in paragraph 1.6. Submittal of the study shall be well-coordinated with submittals of the shop drawings for equipment in related specification sections.



3. Certifications: Two weeks prior to final inspection, submit the following.

- a. Certification by the Contractor that the overcurrent protective devices have been set in accordance with the approved study.

#### **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. Institute of Electrical and Electronics Engineers (IEEE):
  - 242-01.....Protection and Coordination of Industrial and Commercial Power Systems
  - 399-97.....Industrial and Commercial Power Systems Analysis
  - 1584a-04.....Guide for Performing Arc-Flash Hazard Calculations

#### **1.6 STUDY REQUIREMENTS**

- A. The study shall include one line diagram, short-circuit and ground fault analysis, and protective coordination plots for all overcurrent protective devices.
- B. One Line Diagram:
  - 1. Show all electrical equipment and wiring to be protected by the overcurrent devices.
  - 2. Show the following specific information:
    - a. Calculated fault impedance, X/R ratios, and short-circuit values at each feeder and branch circuit bus.
    - b. Relay, circuit breaker, and fuse ratings.
    - c. Generator kW/kVA and transformer kVA and voltage ratings, percent impedance, X/R ratios, and wiring connections.
    - d. Voltage at each bus.
    - e. Identification of each bus, matching the identification on the drawings.
    - f. Conduit, conductor, and busway material, size, length, and X/R ratios.
- C. Short-Circuit Study:

1. The study shall be performed using computer software designed for this purpose. Pertinent data and the rationale employed in developing the calculations shall be described in the introductory remarks of the study.
2. Calculate the fault impedance to determine the available short-circuit and ground fault currents at each bus. Incorporate applicable motor and/or generator contribution in determining the momentary and interrupting ratings of the overcurrent protective devices.
3. Present the results of the short-circuit study in a table. Include the following:
  - a. Device identification.
  - b. Operating voltage.
  - c. Overcurrent protective device type and rating.
  - d. Calculated short-circuit current.

D. Coordination Curves:

1. Prepare the coordination curves to determine the required settings of overcurrent protective devices to demonstrate selective coordination. Graphically illustrate on log-log paper that adequate time separation exists between devices, including the utility company upstream device if applicable. Plot the specific time-current characteristics of each overcurrent protective device in such a manner that all devices are clearly depicted.
2. The following specific information shall also be shown on the coordination curves:
  - a. Device identification.
  - b. Potential transformer and current transformer ratios.
  - c. Three-phase and single-phase ANSI damage points or curves for each cable, transformer, or generator.
  - d. Applicable circuit breaker or protective relay characteristic curves.
  - e. No-damage, melting, and clearing curves for fuses.
  - f. Transformer in-rush points.
3. Develop a table to summarize the settings selected for the overcurrent protective devices. Include the following in the table:
  - a. Device identification.

- b. Protective relay or circuit breaker potential and current transformer ratios, sensor rating, and available and suggested pickup and delay settings for each available trip characteristic.
- c. Fuse rating and type.

#### **1.7 ANALYSIS**

- A. Analyze the short-circuit calculations, and highlight any equipment determined to be underrated as specified. Propose solutions to effectively protect the underrated equipment.

#### **1.8 ADJUSTMENTS, SETTINGS, AND MODIFICATIONS**

- A. Final field settings and minor modifications of the overcurrent protective devices shall be made to conform with the study, without additional cost to the Government.

**PART 2 - PRODUCTS (NOT USED)**

**PART 3 - EXECUTION (NOT USED)**

---END---

**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 COR. 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 COR 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 COR 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 -----

**SECTION 26 24 16**  
**PANELBOARDS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section specifies the furnishing, installation, and connection of panelboards.

**1.2 RELATED WORK**

- A. Section 09 91 00, PAINTING: Painting of panelboards.
- B. Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS: Requirements for seismic restraint of non-structural components.//
- D. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: Requirements that apply to all sections of Division 26.
- E. Section 26 05 19, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES: Low-voltage conductors.
- F. Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS: Requirements for personnel safety and to provide a low impedance path for possible ground fault currents.
- G. Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS: Conduits.
- H. Section 26 05 73, OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY: Short circuit and coordination study, and requirements for a coordinated electrical system
- I. Section 26 43 13, SURGE PROTECTIVE DEVICES: Surge protective devices integral to panelboards.

**1.3 QUALITY ASSURANCE**

- A. Refer to Paragraph, QUALIFICATIONS (PRODUCTS AND SERVICES), in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

**1.4 SUBMITTALS**

- A. Submit six copies of the following in accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.
  - 1. Shop Drawings:
    - a. Submit sufficient information to demonstrate compliance with drawings and specifications.
    - b. Include electrical ratings, dimensions, mounting details, materials, required clearances, terminations, weight, circuit



breakers, wiring and connection diagrams, accessories, and nameplate data.

- c. Certification from the manufacturer that a representative panelboard has been seismically tested to International Building Code requirements. Certification shall be based upon simulated seismic forces on a shake table or by analytical methods, but not by experience data or other methods.//
- 2. Manuals:
  - a. Submit, simultaneously with the shop drawings, complete maintenance and operating manuals including technical data sheets, wiring diagrams, and information for ordering circuit breakers and replacement parts.
    - 1) Include schematic diagrams, with all terminals identified, matching terminal identification in the panelboards.
    - 2) Include information for testing, repair, troubleshooting, assembly, and disassembly.
  - b. If changes have been made to the maintenance and operating manuals originally submitted, submit updated maintenance and operating manuals two weeks prior to the final inspection.
- 3. Certifications: Two weeks prior to final inspection, submit the following.
  - a. Certification by the manufacturer that the panelboards conform to the requirements of the drawings and specifications.
  - b. Certification by the Contractor that the panelboards have been properly installed, adjusted, 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. International Code Council (ICC):
  - IBC-12.....International Building Code
- C. National Electrical Manufacturers Association (NEMA):
  - PB 1-11.....Panelboards
  - 250-08.....Enclosures for Electrical Equipment (1,000V Maximum)

- D. National Fire Protection Association (NFPA):
  - 70-11.....National Electrical Code (NEC)
  - 70E-12.....Standard for Electrical Safety in the Workplace
- E. Underwriters Laboratories, Inc. (UL):
  - 50-95.....Enclosures for Electrical Equipment
  - 67-09.....Panelboards
  - 489-09.....Molded Case Circuit Breakers and Circuit  
Breaker Enclosures

## **PART 2 - PRODUCTS**

### **2.1 GENERAL REQUIREMENTS**

- A. Panelboards shall be in accordance with NEC, NEMA, UL, as specified, and as shown on the drawings.
- B. Panelboards shall have main breaker or main lugs, bus size, voltage, phases, number of circuit breaker mounting spaces, top or bottom feed, flush or surface mounting, branch circuit breakers, and accessories as shown on the drawings.
- C. Panelboards shall be completely factory-assembled with molded case circuit breakers and integral accessories as shown on the drawings or specified herein.
- D. Non-reduced size copper bus bars, rigidly supported on molded insulators, and fabricated for bolt-on type circuit breakers.
- E. Bus bar connections to the branch circuit breakers shall be the "distributed phase" or "phase sequence" type.
- F. Mechanical lugs furnished with panelboards shall be cast, stamped, or machined metal alloys listed for use with the conductors to which they will be connected.
- G. Neutral bus shall be 100%rated, mounted on insulated supports.
- H. Grounding bus bar shall be equipped with screws or lugs for the connection of equipment grounding conductors.
- I. Bus bars shall be braced for the available short-circuit current as shown on the drawings, but not be less than 10,000 A symmetrical for 120/208 V and 120/240 V panelboards, and 14,000 A symmetrical for 277/480 V panelboards.
- J. In two-section panelboards, the main bus in each section shall be full size. The first section shall be furnished with subfeed lugs on the line side of main lugs only, or through-feed lugs for main breaker type

panelboards, and have field-installed cable connections to the second section as shown on the drawings. Panelboard sections with tapped bus or crossover bus are not acceptable.

K. Series-rated panelboards are not permitted.

## **2.2 ENCLOSURES AND TRIMS**

### **A. Enclosures:**

1. Provide galvanized steel enclosures, with NEMA rating as shown on the drawings or as required for the environmental conditions in which installed.
2. Enclosures shall not have ventilating openings.
3. Enclosures may be of one-piece formed steel or of formed sheet steel with end and side panels welded, riveted, or bolted as required.
4. Provide manufacturer's standard option for prepunched knockouts on top and bottom endwalls.
5. Include removable inner dead front cover, independent of the panelboard cover.

### **B. Trims:**

1. Hinged "door-in-door" type.
2. Interior hinged door with hand-operated latch or latches, as required to provide access only to circuit breaker operating handles, not to energized parts.
3. Outer hinged door shall be securely mounted to the panelboard enclosure with factory bolts, screws, clips, or other fasteners, requiring a key or tool for entry. Hand-operated latches are not acceptable.
4. Inner and outer doors shall open left to right.
5. Trims shall be flush or surface type as shown on the drawings.

## **2.3 MOLDED CASE CIRCUIT BREAKERS**

- A. Circuit breakers shall be per UL, NEC, as shown on the drawings, and as specified.
- B. Circuit breakers shall be bolt-on type.
- C. Circuit breakers shall have minimum interrupting rating as required to withstand the available fault current, but not less than:
  1. 120/208 V Panelboard: 10,000 A symmetrical.
  2. 120/240 V Panelboard: 10,000 A symmetrical.
  3. 277/480 V Panelboard: 14,000 A symmetrical.

- D. Circuit breakers shall have automatic, trip free, non-adjustable, inverse time, and instantaneous magnetic trips for less than 400 A frame. Circuit breakers with 400 A frames and above shall have magnetic trip, adjustable from 5x to 10x. Breaker trip setting shall be set in the field, based on the approved protective device study as specified in Section 26 05 73, OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY //Breaker magnetic trip setting shall be set to maximum, unless otherwise noted.
- E. Circuit breaker features shall be as follows:
1. A rugged, integral housing of molded insulating material.
  2. Silver alloy contacts.
  3. Arc quenchers and phase barriers for each pole.
  4. Quick-make, quick-break, operating mechanisms.
  5. A trip element for each pole, thermal magnetic type with long time delay and instantaneous characteristics, a common trip bar for all poles and a single operator.
  6. Electrically and mechanically trip free.
  7. An operating handle which indicates closed, tripped, and open positions.
  8. An overload on one pole of a multi-pole breaker shall automatically cause all the poles of the breaker to open.
  9. Ground fault current interrupting breakers, shunt trip breakers, lighting control breakers (including accessories to switch line currents), or other accessory devices or functions shall be provided where shown on the drawings.

SPEC WRITER NOTE: Delete the paragraph below if not required by the project.

10. For circuit breakers being added to existing panelboards, coordinate the breaker type with existing panelboards. Modify the panel directory accordingly.

#### **2.4 SURGE PROTECTIVE DEVICES**

- A. Where shown on the drawings, furnish panelboards with integral surge protective devices. Refer to Section 26 43 13, SURGE PROTECTIVE DEVICES.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

- A. Installation shall be in accordance with the manufacturer's instructions, the NEC, as shown on the drawings, and as specified.
- B. Locate panelboards so that the present and future conduits can be conveniently connected.
- C. In seismic areas, panelboards shall be adequately anchored and braced per details on structural contract drawings to withstand the seismic forces at the location where installed.
- D. Install a printed schedule of circuits in each panelboard after approval by the COR. Schedules shall reflect final load descriptions, room numbers, and room names connected to each circuit breaker. Schedules shall be printed on the panelboard directory cards and be installed in the appropriate panelboards
- E. Mount panelboards such that the maximum height of the top circuit breaker above the finished floor shall not exceed 1980 mm (78 inches).
- F. Provide blank cover for each unused circuit breaker mounting space.
- G. For panelboards located in areas accessible to the public, paint the exposed surfaces of the trims with finishes to match surrounding surfaces after the panelboards have been installed. Do not paint nameplates.
- H. Rust and scale shall be removed from the inside of existing enclosures where new interior components are to be installed. Paint inside of enclosures with rust-preventive paint before the new interior components are installed. Provide new trim. Trim shall fit tight to the enclosure.
- I. Panelboard enclosures shall not be used for conductors feeding through, spliced, or tapping off to other enclosures or devices.

#### **3.2 ACCEPTANCE CHECKS AND TESTS**

- A. Perform in accordance with the manufacturer's recommendations. In addition, include the following:
  - 1. Visual Inspection and Tests:
    - a. Compare equipment nameplate data with specifications and approved shop drawings.
    - b. Inspect physical, electrical, and mechanical condition.
    - c. Verify appropriate anchorage and required area clearances.

- d. Verify that circuit breaker sizes and types correspond to approved shop drawings.
- e. To verify tightness of accessible bolted electrical connections, use the calibrated torque-wrench method or perform thermographic survey after energization.
- f. Vacuum-clean enclosure interior. Clean enclosure exterior.

### **3.3 FOLLOW-UP VERIFICATION**

- A. Upon completion of acceptance checks, settings, and tests, the Contractor shall demonstrate that the panelboards are in good operating condition and properly performing the intended function.

---END---

**SECTION 26 27 26**  
**WIRING DEVICES**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section specifies the furnishing, installation, connection, and testing of wiring devices.

**1.2 RELATED WORK**

- A. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements that are common to more than one section of Division 26.
- B. Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS: Conduit and boxes.
- C. Section 26 05 19, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES: Cables and wiring.
- D. Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS: Requirements for personnel safety and to provide a low impedance path to ground for possible ground fault currents.
- E. Section 26 51 00, INTERIOR LIGHTING: Fluorescent ballasts and LED drivers for use with manual dimming controls.

**1.3 QUALITY ASSURANCE**

- A. Refer to Paragraph, QUALIFICATIONS (PRODUCTS AND SERVICES), in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

**1.4 SUBMITTALS**

- A. Submit six copies of the following in accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.
  - 1. Shop Drawings:
    - a. Submit sufficient information to demonstrate compliance with drawings and specifications.
    - b. Include electrical ratings, dimensions, mounting details, construction materials, grade, and termination information.
  - 2. Manuals:
    - a. Submit, simultaneously with the shop drawings, companion copies of complete maintenance and operating manuals, including technical data sheets and information for ordering replacement parts.

- b. If changes have been made to the maintenance and operating manuals originally submitted, submit updated maintenance and operating manuals two weeks prior to the final inspection.
- 3. Certifications: Two weeks prior to final inspection, submit the following.
  - a. Certification by the manufacturer that the wiring devices conform to the requirements of the drawings and specifications.
  - b. Certification by the Contractor that the wiring devices have been properly installed and adjusted.

### **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 basic designation only.
- B. National Fire Protection Association (NFPA):
  - 70-11.....National Electrical Code (NEC)
  - 99-12.....Health Care Facilities
- C. National Electrical Manufacturers Association (NEMA):
  - WD 1-10.....General Color Requirements for Wiring Devices
  - WD 6-08 .....Wiring Devices - Dimensional Specifications
- D. Underwriter's Laboratories, Inc. (UL):
  - 5-11.....Surface Metal Raceways and Fittings
  - 20-10.....General-Use Snap Switches
  - 231-07.....Power Outlets
  - 467-07.....Grounding and Bonding Equipment
  - 498-07.....Attachment Plugs and Receptacles
  - 943-11.....Ground-Fault Circuit-Interrupters
  - 1449-07.....Surge Protective Devices
  - 1472-96.....Solid State Dimming Controls

## **PART 2 - PRODUCTS**

### **2.1 RECEPTACLES**

- A. General: All receptacles shall comply with NEMA, NFPA, UL, and as shown on the drawings.
  - 1. Mounting straps shall be plated steel, with break-off plaster ears and shall include a self-grounding feature. Terminal screws shall be brass, brass plated or a copper alloy metal.



2. Receptacles shall have provisions for back wiring with separate metal clamp type terminals (four minimum) and side wiring from four captively held binding screws.

B. Duplex Receptacles: Hospital-grade, single phase, 20 ampere, 120 volts, 2-pole, 3-wire, NEMA 5-20R, with break-off feature for two-circuit operation.

1. Bodies shall be white in color for normal power circuits.
2. Switched duplex receptacles shall be wired so that only the top receptacle is switched. The lower receptacle shall be unswitched.
3. Duplex Receptacles on Emergency Circuit:
  - a. Bodies shall be red in color.
  - b. In rooms without emergency powered general lighting, the emergency receptacles shall be of the self-illuminated type.
4. Ground Fault Interrupter Duplex Receptacles: Shall be an integral unit, hospital-grade, suitable for mounting in a standard outlet box, with end-of-life indication and provisions to isolate the face due to improper wiring.
  - a. Ground fault interrupter shall consist of a differential current transformer, solid state sensing circuitry and a circuit interrupter switch. Device shall have nominal sensitivity to ground leakage current of 4-6 milliamperes and shall function to interrupt the current supply for any value of ground leakage current above five milliamperes (+ or - 1 milliampere) on the load side of the device. Device shall have a minimum nominal tripping time of 0.025 second.
  - b. Ground Fault Interrupter Duplex Receptacles (not hospital-grade) shall be the same as ground fault interrupter hospital-grade receptacles except for the hospital-grade listing.

5. Safety Type Duplex Receptacles:

- a. Bodies shall be gray in color.
  - 1) Shall permit current to flow only while a standard plug is in the proper position in the receptacle.
  - 2) Screws exposed while the wall plates are in place shall be the tamperproof type.

6. Duplex Receptacles (not hospital grade): Shall be the same as hospital grade duplex receptacles except for the hospital grade listing and as follows.

a. Bodies shall be brown nylon.

C. Receptacles; 20, 30, and 50 ampere, 250 Volts: Shall be complete with appropriate cord grip plug.

D. Weatherproof Receptacles: Shall consist of a duplex receptacle, mounted in box with a gasketed, weatherproof, cast metal cover plate and cap over each receptacle opening. The cap shall be permanently attached to the cover plate by a spring-hinged flap. The weatherproof integrity shall not be affected when heavy duty specification or hospital grade attachment plug caps are inserted. Cover plates on outlet boxes mounted flush in the wall shall be gasketed to the wall in a watertight manner.

## **2.2 TOGGLE SWITCHES**

A. Toggle switches shall be totally enclosed tumbler type with nylon bodies. Handles shall be white in color unless otherwise specified or shown on the drawings.

1. Switches installed in hazardous areas shall be explosion-proof type in accordance with the NEC and as shown on the drawings.

2. Shall be single unit toggle, butt contact, quiet AC type, heavy-duty general-purpose use with an integral self grounding mounting strap with break-off plaster ears and provisions for back wiring with separate metal wiring clamps and side wiring with captively held binding screws.

3. Switches shall be rated 20 amperes at 120-277 Volts AC.

## **2.3 MANUAL DIMMING CONTROL**

A. Manual dimming controls shall be fully compatible with fluorescent electronic dimming ballasts and approved by the ballast manufacturer and/or LED dimming driver and be approved by the driver manufacturer, shall operate over full specified dimming range, and shall not degrade the performance or rated life of the electronic dimming ballast and lamp.

B. Provide single-pole or three-way, as shown on the drawings.

C. Manual dimming control and faceplates shall be ivory in color unless otherwise specified.

## **2.4 WALL PLATES**

- A. Wall plates for switches and receptacles shall be type smooth nylon .  
Oversize plates are not acceptable.
- B. Color shall be white unless otherwise specified.
- C. For receptacles or switches mounted adjacent to each other, wall plates shall be common for each group of receptacles or switches.
- D. In areas requiring tamperproof wiring devices, wall plates shall be type 302 stainless steel, and shall have tamperproof screws and beveled edges.
- E. Duplex Receptacles on Emergency Circuit: Wall plates shall be white nylon with the word "EMERGENCY" engraved in 6 mm (1/4 inch) red letters

## **2.5 SURFACE MULTIPLE-OUTLET ASSEMBLIES**

- A. Shall have the following features:
  - 1. Enclosures:
    - a. Thickness of steel shall be not less than 1 mm (0.040 inch) for base and cover. Nominal dimensions shall be 40 mm x 70 mm (1-1/2 inches by 2-3/4 inches) with inside cross sectional area not less than 2250 square mm (3-1/2 square inches). The enclosures shall be thoroughly cleaned, phosphatized, and painted at the factory with primer and the manufacturer's standard baked enamel finish.
  - 2. Receptacles shall be duplex, hospital grade. See paragraph 'RECEPTACLES' in this Section. Device cover plates shall be the manufacturer's standard corrosion resistant finish and shall not exceed the dimensions of the enclosure.
  - 3. Unless otherwise shown on drawings, receptacle spacing shall be 600 mm (24 inches) on centers.
  - 4. Conductors shall be as specified in Section 26 05 21, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLE.
  - 5. Installation fittings shall be the manufacturer's standard bends, offsets, device brackets, inside couplings, wire clips, elbows, and other components as required for a complete system.
  - 6. Bond the assemblies to the branch circuit conduit system.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. Installation shall be in accordance with the NEC and as shown as on the drawings.

- B. Install wiring devices after wall construction and painting is complete.
- C. The ground terminal of each wiring device shall be bonded to the outlet box with an approved green bonding jumper, and also connected to the branch circuit equipment grounding conductor.
- D. Outlet boxes for toggle switches and manual dimming controls shall be mounted on the strike side of doors.
- E. Provide barriers in multigang outlet boxes to comply with the NEC.
- F. Coordinate the electrical work with the work of other trades to ensure that wiring device flush outlets are positioned with box openings aligned with the face of the surrounding finish material. Pay special attention to installations in cabinet work, and in connection with laboratory equipment.
- G. Exact field locations of floors, walls, partitions, doors, windows, and equipment may vary from locations shown on the drawings. Prior to locating sleeves, boxes and chases for roughing-in of conduit and equipment, the Contractor shall coordinate exact field location of the above items with other trades.
- H. Install wall switches 1.1 M (44 inches) above floor, with the toggle OFF position down.
- I. Install wall dimmers 1.1 M (44 inches) above floor.
- J. Install receptacles 450 mm (18 inches) above floor, and 152 mm (6 inches) above counter backsplash or workbenches. Install specific-use receptacles at heights shown on the drawings.
- K. Install vertically mounted receptacles with the ground pin up. Install horizontally mounted receptacles with the ground pin to the right.
- L. When required or recommended by the manufacturer, use a torque screwdriver. Tighten unused terminal screws.
- M. Label device plates with a permanent adhesive label listing panel and circuit feeding the wiring device.

### **3.2 ACCEPTANCE CHECKS AND TESTS**

- A. Perform manufacturer's required field checks in accordance with the manufacturer's recommendations. In addition, include the following:
  - 1. Visual Inspection and Tests:
    - a. Inspect physical and electrical condition.

- b. Vacuum-clean surface metal raceway interior. Clean metal raceway exterior.
  - c. Test wiring devices for damaged conductors, high circuit resistance, poor connections, inadequate fault current path, defective devices, or similar problems using a portable receptacle tester. Correct circuit conditions, remove malfunctioning units and replace with new, and retest as specified above.
  - d. Test GFCI receptacles.
2. Healthcare Occupancy Tests:
- a. Test hospital grade receptacles for retention force per NFPA 99.

---END---

**SECTION 26 29 11  
MOTOR CONTROLLERS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section specifies the furnishing, installation, connection, and testing of motor controllers, including all low- and medium-voltage motor controllers and manual motor controllers, indicated as motor controllers in this section, and low-voltage variable speed motor controllers.
- B. Motor controllers, whether furnished with the equipment specified in other sections or otherwise (with the exception of elevator motor controllers specified in Division 14 and fire pump controllers specified in Division 21), shall meet this specification and all related specifications.

**1.2 RELATED WORK**

- A. Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS: Requirements for seismic restraint for nonstructural components.
- B. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: Requirements that apply to all sections of Division 26.
- C. Section 26 05 19, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES: Low-voltage conductors.
- D. Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS: Requirements for personnel safety and to provide a low impedance path for possible ground fault currents.
- E. Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS: Conduits.
- F. Section 26 24 19, MOTOR CONTROL CENTERS: For multiple motor control assemblies which include motor controllers.

**1.3 QUALITY ASSURANCE**

- A. Refer to Paragraph, QUALIFICATIONS (PRODUCTS AND SERVICES), in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

**1.4 SUBMITTALS**

- A. Submit six copies of the following in accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.
  - 1. Shop Drawings:

- a. Submit sufficient information to demonstrate compliance with drawings and specifications.
  - b. Include electrical ratings, dimensions, weights, mounting details, materials, overcurrent protection devices, overload relays, sizes of enclosures, wiring diagrams, starting characteristics, interlocking, and accessories.
  - c. Certification from the manufacturer that representative motor controllers have been seismically tested to International Building Code requirements. Certification shall be based upon simulated seismic forces on a shake table or by analytical methods, but not by experience data or other methods.
2. Manuals:
- a. Submit, simultaneously with the shop drawings, companion copies of complete maintenance and operating manuals, including technical data sheets, wiring diagrams, and information for ordering replacement parts.
    - 1) Wiring diagrams shall have their terminals identified to facilitate installation, maintenance, and operation.
    - 2) Wiring diagrams shall indicate internal wiring for each item of equipment and interconnections between the items of equipment.
    - 3) Elementary schematic diagrams shall be provided for clarity of operation.
    - 4) Include the catalog numbers for the correct sizes of overload relays for the motor controllers.
  - b. If changes have been made to the maintenance and operating manuals originally submitted, submit updated maintenance and operating manuals two weeks prior to the final inspection.
3. Certifications: Two weeks prior to final inspection, submit the following.
- a. Certification by the manufacturer that the motor controllers conform to the requirements of the drawings and specifications.
  - b. Certification by the Contractor that the motor controllers have been properly installed, adjusted, 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 basic designation only.
- B. Institute of Electrical and Electronic Engineers (IEEE):
- 519-92.....Recommended Practices and Requirements for  
Harmonic Control in Electrical Power Systems
  - C37.90.1-02.....Standard Surge Withstand Capability (SWC) Tests  
for Relays and Relay Systems Associated with  
Electric Power Apparatus
- C. International Code Council (ICC):
- IBC-12.....International Building Code
- D. National Electrical Manufacturers Association (NEMA):
- ICS 1-08.....Industrial Control and Systems: General  
Requirements
  - ICS 1.1-09.....Safety Guidelines for the Application,  
Installation and Maintenance of Solid State  
Control
  - ICS 2-05.....Industrial Control and Systems Controllers,  
Contactors, and Overload Relays Rated 600 Volts
  - ICS 4-05.....Industrial Control and Systems: Terminal Blocks
  - ICS 6-06.....Industrial Control and Systems: Enclosures
  - ICS 7-06.....Industrial Control and Systems: Adjustable-  
Speed Drives
  - ICS 7.1-06.....Safety Standards for Construction and Guide for  
Selection, Installation, and Operation of  
Adjustable-Speed Drive Systems
  - MG 1 Part 31.....Inverter Fed Polyphase Motor Standards
- E. National Fire Protection Association (NFPA):
- 70-11.....National Electrical Code (NEC)
- F. Underwriters Laboratories Inc. (UL):
- 508A-07.....Industrial Control Panels
  - 508C-07.....Power Conversion Equipment
  - UL 1449-06.....Surge Protective Devices



## **PART 2 - PRODUCTS**

### **2.1 MOTOR CONTROLLERS**

- A. Motor controllers shall comply with IEEE, NEMA, NFPA, UL, and as shown on the drawings.
- B. Motor controllers shall be separately enclosed, unless part of another assembly. For installation in motor control centers, provide plug-in, draw-out type motor controllers up through NEMA size 4. NEMA size 5 and above require bolted connections.
- C. Motor controllers shall be combination type, with magnetic controller per Paragraph 2.3 below and with circuit breaker disconnecting means, with external operating handle with lock-open padlocking positions and ON-OFF position indicator.
  - 1. Circuit Breakers:
    - a. Bolt-on thermal-magnetic type with a minimum interrupting rating as indicated on the drawings.
    - b. Equipped with automatic, trip free, non-adjustable, inverse-time, and instantaneous magnetic trips for less than 400A. The magnetic trip shall be adjustable from 5x to 10x for breakers 400A and greater.
    - c. Additional features shall be as follows:
      - 1) A rugged, integral housing of molded insulating material.
      - 2) Silver alloy contacts.
      - 3) Arc quenchers and phase barriers for each pole.
      - 4) Quick-make, quick-break, operating mechanisms.
      - 5) A trip element for each pole, a common trip bar for all poles, and one operator for all poles.//
- D. Enclosures:
  - 1. Enclosures shall be NEMA-type rated 1, 3R, or 12 as indicated on the drawings or as required per the installed environment.
  - 2. Enclosure doors shall be interlocked to prevent opening unless the disconnecting means is open. A "defeater" mechanism shall allow for inspection by qualified personnel with the disconnect means closed. Provide padlocking provisions.
  - 3. All metal surfaces shall be thoroughly cleaned, phosphatized, and factory primed prior to applying light gray baked enamel finish.

E. Motor control circuits:

1. Shall operate at not more than 120 Volts.
2. Shall be grounded, except where the equipment manufacturer recommends that the control circuits be isolated.
3. For each motor operating over 120 Volts, incorporate a separate, heavy duty, control transformer within each motor controller enclosure.
4. Incorporate primary and secondary overcurrent protection for the control power transformers.

F. Overload relays:

1. Electronic type. Devices shall be NEMA type.
  2. One for each pole.
  3. External overload relay reset pushbutton on the door of each motor controller enclosure.
  4. Overload relays shall be matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.
58. Electronic overload relays shall utilize internal current transformers and electro-mechanical components. The relays shall have ambient temperature compensation, single-phase protection, manual or automatic reset, and trip classes of 10, 15, 20 and 30. The relay shall provide fault cause indication, including jam/stall, ground fault, phase loss, and overload.

G. Hand-Off-Automatic (H-O-A) switch is required unless specifically stated on the drawings as not required for a particular controller. H-O-A switch shall be operable without opening enclosure door. H-O-A switch is not required for manual motor controllers.

H. Incorporate into each control circuit a 120 Volt, electronic time-delay relay (ON delay), minimum adjustable range from 0.3 to 10 minutes, with transient protection. Time-delay relay is not required where H-O-A switch is not required.

I. Unless noted otherwise, equip each motor controller with not less than two normally open (N.O.) and two normally closed (N.C.) auxiliary contacts.

J. Provide green (RUN) and red (STOP) pilot lights.

- K. Motor controllers incorporated within equipment assemblies shall also be designed for the specific requirements of the assemblies.
- L. Additional requirements for specific motor controllers, as indicated in other specification sections, shall also apply.

## **2.2 MANUAL MOTOR CONTROLLERS**

- A. Shall be in accordance with applicable requirements of 2.1 above.
- B. Manual motor controllers shall have the following features:
  - 1. Controllers shall be general-purpose Class A, manually operated type with full voltage controller for induction motors, rated in horsepower.
  - 2. Units shall include thermal overload relays, on-off operator, red and green pilot lights, form C auxiliary contacts.
- C. Fractional horsepower manual motor controllers shall have the following features:
  - 1. Controllers shall be general-purpose Class A, manually operated type with full voltage controller for fractional horsepower induction motors.
  - 2. Units shall include thermal overload relays, red pilot light, and toggle operator.

## **2.3 MAGNETIC MOTOR CONTROLLERS**

- A. Shall be in accordance with applicable requirements of 2.1 above.
- B. Controllers shall be general-purpose, Class A magnetic controllers for induction motors rated in horsepower. Minimum NEMA size 0.
- C. Where combination motor controllers are used, combine controller with protective or disconnect device in a common enclosure.
- D. Provide phase loss protection for each controller, with contacts to de-energize the controller upon loss of any phase.
- E. Unless otherwise indicated, provide full voltage non-reversing across-the-line mechanisms for motors less than 75 HP, closed by coil action and opened by gravity. For motors 75 HP and larger, provide reduced-voltage or variable speed controllers as shown on the drawings. Equip controllers with 120 VAC coils and individual control transformer unless otherwise noted.

## **2.4 REDUCED VOLTAGE MOTOR CONTROLLERS**

- A. Shall be in accordance with applicable portions of 2.1 above.
- B. Shall have closed circuit transition.

- C. Shall limit inrush currents to not more than 70 percent of the locked rotor current.
- D. Provide phase loss protection for each motor controller, with contacts to de-energize the motor controller upon loss of any phase.

## **2.5 LOW-VOLTAGE VARIABLE SPEED MOTOR CONTROLLERS (VSMC)**

- A. VSMC shall be in accordance with applicable portions of 2.1 above.
- B. VSMC shall be electronic, with adjustable frequency and voltage, three phase output, capable of driving standard NEMA B three-phase induction motors at full rated speed. The control technique shall be pulse width modulation (PWM), where the VSMC utilizes a full wave bridge design incorporating diode rectifier circuitry. Silicon controlled rectifiers or other control techniques are not acceptable.
- C. VSMC shall be suitable for variable torque loads, and shall be capable of providing sufficient torque to allow the motor to break away from rest upon first application of power.
- D. VSMC shall be capable of operating within voltage parameters of plus 10 to minus 15 percent of line voltage, and be suitably rated for the full load amps of the maximum watts (HP) within its class.
- E. Minimum efficiency shall be 95 percent at 100 percent speed and 85 percent at 50 percent speed.
- F. The displacement power factor of the VSMC shall not be less than 95 percent under any speed or load condition.
- G. VSMC current and voltage harmonic distortion shall not exceed the values allowed by IEEE 519.
- H. Operating and Design Conditions:
  - 1. Elevation: 500 feet Above Mean Sea Level (AMSL)
  - 2. Temperatures: Maximum +90°F Minimum -10°F
  - 3. Relative Humidity: 95%
  - 4. VSMC Location: //Non-Air conditioned space. See drawings.
- I. VSMC shall have the following features:
  - 1. Isolated power for control circuits.
  - 2. Manually resettable overload protection for each phase.
  - 3. Adjustable current limiting circuitry to provide soft motor starting. Maximum starting current shall not exceed 200 percent of motor full load current.

4. Independent acceleration and deceleration time adjustment, manually adjustable from 2 to 2000 seconds. Set timers to the equipment manufacturer's recommended time in the above range.
5. Control input circuitry that will accept 4 to 20 mA current or 0-10 VDC voltage control signals from an external source.
6. Automatic frequency adjustment from 1 Hz to 300 Hz.
7. Circuitry to initiate an orderly shutdown when any of the conditions listed below occur. The VSMC shall not be damaged by any of these electrical disturbances and shall automatically restart when the conditions are corrected. The VSMC shall be able to restart into a rotating motor operating in either the forward or reverse direction and matching that frequency.
  - a. Incorrect phase sequence.
  - b. Single phasing.
  - c. Overvoltage in excess of 10 percent.
  - d. Undervoltage in excess of 15 percent.
  - e. Running overcurrent above 110 percent (VSMC shall not automatically reset for this condition.)
  - f. Instantaneous overcurrent above 150 percent (VSMC shall not automatically reset for this condition).
  - g. Short duration power outages of 12 cycles or less (i.e., distribution line switching, generator testing, and automatic transfer switch operations.)
8. Provide automatic shutdown upon receiving a power transfer warning signal from an automatic transfer switch. VSMC shall automatically restart motor after the power transfer.
9. Automatic Reset/Restart: Attempt three restarts after VSMC fault or on return of power after an interruption and before shutting down for manual reset or fault correction, with adjustable delay time between restart attempts.
10. Power-Interruption Protection: To prevent motor from re-energizing after a power interruption until motor has stopped, unless "Bidirectional Autospeed Search" feature is available and engaged.
11. Bidirectional Autospeed Search: Capable of starting VSMC into rotating loads spinning in either direction and returning motor to

- set speed in proper direction, without causing damage to VSMC, motor, or load.
- J. VSMC shall include an input circuit breaker which will disconnect all input power, interlocked with the door so that the door cannot be opened with the circuit breaker in the closed position.
- K. VSMC shall include a 5% line reactor and a RFI/EMI filter.
- L. Surge Suppression: Provide three-phase protection against damage from supply voltage surges in accordance with UL 1449.
- M. VSMC shall include front-accessible operator station, with sealed keypad and digital display, which allows complete programming, operating, monitoring, and diagnostic capabilities.
1. Typical control functions shall include but not be limited to:
    - a. HAND-OFF-AUTOMATIC-RESET, with manual speed control in HAND mode.
    - b. NORMAL-BYPASS.
    - c. NORMAL-TEST, which allows testing and adjusting of the VSMC while in bypass mode.
  2. Typical monitoring functions shall include but not be limited to:
    - a. Output frequency (Hz).
    - b. Motor speed and status (run, stop, fault).
    - c. Output voltage and current.
  3. Typical fault and alarm functions shall include but not be limited to:
    - a. Loss of input signal, under- and over-voltage, inverter overcurrent, motor overload, critical frequency rejection with selectable and adjustable deadbands, instantaneous line-to-line and line-to-ground overcurrent, loss-of-phase, reverse-phase, and short circuit.
    - b. System protection indicators indicating that the system has shutdown and will not automatically restart.
- N. VSMC shall include two N.O. and two N.C. dry contacts rated 120 Volts, 10 amperes, 60 Hz.
- O. Hardware, software, network interfaces, gateways, and programming to control and monitor the VSMC by control systems specified in other specification sections, including but not limited to Divisions 22 and 23.

- P. Network communications ports: As required for connectivity to control systems specified in other specification sections, including but not limited to Divisions 22 and 23.
- Q. Communications protocols: As required for communications with control systems specified in other specification sections, including but not limited to Divisions 22 and 23.
- R. Bypass controller: Provide contactor-style bypass, arranged to bypass the inverter.
  - 1. Inverter Output Contactor and Bypass Contactor: Load-break NEMA-rated contactor.
  - 2. Motor overload relays.
  - 3. HAND-OFF-AUTOMATIC bypass control.
- S. Bypass operation: Transfers motor between inverter output and bypass circuit, manually, automatically, or both. VSMC shall be capable of stable operation (starting, stopping, and running), and control by fire alarm and detection systems, with motor completely disconnected from the inverter output. Transfer between inverter and bypass contactor and retransfer shall only be allowed with the motor at zero speed.
- T. Inverter Isolating Switch: Provide non-load-break switch arranged to isolate inverter and permit safe troubleshooting and testing of the inverter, both energized and de-energized, while motor is operating in bypass mode. Include padlockable, door-mounted handle mechanism.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

- A. Install motor controllers in accordance with the NEC, as shown on the drawings, and as recommended by the manufacturer.
- B. In seismic areas, motor controllers shall be adequately anchored and braced per details on structural contract drawings to withstand the seismic forces at the location where installed.
- C. Install manual motor controllers in flush enclosures in finished areas.
- D. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and electronic overload relay pickup and trip ranges.
- E. Program variable speed motor controllers per the manufacturer's instructions and in coordination with other trades so that a complete and functional system is delivered.

F. Adjust trip settings of circuit breakers and motor circuit protectors with adjustable instantaneous trip elements. Initially adjust at six times the motor nameplate full-load ampere ratings and attempt to start motors several times, allowing for motor cooldown between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed eight times the motor full-load amperes (or 11 times for NEMA Premium Efficiency motors if required). Where these maximum settings do not allow starting of a motor, notify COR before increasing settings.

### **3.2 ACCEPTANCE CHECKS AND TESTS**

A. Perform manufacturer's required field tests in accordance with the manufacturer's recommendations. In addition, include the following:

#### **1. Visual Inspection and Tests:**

- a. Compare equipment nameplate data with specifications and approved shop drawings.
- b. Inspect physical, electrical, and mechanical condition.
- c. Verify appropriate anchorage, required area clearances, and correct alignment.
- d. Verify that circuit breaker, motor circuit protector, and fuse sizes and types correspond to approved shop drawings.
- e. Verify overload relay ratings are correct.
- f. Vacuum-clean enclosure interior. Clean enclosure exterior.
- g. Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data.
- h. Test all control and safety features of the motor controllers.
- i. For low-voltage variable speed motor controllers, final programming and connections shall be by a factory-trained technician. Set all programmable functions of the variable speed motor controllers to meet the requirements and conditions of use.

### **3.3 FOLLOW-UP VERIFICATION**

A. Upon completion of acceptance checks, settings, and tests, the Contractor shall show by demonstration in service that the motor controllers are in good operating condition and properly performing the intended functions.



**3.4 SPARE PARTS**

- A. Two weeks prior to the final inspection, provide one complete set of spare fuses for each motor controller.

**3.5 INSTRUCTION**

- A. Furnish the services of a factory-trained technician for two 4-hour training periods for instructing personnel in the maintenance and operation of the motor controllers, on the dates requested by the COR.

---END---

**SECTION 26 29 21**  
**ENCLOSED SWITCHES AND CIRCUIT BREAKERS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section specifies the furnishing, installation, and connection of fused and unfused disconnect switches (indicated as switches in this section), and separately-enclosed circuit breakers for use in electrical systems rated 600 V and below.

**1.2 RELATED WORK**

- A. Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS: Requirements for seismic restraint of non-structural components.
- B. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: Requirements that apply to all sections of Division 26.
- C. Section 26 05 19, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES: Low-voltage conductors.
- D. Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS: Requirements for personnel safety and to provide a low impedance path for possible ground faults.
- E. Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS: Conduits.
- F. Section 26 24 16, PANELBOARDS: Molded-case circuit breakers.

**1.3 QUALITY ASSURANCE**

- A. Refer to Paragraph, QUALIFICATIONS (PRODUCTS AND SERVICES), in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

**1.4 SUBMITTALS**

- A. Submit six copies of the following in accordance with Section 26 05 11, 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, dimensions, mounting details, materials, required clearances, terminations, weight, fuses, circuit breakers, wiring and connection diagrams, accessories, and device nameplate data.

- c. Certification from the manufacturer that representative enclosed switches and circuit breakers have been seismically tested to International Building Code requirements. Certification shall be based upon simulated seismic forces on a shake table or by analytical methods, but not by experience data or other methods.
- 2. Manuals:
  - a. Submit complete maintenance and operating manuals including technical data sheets, wiring diagrams, and information for ordering fuses, circuit breakers, and replacement parts.
    - 1) Include schematic diagrams, with all terminals identified, matching terminal identification in the enclosed switches and circuit breakers.
    - 2) Include information for testing, repair, troubleshooting, assembly, and disassembly.
  - b. If changes have been made to the maintenance and operating manuals originally submitted, submit updated maintenance and operating manuals two weeks prior to the final inspection.
- 3. Certifications: Two weeks prior to final inspection, submit the following.
  - a. Certification by the manufacturer that the enclosed switches and circuit breakers conform to the requirements of the drawings and specifications.
  - b. Certification by the Contractor that the enclosed switches and circuit breakers have been properly installed, adjusted, 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. International Code Council (ICC):
  - IBC-12.....International Building Code
- C. National Electrical Manufacturers Association (NEMA):
  - FU 1-07.....Low Voltage Cartridge Fuses
  - KS 1-06.....Enclosed and Miscellaneous Distribution  
Equipment Switches (600 Volts Maximum)

- D. National Fire Protection Association (NFPA):
  - 70-11.....National Electrical Code (NEC)
- E. Underwriters Laboratories, Inc. (UL):
  - 98-07.....Enclosed and Dead-Front Switches
  - 248-00.....Low Voltage Fuses
  - 489-09.....Molded Case Circuit Breakers and Circuit  
Breaker Enclosures

## **PART 2 - PRODUCTS**

### **2.1 FUSED SWITCHES RATED 600 AMPERES AND LESS**

- A. Switches shall be in accordance with NEMA, NEC, UL, as specified, and as shown on the drawings.
- B. Shall be NEMA classified General Duty (GD) for 240 V switches, and NEMA classified Heavy Duty (HD) for 480 V switches.
- C. Shall be horsepower (HP) rated.
- D. Shall have the following features:
  - 1. Switch mechanism shall be the quick-make, quick-break type.
  - 2. Copper blades, visible in the open position.
  - 3. An arc chute for each pole.
  - 4. External operating handle shall indicate open and closed positions, and have lock-open padlocking provisions.
  - 5. Mechanical interlock shall permit opening of the door only when the switch is in the open position, defeatable to permit inspection.
  - 6. Fuse holders for the sizes and types of fuses specified.
  - 7. Solid neutral for each switch being installed in a circuit which includes a neutral conductor.
  - 8. Ground lugs for each ground conductor.
  - 9. Enclosures:
    - a. Shall be the NEMA types shown on the drawings.
    - b. Where the types of switch enclosures are not shown, they shall be the NEMA types most suitable for the ambient environmental conditions.
    - c. Shall be finished with manufacturer's standard gray baked enamel paint over pretreated steel.
  - 10. Electrically operated switches shall only be installed where shown on the drawings.

## **2.2 UNFUSED SWITCHES RATED 600 AMPERES AND LESS**

- A. Shall be the same as fused switches, but without provisions for fuses.

## **2.3 FUSED SWITCHES RATED OVER 600 AMPERES TO 1200 AMPERES**

- A. Shall be the same as fused switches, and shall be NEMA classified Heavy Duty (HD).

## **2.4 MOTOR RATED TOGGLE SWITCHES**

- A. Type 1, general purpose for single-phase motors rated up to 1 horsepower.
- B. Quick-make, quick-break toggle switch with external reset button and thermal overload protection matched to nameplate full-load current of actual protected motor.

## **2.5 CARTRIDGE FUSES**

- A. Shall be in accordance with NEMA FU 1.
- B. Service Entrance: Class L or Class T, fast acting.
- C. Feeders: Class J, fast acting.
- D. Motor Branch Circuits: Class RK5, time delay.
- E. Other Branch Circuits: Class RK5, time delay.
- F. Control Circuits: Class CC, fast acting.

## **2.6 SEPARATELY-ENCLOSED CIRCUIT BREAKERS**

- A. Provide circuit breakers in accordance with the applicable requirements in Section 26 24 16, PANELBOARDS.
- B. Enclosures shall be the NEMA types shown on the drawings. Where the types are not shown, they shall be the NEMA type most suitable for the ambient environmental conditions.

# **PART 3 - EXECUTION**

## **3.1 INSTALLATION**

- A. Installation shall be in accordance with the manufacturer's instructions, the NEC, as shown on the drawings, and as specified.
- B. In seismic areas, enclosed switches and circuit breakers shall be adequately anchored and braced per details on structural contract drawings to withstand the seismic forces at the location where installed.
- C. Fused switches shall be furnished complete with fuses. Arrange fuses such that rating information is readable without removing the fuses.

### 3.2 ACCEPTANCE CHECKS AND TESTS

A. Perform in accordance with the manufacturer's recommendations. In addition, include the following:

1. Visual Inspection and Tests:

- a. Compare equipment nameplate data with specifications and approved shop drawings.
- b. Inspect physical, electrical, and mechanical condition.
- c. Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method.
- d. Vacuum-clean enclosure interior. Clean enclosure exterior.

### 3.3 SPARE PARTS

A. Two weeks prior to the final inspection, furnish one complete set of spare fuses for each fused disconnect switch installed on the project. Deliver the spare fuses to the COR.

---END---