

# **TECHNICAL SPECIFICATIONS**

## **Volume 1 of 1**

Department of Veterans Affairs  
Louis Stokes Cleveland VA Medical Center  
**WADE PARK**  
10701 East Boulevard Cleveland, OH 44106

### **ENERGY CONSERVATION UPGRADES**

#### **Project No. 541-10-1004**

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DEPARTMENT OF VETERANS AFFAIRS

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**VA-250-11-IB-0176**

VAMC WADE PARK  
Energy Conservation Upgrades  
Project No. 541-10-1004

5-E4

Electrical Details and Schedules

**ASBESTOS ABATEMENT**

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Schedule of Asbestos Abatement Items & Details

- - - E N D - - -

SECTION 01 00 00  
GENERAL REQUIREMENTS

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**SECTION 01 00 00  
GENERAL REQUIREMENTS****1.1 GENERAL INTENTION**

- A. Contractor shall completely prepare site for building operations, including demolition and removal of existing structures, and furnish labor and materials and perform work for Energy Conservation Upgrades as required by drawings and specifications.
- B. Visits to the site by Bidders may be made only by appointment with the Medical Center Contracting Officer.
- C. Offices of Fredrick, Fredrick, & Heller Engineers, Inc. and Perspectus Architecture, as Architect-Engineers, will render certain technical services during construction. Such services shall be considered as advisory to the Government and shall not be construed as expressing or implying a contractual act of the Government without affirmations by Contracting Officer or his duly authorized representative.
- D. Before placement and installation of work subject to tests by testing laboratory retained and paid for by the Contractor, the Contractor shall notify the COTR in sufficient time to enable 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 COTR.
- E. All employees of general contractor and subcontractors shall comply with VA security management program and obtain permission of the VA police, be identified by project and employer, and restricted from unauthorized access.
- F. Prior to commencing work, general contractor shall provide proof that a OSHA certified "competent person" (CP) (29 CFR 1926.20(b)(2)) will maintain a presence at the work site whenever the general or subcontractors are present.
- G. Training:
  - 1. Beginning July 31, 2005, all employees of general contractor or subcontractors shall have the following required hours of OSHA certified Construction Safety course and /or other relevant competency training, as determined by VA CP with input from the ICRA team.
    - a. Superintendent: 30 hours
    - b. All other Workers: 10 hours
  - 2. Submit training records of all such employees for approval before the start of work.

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

- A. ITEM 1, Energy Conservation Upgrades: Work includes general construction, alterations, structural, mechanical, plumbing, fire protection, and electrical work, utility systems, and necessary removal of existing structures and construction and certain other items. All work to be completed within 375 calendar days from date of receipt of Notice to Proceed.
- B. BID ITEM 2, (Alternate Deduct No. 1):
1. Same as BID ITEM 1 except delete the following;
    - a. Remove, furnish, install, connect, and test roof ductwork shown on drawing 2-H3.
  2. All work to be performed within 375 calendar days from date of receipt of Notice to Proceed.

**1.3 SPECIFICATIONS AND DRAWINGS FOR CONTRACTOR**

- A. AFTER AWARD OF CONTRACT, zero (0) sets of specifications and drawings will be furnished.

**1.4 CONSTRUCTION SECURITY REQUIREMENTS**

- A. Security Plan:
1. The security plan defines both physical and administrative security procedures that will remain effective for the entire duration of the project.
  2. The General Contractor is responsible for assuring that all sub-contractors working on the project and their employees also comply with these regulations.
- B. Security Procedures:
1. General Contractor's employees shall not enter the project site without appropriate badge. They may also be subject to inspection of their personal effects when entering or leaving the project site.
  2. For working outside the "regular hours" as defined in the contract, The General Contractor shall give 3 days notice to the Contracting Officer so that security arrangements can be provided for the employees. This notice is separate from any notices required for utility shutdown described later in this section.
  3. No photography of VA premises is allowed without written permission of the Contracting Officer.
  4. VA reserves the right to close down or shut down the project site and order General Contractor's employees off the premises in the event of a national emergency. The General Contractor may return to the site only with the written approval of the Contracting Officer.

## C. Key Control:

1. The General Contractor shall provide duplicate keys and lock combinations to the COTR for the purpose of security inspections of every area of project including tool boxes and parked machines and take any emergency action.
2. The General Contractor shall turn over all permanent lock cylinders to the VA locksmith for permanent installation. See Section 08 71 00, DOOR HARDWARE and coordinate.
3. All construction doors/access doors must use VA key system and remain locked at all times from the corridor/exterior side.

## D. Motor Vehicle Restrictions

1. Vehicle authorization request shall be required for any vehicle entering the site and such request 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.
2. No parking is available at Medical Center for contractors and Contractor commuter vehicles shall be parked off-site.

**1.5 FIRE SAFETY**

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

1. American Society for Testing and Materials (ASTM):  
E84-2008.....Surface Burning Characteristics of Building  
Materials
2. National Fire Protection Association (NFPA):  
10-2006.....Standard for Portable Fire Extinguishers  
30-2007.....Flammable and Combustible Liquids Code  
51B-2003.....Standard for Fire Prevention During Welding,  
Cutting and Other Hot Work  
70-2007.....National Electrical Code  
241-2004.....Standard for Safeguarding Construction,  
Alteration, and Demolition Operations
3. Occupational Safety and Health Administration (OSHA):  
29 CFR 1926.....Safety and Health Regulations for Construction

B. Fire Safety Plan: 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 COTR and Facility Safety Manager for review for compliance with contract requirements in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA AND SAMPLES. Prior to any worker for

the contractor or subcontractors beginning work, they shall undergo a safety briefing provided by the general contractor's competent person per OSHA requirements. This briefing shall include information on the construction limits, VAMC safety guidelines, means of egress, break areas, work hours, locations of restrooms, use of VAMC equipment, etc. Documentation shall be provided to the COTR that individuals have undergone contractor's safety briefing.

1. A Hazardous Work Activity Checklist must be completed by the Contractor. Any activity with a YES response is to be detailed in the Site Specific Safety Plan. A sample Hazardous Work Activity Checklist is included at the end of this specification.

- C. 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.
- 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 6 m (20 feet) exposing overall length, separate by 3m (10 feet).
- E. Temporary Construction Partitions:
  - 1. Install and maintain temporary construction partitions to provide smoke-tight separations between construction areas and adjoining areas. Construct partitions of gypsum board or treated plywood (flame spread rating of 25 or less in accordance with ASTM E84) on both sides of fire retardant treated wood or metal steel studs. Extend the partitions through suspended ceilings to floor slab deck or roof. Seal joints and penetrations. At door openings, install Class C, ¾ hour fire/smoke rated doors with self-closing devices and VA locking system (storeroom type lock always locked from the corridor side).
  - 2. Install temporary construction partitions as shown on drawings to maintain integrity of existing exit stair enclosures, exit passageways, fire-rated enclosures of hazardous areas, horizontal exits, smoke barriers, vertical shafts and openings enclosures.
  - 3. Close openings in smoke barriers and fire-rated construction to maintain fire ratings. Seal penetrations with listed through-penetration firestop materials in accordance with Section 07 84 00, FIRESTOPPING.
- F. Temporary Heating and Electrical: Install, use and maintain installations in accordance with 29 CFR 1926, NFPA 241 and NFPA 70.
- G. Means of Egress: Do not block exiting for occupied buildings, including paths from exits to roads. Minimize disruptions and coordinate with COTR.

- H. Egress Routes for Construction Workers: Maintain free and unobstructed egress. Inspect daily. Report findings and corrective actions weekly to COTR. Any construction materials found in exit stairs or corridors will be disposed of at Contractor's expense.
- I. Fire Extinguishers: Provide and maintain extinguishers in construction areas and temporary storage areas in accordance with 29 CFR 1926, NFPA 241 and NFPA 10.
- J. Flammable and Combustible Liquids: Store, dispense and use liquids in accordance with 29 CFR 1926, NFPA 241 and NFPA 30.
- 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, 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 COTR. 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 COTR.
- M. Smoke Detectors: Prevent accidental operation. Remove temporary covers at end of work operations each day. Coordinate with COTR.
- N. Hot Work: Perform and safeguard hot work operations in accordance with NFPA 241 and NFPA 51B. Coordinate with COTR. Obtain permits from COTR at least 48 hours in advance. Provide temporary ventilation to sub-basement for any hot work to occur in the sub-basement area.
- O. Fire Hazard Prevention and Safety Inspections: Inspect entire construction areas weekly. Coordinate with, and report findings and corrective actions weekly to COTR.
- 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. (Refer to Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT for GEMS Policy Requirements)
- R. Perform other construction, alteration and demolition operations in accordance with 29 CFR 1926.

- S. If required, submit documentation to the COTR that personnel have been trained in the fire safety aspects of working in areas with impaired structural or compartmentalization features.
- T. See additional OSHA Requirements and Safety and Health Regulations attachment at the end of this specification section.

#### **1.6 OPERATIONS AND STORAGE AREAS**

- A. The Contractor shall confine all operations (including storage of materials) on Government premises to areas authorized or approved by the Contracting Officer. The Contractor shall hold and save the Government, its officers and agents, free and harmless from liability of any nature occasioned by the Contractor's performance.
- B. Temporary buildings (e.g., storage sheds, shops, offices) and utilities may be erected by the Contractor only with the approval of the Contracting Officer and shall be built with labor and materials furnished by the Contractor without expense to the Government. The temporary buildings and utilities shall remain the property of the Contractor and shall be removed by the Contractor at its expense upon completion of the work. With the written consent of the Contracting Officer, the buildings and utilities may be abandoned and need not be removed.
- C. The Contractor shall, under regulations prescribed by the Contracting Officer, use only established roadways, or use temporary roadways constructed by the Contractor when and as authorized by the Contracting Officer. When materials are transported in prosecuting the work, vehicles shall not be loaded beyond the loading capacity recommended by the manufacturer of the vehicle or prescribed by any Federal, State, or local law or regulation. When it is necessary to cross curbs or sidewalks, the Contractor shall protect them from damage. The Contractor shall repair or pay for the repair of any damaged curbs, sidewalks, or roads.
- D. Working space and space available for storing materials shall be as determined by the COTR.
- E. Workmen are subject to rules of Medical Center applicable to their conduct.
- F. Execute work so as to interfere as little as possible with normal functioning of Medical Center as a whole, including operations of utility services, fire protection systems and any existing equipment, and with work being done by others. Use of equipment and tools that transmit vibrations and noises through the building structure, are not permitted in buildings that are occupied, during construction, jointly by patients or medical personnel, and Contractor's personnel, except as permitted by COTR where required by limited working space.

1. Schedule delivery of materials and equipment to immediate construction working areas within buildings in use by Department of Veterans Affairs in quantities sufficient that do not impede with Medical Center activities. Provide unobstructed access to Medical Center areas required to remain in operation.
  2. Where access by Medical Center personnel to vacated portions of buildings is not required, storage of Contractor's materials and equipment will be permitted subject to fire and safety requirements and review and approval by COTR.
- G. Phasing: The work for this project is intended to be accomplished in one phase. If the Contractor elects to create phases, Contractor shall furnish the COTR with a schedule of approximate phasing dates on which the Contractor intends to accomplish work in each specific area of site, building or portion thereof. In addition, Contractor shall notify the COTR two weeks in advance for final approval of the proposed date of starting work in each specific area of site, building or portion thereof. Arrange such dates to insure accomplishment of this work in successive phases mutually agreeable to COTR and Contractor. Final inspection of each phase before moving to the next phase will be required through the Contracting Officer and COTR.

**Phase I:** As shown on drawings.

- H. When a building is 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 (Department of Veterans Affairs or municipal) whichever will be required to respond to an alarm from Contractor's employee or watchman.
- I. Utilities Services: Maintain existing utility services for Medical Center at all times. Provide temporary facilities, labor, materials, equipment, connections, and utilities to assure uninterrupted services. Where necessary to cut existing water, steam, gases, sewer or air pipes, or conduits, wires, cables, etc. of utility services or of fire protection systems and communications systems (including telephone), they shall be

cut and capped at suitable places where shown; or, in absence of such indication, where directed by COTR.

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 COTR. 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 Medical Center Director's prior knowledge and written approval. Refer to specification Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS for additional requirements.
  2. Contractor shall submit a request to interrupt any such services to COTR, in writing, three (3) days in advance of a minor shut down and two (2) weeks in advance of major a interruption. Request shall state reason, date, exact time of, and approximate duration of such interruption.
  3. Contractor will be advised (in writing) of approval of request, or of which other date and/or time such interruption will cause least inconvenience to operations of Medical Center. Interruption time approved by Medical Center may occur at other than Contractor's normal working hours.
  4. Major interruptions of any system, including crane and dock usage, must be requested, in writing, at least 14 calendar days prior to the desired time and shall be performed as directed by the COTR.
  5. In case of a contract construction emergency, service will be interrupted on approval of COTR. 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 Government and not the Contractor.
  7. All utility service shutdowns such as water, gas, steam, sewers, electricity, or fire protection shall occur during off-hours or weekends at no additional cost to the Government.
- J. Abandoned Lines: All service lines such as wires, cables, conduits, ducts, pipes and the like, and their hangers or supports, which are to be abandoned but are not required to be entirely removed, shall be sealed, capped or plugged at project boundary line. 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.

K. To minimize interference of construction activities with flow of Medical Center traffic, comply with the following:

1. Keep roads, walks and entrances to grounds, to parking and to occupied areas of buildings clear of construction materials, debris and standing construction equipment and vehicles.
2. Method and scheduling of required cutting, altering and removal of existing roads, walks and entrances must be approved by the COTR.

L. Coordinate the work for this contract with other construction operations as directed by COTR. This includes the scheduling of traffic and the use of roadways, as specified in Article, USE OF ROADWAYS.

#### 1.7 ALTERATIONS

A. Survey: Before any work is started, the Contractor shall make a thorough survey with the COTR areas of buildings in which alterations occur and areas which are anticipated routes of access, and furnish a report, signed by both, to the Contracting Officer. This report shall list by rooms and spaces:

1. Existing condition and types of resilient flooring, doors, windows, walls and other surfaces not required to be altered throughout affected areas of 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 Contractor and COTR.

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 COTR, 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.

C. Re-Survey: Thirty days before expected partial or final inspection date, the Contractor and COTR together shall make a thorough re-survey of the areas of buildings involved. They shall furnish a report on conditions then existing, of resilient flooring, doors, windows, walls and other surfaces as compared with conditions of same as noted in first condition survey report:

1. Re-survey report shall also list any damage caused by Contractor to such flooring and other surfaces, despite protection measures; and, will form basis for determining extent of repair work required of Contractor to restore damage caused by Contractor's workmen in executing work of this contract.

D. Protection: Provide the following protective measures:

1. Wherever existing roof surfaces are disturbed they shall be protected against water infiltration. In case of leaks, they shall be repaired immediately upon discovery.
2. Temporary protection against damage for portions of existing structures and grounds where work is to be done, materials handled and equipment moved and/or relocated.
3. Protection of interior of existing structures at all times, from damage, dust and weather inclemency. Wherever work is performed, floor surfaces that are to remain in place shall be adequately protected prior to starting work, and this protection shall be maintained intact until all work in the area is completed.

#### 1.8 INFECTION PREVENTION MEASURES

- A. Infection Control permits (see sample at the end of this specification section) will be issued by the COTR. 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 III**, however, work outside the primary project scope area may vary. The required infection control precautions are denoted on the following table:

#### Description of Required Infection Control Precautions *by Class*

During Construction Project	Upon Completion of Project
<b>CLASS I</b> <ol style="list-style-type: none"> <li>1. Notify and receive permission from the COTR to perform requested work.</li> <li>2. Execute work by methods to minimize raising dust from construction operations.</li> <li>3. Immediately replace a ceiling tile displaced for visual inspection.</li> </ol>	<ol style="list-style-type: none"> <li>1. Notify COTR for inspection once the work is complete.</li> </ol>

<b>CLASS II</b>	<ol style="list-style-type: none"> <li>1. Notify and receive permission from the COTR to perform requested work.</li> <li>2. Provide active means to prevent airborne dust from dispersing into atmosphere.</li> <li>3. Water mist work surfaces to control dust while cutting.</li> <li>4. Seal unused doors with duct tape.</li> <li>5. Block off and seal air vents.</li> <li>6. Place dust mat at entrance and exit of work area.</li> <li>7. Remove or isolate HVAC system in areas where work is being performed.</li> </ol>	<ol style="list-style-type: none"> <li>1. Wipe work surfaces with disinfectant.</li> <li>2. Contain construction waste before transport in tightly covered containers.</li> <li>3. Wet mop and/or vacuum with HEPA filtered vacuum before leaving work area.</li> <li>4. Remove isolation of HVAC system in areas where work is being performed.</li> </ol>
<b>CLASS III</b>	<ol style="list-style-type: none"> <li>1. Obtain and post valid Infection Control Construction Permit at each work site. Permit must be signed by COTR, I.C. Nurse and General Contractor to be valid.</li> <li>2. Remove or isolate HVAC system in area where work is being done to prevent contamination of duct system.</li> <li>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. Construction of barrier will need to occur outside normal work shifts with approval of COTR.</li> <li>4. Construct anteroom where possible and directed by COTR.</li> <li>5. Maintain negative air pressure within work site utilizing HEPA equipped air filtration units.</li> <li>6. Contain construction waste before transport in tightly covered containers.</li> <li>7. Cover transport receptacles or carts. Tape covering unless solid lid.</li> <li>8. If the spread of dust from construction personnel is not contained workers may be required to wear show covers and or be vacuumed prior to leaving worksite at the discretion of the COTR or I.C. Nurse.</li> <li>9. Seal holes, pipes, conduits and punctures appropriately.</li> <li>10. Include particle count readings on daily logs against baseline points as required by COTR or I.C. Nurse.</li> </ol>	<ol style="list-style-type: none"> <li>1. Do not remove barriers from work area until completed project is inspected by the owner's Safety Department.</li> <li>2. Remove barrier materials carefully to minimize spreading of dirt and debris associated with construction. Barriers are required to be removed after hours with approval of COTR.</li> <li>3. Vacuum work area with HEPA filtered vacuums.</li> <li>4. Wet mop area with disinfectant.</li> <li>5. Remove isolation of HVAC system in areas where work is being performed.</li> </ol>

<b>CLASS IV</b>	<ol style="list-style-type: none"> <li>1. Follow all requirements listed in Class III as well as additional requirements listed below.</li> <li>2. 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 the work site.</li> <li>3. All personnel entering work site are required to wear shoe covers. Shoe covers must be changed each time the worker exits the work area.</li> </ol>	<ol style="list-style-type: none"> <li>1. Before work is turned over and accepted by the VA a certified I.H. must be used to certify cleaning as well as swab and air sampling of the area. These tests shall meet or exceed industry standards for the type of area being renovated.</li> </ol>
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- B. An infection control orientation will be provided by the VA Infection Control Personnel to the Contractor prior to construction start.
- C. Implement the requirements of VAMC'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 the safe levels are exceeded.
- D. 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 as specified here. Prior to start of work, prepare a plan detailing project-specific dust protection measures, including periodic status reports, and submit to COTR for review for compliance with contract requirements in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA AND SAMPLES.
1. All personnel involved in the construction or renovation activity shall be educated and trained in infection prevention measures established by the medical center.
- E. Medical Center Infection Control personnel shall monitor for airborne disease (e.g. aspergillosis) as appropriate during construction. A baseline of conditions may 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. In addition:
1. The COTR and VAMC Infection Control personnel shall review pressure differential monitoring documentation to verify that pressure differentials in the construction zone and in the patient-care rooms are appropriate for their settings. The requirement for negative air

- pressure in the construction zone shall be maintained at all times.  
Upon notification, the contractor shall implement corrective measures to restore proper pressure differentials as needed.
2. In case of any problem, the medical center, along with assistance from the contractor, shall conduct an environmental assessment to find and eliminate the source.
- F. 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 COTR. Blank off ducts and diffusers to prevent circulation of dust into occupied areas during construction.
  2. Do not perform dust producing tasks within occupied areas without the approval of the COTR. 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. 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. Barrier installation to be done outside normal Medical Center hours.
    - b. HEPA filtration is required where the exhaust dust may reenter the breathing zone. 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. Adhesive Walk-off/Carpet Walk-off Mats, minimum 600mm x 900mm (24" x 36"), 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.

- d. 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 they are created. Transport these outside the construction area in containers with tightly fitting lids at the end of each shift.
- e. The contractor shall not haul debris through patient-care areas without prior approval of the COTR 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.
- f. 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.
- g. 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.
- h. 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.

G. 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 with reports submitted to COTR.

**1.9 DISPOSAL AND RETENTION**

A. Materials and equipment accruing from work removed and from demolition of buildings or structures, or parts thereof, shall be disposed of as follows:

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

**1.10 RESTORATION**

- A. Remove, cut, alter, replace, patch and repair existing work as necessary to install new work. Except as otherwise shown or specified, do not cut, alter or remove any structural work, and do not disturb any ducts, plumbing, steam, gas, or electric work without approval of the COTR. Existing work to be altered or extended and that is found to be defective in any way, shall be reported to the COTR before it is disturbed. Materials and workmanship used in restoring work, shall conform in type and quality to that of original existing construction, except as otherwise shown or specified.
- B. Upon completion of contract, deliver work complete and undamaged. Existing work (walls, ceilings, partitions, floors, mechanical and electrical work, lawns, paving, roads, walks, etc.) disturbed or removed as a result of performing required new work, shall be patched, repaired, reinstalled, or replaced with new work, and refinished and left in as good condition as existed before commencing work.
- C. At Contractor's own expense, Contractor shall immediately restore to service and repair any damage caused by Contractor's workmen to existing piping and conduits, wires, cables, etc., of utility services or of fire protection systems and communications systems (including telephone) which

are indicated on drawings and which are not scheduled for discontinuance or abandonment.

- D. Expense of repairs to such utilities and systems not shown on drawings or locations of which are unknown will be covered by adjustment to contract time and price in accordance with Bid Solicitation GENERAL CONDITIONS.

#### **1.11 AS-BUILT DRAWINGS**

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

#### **1.12 USE OF ROADWAYS**

- A. For hauling, use only established public roads and roads on Medical Center property and, when authorized by the COTR, 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 bridges.

#### **1.13 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 COTR. If the equipment is not installed and maintained in accordance with the following provisions, the COTR 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 using it and

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

#### **1.14 TEMPORARY USE OF EXISTING ELEVATORS**

- A. Use of existing elevators for handling building materials and Contractor's personnel will be permitted subject to following provisions:
1. Contractor makes all arrangements with the COTR for use of elevators. The COTR will ascertain that elevators are in proper condition. Contractor may use elevators for daily use for personnel only between the hours of 7:00 am and 6:00 pm and for special nonrecurring time intervals when permission is personnel for operating elevators will not be provided by the Department of Veterans Affairs.
  2. Contractor to develop a proposed elevator usage plan for review and approval by COTR.
  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. If brake lining of elevators are excessively worn or damaged during temporary use, they shall be removed and replaced by new brake lining.

4. 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.
5. Place elevator in condition equal, less normal wear, to that existing at time it was placed in service of Contractor as approved by Contracting Officer.

**1.15 TEMPORARY TOILETS**

- A. Provide where directed by COTR, ample temporary sanitary toilet accommodations with suitable sewer and water connections; or, when approved by COTR, provide suitable dry closets where directed. Keep such places clean and free from flies, and all connections and appliances connected therewith are to be removed prior to completion of contract, and premises left perfectly clean.

**1.16 AVAILABILITY AND USE OF UTILITY SERVICES**

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

electricity required for electric cranes and hoisting devices, electrical welding devices and any electrical heating devices providing temporary heat. Electricity for all other uses is available at no cost to the Contractor.

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

1. Obtain water by connecting to the Medical Center water distribution system. Provide reduced pressure backflow preventer at each connection. 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 COTR's discretion) of use of water from Medical Center's system.

G. Steam: Furnish steam system for testing required in various sections of specifications.

1. Obtain steam for testing by connecting to the Medical Center steam distribution system. Steam is available at no cost to the Contractor.
2. Maintain connections, pipe, fittings and fixtures and conserve steam-use so none is wasted. Failure to stop leakage or other waste will be cause for revocation (at COTR's discretion), of use of steam from the Medical Center's system.

#### **1.17 NEW TELEPHONE EQUIPMENT**

The contractor shall coordinate with the work of installation of telephone equipment by others if required. This work shall be completed before the building is turned over to VA.

#### **1.18 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 an authorized representative of the Contracting Officer. Contractor shall furnish all labor, materials, equipment, instruments, and forms, to conduct and record such tests.
- 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 as defined above 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.

#### **1.19 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 (four copies each) for each separate piece of equipment shall be delivered to the COTR coincidental with the delivery of the equipment to the job site. Manuals shall be complete, detailed guides for the maintenance and operation of equipment. They shall include complete information necessary for starting, adjusting, maintaining in continuous operation for long periods of time and dismantling and reassembling of the complete units and sub-assembly components. Manuals shall include an index covering all component parts clearly cross-referenced to diagrams and illustrations. Illustrations shall include "exploded" views showing and identifying each separate item. Emphasis shall be placed on the use of special tools and instruments. The function of each piece of equipment, component, accessory and control shall be clearly and thoroughly explained. All necessary precautions for the operation of the equipment and the reason for each precaution shall be clearly set forth. Manuals must reference the exact model, style and size of the piece of equipment and system being furnished. Manuals referencing equipment similar to but of a different model, style, and size than that furnished will not be accepted.
- C. Instructions: Contractor shall provide qualified, factory-trained manufacturers' representatives to give detailed instructions to assigned Department of Veterans Affairs personnel in the operation and complete maintenance for each piece of equipment. All such training will be at the job site. These requirements are more specifically detailed in the

various technical sections. Instructions for different items of equipment that are component parts of a complete system, shall be given in an integrated, progressive manner. All instructions 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 COTR and shall be considered concluded only when the COTR is satisfied in regard to complete and thorough coverage. The Department of Veterans Affairs reserves the right to request the removal of, and substitution for, any instructor who, in the opinion of the COTR, does not demonstrate sufficient qualifications in accordance with requirements for instructors above.

#### **1.20 GOVERNMENT-FURNISHED PROPERTY**

- A. The Government shall deliver to the Contractor, the Government-furnished property shown on the /Schedule and/or drawings.
- B. Equipment furnished by Government to be installed by Contractor will be furnished to Contractor at the Medical Center.
- 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 Medical Center.
- D. Notify Contracting Officer 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 a representative of the Government. At such time the Contractor shall acknowledge receipt of equipment described, make notations, and immediately furnish the Government 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 Government.
- 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.

#### **1.21 RELOCATED EQUIPMENT AND ITEMS**

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

- - - E N D - - -

## Hazardous Work Activity Checklist

Project: \_\_\_\_\_ Project/Contract #: \_\_\_\_\_

**Any activity answered yes must be addressed in the Site Specific Safety Plan**

Activity	Yes	No
Respiratory protection is required for the work being conducted List specifics:		
Hearing protection is required for the work being conducted List specifics: Type of noise; impact, constant, start up		
Other personal protective equipment is required for the work being conducted, What activity? _____ List specifics: (Gloves, safety Glasses, hard hat, steel toes, overalls)		
There are overhead hazards associated with the work being conducted Wires, power, communication, grounding, location(s), signage List specifics:		
Work is being conducted in a confined space. Permit required? List specifics: Tanks, sewer, tunnels		
Ladders will be necessary for the work being conducted		
Scaffolding will be necessary for the work being conducted List specifics:		
Other work platforms will be necessary for the work being conducted List specifics: Rails, toe boards, netting		
Fall protection is required for the work being conducted List specifics:		
ASBESTOS Abatement Exposure to asbestos may be associated with the work being conducted List specifics: Renovation, Demolition, Emergency Response <u>29 CFR 1910.1001</u>		
Hazardous materials will be used MSDSs will be provided for known substances List specifics: 29 CFR 1910.1200		

## Hazardous Work Activity Checklist

Activity	Yes	No
Hot work(Cutting, Welding, Brazing, etc) Use of VAMC Cleveland Hot Work Policy (MCP 138-012) is required		
Additional ventilation will be necessary for the work being conducted List specifics: Reason for need of ventilation, confined space, foul odor, excessive heat. Note: Temporary ventilation will be required in the sub-basement for welding.		
Operation and maintenance of electric power generation, control, transformation, transmission, and distribution lines and equipment are necessary for the work being conducted List specifics:		
Work will be conducted on energized equipment. Use of VAMC Cleveland Working on Energized Equipment policy (138-034) is required. List specifics: list voltages in area, emergency procedures		
Other electrical work will be conducted List specifics:		
Lock Out/Tag Out will be necessary for the work being conducted List specifics:		
Cranes, derricks, or slings will be necessary for the work being conducted List specifics:		
Excavating will be necessary for work being conducted List site specifics:		
Excavating or earthmoving equipment will be used List specifics:		
Industrial trucks will be used List specifics:		

## Hazardous Work Activity Checklist

Activity	Yes	No
Other motorized vehicles will be used List specifics:		
Concrete and masonry construction operations will be necessary for work being conducted List specifics: % of recycled components		
Steel erection activities will be necessary for the work being conducted List specifics: New Steel % of recycled material,		
Alteration, conversion, or improvement of existing electric transmission and distribution lines and equipment will be necessary for the work being conducted List specifics:		
Hand and portable powered tools or other hand-held equipment will be used		
Compressed gas or compressed air equipment is necessary for work being conducted		
List all other hazardous activities that will be conducted or potentially hazardous equipment that will be used		

## Hazardous Work Activity Checklist

Activity	Yes	No
Demolition will be necessary for the work being conducted		
<i>New Construction:</i> Minimum ___%___ of total project waste shall be diverted from landfill. Recycled aggregate, Concrete, Steel		
<i>Interior Remodeling:</i> Minimum ___%___ of total project waste shall be diverted from landfill. a) Ceiling tile b) Steel c) Carpet		
The following waste categories, at a minimum, shall be diverted from landfill a) Green waste (biodegradable landscaping materials). b) Soil. c) Inerts (concrete, asphalt, masonry). d) Clean dimensional wood, palette wood. e) Engineered wood products: plywood, particle board, I-joists, etc. f) Cardboard, paper, packaging. g) Asphalt roofing materials. h) Insulation. i) Gypsum board. j) Carpet and pad. k) Paint. l) Plastics: ABS, PVC. m) Beverage containers.		

Submitted by (Contractor) \_\_\_\_\_ Date: \_\_\_\_\_

Reviewed by (COTR) \_\_\_\_\_ Date: \_\_\_\_\_

Reviewed by (CSM) \_\_\_\_\_ Date: \_\_\_\_\_

## ***OSHA Requirements and Safety and Health Regulations***

### **PART 1 - OSHA Requirements**

#### **1.1 General**

- A. Contractors are required to comply with the Occupational Safety and Health Act of 1970. This will include the safety and health standard found in Code of Federal Regulations (CFR) 1910 and 1926. Copies of those standards can be obtained from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C., 20420.
- B. In addition, Contractor will be required to comply with other applicable Medical Center policies and safety regulations. These policies and regulations will be presented to the Contractor at the pre-construction meeting. Each of the Contractor's employees will be required to read the statement of policies and regulations, and sign an acknowledgment that such policies and regulations are understood. Signed acknowledgment will be returned to the Contract Officer Technical Representative (COTR).
- C. Contractors involved with the removal, alteration or disturbance of asbestos-type insulation or materials or lead paint will be required to comply strictly with the regulations found in CFR 1910.1001 and the appropriate Environmental Protection Agency (EPA) lead regulations regarding disposal of asbestos or lead paint. Assistance in identifying asbestos or lead can be requested from the Medical Center's Industrial Hygienist and the COTR.
- D. Contractors entering locations of asbestos contamination or lead paint residue (i.e., pipe, basements, walls, windows) shall be responsible for providing respiratory protection to their employees and ensuring respirators are worn in accordance with the Occupational Safety and Health Administration (OSHA) [CFR 1910.1001(g)]. Asbestos-or lead paint-contaminated areas shall be defined on project drawings. The minimum equipment requirements will be a half-mask air-purifying respirator equipped with high efficiency filters and disposable coveralls, or as determined by air monitoring results.
- E. Contractor, along with other submittals and at least two weeks prior to bringing any materials on-site, must submit a complete list of chemicals the Contractor will use and Material Safety Data Sheets (MSDS) for all hazardous materials as defined in OSHA 1910.1200(d), Hazard Determination. Contracting Officer shall have final approval of all materials brought on site.

- F. The Contractor will be held solely responsible for the safety and health of their employees. The contractor will also be held responsible for protecting the health and safety of the VA Community (patients, staff, and visitors) from the unwanted effects of construction. VA staff will monitor the Contractor's performance in complying with all safety and health aspects of the project. Severe or constant violations may result in an immediate work stoppage or request for a Compliance Officer from the Occupational Safety and Health Administration.
- G. During all phases of demolition, construction and alterations, Contractors are required to understand and strictly follow National Fire Protection Association (NFPA) 241, Standard for Safeguarding Construction, Alteration and Demolition Operations. The Medical Center's Safety and Occupational Health Specialist or Industrial Hygienist will closely monitor the work area for compliance. Appropriate action will be taken for non-compliance.

## **PART 2 - Specific VA Medical Center Fire and Safety Policies, Procedures and Regulations**

### **2.1 Introduction.**

- A. The safety and fire protection of patients, employees, members of the public and government is one of continuous concern to this Medical Center.
- B. Contractors, their supervisors and employees are required to comply with Medical Center policies to ensure the occupational safety and health of all. Failure to comply may result in work stoppage.
- C. While working at this Medical Center, contractors are responsible for the occupational safety and health of their employees. Contractors are required to comply with the applicable OSHA standards found in 29 CFR 1910 for general industry and 29 CFR 1926 for construction. Failure to comply with these standards may result in work stoppage and a request to the Area Director of OSHA for a Compliance Officer to inspect your work site.
- D. Contractors are to comply with the requirements found in the National Fire Protection Association (NFPA) 241, Building Construction and Demolition Operation, and NFPA 51B, Fire Prevention in Use of Cutting and Welding Processes.
- E. Questions regarding occupational safety and health issues can be addressed to the Medical Center Safety and Occupational Health Specialist (ext. 4172) or Industrial Hygienist (ext. 4628).

- F. Smoking is not permitted in any interior areas of the Medical Center, including all interior stairwells, tunnels, construction and/or service/maintenance sites. Compliance with this policy by your direct and subcontracted labor force is required.

## **2.2 Hazard Communication**

- A. Contractors shall comply with OSHA Standard 29 CFR 1926.59, Hazard Communication.
- B. Contractors shall submit to the COTR, copies of MSDS covering all hazardous materials to which the Contractor and VA employees are exposed.
- C. Contractors shall inform the Safety Officer of the hazards to which VA personnel and patients may be exposed.
- D. Contractors shall have a written Hazard Communication Program available at the construction site, which details how the Contractor will comply with 29 CFR 1926.59.

## **2.3 Fires**

- A. All fires must be reported. In the event of a fire in your work area, use the nearest pull box station, and also notify Medical Center staff in the immediate area. Emergency notification can also be accomplished by dialing ext. 2222.
- B. Be sure to give the exact location from where you are calling and the nature of the emergency. If a Contractor experiences a fire that was rapidly extinguished by your staff, you still must notify the COTR within an hour of the event so that an investigation of the fire can be accomplished.

## **2.4 Fire Alarms, Smoke Detection and Sprinkler System**

If the nature of your work requires the deactivation of the fire alarm, smoke detection or sprinkler system, you must notify the COTR. Notification must be made in accordance with the major and minor shutdown requirements of the specification so time can be allowed to deactivate the system and provide alternative measures for fire protection. Under no circumstance is a Contractor allowed to deactivate any of the fire protection systems in this Medical Center.

## **2.5 Smoke Detectors**

False alarms will not be tolerated. You are required to be familiar with the location of the smoke detectors in your work area. When performing cutting, burning or welding or any

other operations that may cause smoke or dust, you must take steps to temporarily cover smoke detectors in order to prevent false alarms. Failure to take the appropriate action will result in the Contracting Officer assessing actual costs for government response for each false alarm that is preventable. Prior to covering the smoke detectors, the Contractor will notify the COTR, who will also be notified when the covers are removed.

## **2.6 Hot Work Permit**

- A. Hot work is defined as operations including, but not limited to, cutting, welding, thermal welding, brazing, soldering, grinding, thermal spraying, thawing pipes or any similar situation. If such work is required, whenever possible the Contractor must notify the COTR no less than three (3) days in advance of such work. The Competent Hot Work Supervisor (CHWS) will inspect the work area and issue a Hot Work Permit, authorizing the performance of such work.
- B. All hot work will be performed in compliance with the Medical Center's policy 138-012 regarding Hot Work Permits and NFPA 241, Safeguarding Construction, Alteration and Demolition Operations; and NFPA 51B, Fire Prevention in Use of Cutting and Welding Processes; and applicable OSHA standard. A hot work permit will only be issued to individuals familiar with these regulations.
- C. A Hot Work Permit will be issued only for the period necessary to perform such work. In the event the time necessary will exceed one day, a Hot Work Permit may be issued for the period needed; however, the CHWS will inspect the area daily. Hot Work Permit will apply only to the location identified on the permit. If additional areas involve hot work, then additional permits must be requested.
- D. Contractors will not be allowed to perform hot work processes without the appropriate permit.
- E. Any work involving the Medical Center's fire protection system will require advance notification. Under no circumstance will the Contractor or employee attempt to alter or tamper with the existing fire protection system.
- F. Thirty minutes following completion of the hot work, the Fire Watch will perform an inspection of the area to confirm that sparks or drops of hot metal are not present.

## **2.7 Temporary Enclosures**

Only non-combustible materials will be used to construct temporary enclosures or barriers at this Medical Center. Materials used to construct dust barriers must conform to NFPA 701, Standard Methods of Fire Tests for Flame-Resistant Textiles and Films.

## **2.8 Flammable Liquids**

All flammable liquids will be kept in approved safety containers. Only the amount necessary for your immediate work will be allowed in the building. Flammable liquids must be removed from the building at the end of each day.

## **2.9 Compressed Gas Cylinders**

Compressed gas shall be secured in an upright position at all times. A suitable cylinder cart will be used to transport compressed gas cylinders. Only those compressed gas cylinders necessary for immediate work will be allowed in occupied buildings. All other compressed gas cylinders will be stored outside of buildings in a designated area. Contractors will comply with applicable standards compressed gas cylinders found in 29 CFR 1910 and 1926 (OSHA).

## **2.10 Internal Combustion Engine-Powered Equipment**

Equipment powered by an internal combustion engine (such as saws, compressors, generators, etc.) will not be used in an occupied building. Special consideration may be given for unoccupied buildings only if the OSHA and NFPA requirements have been met.

## **2.11 Powder-Activated Tools**

The operator of powder-activated tools must be trained and certified to use them. Powder-activated tools will be kept secured at all times. When not in use, the tools will be locked up. When in use, the operator will have the tool under his immediate control.

## **2.12 Tools**

- A. Under no circumstances will equipment, tools and other items of work to be left unattended for any reason. All tools, equipment and items of work must be under the immediate control of your employee.
- B. If for some reason a work area must be left unattended, then tools and other equipment must be placed in an appropriate box or container and locked. All tool boxes, containers or any other device used for the storage of tools and equipment will be provided with a latch and padlock, and will be kept locked at all times, except for putting in and removing tools.
- C. All doors to work areas will be closed and locked when rooms are left unattended. Failure to comply with this policy will be considered a violation of VA Regulations 1.218(b), Failure to comply with signs of a directive and restrictive nature posted for safety purposes, and subject to a \$50.00 fine. Subsequent similar violations may result in both imposition of such a fine as well as the Contracting Officer taking

action under the contract's Accident Prevention Clause [Federal Acquisition Regulation (FAR) 52.236-13] to suspend all contract work until violations may be satisfactorily resolved, or under FAR 52.236-5, Material and Workmanship Clause, to remove from the worksite any personnel deemed by the Contracting Officer to be careless to the point of jeopardizing the welfare of facility patients or staff.

- D. You must report any tools or equipment that are missing to the VA Police Department.
- E. Tools and equipment found unattended will be confiscated and removed from the work area.

### **2.13 Ladders**

Ladders must not be left unattended in an upright position. Ladders must be attended at all times or taken down, and chained securely to a stationary object.

### **2.14 Scaffolds**

All scaffolds will be attended at all times. When not in use, an effective barricade (fence) will be erected around the scaffold to prevent use by unauthorized personnel (Reference OSHA 1926, Subpart L).

### **2.15 Excavations**

The contractor shall comply with OSHA 1926, Subpart P. An OSHA Competent Person must be on site during the excavation. The contractor shall coordinate with COTR and utility companies prior to the excavation to identify underground utilities tanks, etc. All excavations left unattended will be provided with a barricade suitable to prevent entry by unauthorized persons.

### **2.16 Storage**

You must make prior arrangements with the COTR for the storage of building materials. Storage will not be allowed to accumulate in the Medical Center buildings.

### **2.17 Trash and Debris**

You must remove all trash and debris from the work area on a daily basis. Trash and debris will not be allowed to accumulate inside or outside of the buildings. You are responsible for making arrangements for removal of trash from the Medical Center facility.

## **2.18 Protection of Floors**

It may be necessary at times to take steps to protect floors from dirt, debris, paint, etc. A tarp or other protective covering may be used in accordance with specifications outlined in the general requirements section. However, you must maintain the proper amount of floor space for the safe passage of pedestrian traffic.

## **2.19 Signs**

Signs must be placed at the entrance to work areas warning people of your work. Signs must be suitable for the condition of the work. Small pieces of paper with printing or writing are not acceptable. The VA Medical Center (VAMC) Safety Officer or COTR can be consulted in this matter.

## **2.20 Accidents and Injuries**

Contractors must report all accidents and injuries involving their employees.

## **2.21 Infection Control**

Contractors must control the generation of dust and the contamination of patient care surfaces, supplies and equipment. During demolition phases of the construction:

- A. The construction area shall be under negative pressure, ensuring there is an appreciable flow of clean air from the VA-occupied portion of the facility into the construction area. The airflow shall be sufficiently strong enough to draw in the plastic door flaps commonly located at the construction entrance or at the specific site within the construction area.
- B. Construction debris being transported through the VA-occupied portion of the facility shall be covered and/or wetted.
- C. Construction employees shall remove dust-laden clothing before entering the VA-occupied portion of the facility.
- D. Carpet/sticky mats shall be placed at all construction entrances, and be satisfactorily maintained so as to minimize the tracking of dust into the VA-occupied portion of the facility.
- E. Dry sweeping of dust and debris is not to be performed.
- F. Contractor must obtain an Infection Control Construction permit from the COTR before work can begin. A separate permit is required for each area work is being

done. Permit must be signed by the I.C. Nurse, COTR, and Contractor. Permit is required to be posted outside work site at all times.

(Control measures B - E above must be practiced during the construction phase.)

## **2.22 Confined Space Entry**

- A. Contractor will be notified if a project work area contains spaces requiring a confined space work permit. Entry to these confined space areas will only be permitted through compliance with a permit space program meeting the requirements of 29 CFR 1910.146 and 1926.21(b)(6).
- B. Contractor will be apprised of the elements including the hazards identified and the Medical Center's (last employer) experience with the space that makes the space in question a permit space.
- C. Contractor will be apprised of any precautions or procedures that the Medical Center has implemented for the protection of employees in or near permit space where Contractor personnel will be working.
- D. Medical Center and Contractor will coordinate entry operations when both Medical Center personnel and Contractor personnel will be working in or near permit spaces as required by 29 CFR 1910.146(d)(ii) and 1926.21(b)(6).
- E. Contractor will obtain any available information regarding permit space hazards and entry operation from the Medical Center.
- F. At the conclusion of the entry operations, the Medical Center and Contractor will discuss any hazards confronted or created in permit spaces.
- G. The Contractor is responsible for complying with 29 CFR 1910.246(d) through (g) and 1926.21(b)(6). The Medical Center, does not provide rescue and emergency services required by 29 CFR 1910.246(k) and 1926.21(b)(6).

## **2.23 Contractor Parking and Material Delivery**

Contractor's parking is not available at the medical center and the delivery of building materials tools, etc., must be pre-arranged with the COTR.

## SAMPLE INFECTION CONTROL PERMIT

<b>Infection Control Construction Permit</b>	
<b>Construction Class:</b>	
<b>Project Name and Number:</b>	<b>Permit #:</b>
<b>Location of Construction:</b>	
<b>COTR:</b>	<b>Telephone:</b>
<b>Contractor Performing Work:</b>	
<b>Supervisor:</b>	<b>Telephone:</b>
<b>CLASS I</b>	<ol style="list-style-type: none"> <li>1. Obtain approval from COTR before activities begin</li> <li>2. Work performed is limited to inspections and minor installations</li> <li>3. Execute work by methods to minimize raising dust from inspection operations</li> <li>4. Permit does not need to be posted for this classification.</li> </ol>
<b>CLASS II</b>	<ol style="list-style-type: none"> <li>1. Obtain and post infection control permit at work location before work begins</li> <li>2. Provide active means to prevent air borne dust from dispersing into atmosphere</li> <li>3. Place dust mat at entrances and exits of work sites</li> <li>4. Tools and equipment must be cleaned prior to entrance to the medical center</li> <li>5. Isolate HVAC and seal unused doors with duct tape</li> <li>6. Contain construction waste before transport in tightly covered containers</li> </ol>
<b>CLASS III</b>	<ol style="list-style-type: none"> <li>1. Obtain and post infection control permit at work location before work begins</li> <li>2. Follow all requirements listed for Class II in addition to requirements listed below</li> <li>3. Isolate supply and return ductwork to prevent contamination of system.</li> <li>4. Complete all critical dust barriers as well as the creation of an anti-room where required for inspection by COTR before work begins.</li> <li>5. Maintain negative air pressure within work site utilizing HEPA equipped air filtration units.</li> <li>6. Construct anteroom where required by COTR and I.C. Nurse</li> <li>7. Obtain COTR approval before construction and removal of any dust partitions</li> <li>8. Include particle count readings on daily logs against baseline points as required by COTR or I.C. Nurse.</li> </ol>
<b>CLASS IV</b>	<ol style="list-style-type: none"> <li>1. Obtain and post infection control permit at work location before work begins</li> <li>2. Follow all requirements listed for Class III in addition to requirements listed below</li> <li>3. Workers are required to wear clean suits on site</li> <li>4. All personnel entering and leaving work site must be vacuumed using a HEPA filtered vacuum cleaner.</li> <li>5. This class of permit will require additional specialized precautions unique to each activity which will be listed below</li> </ol>
<b>Additional Requirements:</b>	
<b>Infection Control Nurse:</b>	<b>Date:</b>
<b>COTR:</b>	<b>Date:</b>
<b>Contractor:</b>	<b>Date:</b>

## Infection Control Risk Assessment Matrix of Precautions for Construction & Renovation

**Step One:**

**Using the following table, identify the Type of Construction Project Activity (Type A-D)**

TYPE A	<b>Inspection and Non-Invasive Activities</b>  Includes, but is not limited to: <ul style="list-style-type: none"><li>• Removal of ceiling tiles for visual inspection limited to 1 tile per 50 square feet</li><li>• Painting (but sanding)</li><li>• Wall covering, electrical work, minor plumbing, and activities, which do not generate dust or require cutting of walls or access to ceiling other than for visual inspection.</li></ul>
TYPE B	<b>Small scale, short duration activities create minimal dust</b>  Includes, but is not limited to: <ul style="list-style-type: none"><li>• Installation of telephone and computer cabling</li><li>• Access to chase spaces</li><li>• Cutting of walls or ceiling where dust migration can be controlled</li></ul>
TYPE C	<b>Work that generates a moderate to high level of dust or requires demolition or Removal of any fixed building components or assemblies</b> <ul style="list-style-type: none"><li>• Sanding of walls for painting or wall covering</li><li>• Removal of floor coverings, ceiling tiles and casework</li><li>• New wall construction</li><li>• Minor dust work or electrical work above ceilings</li><li>• Major cabling activities</li><li>• Any activity that cannot be completed within single work shift</li></ul>
TYPE D	<b>Major demolition and construction projects</b> Includes, but is not limited to: <ul style="list-style-type: none"><li>• Activities which require consecutive work shifts</li><li>• Requires heavy demolition</li><li>• New Construction</li></ul>

**Step Two:**

Using the following table, identify the **Patient Risk Groups** that will be affected.  
If more than one risk group will be affected, select the higher risk group.

Low Risk	Medium Risk	High Risk	Highest Risk
<ul style="list-style-type: none"> <li>Office areas</li> </ul>	<ul style="list-style-type: none"> <li>Echocardiography</li> <li>Endoscopy</li> <li>Nuclear Medicine</li> <li>Physical Therapy</li> <li>Radiology</li> <li>Respiratory Therapy</li> <li>Mental Health Unit</li> <li>Domiciliary</li> <li>Primary Care Clinics</li> </ul>	<ul style="list-style-type: none"> <li>Emergency Room</li> <li>Laboratories (specimen)</li> <li>OutPatient Surgery</li> <li>Pharmacy</li> <li>Nursing Home Care Unit</li> <li>Intermediate Care Unit</li> </ul>	<ul style="list-style-type: none"> <li>Any area caring for immunocomprised Patients</li> <li>SPD</li> <li>Intensive Care Unit</li> <li>Medical Unit</li> <li>Negative pressure isolation rooms</li> <li>Oncology</li> </ul>

**Step Three: Match the**

**Patient Risk Group (Low, Medium, High Highest)** with the planned **Construction Project Type (A, B, C, D)** on the following matrix, to find the **Class of Precautions (I, II, III or IV)** on level of infection control activities required.

**Class I-IV Precautions are delineated on the following page.**

**IC Matrix-Class of Precautions: Construction Project by Patient Risk**

Patient Risk Group	Construction Project Type			
	TYPE A	TYPE B	TYPE C	TYPE D
LOW Risk	I	II	II	III
MEDIUM Risk	I	II	III	IV
HIGH Risk	I	II	III	IV
HIGHEST Risk	I	III	III	IV

**Note:** Infection Control approval will be required when the Construction Activity and Risk Level indicate that **Class III** or **Class IV** control procedures are necessary.

**Description of Required Infection Control Precaution by Class**

**During Construction Project**

**Upon Construction of Project**

<p><b>C L A S S  I</b></p>	<ol style="list-style-type: none"> <li>1. Execute work by methods to minimize raising dust from construction operations.</li> <li>2. Immediately replace a ceiling tile displaced for visual inspection.</li> </ol>	
<p><b>C L A S S  I I</b></p>	<ol style="list-style-type: none"> <li>1. Provide active means to prevent airborne dust from dispersing into atmosphere.</li> <li>2. Water mist work surfaces to control dust while cutting.</li> <li>3. Seal unused doors with duct tapes.</li> <li>4. Block off and seal air vents.</li> <li>5. Place dust mat at entrance and exit of work area.</li> <li>6. Remove or isolate HVAC systems in areas where work is being performed.</li> </ol>	<ol style="list-style-type: none"> <li>1. Wet wipe work surfaces</li> <li>2. Contain construction waste before transport in tightly covered containers.</li> <li>3. Wet mop and/or vacuum with HEPA filtered vacuum before leaving work area.</li> <li>4. Remove isolation of HVAC system in areas where work is being performed.</li> </ol>
<p><b>C L A S S  I I I</b></p>	<ol style="list-style-type: none"> <li>1. Remove or isolate HVAC system in area where work is being done to prevent contamination of duct system.</li> <li>2. Complete all critical barriers i.e. sheetrock, plywood, plastic, to seal area from non-work site before construction begins.</li> <li>3. Maintain negative air pressure within work site utilizing HEPA equipped air filtration units.</li> <li>4. Place dust mat at entrance and exit of work area.</li> <li>5. Contain construction waste before transport in tightly covered containers.</li> <li>6. Cover transport receptacles or carts. Tape covering unless solid lid.</li> </ol>	<ol style="list-style-type: none"> <li>1. Do not remove barriers from work area until completed project by the infection Control Nurse and thoroughly cleaned by the Environmental Management Service.</li> <li>2. Remove barrier materials carefully to minimize spreading of dirt and debris associated with construction.</li> <li>3. Vacuum work area with HEPA filtered vacuums.</li> <li>4. Wet mop area with disinfectant.</li> <li>5. Remove isolation of HVAC system in areas where work is being performed.</li> </ol>

<p><b>C L A S S  I V</b></p>	<ol style="list-style-type: none"> <li>1.Isolate HVAC system in area where work is being done to prevent contamination of duct system.</li> <li>2.Complete all critical barrier i.e. sheetrock, plywood, plastic, to seal area from non-work area before construction begins.</li> <li>3.Maintain negative air pressure within work site utilizing HEPA equipped air filtration units.</li> <li>4.Seal holes, pipes, conduits, and punctures appropriately.</li> <li>5.Contain construction waste before transport in tightly covered containers.</li> <li>6 .Cover transport receptacles or carts. Tape covering unless solid lid.</li> </ol>	<ol style="list-style-type: none"> <li>1.Do not remove barriers from work area until completed project is inspected by the Infection Control Nurse and thoroughly cleaned by the Environmental Management Service.</li> <li>2.Vacuum work area with HEPA filtered vacuums.</li> <li>3.Wet mop area with disinfectant.</li> <li>4.Remove isolation of HVAC system in areas where work is being performed.</li> <li>5.Remove barrier material carefully to minimize spreading of dirt and debris associated with construction.</li> </ol>
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**Step 4. Identify the area surroundings the project area, assessing potential impact.**

Unit Below	Unit Above	Lateral	Lateral	Behind	Front
Risk Group	Risk Group	Risk Group	Risk Group	Risk Group	Risk Group

**Step 5. Identify specific site of activity eg, patient rooms, medication room, etc.**

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**Step 6. Identify issues related to: ventilation, plumbing, electrical in terms of the occurrence of probable outages.**

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**Step 7. Identify containment measures, using prior assessment. What types of barriers? (Eg, solids wall barriers); Will HEPA filtration be required?**

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(Note: Renovation/construction area shall be isolated from the occupied areas during construction and shall be negative with respect to surrounding areas)

**Step 8 Consider potential risk of water damage. Is there a risk due to compromising structural integrity? (e.g.; wall, ceiling, roof)**

**Step 9. Work hours: Can or will the work be done during non-patient care hours?**

**Step 10: Do plans allow for adequate number of isolation/negative airflow rooms?**

**Step 11. Do the plans allow for the required number & type of handwashing sinks?**

**Step 12 Does the infection control staff agree with the minimum number of sinks for this project?** (Verify against AIA Guidelines for types and area)

**Step 13 Does the infection control staff agree with the plans relative to clean and soiled utility rooms?**

**Step 14 Plan to discuss the following containment issues with the project team.**

**Eg, traffic flow, housekeeping, debris removal (how and when)**

**Appendix: Identify and communicate the responsibility for project monitoring that includes infection control concerns and risk. The ICRA may be modified throughout the project.  
Revisions must be communicated to the Project Management**

<b>Infection Control Construction Permit</b>					
					Permit No.
Location of Construction:			Project Start Date:		
Project Coordinator:			Estimated Duration:		
Contractor Performing Work:			Permit Expiration Date:		
Supervisor:			Telephone:		
YES	NO	Construction Activity	YES	NO	INFECTION CONTROL RISK GROUP
		TYPE A: Inspection, non-invasive activity			GROUP 1: Low Risk
		TYPE D: Small scale, short duration Moderate to high level			GROUP 2: Medium Risk
		TYPE C: Activity generates moderate to high Levels of dust, requires greater work shift for completion			GROUP 3: Medium/High Risk
		TYPE D: Major duration and construction activities requiring consecutive work shift			GROUP 4: Highest Risk
CLASS I		1. Execute work by methods to minimize raising dust from Construction operations. 2. Immediately replace any ceiling tile displaced for visual Inspection.		3. Minor Demolition for Remodeling.	
CLASS II		1. Provide active means to prevent air-borne dust from dispensing into atmosphere. 2. Water mist work surfaces to control dust while cutting. 3. Seal unused doors with duct tape. 4. Block off and seal air vents. 5. Wipe surfaces with disinfectant.		6. Vacuum work with HEPA filtered vacuum. 7. Wet mop and/or vacuum with HEPA filtered vacuum before leaving work area. 8. Place dust mat at entrance and exit of work area. 9. Remove or isolate HVAC system in area where work is being performed.	
CLASS III		1. Obtain infection control permit before construction begins. 2. Isolate HVAC system in area where work is being done to prevent contamination of the duct system. 3. Complete all critical barriers or implement control cube method before construction begins. 4. Maintain negative air pressure within work site utilizing HEPA equipped air filtration units. 5. Do not remove barriers from work area until complete project is thoroughly cleaned by Env. Services Dept.		6. Vacuum work with HEPA filtered vacuums. 7. Wet mop with disinfectant. 8. Remove barrier materials carefully to minimize spreading of dirt and debris associated with construction. 9. Contain construction waste before transport in tightly covered containers. 10. Cover transport receptacles or carts. Tape covering. 11. Remove or isolate HVAC system in areas where work is being performed.	
Date					
Initial					

CLASS IV	1. Obtain infection control permit before construction begins. 2. Isolate HVAC system in area where work is being done to prevent contamination of duct system. 3. Complete all critical barriers or implement control cube method before construction begins. 4. Maintain negative air pressure within work site utilizing HEPA equipped air filtration unit. 5. Seal holes, pipes, conduits, and punctures appropriately. 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 overalls that are removed each time they leave the work site.	7. All personnel entering work site are required to wear shoe covers. 8. Do not remove barriers from work area until completed project is thoroughly cleaned by the Environmental Service Dept. 9. Vacuum work area with HEPA filtered vacuums. 10 Wet mop with disinfectant. 11.Remove barrier materials carefully to minimize spreading of dirt and debris associated with construction. 12.Contain construction waste before transport in tightly covered containers. 13.Cover transport receptacles or carts. Tape covering. 14.Remove or isolate HVAC system in areas where work is being done.
Date		
Initial		
Additional Requirements:		
Date Initials:	Exceptions/Additions to this permit Date Initials are noted by attached memoranda	
Permit Request By:	Permit Authorized By:	
Date:	Date:	

### Possible threats to your organization

#### Security

- Bomb threat
- Civil disturbance
- Gang-related activity
- Hostage situation
- Infant abduction
- Location in a high-crime area
- Terrorist attack, including biological, chemical, radiation and explosive-internal or external
- Visiting or injured VIP
- Workplace violence

#### Utility Failures

- Central medical vacuum
- Central oxygen
- Electrical
- Emergency generator
- Fire suppression/alarm system
- Heating, ventilating, and air-conditioning (HVAC)
- Information system/computers
- Natural gas
- Overhead paging
- Sewage
- Telephone/telecommunications

- Water main break

Weather

- Blizzard or snowstorm
- Earthquake
- Hail
- High winds
- Hurricane
- Ice storm
- Severe cold
- Severe heat/humidity
- Severe rainfall/flood
- Sinkholes
- Tornado

Structural Implications

- Chemical or hazmat spill or release-internal
- Explosion-internal
- Fire, smoke-internal
- Flooding-internal
- Gas leak-internal
- Structural damage to building

Other

- Aviation, bus, or train crash
- Chemical or hazmat spill or release-external
- Explosion-external
- Fire, smoke-external
- Flooding-external
- Gas leak-external
- Other mass casualty incident

Additional Inspection Recommendations to review with the General Contractor on site:

**Temporary construction barriers**

From VACO:

SECTION 01010

**GENERAL REQUIREMENTS**

Install and maintain temporary construction partitions to provide smoke-tight separations between construction areas and adjoining areas. Construct partitions of gypsum board or treated plywood (flame spread rating of 25 or less in accordance with ASTM E84) on both sides of wood or metal steel studs. Extend the partitions through suspended ceilings to floor slab or roof. Seal joints and penetrations. At door openings, install tight-fitting solid-core wood doors with self-closing devices. [From JCAHO:

Temporary construction partitions must be smoke tight and build of noncombustible or limited combustible materials that will not contribute to the development or spread of fire. Plastic sheets may only be used for short-term periods of 30 days or less (when approved by the contracting officer). If the project involves torch cutting, welding, brazing or open flame, then barriers of noncombustible or limited combustible material must be constructed. (Material in parenthesis added.)]

I have read and understand this requirement: \_\_\_\_\_  
Install locks to prevent unauthorized entry into the construction area.

**Smoke Barriers**

Where construction work penetrates smoke barriers or fire rated partitions, close openings in smoke barriers and fire-rated construction to maintain fire ratings. Seal penetrations with listed through-penetration firestop materials.

I have read and understand this requirement: \_\_\_\_\_

**Egress Routes for Construction Workers:**

Maintain free and unobstructed egress in the construction area. Inspect daily.

I have read and understand this requirement: \_\_\_\_\_

**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 have read and understand this requirement: \_\_\_\_\_

**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 and coordinate with the COTR in advance. Where operations create dusty conditions or when spray painting operations are conducted, cover smoke detectors in the construction area with thin paper bags.

I have read and understand this requirement: \_\_\_\_\_

**Hot Work:**

Perform and safeguard hot work operations in accordance with NFPA 241 and NFPA 51B. Obtain hot work permit from COTR.

I have read and understand this requirement: \_\_\_\_\_

**Smoking:**

Smoking is prohibited in and adjacent to construction areas inside existing buildings and additions under construction.

I have read and understand this requirement: \_\_\_\_\_

**Waste:**

The Contractor shall at all times keep the work area, including storage areas, free from accumulation of waste materials. Remove debris and trash from buildings daily.

I have read and understand this requirement: \_\_\_\_\_

**Effects to other parts of the building:**

Execute work so as to interfere as little as possible with normal functioning of the Medical Center as a whole, including operations of utility services, fire protection systems and any existing equipment, and with work being done by others. Use of equipment and tools that transmit vibrations and noises through the building structure, are not permitted in buildings that are occupied by patients or medical personnel except as permitted by COTR.

**Infection Control:**

a. In addition, to the temporary construction barriers of noncombustible or limited combustible material, provide plastic barriers to completely separate construction from the operational areas of the hospital in order to

contain dirt, debris, dust, odors and vapors. Create a barrier reaching from floor to ceiling before any ceiling is entered. Surround the affected area entirely and seal with duct tape at the ceiling, floor and sides. Provide walk-off tack mats to reduce spread of dust.

I have read and understand this requirement: \_\_\_\_\_

b. 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.

I have read and understand this requirement: \_\_\_\_\_

c. Broom clean and wet mop at the end of each workday. Remove debris as they are created. Trash chutes shall be used except when exception is made by the CO. When trash chutes are not required, transport trash and debris outside the construction area in containers with tightly fitting lids. Use freight elevators and routes approved by the COTR for waste removal.

I have read and understand this requirement: \_\_\_\_\_

**Other Safety Measures:**

- a. Provide appropriate safety barricades, signs, and signal lights;
- b. Wear appropriate personal protective equipment;
- c. Comply with the standards issued by the Secretary of Labor at 29 CFR part 1926 and 29 CFR part 1910;
- d. Provide evidence of training when doing any excavations exceeding 5 ft., entering any confined spaces on site, performing asbestos removal; and
- e. Ensure that any additional measures the Contracting Officer determines to be reasonably necessary for the purposes are taken.

I have read and understand this requirement: \_\_\_\_\_

**Unexpected Discovery of Asbestos:**

If material that is suspected to be asbestos containing material is found during demolition operations, the contractor will cease work, take action to safeguard the material from becoming further disturbed, and notify the CO as soon as possible. OHSU will take prompt appropriate action to alleviate identified asbestos exposure hazards where ACM is discovered during construction work.

I have read and understand this requirement: \_\_\_\_\_

**SECTION 01 32 16.13**  
**CONSTRUCTION PROGRESS SCHEDULES**

**PART 1- GENERAL**

**1.1 DESCRIPTION:**

- A. The Contractor shall develop a Construction Progress Schedule demonstrating fulfillment of the contract requirements, shall keep the 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) Precedence Diagramming Method (PDM) technique will be utilized to satisfy both time and cost applications. All schedule data and reports required under this specification section shall be based upon regular total float, not relative total float schedules.
- B. Contractor shall not perform any work onsite until the schedule associated with that work is first approved by the VA.

**1.2 CONTRACTOR'S REPRESENTATIVE:**

- A. The Contractor shall designate an authorized representative in the firm who will be responsible for the preparation of the contract schedule, review and report progress of the project with and to the Contracting Officer's representative.
- 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 and such authority shall not be interrupted throughout the duration of the project.

**1.3 CONTRACTOR'S CONSULTANT:**

- A. To prepare the schedule and electronic copy, which reflects the Contractor's project plan, the Contractor may engage an independent CPM consultant who is skilled in the time and cost application of scheduling using (PDM) network techniques for construction projects, the cost of which is included in the Contractor's bid; or prepared by Contractor's own qualified staff member.

**1.4 COMPUTER PRODUCED SCHEDULES**

- A. The contractor shall provide to the VA weekly computer processing of all computer-produced time/cost schedules and reports generated from weekly project updates. This weekly computer service will include: three copies of up to five different reports (inclusive of all pages) to the contracting officer's representative; a hard copy listing of all project schedule changes, and associated data, made at the update; and the

resulting weekly updated schedule. These must be submitted with and substantively support the contractor's monthly payment request and the signed look-ahead report. The COTR shall identify the five different report formats that the contractor shall provide based upon the weekly schedule updates.

- B. The contractor is responsible for the correctness and timeliness of the computer-produced reports. The Contractor is 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 shall report errors in computer-produced reports to the Contractor's representative within ten calendar days from receipt of reports. The Contractor will reprocess the computer-produced reports and associated electronic copy, when requested by the Contracting Officer's representative, to correct errors which affect the payment and schedule for the project.

#### **1.5 THE CONSTRUCTION PROGRESS SCHEDULE SUBMITTAL**

- A. Within 14 calendar days after receipt of Notice to Proceed, the Contractor shall submit for the Contracting Officer's review; three blue line copies of the complete schedule on sheets of paper 765 x 1070 mm (30 x 42 inches). 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, duration, predecessor and successor relationships, trade code, area code, description, 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, only, 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 schedule. The Contracting Officer's separate approval of the 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 a zero duration. The complete working schedule shall reflect the Contractor's approach to scheduling the complete project. The final schedule in its original form shall

contain no contract changes or delays which may have been incurred during the final schedule development period and shall reflect the Contractors as bid schedule. These changes/delays shall be entered at the first update after the final 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.

- B. Within 14 calendar days after receipt of the complete project schedule, the Contracting Officer or his representative, will accept or reject the schedule.
- C. The VA will process and return the approved baseline schedule data to the contractor for subsequent project schedule reporting and updating. This 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.
- D. The Complete Project Schedule will contain approximately 30 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.~~
- C. 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 ASBESTOS ABATEMENT. The sum of asbestos abatement work activity/event costs shall equal the value of the asbestos bid item in the Contractors' bid.

- E. The Contractor shall cost load work activities/events for all BID ITEMS. The sum of the cost loading for each bid item work activities/events shall equal the value of the item in the Contractors' bid.
- F. Work activities/events for Contractor bond shall have a trade code and area code of BOND.

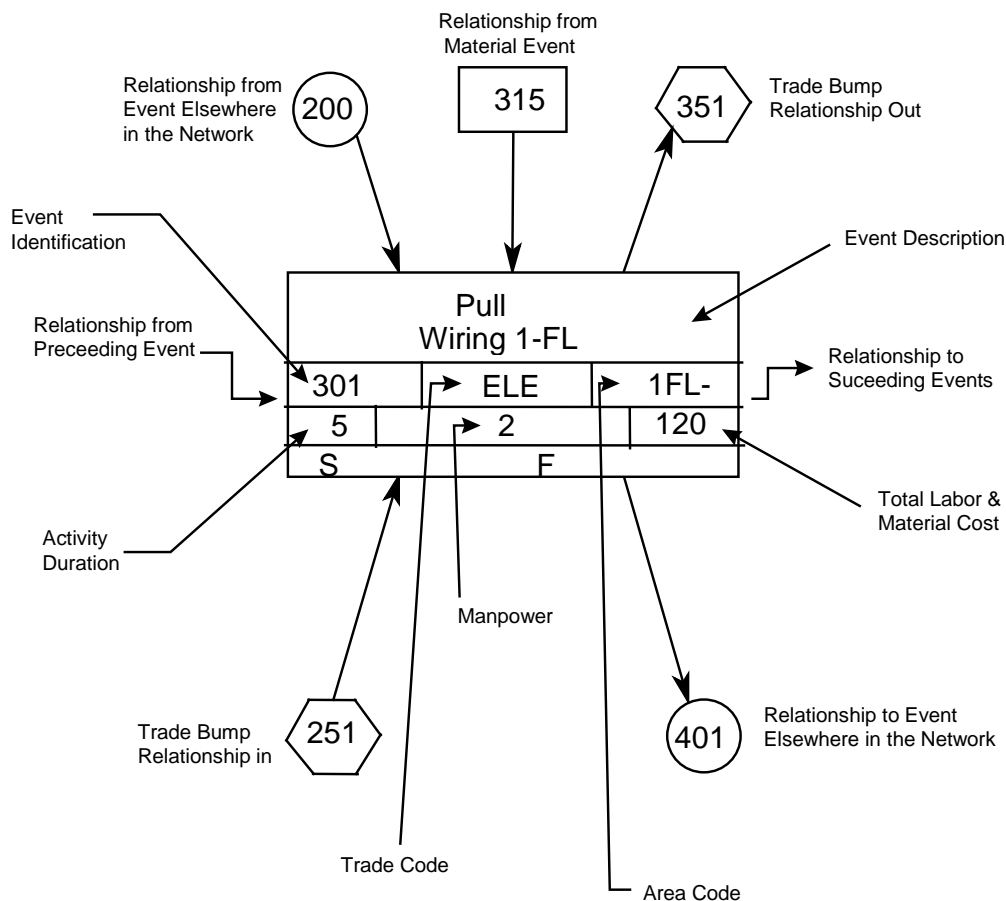
#### 1.7 SCHEDULE REQUIREMENTS

- A. Show on the schedule the sequence and interdependence of work activities/events required for complete performance of all items of work. In preparing the schedule, the Contractor shall:
1. Exercise sufficient care to produce a clear, legible and accurate schedule, refer to the drawing, CPM-1 (Sample CPM Network). Computer plotted schedules shall legibly display and plot all information required by the VA CPM activity/event legend or the computer plotted schedule will not be acceptable. If the computer plotted schedule is not found acceptable by the contracting officer's representative, then the schedule will need to be hand drafted and meet legibility requirements. Group activities related to specific physical areas of the project, on the schedule for ease of understanding and simplification. Provide a key plan on each schedule sheet showing the project area associated with the work activities/events shown on that sheet.
  2. Show the following on each work activity/event:
    - a. Activity/Event ID number.
    - b. Concise description of the work represented by the activity/event. (35 characters or less including spaces preferred).
    - c. Performance responsibility or trade code (five alpha characters or less): GEN, MECH, ELEC, CARP, PLAST, or other acceptable abbreviations.
    - d. Duration (in work days.)
    - e. Cost (in accordance with Article, ACTIVITY/EVENT COST DATA of this section and less than \$9,999,999 per activity).
    - f. Work location or area code (five characters or less), descriptive of the area involved.
    - g. Manpower required (average number of men per day).
    - h. The SYMBOL LEGEND format shown below and on the drawing, CPM-1 (Sample CPM Network) is mandatory and shall be followed in

preparing final schedules.

## SYMBOL LEGEND

Show Network Diagram page number location(s) for all incoming/outgoing node connector(s).



3. 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 Medical Center 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. Schedule these activities/events so that only one phase is scheduled for completion within the same 30 consecutive calendar day period (except for those phases immediately preceding the final acceptance). Maintain this scheduling condition throughout the length of the contract unless waived by the Contracting Officer's representative in writing.
  - f. Work activities/events for the asbestos abatement bid item shall have a trade code of ASB.
  - g. Bid items other than the Base Bid (ITEM 1) and Asbestos Abatement item shall have trade codes corresponding to the appropriate bid item number (e.g., ITM 3, ITM 4 and other items).
- 4. 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.
  - 5. Break up the work into activities/events of a duration no longer than 20 work days each, 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 Contracting Officer may approve the showing of a longer duration. The duration for VA approval of any required submittal, shop drawing, or other submittals shall not be less than 20 work days. The construction time as determined by the CPM schedule from early start to late finish for any sub-phase, phase or the entire project shall not exceed the contract time(s) specified or shown.
  - 6. 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.
  - 7. Uniquely number each activity/event with numbers ranging from 1 to 99998 only. The schedule should be generally numbered in sequence; left to right; top to bottom, and omitting numbers ending in 3, 6, and 9.

- B. Submit the following supporting data in addition to the schedule, activity/event ID schedule and electronic file (s). Failure of the Contractor to include this data will delay the review of the submittal until the Contracting Officer is in receipt of the missing data:
1. The proposed number of working days per week.
  2. The holidays to be observed during the life of the contract (by day, month, and year).
  3. The planned number of shifts per day.
  4. The number of hours per shift.
  5. List the major construction equipment to be used on the site, describing how each piece relates to and will be used in support of the submitted schedule work activities/events.
  6. Provide a typed, doubled spaced, description, at least one page in length, of the plan and your approach to constructing the project.
- C. To the extent that the schedule or any revised schedule shows anything not jointly agreed upon, it shall not be deemed to have been approved by the Contracting Officer. 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 Contracting Officer's approval of the schedule.
- D. Electronic Copy Requirements and CPM Activity/Event Record  
Specifications: Submit to the VA an electronic file(s) containing one file of the data required to produce the 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, PAYMENT UNDER FIXED-PRICE CONSTRUCTION CONTRACTS of the Bid Solicitation GENERAL CONDITIONS. The Contractor is entitled to a monthly progress payment upon approval of estimates as determined from the currently approved updated computer-produced calendar-dated schedule unless, in special situations, the Contracting Officer permits an exception to this requirement. Monthly payment requests shall include: three copies of up to five different reports (inclusive of all pages) to the contracting officer's representative; a listing of all project schedule changes, and associated data, made at the update; and an electronic file (s) of the

resulting weekly updated schedule. These must be submitted with and substantively support the contractor's monthly application and certificate for payment request documents.

- B. When the Contractor fails or refuses to furnish to the Contracting Officer the information and schedule in electronic format, which, in the sole judgment of the Contracting Officer, is necessary for processing the monthly progress payment, the Contractor shall not be deemed to have provided an estimate and supporting schedule data upon which progress payment may be made.

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

- A. Weekly job site progress meetings shall be held on dates mutually agreed to by the Contracting Officer (or Contracting Officer's representative) and the Contractor. Contractor and the CPM consultant will be required to attend all weekly progress meetings. Presence of Subcontractors during progress meeting is optional unless required by the Contracting Officer (or Contracting Officer's representative). The Contractor shall update the project schedule and all other data required by this section shall be accurately filled in and completed prior to the weekly progress meeting. The Contractor shall provide this information to the Contracting Officer or the VA representative in completed form three work days in advance of the progress meeting. Job progress will be reviewed to verify:
1. Actual start and/or finish dates for updated/completed activities/events.
  2. Remaining duration, required to complete 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 schedule and computer-produced schedules.
  4. Percentage for completed and partially completed activities/events.
  5. Logic and duration revisions required by this section of the specifications.
  6. Activity/event duration and percent complete shall be updated independently.
- B. The Contractor shall submit a narrative report as a part of his weekly review and update, in a form agreed upon by the Contractor and the Contracting Officer. The narrative report shall include a description of problem areas; current and anticipated delaying factors and their estimated impact on performance of other activities/events and

completion dates; and an explanation of corrective action taken or proposed.

- C. After completion of the joint review and the Contracting Officer's approval of all entries, the contractor will generate an updated computer-produced calendar-dated schedule.
- D. After completing the weekly schedule update, the contractor's scheduling consultant shall rerun all current period contract change(s) against the prior approved weekly 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 consultant 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 weekly 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 schedule is approved, the contractor must recreate all manual progress payment updates on this approved schedule 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.
- E. After VA acceptance and approval of the final schedule, and after each weekly update, the contractor shall submit to the Contracting Officer three blue line copies of a revised complete schedule showing all completed and partially completed activities/events, contract changes and logic changes made on the intervening updates or at the first update on the final diagram. The Contracting Officer may elect to have the contractor do this on a less frequent basis, but it shall be done on a quarterly basis as a minimum.
- F. 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 weekly 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 weekly 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. Whenever it becomes apparent from the current weekly progress review meeting or the weekly computer-produced calendar-dated 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 Contracting Officer for the proposed schedule changes. If such actions are approved, the CPM revisions shall be incorporated by the Contractor into the schedule before the next update, at no additional cost to the Government.

#### **1.11 CHANGES TO SCHEDULE AND SCHEDULE**

- A. Within 30 calendar days after VA acceptance and approval of any updated computer-produced schedule, the Contractor will submit a revised schedule, the associated electronic copy, 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, indicate an extension of the project completion by 20 working days or 10 percent of the remaining project duration, whichever is less. Such delays 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 of the schedule 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 Medical Center, contract phase(s) and sub phase(s), utilities furnished by the Government to the Contractor, or any other previously contracted item, must be furnished in writing to the Contracting Officer for approval.
- C. Contracting Officer's approval for the revised 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 schedule resulting from contract changes will be included in the proposal for changes in work 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 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 Contracting Officer 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. 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 schedule.
- 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.

- - - E N D - - -

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

- 1.1 For the purposes of this contract, samples, test reports, certificates, and manufacturers' literature and data shall also be subject to the previously referenced requirements. The following text refers to all items collectively as SUBMITTALS.
- 1.2 Submit for approval, all of the items specifically mentioned under the separate sections of the specification, with information sufficient to evidence full compliance with contract requirements. Materials, fabricated articles and the like to be installed in permanent work shall equal those of approved submittals. After an item has been approved, no change in brand or make will be permitted unless:
  - A. Satisfactory written evidence is presented to, and approved by Contracting Officer, that manufacturer cannot make scheduled delivery of approved item or;
  - B. Item delivered has been rejected and substitution of a suitable item is an urgent necessity or;
  - C. Other conditions become apparent which indicates approval of such substitute item to be in best interest of the Government.
- 1.3 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 will not serve as a basis for extending contract time for completion.
- 1.4 Submittals will be reviewed for compliance with contract requirements by Architect-Engineer, and action thereon will be taken by COTR on behalf of the Contracting Officer.
- 1.5 Upon receipt of submittals, Architect-Engineer will assign a file number thereto. Contractor, in any subsequent correspondence, shall refer to this file and identification number to expedite replies relative to previously approved or disapproved submittals.
- 1.6 The Government reserves the right to require additional submittals, whether or not particularly mentioned in this contract.
- 1.7 Schedules called for in specifications and shown on shop drawings shall be submitted for use and information of Department of Veterans Affairs and Architect-Engineer. However, the Contractor shall assume responsibility for coordinating and verifying schedules. The Contracting Officer and Architect-Engineer assumes no responsibility for checking schedules or layout drawings for exact sizes, exact numbers and detailed positioning of items.

- 1.8 Submittals must be submitted by Contractor only and shipped prepaid. Contracting Officer assumes no responsibility for checking quantities or exact numbers included in such submittals.
- A. Submit samples required 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.
- B. Submittals will receive consideration only when covered by a transmittal letter signed by Contractor and an approval stamp. Letter shall be sent via first class mail or FAX and shall contain the list of items, name of Medical Center, name of Contractor, contract number, applicable specification paragraph numbers, applicable drawing numbers (and other information required for exact identification of location for each item), manufacturer and brand, ASTM or Federal Specification Number (if any) and such additional information as may be required by specifications for particular item being furnished. In addition, catalogs shall be marked to indicate specific items submitted for approval.
1. Approval Stamp: Stamp each submittal with a uniform, approval stamp. Include Project name and location, submittal number, Specification Section title and number, name of reviewer, date of Contractor's approval, and statement certifying that submittal has been reviewed, checked, and approved for compliance with the Contract Documents
  2. 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.
  3. 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.
  4. Required certificates shall be signed by an authorized representative of manufacturer or supplier of material, and by Contractor.
- C. In addition to complying with the applicable requirements specified in preceding Article 1.9, 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.

1. Laboratory shall furnish Contracting Officer 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 COTR and to Architect-Engineer simultaneously with submission of material to a commercial testing laboratory.
  5. Laboratory test reports shall be sent directly to COTR 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 so certify on test report.
  7. Laboratory test reports shall also include a recommendation for approval or disapproval of tested item.
- D. 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.
- E. Approved samples will be kept on file by the COTR 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.

F. Submittal drawings (shop, erection or setting drawings) and schedules, required for work of various trades, shall be checked before submission by technically qualified employees of Contractor for accuracy, completeness and compliance with contract requirements. These drawings and schedules shall be stamped and signed by Contractor certifying to such check.

1. For each drawing required, submit one legible photographic paper or vellum reproducible.
2. Reproducible shall be full size.
3. Each drawing shall have marked thereon, proper descriptive title, including Medical Center location, project number, manufacturer's number, reference to contract drawing number, detail Section Number, and Specification Section Number.
4. A space 120 mm by 125 mm (4-3/4 by 5 inches) shall be reserved on each drawing to accommodate approval or disapproval stamp.
5. Submit drawings, ROLLED WITHIN A MAILING TUBE, fully protected for shipment.
6. One reproducible print of approved or disapproved shop drawings will be forwarded to Contractor.
7. When work is directly related and involves more than one trade, shop drawings shall be submitted to Architect-Engineer under one cover.

1.10 Samples, shop drawings, test reports, certificates and manufacturers' literature and data, shall be submitted for approval to

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13212 Shaker Square, Suite 204

Cleveland, Ohio 44120

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

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## **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)  
811 Vermont Avenue, NW - Room 462  
Washington, DC 20420

Telephone Number: (202) 565-5214

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.aabchq.com">http://www.aabchq.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>
GANA	Glass Association of North America <a href="http://www.cssinfo.com/info/gana.html/">http://www.cssinfo.com/info/gana.html/</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>
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  
<http://www.nema.org>

NFPA National Fire Protection Association  
<http://www.nfpa.org>

NHLA National Hardwood Lumber Association  
<http://www.natlhardwood.org>

NIH National Institute of Health  
<http://www.nih.gov>

NIST National Institute of Standards and Technology  
<http://www.nist.gov>

NLMA Northeastern Lumber Manufacturers Association, Inc.  
<http://www.nelma.org>

NPA National Particleboard Association  
18928 Premiere Court  
Gaithersburg, MD 20879  
(301) 670-0604

NSF National Sanitation Foundation  
<http://www.nsf.org>

NWWDA Window and Door Manufacturers Association  
<http://www.nwwda.org>

OSHA Occupational Safety and Health Administration  
Department of Labor  
<http://www.osha.gov>

PCA Portland Cement Association  
<http://www.portcement.org>

PCI Precast Prestressed Concrete Institute  
<http://www.pci.org>

PPIThe Plastic Pipe Institute  
<http://www.plasticpipe.org>

PEIPorcelain Enamel Institute, Inc.

<http://www.porcelainenamel.com>

PTIPost-Tensioning Institute

<http://www.post-tensioning.org>

RFCI The Resilient Floor Covering Institute

<http://www.rfci.com>

RIS Redwood Inspection Service

See - CRA

RMA Rubber Manufacturers Association, Inc.

<http://www.rma.org>

SCMA Southern Cypress Manufacturers Association

<http://www.cypressinfo.org>

SDI Steel Door Institute

<http://www.steeldoor.org>

IGMA Insulating Glass Manufacturers Alliance

<http://www.igmaonline.org>

SJI Steel Joist Institute

<http://www.steeljoist.org>

SMACNA Sheet Metal and Air-Conditioning Contractors

National Association, Inc.

<http://www.smacna.org>

SSPC The Society for Protective Coatings

<http://www.sspc.org>

STISteel 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>

TPITruss 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>

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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 and paid for by Contractor.

**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):
  - T27-06.....Sieve Analysis of Fine and Coarse Aggregates
  - T96-02 (R2006).....Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
  - T99-01 (R2004).....The Moisture-Density Relations of Soils Using a 2.5 Kg (5.5 lb.) Rammer and a 305 mm (12 in.) Drop
  - T104-99 (R2003).....Soundness of Aggregate by Use of Sodium Sulfate or Magnesium Sulfate
  - T180-01 (R2004).....Moisture-Density Relations of Soils using a 4.54 kg (10 lb.) Rammer and a 457 mm (18 in.) Drop
  - T191-02(R2006).....Density of Soil In-Place by the Sand-Cone Method
- C. American Society for Testing and Materials (ASTM):
  - A370-07.....Definitions for Mechanical Testing of Steel Products
  - C31/C31M-06.....Making and Curing Concrete Test Specimens in the Field
  - C33-03.....Concrete Aggregates
  - C39/C39M-05.....Compressive Strength of Cylindrical Concrete Specimens
  - C109/C109M-05.....Compressive Strength of Hydraulic Cement Mortars
  - C138 (REV. A)-01.....Unit Weight, Yield, and Air Content (Gravimetric) of Concrete
  - C140-07.....Sampling and Testing Concrete Masonry Units and Related Units
  - C143/C143M-05.....Slump of Hydraulic Cement Concrete
  - C172-04.....Sampling Freshly Mixed Concrete

C780-07.....Pre-construction and Construction Evaluation of  
Mortars for Plain and Reinforced Unit Masonry  
C1019-97.....Sampling and Testing Grout  
C1064/C1064M-05.....Freshly Mixed Portland Cement Concrete  
C1077-06.....Laboratories Testing Concrete and Concrete  
Aggregates for Use in Construction and Criteria  
for Laboratory Evaluation  
D698-07.....Laboratory Compaction Characteristics of Soil  
Using Standard Effort  
D1557-02.....Laboratory Compaction Characteristics of Soil  
Using Modified Effort  
D2166-2000.....Unconfined Compressive Strength of Cohesive Soil  
D2167-94(R2001).....Density and Unit Weight of Soil in Place by the  
Rubber Balloon Method  
D2216-05.....Laboratory Determination of Water (Moisture)  
Content of Soil and Rock by Mass  
D2974-07.....Moisture, Ash, and Organic Matter of Peat and  
Other Organic Soils  
E329-07.....Agencies Engaged in Construction Inspection  
and/or Testing  
E543-06.....Agencies Performing Non-Destructive Testing  
E605-93(R2006).....Thickness and Density of Sprayed Fire-Resistive  
Material (SFRM) Applied to Structural Members  
E709-(2001).....Guide for Magnetic Particle Examination  
E1155-96(R2001).....Determining FF Floor Flatness and FL Floor  
Levelness Numbers

### 1.3 REQUIREMENTS:

- A. Accreditation Requirements: Testing Laboratory retained and paid for 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 COTR 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 COTR 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 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 COTR. When it appears materials furnished, or work performed by Contractor, fail to meet construction contract requirements, Testing Laboratory shall direct attention of COTR to such failure.
- C. Written Reports: Testing laboratory shall submit test reports to COTR, Contractor, and Local Building Authority within 24 hours after each test is completed unless other arrangements are agreed to in writing by the COTR. Submit reports of tests that fail to meet construction contract requirements on colored paper.
- D. Verbal Reports: Give verbal notification to COTR immediately of any irregularity.
- E. Test Standards: The Contractor shall include a lump sum allowance of \$5000 for furnishing published standards (ASTM, AASHTO, ACI, ANSI, AWS, ASHRAE, UL, etc.) referred to or specifically referenced which are pertinent to any Sections of these specifications. Furnish one set of standards in single copies or bound volumes to the COTR within 60 days. Photocopies are not acceptable. Billings for the standards furnished shall be at the net cost to Testing Laboratory. A preliminary list of test standards, with the estimated costs, shall be submitted to the COTR for review before any publications of reference standards are ordered.

**PART 2 - PRODUCTS (NOT USED)**

**PART 3 - EXECUTION**

**3.1 CONCRETE:**

- A. Batch Plant Inspection and Materials Testing:
1. Perform continuous batch plant inspection until concrete quality is established to satisfaction of COTR with concurrence of Contracting Officer and perform periodic inspections thereafter as determined by COTR.
  2. Periodically inspect and test batch proportioning equipment for accuracy and report deficiencies to COTR.
  3. Sample and test mix ingredients as necessary to insure compliance with specifications.

4. Sample and test aggregates daily and as necessary for moisture content. Test the dry rodded weight of the coarse aggregate whenever a sieve analysis is made, and when it appears there has been a change in the aggregate.
5. Certify, in duplicate, ingredients and proportions and amounts of ingredients in concrete conform to approved trial mixes. When concrete is batched or mixed off immediate building site, certify (by signing, initialing or stamping thereon) on delivery slips (duplicate) that ingredients in truck-load mixes conform to proportions of aggregate weight, cement factor, and water-cement ratio of approved trial mixes.

B. 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 COTR, 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. COTR 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. 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. 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.
  11. Observe conveying, placement, and consolidation of concrete for conformance to specifications.
  12. Observe condition of formed surfaces upon removal of formwork prior to repair of surface defects and observe repair of surface defects.
  13. Observe curing procedures for conformance with specifications, record dates of concrete placement, start of preliminary curing, start of final curing, end of curing period.
  14. 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.
  15. Observe preparations for protection from hot weather, cold weather, sun, and rain, and preparations for curing.
  16. Observe concrete mixing:
    - a. Monitor and record amount of water added at project site.
    - b. Observe minimum and maximum mixing times.
  17. 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 COTR 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.

18. Other inspections:

- a. Grouting under base plates.
- b. Grouting anchor bolts and reinforcing steel in hardened concrete.

C. 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 COTR. 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. Furnish certified compression test reports (duplicate) to COTR. 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.

**3.2 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.

**3.3 SPRAYED-ON FIREPROOFING:**

- A. Provide field inspection and testing services to certify sprayed-on fireproofing has been applied in accordance with contract documents.
- B. Obtain a copy of approved submittals from COTR.

- C. Use approved installation in test areas as criteria for inspection of work.
- D. Test sprayed-on fireproofing for thickness and density in accordance with ASTM E605.
  - 1. Thickness gauge specified in ASTM E605 may be modified for pole extension so that overhead sprayed material can be reached from floor.
- E. Location of test areas for field tests as follows:
  - 1. Thickness: Select one bay per floor, or one bay for each 930 m<sup>2</sup> (10,000 square feet) of floor area, whichever provides for greater number of tests. Take thickness determinations from each of following locations: Metal deck, beam, and column.
  - 2. Density: Take density determinations from each floor, or one test from each 930 m<sup>2</sup> (10,000 square feet) of floor area, whichever provides for greater number of tests, from each of the following areas: Underside of metal deck, beam flanges, and beam web.
- F. Submit inspection reports, certification, and instances of noncompliance to COTR.

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

**1.1 DESCRIPTION**

This specification covers the requirements for management of non-hazardous building construction and demolition waste.

**1.2 RELATED WORK**

- A. Section 02 41 00, DEMOLITION.
- B. Disconnecting utility services prior to demolition: Section 01 00 00, GENERAL REQUIREMENTS.
- C. Reserved items which are to remain the property of the Government: Section 01 00 00, GENERAL REQUIREMENTS.

**1.3 GOVERNMENT POLICY**

- A. Contractor shall practice efficient waste management when sizing, cutting and installing building construction products.
- B. Contractor shall use all reasonable means to divert construction and demolition waste from landfills and incinerators and facilitate their recycling.
- C. Contractor shall be responsible for implementation of any special programs involving rebates or similar incentives related to recycling and any revenues or savings obtained from salvage or recycling shall accrue to the Contractor.
- D. Contractor shall ensure that facilities used for recycling, reuse and disposal shall be permitted for the intended use to the extent required by federal, state and local regulations.

**1.4 PLAN**

- A. Conduct a site assessment to estimate the types of materials that will be generated by demolition at the site. The Whole Building Design Guide website (<http://www.wbdg.org>) has a Construction Waste Management Database that contains information on companies that haul, collect, and process recyclable debris from construction projects
- B. Develop and implement procedures to reuse and recycle materials to the greatest extent feasible based upon the contract, the construction and demolition debris management plan, the estimated quantities of materials, and the availability of recycling facilities.

- C. Prepare and submit to the COTR a written demolition debris management plan. The plan shall include, but not be limited to, the following information:
1. Contractor and project identification information;
  2. Procedures to be used for debris management;
  3. A listing of the materials to be reused, recycled, or taken to the landfill.
  4. The names and locations of reuse and recycling facilities or sites.

#### **1.5 COLLECTION**

- A. Provide necessary containers, bins and storage areas to facilitate effective waste management.
- B. Clearly identify so that recyclable materials are separated from trash and can be transported to respective recycling facility for processing.

#### **1.6 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 law.
- B. Building or demolition materials with no practical use or that cannot be recycled shall be disposed of at a landfill or incinerator.

#### **1.7 REPORT**

With each application for progress payment, the contractor shall submit a 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.

#### **1.8 GEMS POLICY**

- A. The Contractor shall comply with the following Green Environmental Management Systems (GEMS) Contracted Construction Waste Management Policy.

**GREEN ENVIRONMENTAL MANAGEMENT SYSTEMS (GEMS)**  
**Contracted Construction Waste Management Policy**

1. **PURPOSE.** To outline the policy and procedures to ensure effective management/disposal of any waste generated through approved construction projects at the Louis Stokes Cleveland VA Medical Center.
2. **POLICY.** It is the policy of this medical center that construction projects shall generate the least amount of waste possible.
3. **RESPONSIBILITY.** The subcontractor shall employ processes that ensure the generation of as little waste as possible and shall avoid the generation of waste due to the following:
  - a. Over-packaging
  - b. Error
  - c. Poor planning, layout
  - d. Over ordering
  - e. Breakage
  - f. Mishandling
  - g. Contamination
  - h. Damage from weather
4. **PROCEDURES**
  - a. Of the inevitable waste that is generated, as many of the waste materials as economically feasible shall be reused, salvaged or recycled.
  - b. Waste disposal in landfills shall be minimized to the greatest extent possible.
  - c. Contractor to determine site specific percentages of waste to be diverted from landfill.
    - (1) Waste Diversion Goals
      - (a) New Construction: Minimum 5% of total project waste shall be diverted from landfill.
      - (b) Demolition, Major Remodeling: Minimum 5% of total project waste shall be diverted from landfill.
      - (c) Interior Remodeling: Minimum 5% of total project waste shall be diverted from landfill.
    - (2) The following waste categories, at a minimum, shall be diverted from landfill:
      - (a) Green waste (biodegradable landscaping materials)
      - (b) Soil
      - (c) Inerts (concrete, asphalt, masonry)
      - (d) Clean dimensional wood, palette wood
      - (e) Engineered wood products: plywood, particle board, I-joists, etc.
      - (f) Cardboard, paper, packaging
      - (g) Asphalt roofing materials
      - (h) Insulation
      - (i) Gypsum board
      - (j) Carpet and pad
      - (k) Paint
      - (l) Plastics: ABS, PVC

(m) Beverage containers

**5. DESCRIPTION OF WORK**

a. Includes:

- Waste Management Plan development and implementation
- Meetings to discuss goals, issues and training for the Waste Management Plan
- Techniques to minimize waste generation
- Sorting and separation of waste materials
- Reuse of salvaged materials on site
- Salvage of existing materials and items for reuse or resale
- Recycling of materials that cannot be reused or sold
- Record keeping of receipts and records of salvaged, recycled or land filled materials

b. Related Elements:

- Alternates
- Construction waste management
- Site demolition
- Site clearing
- Slope protection/erosion control
- Asphalt concrete
- Crushed stone paving
- Portland cement concrete paving
- Valve boxes
- Storm sewers
- Chain link fences and gates
- Walk, road and parking appurtenances
- Miscellaneous landscaping materials
- Concrete, concrete formwork, and concrete reinforcement
- Cast-in-place concrete
- Unit masonry
- Structural steel
- Steel roof deck/steel floor deck
- Cold formed metal framing
- Metal fabrications
- Rough and finish carpentry
- Engineered structural wood
- Plastic lumber
- Building insulation
- Modified bitumen roofing
- Metal doors
- Wood and plastic doors and frames
- Metal support systems
- Gypsum wallboard
- Acoustical treatment
- Resilient flooring
- Tile and carpet
- Painting
- Toilet compartments
- Louvers and vents
- Signage and graphics
- Ductwork and ductwork accessories

## 6. DEFINITIONS

- 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. Re-Use: 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.
7. **GUIDES.** No preference is given to the recycles listed below; they are listed for the convenience of the contractor.
- Dirt/clean fill
  - Green/landscaping waste
  - Concrete, asphaltic concrete
  - Cardboard, paper, packaging
  - Clean dimensional wood, pallette wood
  - Usable pallettes
  - Metals from banding, ductwork, piping, rebar, roofing, other trim, steel, iron, galvanized sheet steel, stainless steel, aluminum, copper, zinc, lead, brass, and bronze
  - Carpet and pad
  - Gypsum board
  - Paint
  - Insulation
  - Asphalt shingles
  - Beverage containers

8. **SUBMITTALS**

- a. Waste Management Plan. Prior to any waste removal, the Contractor shall submit their Waste Management Plan to the Medical Center. The Plan shall contain the following:
  - (1) Analysis of the estimated job site waste to be generated, including types and quantities.

- (2) Proposed alternatives to land filling. Contractor shall prepare a site specific list of each material proposed to be salvaged, re-used, or recycled during the course of the project.
- (3) Methods handling of materials to be recycled.
  - (a) On site:
    - Materials separation
    - Materials storage
    - Materials protection, where applicable
  - (b) Off site: Provide name of mixed debris recycling facility; include list of materials to be recycled.
- (4) Procedures. A description of the means to be employed in recycling the above materials consistent with requirements for acceptance by designated facilities.
- (5) Landfill Options. The name of the landfill(s) where trash will be disposed of.
- (6) Meetings. Contractor shall conduct Construction Waste Management meetings. Meetings shall include the Subcontractor, the Project Manager and representatives as designated by the Chief Engineer. At a minimum, waste management goals and issues shall be discussed at pre-bid meetings, pre-construction meetings and regular job-site meetings.
- (7) Transportation. A description of the means of transportation of the recyclable materials (whether materials will be site-separated and self-hauled to designated centers, or whether mixed materials will be collected by a waste hauler and removed from the site) and destination of materials.
- (8) Waste Management Plan Implementation
  - (a) Manager. The Subcontractor shall designate an on-site party (or parties) responsible for instructing workers and subcontractors and overseeing and documenting results of the Waste Management Plan for the project.
  - (b) Distribution. The Subcontractor shall distribute copies of the Waste Management Plan to the Medical Center Chief Engineer.
  - (c) Instruction. The Subcontractor shall provide on-site instruction of appropriate separation, handling, recycling, salvage, reuse and return methods to be used by all parties at appropriate stages of the project.
  - (d) Separation Facilities. The Subcontractor shall lay out and label a specific area to facilitate separation of materials for reuse, salvage, recycling, and return. Recycling and waste bin areas are to be kept neat and clean and clearly marked in order to avoid contamination or mixing of materials.
  - (e) Hazardous Wastes. Hazardous wastes shall be separated, stored, and disposed of according to local, state and federal regulations.

b. Reports.

- (1) The Contractor shall submit (monthly, quarterly, at end of job) a Waste Management Progress Report. The report shall contain the amount (in tons or cubic yards) of material land filled from the project, the identity of the landfill, the total amount of tipping fees paid at the landfill and the total disposal cost.
- (2) Manifests shall be from recycle and/or disposal site operators that can legally accept the materials for the purpose of reuse, recycling or disposal.
  - (a) Include legible copies of manifests,
  - (b) Weight tickets, receipts and invoices.
- (3) For each material recycled, reused or salvaged from the project, provide the following:
  - (a) Amount (in tons or cubic yards)
  - (b) Date removed from the job site
  - (c) Receiving party
  - (d) Transportation cost
  - (e) Amount of any money paid or received for the recycled or salvaged material. Net total cost or savings of salvage or recycling each material. Attach manifests, weight tickets, receipts, and/or invoices. Indicate the project information, including project title, name of company completing form, and beginning and ending dates of period covered by summary form.
- (4) The contractor will prohibit employees from taking recyclable waste for personal use or profit.

- - - E N D - - -

**SECTION 01 91 13**

**COMMISSIONING REQUIREMENTS**

**PART 1 - GENERAL**

**1.1 RELATED DOCUMENTS**

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

**1.2 SUMMARY**

- A. The Commissioning Agency shall be a subcontractor of the General Contractor and shall report and be paid by the General Contractor.
- B. Section includes requirements that apply to the implementation of commissioning.
- C. Related Sections:
  - 1. Division 22 Section "Commissioning of Plumbing Systems" for commissioning process activities for plumbing systems, equipment, and components.
  - 2. Division 23 Section "Commissioning of Mechanical Systems" for commissioning process activities for HVAC&R systems, assemblies, equipment, and components.
  - 3. Division 26 Section "Commissioning of Electrical Systems" for commissioning process activities for electrical systems, equipment, and components.
- D. Section includes scope for the following areas:
  - 1. Boiler Room
  - 2. Energy Center
  - 3. Existing Air Handling Units
  - 4. Seventh Floor Penthouse
- E. Refer to Bid Drawings for supplemental notes regarding commissioning scope.
- F. Commissioning Firms are to perform commissioning in accordance with the requirements of the standard under which the Commissioning Firm's qualifications are approved, i.e., ACG Commissioning Guideline, NEBB Commissioning Standard, or SMACNA Commissioning Manual unless otherwise stated herein. Consider mandatory all recommendations and suggested practices contained in the Commissioning Standard. Use the Commissioning Standard for all aspects of Commissioning, including qualifications for the Commissioning Firm and Authority and calibration of Commissioning

instruments. Where the instrument manufacturer calibration recommendations are more stringent than those listed in the Commissioning Standard, the manufacturer's recommendations shall be adhered to. All quality assurance provisions of the Commissioning Standard such as performance guarantees shall be part of this contract. For systems or system components not covered in the Commissioning Standard, Commissioning procedures shall be developed by the Commissioning Authority. Where new procedures, requirements, etc., applicable to the Contract requirements have been published or adopted by the body responsible for the Commissioning Standard used (ACG, NEBB, or TABB), the requirements and recommendations contained in these procedures and requirements shall be considered mandatory.

- G. Current control system for the facility is Andover Controls for the main building and Trane Tracer for the Energy Center.
- H. This is a phased project. The CxA should become familiar with the schedule of completion as this will impact the length of project involvement and testing schedules.

### 1.3 DEFINITIONS

- A. AABC: Associated Air Balance Council
- B. ACG: Associated Air Balance Council Commissioning Group
- C. Commissioning Plan: A document that outlines the organization, schedule, allocation of resources, and documentation requirements of the commissioning process.
- D. Cx: Commissioning
- E. CxA: Commissioning Authority.
- F. NEBB: National Environmental Balancing Bureau
- G. Commissioning Plan: A document that outlines the organization, schedule, allocation of resources, and documentation requirements of the commissioning process.
- H. SMACNA: Sheet Metal and Air-Conditioning Contractors' National Association
- I. Systems, Subsystems, Equipment, and Components: Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, equipment, and components.
- J. TABB: Testing, Adjusting, and Balancing Bureau

#### 1.4 REFERENCES

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

1. ACG Commissioning Guideline (2005) Commissioning Guideline
2. NEBB Commissioning Standard (1999) Procedural Standards for Building Systems Commissioning
3. SMACNA Commissioning Manual (1994, 1<sup>st</sup> Ed) HVAC Systems Commissioning Manual

#### 1.5 SIMILAR TERMS

A. In some instances, terminology differs between the Contract and the Commissioning Standard primarily because the intent of this Section is to use the industry standards specified, along with additional requirements listed herein to produce optimal results. The following table of similar terms is provided for clarification only. Contract requirements take precedent over the corresponding ACG, NEBB, or TABB requirements where differences exist.

B. Similar Terms Table

Contract Term	ACG	NEBB	TABB
Commissioning Standard	ACG Commissioning Guideline	Procedural Standards for Building Systems Commissioning	SMACNA HVAC Commissioning Guideline
Commissioning Authority	ACG Certified Commissioning Agent	NEBB Building Systems Commissioning Certified Professional	TABB Certified Commissioning Supervisor

#### 1.6 SYSTEMS TO BE COMMISSIONED

A. Divisions 2-10 - The following building envelope items will be commissioned in this project.

1. Energy Center Roof Integrity
2. Boiler Room Roof Integrity
3. Verify Access for Maintenance

- B. Division 22 - The following plumbing items will be commissioned in this project.
  - 1. Proper penthouse storm drainage
  - 2. Make-up Water
  - 3. Natural Gas Piping
  - 4. Fuel Oil Piping
  - 5. Fuel Oil Equipment
- C. Division 23 - The following mechanical system will be commissioned in this project.
  - 1. Water-Cooled Chillers
  - 2. Fluid Coolers
  - 3. Glycol Fill Tank
  - 4. Boiler
  - 5. Boiler Flue Stack Economizer System
  - 6. Hydronic Piping (Chilled and Heating)
  - 7. Chemical Treatment
  - 8. Converters (Steam to Hot Water)
  - 9. HVAC Pumps
  - 10. Steam Condensate Piping
  - 11. Air-handling Units (AHU)
  - 12. Humidifiers
  - 13. Convectors
  - 14. Unit Heaters
  - 15. Exhaust Fans
  - 16. Building Automation System (controlled devices, control loops and system integration)
- D. Division 26 - The following electrical system will be commissioned in this project.
  - 1. Variable Frequency Drives (VFD)
  - 2. Motor Starters and Disconnect Switches
  - 3. New Electrical Connections
  - 4. Grounding associated with the new equipment.
  - 5. Labeling and locations.

**1.7 QUALITY ASSURANCE**

- A. Qualifications:

1. Commissioning Firm: Provide a Commissioning Firm that is either a member of ACG or certified by the NEBB or the TABB and certified in all categories and functions where measurements or performance are specified on the plans and specifications. The certification shall be maintained for the entire duration of duties specified herein. If, for any reason, the firm loses subject certification during this period, immediately notify the Contracting Officer and submit another Commissioning Firm for approval. Any firm that has been the subject of disciplinary action by the ACG, the NEBB, or the TABB within the five years preceding Contract Award is not eligible to perform any duties related to the HVAC systems, including Commissioning. All work specified in this Section and in other related Sections to be performed by the Commissioning Firm shall be considered invalid if the Commissioning Firm loses its certification prior to Contract completion and must be performed by an approved successor. These Commissioning services are to assist the prime Contractor in performing the quality oversight for which it is responsible. The Commissioning Firm shall be a subcontractor of the General Contractor and shall be financially and corporately independent of all other sub-contractors. The Commissioning Firm shall report to and be paid by the General Contractor.
2. Commissioning Authority: The Commissioning Authority shall be an ACG Certified Commissioning Agent, a NEBB Building Systems Commissioning Certified Professional, or a TABB Certified Commissioning Supervisor and shall be an employee of the approved Commissioning Firm. The certification shall be maintained for the entire duration of duties specified herein. If, for any reason, the Commissioning Authority loses subject certification during this period, immediately notify the Contracting Officer and submit another Commissioning Authority for approval. Any individual that has been the subject of disciplinary action by the ACG, the NEBB, or the TABB within the five years preceding Contract Award is not eligible to perform any duties related to the HVAC systems, including Commissioning. All work specified in this Section and in other related Sections performed by the Commissioning Authority shall be considered invalid if the Commissioning Authority loses his certification prior to Contract completion and must be performed by the approved successor.

**1.8 COMMISSIONING TEAM**

- A. Members Appointed by the General Contractor:
  - 1. CxA: The designated person, company, or entity that plans, schedules, and coordinates the commissioning team to implement the commissioning process.
  - 2. Subcontractor(s): Other contracting specialties that assist the CxA, who have either been hired directly by the CxA or the General Contractor.
- B. Members Appointed by the Owner:
  - 1. Representatives of the facility user and operation and maintenance personnel.
  - 2. Architect and engineering design professionals.

**1.9 OWNER'S RESPONSIBILITIES**

- A. Assign operation and maintenance personnel and schedule them to participate in commissioning team activities.

**1.10 CxA'S RESPONSIBILITIES**

- A. Organize and lead the commissioning team.
- B. Provide commissioning plan.
- C. Convene commissioning team meetings. At a minimum the CxA should convene the following meetings:
  - 1. Commissioning Kick-Off
  - 2. Commissioning Plan Review
  - 3. Pre-Functional Checklist Review
  - 4. Pre-Functional Deficiencies / Phase Approval
  - 5. Functional Test Procedure Review
  - 6. Functional Testing Deficiencies / Phase Approval (as required)
- D. Develop, submit for review by the Commissioning Team, and complete project-specific, pre-functional checklists and commissioning functional test procedures for systems, subsystems, equipment, and components that fall within the CxA's scope of work to insure proper process documentation and functionality.
- E. Prepare and maintain the Issues Log.
- F. CxA or subcontractor to perform other testing as identified in Section 3.5.
- G. Witness systems, assemblies, equipment, and component startup.
- H. Verify testing, adjusting, and balancing of work is complete.

- I. Direct and witness the functional testing of systems, assemblies, equipment, and components to insure proper functioning prior to owner occupancy.
- J. Compile test data, inspection reports, and certificates; include them in the commissioning report.

**1.11 CONTRACTORS' RESPONSIBILITIES**

- A. The purpose of this section is to specify the contractors' and their sub-contractors' responsibilities in the commissioning process.
- B. Commissioning requires the participation of contractors to ensure that all systems are operating in a manner consistent with the Contract Documents. Contractors shall be familiar with all parts of the commissioning plan issued by the CxA and shall execute all commissioning responsibilities assigned to them in the Contract Documents.
- C. All Contractors: The general commissioning responsibilities applicable to each of the contractors are as follows (all references apply to commissioned equipment only):

1. Construction and Acceptance Phases

- a. Include and itemize the cost of commissioning in the contract price.
- b. Attend a commissioning kick-off meeting and other meetings necessary to facilitate the Cx process.
- c. Provide a copy of the O&M manuals, cut sheets, and shop drawing submittals of commissioned equipment, through normal channels, to the CxA for review.
- d. Provide additional requested documentation, prior to normal O&M manual submittals, to the CxA for development of start-up and functional testing procedures.

- 1) Typically this will include detailed manufacturer installation and start-up, operating, troubleshooting, emergency, and maintenance procedures, full details of any owner-contracted tests, equipment performance diagrams, full factory testing reports, if any, and full warranty information, including all responsibilities of the Owner to keep the warranty in force clearly identified. In addition, the installation, start-up and checkout materials that are actually shipped inside the equipment and the actual field checkout sheet forms to be used

by the factory or field technicians shall be submitted to the CxA.

- e. Contractors shall assist (along with the design engineers) in clarifying the operation and control of commissioned equipment in areas where the specifications, control drawings or equipment documentation is not sufficient for writing detailed testing procedures.
- f. Develop a full start-up and initial checkout plan using manufacturer's start-up procedures and the pre-functional checklists from the CxA for all commissioned equipment. Submit to CxA for review and approval prior to startup.
- g. Perform, complete, and clearly document all full start-up and initial checkout plans, providing a typed copy electronically to the CxA. These documents should be returned to the CxA within two weeks of the start-up of the equipment.
- h. Review, comment, and accept the specific functional performance test procedures provided by the CxA. Contractors shall review test procedures to ensure feasibility, safety and equipment protection and provide necessary written alarm limits to be used during the tests.
- i. Address current A/E punch list items before functional testing. Air and water TAB shall be completed with discrepancies and problems remedied before functional testing of the respective air- or water-related systems.
- j. Provide skilled technicians to execute starting of equipment and to execute the functional performance tests. Ensure that they are available and present during the agreed upon schedules and for sufficient duration to complete the necessary tests, adjustments and problem-solving.
- k. Respond to Commissioning Issues Log items that are relevant to your scope of work within one week of notification.
- l. Correct deficiencies (differences between specified and observed performance) as interpreted by the CxA, GC and A/E and retest the equipment.
- m. Provide information requested by the CxA for final commissioning documentation.

- n. Provide measuring instruments to record test data, and provide data acquisition equipment to record data for the complete range of testing for the required test period.
  - o. Provide documentation requested by the CxA regarding owner training and adjust training as directed by the CxA to best meet the needs of the owner's operating personnel. Training to use expert qualified personnel, as specified.
  - p. Coordinate with equipment manufacturers to determine specific requirements to maintain the validity of the warranty.
2. Warranty Period
- a. Execute seasonal or deferred functional performance testing, witnessed by the CxA.
  - b. Correct deficiencies and make necessary adjustments to O&M manuals and as-built drawings for applicable issues identified in any seasonal testing.
- D. Mechanical Contractor: The responsibilities of the HVAC mechanical contractor, during construction and acceptance phases in addition to those listed in (C) are:
- 1. Provide startup for all HVAC equipment, including the building automation control system.
  - 2. Assist with the TAB contractor and CxA by:
    - a. Putting all HVAC equipment and systems into operation and continuing the operation during each working day of TAB and commissioning, as required.
    - b. Providing temperature and pressure taps according to the Construction Documents for TAB and commissioning testing.
  - 3. List and clearly identify on the as-built drawings the locations of all air-flow stations.
  - 4. Prepare a preliminary schedule for pipe system testing, flushing and cleaning, equipment start-up and TAB start and completion for use by the CxA. Update the schedule as appropriate.
  - 5. Notify the GC or CxA depending on protocol, when pipe system testing, flushing, cleaning, startup of each piece of equipment and TAB will occur. Be responsible to notify the GC or CxA, ahead of time, when commissioning activities not yet performed or not yet scheduled will delay construction. Be proactive in seeing that commissioning

processes are executed and that the CxA has the scheduling information needed to efficiently execute the commissioning process.

E. Controls Contractor: The commissioning responsibilities of the controls contractor, during construction and acceptance phases in addition to those listed in (C) are:

1. Sequences of Operation Submittals: The Controls Contractor's submittals of control drawings shall include complete detailed sequences of operation for each piece of equipment, regardless of the completeness and clarity of the sequences in the specifications. They shall include:
  - a. An overview narrative of the system (1 or 2 paragraphs) generally describing its purpose, components and function.
  - b. All interactions and interlocks with other systems.
  - c. Detailed delineation of control between any packaged controls and the building automation system, listing what points the BAS monitors only and what BAS points are control points and are adjustable.
  - d. Written sequences of control for packaged controlled equipment. (Equipment manufacturers' stock sequences may be included, but will generally require additional narrative).
  - e. Start-up sequences.
  - f. Warm-up mode sequences.
  - g. Normal operating mode sequences.
  - h. Unoccupied mode sequences.
  - i. Shutdown sequences.
  - j. Capacity control sequences and equipment staging.
  - k. Temperature and pressure control: setbacks, setups, resets, etc.
  - l. Detailed sequences for all control strategies, e.g., economizer control, optimum start/stop, staging, optimization, demand limiting, etc.
  - m. Effects of power or equipment failure with all standby component functions.
  - n. Sequences for all alarms and emergency shut downs.
  - o. Seasonal operational differences and recommendations.
  - p. Initial and recommended values for all adjustable settings, setpoints and parameters that are typically set or adjusted by

operating staff; and any other control settings or fixed values, delays, etc. that will be useful during testing and operating the equipment.

- q. Schedules, if known.
- r. To facilitate referencing in testing procedures, all sequences shall be written in small statements, each with a number for reference. For a given system, numbers will not repeat for different sequence sections, unless the sections are numbered.

2. Control Drawings Submittal

- a. The control drawings shall have a key to all abbreviations.
- b. The control drawings shall contain graphic schematic depictions of the systems and each component.
- c. The schematics will include the system and component layout of any equipment that the control system monitors, enables or controls, even if the equipment is primarily controlled by packaged or integral controls.
- d. Provide a full points list with at least the following included for each point:
  - 1) Controlled system
  - 2) Point abbreviation
  - 3) Point description
  - 4) Display unit
  - 5) Control point or setpoint (Yes / No)
  - 6) Monitoring point (Yes / No)
  - 7) Intermediate point (Yes / No)
  - 8) Calculated point (Yes / No)

Key:	
Point Description:	DB temp, airflow, etc.
Control or Setpoint:	Point that controls equipment and can have its setpoint changed (OSA, SAT, etc.)
Intermediate Point:	Point whose value is used to make a calculation which then controls equipment (space temperatures that are averaged to a virtual point to control

	reset).
Monitoring Point:	Point that does not control or contribute to the control of equipment, but is used for operation, maintenance, or performance verification.
Calculated Point:	"Virtual" point generated from calculations of other point values.

3. The Controls Contractor shall keep the CxA informed of all changes to this list during programming and setup.
4. An updated as-built version of the control drawings and sequences of operation shall be included in the final controls O&M manual submittal.
5. Assist and cooperate with the TAB contractor in the following manner:
  - Meet with the TAB contractor prior to beginning TAB and review the TAB plan to determine the capabilities of the control system toward completing TAB. Provide the TAB any needed unique instruments for setting terminal unit boxes and instruct TAB in their use (handheld control system interface for use around the building during TAB, etc.).
    - a. For a given area, have all required pre-functional checklists, calibrations, startup and selected functional tests of the system completed and approved by the CxA prior to TAB.
    - b. Provide a qualified technician to operate the controls to assist the TAB contractor in performing TAB, or provide sufficient training for TAB to operate the system without assistance.
6. Assist and cooperate with the CxA in the following manner:
  - a. Using a skilled technician who is familiar with this building, execute the functional testing of the controls system.
  - b. Assist in the functional testing of all equipment specified as part of the commissioning scope. Provide two-way radios during the testing.
  - c. Execute all control system trend logs specified.
7. The controls contractor shall prepare a written plan indicating in a step-by-step manner, the procedures that will be followed to test, checkout and adjust the control system prior to functional performance testing. At minimum, the plan shall include for each type of equipment controlled by the automatic controls:

- a. System name.
  - b. List of devices.
  - c. Step-by-step procedures for testing each controller after installation, including:
    - 1) Process of verifying proper hardware and wiring installation.
    - 2) Process of downloading programs to local controllers and verifying that they are addressed correctly.
    - 3) Process of performing operational checks of each controlled component.
    - 4) Plan and process for calibrating valve and damper actuators and all sensors.
    - 5) A description of the expected field adjustments for transmitters, controllers and control actuators should control responses fall outside of expected values.
  - d. A copy of the log and field checkout sheets that will document the process. This log must include a place for initial and final read values during calibration of each point and clearly indicate when a sensor or controller has "passed" and is operating within the contract parameters.
  - e. A description of the instrumentation required for testing.
  - f. Indicate what tests on what systems should be completed prior to TAB using the control system for TAB work. Coordinate with the CxA and TAB contractor for this determination.
8. Provide a signed and dated certification to the CxA and GC upon completion of the checkout of each controlled device, equipment and system prior to functional testing for each piece of equipment or system, that all system programming is complete as to all respects of the Contract Documents, except functional testing requirements.
9. List and clearly identify on the as-built duct and piping drawings the locations of all static and differential pressure sensors (air, water and building pressure).
- F. TAB Contractor: The duties of the TAB contractor, in addition to those listed in (C) are:
- 1. Six weeks prior to starting TAB, submit to the GC the qualifications of the site technician for the project, including the name of the

contractors and facility managers of recent projects the technician on which was lead.

2. Submit the outline of the TAB plan and approach for each system and component to the CxA, GC and the controls contractor six weeks prior to starting the TAB. This plan will be developed after the TAB has some familiarity with the control system.
3. The submitted plan will include:
  - a. Certification that the TAB contractor has reviewed the construction documents and the systems with the design engineers and contractors to sufficiently understand the design intent for each system.
  - b. An explanation of the intended use of the building control system. The controls contractor will comment on feasibility of the plan.
  - c. All field checkout sheets and logs to be used that list each piece of equipment to be tested, adjusted and balanced with the data cells to be gathered for each.
  - d. Discussion of what notations and markings will be made on the duct and piping drawings during the process.
  - e. Final test report forms to be used.
  - f. Detailed step-by-step procedures for TAB work for each system and issue: terminal flow calibration (for each terminal type), diffuser proportioning, branch / submain proportioning, total flow calculations, rechecking, diversity issues, expected problems and solutions, etc. Criteria for using air flow straighteners or relocating flow stations and sensors will be discussed. Provide the analogous explanations for the water side.
  - g. List of all air flow, water flow, sound level, system capacity and efficiency measurements to be performed and a description of specific test procedures, parameters, formulas to be used.
  - h. Details of how *total* flow will be determined (Air: sum of terminal flows via BAS calibrated readings or via hood readings of all terminals, supply (SA) and return air (RA) pitot traverse, SA or RA flow stations. Water: pump curves, circuit setter, flow station, ultrasonic, etc.).
  - i. The identification and types of measurement instruments to be used and their most recent calibration date.

- j. Specific procedures that will ensure that both air and water side are operating at the lowest possible pressures and provide methods to verify this.
  - k. Confirmation that TAB understands the outside air ventilation criteria under all conditions.
  - l. Details of whether and how minimum outside air cfm will be verified and set, and for what level (total building, zone, etc.).
  - m. Details of how building static and exhaust fan / relief damper capacity will be checked.
  - n. Proposed selection points for sound measurements and sound measurement methods.
  - o. Details of methods for making any specified coil or other system plant capacity measurements.
  - p. Details of any TAB work to be done in phases (by floor, etc.), or of areas to be built out later.
  - q. Details regarding specified deferred or seasonal TAB work.
  - r. Details of any specified false loading of systems to complete TAB work.
  - s. Details of all exhaust fan balancing and capacity verifications, including any required room pressure differentials.
  - t. Details of any required interstitial cavity differential pressure measurements and calculations.
  - u. Plan for hand-written field technician logs of discrepancies, deficient or uncompleted work by others, contract interpretation requests and lists of completed tests (scope and frequency).
  - v. Plan for formal progress reports (scope and frequency).
  - w. Plan for formal deficiency reports (scope, frequency and distribution).
- 4. A running log of events and issues shall be kept by the TAB field technicians. Submit hand-written reports of discrepancies, deficient or uncompleted work by others, contract interpretation requests and lists of completed tests to the CxA and GC at least twice a week.
  - 5. Communicate in writing to the controls contractor all setpoint and parameter changes made or problems and discrepancies identified during TAB which affect the control system setup and operation.

6. Provide a draft TAB report within two weeks of completion. A copy will be provided to the CxA. The report will contain a full explanation of the methodology, assumptions and the results in a clear format with designations of all uncommon abbreviations and column headings. The report should follow the latest and most rigorous reporting recommendations by AABC, NEBB or ASHRAE Standard 111.
7. Provide the CxA with any requested data, gathered, but not shown on the draft reports.
8. Provide a final TAB report for the CxA with details, as in the draft.
- G. Plumbing Contractor: The responsibilities of the plumbing contractor, during construction and acceptance phases in addition to those listed in (C) are:
  1. Provide pressure test reports for all piping systems to be commissioned.
- H. Electrical Contractor: The responsibilities of the electrical contractor, during construction and acceptance phases in addition to those listed in (C) are:
  1. Provide equipment test reports for all electrical systems to be commissioned.

#### **1.12 COMMISSIONING DOCUMENTATION**

- A. Contractor to provide the following information to the CxA for inclusion in the Commissioning Report:
  1. A plan for delivery and review of submittals, O&M manuals, and other documents and reports.
  2. Detailed manufacturer installation and start-up, operating, troubleshooting, emergency, and maintenance procedures, fan and pump curves, full factory testing reports, if any, and full warranty information, including all responsibilities of the Owner to keep the warranty in force clearly identified. In addition, the installation and checkout materials that are actually shipped inside the equipment and the actual field checkout sheet forms to be used by the factory or field technicians shall be submitted to the Commissioning Authority.
  3. Identification of installed systems, assemblies, equipment, and components including design changes that occurred during the construction phase.

4. Process and schedule for completing pre-functional checklists and manufacturer's pre-start and startup checklists for systems, assemblies, equipment, and components to be verified and tested.
5. Certificate of completion certifying that installation, pre-start checks, and startup procedures have been completed.
6. Certificate of readiness certifying that systems, subsystems, equipment, and associated controls are ready for testing.
7. Test and inspection reports and certificates.
8. Corrective action documents.
9. Verification of testing, adjusting, and balancing reports.

**1.13 SUBMITTALS**

- A. Commissioning Plan: Commissioning Plan prepared in accordance with Commissioning Standard, no later than 28 days after the approval of the Commissioning Authority. The Commissioning Plan includes, at a minimum, the following:
  1. Overview of scope
  2. Project contact list
  3. Roles and Responsibilities
  4. Commissioning Schedule
  5. Commissioning Methodology
  6. Communication Protocol
- B. Pre-Functional Test Checklists: CxA to submit checklists at least 28 days prior to the start of Pre-Functional Test Checks. Submit the schedule for the test checks at least 14 days prior to the start of Pre-Functional Test Checks. Pre-Functional Test Checklists include, at a minimum, information required by the Commissioning Standard.
- C. Functional Performance Tests: CxA to submit test procedures at least 28 days prior to the start of Functional Performance Tests. Submit the schedule for the tests at least 14 days prior to the start of Functional Performance Tests.
- D. Commissioning Report: No later than 14 days after completion of Functional Performance Tests. The Commissioning Report includes, at a minimum, the following:
  1. Executive Summary
  2. Commissioning Plan
  3. Completed Pre-Functional Test Checklists

4. Completed Functional Performance Tests organized by system and by subsystem
5. Inspection reports (Preparatory, Initial and Follow-up inspections)
6. TAB report
7. Results of failed tests, including a description of the corrective action taken.
8. Re-Commissioning Plan

E. Certificates

1. Commissioning Firm: Certification of the proposed Commissioning Firm's qualifications by one of the following ACG, NEBB, or TABB to perform the duties specified herein and in other related Sections, no later than 21 days after the Notice to Proceed. Include in the documentation the date that the Certification was initially granted and the date when the current Certification expires. Any lapses in Certification of the proposed Commissioning Firm or disciplinary action taken by ACG, NEBB, or TABB against the proposed Commissioning Firm shall be described in detail.
2. Commissioning Authority: Certification of the proposed Commissioning Authority's qualifications by one of the following ACG, NEBB, or TABB to perform the duties specified herein and in other related Sections, no later than 21 days after the Notice to Proceed. The documentation shall include the date that the Certification was initially granted and the date when the current Certification expires. Any lapses in Certification of the proposed Commissioning Authority or disciplinary action taken by ACG, NEBB, or TABB against the proposed Commissioning Authority shall be described in detail.

**1.14 SEQUENCING AND SCHEDULING**

- A. Work described in this Section that requires the shut-down of equipment should either be performed on off hours (after 5pm) or should last no more than 30 minutes each hour. The owner reserves the right to change these parameters at any time.
- B. The CxA will be responsible for issuing testing schedules to the owner and receiving owner approval prior to proceeding.
- C. The CxA will coordinate the testing of air-handling units with the project engineers. This is a phased project and not all air-handling units will be available for testing at the start of the project.

**PART 2 - PRODUCTS**

**2.1 TEST EQUIPMENT**

- A. All standard testing equipment required to perform initial checkout and required functional performance testing shall be provided by the commissioning firm for the equipment being tested.
- B. Data logging equipment and software required to test equipment will be provided by the CxA, but shall not become the property of the Owner.
- C. All testing equipment shall be of sufficient quality and accuracy to test and/or measure system performance with the tolerances noted elsewhere 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°F and a resolution of +/- 0.1°F. Pressure sensors shall have an accuracy of +/- 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 when dropped or damaged. Calibration tags shall be affixed or certificates readily available.

**PART 3 - EXECUTION**

**3.1 TESTS**

- A. Establish methods to perform the pre-functional test checklists and functional performance tests in a manner which will provide the information required. Provide all materials, services, and labor required to perform the pre-functional test checks and functional performance tests.

**3.2 PRE-FUNCTIONAL TEST CHECKLISTS AND INITIAL CHECKOUT**

- A. Perform Pre-Functional Test Checklists for all equipment to be commissioned, according to Section 1.6.
- B. Pre-functional test checklists are important to ensure that the equipment and systems are hooked up and operational. It ensures that functional performance testing (in-depth system checkout) may proceed without unnecessary delays. Each piece of equipment receives full pre-functional checkout. No sampling strategies are used. The pre-functional testing for a given system must be successfully completed prior to formal functional performance testing of equipment or subsystems of the given system.
- C. Sensor and Actuator Calibration
  - 1. All field-installed temperature, relative humidity, CO, CO<sub>2</sub>, and pressure sensors, and all actuators (dampers and valves) on all

equipment will be tested for proper calibration by the CxA. All test instruments shall have had a certified calibration within the last 12 months. CxA to follow manufacturers' calibration procedures whenever possible.

2. All procedures used shall be fully documented on the pre-functional checklists or other suitable forms, clearly referencing the procedures followed and written documentation of initial, intermediate and final results.

D. Execution of Pre-functional Test Checklists and Startup

1. The CxA or subcontractors shall complete the checklists and procedures for each piece of equipment.
2. The responsible individual shall sign and date a copy of the completed pre-functional tests and checklists for the commissioning report.
3. Only individuals that have direct knowledge and witnessed that a line item task on the pre-functional 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 NON-CONFORMANCE AND APPROVAL OF PRE-FUNCTIONAL TEST CHECKLISTS**

- A. The CxA shall clearly list any outstanding items of the pre-functional 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 are provided to the commissioning team within two days of test completion.
- B. Non-Conformance
  1. The CxA shall work with the general contractor to correct and retest deficiencies or uncompleted items in accordance with the applicable contract requirements.
- C. Approval
  1. The CxA notes each satisfactory checklist. Formal approval of the pre-functional checklists is made later after review by the commissioning team.

**3.4 FUNCTIONAL PERFORMANCE TESTING**

- A. Perform Functional Performance Tests for all equipment to be commissioned, according to Section 1.6. Begin Functional Performance Tests only after all Pre-Functional Test Checklists have been successfully completed and approved

by the Commissioning Team. Begin Tests with equipment or components and progress through subsystems to complete systems.

B. Objectives and Scope

1. The objective of functional performance testing is to demonstrate that each system is operating according to the original design parameters. Functional testing facilitates identify areas of deficient performance and correct them, improving the operation and functioning of the systems.
2. In general, each system should be operated through all modes of operation (seasonal, occupied, unoccupied, warm-up, cool-down, part-and full-load) where there is a specified system response. Verifying each sequence in the sequences of operation is required. 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 Test Procedures

1. With input from Cx team members, the CxA shall finalize the test procedures and create forms to verify and document proper operation of each piece of equipment and system. Prior to execution, the CxA shall provide a copy of the test procedures to the General Contractor who shall review the tests for feasibility, safety, equipment and warranty protection.
2. The purpose of any given specific test is to verify and document compliance with the stated criteria of acceptance given on the test form. The test procedure forms developed by the CxA shall include (but not be limited to) the following information:
  - a. System and equipment or component name(s)
  - b. Equipment location and ID number
  - c. Unique test ID number, and reference to unique pre-functional checklist ID numbers for the piece of equipment
  - d. Date
  - e. Project name
  - f. Participating parties
  - g. A copy of the specific sequence of operations or other specified parameters being verified

- h. Formulas used in any calculations
- i. Required pre-test field measurements
- j. Instructions for setting up the test.
- k. Special cautions, alarm limits, etc.
- l. Specific step-by-step procedures to execute the test, in a clear, sequential and repeatable format
- m. 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.
- n. A section for comments
- o. Signatures and date block for the CxA

D. Test Methods

- 1. Functional performance testing and verification may be achieved by manual testing (persons manipulate the equipment and observe performance) or by monitoring the performance and analyzing the results using the control system's trend log capabilities or by stand-alone data loggers.
- 2. Simulated Conditions: Simulating conditions (not by an overwritten value) shall be allowed, though timing the testing to experience actual conditions is encouraged wherever practical.
- 3. 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.
- 4. 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.

5. 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 AC compressor lockout work at an outside air temperature below 55F, when the outside air temperature is above 55F, temporarily change the lockout setpoint to be 2F above the current outside air temperature.
6. 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 is completed during pre-functional testing.
7. Setup: Each function and test shall be performed under conditions that simulate actual conditions as close as is practically possible. The contractor executing the test 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 pre-test condition.

E. Coordination and Scheduling

1. The contractors shall provide sufficient notice to the CxA regarding their completion schedule for the pre-functional checklists and startup of all equipment and systems. The CxA will coordinate functional tests with assistance from the GC, The CxA shall direct, witness, document and approve the functional testing of all equipment and systems. The contractors shall execute the tests.
- In general, functional testing is conducted after pre-functional testing and startup has been satisfactorily completed. The control system is sufficiently tested and approved by the CxA before it is used for TAB or to verify performance of other components or systems. The air balancing and water balancing is completed and debugged before functional testing of air-related or water-related equipment or systems. Testing proceeds 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 is checked.

F. Problem Solving

1. The CxA will recommend solutions to problems found, however the burden of responsibility to solve, correct and retest problems is with the contractors and A/E.

**3.5 ADDITIONAL TESTING**

- A. Smoke Tests: CxA to coordinate with general contractor and owner to perform a smoke test on all air-handling units to verify proper system response and alarm.
- B. Leak Tests: CxA to conduct an air-handling unit pressure test on all units in accordance with SMACNA procedures.
- C. Emergency Power: CxA to simulate a loss of power to the systems and verify that the connected systems function properly after the emergency generator is activated.
- D. Seasonal Testing: CxA to coordinate these tests that are delayed until weather conditions are closer to the system's design and will completed them as part of this contract.

**3.6 NON-CONFORMANCE AND APPROVAL OF FUNCTIONAL PERFORMANCE TESTS**

- A. A functional performance test shall be aborted if any system deficiency prevents the successful completion of the test or if any participating non-Government commissioning team member of which participation is specified is not present for the test without documented approval.
- B. Non-Conformance
  1. The CxA will record the results of the functional test on the procedure or test form. All deficiencies or non-conformance issues shall be noted and reported to the commissioning team on a standard non-compliance form.
  2. Corrections of minor deficiencies identified may be made during the tests at the discretion of the CxA. In such cases the deficiency and resolution will be documented on the procedure form.
  3. Major deficiencies of any Functional Performance Test items will be reported to the commissioning team, and the deficiencies will be corrected in accordance with the applicable contract requirements. Once deficiencies are corrected, the item shall then be retested until it has been completed with no errors.
  4. The CxA retains the original non-conformance forms until the end of the project.

C. Approval

1. The CxA notes each satisfactorily demonstrated function on the test form. Formal approval of the functional test is made later after review by the commissioning team.

---END---

**SECTION 01 92 13**

**RETRO-COMMISSIONING REQUIREMENTS**

**PART 1 - GENERAL**

**1.1 RELATED DOCUMENTS**

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

**1.2 SUMMARY**

- A. The Commissioning Agency shall be a subcontractor of the General Contractor and shall report and be paid by the General Contractor.
- B. Section includes requirements that apply to the implementation of retro-commissioning.
- C. Section includes scope for the following areas:
  - 1. East Penthouse
  - 2. West Penthouse
  - 3. Variable-Air-Volume Boxes throughout the building
- D. Refer to Bid Drawings for supplemental notes regarding retro-commissioning scope. The Commissioning Authority may find it helpful to review documents issued as part of previous projects.
- E. The Commissioning Firm will be responsible to provide personnel with the expertise necessary to accomplish the scope of work as outlined in this section. Personnel may include any or all of the following: a testing and balancing subcontractor, a controls subcontractor, and an electrical subcontractor.
- F. Commissioning Firms are to perform commissioning in accordance with the requirements of the standard under which the Commissioning Firm's qualifications are approved, i.e., ACG Commissioning Guideline, NEBB Commissioning Standard, or SMACNA Commissioning Manual unless otherwise stated herein. Consider mandatory all recommendations and suggested practices contained in the Commissioning Standard. Use the Commissioning Standard for all aspects of Commissioning, including qualifications for the Commissioning Firm and Authority and calibration of Commissioning instruments. Where the instrument manufacturer calibration recommendations are more stringent than those listed in the Commissioning Standard, the manufacturer's recommendations shall be adhered to. All quality assurance provisions of the Commissioning Standard such as performance guarantees

shall be part of this contract. For systems or system components not covered in the Commissioning Standard, Commissioning procedures shall be developed by the Commissioning Authority. Where new procedures, requirements, etc., applicable to the Contract requirements have been published or adopted by the body responsible for the Commissioning Standard used (ACG, NEBB, or TABB), the requirements and recommendations contained in these procedures and requirements shall be considered mandatory.

- G. Current control system for the facility is Andover Controls.
- H. This is a phased project. The CxA should become familiar with the schedule of completion as this will impact the length of project involvement and testing schedules.

### 1.3 DEFINITIONS

- A. AABC: Associated Air Balance Council
- B. ACG: Associated Air Balance Council Commissioning Group
- C. Commissioning Plan: A document that outlines the organization, schedule, allocation of resources, and documentation requirements of the commissioning process.
- D. Cx: Commissioning
- E. CxA: Commissioning Authority.
- F. NEBB: National Environmental Balancing Bureau
- G. Retro-Commissioning: Applying the commissioning process to existing systems, subsystems, equipment, and components to verify they are operating properly and following a documented sequence of operation.
- H. SMACNA: Sheet Metal and Air-Conditioning Contractors' National Association
- I. Systems, Subsystems, Equipment, and Components: Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, equipment, and components.
- J. TABB: Testing, Adjusting, and Balancing Bureau

### 1.4 REFERENCES

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.
  - 1. ACG Commissioning Guideline (2005) Commissioning Guideline
  - 2. NEBB Commissioning Standard (1999) Procedural Standards for Building Systems Commissioning

3. SMACNA Commissioning Manual (1994, 1<sup>st</sup> Ed) HVAC Systems Commissioning Manual

**1.5 SIMILAR TERMS**

- A. In some instances, terminology differs between the Contract and the Commissioning Standard primarily because the intent of this Section is to use the industry standards specified, along with additional requirements listed herein to produce optimal results. The following table of similar terms is provided for clarification only. Contract requirements take precedent over the corresponding ACG, NEBB, or TABB requirements where differences exist.
- B. Similar Terms Table

Contract Term	ACG	NEBB	TABB
Commissioning Standard	ACG Commissioning Guideline	Procedural Standards for Building Systems Commissioning	SMACNA HVAC Commissioning Guideline
Commissioning Authority	ACG Certified Commissioning Agent	NEBB Building Systems Commissioning Certified Professional	TABB Certified Commissioning Supervisor

**1.6 SYSTEMS TO BE COMMISSIONED**

- A. Divisions 2-10 - The following building envelope items will be commissioned in this project.
1. Penthouse Roof Integrity
  2. Verify Access for Maintenance
- B. Division 22 - The following plumbing items will be commissioned in this project.
1. Proper penthouse storm drainage
- C. Division 23 - The following mechanical system will be commissioned in this project.
1. Hydronic Piping (Chilled and Heating)
  2. Chemical Treatment
  3. Converters (Steam to Hot Water)
  4. HVAC Pumps

5. Steam Condensate Pumps
  6. Air-handling Units (AHU)
  7. Steam Humidifiers
  8. Electric Unit Heaters
  9. Steam Unit Heaters
  10. Testing, Adjusting and Balancing work
  11. Exhaust Fans
  12. Building Automation System (controlled devices, control loops and system integration)
- D. Division 26 - The following electrical system will be commissioned in this project.
1. Variable Frequency Drives (VFD)
  2. Motor Starters and Disconnect Switches

**1.7 QUALITY ASSURANCE**

A. Qualifications:

1. Commissioning Firm: Provide a Commissioning Firm that is either a member of ACG or certified by the NEBB or the TABB and certified in all categories and functions where measurements or performance are specified on the plans and specifications. The certification shall be maintained for the entire duration of duties specified herein. If, for any reason, the firm loses subject certification during this period, immediately notify the Contracting Officer and submit another Commissioning Firm for approval. Any firm that has been the subject of disciplinary action by the ACG, the NEBB, or the TABB within the five years preceding Contract Award is not eligible to perform any duties related to the HVAC systems, including Commissioning. All work specified in this Section and in other related Sections to be performed by the Commissioning Firm shall be considered invalid if the Commissioning Firm loses its certification prior to Contract completion and must be performed by an approved successor. These Commissioning services are to assist the prime Contractor in performing the quality oversight for which it is responsible. The Commissioning Firm shall be a subcontractor of the General Contractor and shall be financially and corporately independent of all other sub-contractors. The Commissioning Firm shall report to and be paid by the General Contractor.

2. Commissioning Authority: The Commissioning Authority shall be an ACG Certified Commissioning Agent, a NEBB Building Systems Commissioning Certified Professional, or a TABB Certified Commissioning Supervisor and shall be an employee of the approved Commissioning Firm. The certification shall be maintained for the entire duration of duties specified herein. If, for any reason, the Commissioning Authority loses subject certification during this period, immediately notify the Contracting Officer and submit another Commissioning Authority for approval. Any individual that has been the subject of disciplinary action by the ACG, the NEBB, or the TABB within the five years preceding Contract Award is not eligible to perform any duties related to the HVAC systems, including Commissioning. All work specified in this Section and in other related Sections performed by the Commissioning Authority shall be considered invalid if the Commissioning Authority loses his certification prior to Contract completion and must be performed by the approved successor.

#### **1.8 COMMISSIONING TEAM**

- A. Members Appointed by the General Contractor:
  1. CxA: The designated person, company, or entity that plans, schedules, and coordinates the commissioning team to implement the commissioning process.
  2. Subcontractor(s): Other contracting specialties that assist the CxA, who have either been hired directly by the CxA or the General Contractor.
- B. Members Appointed by the Owner:
  1. Representatives of the facility user and operation and maintenance personnel.
  2. Architect and engineering design professionals.

#### **1.9 OWNER'S RESPONSIBILITIES**

- A. Assign operation and maintenance personnel and schedule them to participate in commissioning team activities.

#### **1.10 CxA'S RESPONSIBILITIES**

- A. Organize and lead the commissioning team.
- B. Provide retro-commissioning plan.
- C. Convene commissioning team meetings. At a minimum the CxA should convene the following meetings:

1. Commissioning Kick-Off
  2. Retro-Commissioning Plan Review
  3. Pre-Functional Checklist Review
  4. Pre-Functional Deficiencies / Phase Approval
  5. Functional Test Procedure Review
  6. Functional Testing Deficiencies / Phase Approval (as required)
- D. Develop, submit for review by the Commissioning Team, and complete project-specific, pre-functional checklists and commissioning functional test procedures for systems, subsystems, equipment, and components that fall within the CxA's scope of work to insure proper process documentation and functionality.
- E. Prepare and maintain the Issues Log.
- F. CxA or subcontractor to perform testing, adjusting, and balancing and other testing as identified in Section 3.5.
- G. Compile test data, inspection reports, and certificates; include them in the commissioning report.
- 1.11 DOCUMENTATION**
- A. Bid documents will be provided by the engineer to the commissioning firm for use on this project. These documents are provided for reference only and are not to be considered "as-builts" drawings. All information will be field verified by the CxA.
- B. The commissioning firm will be responsible for the costs of reproduction for any additional documentation that may be required to perform commissioning work. Examples of such documentation may be balancing reports, operation and maintenance manuals, temperature controls drawings, or other submittals.
- 1.12 SUBMITTALS**
- A. Retro-Commissioning Plan: Retro-Commissioning Plan prepared in accordance with Commissioning Standard, no later than 28 days after the approval of the Commissioning Authority. The Retro-Commissioning Plan includes, at a minimum, the following:
1. Overview of scope
  2. Project contact list
  3. Roles and Responsibilities
  4. Commissioning Schedule
  5. Commissioning Methodology
  6. Communication Protocol

- B. Pre-Functional Test Checklists: CxA to submit checklists at least 28 days prior to the start of Pre-Functional Test Checks. Submit the schedule for the test checks at least 14 days prior to the start of Pre-Functional Test Checks. Pre-Functional Test Checklists include, at a minimum, information required by the Commissioning Standard.
- C. Functional Performance Tests: CxA to submit test procedures at least 28 days prior to the start of Functional Performance Tests. Submit the schedule for the tests at least 14 days prior to the start of Functional Performance Tests.
- D. Commissioning Report: No later than 14 days after completion of Functional Performance Tests. The Commissioning Report includes, at a minimum, the following:
  - 1. Executive Summary
  - 2. Retro-Commissioning Plan
  - 3. Completed Pre-Functional Test Checklists
  - 4. Completed Functional Performance Tests organized by system and by subsystem
  - 5. Inspection reports (Preparatory, Initial and Follow-up inspections)
  - 6. TAB report
  - 7. Results of failed tests, including a description of the corrective action taken.
  - 8. Re-Commissioning Plan
- E. Certificates
  - 1. Commissioning Firm: Certification of the proposed Commissioning Firm's qualifications by one of the following ACG, NEBB, or TABB to perform the duties specified herein and in other related Sections, no later than 21 days after the Notice to Proceed. Include in the documentation the date that the Certification was initially granted and the date when the current Certification expires. Any lapses in Certification of the proposed Commissioning Firm or disciplinary action taken by ACG, NEBB, or TABB against the proposed Commissioning Firm shall be described in detail.
  - 2. Commissioning Authority: Certification of the proposed Commissioning Authority's qualifications by one of the following ACG, NEBB, or TABB to perform the duties specified herein and in other related Sections, no later than 21 days after the Notice to Proceed. The documentation

shall include the date that the Certification was initially granted and the date when the current Certification expires. Any lapses in Certification of the proposed Commissioning Authority or disciplinary action taken by ACG, NEBB, or TABB against the proposed Commissioning Authority shall be described in detail.

**1.13 SEQUENCING AND SCHEDULING**

- A. Work described in this Section that requires the shut-down of equipment should either be performed on off hours (after 5pm) or should last no more than 30 minutes each hour. The owner reserves the right to change these parameters at any time.
- B. The CxA will be responsible for issuing testing schedules to the owner and receiving owner approval prior to proceeding.
- C. The CxA will coordinate the testing of air-handling units with the project engineers. This is a phased project and not all air-handling units will be available for testing at the start of the project.

**PART 2 - PRODUCTS**

**2.1 TEST EQUIPMENT**

- A. All standard testing equipment required to perform initial checkout and required functional performance testing shall be provided by the commissioning firm for the equipment being tested.
- B. Data logging equipment and software required to test equipment will be provided by the CxA, but shall not become the property of the Owner.
- C. All testing equipment shall be of sufficient quality and accuracy to test and/or measure system performance with the tolerances noted elsewhere 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°F and a resolution of +/- 0.1°F. Pressure sensors shall have an accuracy of +/- 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 when dropped or damaged. Calibration tags shall be affixed or certificates readily available.

**PART 3 - EXECUTION**

**3.1 TESTS**

- A. Establish methods to perform the pre-functional test checklists and functional performance tests in a manner which will provide the information

required. Provide all materials, services, and labor required to perform the pre-functional test checks and functional performance tests.

### **3.2 PRE-FUNCTIONAL TEST CHECKLISTS AND INITIAL CHECKOUT**

- A. Perform Pre-Functional Test Checklists for all equipment to be commissioned, according to Section 1.6.
- B. Pre-functional test checklists are important to ensure that the equipment and systems are hooked up and operational. It ensures that functional performance testing (in-depth system checkout) may proceed without unnecessary delays. Each piece of equipment receives full pre-functional checkout. No sampling strategies are used. The pre-functional testing for a given system must be successfully completed prior to formal functional performance testing of equipment or subsystems of the given system.
- C. Sensor and Actuator Calibration
  - 1. All field-installed temperature, relative humidity, CO, CO<sub>2</sub>, and pressure sensors, and all actuators (dampers and valves) on all equipment will be tested for proper calibration by the CxA. All test instruments shall have had a certified calibration within the last 12 months. CxA to follow manufacturers' calibration procedures whenever possible.
  - 2. All procedures used shall be fully documented on the pre-functional checklists or other suitable forms, clearly referencing the procedures followed and written documentation of initial, intermediate and final results.
- D. Execution of Pre-functional Test Checklists and Startup
  - 1. The CxA or subcontractors shall complete the checklists and procedures for each piece of equipment.
  - 2. The responsible individual shall sign and date a copy of the completed pre-functional tests and checklists for the commissioning report.
  - 3. Only individuals that have direct knowledge and witnessed that a line item task on the pre-functional 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 NON-CONFORMANCE AND APPROVAL OF PRE-FUNCTIONAL TEST CHECKLISTS**

- A. The CxA shall clearly list any outstanding items of the pre-functional 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 are provided to the commissioning team within two days of test completion.

B. Non-Conformance

1. The CxA shall work with the general contractor to correct and retest deficiencies or uncompleted items in accordance with the applicable contract requirements.

C. Approval

1. The CxA notes each satisfactory checklist. Formal approval of the pre-functional checklists is made later after review by the commissioning team.

**3.4 FUNCTIONAL PERFORMANCE TESTING**

- A. Perform Functional Performance Tests for all equipment to be commissioned, according to Section 1.6. Begin Functional Performance Tests only after all Pre-Functional Test Checklists have been successfully completed and approved by the Commissioning Team. Begin Tests with equipment or components and progress through subsystems to complete systems.

B. Objectives and Scope

1. The objective of functional performance testing is to demonstrate that each system is operating according to the original design parameters. Functional testing facilitates identify areas of deficient performance and correct them, improving the operation and functioning of the systems.
2. In general, each system should be operated through all modes of operation (seasonal, occupied, unoccupied, warm-up, cool-down, part- and full-load) where there is a specified system response. Verifying each sequence in the sequences of operation is required. 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 Test Procedures

1. With input from Cx team members, the CxA shall finalize the test procedures and create forms to verify and document proper operation of each piece of equipment and system. Prior to execution, the CxA shall provide a copy of the test procedures to the General Contractor who shall review the tests for feasibility, safety, equipment and warranty protection.

2. The purpose of any given specific test is to verify and document compliance with the stated criteria of acceptance given on the test form. The test procedure forms developed by the CxA shall include (but not be limited to) the following information:
  - a. System and equipment or component name(s)
  - b. Equipment location and ID number
  - c. Unique test ID number, and reference to unique pre-functional checklist ID numbers for the piece of equipment
  - d. Date
  - e. Project name
  - f. Participating parties
  - g. A copy of the specific sequence of operations or other specified parameters being verified
  - h. Formulas used in any calculations
  - i. Required pre-test field measurements
  - j. Instructions for setting up the test.
  - k. Special cautions, alarm limits, etc.
  - l. Specific step-by-step procedures to execute the test, in a clear, sequential and repeatable format
  - m. 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.
  - n. A section for comments
  - o. Signatures and date block for the CxA

D. Test Methods

1. Functional performance testing and verification may be achieved by manual testing (persons manipulate the equipment and observe performance) or by monitoring the performance and analyzing the results using the control system's trend log capabilities or by stand-alone data loggers.
2. Simulated Conditions: Simulating conditions (not by an overwritten value) shall be allowed, though timing the testing to experience actual conditions is encouraged wherever practical.

3. 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.
4. 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.
5. 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 AC compressor lockout work at an outside air temperature below 55F, when the outside air temperature is above 55F, temporarily change the lockout setpoint to be 2F above the current outside air temperature.
6. 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 is completed during pre-functional testing.
7. Setup: Each function and test shall be performed under conditions that simulate actual conditions as close as is practically possible. The Prime executing the test 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 Prime shall return all affected building equipment and systems, due to these temporary modifications, to their pre-test condition.

### **3.5 ADDITIONAL TESTING**

- A. Testing, Adjusting, and Balancing: CxA or subcontractor to perform testing, adjusting, and balancing on all air-handling units to obtain the following information:
  - 1. Totalized Air Flows
    - a. Supply Air
    - b. Return Air
    - c. Outside Air
    - d. External Static Pressure
    - e. Total Static Pressure
  - 2. Hydronic Water Flows (GPM)
    - a. Chilled Water
    - b. Heating Hot Water
    - c. Pressure Drops across all coils
- B. Smoke Tests: CxA to coordinate with general contractor and owner to perform a smoke test on all air-handling units to verify proper system response and alarm.
- C. Leak Tests: CxA to conduct an air-handling unit pressure test on all units in accordance with SMACNA procedures.
- D. Emergency Power: CxA to simulate a loss of power to the systems and verify that the connected systems function properly after the emergency generator is activated.
- E. Seasonal Testing: CxA to coordinate these tests that are delayed until weather conditions are closer to the system's design and will completed them as part of this contract.

### **3.6 NON-CONFORMANCE AND APPROVAL OF FUNCTIONAL PERFORMANCE TESTS**

- A. A functional performance test shall be aborted if any system deficiency prevents the successful completion of the test or if any participating non-Government commissioning team member of which participation is specified is not present for the test without documented approval.
- B. Non-Conformance
  - 1. The CxA will record the results of the functional test on the procedure or test form. All deficiencies or non-conformance issues shall be noted and reported to the commissioning team on a standard non-compliance form.

2. Corrections of minor deficiencies identified may be made during the tests at the discretion of the CxA. In such cases the deficiency and resolution will be documented on the procedure form.
3. Major deficiencies of any Functional Performance Test items will be reported to the commissioning team, and the deficiencies will be corrected in accordance with the applicable contract requirements. Once deficiencies are corrected, the item shall then be retested until it has been completed with no errors.
4. The CxA retains the original non-conformance forms until the end of the project.

C. Approval

1. The CxA notes each satisfactorily demonstrated function on the test form. Formal approval of the functional test is made later after review by the commissioning team.

---END---

**SECTION 02 41 00  
DEMOLITION**

**PART 1 - GENERAL**

**1.1 DESCRIPTION:**

This section specifies demolition and removal of portions of buildings, utilities, other structures and debris from trash dumps shown.

**1.2 RELATED WORK:**

- A. Disconnecting utility services prior to demolition: Section 01 00 00, GENERAL REQUIREMENTS.
- B. Reserved items that are to remain the property of the Government: Section 01 00 00, GENERAL REQUIREMENTS.
- C. Asbestos Removal: Section 02 82 11, TRADITIONAL ASBESTOS ABATEMENT
- D. Infectious Control: Section 01 00 00, GENERAL REQUIREMENTS, Article 1.8, INFECTION PREVENTION MEASURES.

**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.
- 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.
- C. 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 such as, but not limited to; ice, flooding, or pollution. Vacuum and dust the work area daily.
- D. 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. 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.
  - 3. Keep hydrants clear and accessible at all times. Prohibit debris from accumulating within a radius of 4500 mm (15 feet) of fire hydrants.
- E. 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 Medical Center; any damaged items shall be repaired or replaced as approved by the COTR. 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 COTR's approval.

- F. The work shall comply with the requirements of Section 01 00 00, GENERAL REQUIREMENTS, Article 1.8 INFECTION PREVENTION MEASURES.

**PART 2 - PRODUCTS (NOT USED)**

**PART 3 - EXECUTION**

**3.1 DEMOLITION:**

- A. Debris, including brick, concrete, stone, metals and similar materials shall become property of Contractor and shall be disposed of by him daily, off the Medical Center Property to avoid accumulation at the demolition site. Materials that cannot be removed daily shall be stored in areas specified by the COTR. Contractor shall dispose debris in compliance with applicable federal, state or local permits, rules and/or regulations.

**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 COTR. Clean-up shall include 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 02 82 11  
TRADITIONAL ASBESTOS ABATEMENT

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**PART 1 - GENERAL**

**1.1 SUMMARY OF THE WORK**

**1.1.1 CONTRACT DOCUMENTS AND RELATED REQUIREMENTS**

Drawings, general provisions of the contract, including Division 01 specifications, shall apply to the work of this section. The contract documents show the work to be done under the contract and related requirements and conditions impacting the project. Related requirements and conditions include applicable codes and regulations, notices and permits, existing site conditions and restrictions on use of the site, requirements for partial owner occupancy during the work, coordination with other work and the phasing of the work. In the event the Asbestos Abatement Contractor discovers a conflict in the contract documents and/or requirements or codes, the conflict must be brought to the immediate attention of the Contracting Officer for resolution. Whenever there is a conflict or overlap in the requirements, the most stringent shall apply. Any actions taken by the Contractor without obtaining guidance from the Contracting Officer shall become the sole risk and responsibility of the Asbestos Abatement Contractor. All costs incurred due to such action are also the responsibility of the Asbestos Abatement Contractor.

**1.1.2 EXTENT OF WORK**

- A. Below is a brief description of the estimated quantities of asbestos containing materials to be abated. These quantities are for informational purposes only and are based on the best information available at the time of the specification preparation. The Contractor shall satisfy himself as the actual quantities to be abated. Nothing in this section may be interpreted as limiting the extent of work otherwise required by this contract and related documents.
- B. Removal, clean-up and disposal of asbestos containing materials (ACM) and asbestos/waste contaminated elements in an appropriate regulated area for the following approximate quantities;
  - 100 square feet of sprayed-on fireproofing insulation including any demolition necessary to expose ACM fireproofing
  - 200 square feet of duct insulation including any demolition necessary to expose ACM ductwork
  - 200 square feet of contaminated soil

**1.1.3 RELATED WORK**

- A. Section 07 84 00, FIRESTOPPING.
- B. Section 02 41 00, DEMOLITION.
- C. Division 09, FINISHES

- D. Division 22, PLUMBING.
- E. Section 21 05 11, COMMON WORK RESULTS FOR FIRE SUPPRESSION / Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING / Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION
- F. Section 23 07 11, HVAC, PLUMBING, AND BOILER PLANT INSULATION.
- G. Section 22 11 00, FACILITY WATER DISTRIBUTION / Section 22 13 00, FACILITY SANITARY SEWERAGE / Section 22 14 00, FACILITY STORM DRAINAGE.
- H. Section 23 21 13, HYDRONIC PIPING / Section 23 22 13, STEAM AND CONDENSATE HEATING PIPING.
- I. Section 23 31 00, HVAC DUCTS AND CASINGS

#### **1.1.1.4 TASKS**

The work tasks are summarized briefly as follows:

- A. Pre-abatement activities including pre-abatement meeting(s), inspection(s), notifications, permits, submittal approvals, regulated area preparations, emergency procedures arrangements, and standard operating procedures for asbestos abatement work.
- B. Abatement activities including removal, clean-up, and disposal of ACM waste, recordkeeping, security, monitoring, and inspections.
- C. Cleaning and decontamination activities including final visual inspection, air monitoring and certification of decontamination.

#### **1.1.1.5 CONTRACTORS USE OF PREMISES**

- A. The Contractor and Contractor's personnel shall cooperate fully with the VA representative/consultant to facilitate efficient use of buildings and areas within buildings. The Contractor shall perform the work in accordance with the VA specifications, drawings, phasing plan and in compliance with any/all applicable Federal, State and Local regulations and requirements.
- B. The Contractor shall use the existing facilities in the building strictly within the limits indicated in contract documents as well as the approved pre-abatement work plan. Asbestos abatement drawings of partially occupied buildings will show the limits of regulated areas; the placement of decontamination facilities; the temporary location of bagged waste ACM; the path of transport to outside the building; and the temporary waste storage area for each regulated area. Any variation from the arrangements shown on drawings shall be secured in writing from the VA representative through the pre-abatement plan of action. The following limitations of use shall apply to existing facilities shown on drawings:

#### **1.2 VARIATIONS IN QUANTITY**

The quantities and locations of ACM as indicated on the drawings and the extent of work included in this section are estimated which are limited by the physical constraints imposed by occupancy of the buildings. Accordingly, minor variations (+/- 5%) in quantities of ACM within the regulated area are considered as having no impact on contract price and time requirements of this contract. Where additional work is required beyond the above variation, the contractor shall provide unit prices for newly discovered materials and those prices shall be used for additional work required under the contractor.

### 1.3 STOP ASBESTOS REMOVAL

If the Contracting Officer; their field representative; or the VPIH/CIH presents a written **Stop Asbestos Removal Order**, the Contractor/Personnel shall immediately stop all asbestos removal and maintain HEPA filtered air flow and adequately wet any exposed ACM. The Contractor shall not resume any asbestos removal activity until authorized to do so by the VA. A stop asbestos removal order may be issued at any time the VA determines abatement conditions/activities are not within specification requirements. Work stoppage will continue until conditions have been corrected to the satisfaction of the VA. Standby time and costs for corrective actions will be borne by the Contractor, including the industrial hygienist's time. The occurrence of any of the following events shall be reported immediately by the Contractor's competent person in writing to the VA representative and shall require the Contractor to immediately stop asbestos removal/disturbance activities and initiate fiber reduction activities:

- A.  $\geq$  0.01 f/cc outside a regulated area or  $>$ 0.05 f/cc inside a regulated area;
- B. breach/break in regulated area barrier(s);
- C. less than -0.02" WCG pressure in the regulated area;
- D. serious injury/death at the site;
- E. fire/safety emergency at the site;
- F. respiratory protection system failure;
- G. power failure or loss of wetting agent; or
- H. any visible emissions observed outside the regulated area.

### 1.4 DEFINITIONS

#### 1.4.1 GENERAL

Definitions and explanations here are neither complete nor exclusive of all terms used in the contract documents, but are general for the work to the extent they are not stated more explicitly in another element of the contract documents. Drawings must be recognized as diagrammatic in

nature and not completely descriptive of the requirements indicated therein.

#### 1.4.2 GLOSSARY

**Abatement** - Procedures to control fiber release from asbestos-containing materials, typically during removal. Includes removal, encapsulation, enclosure, demolition and renovation activities related to asbestos.

**ACE** - Asbestos contaminated elements.

**ACM** - Asbestos containing material.

**Aerosol** - Solid or liquid particulate suspended in air.

**Adequately wet** - Sufficiently mixed or penetrated with liquid to prevent the release of particulates. If visible emissions are observed coming from the ACM, then that material has not been adequately wetted.

**Aggressive method** - Removal or disturbance of building material by sanding, abrading, grinding, or other method that breaks, crumbles, or disintegrates intact ACM.

**Aggressive sampling** - EPA AHERA defined clearance sampling method using air moving equipment such as fans and leaf blowers to aggressively disturb and maintain in the air residual fibers after abatement.

**AHERA** - Asbestos Hazard Emergency Response Act. Asbestos regulations for schools issued in 1987.

**Aircell** - Pipe or duct insulation made of corrugated cardboard which contains asbestos.

**Air monitoring** - The process of measuring the fiber content of a known volume of air collected over a specified period of time. The NIOSH 7400 Method, Issue 2 is used to determine the fiber levels in air.

**Air sample filter** - The filter used to collect fibers which are then counted. The filter is made of mixed cellulose ester membrane for PCM (Phase Contrast Microscopy) and polycarbonate for TEM (Transmission Electron Microscopy)

**Amended water** - Water to which a surfactant (wetting agent) has been added to increase the penetrating ability of the liquid.

**Asbestos** - Includes chrysotile, amosite, crocidolite, tremolite asbestos, anthophyllite asbestos, actinolite asbestos, and any of these minerals that have been chemically treated or altered. Asbestos also includes PACM, as defined below.

**Asbestos-containing material (ACM)** - Any material containing more than one percent of asbestos.

**Asbestos contaminated elements (ACE)** - Building elements such as ceilings, walls, lights, or ductwork that are contaminated with asbestos.

**Asbestos-containing waste material** - Asbestos-containing material or asbestos contaminated objects requiring disposal.

**Asbestos waste decontamination facility** - A system consisting of drum/bag washing facilities and a temporary storage area for cleaned containers of asbestos waste. Used as the exit for waste and equipment leaving the regulated area. In an emergency, it may be used to evacuate personnel.

**Authorized person** - Any person authorized by the VA, the Contractor, or government agency and required by work duties to be present in regulated areas.

**Authorized visitor** - Any person approved by the VA; the contractor; or any government agency having jurisdiction over the regulated area.

**Barrier** - Any surface that isolates the regulated area and inhibits fiber migration from the regulated area.

**Containment Barrier** - An airtight barrier consisting of walls, floors, and/or ceilings of sealed plastic sheeting which surrounds and seals the outer perimeter of the regulated area.

**Critical Barrier** - The barrier responsible for isolating the regulated area from adjacent spaces, typically constructed of plastic sheeting secured in place at openings such as doors, windows, or any other opening into the regulated area.

**Primary Barrier** - Barriers placed over critical barriers and exposed directly to abatement work.

**Secondary Barrier** - Any additional sheeting used to isolate and provide protection from debris during abatement work.

**Breathing zone** - The hemisphere forward of the shoulders with a radius of about 150 - 225 mm (6 - 9 inches) from the worker's nose.

**Bridging encapsulant** - An encapsulant that forms a layer on the surface of the ACM.

**Building/facility owner** - The legal entity, including a lessee, which exercises control over management and recordkeeping functions relating to a building and/or facility in which asbestos activities take place.

**Bulk testing** - The collection and analysis of suspect asbestos containing materials.

**Certified Industrial Hygienist (CIH)** - One certified in practice of industrial hygiene by the American Board of Industrial Hygiene. An industrial hygienist Certified in Comprehensive Practice by the American Board of Industrial Hygiene.

**Class I asbestos work** - Activities involving the removal of Thermal System Insulation (TSI) and surfacing ACM and Presumed Asbestos Containing Material (PACM).

**Class II asbestos work** - Activities involving the removal of ACM which is not thermal system insulation or surfacing material. This includes, but is not limited to, the removal of asbestos-containing wallboard, floor tile and sheeting, roofing and siding shingles, and construction mastic.

**Clean room/Changing room** - An uncontaminated room having facilities for the storage of employee's street clothing and uncontaminated materials and equipment.

**Clearance sample** - The final air sample taken after all asbestos work has been done and visually inspected. Performed by the VA's industrial hygiene consultant (VPIH/CIH).

**Closely resemble** - The major workplace conditions which have contributed to the levels of historic asbestos exposure, are no more protective than conditions of the current workplace.

**Competent person** - In addition to the definition in 29 CFR 1926.32(f), one who is capable of identifying existing asbestos hazards in the workplace and selecting the appropriate control strategy for asbestos exposure, who has the authority to take prompt corrective measures to eliminate them, as specified in 29 CFR 1926.32(f); in addition, for Class I and II work who is specially trained in a training course which meets the criteria of EPA's Model Accreditation Plan (40 CFR 763) for supervisor.

**Contractor's Professional Industrial Hygienist (CPIH)** - The asbestos abatement contractor's industrial hygienist. The industrial hygienist must meet the qualification requirements of the PIH.

**Count** - Refers to the fiber count or the average number of fibers greater than five microns in length per cubic centimeter of air.

**Decontamination area/unit** - An enclosed area adjacent to and connected to the regulated area and consisting of an equipment room, shower room, and clean room, which is used for the decontamination of workers, materials, and equipment that are contaminated with asbestos.

**Demolition** - The wrecking or taking out of any load-supporting structural member and any related razing, removing, or stripping of asbestos products.

**Disposal bag** - Typically 6 mil thick siftproof, dustproof, leaktight container used to package and transport asbestos waste from regulated areas to the approved landfill. Each bag/container must be labeled/marked in accordance with EPA, OSHA and DOT requirements.

**Disturbance** - Activities that disrupt the matrix of ACM or PACM, crumble or pulverize ACM or PACM, or generate visible debris from ACM or PACM.

Disturbance includes cutting away small amounts of ACM or PACM, no greater than the amount that can be contained in one standard sized glove bag or waste bag in order to access a building component. In no event shall the amount of ACM or PACM so disturbed exceed that which can be contained in one glove bag or disposal bag which shall not exceed 60 inches in length or width.

**Drum** - A rigid, impermeable container made of cardboard fiber, plastic, or metal which can be sealed in order to be siftproof, dustproof, and leaktight.

**Employee exposure** - The exposure to airborne asbestos that would occur if the employee were not wearing respiratory protection equipment.

**Encapsulant** - A material that surrounds or embeds asbestos fibers in an adhesive matrix and prevents the release of fibers.

**Encapsulation** - Treating ACM with an encapsulant.

**Enclosure** - The construction of an air tight, impermeable, permanent barrier around ACM to control the release of asbestos fibers from the material and also eliminate access to the material.

**Equipment room** - A contaminated room located within the decontamination area that is supplied with impermeable bags or containers for the disposal of contaminated protective clothing and equipment.

**Fiber** - A particulate form of asbestos, 5 microns or longer, with a length to width ratio of at least 3 to 1.

**Fibers per cubic centimeter (f/cc)** - Abbreviation for fibers per cubic centimeter, used to describe the level of asbestos fibers in air.

**Filter** - Media used in respirators, vacuums, or other machines to remove particulate from air.

**Firestopping** - Material used to close the open parts of a structure in order to prevent a fire from spreading.

**Friable asbestos containing material** - Any material containing more than 1 percent asbestos as determined using the method specified in appendix A, Subpart F, 40 CFR 763, section 1, Polarized Light Microscopy, that, when dry, can be crumbled, pulverized, or reduced to powder by hand pressure.

**Glovebag** - Not more than a 60 x 60 inch impervious plastic bag-like enclosure affixed around an asbestos-containing material, with glove-like appendages through which materials and tools may be handled.

**High efficiency particulate air (HEPA) filter** - A filter capable of trapping and retaining at least 99.97 percent of all mono-dispersed particles of 0.3 microns or greater in diameter.

**HEPA vacuum** - Vacuum collection equipment equipped with a HEPA filter system capable of collecting and retaining asbestos fibers.

**Homogeneous area** - An area of surfacing, thermal system insulation or miscellaneous ACM that is uniform in color, texture and date of application.

**HVAC** - Heating, Ventilation and Air Conditioning

**Industrial hygienist** - A professional qualified by education, training, and experience to anticipate, recognize, evaluate and develop controls for occupational health hazards. Meets definition requirements of the American Industrial Hygiene Association (AIHA).

**Industrial hygienist technician** - A person working under the direction of an IH or CIH who has special training, experience, certifications and licenses required for the industrial hygiene work assigned.

**Intact** - The ACM has not crumbled, been pulverized, or otherwise deteriorated so that the asbestos is no longer likely to be bound with its matrix.

**Lockdown** - Applying encapsulant, after a final visual inspection, on all abated surfaces at the conclusion of ACM removal prior to removal of critical barriers.

**National Emission Standards for Hazardous Air Pollutants (NESHAP's)** - EPA's rule to control emissions of asbestos to the environment.

**Negative initial exposure assessment** - A demonstration by the employer which complies with the criteria in 29 CFR 1926.1101 (f)(2)(iii), that employee exposure during an operation is expected to be consistently below the PEL's.

**Negative pressure** - Air pressure which is lower than the surrounding area, created by exhausting air from a sealed regulated area through HEPA equipped filtration units. OSHA requires maintaining -0.02" water column gauge inside the negative pressure enclosure.

**Negative pressure respirator** - A respirator in which the air pressure inside the facepiece is negative during inhalation relative to the air outside the respirator.

**Non-friable ACM** - Material that contains more than 1 percent asbestos but cannot be crumbled, pulverized, or reduced to powder by hand pressure.

**Organic vapor cartridge** - The type of cartridge used on air purifying respirators for organic vapor exposures.

**Outside air** - The air outside buildings and structures, including, but not limited to, the air under a bridge or in an open ferry dock.

**Owner/operator** - Any person who owns, leases, operates, controls, or supervises the facility being demolished or renovated or any person who owns, leases, operates, controls, or supervises the demolition or renovation operation, or both.

**Penetrating encapsulant** - Encapsulant that is absorbed into the ACM matrix without leaving a surface layer.

**Personal sampling/monitoring** - Representative air samples obtained in the breathing zone of the person using a cassette and battery operated pump to determine asbestos exposure.

**Permissible exposure limit (PEL)** - The level of exposure OSHA allows for an 8 hour time weighted average. For asbestos fibers, the PEL is 0.1 fibers per cc.

**Polarized light microscopy (PLM)** - Light microscopy using dispersion staining techniques and refractive indices to identify and quantify the type(s) of asbestos present in a bulk sample.

**Polyethylene sheeting** - Strong plastic barrier material 4 to 6 mils thick, semi-transparent, sometimes flame retardant in compliance with NFPA 241.

**Positive/negative fit check** - A method of verifying the fit of a respirator by closing off the filters and breathing in or closing off the exhalation valve and breathing out while detecting leakage of the respirator.

**Presumed ACM (PACM)** - Thermal system insulation, surfacing, and flooring material installed in buildings prior to 1981. If the building owner has actual knowledge, or should have known through the exercise of due diligence that other materials are ACM, they too must be treated as PACM. The designation of PACM may be rebutted pursuant to 29 CFR 1926.1101 (k)(5).

**Professional IH** - An IH who meets the definition requirements of AIHA; meets the definition requirements of OSHA as a "Competent Person" at 29 CFR 1926.1101 (b); has completed two specialized EPA approved courses on management and supervision of asbestos abatement projects; has formal training in respiratory protection and waste disposal; and has a minimum of four projects of similar complexity with this project of which at least three projects serving as the supervisory IH.

**Project designer** - A person who has successfully completed the training requirements for an asbestos abatement project designer as required by 40 CFR 763 Appendix C, Part I; (B)(5).

**Protection factor** - A value assigned by OSHA/NIOSH to indicate the assigned protection a respirator should provide if worn properly. The

number indicates the reduction of exposure level from outside to inside the respirator.

**Qualitative fit test (QLFT)** - A fit test using a challenge material that can be sensed by the wearer if leakage in the respirator occurs.

**Quantitative fit test (QNFT)** - A fit test using a challenge material which is quantified outside and inside the respirator thus allowing the determination of the actual fit factor.

**Regulated area** - An area established by the employer to demarcate where Class I, II, III asbestos work is conducted, and any adjoining area where debris and waste from such asbestos work may accumulate; and a work area within which airborne concentrations of asbestos exceed, or there is a reasonable possibility they may exceed the PEL.

**Regulated ACM (RACM)** - Friable ACM; Category I nonfriable ACM that has become friable; Category I nonfriable ACM that will be or has been subjected to sanding, grinding, cutting, or abrading or; Category II nonfriable ACM that has a high probability of becoming or has become crumbled, pulverized, or reduced to powder by the forces expected to act on the material in the course of the demolition or renovation operation.

**Removal** - All operations where ACM, PACM and/or RACM is taken out or stripped from structures or substrates, including demolition operations.

**Renovation** - Altering a facility or one or more facility components in any way, including the stripping or removal of asbestos from a facility component which does not involve demolition activity.

**Repair** - Overhauling, rebuilding, reconstructing, or reconditioning of structures or substrates, including encapsulation or other repair of ACM or PACM attached to structures or substrates.

**Shower room** - The portion of the PDF where personnel shower before leaving the regulated area. Also used for bag/drum decontamination in the EDF.

**Standard operating procedures (SOP's)** - Asbestos work procedures required to be submitted by the contractor before work begins.

**Supplied air respirator (SAR)** - A respirator that utilizes an air supply separate from the air in the regulated area.

**Surfacing ACM** - A material containing more than 1 percent asbestos that is sprayed, troweled on or otherwise applied to surfaces for acoustical, fireproofing and other purposes.

**Surfactant** - A chemical added to water to decrease water's surface tension thus making it more penetrating into ACM.

**Thermal system ACM** - A material containing more than 1 percent asbestos applied to pipes, fittings, boilers, breeching, tanks, ducts, or other structural components to prevent heat loss or gain.

**Transmission electron microscopy (TEM)** - A microscopy method that can identify and count asbestos fibers.

**VA Industrial Hygienist (VPIH)** - Department of Veterans Affairs Professional Industrial Hygienist.

**VA Certified Industrial Hygienist (VPCIH)** - Department of Veteran's Affairs Professional Certified Industrial Hygienist.

**VA Representative** - The VA official responsible for on-going project work.

**Visible emissions** - Any emissions, which are visually detectable without the aid of instruments, coming from ACM/PACM/RACM or ACM waste material.

**Waste/Equipment decontamination facility (W/EDF)** - The area in which equipment is decontaminated before removal from the regulated area.

**Waste generator** - Any owner or operator whose act or process produces asbestos-containing waste material.

**Waste shipment record** - The shipping document, required to be originated and signed by the waste generator, used to track and substantiate the disposition of asbestos-containing waste material.

**Wet cleaning** - The process of thoroughly eliminating, by wet methods, any asbestos contamination from surfaces or objects.

#### 1.4.3 REFERENCED STANDARDS ORGANIZATIONS

The following acronyms or abbreviations as referenced in contract/specification documents are defined to mean the associated names. Names and addresses may be subject to change.

- A. VA Department of Veterans Affairs  
810 Vermont Avenue, NW  
Washington, DC 20420
- B. AIHA American Industrial Hygiene Association  
2700 Prosperity Avenue, Suite 250  
Fairfax, VA 22031  
703-849-8888
- C. ANSI American National Standards Institute  
1430 Broadway  
New York, NY 10018  
212-354-3300
- D. ASTM American Society for Testing and Materials  
1916 Race St.

Philadelphia, PA 19103

215-299-5400

E. CFR Code of Federal Regulations

Government Printing Office

Washington, DC 20420

F. CGA Compressed Gas Association

1235 Jefferson Davis Highway

Arlington, VA 22202

703-979-0900

G. CS Commercial Standard of the National Institute of Standards and  
Technology (NIST)

U. S. Department of Commerce

Government Printing Office

Washington, DC 20420

H. EPA Environmental Protection Agency

401 M St., SW

Washington, DC 20460

202-382-3949

I. MIL-STD Military Standards/Standardization Division

Office of the Assistant Secretary of Defense

Washington, DC 20420

J. MSHA Mine Safety and Health Administration

Respiratory Protection Division

Ballston Tower #3

Department of Labor

Arlington, VA 22203

703-235-1452

K. NIST National Institute for Standards and Technology

U. S. Department of Commerce

Gaithersburg, MD 20234

301-921-1000

L. NEC National Electrical Code (by NFPA)

M. NEMA National Electrical Manufacturer's Association

2101 L Street, N.W.

Washington, DC 20037

N. NFPA National Fire Protection Association

1 Batterymarch Park

P.O. Box 9101

Quincy, MA 02269-9101

800-344-3555

- O. NIOSH National Institutes for Occupational Safety and Health  
4676 Columbia Parkway  
Cincinnati, OH 45226  
513-533-8236
- P. OSHA Occupational Safety and Health Administration  
U.S. Department of Labor  
Government Printing Office  
Washington, DC 20402
- Q. UL Underwriters Laboratory  
333 Pfingsten Rd.  
Northbrook, IL 60062  
312-272-8800
- R. USA United States Army  
Army Chemical Corps  
Department of Defense  
Washington, DC 20420

#### **1.5 APPLICABLE CODES AND REGULATIONS**

##### **1.5.1 GENERAL APPLICABILITY OF CODES, REGULATIONS, AND STANDARDS**

- A. All work under this contract shall be done in strict accordance with all applicable Federal, State, and local regulations, standards and codes governing asbestos abatement, and any other trade work done in conjunction with the abatement. All applicable codes, regulations and standards are adopted into this specification and will have the same force and effect as this specification.
- B. The most recent edition of any relevant regulation, standard, document or code shall be in effect. Where conflict among the requirements or with these specification exists, the most stringent requirement(s) shall be utilized.
- C. Copies of all standards, regulations, codes and other applicable documents, including this specification and those listed in Section 1.5 shall be available at the worksite in the clean change area of the worker decontamination system.

##### **1.5.2 ASBESTOS ABATEMENT CONTRACTOR RESPONSIBILITY**

The Asbestos Abatement Contractor (Contractor) shall assume full responsibility and liability for compliance with all applicable Federal, State and Local regulations related to any and all aspects of the abatement project. The Contractor is responsible for providing and maintaining training, accreditations, medical exams, medical records, personal protective equipment as required by applicable Federal, State and Local regulations. The Contractor shall hold the VA and VPIH/CIH

consultants harmless for any Contractor's failure to comply with any applicable work, packaging, transporting, disposal, safety, health, or environmental requirement on the part of himself, his employees, or his subcontractors. The Contractor will incur all costs of the CPIH, including all sampling/analytical costs to assure compliance with OSHA/EPA/State requirements related to failure to comply with the regulations applicable to the work.

#### **1.5.3 FEDERAL REQUIREMENTS**

Federal requirements which govern of asbestos abatement include, but are not limited to, the following regulations.

- A. Occupational Safety and Health Administration (**OSHA**)
  - 1. Title 29 CFR 1926.1101 - Construction Standard for Asbestos
  - 2. Title 29 CFR 1910.132 - Personal Protective Equipment
  - 3. Title 29 CFR 1910.134 - Respiratory Protection
  - 4. Title 29 CFR 1926 - Construction Industry Standards
  - 5. Title 29 CFR 1910.20 - Access to Employee Exposure and Medical Records
  - 6. Title 29 CFR 1910.1200 - Hazard Communication
  - 7. Title 29 CFR 1910.151 - Medical and First Aid
- B. Environmental Protection Agency (**EPA**):
  - 1. 40 CFR 61 Subpart A and M (Revised Subpart B) - National Emission Standard for Hazardous Air Pollutants - Asbestos.
  - 2. 40 CFR 763.80 - Asbestos Hazard Emergency Response Act (AHERA)
- C. Department of Transportation (**DOT**)
  - Title 49 CFR 100 - 185 - Transportation

#### **1.5.4 STATE REQUIREMENTS**

State requirements that apply to the asbestos abatement work, disposal, clearance, etc., include, but are not limited to, the following:

**ASBESTOS ABATEMENT CONTRACTOR LICENSING AND TRAINING, OHIO  
ADMINISTRATIVE CODE, RULES 3701-34-01 THROUGH 3701-34-7**

#### **1.5.5 LOCAL REQUIREMENTS**

If local requirements are more stringent than federal or state standards, the local standards are to be followed.

#### **1.5.6 STANDARDS**

- A. Standards which govern asbestos abatement activities include, but are not limited to, the following:
  - 1. American National Standards Institute (ANSI) Z9.2-79 - Fundamentals Governing the Design and Operation of Local Exhaust Systems Z88.2 - Practices for Respiratory Protection.

2. Underwriters Laboratories (UL) 586-90 - UL Standard for Safety of HEPA Filter Units, 7th Edition.

B. Standards which govern encapsulation work include, but are not limited to the following:

1. American Society for Testing and Materials (ASTM)

C. Standards which govern the fire and safety concerns in abatement work include, but are not limited to, the following:

1. National Fire Protection Association (NFPA) 241 - Standard for Safeguarding Construction, Alteration, and Demolition Operations.

2. NFPA 701 - Standard Methods for Fire Tests for Flame Resistant Textiles and Film.

3. NFPA 101 - Life Safety Code

#### 1.5.7 EPA GUIDANCE DOCUMENTS

A. EPA guidance documents which discuss asbestos abatement work activities are listed below. These documents are made part of this section by reference. EPA publications can be ordered from (800) 424-9065.

B. Guidance for Controlling ACM in Buildings (Purple Book) EPA 560/5-85-024

C. Asbestos Waste Management Guidance EPA 530-SW-85-007

D. A Guide to Respiratory Protection for the Asbestos Abatement Industry EPA-560-OPTS-86-001

E. Guide to Managing Asbestos in Place (Green Book) TS 799 20T July 1990

#### 1.5.8 NOTICES

A. State and Local agencies: Send written notification as required by state and local regulations including the local fire department prior to beginning any work on ACM as follows:

Send written notification as required by USEPA National Emissions Standards for Hazardous Air Pollutants (NESHAPS) Asbestos regulations (40 CFR 61, Subpart M) to the regional Asbestos NESHAPS Contact at least 10 days prior to beginning any work on asbestos abatement or related work. Send notification to the following address:

Department of Public Health  
Division of Air Quality  
1925 St. Clair Avenue  
Cleveland, Ohio 44114-2080

Send written notification as required by Ohio Department of Health at least 10 days prior to beginning any work on any planned asbestos hazard abatement project as required by chapter 3701-34. Send notification to the following address:

Ohio Department of Health  
P.O. Box 15278  
Columbus, Ohio 43215

- B. Copies of notifications shall be submitted to the VA for the facility's records in the same time frame notification is given to EPA, State, and Local authorities.

**1.5.9 PERMITS/LICENSES**

- A. The contractor shall apply for and have all required permits and licenses to perform asbestos abatement work as required by Federal, State, and Local regulations.
- B. Contractor shall maintain a current Ohio Department of Health "Asbestos Abatement Contractor" license in accordance with paragraph (C) of rule 3701-34-01 of the Administrative Code.

**1.5.10 POSTING AND FILING OF REGULATIONS**

- A. Maintain two (2) copies of applicable federal, state, and local regulations. Post one copy of each in the clean room at the regulated area where workers will have daily access to the regulations and keep another copy in the Contractor's office.

**1.5.11 VA RESPONSIBILITIES**

Prior to commencement of work:

- A. Notify occupants adjacent to regulated areas of project dates and requirements for relocation, if needed. Arrangements must be made prior to starting work for relocation of desks, files, equipment and personal possessions to avoid unauthorized access into the regulated area. **Note: Notification of adjacent personnel is required by OSHA in 29 CFR 1926.1101 (k) to prevent unnecessary or unauthorized access to the regulated area.**
- B. Submit to the Contractor results of background air sampling; including location of samples, person who collected the samples, equipment utilized and method of analysis. During abatement, submit to the Contractor, results of bulk material analysis and air sampling data collected during the course of the abatement. This information shall not release the Contractor from any responsibility for OSHA compliance.

**1.5.12 SITE SECURITY**

- A. Regulated area access is to be restricted only to authorized, trained/accredited and protected personnel. These may include the Contractor's employees, employees of Subcontractors, VA employees and representatives, State and local inspectors, and any other designated individuals. A list of authorized personnel shall be established prior to commencing the project and be posted in the clean room of the decontamination unit.

- B. Entry into the regulated area by unauthorized individuals shall be reported immediately to the Competent Person by anyone observing the entry. The Competent Person shall immediately notify the VA.
- C. A log book shall be maintained in the clean room of the decontamination unit. Anyone who enters the regulated area must record their name, affiliation, time in, and time out for each entry.
- D. Access to the regulated area shall be through a single decontamination unit. All other access (doors, windows, hallways, etc.) shall be sealed or locked to prevent entry to or exit from the regulated area. The only exceptions for this requirement are the waste/equipment load-out area which shall be sealed except during the removal of containerized asbestos waste from the regulated area, and emergency exits. Emergency exits shall not be locked from the inside, however, they shall be sealed with poly sheeting and taped until needed.
- E. The Contractor's Competent Person shall control site security during abatement operations in order to isolate work in progress and protect adjacent personnel. A 24 hour security system shall be provided at the entrance to the regulated area to assure that all entrants are logged in/out and that only authorized personnel are allowed entrance.
- F. The Contractor will have the VA's assistance in notifying adjacent personnel of the presence, location and quantity of ACM in the regulated area and enforcement of restricted access by the VA's employees.
- G. The regulated area shall be locked during non-working hours and secured by VA security/police guards.

#### **1.5.13 EMERGENCY ACTION PLAN AND ARRANGEMENTS**

- A. An Emergency Action Plan shall be developed by prior to commencing abatement activities and shall be agreed to by the Contractor and the VA. The Plan shall meet the requirements of 29 CFR 1910.38 (a);(b).
- B. Emergency procedures shall be in written form and prominently posted in the clean room and equipment room of the decontamination unit. Everyone, prior to entering the regulated area, must read and sign these procedures to acknowledge understanding of the regulated area layout, location of emergency exits and emergency procedures.
- C. Emergency planning shall include written notification of police, fire, and emergency medical personnel of planned abatement activities; work schedule; layout of regulated area; and access to the regulated area, particularly barriers that may affect response capabilities.
- D. Emergency planning shall include consideration of fire, explosion, hazardous atmospheres, electrical hazards, slips/trips and falls, confined spaces, and heat stress illness. Written procedures for

response to emergency situations shall be developed and employee training in procedures shall be provided.

- E. Employees shall be trained in regulated area/site evacuation procedures in the event of workplace emergencies.
  - 1. For non life-threatening situations - employees injured or otherwise incapacitated shall decontaminate following normal procedures with assistance from fellow workers, if necessary, before exiting the regulated area to obtain proper medical treatment.
  - 2. For life-threatening injury or illness, worker decontamination shall take least priority after measures to stabilize the injured worker, remove them from the regulated area, and secure proper medical treatment.
- F. Telephone numbers of any/all emergency response personnel shall be prominently posted in the clean room, along with the location of the nearest telephone.
- G. The Contractor shall provide verification of first aid/CPR training for personnel responsible for providing first aid/CPR. OSHA requires medical assistance within 3-4 minutes of a life-threatening injury/illness. Bloodborne Pathogen training shall also be verified for those personnel required to provide first aid/CPR.
- H. The Emergency Action Plan shall provide for a Contingency Plan in the event that an incident occurs that may require the modification of the standard operating procedures during abatement. Such incidents include, but are not limited to, fire; accident; power failure; negative pressure failure; and supplied air system failure. The Contractor shall detail procedures to be followed in the event of an incident assuring that asbestos abatement work is stopped and wetting is continued until correction of the problem.

#### **1.5.14 PRE-CONSTRUCTION MEETING**

Prior to commencing the work, the Contractor shall meet with the VA Certified Industrial Hygienist (VPCIH) to present and review, as appropriate, the items following this paragraph. The Contractor's Competent Person(s) who will be on-site shall participate in the pre-start meeting. The pre-start meeting is to discuss and determine procedures to be used during the project. At this meeting, the Contractor shall provide:

- A. Proof of Contractor licensing.
- B. Proof the Competent Person(s) is trained and accredited and approved for working in this State. Verification of the experience of the Competent Person(s) shall also be presented.

- C. A list of all workers who will participate in the project, including experience and verification of training and accreditation.
- D. A list of and verification of training for all personnel who have current first-aid/CPR training. A minimum of one person per shift must have adequate training.
- E. Current medical written opinions for all personnel working on-site meeting the requirements of 29 CFR 1926.1101 (m).
- F. Current fit-tests for all personnel wearing respirators on-site meeting the requirements of 29 CFR 1926.1101 (h) and Appendix C.
- G. A copy of the Contractor's Standard Operating Procedures for Asbestos Abatement. In these procedures, the following information must be detailed, specific for this project.
  - 1. Regulated area preparation procedures;
  - 2. Notification requirements procedure of Contractor as required in 29 CFR 1926.1101 (d);
  - 3. Decontamination area set-up/layout and decontamination procedures for employees;
  - 4. Abatement methods/procedures and equipment to be used;
  - 5. Personal protective equipment to be used;
- H. At this meeting the Contractor shall provide all submittals as required.
- I. Procedures for handling, packaging and disposal of asbestos waste.
- J. Emergency Action Plan and Contingency Plan Procedures.

#### **1.6 PROJECT COORDINATION**

The following are the minimum administrative and supervisory personnel necessary for coordination of the work.

##### **1.6.1 PERSONNEL**

- A. Administrative and supervisory personnel shall consist of a qualified Competent Person(s) as defined by OSHA in the Construction Standards and the Asbestos Construction Standard; Contractor Professional Industrial Hygienist and Industrial Hygiene Technicians. These employees are the Contractor's representatives responsible for compliance with these specifications and all other applicable requirements.
- B. Non-supervisory personnel shall consist of an adequate number of qualified personnel to meet the schedule requirements of the project. Personnel shall meet required qualifications. Personnel utilized on-site shall be pre-approved by the VA representative. A request for approval shall be submitted for any person to be employed during the project giving the person's name; social security number; qualifications; accreditation card with color picture; Certificate of Worker's

Acknowledgment; and Affidavit of Medical Surveillance and Respiratory Protection and current Respirator Fit Test.

C. Minimum qualifications for Contractor and assigned personnel are:

1. The Contractor has conducted within the last three (3) years, three (3) projects of similar complexity and dollar value as this project; has not been cited and penalized for serious violations of asbestos regulations in the past three (3) years; has adequate liability/occurrence insurance for asbestos work; is licensed in applicable states; has adequate and qualified personnel available to complete the work; has comprehensive standard operating procedures for asbestos work; has adequate materials, equipment and supplies to perform the work.
2. The Competent Person has four (4) years of abatement experience of which two (2) years were as the Competent Person on the project; meets the OSHA definition of a Competent Person; has been the Competent Person on two (2) projects of similar size and complexity as this project; has completed EPA AHERA/OSHA/State/Local training requirements/accreditation(s) and refreshers; and has all required OSHA documentation related to medical and respiratory protection.
3. The Contractor Professional Industrial Hygienist (CPIH) shall have five (5) years of monitoring experience and supervision of asbestos abatement projects; has participated as senior IH on five (5) abatement projects, three (3) of which are similar in size and complexity as this project; has developed at least one complete standard operating procedure for asbestos abatement; has trained abatement personnel for three (3) years; has specialized EPA AHERA/OSHA training in asbestos abatement management, respiratory protection, waste disposal and asbestos inspection; has completed the NIOSH 582 Course, Contractor/Supervisor course; and has appropriate medical/respiratory protection records/documentation.
4. The Abatement Personnel shall have completed the EPA AHERA/OSHA abatement worker course; have training on the standard operating procedures of the Contractor; has one year of asbestos abatement experience; has applicable medical and respiratory protection documentation; has certificate of training/current refresher and State accreditation/license.

**1.7 RESPIRATORY PROTECTION**

**1.7.1 GENERAL - RESPIRATORY PROTECTION PROGRAM**

The Contractor shall develop and implement a Respiratory Protection Program (RPP) which is in compliance with the January 8, 1998 OSHA

requirements found at 29 CFR 1926.1101 and 29 CFR 1910.132;134. ANSI Standard Z88.2-1992 provides excellent guidance for developing a respiratory protection program. All respirators used must be NIOSH approved for asbestos abatement activities. The written respiratory protection shall, at a minimum, contain the basic requirements found at 29 CFR 1910.134 (c)(1)(i - ix) - Respiratory Protection Program.

**1.7.2 RESPIRATORY PROTECTION PROGRAM COORDINATOR**

The Respiratory Protection Program Coordinator (RPPC) must be identified and shall have two (2) years experience coordinating the program. The RPPC must submit a signed statement attesting to the fact that the program meets the above requirements.

**1.7.3 SELECTION AND USE OF RESPIRATORS**

The procedure for the selection and use of respirators must be submitted to the VA as part of the Contractor's qualification. The procedure must be written clearly enough for workers to understand. A copy of the Respiratory Protection Program must be available in the clean room of the decontamination unit for reference by employees or authorized visitors.

**1.7.4 MINIMUM RESPIRATORY PROTECTION**

Minimum respiratory protection shall be a full face powered air purifying respirator when fiber levels are maintained consistently at or below 0.5 f/cc. A higher level of respiratory protection may be provided or required, depending on fiber levels. Respirator selection shall meet the requirements of 29 CFR 1926.1101 (h); Table 1, except as indicated in this paragraph. Abatement personnel must have a respirator for their exclusive use.

**1.7.5 MEDICAL WRITTEN OPINION**

No employee shall be allowed to wear a respirator unless a physician has determined they are capable of doing so and has issued a current written opinion for that person.

**1.7.6 RESPIRATOR FIT TEST**

All personnel wearing respirators shall have a current qualitative/quantitative fit test which was conducted in accordance with 29 CFR 1910.134 (f) and Appendix A. Quantitative fit tests shall be done for PAPR's which have been put into a failure mode.

**1.7.7 RESPIRATOR FIT CHECK**

The Competent Person shall assure that the positive/negative fit check is done each time the respirator is donned by an employee. Headcoverings must cover respirator headstraps. Any situation that prevents an effective facepiece to face seal as evidenced by failure of a fit check

shall preclude that person from wearing a respirator until resolution of the problem.

**1.7.8 MAINTENANCE AND CARE OF RESPIRATORS**

The Respiratory Protection Program Coordinator shall submit evidence and documentation showing compliance with 29 CFR 1910.134 (h) Maintenance and care of respirators.

**1.7.9 SUPPLIED AIR SYSTEMS**

If a supplied air system is used, the system shall meet all requirements of 29 CFR 1910.134 and the ANSI/Compressed Gas Association (CGA) Commodity Specification for Air current requirements for Type 1 - Grade D breathing air. Low pressure systems are not allowed to be used on asbestos abatement projects. Supplied Air respirator use shall be in accordance with EPA/NIOSH publication EPA-560-OPTS-86-001 "A Guide to Respiratory Protection for the Asbestos Abatement Industry".

**1.8 WORKER PROTECTION**

**1.8.1 TRAINING OF ABATEMENT PERSONNEL**

Prior to beginning any abatement activity, all personnel shall be trained in accordance with OSHA 29 CFR 1926.1101 (k)(9) and any additional State/Local requirements. Training must include, at a minimum, the elements listed at 29 CFR 1926.1101 (k)(9)(viii). Training shall have been conducted by a third party, EPA/State approved trainer meeting the requirements of EPA 40 CFR 763 Appendix C (AHERA MAP). Initial training certificates and current refresher and accreditation proof must be submitted for each person working at the site.

**1.8.2 MEDICAL EXAMINATIONS**

Medical examinations meeting the requirements of 29 CFR 1926.1101 (m) shall be provided for all personnel working in the regulated area, regardless of exposure levels. A current physician's written opinion as required by 29 CFR 1926.1101 (m)(4) shall be provided for each person and shall include in the opinion the person has been evaluated for working in a heat stress environment while wearing personal protective equipment and is able to perform the work.

**1.8.3 PERSONAL PROTECTIVE EQUIPMENT**

Provide whole body clothing, head coverings, gloves and foot coverings and any other personal protective equipment as determined by conducting the hazard assessment required by OSHA at 29 CFR 1910.132 (d). The Competent Person shall ensure the integrity of personal protective equipment worn for the duration of the project. Duct tape shall be used to secure all suit sleeves to wrists and to secure foot coverings at the ankle.

#### 1.8.4 REGULATED AREA ENTRY PROCEDURE

The Competent Person shall ensure that each time workers enter the regulated area, they remove ALL street clothes in the clean room of the decontamination unit and put on new disposable coveralls, head coverings, a clean respirator, and then proceed through the shower room to the equipment room where they put on non-disposable required personal protective equipment.

#### 1.8.5 DECONTAMINATION PROCEDURE - PAPR

The Competent Person shall require all personnel to adhere to following decontamination procedures whenever they leave the regulated area.

- A. When exiting the regulated area, remove disposable coveralls, and ALL other clothes, disposable head coverings, and foot coverings or boots in the equipment room.
- B. Still wearing the respirator and completely naked, proceed to the shower. Showering is MANDATORY. Care must be taken to follow reasonable procedures in removing the respirator to avoid asbestos fibers while showering. The following procedure is required as a minimum:
  1. Thoroughly wet body including hair and face. If using a PAPR hold blower above head to keep filters dry.
  2. With respirator still in place, thoroughly decontaminate body, hair, respirator face piece, and all other parts of the respirator except the blower and battery pack on a PAPR. Pay particular attention to cleaning the seal between the face and respirator facepiece and under the respirator straps.
  3. Take a deep breath, hold it and/or exhale slowly, completely wetting hair, face, and respirator. While still holding breath, remove the respirator and hold it away from the face before starting to breathe.
- C. Carefully decontaminate the facepiece of the respirator inside and out. If using a PAPR, shut down using the following sequence: a) first cap inlets to filters; b) turn blower off to keep debris collected on the inlet side of the filter from dislodging and contaminating the outside of the unit; c) thoroughly decontaminate blower and hoses; d) carefully decontaminate battery pack with a wet rag being cautious of getting water in the battery pack thus preventing destruction. **(THIS PROCEDURE IS NOT A SUBSTITUTE FOR RESPIRATOR CLEANING!)**.
- D. Shower and wash body completely with soap and water. Rinse thoroughly.
- E. Rinse shower room walls and floor to drain prior to exiting.
- F. Proceed from shower to clean room; dry off and change into street clothes or into new disposable work clothing.

#### **1.8.6 REGULATED AREA REQUIREMENTS**

The Competent Person shall meet all requirements of 29 CFR 1926.1101 (o) and assure that all requirements for regulated areas at 29 CFR 1926.1101 (e) are met. All personnel in the regulated area shall not be allowed to eat, drink, smoke, chew tobacco or gum, apply cosmetics, or in any way interfere with the fit of their respirator.

#### **1.9 DECONTAMINATION FACILITIES**

##### **1.9.1 DESCRIPTION**

Provide each regulated area with separate personnel (PDF) and waste/equipment decontamination facilities (W/EDF). Ensure that the PDF are the only means of ingress and egress to the regulated area and that all equipment, bagged waste, and other material exit the regulated area only through the W/EDF.

##### **1.9.2 GENERAL REQUIREMENTS**

All personnel entering or exiting a regulated area must go through the PDF and shall follow the requirements at 29 CFR 1926.1101 (j)(1) and these specifications. All waste, equipment and contaminated materials must exit the regulated area through the W/EDF and be decontaminated in accordance with these specifications. Walls and ceilings of the PDF and W/EDF must be constructed of a minimum of 3 layers of 6 mil opaque fire retardant polyethylene sheeting and be securely attached to existing building components and/or an adequate temporary framework. A minimum of 3 layers of 6 mil poly shall also be used to cover the floor under the PDF and W/EDF units. Construct doors so that they overlap and secure to adjacent surfaces. Weight inner doorway sheets with layers of duct tape so that they close quickly after release. Put arrows on sheets so they show direction of travel and overlap. If the building adjacent area is occupied, construct a solid barrier on the occupied side(s) to protect the sheeting and reduce potential for non-authorized personnel entering the regulated area.

##### **1.9.3 TEMPORARY FACILITIES TO THE PDF AND W/EDF**

The Competent Person shall provide temporary water service connections to the PDF and W/EDF. Backflow prevention must be provided at the point of connection to the VA system. Water supply must be of adequate pressure and meet requirements of 29 CFR 1910.141(d)(3). Provide adequate temporary overhead electric power with ground fault circuit interruption (GFCI) protection. Provide a sub-panel for all temporary power in the clean room. Provide adequate lighting to provide a minimum of 50 foot candles in the PDF and W/EDF. Provide temporary heat, if needed, to maintain 70°F throughout the PDF and W/EDF.

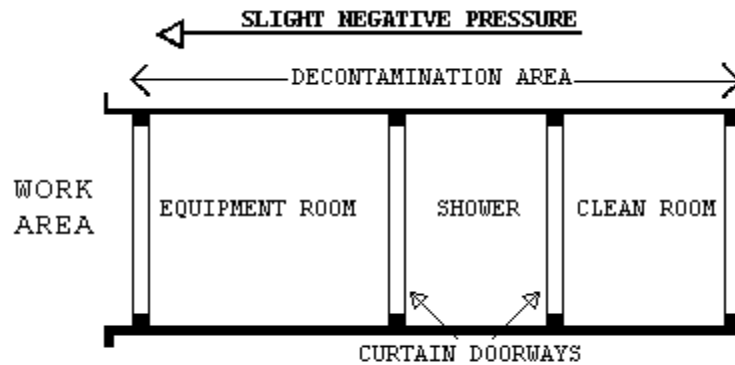
#### 1.9.4 PERSONNEL DECONTAMINATION FACILITY (PDF)

The Competent Person shall provide a PDF consisting of shower room which is contiguous to a clean room and equipment room which is connected to the regulated area. The PDF must be sized to accommodate the number of personnel scheduled for the project. The shower room, located in the center of the PDF, shall be fitted with as many portable showers as necessary to insure all employees can complete the entire decontamination procedure within 15 minutes. The PDF shall be constructed of opaque poly for privacy. The PDF shall be constructed to eliminate any parallel routes of egress without showering.

1. Clean Room: The clean room must be physically and visually separated from the rest of the building to protect the privacy of personnel changing clothes. The clean room shall be constructed of at least 3 layers of 6 mil opaque fire retardant poly to provide an air tight room. Provide a minimum of 2 - 900 mm (3 foot) wide 6 mil poly opaque fire retardant doorways. One doorway shall be the entry from outside the PDF and the second doorway shall be to the shower room of the PDF. The floor of the clean room shall be maintained in a clean, dry condition. Shower overflow shall not be allowed into the clean room. Provide 1 storage locker per person. A portable fire extinguisher, Type ABC, shall be provided in accordance with OSHA and NFPA Standard 10. All persons entering the regulated area shall remove all street clothing in the clean room and dress in disposable protective clothing and respiratory protection. Any person entering the clean room does so either from the outside with street clothing on or is coming from the shower room completely naked and thoroughly washed. Females required to enter the regulated area shall be ensured of their privacy throughout the entry/exit process by posting guards at both entry points to the PDF so no male can enter or exit the PDF during her stay in the PDF.
2. Shower Room: The Competent Person shall assure that the shower room is a completely water tight compartment to be used for the movement of all personnel from the clean room to the equipment room and for the showering of all personnel going from the equipment room to the clean room. Each shower shall be constructed so water runs down the walls of the shower and into a drip pan. Install a freely draining smooth floor on top of the shower pan. The shower room shall be separated from the rest of the building and from the clean room and equipment room using air tight walls made from at least 3 layers of 6 mil opaque fire retardant poly. The shower shall be equipped with a

shower head and controls, hot and cold water, drainage, soap dish and continuous supply of soap, and shall be maintained in a sanitary condition throughout its use. The controls shall be arranged so an individual can shower without assistance. Provide a flexible hose shower head, hose bibs and all other items shown on Shower Schematic. Waste water will be pumped to a drain after being filtered through a minimum of a 100 micron sock in the shower drain; a 20 micron filter; and a final 5 micron filter. Filters will be changed a minimum of daily or more often as needed. Filter changes must be done in the shower to prevent loss of contaminated water. Hose down all shower surfaces after each shift and clean any debris from the shower pan. Residue is to be disposed of as asbestos waste.

3. Equipment Room: The Competent Person shall provide an equipment room which shall be an air tight compartment for the storage of work equipment/tools, reusable personal protective equipment, except for a respirator and for use as a gross decontamination area for personnel exiting the regulated area. The equipment room shall be separated from the regulated area by a minimum 3 foot wide door made with 2 layers of 6 mil opaque fire retardant poly. The equipment room shall be separated from the regulated area, the shower room and the rest of the building by air tight walls and ceiling constructed of a minimum of 3 layers of 6 mil opaque fire retardant poly. Damp wipe all surfaces of the equipment room after each shift change. Provide an additional loose layer of 6 mil fire retardant poly per shift change and remove this layer after each shift. If needed, provide a temporary electrical sub-panel equipped with GFCI in the equipment room to accommodate any equipment required in the regulated area.
4. The PDF shall look like as follows: Clean room at the entrance followed by a shower room followed by an equipment room leading to the regulated area. Each doorway in the PDF is minimum of 2 layers of 6 mil opaque fire retardant poly.



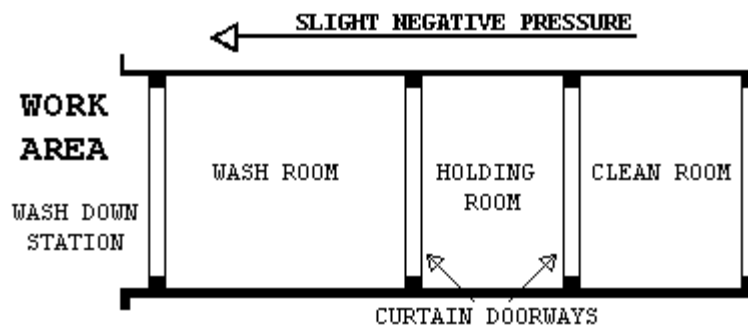
#### 1.9.5 WASTE/EQUIPMENT DECONTAMINATION FACILITY (W/EDF)

The Competent Person shall provide an W/EDF consisting of a wash room, holding room, and clean room for removal of waste, equipment and contaminated material from the regulated area. Personnel shall not enter or exit the W/EDF except in the event of an emergency. Clean debris and residue in the W/EDF daily. All surfaces in the W/EDF shall be wiped/hosed down after each shift and all debris shall be cleaned from the shower pan. The W/EDF shall consist of the following:

1. Wash Down Station: Provide an enclosed shower unit in the regulated area just outside the Wash Room as an equipment bag and container cleaning station.
2. Wash Room: Provide a wash room for cleaning of bagged or containerized asbestos containing waste materials passed from the regulated area. Construct the wash room using 50 x 100 mm (2" x 4") wood framing and 3 layers of 6 mil fire retardant poly. Locate the wash room so that packaged materials, after being wiped clean, can be passed to the Holding Room. Doorways in the wash room shall be constructed of 2 layers of 6 mil fire retardant poly.
3. Holding Room: Provide a holding room as a drop location for bagged materials passed from the wash room. Construct the holding room using 50 x 100 mm (2" x 4") wood framing and 3 layers of 6 mil fire retardant poly. The holding room shall be located so that bagged material cannot be passed from the wash room to the clean room unless it goes through the holding room. Doorways in the holding room shall be constructed of 2 layers of 6 mil fire retardant poly.
4. Clean Room: Provide a clean room to isolate the holding room from the exterior of the regulated area. Construct the clean room using 2 x 4 wood framing and 2 layers of 6 mil fire retardant poly. The clean

room shall be located so as to provide access to the holding room from the building exterior. Doorways to the clean room shall be constructed of 2 layers of 6 mil fire retardant poly. When a negative pressure differential system is used, a rigid enclosure separation between the W/EDF clean room and the adjacent areas shall be provided.

5. The W/EDF shall be provided as follows: Wash Room leading to a Holding Room followed by a Clean Room leading to outside the regulated area. See diagram.



#### 1.9.6 WASTE/EQUIPMENT DECONTAMINATION PROCEDURES

At washdown station in the regulated area, thoroughly wet clean contaminated equipment and/or sealed polyethylene bags and pass into Wash Room after visual inspection. When passing anything into the Wash Room, close all doorways of the W/EDF, other than the doorway between the washdown station and the Wash Room. Keep all outside personnel clear of the W/EDF. Once inside the Wash Room, wet clean the equipment and/or bags. After cleaning and inspection, pass items into the Holding Room. Close all doorways except the doorway between the Holding Room and the Clean Room. Workers from the Clean Room/Exterior shall enter the Holding Room and remove the decontaminated/cleaned equipment/bags for removal and disposal. These personnel will not be required to wear PPE. At no time shall personnel from the clean side be allowed to enter the Wash Room.

**PART 2 - PRODUCTS, MATERIALS AND EQUIPMENT**

**2.1 MATERIALS AND EQUIPMENT**

**2.1.1 GENERAL REQUIREMENTS**

Prior to the start of work, the contractor shall provide and maintain a sufficient quantity of materials and equipment to assure continuous and efficient work throughout the duration of the project. Work shall not start unless the following items have been delivered to the site and the CPIH has submitted verification to the VA's representative.

- A. All materials shall be delivered in their original package, container or bundle bearing the name of the manufacturer and the brand name (where applicable).
- B. Store all materials subject to damage off the ground, away from wet or damp surfaces and under cover sufficient enough to prevent damage or contamination. Flammable materials cannot be stored inside buildings. Replacement materials shall be stored outside of the regulated area until abatement is completed.
- C. The Contractor shall not block or hinder use of buildings by patients, staff, and visitors to the VA in partially occupied buildings by placing materials/equipment in any unauthorized place.
- D. The Competent Person shall inspect for damaged, deteriorating or previously used materials. Such materials shall not be used and shall be removed from the worksite and disposed of properly.
- E. Polyethylene sheeting for walls in the regulated area shall be a minimum of 4-mils. For floors and all other uses, sheeting of at least 6-mils shall be used in widths selected to minimize the frequency of joints. Fire retardant poly shall be used throughout.
- F. The method of attaching polyethylene sheeting shall be agreed upon in advance by the Contractor and the VA and selected to minimize damage to equipment and surfaces. Method of attachment may include any combination of moisture resistant duct tape furring strips, spray glue, staples, nails, screws, lumber and plywood for enclosures or other effective procedures capable of sealing polyethylene to dissimilar finished or unfinished surfaces under both wet and dry conditions.
- G. Polyethylene sheeting utilized for the PDF shall be opaque white or black in color, 6 mil fire retardant poly.
- H. Installation and plumbing hardware, showers, hoses, drain pans, sump pumps and waste water filtration system shall be provided by the Contractor.
- I. An adequate number of HEPA vacuums, scrapers, sprayers, nylon brushes, brooms, disposable mops, rags, sponges, staple guns, shovels, ladders

and scaffolding of suitable height and length as well as meeting OSHA requirements, fall protection devices, water hose to reach all areas in the regulated area, airless spray equipment, and any other tools, materials or equipment required to conduct the abatement project. All electrically operated hand tools, equipment, electric cords shall be connected to GFCI protection.

- J. Special protection for objects in the regulated area shall be detailed (e.g., plywood over carpeting or hardwood floors to prevent damage from scaffolds, water and falling material).
- K. Disposal bags - 2 layers of 6 mil, for asbestos waste shall be pre-printed with labels, markings and address as required by OSHA, EPA and DOT regulations.
- L. The VA shall be provided a copy of the MSDS as required for all hazardous chemicals under OSHA 29 CFR 1910.1200 - Hazard Communication. Chlorinated compounds shall not be used with any spray adhesive or other product. Appropriate encapsulant(s) shall be provided.
- M. OSHA DANGER demarcation signs, as many and as required by OSHA 29 CFR 1926.1101(k)(7) shall be provided and placed by the Competent Person. All other posters and notices required by Federal and State regulations shall be posted in the Clean Room.
- N. Adequate and appropriate PPE for the project and number of personnel/shifts shall be provided. All personal protective equipment issued must be based on a hazard assessment conducted under 29 CFR 1910.132(d).

#### **2.1.2 NEGATIVE PRESSURE FILTRATION SYSTEM**

The Contractor shall provide enough HEPA negative air machines to completely exchange the regulated area air volume 4 times per hour. The Competent Person shall determine the number of units needed for the regulated area by dividing the cubic feet in the regulated area by 15 and then dividing that result by the cubic feet per minute (CFM) for each unit to determine the number of units needed to effect 4 air changes per hour. Provide a standby unit in the event of machine failure and/or emergency in an adjacent area.

#### **2.1.3 DESIGN AND LAYOUT**

- A. Before start of work submit the design and layout of the regulated area and the negative air machines. The submittal shall indicate the number of, location of and size of negative air machines. The point(s) of exhaust, air flow within the regulated area, anticipated negative pressure differential, and supporting calculations for sizing shall be provided. In addition, submit the following:

1. Method of supplying power to the units and designation/location of the panels.
2. Description of testing method(s) for correct air volume and pressure differential.
3. If auxiliary power supply is to be provided for the negative air machines, provide a schematic diagram of the power supply and manufacturer's data on the generator and switch.

**2.1.4 NEGATIVE AIR MACHINES (HEPA UNITS)**

- A. Negative Air Machine Cabinet: The cabinet shall be constructed of steel or other durable material capable of withstanding potential damage from rough handling and transportation. The width of the cabinet shall be less than 30" in order to fit in standard doorways. The cabinet must be factory sealed to prevent asbestos fibers from being released during use, transport, or maintenance. Any access to and replacement of filters shall be from the inlet end. The unit must be on casters or wheels.
- B. Negative Air Machine Fan: The rating capacity of the fan must indicate the CFM under actual operating conditions. Manufacturer's typically use "free-air" (no resistance) conditions when rating fans. The fan must be a centrifugal type fan.
- C. Negative Air Machine Final Filter: The final filter shall be a HEPA filter. The filter media must be completely sealed on all edges within a structurally rigid frame. The filter shall align with a continuous flexible gasket material in the negative air machine housing to form an air tight seal. Each HEPA filter shall be certified by the manufacturer to have an efficiency of not less than 99.97% when challenged with 0.3  $\mu\text{m}$  dioctylphthalate (DOP) particles. Testing shall have been done in accordance with Military Standard MIL-STD-282 and Army Instruction Manual 136-300-175A. Each filter must bear a UL586 label to indicate ability to perform under specified conditions. Each filter shall be marked with the name of the manufacturer, serial number, air flow rating, efficiency and resistance, and the direction of test air flow.
- D. Negative Air Machine Pre-filters: The pre-filters, which protect the final HEPA filter by removing larger particles, are required to prolong the operating life of the HEPA filter. Two stages of pre-filtration are required. A first stage pre-filter shall be a low efficiency type for particles 10  $\mu\text{m}$  or larger. A second stage pre-filter shall have a medium efficiency effective for particles down to 5  $\mu\text{m}$  or larger. Pre-filters shall be installed either on or in the intake opening of the NAM and the second stage filter must be held in place with a special housing or clamps.

- E. Negative Air Machine Instrumentation: Each unit must be equipped with a gauge to measure the pressure drop across the filters and to indicate when filters have become loaded and need to be changed. A table indicating the cfm for various pressure readings on the gauge shall be affixed near the gauge for reference or the reading shall indicate at what point the filters shall be changed, noting cfm delivery. The unit must have an elapsed time meter to show total hours of operation.
- F. Negative Air Machine Safety and Warning Devices: An electrical/mechanical lockout must be provide to prevent the fan from being operated without a HEPA filter. Units must be equipped with an automatic shutdown device to stop the fan in the event of a rupture in the HEPA filter or blockage in the discharge of the fan. Warning lights are required to indicate normal operation; too high a pressure drop across filters; or too low of a pressure drop across filters.
- G. Negative Air Machine Electrical: All electrical components shall be approved by the National Electrical Manufacturer's Association (NEMA) and Underwriter's Laboratories (UL). Each unit must be provided with overload protection and the motor, fan, fan housing, and cabinet must be grounded.

#### **2.1.5 PRESSURE DIFFERENTIAL**

The fully operational negative air system within the regulated area shall continuously maintain a pressure differential of -0.02" water column gauge. Before any disturbance of any asbestos material, this shall be demonstrated to the VA by use of a pressure differential meter/manometer as required by OSHA 29 CFR 1926.1101(e)(5)(i). The Competent Person shall be responsible for providing, maintaining, and documenting the negative pressure and air changes as required by OSHA and this specification.

#### **2.1.6 MONITORING**

The pressure differential shall be continuously monitored and recorded between the regulated area and the area outside the regulated area with a monitoring device that incorporates a strip chart recorder. The strip chart recorder shall become part of the project log and shall indicate at least -0.02" water column gauge for the duration of the project.

#### **2.1.7 AUXILIARY GENERATOR**

If the building is occupied during abatement, provide an auxiliary gasoline/diesel generator located outside the building in an area protected from the weather. In the event of a power failure, the generator must automatically start and supply power to a minimum of 50% of the negative air machines in operation.

#### **2.1.1.8 SUPPLEMENTAL MAKE-UP AIR INLETS**

Provide, as needed for proper air flow in the regulated area, in a location approved by the VA, openings in the plastic sheeting to allow outside air to flow into the regulated area. Auxiliary makeup air inlets must be located as far from the negative air machines as possible, off the floor near the ceiling, and away from the barriers that separate the regulated area from the occupied clean areas. Cover the inlets with weighted flaps which will seal in the event of failure of the negative pressure system.

#### **2.1.1.9 TESTING THE SYSTEM**

The negative pressure system must be tested before any ACM is disturbed in any way. After the regulated area has been completely prepared, the decontamination units set up, and the negative air machines installed, start the units up one at a time. Demonstrate and document the operation and testing of the negative pressure system to the VA using smoke tubes and a negative pressure gauge. Testing must also be done at the start of each work shift.

#### **2.1.1.10 DEMONSTRATION OF THE NEGATIVE AIR PRESSURE SYSTEM**

The demonstration of the operation of the negative pressure system to the VA shall include, but not be limited to, the following:

- A. Plastic barriers and sheeting move lightly in toward the regulated area.
- B. Curtains of the decontamination units move in toward regulated area.
- C. There is a noticeable movement of air through the decontamination units. Use the smoke tube to demonstrate air movement from the clean room to the shower room to the equipment room to the regulated area.
- D. Use smoke tubes to demonstrate air is moving across all areas in which work is to be done. Use a differential pressure gauge to indicate a negative pressure of at least -0.02" across every barrier separating the regulated area from the rest of the building. Modify the system as necessary to meet the above requirements.

#### **2.1.1.11 USE OF SYSTEM DURING ABATEMENT OPERATIONS**

- A. Start units before beginning any disturbance of ACM occurs. After work begins, the units shall run continuously, maintaining 4 actual air changes per hour at a negative pressure differential of -0.02" water column gauge, for the duration of the work until a final visual clearance and final air clearance has been completed.

The negative air machines shall not be shut down for the duration of the project unless authorized by the VA, in writing.

- B. Abatement work shall begin at a location farthest from the units and proceed towards them. If an electric failure occurs, the Competent

Person shall stop all abatement work and immediately begin wetting all exposed asbestos materials for the duration of the power outage. Abatement work shall not resume until power is restored and all units are operating properly again.

- C. The negative air machines shall continue to run after all work is completed and until a final visual clearance and a final air clearance has been completed for that regulated area.

#### **2.1.12 DISMANTLING THE SYSTEM**

After completion of the final visual and final air clearance has been obtained by the VPIH/CIH, the units may be shut down. The units shall have been **completely decontaminated**, all pre-filters removed and disposed of as asbestos waste, asbestos labels attached and the units inlet/outlet sealed with 2 layers of 6 mil poly.

### **2.2 CONTAINMENT BARRIERS AND COVERINGS IN THE REGULATED AREA**

#### **2.2.1 GENERAL**

Seal off the perimeter to the regulated area to completely isolate the regulated area from adjacent spaces. All surfaces in the regulated area must be covered to prevent contamination and to facilitate clean-up. Should adjacent areas become contaminated as a result of the work, shall immediately stop work and clean up the contamination at no additional cost to the VA. Provide firestopping and identify all fire barrier penetrations due to abatement work as specified in Section 2.2.8; FIRESTOPPING.

#### **2.2.2 PREPARATION PRIOR TO SEALING THE REGULATED AREA**

Place all tools, scaffolding, materials and equipment needed for working in the regulated area prior to erecting any plastic sheeting. All uncontaminated removable furniture, equipment and/or supplies shall be removed by the VA from the regulated area before commencing work. Any objects remaining in the regulated area shall be completely covered with 2 layers of 6-mil fire retardant poly sheeting and secured with duct tape. Lock out and tag out any HVAC/electrical systems in the regulated area.

#### **2.2.3 CONTROLLING ACCESS TO THE REGULATED AREA**

Access to the regulated area is allowed only through the personnel decontamination facility (PDF). All other means of access shall be eliminated and OSHA DANGER demarcation signs posted as required by OSHA. If the regulated area is adjacent to or within view of an occupied area, provide a visual barrier of 6 mil opaque fire retardant poly to prevent building occupant observation. If the adjacent area is accessible to the

public, the barrier must be solid and capable of withstanding the negative pressure.

#### **2.2.4 CRITICAL BARRIERS**

Completely separate any operations in the regulated area from adjacent areas using 2 layers of 6 mil fire retardant poly and duct tape. Individually seal with 2 layers of 6 mil poly and duct tape all HVAC openings into the regulated area. Individually seal all lighting fixtures, clocks, doors, windows, convectors, speakers, or any other objects/openings in the regulated area. Heat must be shut off any objects covered with poly.

#### **2.2.5 PRIMARY BARRIERS**

- A. Cover the regulated area with two layers of 6 mil fire retardant poly on the floors and two layers of 4 mil fire retardant poly on the walls, unless otherwise directed in writing by the VA representative. Floor layers must form a right angle with the wall and turn up the wall at least 300 mm (12"). Seams must overlap at least 1800 mm (6') and must be spray glued and taped. Install sheeting so that layers can be removed independently from each other. Carpeting shall be covered with three layers of 6 mil poly. Corrugated cardboard sheets must be placed between the bottom and middle layers of poly. Mechanically support and seal with duct tape and glue all wall layers.
- B. If stairs and ramps are covered with 6 mil plastic, two layers must be used. Provide 19 mm (3/4") exterior grade plywood treads held in place with duct tape/glue on the plastic. Do not cover rungs or rails with any isolation materials.

#### **2.2.6 SECONDARY BARRIERS**

A loose layer of 6 mil shall be used as a drop cloth to protect the primary layers from debris generated during the abatement. This layer shall be replaced as needed during the work minimally once per work day.

#### **2.2.7 EXTENSION OF THE REGULATED AREA**

If the enclosure of the regulated area is breached in any way that could allow contamination to occur, the affected area shall be included in the regulated area and constructed as per this section. Decontamination measures must be started immediately and continue until air monitoring indicates background levels are met.

#### **2.2.8 FIRESTOPPING**

- A. Through penetrations caused by cables, cable trays, pipes, sleeves must be firestopped with a fire-rated firestop system providing an air tight seal.

- B. Firestop materials that are not equal to the wall or ceiling penetrated shall be brought to the attention of the VA Representative. The contractor shall list all areas of penetration, the type of sealant used, and whether or not the location is fire rated. Any discovery of penetrations during abatement shall be brought to the attention of the VA representative immediately. All walls, floors and ceilings are considered fire rated unless otherwise determined by the VA Representative or Fire Marshall.
- C. Any visible openings whether or not caused by a penetration shall be reported by the Contractor to the VA Representative for a sealant system determination. Firestops shall meet ASTM E814 and UL 1479 requirements for the opening size, penetrant, and fire rating needed.

## **2.3 MONITORING, INSPECTION AND TESTING**

### **2.3.1 GENERAL**

- A. Perform throughout abatement work monitoring, inspection and testing inside and around the regulated area in accordance with the OSHA requirements and these specifications. The CPIH shall be responsible for and shall inspect and oversee the performance of the Contractor IH Technician. The IH Technician shall continuously inspect and monitor conditions inside the regulated area to ensure compliance with these specifications. In addition, the CPIH shall personally manage air sample collection, analysis, and evaluation for personnel, regulated area, and adjacent area samples to satisfy OSHA requirements. Additional inspection and testing requirements are also indicated in other parts of this specification.
- B. The VA will employ an independent industrial hygienist (VPIH/CIH) consultant and/or use its own IH to perform various services on behalf of the VA. The VPIH/CIH will perform the necessary monitoring, inspection, testing, and other support services to ensure that VA patients, employees, and visitors will not be adversely affected by the abatement work, and that the abatement work proceeds in accordance with these specifications, that the abated areas or abated buildings have been successfully decontaminated. The work of the VPIH/CIH consultant in no way relieves the Contractor from their responsibility to perform the work in accordance with contract/specification requirements, to perform continuous inspection, monitoring and testing for the safety of their employees, and to perform other such services as specified. The cost of the VPIH/CIH and their services will be borne by the VA except for any repeat of final inspection and testing that may be required due to

unsatisfactory initial results. Any repeated final inspections and/or testing, if required, will be paid for by the Contractor.

- C. If fibers counted by the VPIH/CIH during abatement work, either inside or outside the regulated area, utilizing the NIOSH 7400 air monitoring method, exceed the specified respective limits, the Contractor shall stop work. The Contractor may request confirmation of the results by analysis of the samples by TEM. Request must be in writing and submitted to the VA's representative. Cost for the confirmation of results will be borne by the Contractor for both the collection and analysis of samples and for the time delay that may/does result for this confirmation. Confirmation sampling and analysis will be the responsibility of the CPIH with review and approval of the VPIH/CIH. An agreement between the CPIH and the VPIH/CIH shall be reached on the exact details of the confirmation effort, in writing, including such things as the number of samples, location, collection, quality control on-site, analytical laboratory, interpretation of results and any follow-up actions. This written agreement shall be co-signed by the IH's and delivered to the VA's representative.

#### **2.3.2 SCOPE OF SERVICES OF THE VPIH/CIH CONSULTANT**

- A. The purpose of the work of the VPIH/CIH is to: assure quality; adherence to the specification; resolve problems; prevent the spread of contamination beyond the regulated area; and assure clearance at the end of the project. In addition, their work includes performing the final inspection and testing to determine whether the regulated area or building has been adequately decontaminated. All air monitoring is to be done utilizing PCM/TEM. The VPIH/CIH will perform the following tasks:
1. Task 1: Establish background levels before abatement begins by collecting background samples. Retain samples for possible TEM analysis.
  2. Task 2: Perform continuous air monitoring, inspection, and testing outside the regulated area during actual abatement work to detect any faults in the regulated area isolation and any adverse impact on the surroundings from regulated area activities.
  3. Task 3: Perform unannounced visits to spot check overall compliance of work with contract/specifications. These visits may include any inspection, monitoring, and testing inside and outside the regulated area and all aspects of the operation except personnel monitoring.
  4. Task 4: Provide support to the VA representative such as evaluation of submittals from the Contractor, resolution of conflicts, interpret data, etc.

5. Task 5: Perform, in the presence of the VA representative, final inspection and testing of a decontaminated regulated area at the conclusion of the abatement to certify compliance with all regulations and VA requirements/specifications.
  6. Task 6: Issue certificate of decontamination for each regulated area and project report.
- B. All documentation, inspection results and testing results generated by the VPIH/CIH will be available to the Contractor for information and consideration. The Contractor shall cooperate with and support the VPIH/CIH for efficient and smooth performance of their work.
- C. The monitoring and inspection results of the VPIH/CIH will be used by the VA to issue any Stop Removal orders to the Contractor during abatement work and to accept or reject a regulated area or building as decontaminated.

#### **2.3.3 MONITORING, INSPECTION AND TESTING BY CONTRACTOR CPIH**

The Contractor's CPIH is responsible for managing all monitoring, inspections, and testing required by these specifications, as well as any and all regulatory requirements adopted by these specifications. The CPIH is responsible for the continuous monitoring of all subsystems and procedures which could affect the health and safety of the Contractor's personnel. Safety and health conditions and the provision of those conditions inside the regulated area for all persons entering the regulated area is the exclusive responsibility of the Contractor/Competent Person. The person performing the personnel and area air monitoring inside the regulated area shall be an IH Technician, who shall be trained and shall have specialized field experience in air sampling and analysis. The IH Technician shall have a NIOSH 582 Course or equivalent and show proof. The IH Technician shall participate in the AIHA Asbestos Analysis Registry or participate in the Proficiency Analytic Testing program of AIHA for fiber counting quality control assurance. The IH Technician shall also be an accredited EPA/State Contractor/Supervisor and Building Inspector. The IH Technician shall have participated in five abatement projects collecting personal and area samples as well as responsibility for documentation. The analytic laboratory used by the Contractor to analyze the samples shall be AIHA accredited for asbestos PAT. A daily log documenting all OSHA requirements for air monitoring for asbestos in 29 CFR 1926.1101(f), (g) and Appendix A. This log shall be made available to the VA representative and the VPIH/CIH. The log will contain, at a minimum, information on personnel or area sampled, other persons represented by

the sample, the date of sample collection, start and stop times for sampling, sample volume, flow rate, and fibers/cc. The CPIH shall collect and analyze samples for each representative job being done in the regulated area, i.e., removal, wetting, clean-up, and load-out. No fewer than two personal samples per shift shall be collected and one area sample per 1,000 square feet of regulated area where abatement is taking place and one sample per shift in the clean room area shall be collected. In addition to the continuous monitoring required, the CPIH will perform inspection and testing at the final stages of abatement for each regulated area as specified in the CPIH responsibilities.

#### **2.4 STANDARD OPERATING PROCEDURES**

The Contractor shall have established Standard Operating Procedures (SOP's) in printed form and loose leaf folder consisting of simplified text, diagrams, sketches, and pictures that establish and explain clearly the procedures to be followed during all phases of the work by the Contractor's personnel. The SOP's must be modified as needed to address specific requirements of this project and the specifications. The SOP's shall be submitted for review and approval prior to the start of any abatement work. The minimum topics and areas to be covered by the SOP's are:

- A. Minimum Personnel Qualifications
- B. Emergency Action Plan/Contingency Plans and Arrangements
- C. Security and Safety Procedures
- D. Respiratory Protection/Personal Protective Equipment Program and Training
- E. Medical Surveillance Program and Recordkeeping
- F. Regulated Area Requirements - Containment Barriers/Isolation of Regulated Area
- G. Decontamination Facilities and Entry/Exit Procedures (PDF and W/EDF)
- H. Negative Pressure Systems Requirements
- I. Monitoring, Inspections, and Testing
- J. Removal Procedures for ACM
- K. Removal of Contaminated Soil (if applicable)
- L. Encapsulation Procedures for ACM
- M. Disposal of ACM waste/equipment
- N. Regulated Area Decontamination/Clean-up
- O. Regulated Area Visual and Air Clearance
- P. Project Completion/Closeout

## 2.5 SUBMITTALS

### 2.5.1 PRE-START MEETING SUBMITTALS

Submit to the VA a minimum of 14 days prior to the pre-start meeting the following for review and approval. Meeting this requirement is a prerequisite for the pre-start meeting for this project:

- A. Submit a detailed work schedule for the entire project reflecting contract documents and the phasing/schedule requirements from the CPM chart.
- B. Submit a staff organization chart showing all personnel who will be working on the project and their capacity/function. Provide their qualifications, training, accreditations, and licenses, as appropriate. Provide a copy of the "Certificate of Worker's Acknowledgment" and the "Affidavit of Medical Surveillance and Respiratory Protection" for each person.
- C. Submit Standard Operating Procedures developed specifically for this project, incorporating the requirements of the specifications, prepared, signed and dated by the CPIH.
- D. Submit the specifics of the materials and equipment to be used for this project with brand names, model numbers, performance characteristics, pictures/diagrams, and number available for the following:
  1. Supplied air system, if used, negative air machines, HEPA vacuums, air monitoring pumps, calibration devices, pressure differential monitoring device and emergency power generating system.
  2. Waste water filtration system, shower system, containment barriers.
  3. Encapsulants, surfactants, hand held sprayers, airless sprayers, glovebags, fire extinguishers.
  4. Respirators, protective clothing, personal protective equipment.
  5. Fire safety equipment to be used in the regulated area.
- E. Submit the name, location, and phone number of the approved landfill; proof/verification the landfill is approved for ACM disposal; the landfill's requirements for ACM waste; the type of vehicle to be used for transportation; and name, address, and phone number of subcontractor, if used. Proof of asbestos training for transportation personnel shall be provided.
- F. Submit required notifications and arrangements made with regulatory agencies having regulatory jurisdiction and the specific contingency/emergency arrangements made with local health, fire, ambulance, hospital authorities and any other notifications/arrangements.

- G. Submit the name, location and verification of the laboratory and/or personnel to be used for analysis of air and/or bulk samples. Air monitoring must be done in accordance with OSHA 29 CFR 1926.1101(f) and Appendix A.
- H. Submit qualifications verification: Submit the following evidence of qualifications. Make sure that all references are current and verifiable by providing current phone numbers and documentation.
1. Asbestos Abatement Company: Project experience within the past 3 years; listing projects first most similar to this project: Project Name; Type of Abatement; Duration; Cost; Reference Name/Phone Number; Final Clearance; Completion Date
  2. List of project(s) halted by owner, A/E, IH, regulatory agency in the last 3 years: Project Name; Reason; Date; Reference Name/Number; Resolution
  3. List asbestos regulatory citations, penalties, damages paid and legal actions taken against the company in the last 3 years. Provide copies and all information needed for verification.
- I. Submit information on personnel: Provide a resume; address each item completely; copies of certificates, accreditations, and licenses. Submit an affidavit signed by the CPIH stating that all personnel submitted below have medical records in accordance with OSHA 29 CFR 1926.1101(m) and 29 CFR 1910.20 and that the company has implemented a medical surveillance program and maintains recordkeeping in accordance with the above regulations. Submit the phone number and doctor/clinic/hospital used for medical evaluations.
1. CPIH: Name; years of abatement experience; list of projects similar to this one; certificates, licenses, accreditations for proof of AHERA/OSHA specialized asbestos training; professional affiliations; number of workers trained; samples of training materials; samples of SOP's developed; medical opinion; current respirator fit test.
  2. Competent Person(s)/Supervisor(s): Number; names; social security numbers; years of abatement experience as Competent Person/Supervisor; list of similar projects as Competent Person/Supervisor; as a worker; certificates, licenses, accreditations; proof of AHERA/OSHA specialized asbestos training; maximum number of personnel supervised on a project; medical opinion; current respirator fit test.
  3. Workers: Numbers; names; social security numbers; years of abatement experience; certificates, licenses, accreditations; training courses

in asbestos abatement and respiratory protection; medical opinion;  
current respirator fit test.

- J. Submit copies of State license for asbestos abatement; copy of insurance policy, including exclusions with a letter from agent stating in plain english the coverage provided and the fact that asbestos abatement activities are covered by the policy; copy of SOP's incorporating the requirements of this specification; information on who provides your training, how often; who provides medical surveillance, how often; who does and how is air monitoring conducted; a list of references of independent laboratories/IH's familiar with your air monitoring and standard operating procedures; copies of monitoring results of the five referenced projects listed and analytical method(s) used.
- K. Rented equipment must be decontaminated prior to returning to the rental agency.
- L. Submit, before the start of work, the manufacturer's technical data for all types of encapsulants and the MSDS. Provide application instructions also.

#### **2.5.2 SUBMITTALS DURING ABATEMENT**

- A. The Competent Person shall maintain and submit a daily log at the regulated area documenting the dates and times of the following: purpose, attendees and summary of meetings; all personnel entering/exiting the regulated area; document and discuss the resolution of unusual events such as barrier breeching, equipment failures, emergencies, and any cause for stopping work; representative air monitoring and results/TWA's/EL's. Submit this information daily to the VPIH/CIH.
- B. The CPIH shall document and maintain the inspection and approval of the regulated area preparation prior to start of work and daily during work.
  - 1. Removal of any poly barriers.
  - 2. Visual inspection/testing by the CPIH prior to application of lockdown.
  - 3. Packaging and removal of ACM waste from regulated area.
  - 4. Disposal of ACM waste materials; copies of Waste Shipment Records/landfill receipts to the VA's representative on a weekly basis.

#### **2.5.3 SUBMITTALS AT COMPLETION OF ABATEMENT**

The CPIH shall submit a project report consisting of the daily log book requirements and documentation of events during the abatement project including Waste Shipment Records signed by the landfill's agent. The report shall include a certificate of completion, signed and dated by

the CPIH, in accordance with Attachment #1. All clearance and perimeter samples must be submitted. The VA Representative will retain the abatement report after completion of the project.

## **2.6 ENCAPSULANTS**

### **2.6.1 TYPES OF ENCAPSULANTS**

- A. The following four types of encapsulants, if used, must comply with performance requirements as stated in paragraph 2.6.2:
1. Removal encapsulant - used as a wetting agent to remove ACM.
  2. Bridging encapsulant - provides a tough, durable coating on ACM.
  3. Penetrating encapsulant - penetrates/encapsulates ACM at least 13 mm (1/2").
  4. Lockdown encapsulant - seals microscopic fibers on surfaces after ACM removal.

### **2.6.2 PERFORMANCE REQUIREMENTS**

Encapsulants shall meet the latest requirements of EPA; shall not contain toxic or hazardous substances; or solvents; and shall comply with the following performance requirements:

- A. General Requirements for all Encapsulants:
1. ASTM E84: Flame spread of 25; smoke emission of 50.
  2. University of Pittsburgh Protocol: Combustion Toxicity; zero mortality.
  3. ASTM C732: Accelerated Aging Test; Life Expectancy - 20 years.
  4. ASTM E96: Permeability - minimum of 0.4 perms.
- B. Bridging/Penetrating Encapsulants:
1. ASTM E736: Cohesion/Adhesion Test - 24 kPa (50 lbs/ft<sup>2</sup>).
  2. ASTM E119: Fire Resistance - 3 hours (Classified by UL for use on fibrous/cementitious fireproofing).
  3. ASTM D2794: Gardner Impact Test; Impact Resistance - minimum 11.5 kg-mm (43 in/lb).
  4. ASTM D522: Mandrel Bend Test; Flexibility - no rupture or cracking.
- C. Lockdown Encapsulants:
1. ASTM E119: Fire resistance - 3 hours (tested with fireproofing over encapsulant applied directly to steel member).
  2. ASTM E736: Bond Strength - 48 kPa (100 lbs/ft<sup>2</sup>) (test compatibility with cementitious and fibrous fireproofing).
  3. In certain situations, encapsulants may have to be applied to hot pipes/equipment. The encapsulant must be able to withstand high temperatures without cracking or off-gassing any noxious vapors during application.

### **2.6.3 CERTIFICATES OF COMPLIANCE**

The Contractor shall submit to the VA representative certification from the manufacturer indicating compliance with performance requirements for encapsulants when applied according to manufacturer recommendations.

## **PART 3 - EXECUTION**

### **3.1 PRE-ABATEMENT ACTIVITIES**

#### **3.1.1 PRE-ABATEMENT MEETING**

The VA representative, upon receipt, review, and substantial approval of all pre-abatement submittals and verification by the CPIH that all materials and equipment required for the project are on the site, will arrange for a pre-abatement meeting between the Contractor, the CPIH, Competent Person(s), the VA representative(s), and the VPIH/CIH. The purpose of the meeting is to discuss any aspect of the submittals needing clarification or amplification and to discuss any aspect of the project execution and the sequence of the operation. The Contractor shall be prepared to provide any supplemental information/documentation to the VA's representative regarding any submittals, documentation, materials or equipment. Upon satisfactory resolution of any outstanding issues, the VA's representative will issue a written order to proceed to the Contractor. No abatement work of any kind described in the following provisions shall be initiated prior to the VA written order to proceed.

#### **3.1.2 PRE-ABATEMENT INSPECTIONS AND PREPARATIONS**

Before any work begins on the construction of the regulated area, the Contractor will:

- A. Conduct a space-by-space inspection with an authorized VA representative and prepare a written inventory of all existing damage in those spaces where asbestos abatement will occur. Still or video photography may be used to supplement the written damage inventory. Document will be signed and certified as accurate by both parties.
- B. The VA Representative, the Contractor, and the VPIH/CIH must be aware of 10/95 A/E Quality Alert indicating the failure to identify asbestos in the areas listed. Make sure these areas are looked at/reviewed on the project: Lay-in ceilings concealing ACM; ACM behind walls/windows from previous renovations; inside chases/walls; transite piping/ductwork/sheets; behind radiators; roofing materials; below window sills; water/sewer lines; electrical conduit coverings; crawl spaces( previous abatement contamination); flooring/mastic covered by carpeting/new flooring; exterior insulated wall panels; on underground fuel tanks; steam line trench coverings.

- C. Ensure that all furniture, machinery, equipment, curtains, drapes, blinds, and other movable objects required to be removed from the regulated area have been cleaned and removed or properly protected from contamination.
- D. If present and required, remove and dispose of carpeting from floors in the regulated area.
- E. Inspect existing firestopping in the regulated area. Correct as needed.

### **3.1.3 PRE-ABATEMENT CONSTRUCTION AND OPERATIONS**

- A. Perform all preparatory work for the first regulated area in accordance with the approved work schedule and with this specification.
- B. Upon completion of all preparatory work, the CPIH will inspect the work and systems and will notify the VA's representative when the work is completed in accordance with this specification. The VA's representative may inspect the regulated area and the systems with the VPIH/CIH and may require that upon satisfactory inspection, the Contractor's employees perform all major aspects of the approved SOP's, especially worker protection, respiratory systems, contingency plans, decontamination procedures, and monitoring to demonstrate satisfactory operation. The operational systems for respiratory protection and the negative pressure system shall be demonstrated for proper performance.
- C. The CPIH shall document the pre-abatement activities described above and deliver a copy to the VA's representative.
- D. Upon satisfactory inspection of the installation of and operation of systems the VA's representative will notify the Contractor in writing to proceed with the asbestos abatement work in accordance with this specification and all applicable regulations.

### **3.2 REGULATED AREA PREPARATIONS**

- A. Post OSHA DANGER signs meeting the specifications of OSHA 29 CFR 1926.1101 at any location and approaches to the regulated area where airborne concentrations of asbestos may exceed ambient background levels. Signs shall be posted at a distance sufficiently far enough away from the regulated area to permit any personnel to read the sign and take the necessary measures to avoid exposure. Additional signs will be posted following construction of the regulated area enclosure.
- B. Shut down and lock out electric power to the regulated area. Provide temporary power and lighting. Insure safe installation including GFCI of temporary power sources and equipment by compliance with all applicable electrical code requirements and OSHA requirements for temporary electrical systems. Electricity shall be provided by the VA.

- C. Shut down and lock out heating, cooling, and air conditioning system (HVAC) components that are in, supply or pass through the regulated area. Investigate the regulated area and agree on pre-abatement condition with the VA's representative. Seal all intake and exhaust vents in the regulated area with duct tape and 2 layers of 6-mil poly. Also, seal any seams in system components that pass through the regulated area. Remove all contaminated HVAC system filters and place in labeled 6-mil polyethylene disposal bags for staging and eventual disposal as asbestos waste.
- D. The Contractor shall provide sanitary facilities for abatement personnel and maintain them in a clean and sanitary condition throughout the abatement project.
- E. The VA will provide water for abatement purposes. The Contractor shall connect to the existing VA system. The service to the shower(s) shall be supplied with backflow prevention.
- F. Pre-clean all movable objects within the regulated area using a HEPA filtered vacuum and/or wet cleaning methods as appropriate. After cleaning, these objects shall be removed from the regulated area and carefully stored in an uncontaminated location. Drapes, clothing, upholstered furniture and other fabric items should be disposed of as asbestos contaminated waste. Cleaning these asbestos contaminated items utilizing HEPA vacuum techniques and off-premises steam cleaning is very difficult and cannot guarantee decontamination. Since adequate cleaning of contaminated fabrics is difficult, the VA will determine whether this option is an appropriate one. Carpeting will be disposed of prior to abatement if in the regulated area.
- G. Pre-clean all fixed objects in the regulated area using HEPA filtered vacuums and/or wet cleaning techniques as appropriate. Careful attention must be paid to machinery behind grills or gratings where access may be difficult but contamination may be significant. Also, pay particular attention to wall, floor and ceiling penetration behind fixed items. After precleaning, enclose fixed objects with 2 layers of 6-mil poly and seal securely in place with duct tape. Objects (e.g., permanent fixtures, shelves, electronic equipment, laboratory tables, sprinklers, alarm systems, closed circuit TV equipment and computer cables) which must remain in the regulated area and that require special ventilation or enclosure requirements should be designated here along with specified means of protection. Contact the manufacturer for special protection requirements.

- H. Pre-clean all surfaces in the regulated area using HEPA filtered vacuums and/or wet cleaning methods as appropriate. Do not use any methods that would raise dust such as dry sweeping or vacuuming with equipment not equipped with HEPA filters. Do not disturb asbestos-containing materials during this pre-cleaning phase.

### **3.3 CONTAINMENT BARRIERS AND COVERINGS FOR THE REGULATED AREA GENERAL:**

Follow requirements of Section 2.2 - Containment Barriers and Coverings.

### **3.4 REMOVAL OF ACM**

#### **3.4.1 WETTING ACM**

- A. Use amended water for the wetting of ACM prior to removal. The Competent Person shall assure the wetting of ACM meets the definition of "adequately wet" in the EPA NESHAP's regulation and OSHA's "wet methods" for the duration of the project. A removal encapsulant may be used instead of amended water with written approval of the VA's representative.
- B. Amended Water: Provide water to which a surfactant has been added shall be used to wet the ACM and reduce the potential for fiber release during disturbance of ACM. The mixture must be equal to or greater than the wetting provided by water amended by a surfactant consisting one ounce of 50% polyoxyethylene ester and 50% polyoxyethylene ether mixed with 5 gallons (19L) of water.
- C. Removal Encapsulant: Provide a penetrating encapsulant designed specifically for the removal of ACM. The material must, when used, result in adequate wetting of the ACM and retard fiber release during removal.

#### **3.4.2 SECONDARY BARRIER AND WALKWAYS**

- A. Install as a drop cloth a 6 mil poly sheet at the beginning of each work shift where removal is to be done during that shift. Completely cover floors and any walls within 10 feet (3M) of the area where work is to be done. Secure the secondary barrier with duct tape to prevent debris from getting behind it. Remove the secondary barrier at the end of the shift or as work in the area is completed. Keep residue on the secondary barrier wetted. When removing, fold inward to prevent spillage and place in a disposal bag.
- B. Install walkways using 6 mil black poly between the regulated area and the decontamination facilities (PDF and W/EDF) to protect the primary layers from contamination and damage. Install the walkways at the beginning of each shift and remove at the end of each shift.

### 3.4.3 WET REMOVAL OF ACM

- A. Adequately and thoroughly wet the ACM to be removed prior to removal to reduce/prevent fiber release to the air. Adequate time must be allowed for the amended water to saturate the ACM. Abatement personnel must not disturb dry ACM. Use a fine spray of amended water or removal encapsulant. Saturate the material sufficiently to wet to the substrate without causing excessive dripping. The material must be sprayed repeatedly/continuously during the removal process in order to maintain adequately wet conditions. Removal encapsulants must be applied in accordance with the manufacturer's written instructions. Perforate or carefully separate, using wet methods, an outer covering that is painted or jacketed in order to allow penetration and wetting of the material. Where necessary, carefully remove covering while wetting to minimize fiber release. **In no event shall dry removal occur except in the case of electrical hazards or a greater safety issue is possible!**
- B. If ACM does not wet well with amended water due to coating or jacketing, remove as follows:
1. Mist work area continuously with amended water whenever necessary to reduce airborne fiber levels.
  2. Remove saturated ACM in small sections. Do not allow material to dry out. As material is removed, bag material while still wet into disposal bags. Twist tightly the bag neck, bend over (gooseneck) and seal with a minimum of three tight wraps of duct tape. Clean /decontaminate the outside of any residue and move to washdown station adjacent to W/EDF.
  3. Fireproofing or Architectural Finish on Scratch Coat: Spray with a fine mist of amended water or removal encapsulant. Allow time for saturation to the substrate. Do not oversaturate causing excess dripping. Scrape material from substrate. Remove material in manageable quantities and control falling to staging or floor. If the falling distance is over 20 feet (6M), use a drop chute to contain material through descent. Remove residue remaining on the scratch coat after scraping is done using a stiff bristle hand brush. If a removal encapsulant is used, remove residue completely before the encapsulant dries. Re-wet the substrate as needed to prevent drying before the residue is removed.
  4. Fireproofing or Architectural Finish on Wire Lath: Spray with a fine mist of amended water or removal encapsulant. Allow time to completely saturate the material. Do not oversaturate causing excess dripping. If the surface has been painted or otherwise coated, cut

small holes as needed and apply amended water or removal encapsulant from above. Cut saturated wire lath into 2' x 6' (50mm x 150mm) sections and cut hanger wires. Roll up complete with ACM, cover in burlap and hand place in disposal bag. Do not drop to floor. After removal of lath/ACM, remove any overspray on decking and structure using stiff bristle nylon brushes. Depending on hardness of overspray, scrapers may be needed for removal.

5. Pipe/Tank/Vessel/Boiler Insulation: Remove the outer layer of wrap while spraying with amended water in order to saturate the ACM. Spray ACM with a fine mist of amended water or removal encapsulant. Allow time to saturate the material to the substrate. Cut bands holding pre-formed pipe insulation sections. Slit jacketing at the seams, remove and hand place in a disposal bag. Do not allow dropping to the floor. Remove molded fitting insulation/mud in large pieces and hand place in a disposal bag. Remove any residue on pipe or fitting with a stiff bristle nylon brush. In locations where pipe fitting insulation is removed from fibrous glass or other non-asbestos insulated straight runs of pipe, remove fibrous material at least 6" from the point it contacts the ACM.

### **3.5 LOCKDOWN ENCAPSULATION**

#### **3.5.1 GENERAL**

Lockdown encapsulation is an integral part of the ACM removal. At the conclusion of ACM removal and before removal of the primary barriers, all surfaces shall be encapsulated with a bridging encapsulant.

#### **3.5.2 DELIVERY AND STORAGE**

Deliver materials to the job site in original, new and unopened containers bearing the manufacturer's name and label as well as the following information: name of material, manufacturer's stock number, date of manufacture, thinning instructions, application instructions and the MSDS for the material.

#### **3.5.3 WORKER PROTECTION**

Before beginning work with any material for which an MSDS has been submitted, provide workers with any required personal protective equipment. The required personal protective equipment shall be used whenever exposure to the material might occur. In addition to OSHA/specification requirements for respiratory protection, a paint pre-filter and an organic vapor cartridge, at a minimum, shall be used in addition to the HEPA filter when a solvent based encapsulant is used. The CPIH shall be responsible for provision of adequate respiratory protection.

#### **3.5.4 ENCAPSULATION OF SCRATCH COAT PLASTER OR PIPING**

- A. Apply two coats of encapsulant to the scratch coat plaster or piping after all ACM has been removed. Apply in strict accordance with the manufacturer's instructions. Any deviation from the instructions must be approved by the VA's representative in writing prior to commencing the work.
- B. Apply the encapsulant with an airless sprayer at a pressure and using a nozzle orifice as recommended by the manufacturer. Apply the first coat while the scratch coat is still damp from the asbestos removal process, after passing the visual inspection. If the surface has been allowed to dry, wet wipe or HEPA vacuum prior to spraying with encapsulant. Apply a second coat over the first coat in strict conformance with the manufacturer's instructions. Color the encapsulant and contrast the color in the second coat so that visual confirmation of completeness and uniform coverage of each coat is possible. Adhere to the manufacturer's instructions for coloring. At the completion of the encapsulation, the surface must be a uniform third color produced by the mixture.

#### **3.5.5 SEALING EXPOSED EDGES**

Seal edges of ACM exposed by removal work which is inaccessible, such as a sleeve, wall penetration, etc., with two coats of encapsulant. Prior to sealing, permit the exposed edges to dry completely to permit penetration of the encapsulant. Apply in accordance with 3.5.4 (B).

### **3.6 DISPOSAL OF ACM WASTE MATERIALS**

#### **3.6.1 GENERAL**

Dispose of waste ACM and debris which is packaged in accordance with these specifications, OSHA, EPA and DOT. The landfill requirements for packaging must also be met. Disposal shall be done at an approved landfill. Disposal of non-friable ACM shall be done in accordance with applicable regulations.

#### **3.6.2 PROCEDURES**

- A. Asbestos waste shall be packaged and moved through the W/EDF into a covered transport container in accordance with procedures in this specification. Waste shall be double-bagged prior to disposal. Wetted waste can be very heavy. Bags shall not be overfilled. Bags shall be securely sealed to prevent accidental opening and/or leakage. The top shall be tightly twisted and goosenecked prior to tightly sealing with at least three wraps of duct tape. Ensure that unauthorized persons do not have access to the waste material once it is outside the regulated area. All transport containers must be covered at all times when not in

use. NESHAP's signs must be on containers during loading and unloading. Material shall not be transported in open vehicles. If drums are used for packaging, the drums shall be labeled properly and shall not be re-used.

- B. Waste Load Out: Waste load out shall be done in accordance with the procedures in W/EDF Decontamination Procedures. Bags shall be decontaminated on exterior surfaces by wet cleaning and/or HEPA vacuuming before being placed in the second bag.
- C. Asbestos waste with sharp edged components, i.e., nails, screws, lath, strapping, tin sheeting, jacketing, metal mesh, etc., which might tear poly bags shall be wrapped securely in burlap before packaging and, if needed, use a poly lined fiber drum as the second container, prior to disposal.

### **3.7 PROJECT DECONTAMINATION**

#### **3.7.1 GENERAL**

- A. The entire work related to project decontamination shall be performed under the close supervision and monitoring of the CPIH.
- B. If the asbestos abatement work is in an area which was contaminated prior to the start of abatement, the decontamination will be done by cleaning the primary barrier poly prior to its removal and cleanings of the surfaces of the regulated area after the primary barrier removal.
- C. If the asbestos abatement work is in an area which was uncontaminated prior to the start of abatement, the decontamination will be done by cleaning the primary barrier poly prior to its removal, thus preventing contamination of the building when the regulated area critical barriers are removed.

#### **3.7.2 REGULATED AREA CLEARANCE**

Air testing and other requirements which must be met before release of the Contractor and re-occupancy of the regulated area space are specified in Final Testing Procedures.

#### **3.7.3 WORK DESCRIPTION**

Decontamination includes the clearance of the air in the regulated area and the decontamination and removal of the enclosures/facilities installed prior to the abatement work including primary/critical barriers, PDF and W/EDF facilities, and negative pressure systems.

#### **3.7.4 PRE-DECONTAMINATION CONDITIONS**

- A. Before decontamination starts, all ACM waste from the regulated area shall be removed, all waste collected and removed, and the loose 6 mil layer of poly removed and disposed of along with any gross debris generated by the work.

B. At the start of decontamination, the following shall be in place:

1. Primary barriers consisting of 2 layers of 6 mil poly on the floor and 4 mil poly on the walls.
2. Critical barriers consisting of 2 layers of 6 mil poly which is the sole barrier between the regulated area and openings to the rest of the building or outside.
4. Decontamination facilities for personnel and equipment in operating condition and the negative pressure system in operation.

**3.7.5 FIRST CLEANING**

Carry out a first cleaning of all surfaces of the regulated area including items of remaining poly sheeting, tools, scaffolding, ladders/staging by wet methods and/or HEPA vacuuming. Do not use dry dusting/sweeping methods. Use each surface of a cleaning cloth one time only and then dispose of as contaminated waste. Continue this cleaning until there is no visible residue from abated surfaces or poly or other surfaces. Remove all filters in the air handling system and dispose of as ACM waste in accordance with these specifications. The negative pressure system shall remain in operation during this time. If determined by the CPIH/VPIH/CIH additional cleaning(s) may be needed.

**3.7.6 PRE-CLEARANCE INSPECTION AND TESTING**

The CPIH and VPIH/CIH will perform a thorough and detailed visual inspection at the end of the cleaning to determine whether there is any visible residue in the regulated area. If the visual inspection is acceptable, the CPIH will perform pre-clearance sampling using aggressive clearance as detailed in 40 CFR 763 Subpart E (AHERA) Appendix A (III)(B)(7)(d). If the sampling results show values below 0.01 f/cc, then the Contractor shall notify the VA's representative of the results with a brief report from the CPIH documenting the inspection and sampling results and a statement verifying that the regulated area is ready for lockdown encapsulation. The VA reserves the right to utilize their own VPIH/CIH to perform a pre-clearance inspection and testing for verification.

**3.7.7 LOCKDOWN ENCAPSULATION OF ABATED SURFACES**

With the express written permission of the VA's representative, perform lockdown encapsulation of all surfaces from which asbestos was abated in accordance with the procedures in this specification. Negative pressure shall be maintained in the regulated area during the lockdown application.

### **3.8 FINAL VISUAL INSPECTION AND AIR CLEARANCE TESTING**

#### **3.8.1 GENERAL**

Notify the VA representative 24 hours in advance for the performance of the final visual inspection and testing. The final visual inspection and testing will be performed by the VPIH/CIH starting after the final cleaning.

#### **3.8.2 FINAL VISUAL INSPECTION**

Final visual inspection will include the entire regulated area, the PDF, all poly sheeting, seals over HVAC openings, doorways, windows, and any other openings. If any debris, residue, dust or any other suspect material is detected, the final cleaning shall be repeated at no cost to the VA. Dust/material samples may be collected and analyzed at no cost to the VA at the discretion of the VPIH/CIH to confirm visual findings. When the regulated area is visually clean the final testing can be done.

#### **3.8.3 FINAL AIR CLEARANCE TESTING**

- A. After an acceptable final visual inspection by the VPIH/CIH and VA Representative AE Project Engineer, the VPIH/CIH will perform the final testing. Air samples will be collected and analyzed in accordance with procedures for AHERA in this specification. If work is less than 260 lf/160 sf, 5 PCM samples may be collected for clearance. If work is equal to or more than 260 lf/160 sf, TEM sampling shall be done for clearance. TEM analysis shall be done in accordance with procedures in this specification. If the release criteria are not met, the Contractor shall repeat the final cleaning and continue decontamination procedures until clearance is achieved. All **additional inspection and testing costs will be borne by the Contractor.**
- B. If release criteria are met, proceed to perform the abatement closeout and to issue the certificate of completion in accordance with these specifications.

#### **3.8.4 FINAL AIR CLEARANCE PROCEDURES**

- A. Contractor's Release Criteria: Work in a regulated area is complete when the regulated area is visually clean and airborne fiber levels have been reduced to or below 0.01 f/cc as measured with PCM/TEM methods
- B. Air Monitoring and Final Clearance Sampling: To determine if the elevated airborne fiber counts encountered during abatement operations have been reduced to the specified level, the VPIH/CIH will secure samples and analyze them according to the following procedures:
  1. Fibers Counted: "Fibers" referred to in this section shall be either all fibers regardless of composition as counted in the NIOSH 7400 PCM method or asbestos fibers counted using the AHERA TEM method.

2. Aggressive Sampling: All final air testing samples shall be collected using aggressive sampling techniques except where soil is not encapsulated or enclosed. Samples will be collected on 0.8µ MCE filters for PCM analysis and 0.45µ Polycarbonate filters for TEM. A minimum of 1200 Liters of air shall be collected for clearance samples. Before pumps are started, initiate aggressive sampling as detailed in 40 CFR 763 Subpart E (AHERA) Appendix A (III)(B)(7)(d). Air samples will be collected in areas subject to normal air circulation away from corners, obstructed locations, and locations near windows, doors, or vents. After air sampling pumps have been shut off, circulating fans shall be shut off. The negative pressure system shall continue to operate.

**3.8.5 CLEARANCE SAMPLING USING PCM - LESS THAN 260LF/160SF:**

- A. The VPIH/CIH will perform clearance samples as indicated by the specification.
- B. The NIOSH 7400 PCM method will be used for clearance sampling with a minimum collection volume of 1200 Liters of air. A minimum of 5 PCM clearance samples shall be collected. All samples must be equal to or less than 0.01 f/cc to clear the regulated area.

**3.8.6 CLEARANCE SAMPLING USING TEM - EQUAL TO OR MORE THAN 260LF/160SF: TEM**

Clearance requires 13 samples be collected; 5 inside the regulated area; 5 outside the regulated area; and 3 field blanks.

**3.8.7 LABORATORY TESTING OF PCM CLEARANCE SAMPLES**

The services of an AIHA accredited laboratory will be employed by the VA to perform analysis for the air samples. Samples will be sent daily by the VPIH/CIH so that verbal/faxed reports can be received within 24 hours. A complete record, certified by the laboratory, of all air monitoring tests and results will be furnished to the VA's representative and the Contractor.

**3.8.8 LABORATORY TESTING OF TEM SAMPLES**

Samples shall be sent by the VPIH/CIH to an accredited laboratory for analysis by TEM. Verbal/faxed results from the laboratory shall be available within 24 hours after receipt of the samples. A complete record, certified by the laboratory, of all TEM results shall be furnished to the VA's representative and the Contractor.

**3.9 ABATEMENT CLOSEOUT AND CERTIFICATE OF COMPLIANCE**

**3.9.1 COMPLETION OF ABATEMENT WORK**

After thorough decontamination, seal negative air machines with 2 layers of 6 mil poly and duct tape to form a tight seal at the intake/outlet ends before removal from the regulated area. Complete asbestos abatement

work upon meeting the regulated area visual and air clearance criteria and fulfilling the following:

- A. Remove all equipment and materials from the project area.
- B. Dispose of all packaged ACM waste as required.
- C. Repair or replace all interior finishes damaged during the abatement work, as required.
- D. Fulfill other project closeout requirements as required in this specification.

**3.9.2 CERTIFICATE OF COMPLETION BY CONTRACTOR**

The CPIH shall complete and sign the "Certificate of Completion" in accordance with Attachment 1 at the completion of the abatement and decontamination of the regulated area.

**3.9.3 WORK SHIFTS**

All work shall be done during administrative hours (8:00 AM to 4:30 PM) Monday -Friday excluding Federal Holidays. Any change in the work schedule must be approved in writing by the VA Representative.

**3.9.4 RE-INSULATION**

If required as part of the contract, replace all asbestos containing insulation/fire-proofing with suitable non-asbestos material. Provide MSDS's for all replacement materials. Refer to Section 23 07 11, HVAC, PLUMBING, AND BOILER PLANT INSULATION.

ATTACHMENT #1

**CERTIFICATE OF COMPLETION**

DATE:

PROJECT NAME:

VAMC/ADDRESS:

1. I certify that I have personally inspected, monitored and supervised the abatement work of (specify regulated area or Building):  
which took place from / / to / /
2. That throughout the work all applicable requirements/regulations and the VA's specifications were met.
3. That any person who entered the regulated area was protected with the appropriate personal protective equipment and respirator and that they followed the proper entry and exit procedures and the proper operating procedures for the duration of the work.
4. That all employees of the Contractor engaged in this work were trained in respiratory protection, were experienced with abatement work, had proper medical surveillance documentation, were fit-tested for their respirator, and were not exposed at any time during the work to asbestos without the benefit of appropriate respiratory protection.
5. That I performed and supervised all inspection and testing specified and required by applicable regulations and VA specifications.
6. That the conditions inside the regulated area were always maintained in a safe and healthy condition and the maximum fiber count never exceeded 0.5 f/cc, except as described below.
7. That the negative pressure system was installed, operated and maintained in order to provide a minimum of 4 actual air changes per hour with a continuous -0.02" of water column pressure.

Signature/Date:

Signature/Date:

**ATTACHMENT #2**

**CERTIFICATE OF WORKER'S ACKNOWLEDGMENT**

PROJECT NAME:

DATE:

PROJECT ADDRESS:

ABATEMENT CONTRACTOR'S NAME:

WORKING WITH ASBESTOS CAN BE HAZARDOUS TO YOUR HEALTH. INHALING ASBESTOS HAS BEEN LINKED WITH VARIOUS TYPES OF CANCERS. IF YOU SMOKE AND INHALE ASBESTOS FIBERS YOUR CHANCES OF DEVELOPING LUNG CANCER IS GREATER THAN THAT OF THE NON-SMOKING PUBLIC.

Your employer's contract with the owner for the above project requires that: You must be supplied with the proper personal protective equipment including an adequate respirator and be trained in its use. You must be trained in safe and healthy work practices and in the use of the equipment found at an asbestos abatement project. You must receive/have a current medical examination for working with asbestos. These things shall be provided at no cost to you. By signing this certificate you are indicating to the owner that your employer has met these obligations.

RESPIRATORY PROTECTION: I have been trained in the proper use of respirators and have been informed of the type of respirator to be used on the above indicated project. I have a copy of the written Respiratory Protection Program issued by my employer. I have been provided for my exclusive use, at no cost, with a respirator to be used on the above indicated project.

TRAINING COURSE: I have been trained by a third party, State/EPA accredited trainer in the requirements for an AHERA/OSHA Asbestos Abatement Worker training course, 32 hours minimum duration. I currently have a valid State accreditation certificate. The topics covered in the course include, as a minimum, the following:

- Physical Characteristics and Background Information on Asbestos
- Potential Health Effects Related to Exposure to Asbestos
- Employee Personal Protective Equipment
- Establishment of a Respiratory Protection Program
- State of the Art Work Practices
- Personal Hygiene
- Additional Safety Hazards
- Medical Monitoring
- Air Monitoring
- Relevant Federal, State and Local Regulatory Requirements, Procedures, and Standards
- Asbestos Waste Disposal

MEDICAL EXAMINATION: I have had a medical examination within the past 12 months which was paid for by my employer. This examination included: health history, occupational history, pulmonary function test, and may have included a chest x-ray evaluation. The physician issued a positive written opinion after the examination.

Signature:

Printed Name:

Social Security Number:

Witness:

**ATTACHMENT #3**

**AFFIDAVIT OF MEDICAL SURVEILLANCE, RESPIRATORY PROTECTION AND  
TRAINING/ACCREDITATION**

VA PROJECT NAME AND NUMBER:

VA MEDICAL FACILITY:

ABATEMENT CONTRACTOR'S NAME AND ADDRESS:

1. I verify that the following individual

Name:

Social Security Number:

who is proposed to be employed in asbestos abatement work associated with the above project by the named. Contractor, is included in a medical surveillance program in accordance with 29 CFR 1926.1101(m), and that complete records of the medical surveillance program as required by 29 CFR 1926.1101(m)(n) and 29 CFR 1910.20 are kept at the offices of the Contractor at the following address.

Address:

2. I verify that this individual has been trained, fit-tested and instructed in the use of all appropriate respiratory protection systems and that the person is capable of working in safe and healthy manner as expected and required in the expected work environment of this project.
3. I verify that this individual has been trained as required by 29 CFR 1926.1101(k). This individual has also obtained a valid State accreditation certificate. Documentation will be kept on-site.
4. I verify that I meet the minimum qualifications criteria of the VA specifications for a CPIH.

Signature of CPIH:

Date:

Printed Name of CPIH:

Signature of Contractor:

Date:

Printed Name of Contractor:



**SECTION 02 82 13.13**  
**GLOVEBAG ASBESTOS ABATEMENT**

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**PART 1 - GENERAL**

**1.1 SUMMARY OF THE WORK**

**1.1.1 CONTRACT DOCUMENTS AND RELATED REQUIREMENTS**

Drawings, general provisions of the contract, including Division 01 specifications, shall apply to the work of this section. The contract documents show the work to be done under the contract and related requirements and conditions impacting the project. Related requirements and conditions include applicable codes and regulations, notices and permits, existing site conditions and restrictions on use of the site, requirements for partial owner occupancy during the work, coordination with other work and the phasing of the work. In the event the Asbestos Abatement Contractor (Contractor) discovers a conflict in the contract documents and/or requirements or codes, the conflict must be brought to the immediate attention of the Contracting Officer for resolution. Whenever there is a conflict or overlap in the requirements, the most stringent shall apply. Any actions taken by the Contractor without obtaining guidance from the Contracting Officer shall become the sole risk and responsibility of the Contractor. All cost incurred due to such action are also the responsibility of the Contractor.

**1.1.2 EXTENT OF WORK**

- A. Below is a brief description of the estimated quantities of asbestos containing materials to be abated by the glovebag method. These quantities are for informational purposes only and are based on the best information available at the time of the specification preparation. The Contractor shall satisfy himself as the actual quantities to be abated. Nothing in this section may be interpreted as limiting the extent of work otherwise required by this contract and related documents.
- B. Removal, clean-up and disposal of ACM piping and fittings and asbestos contaminated elements in an appropriate regulated area in the following approximate quantities;
  - (60) each asbestos-containing pipe insulation joints
  - (100) ln ft of asbestos-containing pipe insulation

**1.1.3 RELATED WORK**

- A. Section 07 84 00; FIRESTOPPING.
- B. Section 02 41 00; DEMOLITION.
- C. Division 09; FINISHES.
- D. Division 22; PLUMBING.
- E. Section 21 05 11, COMMON WORK RESULTS FOR FIRE SUPPRESSION / Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING / Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION

- F. Section 23 07 11, HVAC, PLUMBING, AND BOILER PLANT INSULATION.
- G. Section 22 05 23, GENERAL-DUTY VALVES FOR PLUMBING PIPING / Section 22 11 00, FACILITY WATER DISTRIBUTION / Section 22 13 00, FACILITY SANITARY SEWERAGE / Section 22 14 00, FACILITY STORM DRAINAGE.
- H. Section 23 21 13, HYDRONIC PIPING / Section 23 22 13, STEAM AND CONDENSATE HEATING PIPING.
- I. Section 23 31 00, HVAC DUCTS AND CASINGS

#### **1.1.4 TASKS**

The work tasks are summarized briefly as follows:

- A. Pre-abatement activities including pre-abatement meeting(s), inspection(s), notifications, permits, submittal approvals, work-site preparations, emergency procedures arrangements, and standard operating procedures for glovebag asbestos abatement work.
- B. Abatement activities including removal, clean-up and disposal of ACM waste, recordkeeping, security, monitoring, and inspections.
- C. Cleaning and decontamination activities including final visual inspection, air monitoring and certification of decontamination.

#### **1.1.5 ABATEMENT CONTRACTOR USE OF PREMISES**

- A. The Contractor and Contractor's personnel shall cooperate fully with the VA representative/consultant to facilitate efficient use of buildings and areas within buildings. The Contractor shall perform the work in accordance with the VA specifications, drawings, phasing plan and in compliance with any/all applicable Federal, State, and Local regulations and requirements.
- B. The Contractor shall use the existing facilities in the building strictly within the limits indicated in contract documents as well as the approved pre-abatement work plan. Asbestos abatement drawings of partially occupied buildings will show the limits of regulated areas; the placement of decontamination facilities; the temporary location of bagged waste ACM; the path of transport to outside the building; and the temporary waste storage area for each building/regulated area. Any variation from the arrangements shown on drawings shall be secured in writing from the VA representative through the pre-abatement plan of action.

#### **1.2 VARIATIONS IN QUANTITY**

The quantities and locations of ACM as indicated on the drawings and the extent of work included in this section are estimates which are limited by the physical constraints imposed by occupancy of the buildings. Accordingly, minor variations (+/- 5%) in quantities of ACM within the regulated area are considered as having no impact on contract price and

time requirements of this contract. Where additional work is required beyond the above variation, the Contractor shall provide unit prices for additional footage for newly discovered materials and those prices will be used for additional work under the contract.

### 1.3 STOP ASBESTOS REMOVAL

If the Contracting Officer or their field representative presents a written **Stop Asbestos Removal Order**, the Abatement Contractor/Personnel shall immediately stop all asbestos removal and adequately wet any exposed ACM. The Contractor shall not resume any asbestos removal activity until authorized to do so by the VA. A stop asbestos removal order may be issued at any time the VA determines abatement conditions/activities are not within specification requirements. Work stoppage will continue until conditions have been corrected to the satisfaction of the VA. Standby time and costs for corrective actions will be borne by the Contractor, including the industrial hygienist's time. The occurrence of any of the following events shall be reported immediately by the Contractor in writing to the VA representative and shall require the Contractor to immediately stop asbestos removal activities and initiate fiber reduction activities:

- A.  $\geq$  0.01 f/cc outside a regulated area or  $>$ 0.05 f/cc inside a regulated area;
- B. breach/break in regulated area critical barrier(s)/floor;
- C. serious injury/death at the site;
- D. fire/safety emergency at the site;
- E. respiratory protection system failure;
- F. power failure or loss of wetting agent; or
- G. any visible emissions observed outside the regulated area.

### 1.4 DEFINITIONS

#### 1.4.1 GENERAL

Definitions and explanations here are neither complete nor exclusive of all terms used in the contract documents, but are general for the work to the extent they are not stated more explicitly in another element of the contract documents. Drawings must be recognized as diagrammatic in nature and not completely descriptive of the requirements indicated therein.

#### 1.4.2 GLOSSARY

**Abatement** - Procedures to control fiber release from asbestos-containing materials, typically during removal. Includes removal, encapsulation, enclosure, demolition and renovation activities related to asbestos.

**ACE** - Asbestos contaminated elements.

**ACM** - Asbestos containing material.

**Aerosol** - Solid or liquid particulate suspended in air.

**Adequately wet** - Sufficiently mixed or penetrated with liquid to prevent the release of particulates. If visible emissions are observed coming from the ACM, then that material has not been adequately wetted.

**Aggressive method** - Removal or disturbance of building material by sanding, abrading, grinding, or other method that breaks, crumbles, or disintegrates intact ACM.

**Aggressive sampling** - EPA AHERA defined clearance sampling method using air moving equipment such as fans and leaf blowers to aggressively disturb and maintain in the air residual fibers after abatement.

**AHERA** - Asbestos Hazard Emergency Response Act. Asbestos regulations for schools issued in 1987.

**Aircell** - Pipe or duct insulation made of corrugated cardboard which contains asbestos.

**Air monitoring** - The process of measuring the fiber content of a known volume of air collected over a specified period of time. The NIOSH 7400 Method, Issue 2 is used to determine the fiber levels in air.

**Air sample filter** - The filter used to collect fibers which are then counted. The filter is made of mixed cellulose ester membrane for PCM (Phase Contrast Microscopy) and polycarbonate for TEM (Transmission Electron Microscopy)

**Amended water** - Water to which a surfactant (wetting agent) has been added to increase the penetrating ability of the liquid.

**Asbestos** - Includes chrysotile, amosite, crocidolite, tremolite asbestos, anthophyllite asbestos, actinolite asbestos, and any of these minerals that have been chemically treated or altered. Asbestos also includes PACM, as defined below.

**Asbestos-containing material (ACM)** - Any material containing more than one percent asbestos.

**Asbestos contaminated elements (ACE)** - Building elements such as ceilings, walls, lights, or ductwork that are contaminated with asbestos.

**Asbestos-containing waste material** - Asbestos-containing material or asbestos contaminated objects requiring disposal.

**Asbestos waste decontamination facility** - A system consisting of drum/bag washing facilities and a temporary storage area for cleaned containers of asbestos waste. Used as the exit for waste and equipment leaving the regulated area. In an emergency, it may be used to evacuate personnel.

**Authorized person** - Any person authorized by the VA, the Contractor, or government agency and required by work duties to be present in regulated areas.

**Authorized visitor** - Any person approved by the VA; the contractor; or any government agency having jurisdiction over the regulated area.

**Barrier** - Any surface that isolates the regulated area and inhibits fiber migration from the regulated area.

**Containment Barrier** - An airtight barrier consisting of walls, floors, and/or ceilings of sealed plastic sheeting which surrounds and seals the outer perimeter of the regulated area.

**Critical Barrier** - The barrier responsible for isolating the regulated area from adjacent spaces, typically constructed of plastic sheeting secured in place at openings such as doors, windows, or any other opening into the regulated area.

**Primary Barrier** - Barriers placed over critical barriers and exposed directly to abatement work.

**Secondary Barrier** - Any additional sheeting used to isolate and provide protection from debris during abatement work.

**Breathing zone** - The hemisphere forward of the shoulders with a radius of about 150 - 225 mm (6 - 9 inches) from the worker's nose.

**Bridging encapsulant** - An encapsulant that forms a layer on the surface of the ACM.

**Building/facility owner** - The legal entity, including a lessee, which exercises control over management and recordkeeping functions relating to a building and/or facility in which asbestos activities take place.

**Bulk testing** - The collection and analysis of suspect asbestos containing materials.

**Certified Industrial Hygienist (CIH)** - One certified in practice of industrial hygiene by the American Board of Industrial Hygiene. An industrial hygienist Certified in Comprehensive Practice by the American Board of Industrial Hygiene.

**Class I asbestos work** - Activities involving the removal of Thermal System Insulation (TSI) and surfacing ACM and Presumed Asbestos Containing Material (PACM).

**Class II asbestos work** - Activities involving the removal of ACM which is not thermal system insulation or surfacing material. This includes, but is not limited to, the removal of asbestos-containing wallboard, floor tile and sheeting, roofing and siding shingles, and construction mastic.

**Clean room/Changing room** - An uncontaminated room having facilities for the storage of employee's street clothing and uncontaminated materials and equipment.

**Clearance sample** - The final air sample taken after all asbestos work has been done and visually inspected. Performed by the VA's industrial hygiene consultant (VPIH/CIH).

**Closely resemble** - The major workplace conditions which have contributed to the levels of historic asbestos exposure, are no more protective than conditions of the current workplace.

**Competent person** - In addition to the definition in 29 CFR 1926.32(f), one who is capable of identifying existing asbestos hazards in the workplace and selecting the appropriate control strategy for asbestos exposure, who has the authority to take prompt corrective measures to eliminate them, as specified in 29 CFR 1926.32(f); in addition, for Class I and II work who is specially trained in a training course which meets the criteria of EPA's Model Accreditation Plan (40 CFR 763) for supervisor.

**Contractor's Professional Industrial Hygienist (CPIH)** - The Contractor's industrial hygienist. The industrial hygienist must meet the qualification requirements of the PIH.

**Count** - Refers to the fiber count or the average number of fibers greater than five microns in length per cubic centimeter of air.

**Decontamination area/unit** - An enclosed area adjacent to and connected to the regulated area and consisting of an equipment room, shower room, and clean room, which is used for the decontamination of workers, materials, and equipment that are contaminated with asbestos.

**Demolition** - The wrecking or taking out of any load-supporting structural member and any related razing, removing, or stripping of asbestos products.

**Disposal bag** - Typically 6 mil thick siftproof, dustproof, leaktight container used to package and transport asbestos waste from regulated areas to the approved landfill. Each bag/container must be labeled/marked in accordance with EPA, OSHA and DOT requirements.

**Disturbance** - Activities that disrupt the matrix of ACM or PACM, crumble or pulverize ACM or PACM, or generate visible debris from ACM or PACM. Disturbance includes cutting away small amounts of ACM or PACM, no greater than the amount that can be contained in one standard sized glove bag or waste bag in order to access a building component. In no event shall the amount of ACM or PACM so disturbed exceed that which can

be contained in one glove bag or disposal bag which shall not exceed 60 inches in length or width.

**Drum** - A rigid, impermeable container made of cardboard fiber, plastic, or metal which can be sealed in order to be siftproof, dustproof, and leaktight.

**Employee exposure** - The exposure to airborne asbestos that would occur if the employee were not wearing respiratory protection equipment.

**Encapsulant** - A material that surrounds or embeds asbestos fibers in an adhesive matrix and prevents the release of fibers.

**Encapsulation** - Treating ACM with an encapsulant.

**Enclosure** - The construction of an air tight, impermeable, permanent barrier around ACM to control the release of asbestos fibers from the material and also eliminate access to the material.

**Equipment room** - A contaminated room located within the decontamination area that is supplied with impermeable bags or containers for the disposal of contaminated protective clothing and equipment.

**Fiber** - A particulate form of asbestos, 5 microns or longer, with a length to width ratio of at least 3 to 1.

**Fibers per cubic centimeter (f/cc)** - Abbreviation for fibers per cubic centimeter, used to describe the level of asbestos fibers in air.

**Filter** - Media used in respirators, vacuums, or other machines to remove particulate from air.

**Firestopping** - Material used to close the open parts of a structure in order to prevent a fire from spreading.

**Friable asbestos containing material** - Any material containing more than 1 percent asbestos as determined using the method specified in appendix A, Subpart F, 40 CFR 763, section 1, Polarized Light Microscopy, that, when dry, can be crumbled, pulverized, or reduced to powder by hand pressure.

**Glovebag** - Not more than a 60 x 60 inch impervious plastic bag-like enclosure affixed around an asbestos-containing material, with glove-like appendages through which materials and tools may be handled.

**High efficiency particulate air (HEPA) filter** - A filter capable of trapping and retaining at least 99.97 percent of all mono-dispersed particles of 0.3 microns or greater in diameter.

**HEPA vacuum** - Vacuum collection equipment equipped with a HEPA filter system capable of collecting and retaining asbestos fibers.

**Homogeneous area** - An area of surfacing, thermal system insulation or miscellaneous ACM that is uniform in color, texture and date of application.

**HVAC** - Heating, Ventilation and Air Conditioning

**Industrial hygienist** - A professional qualified by education, training, and experience to anticipate, recognize, evaluate and develop controls for occupational health hazards. Meets definition requirements of the American Industrial Hygiene Association (AIHA).

**Industrial hygienist technician** - A person working under the direction of an IH or CIH who has special training, experience, certifications and licenses required for the industrial hygiene work assigned.

**Intact** - The ACM has not crumbled, been pulverized, or otherwise deteriorated so that the asbestos is no longer likely to be bound with its matrix.

**Lockdown** - Applying encapsulant, after a final visual inspection, on all abated surfaces at the conclusion of ACM removal prior to removal of critical barriers.

**National Emission Standards for Hazardous Air Pollutants (NESHAP's)** - EPA's rule to control emissions of asbestos to the environment.

**Negative initial exposure assessment** - A demonstration by the employer which complies with the criteria in 29 CFR 1926.1101 (f)(2)(iii), that employee exposure during an operation is expected to be consistently below the PEL's.

**Negative pressure** - Air pressure which is lower than the surrounding area, created by exhausting air from a sealed regulated area through HEPA equipped filtration units. OSHA requires maintaining -0.02" water gauge inside the negative pressure enclosure.

**Negative pressure respirator** - A respirator in which the air pressure inside the facepiece is negative during inhalation relative to the air outside the respirator.

**Non-friable ACM** - Material that contains more than 1 percent asbestos but cannot be crumbled, pulverized, or reduced to powder by hand pressure.

**Organic vapor cartridge** - The type of cartridge used on air purifying respirators for organic vapor exposures.

**Outside air** - The air outside buildings and structures, including, but not limited to, the air under a bridge or in an open ferry dock.

**Owner/operator** - Any person who owns, leases, operates, controls, or supervises the facility being demolished or renovated or any person who owns, leases, operates, controls, or supervises the demolition or renovation operation, or both.

**Penetrating encapsulant** - Encapsulant that is absorbed into the ACM matrix without leaving a surface layer.

**Personal sampling/monitoring** - Representative air samples obtained in the breathing zone of the person using a cassette and battery operated pump to determine asbestos exposure.

**Permissible exposure limit (PEL)** - The level of exposure OSHA allows for an 8 hour time weighted average. For asbestos fibers, the PEL is 0.1 fibers per cc.

**Polarized light microscopy (PLM)** - Light microscopy using dispersion staining techniques and refractive indices to identify and quantify the type(s) of asbestos present in a bulk sample.

**Polyethylene sheeting** - Strong plastic barrier material 4 to 6 mils thick, semi-transparent, sometimes flame retardant in compliance with NFPA 241.

**Positive/negative fit check** - A method of verifying the fit of a respirator by closing off the filters and breathing in or closing off the exhalation valve and breathing out while detecting leakage of the respirator.

**Presumed ACM (PACM)** - Thermal system insulation, surfacing, and flooring material installed in buildings prior to 1981. If the building owner has actual knowledge, or should have known through the exercise of due diligence that other materials are ACM, they too must be treated as PACM. The designation of PACM may be rebutted pursuant to 29 CFR 1926.1101 (k)(5).

**Professional IH** - An IH who meets the definition requirements of AIHA; meets the definition requirements of OSHA as a "Competent Person" at 29 CFR 1926.1101 (b); has completed two specialized EPA approved courses on management and supervision of asbestos abatement projects; has formal training in respiratory protection and waste disposal; and has a minimum of four projects of similar complexity with this project of which at least three projects serving as the supervisory IH.

**Project designer** - A person who has successfully completed the training requirements for an asbestos abatement project designer as required by 40 CFR 763 Appendix C, Part I; (B)(5).

**Protection factor** - A value assigned by OSHA/NIOSH to indicate the assigned protection a respirator should provide if worn properly. The number indicates the reduction of exposure level from outside to inside the respirator.

**Qualitative fit test (QLFT)** - A fit test using a challenge material that can be sensed by the wearer if leakage in the respirator occurs.

**Quantitative fit test (QNFT)** - A fit test using a challenge material which is quantified outside and inside the respirator thus allowing the determination of the actual fit factor.

**Regulated area** - An area established by the employer to demarcate where Class I, II, III asbestos work is conducted, and any adjoining area where debris and waste from such asbestos work may accumulate; and a work area within which airborne concentrations of asbestos exceed, or there is a reasonable possibility they may exceed the PEL.

**Regulated ACM (RACM)** - Friable ACM; Category I nonfriable ACM that has become friable; Category I nonfriable ACM that will be or has been subjected to sanding, grinding, cutting, or abrading or; Category II nonfriable ACM that has a high probability of becoming or has become crumbled, pulverized, or reduced to powder by the forces expected to act on the material in the course of the demolition or renovation operation.

**Removal** - All operations where ACM, PACM and/or RACM is taken out or stripped from structures or substrates, including demolition operations.

**Renovation** - Altering a facility or one or more facility components in any way, including the stripping or removal of asbestos from a facility component which does not involve demolition activity.

**Repair** - Overhauling, rebuilding, reconstructing, or reconditioning of structures or substrates, including encapsulation or other repair of ACM or PACM attached to structures or substrates.

**Shower room** - The portion of the PDF where personnel shower before leaving the regulated area. Also used for bag/drum decontamination in the EDF.

**Standard operating procedures (SOP's)** - Asbestos work procedures required to be submitted by the contractor before work begins.

**Supplied air respirator (SAR)** - A respirator that utilizes an air supply separate from the air in the regulated area.

**Surfacing ACM** - A material containing more than 1 percent asbestos that is sprayed, troweled on or otherwise applied to surfaces for acoustical, fireproofing and other purposes.

**Surfactant** - A chemical added to water to decrease water's surface tension thus making it more penetrating into ACM.

**Thermal system ACM** - A material containing more than 1 percent asbestos applied to pipes, fittings, boilers, breeching, tanks, ducts, or other structural components to prevent heat loss or gain.

**Transmission electron microscopy (TEM)** - A microscopy method that can identify and count asbestos fibers.

**VA Industrial Hygienist (VPIH/CIH)** - Department of Veterans Affairs Professional Industrial Hygienist.

**VA Representative** - The VA official responsible for on-going project work.

**Visible emissions** - Any emissions, which are visually detectable without the aid of instruments, coming from ACM/PACM/RACM or ACM waste material.

**Waste generator** - Any owner or operator whose act or process produces asbestos-containing waste material.

**Waste/Equipment decontamination facility (W/EDF)** - The area in which equipment is decontaminated before removal from the regulated area.

**Waste shipment record** - The shipping document, required to be originated and signed by the waste generator, used to track and substantiate the disposition of asbestos-containing waste material.

**Wet cleaning** - The process of thoroughly eliminating, by wet methods, any asbestos contamination from surfaces or objects.

#### 1.4.3 REFERENCED STANDARDS ORGANIZATIONS

The following acronyms or abbreviations as referenced in contract/specification documents are defined to mean the associated names. Names and addresses may be subject to change.

- A. VA Department of Veterans Affairs  
810 Vermont Avenue, NW  
Washington, DC 20420
- B. AIHA American Industrial Hygiene Association  
2700 Prosperity Avenue, Suite 250  
Fairfax, VA 22031  
703-849-8888
- C. ANSI American National Standards Institute  
1430 Broadway  
New York, NY 10018  
212-354-3300
- D. ASTM American Society for Testing and Materials  
1916 Race St.  
Philadelphia, PA 19103  
215-299-5400
- E. CFR Code of Federal Regulations  
Government Printing Office  
Washington, DC 20420
- F. CGA Compressed Gas Association  
1235 Jefferson Davis Highway

Arlington, VA 22202

703-979-0900

- G. CS Commercial Standard of the National Institute of Standards and Technology(NIST)

U. S. Department of Commerce

Government Printing Office

Washington, DC 20420

- H. EPA Environmental Protection Agency

401 M St., SW

Washington, DC 20460

202-382-3949

- I. MIL-STD Military Standards/Standardization Division

Office of the Assistant Secretary of Defense

Washington, DC 20420

- J. MSHA Mine Safety and Health Administration

Respiratory Protection Division

Ballston Tower #3

Department of Labor

Arlington, VA 22203

703-235-1452

- K. NIST National Institute for Standards and Technology

U. S. Department of Commerce

Gaithersburg, MD 20234

301-921-1000

- L. NEC National Electrical Code (by NFPA)

- M. NEMA National Electrical Manufacturer's Association

2101 L Street, NW

Washington, DC 20037

- N. NFPA National Fire Protection Association

1 Batterymarch Park

P.O. Box 9101

Quincy, MA 02269-9101

800-344-3555

- O. NIOSH National Institutes for Occupational Safety and Health

4676 Columbia Parkway

Cincinnati, OH 45226

513-533-8236

- P. OSHA Occupational Safety and Health Administration

U.S. Department of Labor

Government Printing Office  
Washington, DC 20402

Q. UL Underwriters Laboratory  
333 Pfingsten Rd.  
Northbrook, IL 60062  
312-272-8800

R. USA United States Army  
Army Chemical Corps  
Department of Defense  
Washington, DC 20420

## **1.5 APPLICABLE CODES AND REGULATIONS**

### **1.5.1 GENERAL APPLICABILITY OF CODES, REGULATIONS, AND STANDARDS**

- A. All work under this contract shall be done in strict accordance with all applicable Federal, State, and local regulations, standards and codes governing asbestos abatement, and any other trade work done in conjunction with the abatement. All applicable codes, regulations and standards are adopted into this specification and will have the same force and effect as this specification.
- B. The most recent edition of any relevant regulation, standard, document or code shall be in effect. Where conflict among the requirements or with these specification exists, the most stringent requirement(s) shall be utilized.
- C. Copies of all standards, regulations, codes and other applicable documents, including this specification and those listed in Section 1.5 shall be available at the worksite in the clean change area of the worker decontamination system.

### **1.5.2 CONTRACTOR RESPONSIBILITY**

The Contractor shall assume full responsibility and liability for compliance with all applicable Federal, State and Local regulations related to any and all aspects of the abatement project. The contractor is responsible for providing and maintaining training, accreditation, medical exams, medical records, personal protective equipment as required by applicable Federal, State and Local regulations. The contractor shall hold the VA and VPIH/CIH consultants harmless for any failure to comply with any applicable work, packaging, transporting, disposal, safety, health, or environmental requirement on the part of himself, his employees, or his subcontractors. The contractor will incur all costs of the CPIH, including all sampling/analytical costs to assure compliance with OSHA/EPA/State requirements.

### 1.5.3 FEDERAL REQUIREMENTS

Federal requirements which govern some aspect of asbestos abatement include, but are not limited to, the following regulations.

- A. Occupational Safety and Health Administration (OSHA)
  - 1. Title 29 CFR 1926.1101 - Construction Standard for Asbestos
  - 2. Title 29 CFR 1910.132 - Personal Protective Equipment
  - 3. Title 29 CFR 1910.134 - Respiratory Protection
  - 4. Title 29 CFR 1926 - Construction Industry Standards
  - 5. Title 29 CFR 1910.20 - Access to Employee Exposure and Medical Records
  - 6. Title 29 CFR 1910.1200 - Hazard Communication
  - 7. Title 29 CFR 1910.151 - Medical and First Aid
- B. Environmental Protection Agency (EPA)
  - 1. 40 CFR 61 Subpart A and M (Revised Subpart B) - National Emission Standard for Hazardous Air Pollutants - Asbestos.
  - 2. 40 CFR 763.80 - Asbestos Hazard Emergency Response Act (AHERA)
- C. Department of Transportation (DOT)
  - Title 49 CFR 100 - 185 - Transportation

### 1.5.4 STATE REQUIREMENTS:

State requirements that apply to the asbestos abatement work, disposal, clearance, etc., include, but are not limited to, the following:

**ASBESTOS ABATEMENT CONTRACTOR LICENSING AND TRAINING, OHIO  
ADMINISTRATIVE CODE, RULES 3701-34-01 THROUGH 3701-34-7**

### 1.5.5 LOCAL REQUIREMENTS

If local requirements are more stringent than federal or state standards, the local standards are to be followed.

### 1.5.6 STANDARDS

- A. Standards which govern asbestos abatement activities include, but are not limited to, the following:
  - 1. American National Standards Institute (ANSI) Z9.2-79 - Fundamentals Governing the Design and Operation of Local Exhaust Systems Z88.2 - Practices for Respiratory Protection.
  - 2. Underwriters Laboratories (UL) 586-90 - UL Standard for Safety of HEPA filter Units, 7th Edition.
- B. Standards which govern encapsulation work include, but are not limited to, the following:
  - 1. American Society for Testing and Materials (ASTM)
- C. Standards which govern the fire and safety concerns in abatement work include, but are not limited to, the following:

1. National Fire Protection Association (NFPA) 241 - Standard for Safeguarding Construction, Alteration, and Demolition Operations.
2. NFPA 701 - Standard Methods for Fire Tests for Flame Resistant Textiles and Film.
3. NFPA 101 - Life Safety Code

**1.5.7 EPA GUIDANCE DOCUMENTS**

- A. EPA guidance documents which discuss asbestos abatement work activities are listed below. These documents are made part of this section by reference. EPA publications can be ordered from (800) 424-9065.
- B. Guidance for Controlling ACM in Buildings (Purple Book) EPA 560/5-85-024
- C. Asbestos Waste Management Guidance EPA 530-SW-85-007.
- D. A Guide to Respiratory Protection for the Asbestos Abatement Industry EPA-560-OPTS-86-001
- E. Guide to Managing Asbestos in Place (Green Book) TS 799 20T July 1990

**1.5.8 NOTICES**

- A. State and Local agencies: Send written notification as required by state and local regulations including the local fire department prior to beginning any work on ACM as follows:

Send written notification as required by USEPA National Emissions Standards for Hazardous Air Pollutants (NESHAPS) Asbestos regulations (40 CFR 61, Subpart M) to the regional Asbestos NESHAPS Contact at least 10 days prior to beginning any work on asbestos abatement or related work. Send notification to the following address:

Department of Public Health  
Division of Air Quality  
1925 St. Clair Avenue  
Cleveland, Ohio 44114-2080

Send written notification as required by Ohio Department of Health at least 10 days prior to beginning any work on any planned asbestos hazard abatement project as required by chapter 3701-34. Send notification to the following address:

Ohio Department of Health  
P.O. Box 15278  
Columbus, Ohio 43215

- B. Copies of notifications shall be submitted to the VA for the facility's records in the same time frame notification is given to EPA, State, and Local authorities.

#### 1.5.9 PERMITS/LICENSES

- A. The contractor shall apply for and have all required permits and licenses to perform asbestos abatement work as required by Federal, State, and Local regulations.
- B. Contractor shall maintain a current Ohio Department of Health "Asbestos Abatement Contractor" license in accordance with paragraph (C) of rule 3701-34-01 of the Administrative Code

#### 1.5.10 POSTING AND FILING OF REGULATIONS

Maintain two (2) copies of applicable federal, state, and local regulations. Post one copy of each at the regulated area where workers will have daily access to the regulations and keep another copy in the Contractor's office.

#### 1.5.11 VA RESPONSIBILITIES

Prior to commencement of work:

- A. Notify occupants adjacent to regulated areas of project dates and requirements for relocation, if needed. Arrangements must be made prior to starting work for relocation of desks, files, equipment and personal possessions to avoid unauthorized access into the regulated area. **Note: Notification of adjacent personnel is required by OSHA in 29 CFR 1926.1101 (k) to prevent unnecessary or unauthorized access to the regulated area.**
- B. Submit to the Contractor results of background air sampling; including location of samples, person who collected the samples, equipment utilized and method of analysis.
- C. During abatement, submit to the Contractor, results of bulk material analysis and air sampling data collected during the course of the abatement. This information shall not release the Contractor from any responsibility for OSHA compliance.

#### 1.5.12 SITE SECURITY

- A. Regulated area access is to be restricted only to authorized, trained/accredited and protected personnel. These may include the Contractor's employees, employees of Subcontractors, VA employees and representatives, State and local inspectors, and any other designated individuals. A list of authorized personnel shall be established prior to commencing the project and be posted in the clean room of the decontamination unit.
- B. Entry into the regulated area by unauthorized individuals shall be reported immediately to the Competent Person by anyone observing the entry. The Competent Person shall immediately notify the VA.

- C. A log book shall be maintained in the clean room of the decontamination unit. Anyone who enters the regulated area must record their name, affiliation, time in, and time out for each entry.
- D. Access to the regulated area shall be through a single decontamination unit, if required. All other access (doors, windows, hallways, etc.) shall be sealed or locked to prevent entry to or exit from the regulated area. The only exceptions for this requirement are the waste/equipment load-out area which shall be sealed except during the removal of containerized asbestos waste from the regulated area, and emergency exits. Emergency exits shall not be locked from the inside, however, they shall be sealed with poly sheeting and taped until needed.
- E. The Contractor's Competent Person shall control site security during abatement operations in order to isolate work in progress and protect adjacent personnel. A 24 hour security system shall be provided at the entrance to the regulated area to assure that all entrants are logged in/out and that only authorized personnel are allowed entrance.
- F. The Abatement Contractor will have the VA's assistance in notifying adjacent personnel of the presence, location and quantity of ACM in the regulated area and enforcement of restricted access by the VA's employees.
- G. The regulated area shall be locked during non-working hours and secured by VA security guards.

**1.5.13 EMERGENCY ACTION PLAN AND ARRANGEMENTS**

- A. An Emergency Action Plan shall be developed by the Contractor prior to commencing abatement activities and shall be agreed to by the Contractor and the VA. The Plan shall meet the requirements of 29 CFR 1910.38 (a);(b).
- B. Emergency procedures shall be in written form and prominently posted and available in the regulated area. Everyone, prior to entering the regulated area, must read and sign these procedures to acknowledge understanding of the regulated area layout, location of emergency exits and emergency procedures.
- C. Emergency planning shall include written notification of police, fire, and emergency medical personnel of planned abatement activities; work schedule and layout of regulated area, particularly barriers that may affect response capabilities.
- D. Emergency planning shall include consideration of fire, explosion, hazardous atmospheres, electrical hazards, slips/trips and falls, confined spaces, and heat stress illness. Written procedures for

response to emergency situations shall be developed and employee training in procedures shall be provided.

- E. Employees shall be trained in regulated area/site evacuation procedures in the event of workplace emergencies.
  - 1. For non life-threatening situations - employees injured or otherwise incapacitated shall decontaminate following normal procedures with assistance from fellow workers, if necessary, before exiting the regulated area to obtain proper medical treatment.
  - 2. For life-threatening injury or illness, worker decontamination shall take least priority after measures to stabilize the injured worker, remove them from the regulated area, and secure proper medical treatment.
- F. Telephone numbers of all emergency response personnel shall be prominently posted in the clean room, along with the location of the nearest telephone.
- G. The Contractor shall provide verification of first aid/CPR training for personnel responsible for providing first aid/CPR. OSHA requires medical assistance within 3 minutes of a life-threatening injury/illness. Bloodborne Pathogen training shall also be verified for those personnel required to provide first aid/CPR.
- H. The Emergency Action Plan shall provide for a Contingency Plan in the event that an incident occurs that may require the modification of the standard operating procedures during abatement. Such incidents include, but are not limited to, fire; accident; and power failure. The Contractor shall detail procedures to be followed in the event of an incident assuring that work is stopped and wetting is continued until correction of the problem.

#### **1.5.14 PRE-CONSTRUCTION MEETING**

Prior to commencing the work, the Contractor shall meet with the VPCIH to present and review, as appropriate, the items following this paragraph. The Contractor's Competent Person(s) who will be on-site shall participate in the pre-start meeting. The pre-start meeting is to discuss and determine procedures to be used during the project. At this meeting, the Contractor shall provide:

- A. Proof of Contractor licensing.
- B. Proof the Competent Person is trained and accredited and approved for working in this State. Verification of the experience of the Competent Person shall also be presented.
- C. A list of all workers who will participate in the project, including experience and verification of training and accreditation.

- D. A list of and verification of training for all personnel who have current first-aid/CPR training. A minimum of one person per shift must have adequate training.
- E. Current medical written opinions for all personnel working on-site meeting the requirements of 29 CFR 1926.1101 (m).
- F. Current fit-tests for all personnel wearing respirators on-site meeting the requirements of 29 CFR 1926.1101 (h) and Appendix C.
- G. A copy of the Contractor's Standard Operating Procedures for Class I Glovebag Asbestos Abatement. In these procedures, the following information must be detailed, specific for this project.
  - 1. Regulated area preparation procedures;
  - 2. Notification requirements procedure of Contractor as required in 29 CFR 1926.1101 (d);
  - 3. If required, decontamination area set-up/layout and decontamination procedures for employees;
  - 4. Glovebag abatement methods/procedures and equipment to be used;
  - 5. Personal protective equipment to be used;
- H. At this meeting the Contractor shall provide all submittals as required.
- I. Procedures for handling, packaging and disposal of asbestos waste.
- J. Emergency Action Plan and Contingency Plan Procedures.

#### **1.6 PROJECT COORDINATION**

The following are the minimum administrative and supervisory personnel necessary for coordination of the work.

##### **1.6.1 PERSONNEL**

- A. Administrative and supervisory personnel shall consist of a qualified Competent Person as defined by OSHA in the Construction Standards and the Asbestos Construction Standard; Contractor Professional Industrial Hygienist and Industrial Hygiene Technicians. These employees are the Contractor's representatives responsible for compliance with these specifications and all other applicable requirements.
- B. Non-supervisory personnel shall consist of an adequate number of qualified personnel to meet the schedule requirements of the project. Personnel shall meet required qualifications. Personnel utilized on-site shall be pre-approved by the VA representative. A request for approval shall be submitted for any person to be employed during the project giving the person's name; social security number; qualifications; accreditation card with picture; Certificate of Worker's Acknowledgment; and Affidavit of Medical Surveillance and Respiratory Protection and current Respirator Fit Test.
- C. Minimum qualifications for Contractor and assigned personnel are:

1. The Contractor has conducted within the last three (3) years, three (3) projects of similar complexity and dollar value as this project; has not been cited and penalized for serious violations of asbestos regulations in the past three (3) years; has adequate liability/occurrence insurance for asbestos work; is licensed in applicable states; has adequate and qualified personnel available to complete the work; has comprehensive standard operating procedures for asbestos work; has adequate materials, equipment and supplies to perform the work.
2. The Competent Person has four (4) years of abatement experience of which two (2) years were as the Competent Person on the project; meets the OSHA definition of a Competent Person; has been the Competent Person on two (2) projects of similar size and complexity as this project; has completed EPA AHERA/OSHA/State/Local training requirements/accreditation(s) and refreshers; and has all required OSHA documentation related to medical and respiratory protection.
3. The Contractor Professional Industrial Hygienist (CPIH) shall have five (5) years of monitoring experience and supervision of asbestos abatement projects; has participated as senior IH on five (5) abatement projects, three (3) of which are similar in size and complexity as this project; has developed at least one complete standard operating procedure for asbestos abatement; has trained abatement personnel for three (3) years; has specialized EPA AHERA/OSHA training in asbestos abatement management, respiratory protection, waste disposal and asbestos inspection; has completed the NIOSH 582 Course, Contractor/Supervisor course; and has appropriate medical/respiratory protection records/documentation.
4. The Abatement Personnel shall have completed the EPA AHERA/OSHA abatement worker course; have training on the standard operating procedures of the Contractor; has one year of asbestos abatement experience; has applicable medical and respiratory protection documentation; has certificate of training/current refresher and State accreditation/license.

#### **1.7 RESPIRATORY PROTECTION**

##### **1.7.1 GENERAL - RESPIRATORY PROTECTION PROGRAM**

The Contractor shall develop and implement a Respiratory Protection Program (RPP) which is in compliance with the January 8, 1998 OSHA requirements found at 29 CFR 1926.1101 and 29 CFR 1910.132;134. ANSI Standard Z88.2-1992 provides excellent guidance for developing a respiratory protection program All respirators used must be NIOSH

approved for asbestos abatement activities. The written respiratory protection shall, at a minimum, contain the basic requirements found at 29 CFR 1910.134 (c)(1)(i - ix) - Respiratory Protection Program.

**1.7.2 RESPIRATORY PROTECTION PROGRAM COORDINATOR**

The Respiratory Protection Program Coordinator (RPPC) must be identified and shall have two (2) years experience coordinating the program. The RPPC must provide a signed statement attesting to the fact that the program meets the above requirements.

**1.7.3 SELECTION AND USE OF RESPIRATORS**

The procedure for the selection and use of respirators must be submitted to the VA as part of the Contractor's qualification. The procedure must be written clearly enough for workers to understand. A copy of the Respiratory Protection Program must be available in the clean room of the decontamination unit for reference by employees or authorized visitors.

**1.7.4 MINIMUM RESPIRATORY PROTECTION**

Minimum respiratory protection shall be a full face powered air purifying respirator when fiber levels are maintained consistently at or below 0.5 f/cc. A higher level of respiratory protection may be provided or required, depending on fiber levels. Respirator selection shall meet the requirements of 29 CFR 1926.1101 (h); Table 1, except as indicated in this paragraph. Abatement personnel must have a respirator for their exclusive use.

**1.7.5 MEDICAL WRITTEN OPINION**

No employee shall be allowed to wear a respirator unless a physician has determined they are capable of doing so and has issued a written opinion for that person.

**1.7.6 RESPIRATOR FIT TEST**

All personnel wearing respirators shall have a current quantitative fit test which was conducted in accordance with 29 CFR 1910.134 (f) and Appendix A. Fit tests shall be done for PAPR's which have been put into a failure mode.

**1.7.7 RESPIRATOR FIT CHECK**

The Competent Person shall assure that the positive/negative fit check is done each time the respirator is donned by an employee. Headcoverings must cover respirator headstraps. Any situation that prevents an effective facepiece to face seal as evidenced by failure of a fit check shall preclude that person from wearing a respirator until resolution of the problem.

#### **1.7.8 MAINTENANCE AND CARE OF RESPIRATORS**

The Respiratory Protection Program Coordinator shall submit evidence and documentation showing compliance with 29 CFR 1910.134 (h) maintenance and care of respirators.

#### **1.8 WORKER PROTECTION**

##### **1.8.1 TRAINING OF ABATEMENT PERSONNEL**

Prior to beginning any abatement activity, all personnel shall be trained in accordance with OSHA 29 CFR 1926.1101 (k)(9) and any additional State/Local requirements. Training must include, at a minimum, the elements listed at 29 CFR 1926.1101 (k)(9)(viii). Training shall have been conducted by a third party, EPA/State approved trainer meeting the requirements of EPA 40 CFR 763 Appendix C (AHERA MAP). Initial training certificates and current refresher and accreditation proof must be submitted for each person working at the site.

##### **1.8.2 MEDICAL EXAMINATIONS**

Medical examinations meeting the requirements of 29 CFR 1926.1101 (m) shall be provided for all personnel working in the regulated area, regardless of exposure levels. The physician's written opinion as required by 29 CFR 1926.1101 (m)(4) shall be provided for each person and shall include in the opinion the person has been evaluated for working in a heat stress environment while wearing personal protective equipment and is able to perform the work.

##### **1.8.3 PERSONAL PROTECTIVE EQUIPMENT**

Provide whole body clothing, head coverings, foot coverings and any other personal protective equipment as determined by conducting the hazard assessment required by OSHA at 29 CFR 1910.132 (d). The Competent Person shall ensure the integrity of personal protective equipment worn for the duration of the project. Duct tape shall be used to secure all suit sleeves to wrists and to secure foot coverings at the ankle.

##### **1.8.4 REGULATED AREA ENTRY PROCEDURE**

Worker protection shall meet the most stringent requirement. The Competent Person shall ensure that each time workers enter the regulated area, they remove ALL street clothes in the clean room of the decontamination unit and put on new disposable coveralls, head coverings, a clean respirator, and then proceed through the shower room to the equipment room where they put on non-disposable required personal protective equipment.

##### **1.8.5 DECONTAMINATION PROCEDURE - PAPR**

The Competent Person shall require all personnel to adhere to following decontamination procedures whenever they leave the regulated area.

- A. When exiting the regulated area, remove disposable coveralls, and ALL other clothes, disposable head coverings, and foot coverings or boots in the equipment room.
- B. Still wearing the respirator and completely naked, proceed to the shower. Showering is MANDATORY. Care must be taken to follow reasonable procedures in removing the respirator to avoid asbestos fibers while showering. The following procedure is required as a minimum:
  1. Thoroughly wet body including hair and face. If using a PAPR hold blower above head to keep filters dry.
  2. With respirator still in place, thoroughly decontaminate body, hair, respirator face piece, and all other parts of the respirator except the blower and battery pack on a PAPR. Pay particular attention to cleaning the seal between the face and respirator facepiece and under the respirator straps.
  3. Take a deep breath, hold it and/or exhale slowly, completely wetting hair, face, and respirator. While still holding breath, remove the respirator and hold it away from the face before starting to breathe.
- C. Carefully decontaminate the facepiece of the respirator inside and out. If using a PAPR, shut down using the following sequence: a) first cap inlets to filters; b) turn blower off to keep debris collected on the inlet side of the filter from dislodging and contaminating the outside of the unit; c) thoroughly decontaminate blower and hoses; d) carefully decontaminate battery pack with a wet rag being cautious of getting water in the battery pack thus preventing destruction. **THIS PROCEDURE IS NOT A SUBSTITUTE FOR RESPIRATOR CLEANING!**
- D. Shower and wash body completely with soap and water. Rinse thoroughly.
- E. Rinse shower room walls and floor to drain prior to exiting.
- F. Proceed from shower to clean room; dry off and change into street clothes or into new disposable work clothing.

#### **1.8.6 REGULATED AREA REQUIREMENTS**

The Competent Person shall meet all requirements of 29 CFR 1926.1101 (o) and assure that all requirements for Class I glovebag regulated areas at 29 CFR 1926.1101 (e) are met. All personnel in the regulated area shall not be allowed to eat, drink, smoke, chew tobacco or gum, apply cosmetics, or in any way interfere with the fit of their respirator.

#### **1.9 DECONTAMINATION FACILITIES**

##### **1.9.1 DESCRIPTION**

Provide each regulated area with separate personnel (PDF) and waste/equipment decontamination facilities (W/EDF). Ensure that the PDF is the only means of ingress and egress to the regulated area and that

all equipment, bagged waste, and other material exit the regulated area only through the W/EDF.

#### **1.9.2 GENERAL REQUIREMENTS**

All personnel entering or exiting a regulated area shall follow the requirements at 29 CFR 1926.1101 (j)(1) and these specifications. All equipment and materials must exit the regulated area through the W/EDF and be decontaminated in accordance with these specifications. Walls and ceilings of the PDF and W/EDF must be constructed of a minimum of 3 layers of 6 mil opaque fire retardant polyethylene sheeting and be securely attached to existing building components and/or an adequate temporary framework. A minimum of 3 layers of 6 mil poly shall also be used to cover the floor under the PDF and W/EDF units. Construct doors so that they overlap and secure to adjacent surfaces. Weigh sheets with layers of duct tape so that they close quickly after release. Put arrows on sheets so they show direction of travel and overlap. If the building adjacent area is occupied, construct a solid barrier on the occupied side(s) to protect the sheeting.

#### **1.9.3 TEMPORARY FACILITIES TO THE PDF AND W/EDF**

The Competent Person shall provide temporary water service connections to the PDF and W/EDF. Backflow prevention must be provided at the point of connection to the VA system. Water supply must be of adequate pressure and meet requirements of 29 CFR 1910.141(d)(3). Provide adequate temporary electric power with ground fault protection and overhead wiring in the PDF and W/EDF. Provide a sub-panel for all temporary power in the clean room. Provide adequate lighting to provide a minimum of 50 foot candles in the PDF and W/EDF. Provide temporary heat to maintain 70°F throughout the PDF and W/EDF..

#### **1.9.4 PERSONNEL DECONTAMINATION FACILITY (PDF)**

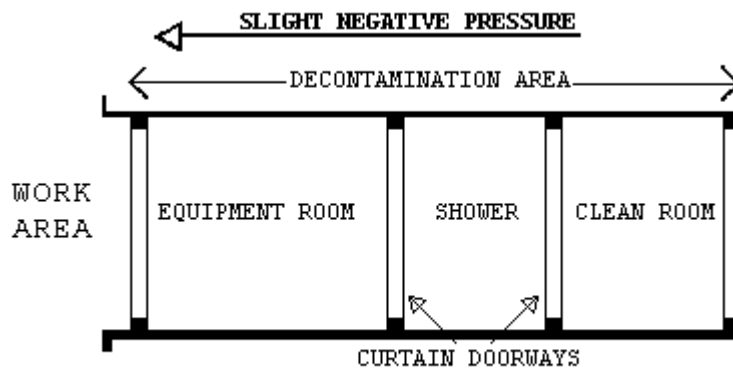
The Competent Person shall provide a PDF consisting of shower room which is contiguous to a clean room and equipment room. The PDF must be sized to accommodate the number of personnel scheduled for the project. The shower room, located in the center of the PDF, shall be fitted with as many portable showers as necessary to insure all employees can complete the entire decontamination procedure within 15 minutes. The PDF shall be constructed of opaque poly for privacy. The PDF shall be constructed to eliminate any parallel routes of egress without showering.

1. Clean Room: The clean room must be physically and visually separated from the rest of the building to protect the privacy of personnel changing clothes. The clean room shall be constructed of at least 2 layers of 6 mil fire retardant poly to provide an air tight room.

- Provide a minimum of 2 - 900 mm (3 foot) wide flapped doorways. One doorway shall be the entry from outside the PDF and the second doorway shall be to the shower room of the PDF. The floor of the clean room shall be maintained in a clean, dry condition. Shower overflow shall not be allowed into the clean room. An adequate supply of disposable towels shall be provided. Provide storage lockers per person. A portable fire extinguisher, Type ABC, shall be provided in accordance with OSHA and NFPA Standard 10. All persons entering the regulated area shall remove all street clothing in the clean room and dress in disposable protective clothing and respiratory protection. Any person entering the clean room does so either from the outside with street clothing on or is coming from the shower room completely naked and thoroughly washed. Females required to enter the regulated area shall be ensured of their privacy throughout the entry/exit process by posting guards at both entry points to the PDF so no male can enter or exit the PDF during her stay in the PDF.
2. Shower Room: The Competent Person shall assure that the shower room is a completely water tight compartment to be used for the movement of all personnel from the clean room to the equipment room and for the showering of all personnel going from the regulated area to the clean room. Each shower shall be constructed so water runs down the walls of the shower and into a drip pan. Install a freely draining smooth floor on top of the shower pan. The shower room shall be separated from the rest of the building and from the clean room and equipment room using air tight walls made from at least 3 layers of 6 mil fire retardant poly. The shower shall be equipped with a shower head and controls, hot and cold water, drainage, soap dish and continuous supply of soap, and shall be maintained in a sanitary condition throughout its use. The controls shall be arranged so an individual can shower without assistance. Provide a flexible hose shower head, hose bibs and all other items shown on Shower Schematic. Waste water will be pumped to a drain after being filtered through a minimum of a 100 micron sock in the shower drain; a 20 micron filter; and a final 5 micron filter. Filters will be changed a minimum of daily or more often as needed. Filter changes must be done in the shower to prevent loss of contaminated water. Hose down all shower surfaces after each shift and clean any debris from the shower pan. Residue is to be disposed of as asbestos waste.
3. Equipment Room: The Competent Person shall provide an equipment room which shall be an air tight compartment for the storage of work

equipment, reusable footwear and for use as a change station for personnel exiting the regulated area. The equipment room shall be separated from the regulated area by a minimum 3 foot wide door made of 2 layers of 6 mil fire retardant poly. The equipment room shall be separated from the regulated area, the shower room and the rest of the building by air tight walls and ceiling constructed of a minimum of 3 layers of 6 mil fire retardant poly. Damp wipe all surfaces of the equipment room after each shift change. Provide an additional loose layer of 6 mil fire retardant poly per shift change and remove this layer after each shift. Provide a temporary electrical sub-panel equipped with GFCI in this room to accommodate any equipment required in the regulated area.

4. The PDF shall consist of the following: Clean room at the entrance followed by a shower room followed by an equipment room leading to the regulated area. Each doorway in the PDF is minimum of 2 layers of 6 mil fire retardant poly.

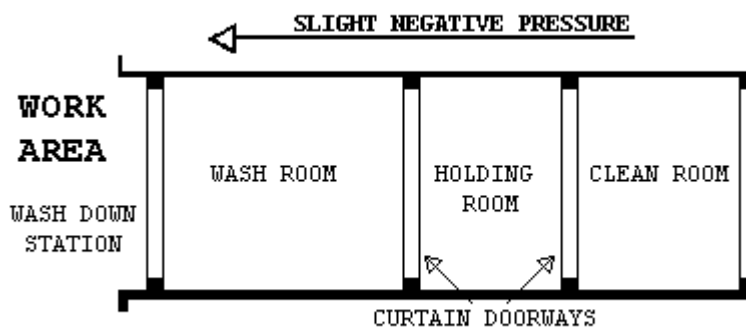


#### 1.9.5 WASTE/EQUIPMENT DECONTAMINATION FACILITY (W/EDF)

The Competent Person shall provide a W/EDF consisting of a wash room, holding room, and clean room for removal of all waste, equipment and contaminated material from the regulated area. Personnel shall not enter or exit the W/EDF except in the event of an emergency. Clean debris and residue in the W/EDF daily. All surfaces in the W/EDF shall be wiped/hosed down after each shift and all debris shall be cleaned from the shower pan. The W/EDF shall consist of the following:

1. Wash Down Station: Provide an enclosed shower unit in the regulated area just outside the Wash Room as an equipment, bag and container cleaning station.

2. Wash Room: Provide a wash room for cleaning of bagged or containerized asbestos containing waste materials passed from the regulated area. Construct the wash room using 50 x 100 mm (2" x 4") wood framing and 3 layers of 6 mil fire retardant poly. Locate the wash room so that packaged materials, after being wiped clean, can be passed to the Holding Room. Doorways in the wash room shall be constructed of 2 layers of 6 mil fire retardant poly.
3. Holding Room: Provide a holding room as a drop location for bagged materials passed from the wash room. Construct the holding room using 50 x 100 mm (2" x 4") wood framing and 3 layers of 6 mil fire retardant poly. The holding room shall be located so that bagged material cannot be passed from the wash room to the clean room unless it goes through the holding room. Doorways in the holding room shall be constructed of 2 layers of 6 mil fire retardant poly.
4. Clean Room: Provide a clean room to isolate the holding room from the building exterior. Construct the clean room using 2 x 4 wood framing and 2 layers of 6 mil fire retardant poly. The clean room shall be located so as to provide access to the holding room from the building exterior. Doorways to the clean room shall be constructed of two layers of 6 mil fire retardant poly.
5. The W/EDF shall be provided as follows: Wash Room leading to a Holding Room followed by a Clean Room leading to outside the regulated area. See diagram.



#### 1.9.6 WASTE/EQUIPMENT DECONTAMINATION PROCEDURES

At washdown station in the regulated area, thoroughly wet clean contaminated equipment and/or sealed polyethylene bags and pass into Wash Room after visual inspection. When passing anything into the Wash

Room, close all doorways of the W/EDF, other than the doorway between the washdown station and the Wash Room. Keep all outside personnel clear of the W/EDF. Once inside the Wash Room, wet clean the equipment and/or bags. After cleaning and inspection, pass items into the Holding Room. Close all doorways except the doorway between the Holding Room and the Clean Room. Workers from the Clean Room/Exterior shall enter the Holding Room and remove the decontaminated/cleaned equipment/bags for removal and disposal. These personnel will not be required to wear PPE. At no time shall personnel from the clean side be allowed to enter the Wash Room.

## **PART 2 - PRODUCTS, MATERIALS AND EQUIPMENT**

### **2.1 MATERIALS AND EQUIPMENT**

#### **2.1.1 GENERAL REQUIREMENTS (ALL ABATEMENT PROJECTS)**

Prior to the start of work, the Contractor shall provide and maintain a sufficient quantity of materials and equipment to assure continuous and efficient work throughout the duration of the project. Work shall not start unless the following items have been delivered to the site and the CPIH has submitted verification to the VA's representative to this effect:

- A. All materials shall be delivered in their original package, container or bundle bearing the name of the manufacturer and the brand name (where applicable).
- B. Store all materials subject to damage off the ground, away from wet or damp surfaces and under cover sufficient enough to prevent damage or contamination. Flammable materials cannot be stored inside buildings. Replacement materials shall be stored outside of the regulated/work area until abatement is completed.
- C. The Contractor shall not block or hinder use of buildings by patients, staff, and visitors to the VA in partially occupied buildings by placing materials/equipment in any unauthorized place.
- D. The Competent Person shall inspect for damaged, deteriorating or previously used materials. Such materials shall not be used and shall be removed from the worksite and disposed of properly.
- E. Poly sheeting put under the glovebag regulated area shall be a minimum of 6 mils in thickness.
- F. If required, the method of attaching polyethylene sheeting shall be agreed upon in advance by the Contractor and the VA and selected to minimize damage to equipment and surfaces.
- G. Polyethylene sheeting utilized for personnel decontamination facility shall be opaque white or black in color, 6 mil fire retardant poly.

- H. Installation and plumbing hardware, showers, hoses, drain pans, sump pumps and waste water filtration system shall be provided by the Contractor.
- I. An adequate number of HEPA vacuums, scrapers, sprayers, nylon brushes, brooms, disposable mops, rags, sponges, staple guns, shovels, ladders and scaffolding of suitable height and length as well as meeting OSHA requirements shall be provided. Fall protection devices, water hose to reach all areas in the regulated area, airless spray equipment, and any other tools, materials or equipment required to conduct the abatement project shall also be provided. All electrically operated hand tools, equipment, electric cords shall be equipped with GFCI protection.
- J. Special protection for objects in the regulated area shall be detailed (e.g., plywood over carpeting or hardwood floors to prevent damage from scaffolds, water, and falling material).
- K. Disposal bags - 2 layers of 6 mil, for asbestos waste shall be pre-printed with labels, markings and address as required by OSHA, EPA and DOT regulations.
- L. The VA shall be provided a copy of the MSDS as required for all hazardous chemicals under OSHA 29 CFR 1910.1200 - Hazard Communication. Chlorinated compounds shall not be used with any spray adhesive or other product. Appropriate encapsulant(s) shall be provided.
- M. OSHA DANGER demarcation signs, as many and as required by OSHA 29 CFR 1926.1101(k)(7) shall be provided and placed by the Competent Person. All other posters and notices required by Federal and State regulations shall be posted in the Clean Room.
- N. Adequate and appropriate PPE for the project and number of personnel/shifts shall be provided. All personal protective equipment issued must be based on a hazard assessment conducted under 29 CFR 1910.132(d).

## **2.2 CONTAINMENT BARRIERS AND COVERINGS IN THE REGULATED AREA**

### **2.2.1 GENERAL**

Using critical barriers, seal off the perimeter to the regulated area to completely isolate the regulated area from adjacent spaces. All horizontal surfaces in the regulated area must be covered with 2 layers of 6 mil fire retardant poly to prevent contamination and to facilitate clean-up. Should adjacent areas become contaminated, immediately stop work and clean up the contamination at no additional cost to the Government. Provide firestopping and identify all fire barrier penetrations due to abatement work as specified in Section 2.2.8; FIRESTOPPING.

**2.2.2 PREPARATION PRIOR TO SEALING THE REGULATED AREA**

- A. Place all tools, scaffolding, materials and equipment needed for working in the regulated area prior to erecting any plastic sheeting. Remove all uncontaminated removable furniture, equipment and/or supplies from the regulated area before commencing work, or completely cover with 2 layers of 6-mil fire retardant poly sheeting and secure with duct tape. Lock out and tag out any HVAC systems in the regulated area.

**2.2.3 CONTROLLING ACCESS TO THE REGULATED AREA**

- A. Access to the regulated area is allowed only through the personnel decontamination facility (PDF), if required. All other means of access shall be eliminated and OSHA Danger demarcation signs posted as required by OSHA. If the regulated area is adjacent to or within view of an occupied area, provide a visual barrier of 6 mil opaque fire retardant poly sheeting to prevent building occupant observation. If the adjacent area is accessible to the public, the barrier must be solid.

**2.2.4 CRITICAL BARRIERS**

- A. Completely separate any openings into the regulated area from adjacent areas using fire retardant poly at least 6 mils thick and duct tape. Individually seal with 2 layers of 6 mil poly and duct tape all HVAC openings into the regulated area. Individually seal all lighting fixtures, clocks, doors, windows, convectors, speakers, or any other objects in the regulated area. Heat must be shut off any objects covered with poly.

**2.2.5 SECONDARY BARRIERS**

- A. A loose layer of 6 mil fire retardant poly shall be used as a drop cloth to protect the floor/horizontal surfaces from debris generated during the glovebag abatement. This layer shall be replaced as needed during the work.

**2.2.6 EXTENSION OF THE REGULATED AREA**

- A. If the enclosure of the regulated area is breached in any way that could allow contamination to occur, the affected area shall be included in the regulated area and constructed as per this section. If the affected area cannot be added to the regulated area, decontamination measures must be started immediately and continue until air monitoring indicates background levels are met.

**2.2.7 FIRESTOPPING**

- A. Through penetrations caused by cables, cable trays, pipes, sleeves must be firestopped with a fire-rated firestop system providing an air tight seal.

- B. Firestop materials that are not equal to the wall or ceiling penetrated shall be brought to the attention of the VA Representative. The Contractor shall list all areas of penetration, the type of sealant used, and whether or not the location is fire rated. Any discovery of penetrations during abatement shall be brought to the attention of the VA Representative immediately. All walls, floors and ceilings are considered fire rated unless otherwise determined by the VA Representative or Fire Marshall.
- C. Any visible openings whether or not caused by a penetration shall be reported by the Contractor to the VA Representative for a sealant system determination. Firestops shall meet ASTM E814 and UL 1479 requirements for the opening size, penetrant, and fire rating needed.

## **2.3 MONITORING, INSPECTION AND TESTING**

### **2.3.1 GENERAL**

- A. Perform throughout abatement work monitoring, inspection and testing inside and around the regulated area in accordance with the OSHA requirements and these specifications. The CPIH shall periodically inspect and oversee the performance of the Contractor IH Technician. The IH Technician shall continuously inspect and monitor conditions inside the regulated area to ensure compliance with these specifications. In addition, the CPIH shall personally manage air sample collection, analysis, and evaluation for personnel, regulated area, and adjacent area samples to satisfy OSHA requirements. Additional inspection and testing requirements are also indicated in other parts of this specification.
- B. The VA will employ an independent industrial hygienist (VPIH/CIH) consultant and/or use its own IH to perform various services on behalf of the VA. The VPIH/CIH will perform the necessary monitoring, inspection, testing, and other support services to ensure that VA patients, employees, and visitors will not be adversely affected by the abatement work, and that the abatement work proceeds in accordance with these specifications, that the abated areas or abated buildings have been successfully decontaminated. The work of the VPIH/CIH consultant in no way relieves the Contractor from their responsibility to perform the work in accordance with contract/specification requirements, to perform continuous inspection, monitoring and testing for the safety of their employees, and to perform other such services as specified. The cost of the VPIH/CIH and their services will be borne by the VA except for any repeat of final inspection and testing that may be required due to

unsatisfactory initial results. Any repeated final inspections and/or testing, if required, will be paid for by the Contractor.

- C. If fibers counted by the VPIH/CIH during abatement work, either inside or outside the regulated area, utilizing the NIOSH 7400 air monitoring method, exceed the specified respective limits, the Contractor shall stop work. The Contractor may request confirmation of the results by analysis of the samples by TEM. Request must be in writing and submitted to the VA's representative. Cost for the confirmation of results will be borne by the Contractor for both the collection and analysis of samples and for the time delay that may/does result for this confirmation. Confirmation sampling and analysis will be the responsibility of the CPIH with review and approval of the VPIH/CIH. An agreement between the CPIH and the VPIH/CIH shall be reached on the exact details of the confirmation effort, in writing, including such things as the number of samples, location, collection, quality control on-site, analytical laboratory, interpretation of results and any follow-up actions. This written agreement shall be co-signed by the IH's and delivered to the VA's representative.

#### **2.3.2 SCOPE OF SERVICES OF THE VPIH/CIH CONSULTANT**

- A. The purpose of the work of the VPIH/CIH is to: Assure quality; resolve problems; and prevent the spread of contamination beyond the regulated area. In addition, their work includes performing the final inspection and testing to determine whether the regulated area or building has been adequately decontaminated. All air monitoring is to be done utilizing PCM/TEM. The VPIH/CIH will perform the following tasks:
1. Task 1: Establish background levels before abatement begins by collecting background samples. Retain samples for possible TEM analysis.
  2. Task 2: Perform continuous air monitoring, inspection, and testing outside the regulated area during actual abatement work to detect any faults in the regulated area isolation and any adverse impact on the surroundings from regulated area activities.
  3. Task 3: Perform unannounced visits to spot check overall compliance of work with contract/specifications. These visits may include any inspection, monitoring, and testing inside and outside the regulated area and all aspects of the operation except personnel monitoring.
  4. Task 4: Provide support to the VA representative such as evaluation of submittals from the Contractor, resolution of unforeseen developments, etc.

5. Task 5: Perform, in the presence of the VA representative, final inspection and testing of a decontaminated regulated area or building at the conclusion of the abatement and clean-up work to certify compliance with all regulations and the VA requirements/specifications.
  6. Task 6: Issue certificate of decontamination for each regulated area or building and project report.
- B. All data, inspection results and testing results generated by the VPIH/CIH will be available to the Contractor for information and consideration. The Contractor shall cooperate with and support the VPIH/CIH for efficient and smooth performance of their work.
- C. The monitoring and inspection results of the VPIH/CIH will be used by the VA to issue any Stop Removal orders to the Contractor during abatement work and to accept or reject a regulated area or building as decontaminated.

**2.3.3 MONITORING, INSPECTION AND TESTING BY ABATEMENT CONTRACTOR CPIH**

The CPIH is responsible for managing all monitoring, inspections, and testing required by these specifications, as well as any and all regulatory requirements adopted by these specifications. The CPIH is responsible for the continuous monitoring of all subsystems and procedures which could affect the health and safety of the Contractor's personnel. Safety and health conditions and the provision of those conditions inside the regulated area for all persons entering the regulated area is the exclusive responsibility of the Contractor /Competent Person. The person performing the personnel and area air monitoring inside the regulated area shall be an IH Technician, who shall be trained and shall have specialized field experience in air sampling and analysis. The IH Technician shall have a NIOSH 582 Course or equivalent and show proof. The IH Technician shall participate in the AIHA Asbestos Analysis Registry or participate in the Proficiency Analytic Testing program of AIHA for fiber counting quality control assurance. The IH Technician shall also be an accredited EPA/State Contractor/Supervisor and Building Inspector. The IH Technician shall have participated in five abatement projects collecting personal and area samples as well as responsibility for documentation. The analytic laboratory used by the Contractor to analyze the samples shall be AIHA accredited for asbestos PAT. A daily log documenting all OSHA requirements for air monitoring for asbestos in 29 CFR 1926.1101(f), (g) and Appendix A. This log shall be made available to the VA representative and the VPIH/CIH. The log will contain, at a minimum,

information on personnel or area sampled, other persons represented by the sample, the date of sample collection, start and stop times for sampling, sample volume, flow rate, and fibers/cc. The CPIH shall collect and analyze samples for each representative job being done in the regulated area, i.e., removal, wetting, clean-up, and load-out. No fewer than two personal samples per shift shall be collected and one area sample per 1,000 square feet of regulated area where abatement is taking place and one sample per shift in the clean room area shall be collected. In addition to the continuous monitoring required, the CPIH will perform inspection and testing at the final stages of abatement for each regulated area as specified in the CPIH responsibilities.

## **2.4 STANDARD OPERATING PROCEDURES**

The Contractor shall have established Standard Operating Procedures (SOP's) in printed form and loose leaf folder consisting of simplified text, diagrams, sketches, and pictures that establish and explain clearly the ways and procedures to be followed during all phases of the work by the Contractor's personnel. The SOP's must be modified as needed to address specific requirements of the project. The SOP's shall be submitted for review and approval prior to the start of any abatement work. The minimum topics and areas to be covered by the SOP's are:

- A. Minimum Personnel Qualifications
- B. Contingency Plans and Arrangements
- C. Security and Safety Procedures
- D. Respiratory Protection/Personal Protective Equipment Program and Training
- E. Medical Surveillance Program and Recordkeeping
- F. Regulated Area Requirements for Glovebag Abatement
- G. Decontamination Facilities and Entry/Exit Procedures (PDF and W/EDF)
- H. Monitoring, Inspections, and Testing
- I. Removal Procedures For Piping ACM Using the Glovebag Method
- J. Disposal of ACM waste
- K. Regulated Area Decontamination/Clean-up
- L. Regulated Area Visual and Air Clearance
- M. Project Completion/Closeout

## **2.5 SUBMITTALS**

### **2.5.1 PRE-CONSTRUCTION MEETING SUBMITTALS**

Submit to the VA a minimum of 14 days prior to the pre-start meeting the following for review and approval. Meeting this requirement is a prerequisite for the pre-start meeting for this project.

- A. Submit a detailed work schedule for the entire project reflecting contract documents and the phasing/schedule requirements from the CPM chart.
- B. Submit a staff organization chart showing all personnel who will be working on the project and their capacity/function. Provide their qualifications, training, accreditations, and licenses, as appropriate. Provide a copy of the "Certificate of Worker's Acknowledgment" and the "Affidavit of Medical Surveillance and Respiratory Protection" for each person.
- C. Submit Standard Operating Procedures developed specifically for this project, incorporating the requirements of the specifications, prepared, signed and dated by the CPIH.
- D. Submit the specifics of the materials and equipment to be used for this project with brand names, model numbers, performance characteristics, pictures/diagrams, and number available for the following:
  - 1. HEPA vacuums, air monitoring pumps, calibration devices, and emergency power generating system.
  - 2. Waste water filtration system, shower system, critical/floor barriers.
  - 3. Encapsulants, surfactants, hand held sprayers, airless sprayers, glovebags, fire extinguishers.
  - 4. Personal protective equipment.
  - 5. Fire safety equipment to be used in the regulated area.
- E. Submit the name, location, and phone number of the approved landfill; proof/verification the landfill is approved for ACM disposal; the landfill's requirements for ACM waste; the type of vehicle to be used for transportation; and name, address, and phone number of subcontractor, if used. Proof of asbestos training for transportation personnel shall be provided.
- F. Submit required notifications and arrangements made with regulatory agencies having regulatory jurisdiction and the specific contingency/emergency arrangements made with local health, fire, ambulance, hospital authorities and any other notifications/arrangements.
- G. Submit the name, location and verification of the laboratory and/or personnel to be used for analysis of air and/or bulk samples. Air monitoring must be done in accordance with OSHA 29 CFR 1926.1101(f) and Appendix A.

- H. Submit qualifications verification: Submit the following evidence of qualifications. Make sure that all references are current and verifiable by providing current phone numbers and documentation.
1. Asbestos Abatement Company: Project experience within the past 3 years; listing projects first most similar to this project:  
Project Name; Type of Abatement; Duration; Cost; Reference Name/Phone Number; Final Clearance; Completion Date
  2. List of project(s) halted by owner, A/E, IH, regulatory agency in the last 3 years:  
Project Name; Reason; Date; Reference Name/Number; Resolution
  3. List asbestos regulatory citations, penalties, damages paid and legal actions taken against the company in the last 3 years. Provide copies and all information needed for verification.
- I. Submit information on personnel: Provide a resume; address each item completely; provide references; phone numbers; copies of certificates, accreditations, and licenses. Submit an affidavit signed by the CPIH stating that all personnel submitted below have medical records in accordance with OSHA 29 CFR 1926.1101(m) and 29 CFR 1910.20 and that the company has implemented a medical surveillance program and maintains recordkeeping in accordance with the above regulations. Submit the phone number and doctor/clinic/hospital used for medical evaluations.
1. CPIH: Name; years of abatement experience; list of projects similar to this one; certificates, licenses, accreditations for proof of AHERA/OSHA specialized asbestos training; professional affiliations; number of workers trained; samples of training materials; samples of SOP's developed; medical opinion; current respirator fit test.
  2. Competent Person(s)/Supervisor(s): Number; names; social security numbers; years of abatement experience as Competent Person /Supervisor; list of similar projects as Competent Person/Supervisor; as a worker; certificates, licenses, accreditations; proof of AHERA/OSHA specialized asbestos training; maximum number of personnel supervised on a project; medical opinion; current respirator fit test.
  3. Workers: Numbers; names; social security numbers; years of abatement experience; certificates, licenses, accreditations; training courses in asbestos abatement and respiratory protection; medical opinion; current respirator fit test.
- J. Submit copies of State license for asbestos abatement; copy of insurance policy, including exclusions with a letter from agent stating in plain english the coverage provided and the fact that asbestos abatement

activities are covered by the policy; copy of SOP's incorporating the requirements of this specification; information on who provides your training, how often; who provides medical surveillance, how often; who does and how is air monitoring conducted; a list of references of independent laboratories/IH's familiar with your air monitoring and standard operating procedures; copies of monitoring results of the five referenced projects listed and analytical method(s) used.

- K. When rental equipment is to be used in regulated areas or used to transport asbestos waste, the contractor shall assure complete decontamination of the rental equipment before return to the rental agency.
1. Submit, before the start of work, the manufacturer's technical data and MSDS for encapsulants used on the project. Provide application instructions also.

#### **2.5.2 SUBMITTALS DURING ABATEMENT**

- A. The Competent Person shall maintain and submit a daily log at the regulated area documenting the dates and times of the following: purpose, attendees and summary of meetings; all personnel entering/exiting the regulated area; document and discuss the resolution of unusual events such as critical barrier breeching, equipment failures, emergencies, and any cause for stopping work; representative air monitoring and results/TWA's/EL's. Submit this daily log to VA's representative.
- B. The CPIH shall document and maintain the following during abatement and submit as appropriate to the VA's representative.
1. Inspection and approval of the regulated area preparation prior to start of work and daily during work.
  2. Removal of any poly critical/floor barriers.
  3. Visual inspection/testing by the CPIH prior to application of lockdown encapsulation.
  4. Packaging and removal of ACM waste from regulated area.
  5. Disposal of ACM waste materials; copies of Waste Shipment Records/landfill receipts to the VA's representative on a weekly basis.

#### **2.5.3 SUBMITTALS AT COMPLETION OF ABATEMENT**

The CPIH shall submit a project report consisting of the daily log book requirements and documentation of events during the abatement project including Waste Shipment Records signed by the landfill's agent. The report shall include a certificate of completion, signed and dated by the CPIH, in accordance with Attachment #1. The VA Representative will

forward the abatement report to the Medical Center after completion of the project.

## **2.6 ENCAPSULANTS**

### **2.6.1 TYPES OF ENCAPSULANTS**

- A. The following four types of encapsulants must comply with performance requirements as stated in paragraph 2.6.2:
1. Removal encapsulant - used as a wetting agent to remove ACM.
  2. Bridging encapsulant - provides a tough, durable coating on ACM.
  3. Penetrating encapsulant - penetrates/encapsulates ACM at least 13 mm (1/2").
  4. Lockdown encapsulant - seals microscopic fibers on surfaces after ACM removal.

### **2.6.2 PERFORMANCE REQUIREMENTS**

Encapsulants shall meet the latest requirements of EPA; shall not contain toxic or hazardous substances; or solvents; and shall comply with the following performance requirements:

- A. General Requirements for all Encapsulants:
1. ASTM E84: Flame spread of 25; smoke emission of 50.
  2. University of Pittsburgh Protocol: Combustion Toxicity; zero mortality.
  3. ASTM C732: Accelerated Aging Test; Life Expectancy - 20 years.
  4. ASTM E96: Permeability - minimum of 0.4 perms.
- B. Bridging/Penetrating Encapsulants:
1. ASTM E736: Cohesion/Adhesion Test - 24 kPa (50 lbs/ft<sup>2</sup>).
  2. ASTM E119: Fire Resistance - 3 hours (Classified by UL for use on fibrous/cementitious fireproofing).
  3. ASTM D2794: Gardner Impact Test; Impact Resistance - minimum 11.5 kg-mm (43 in/lb).
  4. ASTM D522: Mandrel Bend Test; Flexibility - no rupture or cracking.
- C. Lockdown Encapsulants:
1. ASTM E119: Fire resistance - 3 hours (tested with fireproofing over encapsulant applied directly to steel member).
  2. ASTM E736: Bond Strength - 48 kPa (100 lbs/ft<sup>2</sup>) (test compatibility with cementitious and fibrous fireproofing).
  3. In certain situations, encapsulants may have to be applied to hot pipes/equipment. The encapsulant must be able to withstand high temperatures without cracking or off-gassing any noxious vapors during application.

## **2.7 CERTIFICATES OF COMPLIANCE**

The Contractor shall submit to the VA representative certification from the manufacturer indicating compliance with performance requirements for encapsulants when applied according to manufacturer recommendations.

## **2.8 RECYCLABLE PROTECTIVE CLOTHING**

If recyclable clothing is provided, all requirements of EPA, DOT and OSHA shall be met.

# **PART 3 - EXECUTION**

## **3.1 PRE-ABATEMENT ACTIVITIES**

### **3.1.1 PRE-ABATEMENT MEETING**

The VA representative, upon receipt, review, and substantial approval of all pre-abatement submittals and verification by the CPIH that all materials and equipment required for the project are on the site, will arrange for a pre-abatement meeting between the Contractor, the CPIH, Competent Person(s), the VA representative(s), and the VPIH/CIH. The purpose of the meeting is to discuss any aspect of the submittals needing clarification or amplification and to discuss any aspect of the project execution and the sequence of the operation. The Contractor shall be prepared to provide any supplemental information/documentation to the VA's representative regarding any submittals, documentation, materials or equipment. Upon satisfactory resolution of any outstanding issues, the VA's representative will issue a written order to proceed to the Contractor. No abatement work of any kind described in the following provisions shall be initiated prior to the VA written order to proceed.

### **3.1.2 PRE-ABATEMENT INSPECTIONS AND PREPARATIONS**

Before any work begins on the construction of the regulated area, the Contractor will:

- A. Conduct a space-by-space inspection with an authorized VA representative and prepare a written inventory of all existing damage in those spaces where asbestos abatement will occur. Still or video photography may be used to supplement the written damage inventory. Document will be signed and certified as accurate by both parties.
- B. The VA Representative, the Contractor, and the VPIH/CIH must be aware of 10/95 A/E Quality Alert indicating the failure to identify asbestos as applicable to glovebag abatement in the areas listed. Make sure these areas are looked at/reviewed on the project: Lay-in ceilings concealing ACM; ACM behind walls/windows from previous renovations; inside chases/walls; transite piping/ductwork/sheets; behind radiators; below window sills; water/sewer lines; electrical conduit coverings; steam line trench coverings.

- C. Ensure that all furniture, machinery, equipment, curtains, drapes, blinds, and other movable objects which the Contractor is required to remove from the regulated area have been cleaned and removed or properly protected from contamination.
- D. Shut down and seal with a minimum of 2 layers of 6 mil fire retardant poly all HVAC systems serving the regulated area. The regulated area critical barriers shall be completely isolated from any other air in the building. The VA's representative will monitor the isolation provision.
- E. Shut down and lock out in accordance with 29 CFR 1910.147 all electrical circuits which pose a potential hazard. Electrical arrangements will be tailored to the particular regulated area and the systems involved. All electrical circuits affected will be turned off at the circuit box outside the regulated area, not just the wall switch. The goal is to eliminate the potential for electrical shock which is a major threat to life in the regulated area due to water use and possible energized circuits. Electrical lines used to power equipment in the regulated area shall conform to all electrical safety standards and shall be isolated by the use of a ground fault circuit interrupter (GFCI). All GFCI shall be tested prior to use. The VA's representative will monitor the electrical shutdown.
- F. If required, remove and dispose of carpeting from floors in the regulated area.
- G. Inspect existing firestopping in the regulated area. Correct as needed.

### **3.1.3 PRE-ABATEMENT CONSTRUCTION AND OPERATIONS**

- A. Perform all preparatory work for the first regulated area in accordance with the approved work schedule and with this specification.
- B. Upon completion of all preparatory work, the CPIH will inspect the work and systems and will notify the VA's representative when the work is completed in accordance with this specification. The VA's representative may inspect the regulated area and the systems with the VPIH/CIH and may require that upon satisfactory inspection, the Contractor's employees perform all major aspects of the approved SOP's, especially worker protection, respiratory systems, contingency plans, decontamination procedures, and monitoring to demonstrate satisfactory operation.
- C. The CPIH shall document the pre-abatement activities described above and deliver a copy to the VA's representative.
- D. Upon satisfactory inspection of the installation of and operation of systems the VA's representative will notify the Contractor in writing to proceed with the asbestos abatement work in accordance with this specification.

### **3.2 REGULATED AREA PREPARATIONS**

#### **3.2.1 OSHA DANGER SIGNS**

Post OSHA DANGER signs meeting the specifications of OSHA 29 CFR 1926.1101 at any location and approaches to the regulated area where airborne concentrations of asbestos may exceed ambient background levels. Signs shall be posted at a distance sufficiently far enough away from the regulated area to permit any personnel to read the sign and take the necessary measures to avoid exposure. Additional signs will be posted following construction of the regulated area enclosure.

#### **3.2.2 SHUT DOWN - LOCK OUT ELECTRICAL**

Shut down and lock out electric power to the regulated area. Provide temporary power and lighting. Insure safe installation including GFCI of temporary power sources and equipment by compliance with all applicable electrical code requirements and OSHA requirements for temporary electrical systems. Electricity shall be provided by the VA.

#### **3.2.3 SHUT DOWN - LOCK OUT HVAC**

Shut down and lock out heating, cooling, and air conditioning system (HVAC) components that are in, supply or pass through the regulated area.

Investigate the regulated area and agree on pre-abatement condition with the VA's representative. Seal all intake and exhaust vents in the regulated area with duct tape and 2 layers of 6-mil poly. Also, seal any seams in system components that pass through the regulated area. Remove all contaminated HVAC system filters and place in labeled 6-mil poly disposal bags for disposal as asbestos waste.

#### **3.2.4 SANITARY FACILITIES**

The Contractor shall provide sanitary facilities for abatement personnel and maintain them in a clean and sanitary condition throughout the abatement project.

#### **3.2.5 WATER FOR ABATEMENT**

The VA will provide water for abatement purposes. The Contractor shall connect to the existing VA system. The service to the shower(s) shall be supplied with backflow prevention.

#### **3.2.6 PRE-CLEANING MOVABLE OBJECTS**

Pre-clean all movable objects within the regulated area using a HEPA filtered vacuum and/or wet cleaning methods as appropriate. After cleaning, these objects shall be removed from the regulated area and carefully stored in an uncontaminated location.

### **3.2.7 PRE-CLEANING FIXED OBJECTS**

Pre-clean all fixed objects in the regulated area using HEPA filtered vacuums and/or wet cleaning techniques as appropriate. Careful attention must be paid to machinery behind grills or gratings where access may be difficult but contamination may be significant. Also, pay particular attention to wall, floor and ceiling penetration behind fixed items. After precleaning, enclose fixed objects with 2 layers of 6-mil poly and seal securely in place with duct tape. Objects (e.g., permanent fixtures, shelves, electronic equipment, laboratory tables, sprinklers, alarm systems, closed circuit TV equipment and computer cables) which must remain in the regulated area and that require special ventilation or enclosure requirements should be designated here along with specified means of protection. Contact the manufacturer for special protection requirements.

### **3.2.8 PRE-CLEANING SURFACES IN THE REGULATED AREA**

Pre-clean all surfaces in the regulated area using HEPA filtered vacuums and/or wet cleaning methods as appropriate. Do not use any methods that would raise dust such as dry sweeping or vacuuming with equipment not equipped with HEPA filters. Do not disturb asbestos-containing materials during this pre-cleaning phase.

## **3.3 CONTAINMENT BARRIERS AND COVERINGS FOR THE REGULATED AREA**

### **3.3.1 GENERAL**

Seal off any openings at the perimeter of the regulated area with critical barriers to completely isolate the regulated area and to contain all airborne asbestos contamination created by the abatement activities. Should the adjacent area past the regulated area become contaminated due to improper work activities, the Contractor shall suspend work inside the regulated area, continue wetting, and clean the adjacent areas in accordance with procedures described in these specifications. Any and all costs associated with the adjacent area cleanup shall not be borne by the VA.

### **3.3.2 PREPARATION PRIOR TO SEALING OFF**

Place all materials, equipment and supplies necessary to isolate the regulated area inside the regulated area. Remove all movable material/equipment as described above and secure all unmovable material/equipment as described above. Properly secured material/equipment shall be considered to be outside the regulated area.

### **3.3.3 CONTROLLING ACCESS TO THE REGULATED AREA**

Access to the regulated area shall be permitted only through the PDF. All other means of access shall be closed off by proper sealing and

DANGER signs posted on the clean side of the regulated area where it is adjacent to or within view of any occupiable area. An opaque visual barrier of 6 mil poly shall be provided so that the abatement work is not visible to any building occupants. If the area adjacent to the regulated area is accessible to the public, construct a solid barrier on the public side of the sheeting for protection and isolation of the project. The barrier shall be constructed with nominal 2" x 4" (50mm x 100mm) wood or metal studs 16" (400mm) on centers, securely anchored to prevent movement and covered with a minimum of 1/2" (12.5mm) plywood. Provide an appropriate number of OSHA DANGER signs for each visual and physical barrier. Any alternative method must be given a written approval by the VA's representative.

#### **3.3.4 CRITICAL BARRIERS**

The regulated area must be completely separated from the adjacent areas, and the outside by at least 2 layers of 6 mil fire retardant poly and duct tape/spray adhesive. Individually seal all supply and exhaust ventilation openings, lighting fixtures, clocks, doorways, windows, convectors, speakers, and other openings into the regulated area with 2 layers of 6 mil fire retardant poly, and taped securely in place with duct tape/spray adhesive. Critical barriers must remain in place until all work and clearances have been completed. Light fixtures shall not be operational during abatement. Auxiliary lighting shall be provided. If needed, provide plywood squares 6" x 6" x 3/8" (150mm x 150mm x 18mm) held in place with one 6d smooth masonry/galvanized nail driven through the center of the plywood square and duct tape on the poly so as to clamp the poly to the wall/surface. Locate plywood squares at each end, corner, and 4' (1200mm) maximum on centers.

#### **3.3.5 EXTENSION OF THE REGULATED AREA**

If the regulated area barrier is breached in any manner that could allow the passage of asbestos fibers or debris, the Competent Person shall immediately stop work, continue wetting, and proceed to extend the regulated area to enclose the affected area as per procedures described in this specification. If the affected area cannot be enclosed, decontamination measures and cleanup shall start immediately. All personnel shall be isolated from the affected area until decontamination/cleanup is completed as verified by visual inspection and air monitoring. Air monitoring at completion must indicate background levels.

### **3.3.6 FLOOR BARRIERS:**

All floors within 10' of glovebag work shall be covered with 2 layers of 6 mil fire retardant poly.

### **3.4 REMOVAL OF PIPING ACM**

#### **3.4.1 WETTING MATERIALS**

- A. Use amended water for the wetting of ACM prior to removal. The Competent Person shall assure the wetting of ACM meets the definition of "adequately wet" in the EPA NESHAP's regulation and OSHA's "wet methods" for the duration of the project. A removal encapsulant may be used instead of amended water with written approval of the VA's representative.
- B. Amended Water: Provide water to which a surfactant has been added shall be used to wet the ACM and reduce the potential for fiber release during disturbance of ACM. The mixture must be equal to or greater than the wetting provided by water amended by a surfactant consisting one ounce of 50% polyoxyethylene ester and 50% polyoxyethylene ether mixed with 5 gallons (19L) of water.
- C. Removal Encapsulant: Provide a penetrating encapsulant designed specifically for the removal of ACM. The material must, when used, result in adequate wetting of the ACM and retard fiber release during disturbance equal to or greater than the amended water described above in B.

#### **3.4.2 SECONDARY BARRIER AND WALKWAYS**

- A. Install as a drop cloth a 6 mil poly sheet at the beginning of each work shift where removal is to be done during that shift. Completely floors within 10 feet (3M) of the area where work is to be done. Secure the secondary barrier with duct tape to prevent debris from getting behind it. Remove the secondary barrier at the end of the shift or as work in the area is completed. Keep residue on the secondary barrier wetted. When removing, fold inward to prevent spillage and place in a disposal bag.
- B. Install walkways using 6 mil poly between the regulated area and the decontamination facilities (PDF and W/EDF) to protect the floor from contamination and damage. Install the walkways at the beginning of each shift and remove at the end of each shift.

#### **3.4.3 WET REMOVAL OF ACM**

- A. Using acceptable glovebag procedures, adequately and thoroughly wet the ACM to be removed prior to removal to reduce/prevent fiber release to the air. Adequate time must be allowed for the amended water to saturate the ACM. Abatement personnel must not disturb dry ACM. Use a fine spray

of amended water or removal encapsulant. Saturate the material sufficiently to wet to the substrate without causing excessive dripping. The material must be sprayed repeatedly/continuously during the removal process in order to maintain adequately wet conditions. Removal encapsulants must be applied in accordance with the manufacturer's written instructions. Perforate or carefully separate, using wet methods, an outer covering that is painted or jacketed in order to allow penetration and wetting of the material. Where necessary, carefully remove covering while wetting to minimize fiber release. In no event shall dry removal occur except in the case of electrical hazards or a greater safety issue is possible!

### **3.5 GLOVEBAG REMOVAL PROCEDURES**

#### **3.5.1 GENERAL**

All applicable OSHA requirements and glovebag manufacturer's recommendations shall be met during glove bagging operations.

1. Mix the surfactant with water in the garden sprayer, following the manufacturer's directions.
2. Have each employee put on a HEPA filtered respirator approved for asbestos and check the fit using the positive/negative fit check.
3. Have each employee put on a disposable full-body suit. Remember, the hood goes over the respirator straps.
4. Check closely the integrity of the glove bag to be used. Check all seams, gloves, sleeves, and glove openings. OSHA requires the bottom of the bag to be seamless.
5. Check the pipe where the work will be performed. If it is damaged (broken lagging, hanging, etc.), wrap the entire length of the pipe in poly sheeting and "candy stripe" it with duct tape.
6. Attach glovebag with required tools per manufacturer's instructions.
7. Using the smoke tube and aspirator bulb, test 10% of glovebags by placing the tube into the water porthole (two-inch opening to glove bag), and fill the bag with smoke and squeeze it. If leaks are found, they should be taped closed using duct tape and the bag should be retested with smoke.
8. Insert the wand from the water sprayer through the water porthole.
9. Insert the hose end from a HEPA vacuum into the upper portion of the glove bag.
10. Wet and remove the pipe insulation.
11. If the section of pipe is covered with an aluminum jacket, remove it first using the wire cutters to cut any bands and the tin snips to

- remove the aluminum. It is important to fold the sharp edges in to prevent cutting the bag when placing it in the bottom.
12. When the work is complete, spray the upper portion of the bag and clean-push all residue into the bottom of the bag with the other waste material. Be very thorough. Use adequate water.
  13. Put all tools, after washing them off in the bag, in one of the sleeves of glove bag and turn it inside out, drawing it outside of the bag. Twist the sleeve tightly several times to seal it and tape it several tight turns with duct tape. Cut through the middle of the duct tape and remove the sleeve. Put the sleeve in the next glove bag or put it in a bucket of water to decontaminate the tools after cutting the sleeve open.
  14. Turn on the HEPA vacuum and collapse the bag completely. Remove the vacuum nozzle, seal the hole with duct tape, twist the bag tightly several times in the middle, and tape it to keep the material in the bottom during removal of the glove bag from the pipe.
  15. Slip a disposal bag over the glove bag (still attached to the pipe). Remove the tape securing the ends, and slit open the top of the glove bag and carefully fold it down into the disposal bag. Double bag and gooseneck waste materials.

### **3.5.2 NEGATIVE PRESSURE GLOVEBAG PROCEDURE**

1. In addition to the above requirements, the HEPA vacuum shall be run continuously during the glovebag procedure until completion at which time the glovebag will be collapsed by the HEPA vacuum prior to removal from the pipe/component.
2. The HEPA vacuum shall be attached and operated as needed to prevent collapse of the glovebag during the removal process.

## **3.6 LOCKDOWN ENCAPSULATION**

### **3.6.1 GENERAL**

Lockdown encapsulation is an integral part of the ACM removal. At the conclusion of ACM removal and before removal of the primary barriers, all piping surfaces shall be encapsulated with a bridging encapsulant.

### **3.6.2 SEALING EXPOSED EDGES**

Seal edges of ACM exposed by removal work with two coats of encapsulant. Prior to sealing, permit the exposed edges to dry completely to permit penetration of the encapsulant.

## **3.7 DISPOSAL OF ACM WASTE MATERIALS**

### **3.7.1 GENERAL**

Dispose of waste ACM and debris which is packaged in accordance with these specifications, OSHA, EPA and DOT. The landfill requirements for

packaging must also be met. Disposal shall be done at the approved landfill. Disposal of non-friable ACM shall be done in accordance with applicable regulations.

### **3.7.2 PROCEDURES**

- A. Asbestos waste shall be packaged and moved through the W/EDF into a covered transport container in accordance with procedures in this specification. Waste shall be double-bagged prior to disposal. Wetted waste can be very heavy. Bags shall not be overfilled. Bags shall securely sealed to prevent accidental opening and/or leakage. The top shall be tightly twisted and goosenecked prior to tightly sealing with at least three wraps of duct tape. Ensure that unauthorized persons do not have access to the waste material once it is outside the regulated area. All transport containers must be covered at all times when not in use. NESHAP's signs must be on containers during loading and unloading. Material shall not be transported in open vehicles. If drums are used for packaging, the drums shall be labeled properly and shall not be re-used.
- B. Waste Load Out: Waste load out shall be done in accordance with the procedures in W/EDF Decontamination Procedures. Bags shall be decontaminated on exterior surfaces by wet cleaning and/or HEPA vacuuming before being placed in the second bag.
- C. Asbestos waste with sharp edged components, i.e., nails, screws, lath, strapping, tin sheeting, jacketing, metal mesh, etc., which might tear poly bags shall be wrapped securely in burlap before packaging and, if needed, use a poly lined fiber drum as the second container, prior to disposal.

## **3.8 PROJECT DECONTAMINATION**

### **3.8.1 GENERAL**

- A. The entire work related to project decontamination shall be performed under the close supervision and monitoring of the CPIH.
- B. If the asbestos abatement work is in an area which was contaminated prior to the start of abatement, the decontamination will be done by cleaning the primary barrier poly prior to its removal and cleaning of the regulated area surfaces after the primary barrier removal.
- C. If the asbestos abatement work is in an area which was uncontaminated prior to the start of abatement, the decontamination will be done by cleaning the primary barrier poly prior to its removal, thus preventing contamination of the building when the regulated area critical barriers are removed.

### **3.8.2 REGULATED AREA CLEARANCE**

Air testing and other requirements which must be met before release of the Contractor and re-occupancy of the regulated area space are specified in Final Testing Procedures.

### **3.8.3 WORK DESCRIPTION**

Decontamination includes the cleaning and clearance of the air in the regulated area and the decontamination and removal of the enclosures/facilities installed prior to the abatement work including primary/critical barriers, PDF and W/EDF facilities.

### **3.8.4 PRE-DECONTAMINATION CONDITIONS**

- A. Before decontamination starts, all ACM waste from the regulated area shall be removed, all waste collected and removed, and the secondary barrier of poly removed and disposed of along with any gross debris generated by the work.
- B. At the start of decontamination, the following shall be in place:
  - 1. Critical barriers over all openings consisting of two layers of 6 mil poly which is the sole barrier between the regulated area and the rest of the building or outside.
  - 3. Decontamination facilities, if required for personnel and equipment in operating condition.

### **3.8.5 FIRST CLEANING**

Carry out a first cleaning of all surfaces of the regulated area including items of remaining poly sheeting, tools, scaffolding, ladders/staging by wet methods and/or HEPA vacuuming. Do not use dry dusting/sweeping methods. Use each surface of a cleaning cloth one time only and then dispose of as contaminated waste. Continue this cleaning until there is no visible residue from abated surfaces or poly or other surfaces. If determined by the CPIH/VPIH/CIH additional cleaning(s) may be needed.

### **3.8.6 PRE-CLEARANCE INSPECTION AND TESTING**

The CPIH and VPIH/CIH will perform a thorough and detailed visual inspection after the first cleaning to determine whether there is any visible residue in the regulated area. If the visual inspection is acceptable, the CPIH will perform pre-clearance sampling using aggressive clearance as detailed in 40 CFR 763 Subpart E (AHERA) Appendix A(III)(B)(7)(d). If the sampling results show values below 0.01 f/cc, then the Contractor shall notify the VA's representative of the results with a brief report from the CPIH documenting the inspection and sampling results and a statement verifying that the regulated area is ready for lockdown encapsulation. The VA reserves the right to utilize

their own VPIH/CIH to perform a pre-clearance inspection and testing for verification.

### **3.8.7 LOCKDOWN ENCAPSULATION OF ABATED SURFACES**

With the express written permission of the VA's representative, perform lockdown encapsulation of all surfaces from which asbestos was abated in accordance with the procedures in this specification.

## **3.9 FINAL VISUAL INSPECTIONS AND AIR CLEARANCE TESTING**

### **3.9.1 GENERAL**

Notify the VA representative 24 hours in advance for the performance of the final visual inspection and testing. The final visual inspection and testing will be performed by the VPIH/CIH after the final cleaning.

### **3.9.2 FINAL VISUAL INSPECTION**

Final visual inspection will include the entire regulated area, the PDF, all poly sheeting, seals over HVAC openings, doorways, windows, and any other openings. If any debris, residue, dust or any other suspect material is detected, the final cleaning shall be repeated at no cost to the VA. Dust/material samples may be collected and analyzed at no cost to the VA at the discretion of the VPIH/CIH to confirm visual findings. When the regulated area is visually clean the final testing can be done.

### **3.9.3 FINAL AIR CLEARANCE TESTING**

- A. After an acceptable final visual inspection by the VPIH/CIH and VA Representative, the VPIH/CIH will perform the final testing. Air samples will be collected and analyzed in accordance with procedures for PCM in this specification. If the release criteria are not met, the Contractor shall repeat the final cleaning and continue decontamination procedures. Additional inspection and testing will be done at the expense of the Contractor.
- B. If the results of the PCM are acceptable, remove the critical barriers. Any small quantities of residue material found upon removal of the poly shall be removed with a HEPA vacuum and localized isolation. If significant quantities are found as determined by the VPIH/CIH, then the entire area affected shall be cleaned as specified in the final cleaning.
- C. When release criteria are met, proceed to perform the abatement closeout and to issue the certificate of completion in accordance with these specifications.

### **3.9.4 FINAL AIR CLEARANCE PROCEDURES**

- A. Contractor's Release Criteria: Work in a regulated area is complete when the regulated area is visually clean and airborne fiber levels have been reduced to or below 0.01 f/cc as measured with PCM methods.

B. Air Monitoring and Final Clearance Sampling: To determine if the elevated airborne fiber counts encountered during abatement operations have been reduced to the specified level, the VPIH/CIH will secure samples and analyze them according to the following procedures:

1. Fibers Counted: "Fibers" referred to in this section shall be either all fibers regardless of composition as counted in the NIOSH 7400 PCM method.
2. Aggressive Sampling: All final air testing samples shall be collected using aggressive sampling techniques. Samples will be collected on 0.8µ MCE filters for PCM analysis and 0.45µ Polycarbonate filters for TEM analysis. Before pumps are started, initiate aggressive sampling as detailed in 40 CFR 763 Subpart E (AHERA) Appendix A (III)(B)(7)(d). Air samples will be collected in areas subject to normal air circulation away from corners, obstructed locations, and locations near windows, doors, or vents. After air sampling pumps have been shut off, circulating fans shall be shut off.

#### **3.9.5 CLEARANCE SAMPLING USING PCM**

The NIOSH 7400 method will be used for clearance sampling with a minimum collection volume of 1200 Liters of air. A minimum of 5 PCM clearance samples will be collected.

#### **3.9.7 LABORATORY TESTING OF PCM SAMPLES**

The services of an AIHA accredited laboratory will be employed by the VA to perform analysis of the air samples. Samples will be sent by the VPIH/CIH so that verbal/faxed reports can be received within 24 hours. A complete record, certified by the laboratory, of all air monitoring tests and results will be furnished to the VA's representative and the Contractor.

### **3.10 ABATEMENT CLOSEOUT AND CERTIFICATE OF COMPLIANCE**

#### **3.10.1 COMPLETION OF ABATEMENT WORK**

After thorough decontamination, complete asbestos abatement work upon meeting the regulated area clearance criteria and fulfilling the following:

- A. Remove all equipment, materials, and debris from the project area.
- B. Package and dispose of all asbestos waste as required.
- C. Repair or replace all interior finishes damaged during the abatement work.
- D. Fulfill other project closeout requirements as specified elsewhere in this specification.

**3.10.2 CERTIFICATE OF COMPLETION BY CONTRACTOR**

The CPIH shall complete and sign the "Certificate of Completion" in accordance with Attachment 1 at the completion of the abatement and decontamination of the regulated area.

**3.10.3 WORK SHIFTS**

All work shall be done during administrative hours (8:00 AM to 4:30 PM) Monday - Friday excluding Federal Holidays. Any change in the work schedule must be approved in writing by the VA Representative.

**3.10.4 RE-INSULATION**

If required as part of the contract, replace all asbestos containing insulation with suitable non-asbestos material. Provide MSDS's for all replacement materials. Refer to Section 23 07 11, HVAC, PLUMBING, AND BOILER PLANT INSULATION.

ATTACHMENT #1

**CERTIFICATE OF COMPLETION**

DATE:

PROJECT NAME:

VAMC/ADDRESS:

1. I certify that I have personally inspected, monitored and supervised the abatement work of

(specify regulated area or Building):

which took place from to.

2. That throughout the work all applicable requirements/regulations and the VA's specifications were met.
3. That any person who entered the regulated area was protected with the appropriate personal protective equipment and respirator and that they followed the proper entry and exit procedures and the proper operating procedures for the duration of the work.
4. That all employees of the Abatement Contractor engaged in this work were trained in respiratory protection, were experienced with abatement work, had proper medical surveillance documentation, were fit-tested for their respirator, and were not exposed at any time during the work to asbestos without the benefit of appropriate respiratory protection.
5. That I performed and supervised all inspection and testing specified and required by applicable regulations and VA specifications.
6. That the conditions inside the regulated area were always maintained in a safe and healthy condition and the maximum fiber count never exceeded 0.5 f/cc, except as described below.
7. That all glovebag work was done in accordance with OSHA requirements and the manufacturer's recommendations.

CPIH Name:

Signature/Date:

Asbestos Abatement Contractor's Name:

Signature/Date:

**ATTACHMENT #2**

**CERTIFICATE OF WORKER'S ACKNOWLEDGMENT**

**DATE:**

PROJECT NAME:

PROJECT ADDRESS:

ABATEMENT CONTRACTOR'S NAME:

**WORKING WITH ASBESTOS CAN BE HAZARDOUS TO YOUR HEALTH. INHALING ASBESTOS HAS BEEN LINKED WITH VARIOUS TYPES OF CANCERS. IF YOU SMOKE AND INHALE ASBESTOS FIBERS YOUR CHANCES OF DEVELOPING LUNG CANCER IS GREATER THAN THAT OF THE NON-SMOKING PUBLIC.**

Your employer's contract with the owner for the above project requires that: You must be supplied with the proper personal protective equipment including an adequate respirator and be trained in its use. You must be trained in safe and healthy work practices and in the use of the equipment found at an asbestos abatement project. You must receive/have a current medical examination for working with asbestos. These things shall be provided at no cost to you. By signing this certificate you are indicating to the owner that your employer has met these obligations.

**RESPIRATORY PROTECTION:** I have been trained in the proper use of respirators and have been informed of the type of respirator to be used on the above indicated project. I have a copy of the written Respiratory Protection Program issued by my employer. I have been provided for my exclusive use, at no cost, with a respirator to be used on the above indicated project.

**TRAINING COURSE:** I have been trained by a third party, State/EPA accredited trainer in the requirements for an AHERA/OSHA Asbestos Abatement Worker training course, 32 hours minimum duration. I currently have a valid State accreditation certificate. The topics covered in the course include, as a minimum, the following:

- Physical Characteristics and Background Information on Asbestos
- Potential Health Effects Related to Exposure to Asbestos
- Employee Personal Protective Equipment
- Establishment of a Respiratory Protection Program
- State of the Art Work Practices
- Personal Hygiene
- Additional Safety Hazards
- Medical Monitoring
- Air Monitoring
- Relevant Federal, State and Local Regulatory Requirements, Procedures, and Standards
- Asbestos Waste Disposal

**MEDICAL EXAMINATION:** I have had a medical examination within the past 12 months which was paid for by my employer. This examination included: health history, occupational history, pulmonary function test, and may have included a chest x-ray evaluation. The physician issued a positive written opinion after the examination.

Signature:

Social Security Number:

PRINTED NAME:

WITNESS: ATTACHMENT #3

**AFFIDAVIT OF MEDICAL SURVEILLANCE, RESPIRATORY PROTECTION AND  
TRAINING/ACCREDITATION**

VA PROJECT NAME AND NUMBER:

VA MEDICAL FACILITY:

ABATEMENT CONTRACTOR'S NAME AND ADDRESS:

1. I verify that the following individual

Name:

Social Security Number:

who is proposed to be employed in asbestos abatement work associated with the above project by the named Abatement Contractor, is included in a medical surveillance program in accordance with 29 CFR 1926.1101(m), and that complete records of the medical surveillance program as required by 29 CFR 1926.1101(m)(n) and 29 CFR 1910.20 are kept at the offices of the Abatement Contractor at the following address.

Address:

2. I verify that this individual has been trained, fit-tested and instructed in the use of all appropriate respiratory protection systems and that the person is capable of working in safe and healthy manner as expected and required in the expected work environment of this project.
3. I verify that this individual has been trained as required by 29 CFR 1926.1101(k). This individual has also obtained a valid State accreditation certificate. Documentation will be kept on-site.
4. I verify that I meet the minimum qualifications criteria of the VA specifications for a CPIH.

Signature of CPIH:

Date:

Printed Name of CPIH:

Signature of Contractor:

Date:

Printed Name of Contractor:



SECTION 02 82 13.19  
ASBESTOS FLOOR TILE AND MASTIC ABATEMENT  
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PART 1 - GENERAL

**1.1 SUMMARY OF THE WORK**

**1.1.1 CONTRACT DOCUMENTS AND RELATED REQUIREMENTS**

Drawings, general provisions of the contract, including Division 01 specifications, shall apply to the work of this section. The contract documents show the work to be done under the contract and related requirements and conditions impacting the project. Related requirements and conditions include applicable codes and regulations, notices and permits, existing site conditions and restrictions on use of the site, requirements for partial owner occupancy during the work, coordination with other work and the phasing of the work. In the event the Asbestos Abatement Contractor (Contractor) discovers a conflict in the contract documents and/or requirements or codes, the conflict must be brought to the immediate attention of the Contracting Officer for resolution. Whenever there is a conflict or overlap in the requirements, the most stringent shall apply. Any actions taken by the Contractor without obtaining guidance from the Contracting Officer shall become the sole risk and responsibility of the Contractor. All cost incurred due to such action are also the responsibility of the Contractor.

**1.1.2 EXTENT OF WORK**

- A. Below is a brief description of the estimated quantities of asbestos flooring materials to be abated. These quantities are for informational purposes only and are based on the best information available at the time of the specification preparation. The Contractor shall satisfy himself as the actual quantities to be abated. Nothing in this section may be interpreted as limiting the extent of work otherwise required by this contract and related documents.
- B. Removal, clean-up and disposal of ACM floor tile mastic in an appropriate regulated area in the following approximate quantities;  
25 each 12"x12" areas with asbestos-containing floor tile and/or mastic

**1.1.3 RELATED WORK**

- A. Section 07 84 00, FIRESTOPPING.
- B. Section 02 41 00, DEMOLITION.
- C. Division 09; FINISHES.

**1.1.4 TASKS**

The work tasks are summarized briefly as follows:

- A. Pre-abatement activities including pre-abatement meeting(s), inspection(s), notifications, permits, submittal approvals, work-site preparations, emergency procedures arrangements, and standard operating procedures for Class II asbestos abatement work.

- B. Abatement activities including removal, clean-up and disposal of ACM waste, recordkeeping, security, monitoring, and inspections.
- C. Cleaning and decontamination activities including final visual inspection, air monitoring and certification of decontamination.

#### **1.1.5 ABATEMENT CONTRACTOR USE OF PREMISES**

- A. The Contractor and Contractor's personnel shall cooperate fully with the VA representative/consultant to facilitate efficient use of buildings and areas within buildings. The Contractor shall perform the work in accordance with the VA specifications, drawings, phasing plan and in compliance with any/all applicable Federal, State and Local regulations and requirements.
- B. The Contractor shall use the existing facilities in the building strictly within the limits indicated in contract documents as well as the approved pre-abatement work plan. Asbestos abatement drawings of partially occupied buildings will show the limits of regulated areas; the placement of decontamination facilities; the temporary location of bagged waste ACM; the path of transport to outside the building; and the temporary waste storage area for each building/regulated area. Any variation from the arrangements shown on drawings shall be secured in writing from the VA representative through the pre-abatement plan of action.

#### **1.2 VARIATIONS IN QUANTITY**

The quantities and locations of ACM as indicated on the drawings and the extent of work included in this section are estimates which are limited by the physical constraints imposed by occupancy of the buildings. Accordingly, minor variations (+/- 5%) in quantities of ACM within the regulated area are considered as having no impact on contract price and time requirements of this contract. Where additional work is required beyond the above variation, the Contractor shall provide unit prices for additional work that is newly discovered materials and those prices will be used for additional work under the contract.

#### **1.3 STOP ASBESTOS REMOVAL**

If the Contracting Officer or their field representative presents a written **Stop Asbestos Removal Order**, the Contractor/Personnel shall immediately stop all asbestos removal and adequately wet any exposed ACM. The Contractor shall not resume any asbestos removal activity until authorized to do so by the VA. A stop asbestos removal order may be issued at any time the VA determines abatement conditions/ activities are not within specification requirements. Work stoppage will continue until conditions have been corrected to the satisfaction of the VA.

Standby time and costs for corrective actions will be borne by the Contractor, including the industrial hygienist's time. The occurrence of any of the following events shall be reported immediately by the Contractor in writing to the VA representative and shall require the Contractor to immediately stop asbestos removal activities and initiate fiber reduction activities:

- A.  $\geq$  0.01 f/cc outside a regulated area or  $>0.05$  f/cc inside a regulated area;
- B. breach/break in regulated area critical barrier(s)/floor;
- C. serious injury/death at the site;
- D. fire/safety emergency at the site;
- E. respiratory protection system failure;
- F. power failure loss of wetting agent; or
- G. any visible emissions observed outside the regulated area.

#### 1.4 DEFINITIONS

##### 1.4.1 GENERAL

Definitions and explanations here are neither complete nor exclusive of all terms used in the contract documents, but are general for the work to the extent they are not stated more explicitly in another element of the contract documents. Drawings must be recognized as diagrammatic in nature and not completely descriptive of the requirements indicated therein.

##### 1.4.2 GLOSSARY

**Abatement** - Procedures to control fiber release from asbestos-containing materials, typically during removal. Includes removal, encapsulation, enclosure, demolition and renovation activities related to asbestos.

**ACE** - Asbestos contaminated elements.

**ACM** - Asbestos containing material.

**Aerosol** - Solid or liquid particulate suspended in air.

**Adequately wet** - Sufficiently mixed or penetrated with liquid to prevent the release of particulates. If visible emissions are observed coming from the ACM, then that material has not been adequately wetted.

**Aggressive method** - Removal or disturbance of building material by sanding, abrading, grinding, or other method that breaks, crumbles, or disintegrates intact ACM.

**Aggressive sampling** - EPA AHERA defined clearance sampling method using air moving equipment such as fans and leaf blowers to aggressively disturb and maintain in the air residual fibers after abatement.

**AHERA** - Asbestos Hazard Emergency Response Act. Asbestos regulations for schools issued in 1987.

**Aircell** - Pipe or duct insulation made of corrugated cardboard which contains asbestos.

**Air monitoring** - The process of measuring the fiber content of a known volume of air collected over a specified period of time. The NIOSH 7400 Method, Issue 2 is used to determine the fiber levels in air.

**Air sample filter** - The filter used to collect fibers which are then counted. The filter is made of mixed cellulose ester membrane for PCM (Phase Contrast Microscopy) and polycarbonate for TEM (Transmission Electron Microscopy)

**Amended water** - Water to which a surfactant (wetting agent) has been added to increase the penetrating ability of the liquid.

**Asbestos** - Includes chrysotile, amosite, crocidolite, tremolite asbestos, anthophyllite asbestos, actinolite asbestos, and any of these minerals that have been chemically treated or altered. Asbestos also includes PACM, as defined below.

**Asbestos-containing material (ACM)** - Any material containing more than one percent asbestos.

**Asbestos contaminated elements (ACE)** - Building elements such as ceilings, walls, lights, or ductwork that are contaminated with asbestos.

**Asbestos-containing waste material** - Asbestos-containing material or asbestos contaminated objects requiring disposal.

**Asbestos waste decontamination facility** - A system consisting of drum/bag washing facilities and a temporary storage area for cleaned containers of asbestos waste. Used as the exit for waste and equipment leaving the regulated area. In an emergency, it may be used to evacuate personnel.

**Authorized person** - Any person authorized by the VA, the Contractor, or government agency and required by work duties to be present in regulated areas.

**Authorized visitor** - Any person approved by the VA; the contractor; or any government agency having jurisdiction over the regulated area.

**Barrier** - Any surface that isolates the regulated area and inhibits fiber migration from the regulated area.

**Containment Barrier** - An airtight barrier consisting of walls, floors, and/or ceilings of sealed plastic sheeting which surrounds and seals the outer perimeter of the regulated area.

**Critical Barrier** - The barrier responsible for isolating the regulated area from adjacent spaces, typically constructed of plastic sheeting secured in place at openings such as doors, windows, or any other opening into the regulated area.

**Primary Barrier** - Barriers placed over critical barriers and exposed directly to abatement work.

**Secondary Barrier** - Any additional sheeting used to isolate and provide protection from debris during abatement work.

**Breathing zone** - The hemisphere forward of the shoulders with a radius of about 150 - 225 mm (6 - 9 inches) from the worker's nose.

**Bridging encapsulant** - An encapsulant that forms a layer on the surface of the ACM.

**Building/facility owner** - The legal entity, including a lessee, which exercises control over management and recordkeeping functions relating to a building and/or facility in which asbestos activities take place.

**Bulk testing** - The collection and analysis of suspect asbestos containing materials.

**Certified Industrial Hygienist (CIH)** - One certified in practice of industrial hygiene by the American Board of Industrial Hygiene. An industrial hygienist Certified in Comprehensive Practice by the American Board of Industrial Hygiene.

**Class I asbestos work** - Activities involving the removal of Thermal System Insulation (TSI) and surfacing ACM and Presumed Asbestos Containing Material (PACM).

**Class II asbestos work** - Activities involving the removal of ACM which is not thermal system insulation or surfacing material. This includes, but is not limited to, the removal of asbestos-containing wallboard, floor tile and sheeting, roofing and siding shingles, and construction mastic.

**Clean room/Changing room** - An uncontaminated room having facilities for the storage of employee's street clothing and uncontaminated materials and equipment.

**Clearance sample** - The final air sample taken after all asbestos work has been done and visually inspected.

Performed by the VA's industrial hygiene consultant (VPIH).

**Closely resemble** - The major workplace conditions which have contributed to the levels of historic asbestos exposure, are no more protective than conditions of the current workplace.

**Competent person** - In addition to the definition in 29 CFR 1926.32(f), one who is capable of identifying existing asbestos hazards in the workplace and selecting the appropriate control strategy for asbestos exposure, who has the authority to take prompt corrective measures to eliminate them, as specified in 29 CFR 1926.32(f); in addition, for Class I and II work who is specially trained in a training course which meets the criteria of EPA's Model Accreditation Plan (40 CFR 763) for supervisor.

**Contractor's Professional Industrial Hygienist (CPIH)** - The Contractor's industrial hygienist. The industrial hygienist must meet the qualification requirements of the PIH.

**Count** - Refers to the fiber count or the average number of fibers greater than five microns in length per cubic centimeter of air.

**Decontamination area/unit** - An enclosed area adjacent to and connected to the regulated area and consisting of an equipment room, shower room, and clean room, which is used for the decontamination of workers, materials, and equipment that are contaminated with asbestos.

**Demolition** - The wrecking or taking out of any load-supporting structural member and any related razing, removing, or stripping of asbestos products.

**Disposal bag** - Typically 6 mil thick siftproof, dustproof, leaktight container used to package and transport asbestos waste from regulated areas to the approved landfill. Each bag/container must be labeled/marked in accordance with EPA, OSHA and DOT requirements.

**Disturbance** - Activities that disrupt the matrix of ACM or PACM, crumble or pulverize ACM or PACM, or generate visible debris from ACM or PACM. Disturbance includes cutting away small amounts of ACM or PACM, no greater than the amount that can be contained in one standard sized glove bag or waste bag in order to access a building component. In no event shall the amount of ACM or PACM so disturbed exceed that which can be contained in one glove bag or disposal bag which shall not exceed 60 inches in length or width.

**Drum** - A rigid, impermeable container made of cardboard fiber, plastic, or metal which can be sealed in order to be siftproof, dustproof, and leaktight.

**Employee exposure** - The exposure to airborne asbestos that would occur if the employee were not wearing respiratory protection equipment.

**Encapsulant** - A material that surrounds or embeds asbestos fibers in an adhesive matrix and prevents the release of fibers.

**Encapsulation** - Treating ACM with an encapsulant.

**Enclosure** - The construction of an air tight, impermeable, permanent barrier around ACM to control the release of asbestos fibers from the material and also eliminate access to the material.

**Equipment room** - A contaminated room located within the decontamination area that is supplied with impermeable bags or containers for the disposal of contaminated protective clothing and equipment.

**Fiber** - A particulate form of asbestos, 5 microns or longer, with a length to width ratio of at least 3 to 1.

**Fibers per cubic centimeter (f/cc)** - Abbreviation for fibers per cubic centimeter, used to describe the level of asbestos fibers in air.

**Filter** - Media used in respirators, vacuums, or other machines to remove particulate from air.

**Firestopping** - Material used to close the open parts of a structure in order to prevent a fire from spreading.

**Friable asbestos containing material** - Any material containing more than 1 percent asbestos as determined using the method specified in Appendix A, Subpart F, 40 CFR 763, Section 1, Polarized Light Microscopy, that, when dry, can be crumbled, pulverized, or reduced to powder by hand pressure.

**Glovebag** - Not more than a 60 x 60 inch impervious plastic bag-like enclosure affixed around an asbestos-containing material, with glove-like appendages through which materials and tools may be handled.

**High efficiency particulate air HEPA)filter** - A filter capable of trapping and retaining at least 99.97 percent of all mono-dispersed particles of 0.3 microns or greater in diameter.

**HEPA vacuum** - Vacuum collection equipment equipped with a HEPA filter system capable of collecting and retaining asbestos fibers.

**Homogeneous area** - An area of surfacing, thermal system insulation or miscellaneous ACM that is uniform in color, texture and date of application.

**HVAC** - Heating, Ventilation and Air Conditioning

**Industrial hygienist** - A professional qualified by education, training, and experience to anticipate, recognize, evaluate and develop controls for occupational health hazards. Meets definition requirements of the American Industrial Hygiene Association (AIHA).

**Industrial hygienist technician** - A person working under the direction of an IH or CIH who has special training, experience, certifications and licenses required for the industrial hygiene work assigned.

**Intact** - The ACM has not crumbled, been pulverized, or otherwise deteriorated so that the asbestos is no longer likely to be bound with its matrix.

**Lockdown** - Applying encapsulant, after a final visual inspection, on all abated surfaces at the conclusion of ACM removal prior to removal of critical barriers.

**National Emission Standards for Hazardous Air Pollutants (NESHAP's)** - EPA's rule to control emissions of asbestos to the environment.

**Negative initial exposure assessment** - A demonstration by the employer which complies with the criteria in 29 CFR 1926.1101 (f)(2)(iii), that employee exposure during an operation is expected to be consistently below the PEL's.

**Negative pressure** - Air pressure which is lower than the surrounding area, created by exhausting air from a sealed regulated area through HEPA equipped filtration units. OSHA requires maintaining -0.02" water gauge inside the negative pressure enclosure.

**Negative pressure respirator** - A respirator in which the air pressure inside the facepiece is negative during inhalation relative to the air outside the respirator.

**Non-friable ACM** - Material that contains more than 1 percent asbestos but cannot be crumbled, pulverized, or reduced to powder by hand pressure.

**Organic vapor cartridge** - The type of cartridge used on air purifying respirators for organic vapor exposures.

**Outside air** - The air outside buildings and structures, including, but not limited to, the air under a bridge or in an open ferry dock.

**Owner/operator** - Any person who owns, leases, operates, controls, or supervises the facility being demolished or renovated or any person who owns, leases, operates, controls, or supervises the demolition or renovation operation, or both.

**Penetrating encapsulant** - Encapsulant that is absorbed into the ACM matrix without leaving a surface layer.

**Personal sampling/monitoring** - Representative air samples obtained in the breathing zone of the person using a cassette and battery operated pump to determine asbestos exposure.

**Permissible exposure limit (PEL)** - The level of exposure OSHA allows for an 8 hour time weighted average. For asbestos fibers, the PEL is 0.1 fibers per cc.

**Polarized light microscopy (PLM)** - Light microscopy using dispersion staining techniques and refractive indices to identify and quantify the type(s) of asbestos present in a bulk sample.

**Polyethylene sheeting** - Strong plastic barrier material 4 to 6 mils thick, semi-transparent, sometimes flame retardant in compliance with NFPA 241.

**Positive/negative fit check** - A method of verifying the fit of a respirator by closing off the filters and breathing in or closing off the exhalation valve and breathing out while detecting leakage of the respirator.

**Presumed ACM (PACM)** - Thermal system insulation, surfacing, and flooring material installed in buildings prior to 1981. If the building owner has actual knowledge, or should have known through the exercise of due diligence that other materials are ACM, they too must be treated as PACM. The designation of PACM may be rebutted pursuant to 29 CFR 1926.1101 (k)(5).

**Professional IH** - An IH who meets the definition requirements of AIHA; meets the definition requirements of OSHA as a "Competent Person" at 29 CFR 1926.1101 (b); has completed two specialized EPA approved courses on management and supervision of asbestos abatement projects; has formal training in respiratory protection and waste disposal; and has a minimum of four projects of similar complexity with this project of which at least three projects serving as the supervisory IH.

**Project designer** - A person who has successfully completed the training requirements for an asbestos abatement project designer as required by 40 CFR 763 Appendix C, Part I; (B)(5).

**Protection factor** - A value assigned by OSHA/NIOSH to indicate the assigned protection a respirator should provide if worn properly. The number indicates the reduction of exposure level from outside to inside the respirator.

**Qualitative fit test (QLFT)** - A fit test using a challenge material that can be sensed by the wearer if leakage in the respirator occurs.

**Quantitative fit test (QNFT)** - A fit test using a challenge material which is quantified outside and inside the respirator thus allowing the determination of the actual fit factor.

**Regulated area** - An area established by the employer to demarcate where Class I, II, III asbestos work is conducted, and any adjoining area where debris and waste from such asbestos work may accumulate; and a work area within which airborne concentrations of asbestos exceed, or there is a reasonable possibility they may exceed the PEL.

**Regulated ACM (RACM)** - Friable ACM; Category I nonfriable ACM that has become friable; Category I nonfriable ACM that will be or has been subjected to sanding, grinding, cutting, or abrading or; Category II nonfriable ACM that has a high probability of becoming or has become crumbled, pulverized, or reduced to powder by the forces expected to act on the material in the course of the demolition or renovation operation.

**Removal** - All operations where ACM, PACM and/or RACM is taken out or stripped from structures or substrates, including demolition operations.

**Renovation** - Altering a facility or one or more facility components in any way, including the stripping or removal of asbestos from a facility component which does not involve demolition activity.

**Repair** - Overhauling, rebuilding, reconstructing, or reconditioning of structures or substrates, including encapsulation or other repair of ACM or PACM attached to structures or substrates.

**Shower room** - The portion of the PDF where personnel shower before leaving the regulated area. Also used for bag/drum decontamination in the EDF.

**Standard operating procedures (SOP's)** - Asbestos work procedures required to be submitted by the contractor before work begins.

**Supplied air respirator (SAR)** - A respirator that utilizes an air supply separate from the air in the regulated area.

**Surfacing ACM** - A material containing more than 1 percent asbestos that is sprayed, troweled on or otherwise applied to surfaces for acoustical, fireproofing and other purposes.

**Surfactant** - A chemical added to water to decrease water's surface tension thus making it more penetrating into ACM.

**Thermal system ACM** - A material containing more than 1 percent asbestos applied to pipes, fittings, boilers, breeching, tanks, ducts, or other structural components to prevent heat loss or gain.

**Transmission electron microscopy (TEM)** - A microscopy method that can identify and count asbestos fibers.

**VA Industrial Hygienist (VPIH/CIH)** - Department of Veterans Affairs Professional Industrial Hygienist.

**VA Representative** - The VA official responsible for on-going project work.

**Visible emissions** - Any emissions, which are visually detectable without the aid of instruments, coming from ACM/PACM/RACM or ACM waste material.

**Waste/Equipment decontamination area (W/EDA)** - The area in which waste is packaged and equipment is decontaminated before removal from the regulated area.

**Waste generator** - Any owner or operator whose act or process produces asbestos-containing waste material.

**Waste shipment record** - The shipping document, required to be originated and signed by the waste generator, used to track and substantiate the disposition of asbestos-containing waste material.

**Wet cleaning** - The process of thoroughly eliminating, by wet methods, any asbestos contamination from surfaces or objects.

#### 1.4.3 REFERENCED STANDARDS ORGANIZATIONS

The following acronyms or abbreviations as referenced in contract/specification documents are defined to mean the associated names. Names and addresses may be subject to change.

- A. VA Department of Veterans Affairs  
810 Vermont Avenue, NW  
Washington, DC 20420
- B. AIHA American Industrial Hygiene Association  
2700 Prosperity Avenue, Suite 250  
Fairfax, VA 22031  
703-849-8888
- C. ANSI American National Standards Institute  
1430 Broadway  
New York, NY 10018  
212-354-3300
- D. ASTM American Society for Testing and Materials  
1916 Race St.  
Philadelphia, PA 19103  
215-299-5400
- E. CFR Code of Federal Regulations  
Government Printing Office  
Washington, DC 20420
- F. CGA Compressed Gas Association  
1235 Jefferson Davis Highway  
Arlington, VA 22202  
703-979-0900
- G. CS Commercial Standard of the National Institute of Standards and Technology (NIST)  
U. S. Department of Commerce

Government Printing Office

Washington, DC 20420

H. EPA Environmental Protection Agency

401 M St., SW

Washington, DC 20460

202-382-3949

I. MIL-STD Military Standards/Standardization Division

Office of the Assistant Secretary of Defense

Washington, DC 20420

J. MSHA Mine Safety and Health Administration

Respiratory Protection Division

Ballston Tower #3

Department of Labor

Arlington, VA 22203

703-235-1452

K. NIST National Institute for Standards and Technology

U. S. Department of Commerce

Gaithersburg, MD 20234

301-921-1000

L. NEC National Electrical Code (by NFPA)

M. NEMA National Electrical Manufacturer's Association

2101 L Street, NW

Washington, DC 20037

N. NFPA National Fire Protection Association

1 Batterymarch Park

P.O. Box 9101

Quincy, MA 02269-9101

800-344-3555

O. NIOSH National Institutes for Occupational Safety and Health

4676 Columbia Parkway

Cincinnati, OH 45226

513-533-8236

P. OSHA Occupational Safety and Health Administration

U.S. Department of Labor

Government Printing Office

Washington, DC 20402

Q. UL Underwriters Laboratory

333 Pfingsten Rd.

Northbrook, IL 60062

312-272-8800

R. USA United States Army  
Army Chemical Corps  
Department of Defense  
Washington, DC 20420

## **1.5 APPLICABLE CODES AND REGULATIONS**

### **1.5.1 GENERAL APPLICABILITY OF CODES, REGULATIONS, AND STANDARDS**

- A. All work under this contract shall be done in strict accordance with all applicable Federal, State, and local regulations, standards and codes governing asbestos abatement, and any other trade work done in conjunction with the abatement. All applicable codes, regulations and standards are adopted into this specification and will have the same force and effect as this specification.
- B. The most recent edition of any relevant regulation, standard, document or code shall be in effect. Where conflict among the requirements or with these specifications exists, the most stringent requirement(s) shall be utilized.
- C. Copies of all standards, regulations, codes and other applicable documents, including this specification and those listed in Section 1.5 shall be available at the worksite in the clean change area of the worker decontamination system.

### **1.5.2 CONTRACTOR RESPONSIBILITY**

The Contractor shall assume full responsibility and liability for compliance with all applicable Federal, State and Local regulations related to any and all aspects of the abatement project. The Contractor is responsible for providing and maintaining training, accreditations, medical exams, medical records, personal protective equipment as required by applicable Federal, State and Local regulations. The contractor shall hold the VA and VPIH/CIH consultants harmless for any failure to comply with any applicable work, packaging, transporting, disposal, safety, health, or environmental requirement on the part of himself, his employees, or his subcontractors. The contractor will incur all costs of the CPIH, including all sampling/analytical costs to assure compliance with OSHA/EPA/State requirements.

### **1.5.3 FEDERAL REQUIREMENTS**

Federal requirements which govern some aspect of asbestos abatement include, but are not limited to, the following regulations.

- A. Occupational Safety and Health Administration (OSHA)
  - 1. Title 29 CFR 1926.1101 - Construction Standard for Asbestos
  - 2. Title 29 CFR 1910.132 - Personal Protective Equipment
  - 3. Title 29 CFR 1910.134 - Respiratory Protection

4. Title 29 CFR 1926 - Construction Industry Standards
5. Title 29 CFR 1910.20 - Access to Employee Exposure and Medical Records
6. Title 29 CFR 1910.1200 - Hazard Communication
7. Title 29 CFR 1910.151 - Medical and First Aid
- B. Environmental Protection Agency (EPA)
  1. 40 CFR 61 Subpart A and M (Revised Subpart B) - National Emission Standard for Hazardous Air Pollutants - Asbestos.
  2. 40 CFR 763.80 - Asbestos Hazard Emergency Response Act (AHERA)
- C. Department of Transportation (DOT)

Title 49 CFR 100 - 185 - Transportation

#### **1.5.4 STATE REQUIREMENTS**

State requirements that apply to the asbestos abatement work, disposal, clearance, etc., include, but are not limited to, the following:  
State requirements that apply to the asbestos abatement work, disposal, clearance, etc., include, but are not limited to, the following:

**ASBESTOS ABATEMENT CONTRACTOR LICENSING AND TRAINING, OHIO  
ADMINISTRATIVE CODE, RULES 3701-34-01 THROUGH 3701-34-7**

#### **1.5.5 LOCAL REQUIREMENTS**

If local requirements are more stringent than federal or state standards, the local standards are to be followed.

#### **1.5.6 STANDARDS**

- A. Standards which govern asbestos abatement activities include, but are not limited to, the following:
  1. American National Standards Institute (ANSI) Z9.2-79 - Fundamentals Governing the Design and Operation of Local Exhaust Systems Z88.2 - Practices for Respiratory Protection.
  2. Underwriters Laboratories (UL) 586-90 - UL Standard for Safety of HEPA filter Units, 7th Edition.
- B. Standards which govern encapsulation work include, but are not limited to, the following:
  1. American Society for Testing and Materials (ASTM)
- C. Standards which govern the fire and safety concerns in abatement work include, but are not limited to, the following:
  1. National Fire Protection Association (NFPA) 241 - Standard for Safeguarding Construction, Alteration, and Demolition Operations.
  2. NFPA 701 - Standard Methods for Fire Tests for Flame Resistant Textiles and Film.
  3. NFPA 101 - Life Safety Code

#### 1.5.7 EPA GUIDANCE DOCUMENTS

- A. EPA guidance documents which discuss asbestos abatement work activities are listed below. These documents are made part of this section by reference. EPA publications can be ordered from (800) 424-9065.
- B. Guidance for Controlling ACM in Buildings (Purple Book) EPA 560/5-85-024
- C. Asbestos Waste Management Guidance EPA 530-SW-85-007
- D. A Guide to Respiratory Protection for the Asbestos Abatement Industry EPA-560-OPTS-86-001
- E. Guide to Managing Asbestos in Place (Green Book) TS 799 20T July 1990

#### 1.5.8 NOTICES

- A. State and Local agencies: Send written notification as required by state and local regulations including the local fire department prior to beginning any work on ACM as follows:

Send written notification as required by USEPA National Emissions Standards for Hazardous Air Pollutants (NESHAPS) Asbestos regulations (40 CFR 61, Subpart M) to the regional Asbestos NESHAPS Contact at least 10 days prior to beginning any work on asbestos abatement or related work. Send notification to the following address:

Department of Public Health  
Division of Air Quality  
1925 St. Clair Avenue  
Cleveland, Ohio 44114-2080

Send written notification as required by Ohio Department of Health at least 10 days prior to beginning any work on any planned asbestos hazard abatement project as required by chapter 3701-34. Send notification to the following address:

Ohio Department of Health  
P.O. Box 15278  
Columbus, Ohio 43215

- B. Copies of notifications shall be submitted to the VA for the facility's records in the same time frame notification is given to EPA, State, and Local authorities.

#### 1.5.9 PERMITS/LICENSES

- A. The contractor shall apply for and have all required permits and licenses to perform asbestos abatement work as required by Federal, State, and Local regulations.
- B. Contractor shall maintain a current Ohio Department of Health "Asbestos Abatement Contractor" license in accordance with paragraph (C) of rule 3701-34-01 of the Administrative Code

#### 1.5.10 POSTING AND FILING OF REGULATIONS

- A. Maintain two (2) copies of applicable federal, state, and local regulations. Post one copy of each at the regulated area where workers will have daily access to the regulations and keep another copy in the Contractor's office.

#### 1.5.11 VA RESPONSIBILITIES

Prior to commencement of work:

- A. Notify occupants adjacent to regulated areas of project dates and requirements for relocation, if needed. Arrangements must be made prior to starting work for relocation of desks, files, equipment and personal possessions to avoid unauthorized access into the regulated area. **Note: Notification of adjacent personnel is required by OSHA in 29 CFR 1926.1101 (k) to prevent unnecessary or unauthorized access to the regulated area.**
- B. Submit to the Contractor results of background air sampling; including location of samples, person who collected the samples, equipment utilized and method of analysis. During abatement, submit to the Contractor, results of bulk material analysis and air sampling data collected during the course of the abatement. This information shall not release the Contractor from any responsibility for OSHA compliance.

#### 1.5.12 SITE SECURITY

- A. Regulated area access is to be restricted only to authorized, trained/accredited and protected personnel. These may include the Contractor's employees, employees of Subcontractors, VA employees and representatives, State and local inspectors, and any other designated individuals. A list of authorized personnel shall be established prior to commencing the project and be posted in the clean room of the decontamination unit.
- B. Entry into the regulated area by unauthorized individuals shall be reported immediately to the Competent Person by anyone observing the entry. The Competent person shall immediately notify the VA.
- C. A log book shall be maintained in the clean room of the decontamination unit. Anyone who enters the regulated area must record their name, affiliation, time in, and time out for each entry.
- D. Access to the regulated area shall be through of a critical barrier doorway. All other access (doors, windows, hallways, etc.) shall be sealed or locked to prevent entry to or exit from the regulated area. The only exceptions for this requirement are the waste/equipment load-out area which shall be sealed except during the removal of containerized asbestos waste from the regulated area, and emergency

exits. Emergency exits shall not be locked from the inside, however, they shall be sealed with poly sheeting and taped until needed.

- E. The Contractor's Competent Person shall control site security during abatement operations in order to isolate work in progress and protect adjacent personnel. A 24 hour security system shall be provided at the entrance to the regulated area to assure that all entrants are logged in/out and that only authorized personnel are allowed entrance.
- F. The Contractor will have the VA's assistance in notifying adjacent personnel of the presence, location and quantity of ACM in the regulated area and enforcement of restricted access by the VA's employees.
- G. The regulated area shall be locked during non-working hours and secured by VA security guards.

#### **1.5.13 EMERGENCY ACTION PLAN AND ARRANGEMENTS**

- A. An Emergency Action Plan shall be developed by the Contractor prior to commencing abatement activities and shall be agreed to by the Contractor and the VA. The Plan shall meet the requirements of 29 CFR 1910.38 (a);(b).
- B. Emergency procedures shall be in written form and prominently posted and available in the regulated area. Everyone, prior to entering the regulated area, must read and sign these procedures to acknowledge understanding of the regulated area layout, location of emergency exits and emergency procedures.
- C. Emergency planning shall include written notification of police, fire, and emergency medical personnel of planned abatement activities; work schedule and layout of regulated area, particularly barriers that may affect response capabilities.
- D. Emergency planning shall include consideration of fire, explosion, hazardous atmospheres, electrical hazards, slips/trips and falls, confined spaces, and heat stress illness. Written procedures for response to emergency situations shall be developed and employee training in procedures shall be provided.
- E. Employees shall be trained in regulated area/site evacuation procedures in the event of workplace emergencies.
  - 1. For non life-threatening situations - employees injured or otherwise incapacitated shall decontaminate following normal procedures with assistance from fellow workers, if necessary, before exiting the regulated area to obtain proper medical treatment.
  - 2. For life-threatening injury or illness, worker decontamination shall take least priority after measures to stabilize the injured worker,

remove them from the regulated area, and secure proper medical treatment.

- F. Telephone numbers of all emergency response personnel shall be prominently posted in the clean room, along with the location of the nearest telephone.
- G. The Contractor shall provide verification of first aid/CPR training for personnel responsible for providing first aid/CPR. OSHA requires medical assistance within 3 minutes of a life-threatening injury/illness. Bloodborne Pathogen training shall also be verified for those personnel required to provide first aid/CPR.
- H. The Emergency Action Plan shall provide for a Contingency Plan in the event that an incident occurs that may require the modification of the standard operating procedures during abatement. Such incidents include, but are not limited to, fire; accident; and power failure. The Contractor shall detail procedures to be followed in the event of an incident assuring that work is stopped and wetting is continued until correction of the problem.

#### **1.5.14 PRE-START MEETING**

Prior to commencing the work, the Contractor shall meet with the VPCIH to present and review, as appropriate, the items following this paragraph. The Contractor's Competent Person(s) who will be on-site shall participate in the pre-start meeting. The pre-start meeting is to discuss and determine procedures to be used during the project. At this meeting, the Contractor shall provide:

- A. Proof of Contractor licensing.
- B. Proof the Competent Person is trained and accredited and approved for working in this State. Verification of the experience of the Competent Person shall also be presented.
- C. A list of all workers who will participate in the project, including experience and verification of training and accreditation.
- D. A list of and verification of training for all personnel who have current first-aid/CPR training. A minimum of one person per shift must have adequate training.
- E. Current medical written opinions for all personnel working on-site meeting the requirements of 29 CFR 1926.1101 (m).
- F. Current fit-tests for all personnel wearing respirators on-site meeting the requirements of 29 CFR 1926.1101 (h) and Appendix C.
- G. A copy of the Contractor's Standard Operating Procedures for Class I Glovebag Asbestos Abatement. In these procedures, the following information must be detailed, specific for this project.

1. Regulated area preparation procedures;
  2. Notification requirements procedure of Contractor as required in 29 CFR 1926.1101 (d);
  3. and Decontamination procedures for employees;
  4. Class II abatement methods/procedures and equipment to be used;
  5. Personal protective equipment to be used;
- H. At this meeting the Contractor shall provide all submittals as required.
- I. Procedures for handling, packaging and disposal of asbestos waste.
- J. Emergency Action Plan and Contingency Plan procedures.

#### **1.6 PROJECT COORDINATION**

The following are the minimum administrative and supervisory personnel necessary for coordination of the work.

##### **1.6.1 PERSONNEL**

- A. Administrative and supervisory personnel shall consist of a qualified Competent Person as defined by OSHA in the Construction Standards and the Asbestos Construction Standard; Contractor Professional Industrial Hygienist and Industrial Hygiene Technicians. These employees are the Contractor's representatives responsible for compliance with these specifications and all other applicable requirements.
- B. Non-supervisory personnel shall consist of an adequate number of qualified personnel to meet the schedule requirements of the project. Personnel shall meet required qualifications. Personnel utilized on-site shall be pre-approved by the VA representative. A request for approval shall be submitted for any person to be employed during the project giving the person's name; social security number; qualifications; accreditation card with picture; Certificate of Worker's Acknowledgment; and Affidavit of Medical Surveillance and Respiratory Protection and current Respirator Fit Test.
- C. Minimum qualifications for Contractor and assigned personnel are:
  1. The Contractor has conducted within the last three (3) years, three (3) projects of similar complexity and dollar value as this project; has not been cited and penalized for serious violations of asbestos regulations in the past three (3) years; has adequate liability/occurrence insurance for asbestos work; is licensed in applicable states; has adequate and qualified personnel available to complete the work; has comprehensive standard operating procedures for asbestos work; has adequate materials, equipment and supplies to perform the work.
  2. The Competent Person has four (4) years of abatement experience of which two (2) years were as the Competent Person on the project;

- meets the OSHA definition of a Competent Person; has been the Competent Person on two (2) projects of similar size and complexity as this project; has completed EPA AHERA/OSHA/State/Local training requirements/accreditation(s) and refreshers; and has all required OSHA documentation related to medical and respiratory protection.
3. The Contractor Professional Industrial Hygienist (CPIH) shall have five (5) years of monitoring experience and supervision of asbestos abatement projects; has participated as senior IH on five (5) abatement projects, three (3) of which are similar in size and complexity as this project; has developed at least one complete standard operating procedure for asbestos abatement; has trained abatement personnel for three (3) years; has specialized EPA AHERA/OSHA training in asbestos abatement management, respiratory protection, waste disposal and asbestos inspection; has completed the NIOSH 582 Course, Contractor/Supervisor course; and has appropriate medical/respiratory protection records/documentation.
  4. The Abatement Personnel shall have completed the EPA AHERA/OSHA abatement worker course; have training on the standard operating procedures of the Contractor; has one year of asbestos abatement experience; has applicable medical and respiratory protection documentation; has certificate of training/current refresher and State accreditation/license.

## **1.7 RESPIRATORY PROTECTION**

### **1.7.1 GENERAL - RESPIRATORY PROTECTION PROGRAM**

The Contractor shall develop and implement a Respiratory Protection Program (RPP) which is in compliance with the January 8, 1998 OSHA requirements found at 29 CFR 1926.1101 and 29 CFR 1910.132;134. ANSI Standard Z88.2-1992 provides excellent guidance for developing a respiratory protection program. All respirators used must be NIOSH approved for asbestos abatement activities. The written respiratory protection shall, at a minimum, contain the basic requirements found at 29 CFR 1910.134 (c)(1)(i - ix) - Respiratory Protection Program.

### **1.7.2 RESPIRATORY PROTECTION PROGRAM COORDINATOR**

The Respiratory Protection Program Coordinator (RPPC) must be identified and shall have two (2) years experience coordinating the program. The RPPC must provide a signed statement attesting to the fact that the program meets the above requirements.

### **1.7.3 SELECTION AND USE OF RESPIRATORS**

The procedure for the selection and use of respirators must be submitted to the VA as part of the Contractor's qualification. The procedure must

written clearly enough for workers to understand. A copy of the Respiratory Protection Program must be available in the clean room of the decontamination unit for reference by employees or authorized visitors.

**1.7.4 MINIMUM RESPIRATORY PROTECTION**

Minimum respiratory protection shall be a half face, HEPA filtered, air purifying respirator when fiber levels are maintained consistently at or below 0.1 f/cc. A higher level of respiratory protection may be provided or required, depending on fiber levels. Respirator selection shall meet the requirements of 29 CFR 1926.1101 (h); Table 1, except as indicated in this paragraph. Abatement personnel must have a respirator for their exclusive use.

**1.7.5 MEDICAL WRITTEN OPINION**

No employee shall be allowed to wear a respirator unless a physician has determined they are capable of doing so and has issued a current written opinion for that person.

**1.7.6 RESPIRATOR FIT TEST**

All personnel wearing respirators shall have a current qualitative/quantitative fit test which was conducted in accordance with 29 CFR 1910.134 (f) and Appendix A. Fit tests shall be done for PAPR's which have been put into a failure mode.

**1.7.7 RESPIRATOR FIT CHECK**

The Competent Person shall assure that the positive/negative fit check is done each time the respirator is donned by an employee. Headcoverings must cover respirator headstraps. Any situation that prevents an effective facepiece to face seal as evidenced by failure of a fit check shall preclude that person from wearing a respirator until resolution of the problem.

**1.7.8 MAINTENANCE AND CARE OF RESPIRATORS**

The Respiratory Protection Program Coordinator shall submit evidence and documentation showing compliance with 29 CFR 1910.134 (h) Maintenance and care of respirators.

**1.8 WORKER PROTECTION**

**1.8.1 TRAINING OF ABATEMENT PERSONNEL**

Prior to beginning any abatement activity, all personnel shall be trained in accordance with OSHA 29 CFR 1926.1101 (k)(9) and any additional State/Local requirements. Training must include, at a minimum, the elements listed at 29 CFR 1926.1101 (k)(9)(viii). Training shall have been conducted by a third party, EPA/State approved trainer

meeting the requirements of EPA 40 CFR 763 Appendix C (AHERA MAP).  
Initial training certificates and current refresher and accreditation proof must be submitted for each person working at the site.

**1.8.2 MEDICAL EXAMINATIONS**

Medical examinations meeting the requirements of 29 CFR 1926.1101 (m) shall be provided for all personnel working in the regulated area, regardless of exposure levels. The physician's written opinion as required by 29 CFR 1926.1101 (m)(4) shall be provided for each person and shall include in the opinion the person has been evaluated for working in a heat stress environment while wearing personal protective equipment and is able to perform the work.

**1.8.3 PERSONAL PROTECTIVE EQUIPMENT**

Provide whole body clothing, head coverings, foot coverings and any other personal protective equipment as determined by conducting the hazard assessment required by OSHA at 29 CFR 1910.132 (d). The Competent Person shall ensure the integrity of personal protective equipment worn for the duration of the project. Duct tape shall be used to secure all suit sleeves to wrists and to secure foot coverings at the ankle.

**1.8.4 REGULATED AREA ENTRY PROCEDURE**

Worker protection shall meet the most stringent requirements. The Competent Person shall ensure that each time workers enter the regulated area, they remove ALL street clothes in the clean room of the decontamination unit and put on new disposable coveralls, head coverings, a clean respirator, and then proceed through the shower room to the equipment room where they put on non-disposable required personal protective equipment.

**1.8.5 DECONTAMINATION PROCEDURE**

The Competent Person shall require all personnel to adhere to following decontamination procedures whenever they leave the regulated area.

- A. When exiting the regulated area, remove all disposable PPE and dispose of in a disposal bag provided in the regulated area.
- B. Carefully decontaminate and clean the respirator. Put in a clean container/bag.

**1.8.6 REGULATED AREA REQUIREMENTS**

The Competent Person shall meet all requirements of 29 CFR 1926.1101 (o) and assure that all requirements for Class I glovebag regulated areas at 29 CFR 1926.1101 (e) are met applicable to Class II work. All personnel in the regulated area shall not be allowed to eat, drink, smoke, chew

tobacco or gum, apply cosmetics, or in any way interfere with the fit of their respirator.

**1.9 DECONTAMINATION FACILITIES:**

**1.9.1 DESCRIPTION:**

Provide each regulated area with a fiber drum with a disposal bag in it for personnel waste materials.

**1.9.2 WASTE/EQUIPMENT DECONTAMINATION AREA (W/EDA) -** The Competent Person shall provide a W/EDA for removal of all waste, equipment and contaminated material from the regulated area.

**1.9.3 WASTE/EQUIPMENT DECONTAMINATION PROCEDURES:** Contain all waste in 6 mil poly bags. Clean/decontaminate bags and pass through a double 6 mil flap doorway into another bag or fiber drum. Remove to disposal dumpster/gondola/vehicle. At no time shall unprotected personnel from the clean side be allowed to enter the regulated area.

**PART 2 - PRODUCTS, MATERIALS AND EQUIPMENT**

**2.1 MATERIALS AND EQUIPMENT**

**2.1.1 GENERAL REQUIREMENTS (ALL ABATEMENT PROJECTS)**

Prior to the start of work, the Contractor shall provide and maintain a sufficient quantity of materials and equipment to assure continuous and efficient work throughout the duration of the project. Work shall not start unless the following items have been delivered to the site and the CPIH has submitted verification to the VA's representative to this effect:

- A. All materials shall be delivered in their original package, container or bundle bearing the name of the manufacturer and the brand name (where applicable).
- B. Store all materials subject to damage off the ground, away from wet or damp surfaces and under cover sufficient enough to prevent damage or contamination. Flammable materials cannot be stored inside buildings. Replacement materials shall be stored outside of the regulated/work area until abatement is completed.
- C. The Contractor shall not block or hinder use of buildings by patients, staff, and visitors to the VA in partially occupied buildings by placing materials/equipment in any unauthorized place.
- D. The Competent Person shall inspect for damaged, deteriorating or previously used materials. Such materials shall not be used and shall be removed from the worksite and disposed of properly.
- D. Poly sheeting for critical barriers/floors in the regulated area shall be 6 mil.

- F. If required, the method of attaching polyethylene sheeting shall be agreed upon in advance by the Contractor and the VA and selected to minimize damage to equipment and surfaces.
- G. An adequate number of infra-red heating units, HEPA vacuums, scrapers, sprayers, nylon brushes, brooms, disposable mops, rags, sponges, staple guns, shovels, ladders and scaffolding of suitable height and length as well as meeting OSHA requirements shall be provided. Fall protection devices, water hose to reach all areas in the regulated area, airless spray equipment, and any other tools, materials or equipment required to conduct the abatement project shall also be provided. All electrically operated hand tools, equipment, electric cords shall be equipped with GFCI protection.
- H. Special protection for objects in the regulated area shall be detailed. (e.g., plywood over carpeting or hardwood floors to prevent damage from scaffolds, water, and falling material.)
- I. Impermeable fiberboard drums and disposal bags 2 layers of 6 mil, for asbestos waste shall be pre-printed with labels, markings and address as required by OSHA, EPA and DOT regulations.
- J. The VA shall be provided a copy of the MSDS as required for all hazardous chemicals under OSHA 29 CFR 1910.1200 - Hazard Communication. Chlorinated compounds shall not be used with any spray adhesive or other product. Appropriate encapsulant(s) shall be provided.
- K. OSHA DANGER demarcation signs, as many and as required by OSHA 29 CFR 1926.1101(k)(7) shall be provided and placed by the Competent Person. All other posters and notices required by Federal and State regulations shall be posted in the Clean Room.
- L. Adequate and appropriate PPE for the project and number of personnel/shifts shall be provided. All personal protective equipment issued must be based on a hazard assessment conducted under 29 CFR 1910.132(d).

## **2.2 CONTAINMENT BARRIERS AND COVERINGS IN THE REGULATED AREA**

### **2.2.1 GENERAL**

- A. Using critical barriers, seal off the perimeter to the regulated area to completely isolate the regulated area from adjacent spaces. All horizontal surfaces, as required, in the regulated area must be covered with 2 layers of 6 mil fire retardant poly to prevent contamination and to facilitate clean-up. Should adjacent areas become contaminated, immediately stop work and clean up the contamination at no additional cost to the Government. Provide firestopping and identify all fire

barrier penetrations due to abatement work as specified in Section 2.2.8; Section 07 84 00, FIRESTOPPING.

**2.2.2 PREPARATION PRIOR TO SEALING THE REGULATED AREA**

- B. Place all tools, scaffolding, materials and equipment needed for working in the regulated area prior to erecting any plastic sheeting. Remove all uncontaminated removable furniture, equipment and/or supplies from the regulated area before commencing work, or completely cover with two layers of 6-mil fire retardant poly sheeting and secure with duct tape. Lock out and tag out any HVAC systems in the regulated area.

**2.2.3 CONTROLLING ACCESS TO THE REGULATED AREA**

Access to the regulated area is allowed only through the personnel decontamination facility (PDF), if required. All other means of access shall be eliminated and OSHA DANGER demarcation signs posted as required by OSHA. If the regulated area is adjacent to or within view of an occupied area, provide a visual barrier of 6 mil opaque fire retardant poly sheeting to prevent building occupant observation. If the adjacent area is accessible to the public, the barrier must be solid.

**2.2.4 CRITICAL BARRIERS**

Completely separate any openings into the regulated area from adjacent areas using fire retardant poly at least 6 mils thick and duct tape. Individually seal with two layers of 6 mil poly and duct tape all HVAC openings into the regulated area. Individually seal all lighting fixtures, clocks, doors, windows, convectors, speakers, or any other objects in the regulated area. Heat must be shut off any objects covered with poly.

**2.2.5 SECONDARY BARRIERS:**

A loose layer of 6 mil fire retardant poly shall be used as a drop cloth to protect the floor/horizontal surfaces from debris generated during the Class II work, except for floor tile abatement. This layer shall be replaced as needed during the work.

**2.2.6 EXTENSION OF THE REGULATED AREA**

If the enclosure of the regulated area is breached in any way that could allow contamination to occur, the affected area shall be included in the regulated area and constructed as per this section. If the affected area cannot be added to the regulated area, decontamination measures must be started immediately and continue until air monitoring indicates background levels are met.

**2.2.7 FIRESTOPPING:**

- A. Through penetrations caused by cables, cable trays, pipes, sleeves must be firestopped with a fire-rated firestop system providing an air tight seal.
- B. Firestop materials that are not equal to the wall or ceiling penetrated shall be brought to the attention of the VA Representative. The Contractor shall list all areas of penetration, the type of sealant used, and whether or not the location is fire rated. Any discovery of penetrations during abatement shall be brought to the attention of the VA Representative immediately. All walls, floors and ceilings are considered fire rated unless otherwise determined by the VA Representative or Fire Marshall.
- C. Any visible openings whether or not caused by a penetration shall be reported by the Contractor to the VA Representative for a sealant system determination. Firestops shall meet ASTM E814 and UL 1479 requirements for the opening size, penetrant, and fire rating needed.

**2.3 MONITORING, INSPECTION AND TESTING**

**2.3.1 GENERAL**

- A. Perform throughout abatement work monitoring, inspection and testing inside and around the regulated area in accordance with the OSHA requirements and these specifications. The CPIH shall periodically inspect and oversee the performance of the Contractor IH Technician. The IH Technician shall continuously inspect and monitor conditions inside the regulated area to ensure compliance with these specifications. In addition, the CPIH shall personally manage air sample collection, analysis, and evaluation for personnel, regulated area, and adjacent area samples to satisfy OSHA requirements. Additional inspection and testing requirements are also indicated in other parts of this specification.
- B. The VA will employ an independent industrial hygienist (VPIH/CIH) consultant and/or use its own IH to perform various services on behalf of the VA. The VPIH/CIH will perform the necessary monitoring, inspection, testing, and other support services to ensure that VA patients, employees, and visitors will not be adversely affected by the abatement work, and that the abatement work proceeds in accordance with these specifications, that the abated areas or abated buildings have been successfully decontaminated. The work of the VPIH/CIH consultant in no way relieves the Contractor from their responsibility to perform the work in accordance with contract/specification requirements, to perform continuous inspection, monitoring and testing for the safety of their

employees, and to perform other such services as specified. The cost of the VPIH/CIH and their services will be borne by the VA except for any repeat of final inspection and testing that may be required due to unsatisfactory initial results. Any repeated final inspections and/or testing, if required, will be paid for by the Contractor.

- C. If fibers counted by the VPIH/CIH during abatement work inside the regulated area, utilizing the NIOSH 7400 air monitoring method, exceed 0.05 f/cc, the Contractor shall stop work. If fiber levels exceed 0.01 f/cc outside the regulated area, the Contractor shall stop work. The Contractor may request confirmation of the results by analysis of the samples by TEM. Request must be in writing and submitted to the VA's representative. Cost for the confirmation of results will be borne by the Contractor for both the collection and analysis of samples and for the time delay that may/does result for this confirmation. Confirmation sampling and analysis will be the responsibility of the CPIH with review and approval of the VPIH/CIH. An agreement between the CPIH and the VPIH/CIH shall be reached on the exact details of the confirmation effort, in writing, including such things as the number of samples, location, collection, quality control on-site, analytical laboratory, interpretation of results and any follow-up actions. This written agreement shall be co-signed by the IH's and delivered to the VA's representative.

#### **2.3.2 SCOPE OF SERVICES OF THE VPIH/CIH CONSULTANT**

- A. The purpose of the work of the VPIH/CIH is to: assure quality; resolve problems; and prevent the spread of contamination beyond the regulated area. In addition, their work includes performing the final inspection and testing to determine whether the regulated area or building has been adequately decontaminated. All air monitoring is to be done utilizing PCM/TEM. The VPIH/CIH will perform the following tasks:
1. Task 1: Establish background levels before abatement begins by collecting background samples. Retain samples for possible TEM analysis.
  2. Task 2: Perform continuous air monitoring, inspection, and testing outside the regulated area during actual abatement work to detect any faults in the regulated area isolation and any adverse impact on the surroundings from regulated area activities.
  3. Task 3: Perform unannounced visits to spot check overall compliance of work with contract/specifications. These visits may include any inspection, monitoring, and testing inside and outside the regulated area and all aspects of the operation except personnel monitoring.

4. Task 4: Provide support to the VA representative such as evaluation of submittals from the Contractor, resolution of unforeseen developments, etc.
  5. Task 5: Perform, in the presence of the VA representative, final inspection and testing of a decontaminated regulated area or building at the conclusion of the abatement and clean-up work to certify compliance with all regulations and the VA requirements/specifications.
  6. Task 6: Issue certificate of decontamination for each regulated area or building and project report.
- B. All documentation, inspection results and testing results generated by the VPIH/CIH will be available to the Contractor for information and consideration. The Contractor shall cooperate with and support the VPIH/CIH for efficient and smooth performance of their work.
- C. The monitoring and inspection results of the VPIH/CIH will be used by the VA to issue any Stop Removal orders to the Contractor during abatement work and to accept or reject a regulated area or building as decontaminated.
- D. All air sampling and analysis data will be recorded on VA Form 10-0018.

#### **2.3.3 MONITORING, INSPECTION AND TESTING BY CONTRACTOR CPIH**

The CPIH is responsible for managing all monitoring, inspections, and testing required by these specifications, as well as any and all regulatory requirements adopted by these specifications. The CPIH is responsible for the continuous monitoring of all subsystems and procedures which could affect the health and safety of the Contractor's personnel. Safety and health conditions and the provision of those conditions inside the regulated area for all persons entering the regulated area is the exclusive responsibility of the Contractor /Competent Person. The person performing the personnel and area air monitoring inside the regulated area shall be an IH Technician, who shall be trained and shall have specialized field experience in air sampling and analysis. The IH Technician shall have a NIOSH 582 Course or equivalent and show proof. The IH Technician shall participate in the AIHA Asbestos Analysis Registry or participate in the Proficiency Analytic Testing program of AIHA for fiber counting quality control assurance. The IH Technician shall also be an accredited EPA/State Contractor/Supervisor and Building Inspector. The IH Technician shall have participated in five abatement projects collecting personal and area samples as well as responsibility for documentation. The analytic laboratory used by the Abatement Contractor to analyze the samples shall

be AIHA accredited for asbestos PAT. A daily log documenting all OSHA requirements for air monitoring for asbestos in 29 CFR 1926.1101(f), (g) and Appendix A. This log shall be made available to the VA representative and the VPIH/CIH. The log will contain, at a minimum, information on personnel or area sampled, other persons represented by the sample, the date of sample collection, start and stop times for sampling, sample volume, flow rate, and fibers/cc. The CPIH shall collect and analyze samples for each representative job being done in the regulated area, i.e., removal, wetting, clean-up, and load-out. No fewer than two personal samples per shift shall be collected and one area sample per 1,000 square feet of regulated area where abatement is taking place and one sample per shift in the clean room area shall be collected. In addition to the continuous monitoring required, the CPIH will perform inspection and testing at the final stages of abatement for each regulated area as specified in the CPIH responsibilities.

#### **2.4 STANDARD OPERATING PROCEDURES**

The Contractor shall have established Standard Operating Procedures (SOP's) in printed form and loose leaf folder consisting of simplified text, diagrams, sketches, and pictures that establish and explain clearly the ways and procedures to be followed during all phases of the work by the contractor's personnel. The SOP's must be modified as needed to address specific requirements of the project. The SOP's shall be submitted for review and approval prior to the start of any abatement work. The minimum topics and areas to be covered by the SOP's are:

- A. Minimum Personnel Qualifications
- B. Contingency Plans and Arrangements
- C. Security and Safety Procedures
- D. Respiratory Protection/Personal Protective Equipment Program and Training
- E. Medical Surveillance Program and Recordkeeping
- F. Regulated Area Requirements for Class II work
- G. Decontamination Facilities and Entry/Exit Procedures (PDF and W/EDF)
- H. Monitoring, Inspections, and Testing
- I. Removal Procedures for Class II Materials
- J. Disposal of ACM Waste
- K. Regulated Area Decontamination/Clean-up
- L. Regulated Area Visual and Air Clearance
- M. Project Completion/Closeout

## 2.5 SUBMITTALS

### 2.5.1 PRE-START MEETING SUBMITTALS

Submit to the VA a minimum of 14 days prior to the pre-start meeting the following for review and approval. Meeting this requirement is a prerequisite for the pre-start meeting for this project.

- A. Submit a detailed work schedule for the entire project reflecting contract documents and the phasing/schedule requirements from the CPM chart.
- B. Submit a staff organization chart showing all personnel who will be working on the project and their capacity/function. Provide their qualifications, training, accreditations, and licenses, as appropriate. Provide a copy of the "Certificate of Worker's Acknowledgment" and the "Affidavit of Medical Surveillance and Respiratory Protection" for each person.
- C. Submit Standard Operating Procedures developed specifically for this project, incorporating the requirements of the specifications, prepared, signed and dated by the CPIH.
- D. Submit the specifics of the materials and equipment to be used for this project with brand names, model numbers, performance characteristics, pictures/diagrams, and number available for the following:
  1. HEPA vacuums, air monitoring pumps, calibration devices, infrared heating machines, and emergency power generating system.
  2. Encapsulants, surfactants, hand held sprayers, airless sprayers, fire extinguishers.
  3. Personal protective equipment.
  4. Fire safety equipment to be used in the regulated area.
- E. Submit the name, location, and phone number of the approved landfill; proof/verification the landfill is approved for ACM disposal; the landfill's requirements for ACM waste; the type of vehicle to be used for transportation; and name, address, and phone number of subcontractor, if used. Proof of asbestos training for transportation personnel shall be provided.
- F. Submit required notifications and arrangements made with regulatory agencies having regulatory jurisdiction and the specific contingency/emergency arrangements made with local health, fire, ambulance, hospital authorities and any other notifications/arrangements.
- G. Submit the name, location and verification of the laboratory and/or personnel to be used for analysis of air and/or bulk samples. Air

monitoring must be done in accordance with OSHA 29 CFR 1926.1101(f) and Appendix A.

- H. Submit qualifications verification: Submit the following evidence of qualifications. Make sure that all references are current and verifiable by providing current phone numbers and documentation.
1. Asbestos Abatement Company: Project experience within the past 3 years; listing projects first most similar to this project:  
Project Name; Type of Abatement; Duration; Cost; Reference Name/Phone Number; Final Clearance; Completion Date
  2. List of project(s) halted by owner, A/E, IH, regulatory agency in the last 3 years:  
Project Name; Reason; Date; Reference Name/Number; Resolution
  3. List asbestos regulatory citations, penalties, damages paid and legal actions taken against the company in the last 3 years. Provide copies and all information needed for verification.
- I. Submit information on personnel: Provide a resume; address each item completely; provide references; phone numbers; copies of certificates, accreditations, and licenses. Submit an affidavit signed by the CPIH stating that all personnel submitted below have medical records in accordance with OSHA 29 CFR 1926.1101(m) and 29 CFR 1910.20 and that the company has implemented a medical surveillance program and maintains recordkeeping in accordance with the above regulations. Submit the phone number and doctor/clinic/hospital used for medical evaluations.
1. CPIH: Name; years of abatement experience; list of projects similar to this one; certificates, licenses, accreditations for proof of AHERA/OSHA specialized asbestos training; professional affiliations; number of workers trained; samples of training materials; samples of SOP's developed; medical opinion; current respirator fit test.
  2. Competent Person(s)/Supervisor(s): Number; names; social security numbers; years of abatement experience as Competent Person/Supervisor; list of similar projects as Competent Person/Supervisor; as a worker; certificates, licenses, accreditations; proof of AHERA/OSHA specialized asbestos training; maximum number of personnel supervised on a project; medical opinion; current respirator fit test.
  3. Workers: Numbers; names; social security numbers; years of abatement experience; certificates, licenses, accreditations; training courses in asbestos abatement and respiratory protection; medical opinion; current respirator fit test.

- J. Submit copies of State license for asbestos abatement; copy of insurance policy, including exclusions with a letter from agent stating in plain English the coverage provided and the fact that asbestos abatement activities are covered by the policy; copy of SOP's incorporating the requirements of this specification; information on who provides your training, how often; who provides medical surveillance, how often; who does and how is air monitoring conducted; a list of references of independent laboratories/IH's familiar with your air monitoring and standard operating procedures; copies of monitoring results of the five referenced projects listed and analytical method(s) used.
- K. When rental equipment is to be used in regulated areas or used to transport asbestos waste, the contractor shall assure complete decontamination of the rental equipment before return to the rental agency.

#### **2.5.2 SUBMITTALS DURING ABATEMENT**

- A. The Competent Person shall maintain and submit a daily log at the regulated area documenting the dates and times of the following: purpose, attendees and summary of meetings; all personnel entering/exiting the regulated area; document and discuss the resolution of unusual events such as critical barrier breaching, equipment failures, emergencies, and any cause for stopping work; representative air monitoring and results/TWA's/EL's. Submit this daily log to VA's representative.
- B. The CPIH shall document and maintain the following during abatement and submit as appropriate to the VA's representative.
1. Inspection and approval of the regulated area preparation prior to start of work and daily during work.
  2. Removal of any poly critical/floor barriers.
  3. Visual inspection/testing by the CPIH.
  4. Packaging and removal of ACM waste from regulated area.
  5. Disposal of ACM waste materials; copies of Waste Shipment Records/landfill receipts to the VA's representative on a weekly basis.

#### **2.5.3 SUBMITTALS AT COMPLETION OF ABATEMENT**

The CPIH shall submit a project report consisting of the daily log book requirements and documentation of events during the abatement project including Waste Shipment Records signed by the landfill's agent. The report shall include a certificate of completion, signed and dated by the CPIH, in accordance with Attachment #1. The VA Representative will

forward the abatement report to the Medical Center after completion of the project.

### **PART 3 - EXECUTION**

#### **3.1 PRE-ABATEMENT ACTIVITIES**

##### **3.1.1 PRE-ABATEMENT MEETING**

The VA representative, upon receipt, review, and substantial approval of all pre-abatement submittals and verification by the CPIH that all materials and equipment required for the project are on the site, will arrange for a pre-abatement meeting between the Contractor, the CPIH, Competent Person(s), the VA representative(s), and the VPIH/CIH. The purpose of the meeting is to discuss any aspect of the submittals needing clarification or amplification and to discuss any aspect of the project execution and the sequence of the operation. The Contractor shall be prepared to provide any supplemental information/ documentation to the VA's representative regarding any submittals, documentation, materials or equipment. Upon satisfactory resolution of any outstanding issues, the VA's representative will issue a written order to proceed to the Contractor. No abatement work of any kind described in the following provisions shall be initiated prior to the VA written order to proceed.

##### **3.1.2 PRE-ABATEMENT INSPECTIONS AND PREPARATIONS**

Before any work begins on the construction of the regulated area, the Contractor will:

- A. Conduct a space-by-space inspection with an authorized VA representative and prepare a written inventory of all existing damage in those spaces where asbestos abatement will occur. Still or video photography may be used to supplement the written damage inventory. Document will be signed and certified as accurate by both parties.
- B. The VA Representative, the Contractor, and the VPIH/CIH must be aware of 10/95 A/E Quality Alert indicating the failure to identify asbestos as applicable to glovebag abatement in the areas listed. Make sure these areas are looked at/reviewed on the project:  
Lay-in ceilings concealing ACM; ACM behind walls/windows from previous renovations; inside chases/walls; transite piping/ductwork/sheets; behind radiators; below window sills; water/sewer lines; electrical conduit coverings; steam line trench coverings.
- C. Ensure that all furniture, machinery, equipment, curtains, drapes, blinds, and other movable objects which the Contractor is required to remove from the regulated area have been cleaned and removed or properly protected from contamination.

- D. Shut down and seal with a minimum of 2 layers of 6 mil fire retardant poly all HVAC systems and critical openings in the regulated area. The regulated area critical barriers shall be completely isolate the regulated area from any other air in the building. The VA's representative will monitor the isolation provision.
- E. Shut down and lock out in accordance with 29 CFR 1910.147 all electrical circuits which pose a potential hazard. Electrical arrangements will be tailored to the particular regulated area and the systems involved. All electrical circuits affected will be turned off at the circuit box outside the regulated area, not just the wall switch. The goal is to eliminate the potential for electrical shock which is a major threat to life in the regulated area due to water use and possible energized circuits. Electrical lines used to power equipment in the regulated area shall conform to all electrical safety standards and shall be isolated by the use of a ground fault circuit interrupter (GFCI). All GFCI shall be tested prior to use. The VA's representative will monitor the electrical shutdown.
- F. If required, remove and dispose of carpeting from floors in the regulated area.
- G. Inspect existing firestopping in the regulated area. Correct as needed.

### **3.1.3 PRE-ABATEMENT CONSTRUCTION AND OPERATIONS**

- A. Perform all preparatory work for the first regulated area in accordance with the approved work schedule and with this specification.
- B. Upon completion of all preparatory work, the CPIH will inspect the work and systems and will notify the VA's representative when the work is completed in accordance with this specification. The VA's representative may inspect the regulated area and the systems with the VPIH/CIH and may require that upon satisfactory inspection, Contractor's employees perform all major aspects of the approved SOP's, especially worker protection, respiratory systems, contingency plans, decontamination procedures, and monitoring to demonstrate satisfactory operation.
- C. The CPIH shall document the pre-abatement activities described above and deliver a copy to the VA's representative.
- D. Upon satisfactory inspection of the installation of and operation of systems the VA's representative will notify the Contractor in writing to proceed with the Class II asbestos abatement work in accordance with this specification.

### **3.2 REGULATED AREA PREPARATIONS**

#### **3.2.1 OSHA DANGER SIGNS**

Post OSHA DANGER signs meeting the specifications of OSHA 29 CFR 1926.1101 at any location and approaches to the regulated area where airborne concentrations of asbestos may exceed ambient background levels. Signs shall be posted at a distance sufficiently far enough away from the regulated area to permit any personnel to read the sign and take the necessary measures to avoid exposure. Additional signs will be posted following construction of the regulated area enclosure.

#### **3.2.2 SHUT DOWN - LOCK OUT ELECTRICAL**

Shut down and lock out electric power to the regulated area. Provide temporary power and lighting. Insure safe installation including GFCI of temporary power sources and equipment by compliance with all applicable electrical code requirements and OSHA requirements for temporary electrical systems. Electricity shall be provided by the VA.

#### **3.2.3 SHUT DOWN - LOCK OUT HVAC**

Shut down and lock out heating, cooling, and air conditioning system (HVAC) components that are in, supply or pass through the regulated area. Investigate the regulated area and agree on pre-abatement condition with the VA's representative. Seal all intake and exhaust vents in the regulated area with duct tape and 2 layers of 6-mil poly. Also, seal any seams in system components that pass through the regulated area. Remove all contaminated HVAC system filters and place in labeled 6 mil poly disposal bags for disposal as asbestos waste.

#### **3.2.4 SANITARY FACILITIES**

The Contractor shall provide sanitary facilities for abatement personnel and maintain them in a clean and sanitary condition throughout the abatement project.

#### **3.2.5 WATER FOR ABATEMENT**

The VA will provide water for abatement purposes. The Contractor shall connect to the existing VA system. The service to the shower(s) shall be supplied with backflow prevention.

#### **3.2.6 PRE-CLEANING MOVABLE OBJECTS**

Pre-clean all movable objects within the regulated area using a HEPA filtered vacuum and/or wet cleaning methods as appropriate. After cleaning, these objects shall be removed from the regulated area and carefully stored in an uncontaminated location.

### **3.2.7 PRE-CLEANING FIXED OBJECTS**

Pre-clean all fixed objects in the regulated area using HEPA filtered vacuums and/or wet cleaning techniques as appropriate. Careful attention must be paid to machinery behind grills or gratings where access may be difficult but contamination may be significant. Also, pay particular attention to wall, floor and ceiling penetration behind fixed items. After pre-cleaning, enclose fixed objects with 2 layers of 6-mil poly and seal securely in place with duct tape. Objects (e.g., permanent fixtures, shelves, electronic equipment, laboratory tables, sprinklers, alarm systems, closed circuit TV equipment and computer cables) which must remain in the regulated area and that require special ventilation or enclosure requirements should be designated here along with specified means of protection. Contact the manufacturer for special protection requirements.

### **3.2.8 PRE-CLEANING SURFACES IN THE REGULATED AREA**

Pre-clean all surfaces in the regulated area using HEPA filtered vacuums and/or wet cleaning methods as appropriate. Do not use any methods that would raise dust such as dry sweeping or vacuuming with equipment not equipped with HEPA filters. Do not disturb asbestos-containing materials during this pre-cleaning phase.

## **3.3 CONTAINMENT BARRIERS AND COVERINGS FOR THE REGULATED AREA**

### **3.3.1 GENERAL**

Seal off any openings at the perimeter of the regulated area with critical barriers to completely isolate the regulated area and to contain all airborne asbestos contamination created by the abatement activities. Should the adjacent area past the regulated area become contaminated due to improper work activities, the Contractor shall suspend work inside the regulated area, continue wetting, and clean the adjacent areas in accordance with procedures described in these specifications. Any and all costs associated with the adjacent area cleanup shall not be borne by the VA.

### **3.3.2 PREPARATION PRIOR TO SEALING OFF**

Place all infrared machines, materials, equipment and supplies necessary to isolate the regulated area inside the regulated area. Remove all movable material/equipment as described above and secure all unmovable material/equipment as described above. Properly secured material/equipment shall be considered to be outside the regulated area.

### **3.3.3 CONTROLLING ACCESS TO THE REGULATED AREA**

Access to the regulated area shall be permitted only by the competent person. All other means of access shall be closed off by proper sealing

and OSHA DANGER demarcation signs posted on the clean side of the regulated area where it is adjacent to or within view of any occupiable area. An opaque visual barrier of 6 mil poly shall be provided so that the abatement work is not visible to any building occupants. If the area adjacent to the regulated area is accessible to the public, construct a solid barrier on the public side of the sheeting for protection and isolation of the project. The barrier shall be constructed with normal 2" x 4" (50mm x 100mm) wood or metal studs 16" (400mm) on centers, securely anchored to prevent movement and covered with a minimum of ½" (12.5mm) plywood. Provide an appropriate number of OSHA DANGER signs for each visual and physical barrier. Any alternative method must be given a written approval by the VA's representative.

#### **3.3.4 CRITICAL BARRIERS**

The regulated area must be completely separated from the adjacent areas, and the outside by at least 2 layers of 6 mil fire retardant poly and duct tape/spray adhesive. Individually seal all supply and exhaust ventilation openings, lighting fixtures, clocks, doorways, windows, convectors, speakers, and other openings into the regulated area with 2 layers of 6 mil fire retardant poly, and taped securely in place with duct tape/spray adhesive. Critical barriers must remain in place until all work and clearances have been completed.

#### **3.3.5 EXTENSION OF THE REGULATED AREA**

If the regulated area barrier is breached in any manner that could allow the passage of asbestos fibers or debris, the Competent Person shall immediately stop work, continue wetting, and proceed to extend the regulated area to enclose the affected area as per procedures described in this specification. If the affected area cannot be enclosed, decontamination measures and cleanup shall start immediately. All personnel shall be isolated from the affected area until decontamination/cleanup is completed as verified by visual inspection and air monitoring. Air monitoring at completion must indicate background levels or less than 0.01 f/cc.

#### **3.3.6 FLOOR BARRIERS**

If floor removal is not being done, all floors in the regulated area shall be covered with 2 layers of 6 mil fire retardant poly and brought up the wall 12 inches.

### **3.4 REMOVAL OF CLASS II FLOORING; ROOFING; AND TRANSITE MATERIALS:**

#### **3.4.1 GENERAL**

All applicable requirements of OSHA, EPA, and DOT shall be followed during Class II work. Keep materials intact; do not disturb; wet while

working with it; wrap as soon as possible with 2 layers of 6 mil plastic for disposal.

**3.4.2 REMOVAL OF FLOORING MATERIALS:**

- A. All requirements of OSHA Flooring agreement provisions shall be followed:
  - 1. Negative air machine shall be used to effect some negative pressure in the regulated area. A spare machine shall be available.
  - 2. Flooring shall be removed intact, as much as possible. Do not rip or tear flooring.
  - 3. Mechanical chipping or sanding is not allowed.
  - 4. Flooring shall be removed with an infra-red heating unit operated by trained personnel following the manufacturer's instructions.
  - 5. Wet clean and HEPA vacuum the floor before and after removal of flooring.
  - 6. Place a 6 mil poly layer 4' by 10' adjacent to the regulated area for use as a decontaminated area. All waste must be contained in the regulated area.
  - 7. Package all waste in 6 mil poly lined fiberboard drums.

**3.4.3 REMOVAL OF MASTIC**

- A. Mastic removal material must have a flash point above 140°F.
- B. The mastic removal material must be a "low odor" or "no odor" material.
- C. A negative air machine as required under flooring removal shall be provided.
- D. Follow all manufacturers' instructions in the use of the mastic removal material.
- E. Package all waste in 6 mil poly lined fiberboard drums.
- F. Prior to application of any liquid material, check the floor for penetrations and seal before removing mastic.

**3.5 DISPOSAL OF CLASS II WASTE MATERIAL:**

**3.5.1 GENERAL**

Package and dispose of waste materials as per this specification. All OSHA, EPA, and DOT requirements must be met. Landfill requirements for packaging must also be met. Disposal of non-friable waste must be done in accordance with applicable regulations.

**3.6 PROJECT DECONTAMINATION**

**3.6.1 GENERAL**

- A. The entire work related to project decontamination shall be performed under the close supervision and monitoring of the CPIH.
- B. If the asbestos abatement work is in an area which was contaminated prior to the start of abatement, the decontamination will be done by

cleaning the primary barrier poly prior to its removal and cleaning of the regulated area surfaces after the primary barrier removal.

- C. If the asbestos abatement work is in an area which was uncontaminated prior to the start of abatement, the decontamination will be done by cleaning the primary barrier poly prior to its removal, thus preventing contamination of the building when the regulated area critical barriers are removed.

### **3.6.2 REGULATED AREA CLEARANCE**

Air testing and other requirements which must be met before release of the Contractor and re-occupancy of the regulated area space are specified in Final Testing Procedures.

### **3.6.3 WORK DESCRIPTION**

Decontamination includes the cleaning and clearance of the air in the regulated area and the decontamination and removal of the enclosures/facilities installed prior to the abatement work including primary/critical barriers, PDF and W/EDF facilities.

### **3.6.4 PRE-DECONTAMINATION CONDITIONS**

- A. Before decontamination starts, all ACM waste from the regulated area shall be removed, all waste collected and removed, and the secondary barrier of poly removal and disposed of along with any gross debris generated by the work.
- B. At the start of decontamination, the following shall be in place:
1. Critical barriers over all openings consisting of two layers of 6 mil poly which is the sole barrier between the regulated area and the rest of the building or outside.
  2. Decontamination facilities, if required for personnel and equipment in operating condition.

### **3.6.5. CLEANING:**

Clean all surfaces of the regulated area by wet methods and/or HEPA vacuuming. Do not use dry dusting/sweeping methods. If determined by the CPIH/VPIH/CIH additional cleaning(s) may be needed.

## **3.7 VISUAL INSPECTION AND AIR CLEARANCE TESTING**

### **3.7.1 GENERAL**

Notify the VA representative 24 hours in advance for the performance of the final visual inspection and testing. The final visual inspection and testing will be performed by the VPIH/CIH after the cleaning.

### **3.7.2 VISUAL INSPECTION**

Final visual inspection will include the entire regulated area, all poly sheeting, seals over HVAC openings, doorways, windows, and any other

openings. If any debris, residue, dust or any other suspect material is detected, the cleaning shall be repeated at no cost to the VA. Dust/material samples may be collected and analyzed at no cost to the VA at the discretion of the VPIH/CIH to confirm visual findings. When the regulated area is visually clean the final testing can be done.

### **3.7.3 AIR CLEARANCE TESTING**

- A. After an acceptable final visual inspection by the VPIH/CIH and VA Representative, the VPIH/CIH will perform the final testing. Air samples will be collected and analyzed in accordance with procedures for PCM in this specification. If the release criteria are not met, the Contractor shall repeat the final cleaning and continue decontamination procedures. Additional inspection and testing will be done at the expense of the Contractor.
- B. If the results of the PCM are acceptable, remove the critical barriers. Any small quantities of residue material found upon removal of the poly shall be removed with a HEPA vacuum and localized isolation. If significant quantities are found as determined by the VPIH/CIH, then the entire area affected shall be cleaned as specified in the final cleaning.
- C. If release criteria are met, proceed to perform the abatement closeout and to issue the certificate of completion in accordance with these specifications.

### **3.7.4 FINAL AIR CLEARANCE PROCEDURES**

- A. Contractor's Release Criteria: Work in a regulated area is complete when the regulated area is visually clean and airborne fiber levels have been reduced to or below 0.01 f/cc as measured with PCM methods.
- B. Air Monitoring and Final Clearance Sampling: To determine if the elevated airborne fiber counts encountered during abatement operations have been reduced to the specified level, the VPIH/CIH will secure samples and analyze them according to the following procedures:
  - 1. Fibers Counted: "Fibers" referred to in this section shall be either all fibers regardless of composition as counted in the NIOSH 7400 PCM method.
  - 2. All clearance air testing samples shall be collected on 0.8μ MCE filters for PCM analysis. Air samples will be collected in areas subject to normal air circulation. A minimum of 5 PCM samples will be collected with at least 1200 Liters of air sampled. All results must be less than 0.01 f/cc for clearance.

**3.8 ABATEMENT CLOSEOUT AND CERTIFICATE OF COMPLIANCE**

**3.8.1 COMPLETION OF ABATEMENT WORK**

A. After thorough decontamination, complete asbestos abatement work upon meeting the regulated area clearance criteria and fulfilling the following:

1. Remove all equipment, materials, and debris from the project area.
2. Package and dispose of all asbestos waste as required.
3. Repair or replace all interior finishes damaged during the abatement work.
4. Fulfill other project closeout requirements as specified elsewhere in this specification.

**3.8.2 CERTIFICATE OF COMPLETION BY CONTRACTOR**

The CPIH shall complete and sign the "Certificate of Completion" in accordance with Attachment 1 at the completion of the abatement and decontamination of the regulated area.

**3.8.3 WORK SHIFTS**

All work shall be done during administrative hours (8:00 AM to 4:30 PM) Monday - Friday excluding Federal Holidays. Any change in the work schedule must be approved in writing by the VA Representative.

**ATTACHMENT #1**

**CERTIFICATE OF COMPLETION**

DATE:

PROJECT NAME:

VAMC/ADDRESS:

1. I certify that I have personally inspected, monitored and supervised the abatement work of (specify regulated area or Building):  
which took place from            /            /            to            /            /
2. That throughout the work all applicable requirements/regulations and the VA's specifications were met.
3. That any person who entered the regulated area was protected with the appropriate personal protective equipment and respirator and that they followed the proper entry and exit procedures and the proper operating procedures for the duration of the work.
4. That all employees of the Abatement Contractor engaged in this work were trained in respiratory protection, were experienced with abatement work, had proper medical surveillance documentation, were fit-tested for their respirator, and were not exposed at any time during the work to asbestos without the benefit of appropriate respiratory protection.
5. That I performed and supervised all inspection and testing specified and required by applicable regulations and VA specifications.
6. That the conditions inside the regulated area were always maintained in a safe and healthy condition and the maximum fiber count never exceeded 0.5 f/cc, except as described below.
7. That all glovebag work was done in accordance with OSHA requirements and the manufacturer's recommendations.

CPIH Name:

Signature/Date:

Asbestos Abatement Contractor's Name:

Signature/Date:

**ATTACHMENT #2**

**CERTIFICATE OF WORKER'S ACKNOWLEDGMENT**

PROJECT NAME: DATE:  
PROJECT ADDRESS:  
ABATEMENT CONTRACTOR'S NAME:

**WORKING WITH ASBESTOS CAN BE HAZARDOUS TO YOUR HEALTH. INHALING ASBESTOS HAS BEEN LINKED WITH VARIOUS TYPES OF CANCERS. IF YOU SMOKE AND INHALE ASBESTOS FIBERS YOUR CHANCES OF DEVELOPING LUNG CANCER IS GREATER THAN THAT OF THE NON-SMOKING PUBLIC.**

Your employer's contract with the owner for the above project requires that: You must be supplied with the proper personal protective equipment including an adequate respirator and be trained in its use. You must be trained in safe and healthy work practices and in the use of the equipment found at an asbestos abatement project. You must receive/have a current medical examination for working with asbestos. These things shall be provided at no cost to you. By signing this certificate you are indicating to the owner that your employer has met these obligations.

RESPIRATORY PROTECTION: I have been trained in the proper use of respirators and have been informed of the type of respirator to be used on the above indicated project. I have a copy of the written Respiratory Protection Program issued by my employer. I have been provided for my exclusive use, at no cost, with a respirator to be used on the above indicated project.

TRAINING COURSE: I have been trained by a third party, State/EPA accredited trainer in the requirements for an AHERA/OSHA Asbestos Abatement Worker training course, 32 hours minimum duration. I currently have a valid State accreditation certificate. The topics covered in the course include, as a minimum, the following:

- Physical Characteristics and Background Information on Asbestos
- Potential Health Effects Related to Exposure to Asbestos
- Employee Personal Protective Equipment
- Establishment of a Respiratory Protection Program
- State of the Art Work Practices
- Personal Hygiene
- Additional Safety Hazards
- Medical Monitoring
- Air Monitoring
- Relevant Federal, State and Local Regulatory Requirements, Procedures, and Standards
- Asbestos Waste Disposal

MEDICAL EXAMINATION: I have had a medical examination within the past 12 months which was paid for by my employer. This examination included: health history, occupational history, pulmonary function test, and may have included a chest x-ray evaluation. The physician issued a positive written opinion after the examination.

Signature:

Printed Name:

Social Security Number:

Witness:

**ATTACHMENT #3**

**AFFIDAVIT OF MEDICAL SURVEILLANCE, RESPIRATORY PROTECTION AND  
TRAINING/ACCREDITATION**

VA PROJECT NAME AND NUMBER:

VA MEDICAL FACILITY:

ABATEMENT CONTRACTOR'S NAME AND ADDRESS:

1. I verify that the following individual

Name: Social Security Number:

who is proposed to be employed in asbestos abatement work associated with the above project by the named Abatement Contractor, is included in a medical surveillance program in accordance with 29 CFR 1926.1101(m), and that complete records of the medical surveillance program as required by 29 CFR 1926.1101(m)(n) and 29 CFR 1910.20 are kept at the offices of the Abatement Contractor at the following address.

Address:

2. I verify that this individual has been trained, fit-tested and instructed in the use of all appropriate respiratory protection systems and that the person is capable of working in safe and healthy manner as expected and required in the expected work environment of this project.
3. I verify that this individual has been trained as required by 29 CFR 1926.1101(k). This individual has also obtained a valid State accreditation certificate. Documentation will be kept on-site.
4. I verify that I meet the minimum qualifications criteria of the VA specifications for a CPIH.

Signature of CPIH:

Date:

Printed Name of CPIH:

Signature of Contractor:

Date:

Printed Name of Contractor:



**SECTION 03 30 53**  
**CAST-IN-PLACE CONCRETE**

**PART 1 - GENERAL**

**1.1 DESCRIPTION:**

This section specifies cast-in-place structural concrete and material and mixes for other concrete.

**1.2 RELATED WORK:**

A. Materials testing and inspection during construction: Section 01 45 29, TESTING LABORATORY SERVICES.

**1.3 TOLERANCES:**

- A. ACI 117.
- B. Slab Finishes: ACI 117, F-number method in accordance with ASTM E1155.

**1.4 REGULATORY REQUIREMENTS:**

- A. ACI SP-66 ACI Detailing Manual
- B. ACI 318 - Building Code Requirements for Reinforced Concrete.

**1.5 SUBMITTALS:**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Concrete Mix Design.
- C. Shop Drawings: Reinforcing steel: Complete shop drawings.
- D. Manufacturer's Certificates: Chemical admixtures, curing compounds.

**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-06.....Tolerances for Concrete Construction and Materials
  - 211.1-91(R2002).....Proportions for Normal, Heavyweight, and Mass Concrete
  - 301-05.....Specification for Structural Concrete
  - SP-66-04 .....ACI Detailing Manual
  - 318/318R-05.....Building Code Requirements for Reinforced Concrete
  - 347R-04.....Guide to Formwork for Concrete
- C. American Society for Testing And Materials (ASTM):
  - A185-07.....Steel Welded Wire, Fabric, Plain for Concrete Reinforcement

A615/A615M-08.....Deformed and Plain Billet-Steel Bars for  
Concrete Reinforcement  
C31/C31M-08.....Making and Curing Concrete Test Specimens in the  
Field  
C33-07.....Concrete Aggregates  
C39/C39M-05.....Compressive Strength of Cylindrical Concrete  
Specimens  
C94/C94M-07.....Ready-Mixed Concrete  
C143/C143M-05.....Standard Test Method for Slump of Hydraulic  
Cement Concrete  
C150-07.....Portland Cement  
C171-07.....Sheet Material for Curing Concrete  
C172-07.....Sampling Freshly Mixed Concrete  
C192/C192M-07.....Making and Curing Concrete Test Specimens in the  
Laboratory  
C494/C494M-08.....Chemical Admixtures for Concrete  
C618-08.....Coal Fly Ash and Raw or Calcined Natural  
Pozzolan for Use in Concrete

## **PART 2 - PRODUCTS**

### **2.1 FORMS:**

Wood, plywood, metal, or other materials, approved by COTR, of grade or type suitable to obtain type of finish specified.

### **2.2 MATERIALS:**

- A. Portland Cement: ASTM C150, Type I or II.
- B. Fly Ash: ASTM C618, Class C or F including supplementary optional requirements relating to reactive aggregates and alkalis, and loss on ignition (LOI) not to exceed 5 percent.
- C. Coarse Aggregate: ASTM C33, Size 67. Size 467 may be used for footings and walls over 300 mm (12 inches) thick. Coarse aggregate for applied topping and metal pan stair fill shall be Size 7.
- D. Fine Aggregate: ASTM C33.
- E. Mixing Water: Fresh, clean, and potable.
- F. Chemical Admixtures: ASTM C494.
- G. Vapor Barrier: ASTM D4397, 0.25 mm (10 mil).
- H. Reinforcing Steel: ASTM A615 or ASTM A996, deformed. See structural drawings for grade.
- I. Welded Wire Fabric: ASTM A185.
- J. Grout, Non-Shrinking: Premixed ferrous or non-ferrous, 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 18mpa (2500 psi) at 3 days and 35mpa (5000 psi) at 28 days.

### 2.3 CONCRETE MIXES:

- A. Design of concrete mixes using materials specified shall be the responsibility of the Contractor as set forth under Option C of ASTM C94.
- B. Compressive strength at 28 days shall be not less than 30 Mpa, (4000 psi).
- C. Establish strength of concrete by testing prior to beginning concreting operation. Test consists of average of three cylinders made and cured in accordance with ASTM C192 and tested in accordance with ASTM C39.
- D. Maximum slump for vibrated concrete is 100 mm (4 inches) tested in accordance with ASTM C143.
- E. Cement and water factor (See Table I):

TABLE I - CEMENT AND WATER FACTORS FOR CONCRETE

Concrete: Strength	Non-Air-Entrained	
Min. 28 Day Comp. Str. MPa (psi)	Min. Cement kg/m <sup>3</sup> (lbs/c. yd)	Max. Water Cement Ratio
30 (4000) <sup>1,3</sup>	325 (550)	0.55

- 1. If trial mixes are used, the proposed mix design shall achieve a compressive strength 8.3 MPa (1200 psi) in excess of f'c. For concrete strengths above 35 Mpa (5000 psi), the proposed mix design shall achieve a compressive strength 9.7 MPa (1400 psi) in excess of f'c.

### 2.4 BATCHING & MIXING:

- A. Store, batch, and mix materials as specified in ASTM C94.
  - 1. Job-Mixed: Concrete mixed at job site shall be mixed in a batch mixer in manner specified for stationary mixers in ASTM C94.
  - 2. Ready-Mixed: Ready-mixed concrete comply with ASTM C94, except use of non-agitating equipment for transporting concrete to the site will not be permitted. With each load of concrete delivered to project, ready-mixed concrete producer shall furnish, in duplicate, certification as required by ASTM C94.

## PART 3 - EXECUTION

### 3.1 FORMWORK:

- A. Installation conform to ACI 347. 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. Treating and Wetting: Treat or wet contact forms as follows:

1. Coat plywood and board forms with non-staining form sealer. In hot weather cool forms by wetting with cool water just before concrete is placed.
2. Clean and coat removable metal forms with light form oil before reinforcement is placed. In hot weather cool metal forms by thoroughly wetting with water just before placing concrete.
3. Use sealer on reused plywood forms as specified for new material.

C. Inserts, sleeves, and similar items: Flashing reglets, masonry ties, anchors, inserts, wires, hangers, sleeves, boxes for floor hinges and other items specified as furnished under this and other sections of specifications and required to be in their final position at time concrete is placed shall be properly located, accurately positioned and built into construction, and maintained securely in place.

D. Construction Tolerances:

1. 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.
2. Permissible surface irregularities for various classes of materials are defined as "finishes" in specification sections covering individual materials. They are to be distinguished from tolerances specified which are applicable to surface irregularities of structural elements.

**3.2 REINFORCEMENT:**

Details of concrete reinforcement, unless otherwise shown, in accordance with ACI 318 and ACI SP-66. Support and securely tie reinforcing steel to prevent displacement during placing of concrete.

**3.3 VAPOR BARRIER:**

Except where membrane waterproofing is required, place interior concrete slabs on a continuous vapor barrier.

- A. Place 100 mm (4 inches) of fine granular fill over the vapor barrier to act as a blotter for concrete slab.
- B. Lap joints 150 mm (6 inches) and seal with a compatible pressure-sensitive tape.

C. Patch punctures and tears.

**3.4 PLACING CONCRETE:**

- A. Remove water from excavations before concrete is placed. Remove hardened concrete, debris and other foreign materials from interior of forms, and from inside of mixing and conveying equipment. Obtain approval of COTR before placing concrete.
- B. Before placing new concrete on or against concrete which has set, existing surfaces shall be roughened and cleaned free from all laitance, foreign matter, and loose particles.
- C. Convey concrete from mixer to final place of deposit by method which will prevent segregation or loss of ingredients. 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. 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. Place and consolidate concrete in horizontal layers not exceeding 300 mm (12 inches) in thickness. Consolidate concrete by spading, rodding, and mechanical vibrator. Do not secure vibrator to forms or reinforcement. Vibration shall be carried on continuously with placing of concrete.

**3.5 PROTECTION AND CURING:**

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 COTR.

**3.6 SURFACE PREPARATION:**

Immediately after forms have been removed and work has been examined and approved by COTR, remove loose materials, and patch all stone pockets, surface honeycomb, or similar deficiencies with cement mortar made with 1 part portland cement and 2 to 3 parts sand.

**3.7 FINISHES:**

A. Slab Finishes:

- 1. 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.
- 2. Float Finish: Ramps, stair treads, platforms, and equipment pads 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.
3. Finished slab flatness (FF) and levelness (FL) values comply with the following minimum requirements:

Slab on grade	
Specified overall value	F <sub>F</sub> 25/F <sub>L</sub> 20
Minimum local value	F <sub>F</sub> 17/F <sub>L</sub> 15

**3.8 SURFACE TREATMENTS:**

- A. Surface treatments shall be mixed and applied in accordance with manufacturer's printed instructions.

- - - E N D - - -

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

**PART 1 - GENERAL**

**1.1 DESCRIPTION:**

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. Materials testing and inspection during construction: Section 01 45 29, TESTING LABORATORY SERVICES.
- B. Painting: Section 09 91 00, PAINTING.

**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 COTR.

**1.4 TOLERANCES:**

Fabrication tolerances for structural steel shall be held within limits established by ASTM A6, by Section 7, Code of Standard Practice for Buildings and Bridges, and by Standard Mill Practice (AISC Steel Construction Manual, Thirteenth Edition, Pages 1-9).

**1.5 REGULATORY REQUIREMENTS:**

- A. AISC: Specification for Structural Steel Buildings
- B. AISC: 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. Specification for Structural Steel Buildings (2005)
  2. Code of Standard Practice for Steel Buildings and Bridges (March 2005).
- C. American National Standards Institute (ANSI):
- B18.22.1-98.....Plain Washers
- B18.22M-00.....Metric Plain Washers
- D. American Society for Testing and Materials (ASTM):
- A6/A6M-02.....Standard Specification for General Requirements  
for Rolled Structural Steel Bars, Plates,  
Shapes, and Sheet Piling
- A36/A36M-01.....Standard Specification for Carbon Structural  
Steel
- A307-00.....Standard Specification for Carbon Steel Bolts  
and Studs, 60,000 psi Tensile Strength
- A325-02.....Standard Specification for Structural Bolts,  
Steel, Heat Treated, 120/105 ksi Minimum Tensile  
Strength
- A500-01 .....Standard Specification for Hot-Formed Welded and  
Seamless Carbon Steel Structural Tubing in  
Rounds and Shapes
- A572/A572M-01.....Standard Specification for High-Strength  
Low-Alloy Columbium-Vanadium Structural Steel
- A992/A992M-02.....Standard Specification for Structural Steel  
Shapes
- E. American Welding Society (AWS):
- D1.1-02.....Structural Welding Code-Steel
- F. Research Council on Structural Connections (RCSC) of The Engineering  
Foundation:  
Specification for Structural Joints Using ASTM A325 or A490 Bolts
- G. Military Specifications (Mil. Spec.):
- MIL-P-21035.....Paint, High Zinc Dust Content, Galvanizing,  
Repair
- H. 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: ASTM A36, A572, Grade 50 A992.
- B. Structural Tubing: ASTM A500, Grade B
- C. Bolts, Nuts and Washers:
  - 1. High-strength bolts, including nuts and washers: ASTM A325.
  - 2. Bolts and nuts, other than high-strength: ASTM A307, Grade A.
  - 3. Plain washers, other than those in contact with high-strength bolt heads and nuts: ANSI Standard B18.22.1.
- D. Zinc Coating: ASTM A123.
- E. 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. High-Strength Bolts: High-strength bolts tightened to a bolt tension not less than proof load given in Specification for Structural Joints Using ASTM A325 or A490 Bolts. Tightening done with properly calibrated wrenches.

**3.2 FABRICATION:**

Fabrication in accordance with Chapter M, Specification for Steel Buildings.

**3.3 SHOP PAINTING:**

- A. General: Shop paint steel with primer in accordance with Section 6, Code of Standard Practice for Steel Buildings and Bridges.
- 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.
- 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 Section 7, Code of Standard Practice for Steel Buildings and Bridges.

- B. Temporary Supports: Temporary support of structural steel frames during erection in accordance with Section 7, Code of Standard Practice for Steel Buildings and Bridges.

**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.

- - - E N D - - -

**SECTION 06 10 00  
ROUGH CARPENTRY**

**PART 1 - GENERAL**

**1.1 DESCRIPTION:**

Section specifies wood blocking, framing, sheathing, furring, nailers, rough hardware, and light wood construction.

**1.2 SUBMITTALS:**

- A. Submit in accordance with Section 01 33 23, SAMPLES AND SHOP DRAWINGS.
- B. Shop Drawings showing framing connection details, fasteners, connections and dimensions.

**1.3 PRODUCT DELIVERY, STORAGE AND HANDLING:**

- A. Protect lumber and other products from dampness both during and after delivery at site.
- B. Pile lumber in stacks in such manner as to provide air circulation around surfaces of each piece.
- C. Stack plywood and other board products so as to prevent warping.
- D. Locate stacks on well drained areas, supported at least 150 mm (6 inches) above grade and cover with well ventilated sheds having firmly constructed over hanging roof with sufficient end wall to protect lumber from driving rain.

**1.4 APPLICABLE PUBLICATIONS:**

- A. Publications listed below form a part of this specification to extent referenced. Publications are referenced in the text by basic designation only.
- B. American Forest and Paper Association (AFPA):  
National Design Specification for Wood Construction  
WCD Number 1-01.....Conventional Wood Frame Construction
- C. American Institute of Timber Construction (AITC):  
A190.1-02.....Structural Glued Laminated Timber
- D. American Society of Mechanical Engineers (ASME):  
B18.2.1A-99.....Square and Hex Bolts and Screws  
B18.2.2-87 (R99).....Square and Hex Nuts  
B18.6.1-81 (R97).....Wood Screws  
B18.6.4-98.....Thread Forming and Thread Cutting Tapping Screws  
and Metallic Drive Screws
- E. American Plywood Association (APA):  
E30-03.....Engineered Wood Construction Guide
- F. American Society for Testing And Materials (ASTM):

- A47-(R04).....Ferritic Malleable Iron Castings
- A48-03.....Gray Iron Castings
- A653/A653M-05.....Steel Sheet Zinc-Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot Dip Process
- C954-04.....Steel Drill Screws for the Application of Gypsum Board or Metal Plaster Bases to Steel Studs from 0.033 inch (2.24 mm) to 0.112-inch (2.84 mm) in thickness
- C1002-04.....Steel Self-Piercing Tapping Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Metal Studs
- D143-(R00).....Small Clear Specimens of Timber, Method of Testing
- D1760-01.....Pressure Treatment of Timber Products
- D2559-04.....Adhesives for Structural Laminated Wood Products for Use Under Exterior (Wet Use) Exposure Conditions
- D3498-03.....Adhesives for Field-Gluing Plywood to Lumber Framing for Floor Systems
- F844-04.....Washers, Steel, Plan (Flat) Unhardened for General Use
- F1667-03.....Nails, Spikes, and Staples
- G. Federal Specifications (Fed. Spec.):
- MM-L-736C.....Lumber; Hardwood
- H. Commercial Item Description (CID):
- A-A-55615.....Shield, Expansion (Wood Screw and Lag Bolt Self Threading Anchors)
- I. Military Specification (Mil. Spec.):
- MIL-L-19140E.....Lumber and Plywood, Fire-Retardant Treated
- J. Truss Plate Institute (TPI):
- TPI-1 (1995).....Design Specifications for Metal Plate Connected Wood Trusses
- K. U.S. Department of Commerce Product Standard (PS)
- PS 1-95.....Construction and Industrial Plywood
- PS 20-70 (R86).....American Softwood Lumber Standard
- PS 58-74.....Basic Hardboard

**PART 2 - PRODUCTS**

**2.1 LUMBER:**

- A. Unless otherwise specified, each piece of lumber bear grade mark, stamp, or other identifying marks indicating grades of material, and rules or standards under which produced.
  - 1. Identifying marks in accordance with rule or standard under which material is produced, including requirements for qualifications and authority of the inspection organization, usage of authorized identification, and information included in the identification.
  - 2. Inspection agency for lumber approved by the Board of Review, American Lumber Standards Committee, to grade species used.
- B. Structural Members: Species and grade as listed in the AFPA, National Design Specification for Wood Construction having design stresses as shown.
- C. Lumber Other Than Structural:
  - 1. Unless otherwise specified, species graded under the grading rules of an inspection agency approved by Board of Review, American Lumber Standards Committee.
  - 2. Framing lumber: Minimum extreme fiber stress in bending of 1100.
  - 3. Furring, blocking, nailers and similar items 100 mm (4 inches) and narrower Standard Grade; and, members 150 mm (6 inches) and wider, Number 2 Grade.
- D. Sizes:
  - 1. Conforming to Prod. Std., PS20.
  - 2. Size references are nominal sizes, unless otherwise specified, actual sizes within manufacturing tolerances allowed by standard under which produced.
- E. Moisture Content:
  - 1. At time of delivery and maintained at the site.
  - 2. Boards and lumber 50 mm (2 inches) and less in thickness: 19 percent or less.
  - 3. Lumber over 50 mm (2 inches) thick: 25 percent or less.
- F. Fire Retardant Treatment:
  - 1. Mil Spec. MIL-L-19140 with piece of treated material bearing identification of testing agency and showing performance rating.
  - 2. Treatment and performance inspection, by an independent and qualified testing agency that establishes performance ratings.
- G. Preservative Treatment:
  - 1. Do not treat Heart Redwood and Western Red Cedar.

2. Treat wood members and plywood exposed to weather or in contact with plaster, masonry or concrete, including framing of open roofed structures; sills, sole plates, furring, and sleepers that are less than 600 mm (24 inches) from ground; nailers, edge strips, blocking, crickets, curbs, cant, vent strips and other members used in connection with roofing and flashing materials.
3. Treat other members specified as preservative treated (PT).
4. Preservative treat by the pressure method complying with ASTM D1760, except any process involving the use of Chromated Copper arsenate (CCA) for pressure treating wood is not permitted.

## **2.2 PLYWOOD**

- A. Comply with Prod. Std., PS 1.
- B. Bear the mark of a recognized association or independent inspection agency that maintains continuing control over quality of plywood which identifies compliance by veneer grade, group number, span rating where applicable, and glue type.
- C. Sheathing:
  1. APA rated Exposure 1 or Exterior; panel grade CD or better.
  2. Wall sheathing:
    - a. Minimum 9 mm (11/32 inch) thick with supports 400 mm (16 inches) on center and 12 mm (15/32 inch) thick with supports 600 mm (24 inches) on center unless specified otherwise.
    - b. Minimum 1200 mm (48 inches) wide at corners without corner bracing of framing.

## **2.3 ROUGH HARDWARE AND ADHESIVES:**

- A. Anchor Bolts:
  1. ASME B18.2.1 and ANSI B18.2.2 galvanized, 13 mm (1/2 inch) unless shown otherwise.
  2. Extend at least 200 mm (8 inches) into masonry or concrete with ends bent 50 mm (2 inches).
- B. Miscellaneous Bolts: Expansion Bolts: C1D, A-A-55615; lag bolt, long enough to extend at least 65 mm (2-1/2 inches) into masonry or concrete. Use 13 mm (1/2 inch) bolt unless shown otherwise.
- C. Washers
  1. ASTM F844.
  2. Use zinc or cadmium coated steel or cast iron for washers exposed to weather.
- D. Screws:
  1. Wood to Wood: ANSI B18.6.1 or ASTM C1002.

2. Wood to Steel: ASTM C954, or ASTM C1002.

E. Nails:

1. Size and type best suited for purpose unless noted otherwise. Use aluminum-alloy nails, plated nails, or zinc-coated nails, for nailing wood work exposed to weather and on roof blocking.
2. ASTM F1667:
  - a. Common: Type I, Style 10.
  - b. Concrete: Type I, Style 11.
  - c. Barbed: Type I, Style 26.
  - d. Underlayment: Type I, Style 25.
  - e. Masonry: Type I, Style 27.
  - f. Use special nails designed for use with ties, strap anchors, framing connectors, joists hangers, and similar items. Nails not less than 32 mm (1-1/4 inches) long, 8d and deformed or annular ring shank.

F. Framing and Timber Connectors:

1. Fabricate of ASTM A446, Grade A; steel sheet not less than 1.3 mm (0.052 inch) thick unless specified otherwise. Apply standard plating to steel timber connectors after punching, forming and assembly of parts.
2. Framing Angles: Angle designed with bendable legs to provide three way anchors.
3. Straps:
  - a. Designed to provide wind and seismic ties with sizes as shown or specified.
  - b. Strap ties not less than 32 mm (1-1/4 inches) wide.
  - c. Punched for fastener.
4. Metal Bridging:
  - a. Optional to wood bridging.
  - b. V shape deformed strap with not less than 2 nail holes at ends, designed to nail to top and side of framing member and bottom and side of opposite member.
  - c. Not less than 19 mm by 125 mm (3/4 by 5 inches) bendable nailing flange on ends.
  - d. Fabricated of 1 mm (0.04 inch) minimum thick sheet.
5. Joist Hangers:
  - a. Fabricated of 1.6 mm (0.063 inch) minimum thick sheet, U design unless shown otherwise.

- b. Heavy duty hangers fabricated of minimum 2.7 mm (0.108 inch) thick sheet, U design with bent top flange to lap over beam.
- 6. Timber Connectors: Fabricated of steel to shapes shown.
- 7. Joist Ties: Mild steel flats, 5 by 32 mm (3/16 by 1-1/4 inch size with ends bent about 30 degrees from horizontal, and extending at least 400 mm (16 inches) onto framing. Punch each end for three spikes.
- 8. Wall Anchors for Joists and Rafters:
  - a. Mild steel strap, 5 by 32 mm (3/16 by 1-1/4 inch) with wall ends bent 50 mm (2 inches), or provide 9 by 130 mm (3/8 by 5 inch) pin through strap end built into masonry.
  - b. Strap long enough to extend onto three joists or rafters, and punched for spiking at each bearing.
  - c. Strap not less than 100 mm (4 inches) embedded end.
- 9. Joint Plates:
  - a. Steel plate punched for nails.
  - b. Steel plates formed with teeth or prongs for mechanically clamping plates to wood.
  - c. Size for axial eccentricity, and fastener loads.
- G. Adhesives:
  - 1. For field-gluing plywood to lumber framing floor or roof systems: ASTM D3498.
  - 2. For structural laminated Wood: ASTM D2559.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION OF FRAMING AND MISCELLANEOUS WOOD MEMBERS:**

- A. Conform to applicable requirements of the following:
  - 1. AFPA National Design Specification for Wood Construction for timber connectors.
  - 2. AITC Timber Construction Manual for heavy timber construction.
  - 3. AFPA WCD-number 1, Manual for House Framing for nailing and framing unless specified otherwise.
  - 4. APA for installation of plywood or structural use panels.
  - 5. ASTM F 499 for wood underlayment.
  - 6. TPI for metal plate connected wood trusses.
- B. Fasteners:
  - 1. Nails.
    - a. Nail in accordance with the Recommended Nailing Schedule as specified in AFPA Manual for House Framing where detailed nailing requirements are not specified in nailing schedule. Select nail

size and nail spacing sufficient to develop adequate strength for the connection without splitting the members.

- b. Use special nails with framing connectors.
- c. For sheathing and subflooring, select length of nails sufficient to extend 25 mm (1 inch) into supports.
- d. Use eight penny or larger nails for nailing through 25 mm (1 inch) thick lumber and for toe nailing 50 mm (2 inch) thick lumber.
- e. Use 16 penny or larger nails for nailing through 50 mm (2 inch) thick lumber.
- f. Select the size and number of nails in accordance with the Nailing Schedule except for special nails with framing anchors.
- g. Nailing Schedule; Using Common Nails:
  - 1) Joist bearing on sill or girder, toe nail three-8d or framing anchor
  - 2) Bridging to joist, toe nail each end two-8d
  - 3) Ledger strip to beam or girder three-16d under each joint.
  - 4) Subflooring or Sheathing:
    - a) 150 mm (6 inch) wide or less to each joist face nail two-8d.
    - b) Subflooring, more than 150 mm (6 inches) wide, to each stud or joint, face nail three-8d.
    - c) Plywood or structural use panel to each stud or joist face nail 8d, at supported edges 150 mm (6 inches) on center and at intermediate supports 250 mm (10 inches) on center. When gluing plywood to joint framing increase nail spacing to 300 mm (12 inches) at supported edges and 500 mm (20 inches) o.c. at intermediate supports.
  - 5) Sole plate to joist or blocking, through sub floor face nail 20d nails, 400 mm (16 inches) on center.
  - 6) Top plate to stud, end nail two-16d.
  - 7) Stud to sole plate, toe nail or framing anchor. Four-8d
  - 8) Doubled studs, face nail 16d at 600 mm (24 inches) on center.
  - 9) Built-up corner studs 16d at 600 mm (24 inches) (24 inches) on center.
  - 10) Doubled top plates, face nails 16d at 400 mm (16 inches) on center.
  - 11) Top plates, laps, and intersections, face nail two-16d.
  - 12) Continuous header, two pieces 16d at 400 mm (16 inches) on center along each edge.
  - 13) Ceiling joists to plate, toenail three-8d or framing anchor.

- 14) Continuous header to stud, four 16d.
  - 15) Ceiling joists, laps over partitions, face nail three-16d or framing anchor.
  - 16) Ceiling joists, to parallel rafters, face nail three-16d.
  - 17) Rafter to plate, toe nail three-8d. or framing anchor. Brace 25 mm (1 inch) thick board to each stud and plate, face nail three-8d.
  - 18) Built-up girders and beams 20d at 800 mm (32 inches) on center along each edge.
2. Bolts:
- a. Fit bolt heads and nuts bearing on wood with washers.
  - b. Countersink bolt heads flush with the surface of nailers.
  - c. Embed in concrete and solid masonry or use expansion bolts. Special bolts or screws designed for anchor to solid masonry or concrete in drilled holes may be used.
  - d. Use toggle bolts to hollow masonry or sheet metal.
  - e. Use bolts to steel over 2.84 mm (0.112 inch, 11 gage) in thickness. Secure wood nailers to vertical structural steel members with bolts, placed one at ends of nailer and 600 mm (24 inch) intervals between end bolts. Use clips to beam flanges.
3. Drill Screws to steel less than 2.84 mm (0.112 inch) thick.
- a. ASTM C1002 for steel less than 0.84 mm (0.033 inch) thick.
  - b. ASTM C 954 for steel over 0.84 mm (0.033 inch) thick.
4. Power actuated drive pins may be used where practical to anchor to solid masonry, concrete, or steel.
5. Do not anchor to wood plugs or nailing blocks in masonry or concrete. Use metal plugs, inserts or similar fastening.
6. Screws to Join Wood:
- a. Where shown or option to nails.
  - b. ASTM C1002, sized to provide not less than 25 mm (1 inch) penetration into anchorage member.
  - c. Spaced same as nails.
7. Installation of Timber Connectors:
- a. Conform to applicable requirements of the NFPA National Design Specification for Wood Construction.
  - b. Fit wood to connectors and drill holes for fasteners so wood is not split.
- C. Set sills or plates level in full bed of mortar on masonry or concrete walls.

1. Space anchor bolts 1200 mm (4 feet) on centers between ends and within 150 mm (6 inches) of end. Stagger bolts from side to side on plates over 175 mm (7 inches) in width.
2. Use shims of slate, tile or similar approved material to level wood members resting on concrete or masonry. Do not use wood shims or wedges.
3. Closely fit, and set to required lines.
- D. Cut notch, or bore in accordance with NFPA Manual for House-Framing for passage of ducts wires, bolts, pipes, conduits and to accommodate other work. Repair or replace miscut, misfit or damaged work.
- E. Blocking Nailers, and Furring:
  1. Install furring, blocking, nailers, and grounds where shown.
  2. Use longest lengths practicable.
  3. Use fire retardant treated wood blocking where shown at openings and where shown or specified.
  4. Layers of Blocking or Plates:
    - a. Stagger end joints between upper and lower pieces.
    - b. Nail at ends and not over 600 mm (24 inches) between ends.
    - c. Stagger nails from side to side of wood member over 125 mm (5 inches) in width.
- F. Partition and Wall Framing:
  1. Use 50 mm by 100 mm (2 inch by 4 inch) studs spaced 400 mm (16 inches) on centers; unless shown otherwise.
  2. Install double studs at openings and triple studs at corners.
  3. Installation of sole plate:
    - a. Anchor plates of walls or partitions resting on concrete floors in place with expansion bolts, one near ends of piece and at intermediate intervals of not more than 1200 mm (4 feet) or with power actuated drive pins with threaded ends of suitable type and size, spaced 600 mm (2 feet) on center unless shown otherwise.
    - b. Nail plates to wood framing through subfloor as specified in nailing schedule.
  4. Headers or Lintels:
    - a. Make headers for openings of two pieces of 50 mm (2 inch) thick lumber of size shown with plywood filler to finish flush with face of studs or solid lumber of equivalent size.
    - b. Support ends of headers on top of stud cut for height of opening. Spike cut stud to adjacent stud. Spike adjacent stud to header.

5. Use double top plates, with members lapped at least 610 mm (2-feet) spiked together.
6. Install intermediate cut studs over headers and under sills to maintain uniformity of stud spacing.
7. Use single sill plates at bottom of opening unless shown otherwise. Toe nail to end stud, face nail to intermediate studs.
8. Install 50 mm (2 inch) blocking for firestopping so that maximum dimension of any concealed space is not over 2400mm (8 feet) in accordance with NFPA Manual for House Framing.
9. Install corner bracing when plywood or structured use panel sheathing is not used.
  - a. Let corner bracing into exterior surfaces of studs at an angle of approximately 45 degrees, extended completely over walls plates, and secured at bearing with two nails.
  - b. Use 25 mm by 100 mm (1 inch by 4 inch) corner bracing.

G. Rough Bucks:

1. Install rough wood bucks at opening in masonry or concrete where wood frames or trim occur.
2. Brace and maintain bucks plumb and true until masonry has been built around them or concrete cast in place.
3. Cut rough bucks from 50 mm (2 inch) thick stock, of same width as partitions in which they occur and of width shown in exterior walls.
4. Extend bucks full height of openings and across head of openings; fasten securely with anchors specified.

H. Sheathing:

1. Use plywood or structural-use panels for sheathing.
2. Lay panels with joints staggered, with edge and ends 3 mm (1/8 inch) apart and nailed over bearings as specified.
3. Set nails not less than 9 mm (3/8 inch) from edges.
4. Install 50 mm by 100 mm (2 inch by 4 inch) blocking spiked between joists, rafters and studs to support edge or end joints of panels.
5. Match and align sheathing which is an extension of work in place to existing.

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SECTION 07 21 13  
THERMAL AND ACOUSTICAL INSULATION

**PART 1 - GENERAL**

**1.1 DESCRIPTION:**

- A. This section specifies thermal and acoustical insulation for buildings.

**1.2 RELATED WORK**

- A. Safing insulation: Section 07 84 00, FIRESTOPPING.

**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. Insulation, each type used
  2. Adhesive, each type used.
  3. Tape

**1.4 STORAGE AND HANDLING:**

- A. Store insulation materials in weathertight enclosure.
- B. Protect insulation from damage from handling, weather and construction operations before, during, and after installation.

**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 for Testing and Materials (ASTM):
- C553-02.....Mineral Fiber Blanket Thermal Insulation for  
Commercial and Industrial Applications
- C665-06.....Mineral Fiber Blanket Thermal Insulation for  
Light Frame Construction and Manufactured  
Housing
- E84-07.....Surface Burning Characteristics of Building  
Materials

**PART 2 - PRODUCTS**

**2.1 GENERAL:**

- A. Provide insulating materials in thickness and configuration resulting in the following minimum R-Values (aged R-Values where applicable). Where a greater insulation thickness is shown on drawings, provide the greater thickness.
1. Walls: Minimum R=13.

2. Roofs: Minimum R=19, thickness=3".

**2.2 THERMAL INSULATION:**

- A. Faced Mineral-Fiber Blanket Insulation: ASTM C 665, Type III (blankets with reflective membrane facing), Class A (membrane-faced surface with a flame spread of 25 or less); Category 1 (membrane is a vapor barrier), faced with foil-scrim-kraft, foil-scrim, or foil-scrim-polyethylene vapor-retarder membrane on one face; consisting of fibers manufactured from glass, slag wool, or rock wool.

**2.3 ACOUSTICAL INSULATION:**

- A. Mineral Fiber Batt or Blankets: ASTM C665. Maximum flame spread of 25 and smoke development of 450 when tested in accordance with ASTM E84.

**2.4 ADHESIVE:**

- A. As recommended by the manufacturer of the insulation.

**2.5 TAPE:**

- A. Pressure sensitive adhesive on one face.

**PART 3 - EXECUTION**

**3.1 INSTALLATION - GENERAL**

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for Sections in which substrates and related work are specified and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.
- B. Clean substrates of substances harmful to insulations or vapor retarders, including removing projections capable of puncturing vapor retarders or of interfering with insulation attachment.
- C. Comply with insulation manufacturer's written instructions applicable to products and application indicated. Install insulation that is undamaged, dry, and unsoiled and that has not been left exposed at any time to water, ice and snow.
- D. Install batt or blanket insulation with tight joints and filling framing void completely. Seal cuts, tears, and unlapped joints with tape. Fit insulation tight against adjoining construction and penetrations, unless specified otherwise.
- E. Extend insulation in thickness indicated to envelop entire area to be insulated. Cut and fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.

- F. Apply single layer of insulation to produce thickness indicated, unless multiple layers are otherwise shown or required to make up total thickness.

### **3.2 THERMAL INSULATION:**

- A. Apply insulation units to substrates by method indicated, complying with manufacturer's written instructions. If no specific method is indicated, bond units to substrate with adhesive or use mechanical anchorage to provide permanent placement and support of units.
- B. Seal joints between closed-cell (nonbreathing) insulation units by applying adhesive, mastic, or sealant to edges of each unit to form a tight seal as units are shoved into place. Fill voids in completed installation with adhesive, mastic, or sealant as recommended by insulation manufacturer.
- C. Set vapor-retarder-faced units with vapor retarder to warm side of construction, unless otherwise indicated. Do not obstruct ventilation spaces, except for firestopping. Tape joints and ruptures in vapor retarder, and seal each continuous area of insulation to surrounding construction to ensure airtight installation.
- D. Install mineral-fiber blankets in cavities formed by framing members according to the following requirements:
  - 1. Use blanket widths and lengths that fill the cavities formed by framing members. If more than one length is required to fill cavity, provide lengths that will produce a snug fit between ends.
  - 2. Place blankets in cavities formed by framing members to produce a friction fit between edges of insulation and adjoining framing members.
  - 3. For metal-framed wall cavities where cavity heights exceed 96 inches (2438 mm), support unfaced blankets mechanically and support faced blankets by taping stapling flanges to flanges of metal studs.

### **3.3 ACOUSTICAL INSULATION:**

- A. Fasten blanket insulation between metal studs and wall furring with continuous pressure sensitive tape along edges or adhesive.
- B. Pack insulation around door frames and windows and in cracks, expansion joints, control joints, door soffits and other voids. Pack behind outlets, around pipes, ducts, and services encased in wall or partition. Hold insulation in place with pressure sensitive tape or adhesive.

C. Do not compress insulation below required thickness except where embedded items prevent required thickness.

**3.4 PROTECTION:**

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

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**SECTION 07 40 00  
PREFORMED METAL WALL PANELS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

This section specifies uninsulated metal wall panels as shown.

**1.2 RELATED WORK**

- A. Sealant: Section 07 92 00, JOINT SEALANTS.
- B. Color and texture of finish: Refer to drawings.

**1.3 MANUFACTURER'S QUALIFICATIONS**

Metal wall and composite metal wall systems shall be products of a manufacturer regularly engaged in the fabrication and erection of metal panels and of the type and design shown and specified.

**1.4 SUBMITTALS**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Samples: Metal panel, 150 mm (six inch) square, showing finish, each color and texture.
- C. Shop Drawings: Wall panels, showing details of construction and installation. Collateral steel framing, thickness and kind of material, closures, flashing, fastenings and related components and accessories.
- D. Manufacturer's Literature and Data: Wall panels

**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 for Testing and Materials (ASTM):
  - A36/A36M-04..... Structural Steel
  - A653/A653M-04..... Steel Sheet, Zinc-Coated (Galvanized), or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
  - A463-02..... Steel Sheet, Cold-Rolled, Aluminum-Coated, by the Hot-Dip Process
  - A924/A924M-04..... Steel Sheet, Metallic Coated by the Hot-Dip Process
  - A1008/A1008M-04..... Steel, Sheet, Cold-Rolled, Carbon, Structural, High Strength Low Alloy
  - B209/209M-04..... Aluminum and Aluminum Alloy Sheet and Plate
  - C442-04..... Gypsum Backing Board, Gypsum Coreboard, and Gypsum Shaftliner Board

C553-02..... Mineral Fiber Blanket Thermal Insulation for  
Commercial and Industrial Applications  
C591-01..... Unfaced Preformed Rigid Cellular  
Polyisocyanurate Thermal Insulation  
C612-04..... Mineral Fiber Block and Board Thermal  
Insulation  
E119-00..... Fire Test of Building Construction and  
Materials

C. National Association of Architectural Metal Manufacturers (NAAMM):  
AMP 500 Series Metal Finishes Manual

## **PART 2 - PRODUCTS**

### **2.1 ALUMINUM PLATE AND SHEET**

ASTM B209/209M

### **2.2 FASTENERS**

Fasteners for aluminum panels shall be aluminum or stainless steel, and shall be of size, type and holding strength as recommended by manufacturer.

### **2.3 FABRICATION**

A. Composite metal wall system shall consist of factory-formed, aluminum faced composite panels fabricated from two sheets of 0.032 inch thick aluminum facing sheets with metal facings bonded to reaction injected polymeric core, with integral reveals and rout and return joinery. Furnish wall system in one continuous length for full height with no horizontal joints, except at openings. Provide pre-formed returns with gasket and aluminum extrusion receptors and seal plates at vertical joints. Provide manufacturer's standard stiffener as required to meet performance requirements. Work for wall system shall include steel framing members, louvers and frames, closures, fastenings, flashings, coping clips, caulking, reinforcements for support of mechanical and electrical work shown on drawings, steel angles at curbs and beams, vertical steel angles at existing building and all related components and accessories.

### **2.4 FINISH**

A. For composite wall panels, the finishes shall be as follows for aluminum face sheets:

1. Face sheet surface: smooth
2. Face sheet coil-coated finish: Fluoropolymer enamel finish, consisting of a chemical pre-treatment of the base aluminum; then applying a primer coat of 0.2 to 0.4 mil dry film thickness; a

polyvinylidene fluoride resin finish coat of 0.8 mil minimum dry film thickness on one side, and a wash coat of 0.3 to 0.4 mil minimum dry film thickness applied to reverse side.

- B. Aluminum alloy used for color coating shall be as required to produce specified color. Color shall be as indicated on drawings. Color for sheet aluminum shall not deviate more than the colors of extrusion samples.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

- A. General: Install panels in accordance with the manufacturer's approved erection instructions and diagrams, except as specified otherwise. Panels shall be in full and firm contact with supports and with each other at side and end laps. Where panels are cut in the field, or where any of the factory applied coverings or coatings are abraded or damaged in handling or installation, they shall, after the necessary repairs have been made with material of the same type and color as the weather coating, be approved before being installed. All cut ends and edges, including those at openings through the sheets shall be sealed completely. Correct defects or errors in the materials in an approved manner. Replace materials which cannot be corrected in an approved manner with nondefective material. Provide molded closure strips where indicated and whenever sheets terminate with open ends after installation.
- B. Wall Panels: Apply panels with the configuration in a vertical position. Provide panels in full heights from base to coping with no horizontal joints except at the junctions of louver panels and similar locations. Install closure strips, flashings, and sealing material in an approved manner that will assure complete weather tightness. Flashing will not be required where approved "self-flashing" panels are used.
- C. Flashing: All flashing and related closures and accessories in connection with the preformed metal panels shall be provided as indicated and as necessary to provide a watertight installation. Details of installation, which are not indicated, shall be in accordance with the panel manufacturer's printed instruction and details, or the approved shop drawings. Installation shall allow for expansion and contraction of flashing.
- D. Fasteners: Fastener spacings shall be in accordance with the manufacturer's recommendations, and as necessary to withstand the design loads indicated. Install fasteners in straight lines within a

tolerance of 13 mm (1/2-inch) in the length of a bay. Drive exposed penetrating type fasteners normal to the surface, and to a uniform depth to seat gasketed washers properly, and drive so as not to damage factory applied coating. Exercise extreme care in drilling pilot holes for fastenings to keep drills perpendicular and centered in valleys, or crowns, as applicable. After drilling, remove metal filings and burrs from holes prior to installing fasteners and washers. Torque used in applying fasteners shall not exceed that recommended by the manufacturer. Remove panels deformed or otherwise damaged by over-torqued fastenings, and provide new panels. Remove metal shavings and filings from roofs on completion to prevent rusting and discoloration of the panels.

### **3.2 ISOLATION OF ALUMINUM**

- A. Isolate aluminum in contact with or fastened to dissimilar metals other than stainless steel, white bronze, or other metal compatible with aluminum by one of the following:
  - 1. Painting the dissimilar metal with a prime coat of Zinc-Molybdate followed by two coats of aluminum paint.
  - 2. Placing a non-abrasive tape or gasket between the aluminum and the dissimilar metal.
- B. Paint aluminum in contact with or built into mortar, concrete, plaster, or other masonry materials with a coat of alkali-resistant bituminous paint.
- C. Paint aluminum in contact with wood or other absorptive materials, that may become repeatedly wet, with two coats of bituminous paint, or two coats of aluminum paint. Seal joints with caulking material.

### **3.3 PROTECTION AND CLEANING**

- A. Protect panels and other components from damage during and after erection, and until project is accepted by the Government.
- B. After completion of work, all exposed finished surfaces of panels shall be cleaned of soil, discoloration and disfiguration. Touch-up abraded surfaces of panels.

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

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

Formed sheet metal work for flashing and insulated expansion joint covers are specified in this section.

**1.2 RELATED WORK**

A. Sealant compound and installation: Section 07 92 00, JOINT SEALANTS.

**1.3 SUBMITTALS**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Shop Drawings:
  - Flashings
  - Expansion joints
- C. Manufacturer's Literature and Data:
  - Two-piece counterflashing
  - Expansion joint cover, each type
  - Nonreinforced, elastomeric sheeting
- D. Certificates: Stating that aluminum has been given - specified finish thickness of anodizing.

**1.4 APPLICABLE PUBLICATIONS**

- A. The publications listed below for 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):
  - A167-99(R 2004).....Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
  - A653/A653M-05.....Steel Sheet Zinc-Coated (Galvanized) or Zinc Alloy Coated (Galvanized) by the Hot- Dip Process
  - B32-04.....Solder Metal
  - B209-04.....Aluminum and Aluminum-Alloy Sheet and Plate
  - B370-03.....Copper Sheet and Strip for Building Construction
  - D173-03.....Bitumen-Saturated Cotton Fabrics Used in Roofing and Waterproofing
  - D412-98 (R2002).....Vulcanized Rubber and Thermoplastic Elastomers-Tension
  - D1187-97 (R2002).....Asphalt Base Emulsions for Use as Protective Coatings for Metal

Flashing and Sheet Metal

- D1784-03.....Rigid Poly (Vinyl Chloride) (PVC) Compounds and  
Chlorinated Poly (Vinyl Chloride) (CPVC)  
Compounds
- D3656-04.....Insect Screening and Louver Cloth Woven from  
Vinyl-Coated Glass Yarns
- D4586-00.....Asphalt Roof Cement, Asbestos Free
- C. American National Standards Institute/Single Ply Roofing Institute  
(ANSI/SPRI):
- ES-1-2003.....Wind Design Standard for Edge Systems Used with  
Low Slope Roofing Systems
- D. Sheet Metal and Air Conditioning Contractors National Association  
(SMACNA): Architectural Sheet Metal Manual (Fifth Edition, 1993).
- E. National Association of Architectural Metal Manufacturers (NAAMM):  
AMP 500 Series.....Metal Finishes Manual
- F. American Architectural Manufacturers Association (AAMA):  
605-98.....Voluntary Specification for High Performance  
Organic Coatings on Architectural Extrusions  
Panels
- G. Federal Specification (Fed. Spec):
- A-A-1925A.....Shield, Expansion; (Nail Anchors)
- UU-B-790A.....Building Paper, Vegetable Fiber
- H. International Building Code (IBC):  
2003 Edition

## **PART 2 - PRODUCTS**

### **2.1 MATERIALS**

- A. Solder: ASTM B32; flux type and alloy composition as required for use  
with metals to be soldered.
- B. Stainless Steel: ASTM A167, Type 302 or 304, dead soft temper.
- C. 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.
- D. Galvanized Sheet: ASTM, A653.
- E. Nonreinforced, Elastomeric Sheet: Elastomeric substances reduced to  
thermoplastic state and extruded into continuous homogenous sheet (0.056  
inch) thick. Sheet shall have not less than 7 MPa (1,000 psi) tensile  
strength and not more than seven percent tension-set at 50 percent  
elongation when tested in accordance with ASTM D412. Sheet shall show  
no cracking or flaking when bent through 180 degrees over a 1 mm (1/32

inch) diameter mandrel and then bent at same point over same size mandrel in opposite direction through 360 degrees at temperature of - 30°C (-20 °F).

F. Rosin Paper: Fed-Spec. UU-B-790, Type I, Grade D, Style 1b, Rosin-sized sheathing paper, weighing approximately 3 Kg/10 m<sup>2</sup> ( 6 lbs/100 sf).

G. Bituminous Paint: ASTM D1187, Type I.

H. Fasteners:

1. Use copper, copper alloy, bronze, brass, or stainless steel for copper and copper clad stainless steel, and stainless steel for stainless steel and aluminum alloy. Use galvanized steel or stainless steel for galvanized steel.

2. Nails:

a. Minimum diameter for copper nails: 3 mm (0.109 inch).

b. Minimum diameter for aluminum nails 3 mm (0.105 inch).

c. Minimum diameter for stainless steel nails: 2 mm (0.095 inch) and annular threaded.

d. Length to provide not less than 22 mm (7/8 inch) penetration into anchorage.

3. Rivets: Not less than 3 mm (1/8 inch)diameter.

4. Expansion Shields: Fed Spec A-A-1925A.

I. Sealant: As specified in Section 07 92 00 JOINT SEALANTS for exterior locations.

J. Roof Cement: ASTM D4586.

## **2.2 SHEET METAL THICKNESS**

A. Except as otherwise shown or specified use thickness or weight of sheet metal as follows:

B. Concealed Locations (Built into Construction):

1. Copper: 30g (10 oz) minimum 0.33 mm (0.013 inch thick).

2. Stainless steel: 0.25 mm (0.010 inch) thick.

3. Copper clad stainless steel: 0.25 mm (0.010 inch) thick.

4. Galvanized steel: 0.5 mm (0.021 inch) thick.

C. Exposed Locations:

1. Copper: 0.4 Kg (16 oz).

2. Stainless steel: 0.4 mm (0.015 inch).

3. Copper clad stainless steel: 0.4 mm (0.015 inch).

D. Thickness of aluminum or galvanized steel is specified with each item.

## **2.3 FABRICATION, GENERAL**

A. Jointing:

1. In general, copper, stainless steel and copper clad stainless steel joints, except expansion and contraction joints, shall be locked and soldered.
  2. Jointing of copper over 0.5 Kg (20 oz) weight or 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. Unsoldered lap joints shall finish not less than 100 mm (4 inches) wide.
  4. Flat and lap joints shall be made in direction of flow.
  5. Edges of bituminous coated copper, copper covered paper, nonreinforced elastomeric sheeting and polyethylene coated copper shall be jointed by lapping not less than 100 mm (4 inches) in the direction of flow and cementing with asphalt roof cement or sealant as required by the manufacturer's printed instructions.
  6. Soldering:
    - a. Pre tin both mating surfaces with solder for a width not less than 38 mm (1 1/2 inches) of uncoated copper, stainless steel, and copper clad stainless steel.
    - b. Wire brush to produce a bright surface before soldering lead coated copper.
    - c. Treat in accordance with metal producers recommendations other sheet metal required to be soldered.
    - d. Completely remove acid and flux after soldering is completed.
- 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. Space expansion and contraction joints for copper, stainless steel, and copper clad stainless steel at intervals not exceeding 7200 mm (24 feet).
  3. Space expansion and contraction joints for aluminum at intervals not exceeding 5400 mm (18 feet), except do not exceed 3000 mm (10 feet) for gravel stops and fascia-cant systems.
  4. Fabricate slip-type or loose locked joints and fill with sealant unless otherwise specified.

5. 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 cleats for maximum spacing of 300 mm (12 inch) centers unless specified otherwise.
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. Except as otherwise specified, 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. Edges of flashings concealed in masonry joints opposite drain side shall be turned up 6 mm (1/4 inch) to form dam, unless otherwise specified or shown otherwise.

2. 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.
3. All metal roof edges shall meet requirements of IBC 2003.

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.
3. Where copper gravel stops, copings and flashings will carry water onto cast stone, stone, or architectural concrete, or stainless steel.

**2.4 FINISH**

- 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, unless otherwise specified.
- C. Finish exposed metal surfaces as follows, unless specified otherwise:
  1. Copper: Mill finish.
  2. Stainless Steel: Finish No. 2B or 2D.
  3. Aluminum:
    - a. Clear Finish: AA-C22A41 medium matte, clear anodic coating, Class 1 Architectural, 18 mm (0.7 mils) thick.
    - b. Colored Finish: AA-C22A42 (anodized) or AA-C22A44 (electrolytically deposited metallic compound) medium matte, integrally colored coating, Class 1 Architectural, 18 mm (0.7 mils) thick. Dyes will not be accepted.
    - c. Fluorocarbon Finish: AAMA 605.2, high performance organic coating.
    - d. Mill finish.
  4. Steel and Galvanized Steel:
    - a. Finish painted under Section PAINTING unless specified as prefinished item.
    - b. Manufacturer's finish:
      - 1) Baked on prime coat over a phosphate coating.
      - 2) Baked-on prime and finish coat over a phosphate coating.
      - 3) Fluorocarbon Finish: AAMA 605.2, high performance organic coating.

## 2.5 BASE FLASHING

- A. Fabricate metal base flashing up vertical surfaces not less than 200 mm (8 inch) nor more than 400 mm (16 inch).
- B. Form base flashing bent from strip except pipe flashing. Fabricate ends for riveted soldered lap seam joints. Fabricate expansion joint ends as specified.

## 2.6 COUNTERFLASHING

- A. Either copper or stainless steel, unless specified otherwise.
- B. 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. Two-piece, lock in type flashing may be used in lieu of one piece counter-flashing.
  - 4. Manufactured assemblies may be used.
  - 5. Where counterflashing is installed at new work use an integral flange at the top designed to be extended into the masonry joint or reglet in concrete.
  - 6. 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.
- C. One-piece Counterflashing.
  - 1. Back edge turned up and fabricate 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).
- D. Two-Piece Counterflashing:
  - 1. Receiver to extend into masonry wall depth of masonry unit with back edge turned up 6 mm (1/4 inch) and exposed edge designed to receive and lock counterflashing upper edge when inserted.
  - 2. Counterflashing upper edge designed to snap lock into receiver.
- E. 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.

3. Two pieces: Fabricate upper edge to lock into surface mounted receiver. Fabricate receiver joint sealant pocket on upper edge and lower edge to receive counterflashing, with slotted fastener holes at 400 mm (16 inch) centers between upper and lower edge.

F. Where vented edge decks intersect vertical surfaces, form in one piece, shape to slope down to a point level with and in front of edge-set notched plank; then, down vertically, overlapping base flashing.

### **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. Coordinate with masonry work for the application of a skim coat of mortar to surfaces of unit masonry to receive flashing material before the application of flashing.
6. Apply a layer of 7 Kg (15 pound) saturated felt followed by a layer of rosin paper to wood surfaces to be covered with copper. Lap each ply 50 mm (2 inch) with the slope and nail with large headed copper nails.
7. 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.
8. 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.

9. Coordinate with roofing work for the installation of metal base flashings and other metal items having roof flanges for anchorage and watertight installation.
10. Nail continuous cleats on 75 mm (3 inch) on centers in two rows in a staggered position.
11. Nail individual cleats with two nails and bend end tab over nail heads. Lock other end of cleat into hemmed edge.
12. Install flashings in conjunction with other trades so that flashings are inserted in other materials and joined together to provide a water tight installation.
13. 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.
14. 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.
15. Paint aluminum in contact with or built into mortar, concrete, plaster, or other masonry materials with a coat of bituminous paint.
16. 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 COUNTERFLASHING**

#### **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 at new masonry, coordinate to insure proper height, embed in mortar, and end lap.
  2. 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.
  3. 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.
  4. 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.

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**SECTION 07 84 00  
FIRESTOPPING**

**PART 1 GENERAL**

**1.1 DESCRIPTION**

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

**1.2 RELATED WORK**

- A. Sealants and application: Section 07 92 00, JOINT SEALANTS.
- B. Fire and smoke damper assemblies in ductwork: Section 23 31 00, HVAC DUCTS AND CASINGS.

**1.3 SUBMITTALS**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Manufacturers literature, data, and installation instructions for types of firestopping and smoke stopping used.
- C. List of FM, UL, or WH classification number of systems installed.
- D. Certified laboratory test reports for ASTM E814 tests for systems not listed by FM, UL, or WH proposed for use.

**1.4 DELIVERY AND STORAGE**

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

**1.5 WARRANTY**

Firestopping work warranty period to be five years.

**1.6 QUALITY ASSURANCE**

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

**1.7 APPLICABLE PUBLICATIONS**

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

E84-07.....Surface Burning Characteristics of Building  
Materials

E814-06.....Fire Tests of Through-Penetration Fire Stops

C. Factory Mutual Engineering and Research Corporation (FM):

Annual Issue Approval Guide Building Materials

D. Underwriters Laboratories, Inc. (UL):

Annual Issue Building Materials Directory

Annual Issue Fire Resistance Directory

1479-03.....Fire Tests of Through-Penetration Firestops

E. Warnock Hersey (WH):

Annual Issue Certification Listings

**PART 2 - PRODUCTS**

**2.1 FIRESTOP SYSTEMS**

- A. Use either factory built (Firestop Devices) or field erected (through-Penetration Firestop Systems) to form a specific building system maintaining required integrity of the fire barrier and stop the passage of gases or smoke.
- B. Through-penetration firestop systems and firestop devices tested in accordance with ASTM E814 or UL 1479 using the "F" or "T" rating to maintain the same rating and integrity as the fire barrier being sealed. "T" ratings are not required for penetrations smaller than or equal to 100 mm (4 in) nominal pipe or 0.01 m<sup>2</sup> (16 sq. in.) in overall cross sectional area.
- C. Products requiring heat activation to seal an opening by its intumescence shall exhibit a demonstrated ability to function as designed to maintain the fire barrier.
- D. Firestop sealants used for firestopping or smoke sealing shall have following properties:
  - 1. Contain no flammable or toxic solvents.
  - 2. Have no dangerous or flammable out gassing during the drying or curing of products.
  - 3. Water-resistant after drying or curing and unaffected by high humidity, condensation or transient water exposure.
  - 4. When used in exposed areas, shall be capable of being sanded and finished with similar surface treatments as used on the surrounding wall or floor surface.

- E. Firestopping system or devices used for penetrations by glass pipe, plastic pipe or conduits, unenclosed cables, or other non-metallic materials shall have following properties:
1. Classified for use with the particular type of penetrating material used.
  2. Penetrations containing loose electrical cables, computer data cables, and communications cables protected using firestopping systems that allow unrestricted cable changes without damage to the seal.
  3. Intumescent products which would expand to seal the opening and act as fire, smoke, toxic fumes, and, water sealant.
- F. Maximum flame spread of 25 and smoke development of 50 when tested in accordance with ASTM E84.
- G. FM, UL, or WH rated or tested by an approved laboratory in accordance with ASTM E814.
- H. Materials to be asbestos free.

## **2.2 SMOKE STOPPING IN SMOKE PARTITIONS**

- A. Use silicone sealant in smoke partitions as specified in section 07 92 00, JOINT SEALANTS.
- B. Use mineral fiber filler and bond breaker behind sealant.
- C. Sealants shall have a maximum flame spread of 25 and smoke developed of 50 when tested in accordance with E84.
- D. When used in exposed areas capable of being sanded and finished with similar surface treatments as used on the surrounding wall or floor surface.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

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

### **3.2 PREPARATION**

- A. Remove dirt, grease, oil, loose materials, or other substances that prevent adherence and bonding or application of the firestopping or smoke stopping materials.
- B. Remove insulation on insulated pipe for a distance of 150 mm (six inches) on either side of the fire rated assembly prior to applying the

firestopping materials unless the firestopping materials are tested and approved for use on insulated pipes.

**3.3 INSTALLATION**

- A. Do not begin work until the specified material data and installation instructions of the proposed firestopping systems have been submitted and approved.
- B. Install firestopping systems with smoke stopping in accordance with FM, UL, WH, or other approved system details and installation instructions.
- C. Install smoke stopping seals in smoke partitions.

**3.4 CLEAN-UP AND ACCEPTANCE OF WORK**

- A. As work on each floor is completed, remove materials, litter, and debris.
- B. Do not move materials and equipment to the next-scheduled work area until completed work is inspected and accepted by the COTR.
- C. Clean up spills of liquid type materials.

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**SECTION 07 92 00  
JOINT SEALANTS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION:**

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. Firestopping penetrations: Section 07 84 00, FIRESTOPPING.
- B. Mechanical Work: Section 21 05 11, COMMON WORK RESULTS FOR FIRE SUPPRESSION, Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING, Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION.

**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.

**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 5 °C (90 °F) or less than 32 °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. 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):

C509-06.....Elastomeric Cellular Preformed Gasket and  
Sealing Material.

C612-04.....Mineral Fiber Block and Board Thermal  
Insulation.  
C717-07.....Standard Terminology of Building Seals and  
Sealants.  
C834-05.....Latex Sealants.  
C919-02.....Use of Sealants in Acoustical Applications.  
C920-05.....Elastomeric Joint Sealants.  
C1021-01.....Laboratories Engaged in Testing of Building  
Sealants  
C1193-05.....Standard Guide for Use of Joint Sealants.  
C1330-02.....Cylindrical Sealant Backing for Use with Cold  
Liquid Applied Sealants.  
D1056-07.....Specification for Flexible Cellular Materials—  
Sponge or Expanded Rubber.  
E84-07.....Surface Burning Characteristics of Building  
Materials.

C. Sealant, Waterproofing and Restoration Institute (SWRI).  
The Professionals' Guide

## **PART 2 - PRODUCTS**

### **2.1 SEALANTS:**

- A. S-1:
  - 1. ASTM C920, polyurethane or polysulfide.
  - 2. Type M.
  - 3. Class 25.
  - 4. Grade NS.
  - 5. Shore A hardness of 20-40
- B. S-2:
  - 1. ASTM C920, polyurethane or polysulfide.
  - 2. Type M.
  - 3. Class 25.
  - 4. Grade P.
  - 5. Shore A hardness of 25-40.
- C. S-3:
  - 1. ASTM C920, polyurethane or polysulfide.
  - 2. Type S.
  - 3. Class 25, joint movement range of plus or minus 50 percent.
  - 4. Grade NS.

5. Shore A hardness of 15-25.
6. Minimum elongation of 700 percent.

D. S-4:

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

E. S-5:

1. ASTM C920, polyurethane or polysulfide.
2. Type S.
3. Class 25.
4. Grade P.
5. Shore hardness of 15-45.

F. S-6:

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.

G. S-7:

1. ASTM C920, silicone, neutral cure.
2. Type S.
3. Class 25.
4. Grade NS.
5. Shore A hardness of 25-30.
6. Structural glazing application.

H. S-8:

1. ASTM C920, silicone, acetoxycure.
2. Type S.
3. Class 25.
4. Grade NS.
5. Shore A hardness of 25-30.
6. Structural glazing application.

I. S-9:

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.

J. S-10:

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.

K. S-11:

1. ASTM C920 polyurethane.
2. Type M/S.
3. Class 25.
4. Grade P/NS.
5. Shore A hardness of 35 to 50.

L. S-12:

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. Color of sealants for other locations shall be light gray or aluminum, unless specified otherwise.
- B. 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 POURIOUS 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 the following:
    - a. Concrete.
    - b. Masonry.
    - c. Unglazed surfaces of ceramic tile.
  - 3. Remove laitance and form-release agents from concrete.
  - 4. Clean nonporous surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants.
    - a. Metal.
    - b. Glass.
    - c. Porcelain enamel.
    - d. Glazed surfaces of ceramic tile.
- 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 printer 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 degrees C and 38 degrees C (40 and 100 degrees 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 printer 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. 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.

**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. Sanitary Joints:
  1. Walls to Plumbing Fixtures: Type S-9
  2. Counter Tops to Walls: Type S-9
  3. Pipe Penetrations: Type S-9

B. High Temperature Joints over 204 degrees C (400 degrees F):

1. Exhaust Pipes, Flues, Breech Stacks: Type S-7 or S-8

C Interior Caulking:

1. Typical Narrow Joint 6 mm, (1/4 inch) or less at Walls and Adjacent Components: Type C-1, C-2.
2. Perimeter of Doors, Windows, Access Panels which Adjoin Concrete or Masonry Surfaces: Type C-1, C-2.
3. Joints at Masonry Walls and Columns, Piers, Concrete Walls or Exterior Walls: Type C-1, C-2.
4. Exposed Acoustical Joint at Sound Rated Partitions Type C-2
5. Concealed Acoustic Sealant Type S-4, C-1, C-2.

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**SECTION 08 90 00**  
**LOUVERS AND VENTS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

This section specifies fixed and operable wall louvers.

**1.2 RELATED WORK**

A. Color of finish: See drawings.

**1.3 SUBMITTALS**

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

B. Shop Drawings:

Each type, showing performance, material, finish, size of members, operating devices, method of assembly, and installation and anchorage details.

**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. The Master Painters Institute (MPI):

Approved Product List - November 2007

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

A167-99(R2004).....Stainless and Heat-Resisting Chromium - Nickel  
Steel Plate, Sheet, and Strip

A1008/A1008M REV A-07...Steel, Sheet, Carbon, Cold Rolled, Structural,  
and High Strength Low-Alloy with Improved  
Formability

B209/B209M-07.....Aluminum and Aluminum Alloy, Sheet and Plate

B221-06.....Aluminum and Aluminum Alloy Extruded Bars, Rods,  
Wire, Shapes, and Tubes

B221M-07.....Aluminum and Aluminum Alloy Extruded Bars, Rods,  
Wire Shapes, and Tubes

D. National Association of Architectural Metal Manufacturers (NAAMM):

AMP 500-505 (1988).....Metal Finishes Manual

E. National Fire Protection Association (NFPA):

90A-02.....Installation of Air Conditioning and Ventilating  
Systems

F. American Architectural Manufacturers Association (AAMA):

605-98.....High Performance Organic Coatings on  
Architectural Extrusions and Panels

- G. Air Movement and Control Association, Inc. (AMCA):  
500-L-99.....Testing Louvers

## **PART 2 - PRODUCTS**

### **2.1 MATERIALS**

- A. Aluminum, Extruded: ASTM B221/B221M.
- B. Stainless Steel: ASTM A167, Type 302B.
- C. Carbon Steel: ASTM A1008/A1008M.
- D. Aluminum, Plate and Sheet: ASTM B209/B209M.
- E. Fasteners: Fasteners for securing louvers to adjoining construction, except as otherwise specified or shown, shall be toggle or expansion bolts, of size and type as required for each specific type of installation and service condition.
  - 1. Where type, size, or spacing of fasteners is not shown or specified, submit shop drawings showing proposed fasteners, and method of installation.
  - 2. Fasteners for louvers, louver frames, and wire guards shall be of stainless steel or aluminum.
- F. Inorganic Zinc Primer: MPI No. 19.

### **2.2 EXTERIOR WALL LOUVERS**

- A. General:
  - 1. Provide combination type louvers of size and design shown.
  - 2. Heads, sills and jamb sections shall have formed caulking slots or be designed to retain caulking. Head sections shall have exterior drip lip, and sill sections an integral water stop.
  - 3. Furnish louvers with sill extension or separate sill as shown.
  - 4. Frame shall be mechanically fastened or welded construction with welds dressed smooth and flush.
- B. Performance Characteristics:
  - 1. Weather louvers shall have a minimum of 47 percent free area and shall pass 550 fpm free area velocity at a pressure drop not exceeding 0.10 inch water gage and carry not more than 0.01 ounces of water per m<sup>2</sup> (square foot) of free area for 15 minutes when tested per AMCA Standard 500-L.
  - 2. Louvers shall bear AMCA certified rating seals for air performance and water penetration ratings.
- C. Aluminum Louvers:
  - 1. General: Frames, blades, and mullions (sliding interlocking type); 0.125-inch thick extruded aluminum. Blades shall be drainable type and have reinforcing bosses. Provide with bird screen.

2. Louvers, fixed: Make frame sizes 13 mm (1/2-inch) smaller than openings. Single louvers frames shall not exceed 1700 mm (66 inches) wide. When openings exceed 1700 mm (66 inches), provide twin louvers separated by mullion members.
3. Rear adjustable airfoil blades: Rear airfoil blades shall be operated via electric motor. Linkage concealed in frame (weather protected). Louver frame opening sizes, single louver sizes and mullion requirements shall be as specified for fixed louvers. Motors shall be removable and located at jams of louver. Connect motor operator lever arm to operating bar by means of stainless steel connecting rod. Upon failure of motor, airfoil blade damper shall be capable of being operated manually.
4. Filter rack: Provide with optional rear filter rack.
5. Controls: Damper to be interlocked to boiler controls.

### **2.3 CLOSURE ANGLES AND CLOSURE PLATES**

- A. Fabricate from 2 mm (0.074-inch) thick stainless steel or aluminum.
- B. Provide continuous closure angles and closure plates on inside head, jams and sill of exterior wall louvers.
- C. Secure angles and plates to louver frames with screws, and to masonry or concrete with fasteners as specified.

### **2.4 FINISH**

- A. In accordance with NAAMM Metal Finishes Manual: AMP 500-505
- B. Aluminum Louvers:
  1. Anodized finish
    - a. Mill finish, as fabricated.
    - b. Chemically etched medium matte, with clear anodic coating, Class I Architectural, 0.7 mils thick.
- C. Sheet Steel: Baked-on or oven dried shop prime coat.
  1. Paint interior surfaces of lightproof louvers with two additional finish shop coats of baked-on flat black enamel.
  2. Finish painting of exposed surfaces of shop primed louvers is specified in Section 09 91 00, PAINTING.
- D. Steel: Surfaces of steel work, for which no other finish is specified, shall be cleaned free from scale, rust, oil and grease, and then given a light colored prime paint after fabrication, except ferrous metals concealed in finished work. Paint all contact surfaces of assembled work (except welded contact surfaces) with an additional shop coat of similar paint.

## **2.5 PROTECTION**

- A. Provide protection for aluminum against galvanic action wherever dissimilar materials are in contact, by painting the contact surfaces of the dissimilar material with a heavy coat of bituminous paint (complete coverage), or by separating the contact surfaces with a performed synthetic rubber tape having pressure sensitive adhesive coating on one side.
- B. Isolate the aluminum from plaster, concrete and masonry by coating aluminum with zinc-chromate primer.
- C. Protect finished surfaces from damage during fabrication, erection, and after completion of the work. Strippable plastic coating on colored anodized or organic finish is not approved.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. Set work accurately, in alignment and where shown. Items shall be plumb, level, free of rack and twist, and set parallel or perpendicular as required to line and plane of surface.
- B. Furnish setting drawings and instructions for installation of anchors and for the positioning of items having anchors to be built into masonry construction. Provide temporary bracing for such items until masonry is set.
- C. Provide anchoring devices and fasteners as shown and as necessary for securing louvers to building construction as specified. Power actuated drive pins may be used, except for removal items and where members would be deformed or substrate damaged by their use.
- D. Generally, set wall louvers in masonry walls during progress of the work. If wall louvers are not delivered to job in time for installation in prepared openings, make provision for later installation. Set in cast-in-place concrete in prepared openings.

### **3.2 CLEANING AND ADJUSTING**

- A. After installation, all exposed prefinished and plated items and all items fabricated from stainless steel and aluminum shall be cleaned as recommended by the manufacturer and protected from damage until completion of the project.
- B. All movable parts, including hardware, shall be cleaned and adjusted to operate as designed without binding or deformation of the members, so as to be centered in the opening of frame, and where applicable, to have all contact surfaces fit tight and even without forcing or warping the components

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**SECTION 09 22 16**  
**NON-STRUCTURAL METAL FRAMING**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

This section specifies steel studs, fasteners, and accessories.

**1.2 TERMINOLOGY**

- A. Description of terms shall be in accordance with ASTM C754, ASTM C11, ASTM C841 and as specified.
- B. Underside of Structure Overhead: In spaces where steel trusses or bar joists are shown, the underside of structure overhead shall be the underside of the floor or roof construction supported by beams, trusses, or bar joists. In interstitial spaces with walk-on floors the underside of the walk-on floor is the underside of structure overhead.
- C. Thickness of steel specified is the minimum bare (uncoated) steel thickness.

**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. Studs, runners and accessories.
  - 2. Hanger inserts.
  - 3. Channels (Rolled steel).
  - 4. Furring channels.
  - 5. Screws, clips and other fasteners.
- C. Shop Drawings:
  - 1. Typical metal stud and furring construction system including details around openings and corner details.
- D. Test Results: Fire rating test designation, each fire rating required for each assembly.

**1.5 DELIVERY, IDENTIFICATION, HANDLING AND STORAGE**

In accordance with the requirements of ASTM C754.

**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. American Society For Testing And Materials (ASTM)
  - A123-02.....Zinc (Hot-dip Galvanized) Coatings on Iron and Steel Products

A653/A653M-07.....Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process

A641-03.....Zinc-Coated (Galvanized) Carbon Steel Wire

C11-07.....Terminology Relating to Gypsum and Related Building Materials and Systems

C635-04.....Manufacture, Performance, and Testing of Metal Suspension System for Acoustical Tile and Lay-in Panel Ceilings

C636-06.....Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-in Panels

C645-07.....Non-Structural Steel Framing Members

C754-04.....Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products

C841-03.....Installation of Interior Lathing and Furring

C954-04.....Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Steel Studs from 0.033 in. (0.84 mm) to 0.112 in. (2.84 mm) in Thickness

C1002-04.....Steel Self-Piercing Tapping Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs

E580-06.....Application of Ceiling Suspension Systems for Acoustical Tile and Lay-in Panels in Areas Requiring Moderate Seismic Restraint.

## **PART 2 - PRODUCTS**

### **2.1 PROTECTIVE COATING**

Galvanize steel studs, runners (track), rigid (hat section) furring channels, "Z" shaped furring channels, and resilient furring channels, with coating designation of G-60 minimum, per ASTM 123.

### **2.2 STEEL STUDS AND RUNNERS (TRACK)**

- A. ASTM C645, modified for thickness specified and sizes and shown.
  - 1. Use ASTM A525 steel, 0.9 mm (0.0359-inch) thick bare metal (20 gauge).
  - 2. Runners same thickness as studs.
- B. Provide not less than two cutouts in web of each stud, approximately 300 mm (12 inches) from each end, and intermediate cutouts on approximately 600 mm (24-inch) centers.
- C. Doubled studs for openings and studs for supporting concrete backer-board.

D. Studs 3600 mm (12 feet) or less in length shall be in one piece.

### **2.3 FASTENERS, CLIPS, AND OTHER METAL ACCESSORIES**

- A. ASTM C754, except as otherwise specified.
- B. For fire rated construction: Type and size same as used in fire rating test.
- C. Fasteners for steel studs thicker than 0.84 mm (0.033-inch) thick. Use ASTM C954 steel drill screws of size and type recommended by the manufacturer of the material being fastened.
- D. Clips: ASTM C841 (paragraph 6.11), manufacturer's standard items. Clips used in lieu of tie wire shall have holding power equivalent to that provided by the tie wire for the specific application.
- E. Power Actuated Fasteners: Type and size as recommended by the manufacturer of the material being fastened.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION CRITERIA**

- A. Where fire rated construction is required for walls, partitions, columns, beams and floor-ceiling assemblies, the construction shall be same as that used in fire rating test.
- B. Construction requirements for fire rated assemblies and materials shall be as shown and specified, the provisions of the Scope paragraph (1.2) of ASTM C754 and ASTM C841 regarding details of construction shall not apply.

### **3.2 INSTALLING STUDS**

- A. Install studs in accordance with ASTM C754, except as otherwise shown or specified.
- B. Space studs not more than 610 mm (24 inches) on center.
- C. Cut studs 6 mm to 9 mm (1/4 to 3/8-inch) less than floor to underside of structure overhead when extended to underside of structure overhead.
- D. Where studs are shown to terminate above suspended ceilings, provide bracing as shown or extend studs to underside of structure overhead.
- E. Extend studs to underside of structure overhead for fire, rated partitions, smoke partitions, shafts, and sound rated partitions.
- F. Openings:
  - 1. Frame jambs of openings in stud partitions and furring with two studs placed back to back or as shown.
  - 2. Fasten back to back studs together with 9 mm (3/8-inch) long Type S pan head screws at not less than 600 mm (two feet) on center, staggered along webs.
  - 3. Studs fastened flange to flange shall have splice plates on both sides approximately 50 X 75 mm (2 by 3 inches) screwed to each stud

with two screws in each stud. Locate splice plates at 600 mm (24 inches) on center between runner tracks.

G. Fastening Studs:

1. Fasten studs located adjacent to partition intersections, corners and studs at jambs of openings to flange of runner tracks with two screws through each end of each stud and flange of runner.
2. Do not fasten studs to top runner track when studs extend to underside of structure overhead.

**3.3 INSTALLING SUPPORTS REQUIRED BY OTHER TRADES**

- A. Provide for attachment and support of electrical outlets, plumbing, laboratory or heating fixtures, recessed type plumbing fixture accessories, access panel frames, wall bumpers, wood seats, toilet stall partitions, dressing booth partitions, urinal screens, chalkboards, tackboards, wall-hung casework, handrail brackets, recessed fire extinguisher cabinets and other items like auto door buttons and auto door operators supported by stud construction.
- B. Provide additional studs where required. Install metal backing plates, or special metal shapes as required, securely fastened to metal studs.

**3.4 TOLERANCES**

- A. Fastening surface for application of subsequent materials shall not vary more than 3 mm (1/8-inch) from the layout line.
- B. Plumb and align vertical members within 3 mm (1/8-inch.)
- C. Level or align ceilings within 3 mm (1/8-inch.)

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**SECTION 09 91 00  
PAINTING**

**PART 1-GENERAL**

**1.1 DESCRIPTION**

- A. Section specifies field painting.

**1.2 SUBMITTALS**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Manufacturer's Literature and Data:  
Before work is started, submit manufacturer's literature, the current Master Painters Institute (MPI) "Approved Product List" indicating brand label, product name and product code as of the date of contract award, will be used to determine compliance with the submittal requirements of this specification.
- C. Manufacturers' Certificates indicating compliance with specified requirements:  
1. Manufacturer's paint substituted for Federal Specification paints meets or exceeds performance of paint specified.

**1.3 DELIVERY AND STORAGE**

- A. Deliver materials to site in manufacturer's sealed container marked to show following:  
1. Name of manufacturer.  
2. Product type.  
3. Batch number.  
4. Instructions for use.  
5. Safety precautions.
- B. In addition to manufacturer's label, provide a label legibly printed as following:  
1. Federal Specification Number, where applicable, and name of material.  
2. Surface upon which material is to be applied.  
3. If paint or other coating, state coat types; prime, body or finish.
- C. Maintain space for storage, and handling of painting materials and equipment in a neat and orderly condition to prevent spontaneous combustion from occurring or igniting adjacent items.
- D. Store materials at site at least 24 hours before using, at a temperature between 18 and 30 degrees C (65 and 85 degrees F).

**1.4 APPLICABLE PUBLICATIONS**

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

- B. American Conference Of Governmental Industrial Hygienists (ACGIH):  
ACGIH TLV-BKLT-1992.....Threshold Limit Values (TLV) for Chemical  
Substances and Physical Agents and Biological  
Exposure Indices (BEIs)  
ACGIH TLV-DOC.....Documentation of Threshold Limit Values and  
Biological Exposure Indices, (Sixth Edition)
- C. American National Standards Institute (ANSI):  
A13.1-96.....Scheme for the Identification of Piping Systems
- D. American Society for Testing and Materials (ASTM):  
D260-86.....Boiled Linseed Oil
- E. Commercial Item Description (CID):  
A-A-1555.....Water Paint, Powder (Cementitious, White and  
Colors) (WPC) (cancelled)  
A-A-3120.....Paint, For Swimming Pools (RF) (cancelled)
- F. Federal Specifications (Fed Spec):  
TT-P-1411A.....Paint, Copolymer-Resin, Cementitious (For  
Waterproofing Concrete and Masonry Walls) (CEP)
- G. Master Painters Institute (MPI):  
No. 1-04.....Aluminum Paint (AP)  
No. 4-04.....Interior/ Exterior Latex Block Filler  
No. 5-04.....Exterior Alkyd Wood Primer  
No. 7-04.....Exterior Oil Wood Primer  
No. 8-04.....Exterior Alkyd, Flat MPI Gloss Level 1 (EO)  
No. 9-04.....Exterior Alkyd Enamel MPI Gloss Level 6 (EO)  
No. 10-04.....Exterior Latex, Flat (AE)  
No. 11-04.....Exterior Latex, Semi-Gloss (AE)  
No. 18-04.....Organic Zinc Rich Primer  
No. 22-04.....Aluminum Paint, High Heat (up to 590° - 1100F)  
(HR)  
No. 26-04.....Cementitious Galvanized Metal Primer  
No. 27-04.....Exterior / Interior Alkyd Floor Enamel, Gloss (FE)  
No. 31-04.....Polyurethane, Moisture Cured, Clear Gloss (PV)  
No. 36-04.....Knot Sealer  
No. 43-04.....Interior Satin Latex, MPI Gloss Level 4  
No. 44-04.....Interior Low Sheen Latex, MPI Gloss Level 2  
No. 45-04.....Interior Primer Sealer  
No. 46-04.....Interior Enamel Undercoat  
No. 47-04.....Interior Alkyd, Semi-Gloss, MPI Gloss Level 5 (AK)  
No. 48-04.....Interior Alkyd, Gloss, MPI Gloss Level 6 (AK)  
No. 49-04.....Interior Alkyd, Flat, MPI Gloss Level 1 (AK)

- No. 50-04.....Interior Latex Primer Sealer
- No. 51-04.....Interior Alkyd, Eggshell, MPI Gloss Level 3
- No. 52-04.....Interior Latex, MPI Gloss Level 3 (LE)
- No. 53-04.....Interior Latex, Flat, MPI Gloss Level 1 (LE)
- No. 54-04.....Interior Latex, Semi-Gloss, MPI Gloss Level 5 (LE)
- No. 59-04.....Interior/Exterior Alkyd Porch & Floor Enamel, Low  
Gloss (FE)
- No. 60-04.....Interior/Exterior Latex Porch & Floor Paint, Low  
Gloss
- No. 66-04.....Interior Alkyd Fire Retardant, Clear Top-Coat (ULC  
Approved) (FC)
- No. 67-04.....Interior Latex Fire Retardant, Top-Coat (ULC  
Approved) (FR)
- No. 68-04.....Interior/ Exterior Latex Porch & Floor Paint,  
Gloss
- No. 71-04.....Polyurethane, Moisture Cured, Clear, Flat (PV)
- No. 74-04.....Interior Alkyd Varnish, Semi-Gloss
- No. 77-04.....Epoxy Cold Cured, Gloss (EC)
- No. 79-04.....Marine Alkyd Metal Primer
- No. 90-04.....Interior Wood Stain, Semi-Transparent (WS)
- No. 91-04.....Wood Filler Paste
- No. 94-04.....Exterior Alkyd, Semi-Gloss (EO)
- No. 95-04.....Fast Drying Metal Primer
- No. 98-04.....High Build Epoxy Coating
- No. 101-04.....Epoxy Anti-Corrosive Metal Primer
- No. 108-04.....High Build Epoxy Coating, Low Gloss (EC)
- No. 114-04.....Interior Latex, Gloss (LE) and (LG)
- No. 119-04.....Exterior Latex, High Gloss (acrylic) (AE)
- No. 135-04.....Non-Cementitious Galvanized Primer
- No. 138-04.....Interior High Performance Latex, MPI Gloss Level 2  
(LF)
- No. 139-04.....Interior High Performance Latex, MPI Gloss Level 3  
(LL)
- No. 140-02.....Interior High Performance Latex, MPI Gloss Level 4
- No. 141-04.....Interior High Performance Latex (SG) MPI Gloss  
Level 5
- H. Steel Structures Painting Council (SSPC):
- SSPC SP 1-00.....Solvent Cleaning
- SSPC SP 2-00.....Hand Tool Cleaning
- SSPC SP 3-00.....Power Tool Cleaning

## **PART 2 - PRODUCTS**

### **2.1 MATERIALS**

- A. Interior Satin Latex: MPI 43.
- B. Interior Low Sheen Latex: MPI 44.
- C. Interior Primer Sealer: MPI 45.
- D. Interior Enamel Undercoat: MPI 47.
- E. Interior Latex Primer Sealer: MPI 50.
- F. Interior Latex, MPI Gloss Level 3 (LE): MPI 52.
- G. Interior Latex, Semi-Gloss, MPI Gloss Level 5 (LE): MPI 54.

### **2.2 PAINT PROPERTIES**

- A. Use ready-mixed (including colors) paints having metallic powders packaged separately and paints requiring specified additives.
- B. Where no requirements are given in the referenced specifications for primers, use primers with pigment and vehicle, compatible with substrate and finish coats specified.

### **2.3 REGULATORY REQUIREMENTS**

- A. Paint materials shall conform to the restrictions of the local Environmental and Toxic Control jurisdiction.
  - 1. Volatile Organic Compounds (VOC): VOC content of paint materials shall not exceed local, state or district requirements.
  - 2. Lead-Base Paint:
    - a. Comply with Section 410 of the Lead-Based Paint Poisoning Prevention Act, as amended, and with implementing regulations promulgated by Secretary of Housing and Urban Development.
    - b. Regulations concerning prohibition against use of lead-based paint in federal and federally assisted construction, or rehabilitation of residential structures are set forth in Subpart F, Title 24, Code of Federal Regulations, Department of Housing and Urban Development.
  - 3. Asbestos: Materials shall not contain asbestos.
  - 4. Chromate, Cadmium, Mercury, and Silica: Materials shall not contain zinc-chromate, strontium-chromate, Cadmium, mercury or mercury compounds or free crystalline silica.
  - 5. Human Carcinogens: Materials shall not contain any of the ACGIH-BKLT and ACGHI-DOC confirmed or suspected human carcinogens.
  - 6. Comply with the Regional Ozone Transport Commission (OTC) regulations regarding Volatile Organic Content (VOC).

## **PART 3 - EXECUTION**

### **3.1 JOB CONDITIONS**

- A. Safety: Observe required safety regulations and manufacturer's warning and instructions for storage, handling and application of painting materials.

1. Take necessary precautions to protect personnel and property from hazards due to falls, injuries, toxic fumes, fire, explosion, or other harm.
2. Deposit soiled cleaning rags and waste materials in metal containers approved for that purpose. Dispose of such items off the site at end of each days work.

B. Atmospheric and Surface Conditions:

1. Do not apply coating when air or substrate conditions are:
  - a. Less than 3 degrees C (5 degrees F) above dew point.
  - b. Below 10 degrees C (50 degrees F) or over 35 degrees C (95 degrees F), unless specifically pre-approved by the Contracting Officer and the product manufacturer. Under no circumstances shall application conditions exceed manufacturer recommendations.
2. Maintain interior temperatures until paint dries hard.

**3.2 SURFACE PREPARATION**

A. Method of surface preparation is optional, provided results of finish painting produce solid even color and texture specified with no overlays.

B. General:

1. Remove prefinished items not to be painted such as lighting fixtures, escutcheon plates, hardware, trim, and similar items for reinstallation after paint is dried.
2. Remove items for reinstallation and complete painting of such items and adjacent areas when item or adjacent surface is not accessible or finish is different.
3. See other sections of specifications for specified surface conditions and prime coat.
4. Clean surfaces for painting with materials and methods compatible with substrate and specified finish. Remove any residue remaining from cleaning agents used. Do not use solvents, acid, or steam on concrete and masonry.

C. Gypsum Plaster and Gypsum Board:

1. Remove efflorescence, loose and chalking plaster or finishing materials.
2. Remove dust, dirt, and other deterrents to paint adhesion.
3. Fill holes, cracks, and other depressions with CID-A-A-1272A [Plaster, Gypsum (Spackling Compound) finished flush with adjacent surface, with texture to match texture of adjacent surface. Patch holes over 25 mm (1-inch) in diameter as specified in Section for plaster or gypsum board.

### 3.3 PAINT PREPARATION

- A. Thoroughly mix painting materials to ensure uniformity of color, complete dispersion of pigment and uniform composition.
- B. Do not thin unless necessary for application and when finish paint is used for body and prime coats. Use materials and quantities for thinning as specified in manufacturer's printed instructions.
- C. Remove paint skins, then strain paint through commercial paint strainer to remove lumps and other particles.
- D. Mix two component and two part paint and those requiring additives in such a manner as to uniformly blend as specified in manufacturer's printed instructions unless specified otherwise.
- E. For tinting required to produce exact shades specified, use color pigment recommended by the paint manufacturer.

### 3.4 APPLICATION

- A. Start of surface preparation or painting will be construed as acceptance of the surface as satisfactory for the application of materials.
- B. Unless otherwise specified, apply paint in three coats; prime, body, and finish. When two coats applied to prime coat are the same, first coat applied over primer is body coat and second coat is finish coat.
- C. Apply each coat evenly and cover substrate completely.
- D. Allow not less than 48 hours between application of succeeding coats, except as allowed by manufacturer's printed instructions, and approved by Resident Engineer.
- E. Finish surfaces to show solid even color, free from runs, lumps, brushmarks, laps, holidays, or other defects.
- F. Apply by brush, roller or spray, except as otherwise specified.
- G. Do not spray paint in existing occupied spaces unless approved by Resident Engineer, except in spaces sealed from existing occupied spaces.
  - 1. Apply painting materials specifically required by manufacturer to be applied by spraying.
  - 2. In areas, where paint is applied by spray, mask or enclose with polyethylene, or similar air tight material with edges and seams continuously sealed including items specified in WORK NOT PAINTED, motors, controls, telephone, and electrical equipment, fronts of sterilizes and other recessed equipment and similar prefinished items.
- H. Do not paint in closed position operable items such as access doors and panels, window sashes, overhead doors, and similar items except overhead roll-up doors and shutters.

### 3.5 PRIME PAINTING

- A. After surface preparation prime surfaces before application of body and finish coats, except as otherwise specified.
- B. Spot prime and apply body coat to damaged and abraded painted surfaces before applying succeeding coats.
- F. Gypsum Board and Hardboard:
  - 1. Surfaces scheduled to have MPI Gloss Level 1 (LE)) MPI 52 (Interior Latex, MPI Gloss Level 3 (LE)) MPI 54 (Interior Latex, Semi-Gloss, MPI Gloss Level 5 (LE)) MPI 114 (Interior Latex, Gloss (LE) and (LG)) finish: Use (Interior Latex, MPI Gloss Level 3 (LE)) MPI 52 (Interior Latex, MPI Gloss Level 3 (LE)) MPI 54 (Interior Latex, Semi-Gloss, MPI Gloss Level 5 (LE)) MPI 114 (Interior Latex, Gloss (LE) and (LG)) respectively.
  - 2. Primer: MPI 50 (Interior Latex Primer Sealer).

### 3.6 INTERIOR FINISHES

- A. Apply following finish coats over prime coats in spaces or on surfaces.  
~~specified in Section 09050, INTERIOR EXTERIOR FINISHES, MATERIALS AND FINISH SCHEDULES.~~
- B. Gypsum Board:
  - 1. One coat of MPI 45 (Interior Primer Sealer) plus one coat of MPI 139 (Interior High Performance Latex, MPI Gloss level 3 (LL)).
  - 2. Two coats of MPI 138 (Interior High Performance Latex, MPI Gloss Level 2 (LF)).
  - 3. One coat of MPI 45 (Interior Primer Sealer) plus one coat of MPI 54 (Interior Latex, Semi-Gloss, MPI Gloss Level 5 (LE)) or MPI 114 (Interior Latex, Gloss (LE) and (LG)).
  - 4. One coat of MPI 45 (Interior Primer Sealer) plus one coat of MPI 48 (Interior Alkyd Gloss (AK)).
- C. Plaster:
  - 1. One coat of MPI 45 (Interior Primer Sealer) or MPI 50 (Interior Latex Primer Sealer) plus one coat of MPI 139 (Interior High Performance Latex, MPI Gloss level 3 (LL)).
  - 2. Two coats of MPI 51 (Interior Alkyd, Eggshell) (AK)).
  - 3. One coat of MPI 45 (Interior Primer Sealer) or MPI 50 (Interior Latex Primer Sealer) plus one coat of 139 (Interior High Performance Latex, MPI Gloss level 3 (LL)).
  - 4. One coat MPI 101 (Cold Curing Epoxy Prime (EC)).

### 3.7 REFINISHING EXISTING PAINTED SURFACES

- A. Clean, patch and repair existing surfaces as specified under surface preparation.

- B. Remove and reinstall items as specified under surface preparation.
- C. Remove existing finishes or apply separation coats to prevent non compatible coatings from having contact.
- D. Patched or Replaced Areas in Surfaces and Components: Apply spot prime and body coats as specified for new work to repaired areas or replaced components.
- E. Except where scheduled for complete painting apply finish coat over plane surface to nearest break in plane, such as corner, reveal, or frame.
- F. In existing rooms and areas where alterations occur, clean existing stained and natural finished wood retouch abraded surfaces and then give entire surface one coat of MPI 31 (Polyurethane, Moisture Cured, Clear Gloss).
- G. Refinish areas as specified for new work to match adjoining work unless specified or scheduled otherwise.
- H. Coat knots and pitch streaks showing through old finish with MPI 36 (Knot Sealer) before refinishing.
- I. Sand or dull glossy surfaces prior to painting.
- J. Sand existing coatings to a feather edge so that transition between new and existing finish will not show in finished work.

### **3.8 PAINT COLOR**

- A. Color and gloss of finish coats to match existing.
- B. Coat Colors:
  - 1. Color of priming coat: Lighter than body coat.
  - 2. Color of body coat: Lighter than finish coat.
  - 3. Color prime and body coats to not show through the finish coat and to mask surface imperfections or contrasts.

### **3.9 MECHANICAL AND ELECTRICAL WORK FIELD PAINTING SCHEDULE**

- A. Field painting of mechanical and electrical consists of cleaning, touching-up abraded shop prime coats, and applying prime, body and finish coats to materials and equipment if not factory finished in space scheduled to be finished.
- B. Paint various systems specified in Divisions 2, 21, 22, 23 and 26.
- C. Paint after tests have been completed.
- D. Omit prime coat from factory prime-coated items.
- E. Finish painting of mechanical and electrical equipment is not required when located in interstitial spaces, above suspended ceilings, in concealed areas such as pipe and electric closets, pipe basements, pipe tunnels, trenches, attics, roof spaces, shafts and furred spaces except on electrical conduit containing feeders 600 volts or more.
- F. Color:

1. Paint items to match surrounding surfaces.

### 3.10 IDENTITY PAINTING SCHEDULE

- A. Identify designated service in accordance with ANSI A13.1, unless specified otherwise, on exposed piping, piping above removable ceilings, piping in accessible pipe spaces, interstitial spaces, and piping behind access panels.
  1. Legend may be identified using 2.1 G options or by stencil applications.
  2. Apply legends adjacent to changes in direction, on branches, where pipes pass through walls or floors, adjacent to operating accessories such as valves, regulators, strainers and cleanouts a minimum of 12 000 mm (40 feet) apart on straight runs of piping. Identification next to plumbing fixtures is not required.
  3. Locate Legends clearly visible from operating position.
  4. Use arrow to indicate direction of flow.
  5. Identify pipe contents with sufficient additional details such as temperature, pressure, and contents to identify possible hazard. Insert working pressure shown on drawings where asterisk appears for High, Medium, and Low Pressure designations as follows:
    - a. High Pressure - 414 kPa (60 psig) and above.
    - b. Medium Pressure - 104 to 413 kPa (15 to 59 psig).
    - c. Low Pressure - 103 kPa (14 psig) and below.
    - d. Add Fuel oil grade numbers.

6. Legend name in full or in abbreviated form as follows:

	COLOR OF	COLOR OF	COLOR OF	LEGEND
PIPING	EXPOSED PIPING	BACKGROUND	LETTERS	BBREVIATIONS
Blow-off		Yellow	Black	Blow-off
Boiler Feedwater		Yellow	Black	Blr Feed
A/C Condenser Water Supply		Green	White	A/C Cond Wtr Sup
A/C Condenser Water Return		Green	White	A/C Cond Wtr Ret
Chilled Water Supply		Green	White	Ch. Wtr Sup
Chilled Water Return		Green	White	Ch. Wtr Ret
Shop Compressed Air		Yellow	Black	Shop Air
Air-Instrument Controls		Green	White	Air-Inst Cont
Drain Line		Green	White	Drain
Emergency Shower		Green	White	Emg Shower

High Pressure Steam		Yellow	Black	H.P. _____*
High Pressure Condensate Return		Yellow	Black	H.P. Ret _____*
Medium Pressure Steam		Yellow	Black	M. P. Stm _____*
Medium Pressure Condensate Return		Yellow	Black	M.P. Ret _____*
Low Pressure Steam		Yellow	Black	L.P. Stm _____*
Low Pressure Condensate Return		Yellow	Black	L.P. Ret _____*
High Temperature Water Supply		Yellow	Black	H. Temp Wtr Sup
High Temperature Water Return		Yellow	Black	H. Temp Wtr Ret
Hot Water Heating Supply		Yellow	Black	H. W. Htg Sup
Hot Water Heating Return		Yellow	Black	H. W. Htg Ret
Gravity Condensate Return		Yellow	Black	Gravity Cond Ret
Pumped Condensate Return		Yellow	Black	Pumped Cond Ret
Vacuum Condensate Return		Yellow	Black	Vac Cond Ret
Fuel Oil - Grade		Green	White	Fuel Oil-Grade ____*
Boiler Water Sampling		Yellow	Black	Sample
Chemical Feed		Yellow	Black	Chem Feed
Continuous Blow-Down		Yellow	Black	Cont. B D
Pumped Condensate		Black		Pump Cond
Pump Recirculating		Yellow	Black	Pump-Recirc.
Vent Line		Yellow	Black	Vent
Alkali		Yellow	Black	Alk
Bleach		Yellow	Black	Bleach
Detergent		Yellow	Black	Det
Liquid Supply		Yellow	Black	Liq Sup
Reuse Water		Yellow	Black	Reuse Wtr
Cold Water (Domestic)	White	Green	White	C.W. Dom
Hot Water (Domestic)				
Supply	White	Yellow	Black	H.W. Dom
Return	White	Yellow	Black	H.W. Dom Ret
Tempered Water	White	Yellow	Black	Temp. Wtr
Ice Water				
Supply	White	Green	White	Ice Wtr
Return	White	Green	White	Ice Wtr Ret
Reagent Grade Water		Green	White	RG
Reverse Osmosis		Green	White	RO
Sanitary Waste		Green	White	San Waste
Sanitary Vent		Green	White	San Vent
Storm Drainage		Green	White	St Drain

Pump Drainage	Green	White	Pump Disch
Chemical Resistant Pipe			
Waste	Yellow	Black	Acid Waste
Vent	Yellow	Black	Acid Vent
Atmospheric Vent	Green	White	ATV
Silver Recovery	Green	White	Silver Rec
Oral Evacuation	Green	White	Oral Evac
Fuel Gas	Yellow	Black	Gas
Fire Protection Water			
Sprinkler	Red	White	Auto Spr
Standpipe	Red	White	Stand
Sprinkler	Red	White	Drain

7. Electrical Conduits containing feeders over 600 volts, paint legends using 50 mm (2 inch) high black numbers and letters, showing the voltage class rating. Provide legends where conduits pass through walls and floors and at maximum 6100 mm (20 foot) intervals in between. Use labels with yellow background with black border and words Danger High Voltage Class, 5000, 15000, or 25000.
8. See applicable Sections for methods of identification, legends, and abbreviations of the following:
  - a. Regular compressed air lines.
  - b. Dental compressed air lines.
  - c. Laboratory gas and vacuum lines.
  - d. Oral evacuation lines.
  - e. Medical Gases and vacuum lines.
  - f. Conduits containing high voltage feeders over 600 volts.

B. Fire and Smoke Partitions:

1. Identify partitions above ceilings on both sides of partitions except within shafts in letters not less than 64 mm (2 1/2 inches) high.
2. Stenciled message: "SMOKE PARTITION" or, "FIRE PARTITION" as applicable.
3. Locate not more than 6100 mm (20 feet) on center on corridor sides of partitions, and with a least one message per room on room side of partition.
4. Use semigloss paint of color that contrasts with color of substrate.

C. Identify columns in interstitial space:

1. Apply stenciled number and letters to correspond with grid numbering and lettering shown.

2. Paint numbers and letters 100 mm (4 inches) high, locate 450 mm (18 inches) below overhead structural slab.
3. Apply on four sides of interior columns and on inside face only of exterior wall columns.
4. Color:
  - a. Use black on concrete columns.
  - b. Use white or contrasting color on steel columns.

**3.11 PROTECTION CLEAN UP, AND TOUCH-UP**

- A. Protect work from paint droppings and spattering by use of masking, drop cloths, removal of items or by other approved methods.
- B. Upon completion, clean paint from hardware, glass and other surfaces and items not required to be painted of paint drops or smears.
- C. Before final inspection, touch-up or refinished in a manner to produce solid even color and finish texture, free from defects in work which was damaged or discolored.

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**SECTION 10 22 19.13  
DEMOUNTABLE METAL PARTITIONS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

This section specifies movable partitions, metal faced sandwich type with mineral fiber core, nominal 22 mm (7/8 inch) thick.

**1.2 RELATED WORK**

A. Electrical Work: Division 26, ELECTRICAL.

**1.3 DESIGN CRITERIA**

A. Floor fastenings:

Concealed and adjustable to variations in floor level and finish.

B. Door and panel units:

Interchangeable and not less than 1000 mm (40 inches) wide unless otherwise shown.

C. Partition units containing doors:

Adjustable vertically and capable of assembly on floors having normal deviations from a plane surface, without cutting the doors.

D. Provide for installation of electrical wiring through vertical and horizontal frame members.

**1.4 SUBMITTALS**

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

B. Samples:

Metal panel, 200 mm (eight inches) square, with baked-on enamel finish, each color.

C. Shop Drawings:

Complete drawings, 1/2 full scale, showing details of construction and anchorage.

**1.5 APPLICABLE PUBLICATIONS**

A. American Society for Testing and Material (ASTM):

A366-97.....Steel Sheet, and Strip, Carbon, Cold Rolled, and  
Commercial Quality

C665-06.....Mineral-Fiber Blanket Thermal Insulation for  
Light Frame Construction and Manufactured  
Housing

C920-05.....Elastomeric Joint Sealants

C1036-06.....Flat Glass

C1048-04.....Heat-Treated Flat Glass

## PART 2 - PRODUCTS

### 2.1 MATERIALS

- A. Sheet Steel: ASTM A366, Cold-Rolled Commercial Quality of the following thickness:

Panel Face Sheets	0.9 mm (0.036 inch)
Top Filler Face Sheets	0.9 mm (0.036 inch)
End Filler Face Sheets	9 mm (0.036 inch)
Door Face Sheets	0.9 mm (0.036 inch)
Glazing Beads	0.9 mm (0.036 inch)
Door Frames	1.3 mm (0.048 inch)
Post Caps	1.3 mm (0.048 inch)
Cornice	1.3 mm (0.048 inch)
Base	1.3 mm (0.048 inch)
Wall and Ceiling Channels	1.3 mm (0.048 inch)
Posts	1.6 mm (0.060 inch)

- B. Mineral Fiber Insulation: ASTM C665, Type I.

- C. Glazing Cushions:

1. Channel shaped, continuous, of rubber, vinyl, polyethylene or neoprene.

- D. Glass:

1. ASTM C1048, Kind FT (tempered, clear), Condition A, Type, I, Class 1, Quality q3, 6 mm (1/4 inch) thick.
2. ASTM C1036, wire glass, Type II, Class 1, Quality q6, Form 3, finish f1.

### 2.2 FABRICATION

- A. Panels:

1. Fabricate panels of two steel face sheets with mineral fiber core.
2. Space horizontal steel reinforcements in panels minimum of 300 mm (12 inches) on centers vertically.
3. Spot weld reinforcement to face sheets minimum of 75 mm (3 inches) on centers horizontally.
4. Design panels to facilitate field cutting.

- B. Posts:

1. Notch or punch posts for clip connections.
2. Design posts to permit extension of partitions in any or all four directions without disturbing posts in place.
3. Provide convenient access to electrical wiring.

4. Posts caps shall be snap-on type and finish flush with vertical sides of panels.
5. Provide free standing end panels with end posts.
6. Locate switch cutouts 135 mm (54 inches) above finished floor and receptacle cutouts 400 mm (16 inches) above finished floor.

C. Base:

1. Approximately 100 mm (four inches) high with not more than 6 mm (1/4-inch) projection.
2. Provide base on both sides of partitions, adjustable to floor irregularities, and readily removable in unit lengths to afford access to electrical wiring.
3. Provide raceways for electrical wiring.

D. Cornice:

Molded type, approximately 63 mm (2-1/2 inches) high, with provision for electrical wiring.

E. Top Fillers (Cornice To Ceiling):

1. Fabricate of two 3 mm (1/8 inch) thick mineral-board face sheets with mineral fiber core, overall thickness same as panels.
2. Seat bottom of sheets in recess formed in top of metal cornice.
3. Secure top of sheets in steel ceiling channels equipped with inorganic compressive seal.
4. Point joints in mineral-board fillers flush, then tape and finish smooth, and ready for painting.
5. Center vertical joints in filler sheets on snap-on post caps below.

F. End Fillers:

1. Fabricate of two steel face sheets with mineral fiber core and finish same thickness as panel units.
2. Fasten end fillers to adjacent panel verticals and fit end fillers into wall channels, fastened to building construction.
3. Design wall channels to provide for compression strip to seal wall irregularities.
4. Make fillers removable without damaging wall.

G. Doors:

1. Flush metal type, 45 mm (1-3/4 inches) thick of size shown.
2. Reinforce doors with internal bracing no thinner than 0.9 mm (0.036 inch) thick sheet steel extending full height of door and spaced not over 150 mm (6 inches) on centers horizontally.
3. Insulate door panels as specified for partition panels.
4. Reinforce cutouts in doors for hinges, closers, holders, and lock or latch strike points with minimum 11 gage steel plates.

5. Make cut-outs and drilling and tapping of reinforcement for hardware in doors in accordance with templates furnished by hardware manufacturer.
6. Reinforce cutouts and sinkages for mortised template hardware with steel plates and tap as required.
7. Provide 2 mm (3/32 inch) clearance between door at jambs and head, and 19 mm (3/4 inch) clearance between finish floor and bottom of bottom rail.

H. Door Frames:

1. Rabbet frames for doors and reinforce at hinge, closer, and lock points.
2. Make cut-outs and drilling and tapping of reinforcement for hardware on frames in accordance with templates furnished by hardware manufacturer.
3. Provide cut-outs for strike plates and hinges with dust boxes of sheet steel welded to the back of the frames.
4. Drill lock strike jambs of each frame for reception of three mutes as specified in Section 08 71 00, DOOR HARDWARE.

I. Glazing:

1. Bed glass, except tempered glass, in felt, elastic glazing compound, or putty.
2. Set tempered glass using resilient glazing cushions.
3. Provide metal glazing beads, either snap-in type or secure with oval-head screws.
4. Cope or miter corners.

J. Finish:

Clean exposed metal surfaces (except stainless steel, non-ferrous and plated metal) of movable partitions free of scale, rust, oil and grease and apply two coats of baked-on enamel finish.

**PART 3 - EXECUTION**

**3.1 INSTALLATION**

- A. Install partitions so as to be straight, rigid, securely anchored, plumb and level.
- B. All fastening devices are to be as shown on shop drawings.

**3.2 FIELD PAINTING**

Touch-up all nicks and scratches with paint, matching color and texture of baked-on enamel finish, furnished by partition manufacturer.

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**SECTION 21 05 11**  
**COMMON WORK RESULTS FOR FIRE SUPPRESSION**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

A. The requirements of this Section apply to all sections of Division 21.

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.
- D. Section 07 84 00, FIRESTOPPING.
- E. Flashing for Wall and Roof Penetrations: Section 07 60 00, FLASHING AND SHEET METAL.
- F. Section 07 92 00, JOINT SEALANTS.
- G. Section 09 91 00, PAINTING.
- H. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

**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. See other specification sections for any exceptions.
2. Equipment Service: Products shall be supported by a service organization which maintains a complete inventory of repair parts and is located reasonably close to the site.
3. 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.
4. Assembled Units: Manufacturers of equipment assemblies, which use components made by others, assume complete responsibility for the final assembled product.
5. 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.
6. Asbestos products or equipment or materials containing asbestos shall not be used.

- B. 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.
- C. Supports for sprinkler piping shall be in conformance with NFPA 13.
- D. Supports for standpipe shall be in conformance with NFPA 14.

#### **1.4 SUBMITTALS**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Manufacturer's Literature and Data: Submit under the pertinent section rather than under this section.
  - 1. Equipment and materials identification.
  - 2. Fire-stopping materials.
  - 3. Hangers, inserts, supports and bracing. Provide load calculations for variable spring and constant support hangers.
  - 4. Wall, floor, and ceiling plates.
- C. Coordination Drawings: Provide detailed layout drawings of all piping systems. In addition provide details of the following.
  - 1. Mechanical equipment rooms.
  - 2. Interstitial space.
  - 3. Hangers, inserts, supports, and bracing.
  - 4. Pipe sleeves.
  - 5. Equipment penetrations of floors, walls, ceilings, or roofs.
- D. 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.

#### **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 for Testing and Materials (ASTM):  
A36/A36M-2001.....Carbon Structural Steel

A575-96.....Steel Bars, Carbon, Merchant Quality, M-Grades R  
(2002)

E84-2003.....Standard Test Method for Burning Characteristics  
of Building Materials

E119-2000.....Standard Test Method for Fire Tests of Building  
Construction and Materials

C. National Fire Protection Association (NFPA):

90A-96.....Installation of Air Conditioning and Ventilating  
Systems

101-97.....Life Safety Code

**PART 2 - PRODUCTS**

**2.1 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. 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.
- C. Control Items: Label all temperature and humidity sensors, controllers and control dampers. Identify and label each item as they appear on the control diagrams.
- D. Valve Tags and Lists:
  - 1. 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.
  - 2. 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.
  - 3. 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.

**2.2 FIRESTOPPING**

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

**2.3 GALVANIZED REPAIR COMPOUND**

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

## 2.4 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, but may be installed in concrete beam flanges. Any deviation from this requirement must receive prior approval of Resident Engineer.
- 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. 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.

## **2.5 TOOLS AND LUBRICANTS**

- A. Furnish, and turn over to the Resident Engineer, special 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. Tool Containers: Hardwood or metal, permanently identified for intended service and mounted, or located, where directed by the Resident Engineer.
- D. 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.

## **2.6 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. Use also where insulation ends on exposed water supply pipe drop from overhead. Provide a watertight joint in spaces where brass or steel pipe sleeves are specified.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. Coordinate location of piping, sleeves, inserts, hangers, and equipment. Locate piping, sleeves, inserts, hangers, and equipment clear of windows, doors, openings, light outlets, and other services and utilities. Follow manufacturer's published recommendations for installation methods not otherwise specified.
- B. 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. Tightly cover and protect equipment against dirt, water chemical, or mechanical injury. At completion of all work thoroughly exposed materials and equipment.
- C. Install gages, valves, and other devices with due regard for ease in reading or operating and maintaining said devices. Locate and position 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.
- D. 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.
- E. Switchgear 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.
- F. 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 STARTUP AND TEMPORARY OPERATION**

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.

### **3.3 OPERATING AND PERFORMANCE TESTS**

- A. Prior to the final inspection, perform required tests as specified in Section 01 00 00, GENERAL REQUIREMENTS, Article, TESTS 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 for heating systems and for cooling systems respectively during first actual seasonal use of respective systems following completion of work.

### **3.4 INSTRUCTIONS TO VA PERSONNEL**

Provide in accordance with Article, INSTRUCTIONS, of Section 01 00 00, GENERAL REQUIREMENTS.

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**SECTION 21 13 13**  
**WET-PIPE SPRINKLER SYSTEMS**

**PART 1 - GENERAL**

**1.1 SCOPE OF WORK**

- A. Design, installation and testing shall be in accordance with NFPA 13 except for specified exceptions.
- B. The design and installation of a hydraulically calculated automatic wet system complete and ready for operation, for all portions of Building that are part of scope of work, including the penthouse, mechanical equipment rooms, sub-basement, and penthouse interstitial space.
- C. Modification of the existing sprinkler system as indicated on the drawings and as further required by these specifications.

**1.2 RELATED WORK**

- A. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Section 07 84 00, FIRESTOPPING, Treatment of penetrations through rated enclosures.
- C. Section 09 91 00, PAINTING.
- D. Section 21 05 11 COMMON WORK RESULTS FOR FIRE SUPPRESSION.

**1.3 QUALITY ASSURANCE**

- A. Installer Reliability: The installer shall possess a valid State of Ohio fire sprinkler contractor's license. The installer shall have been actively and successfully engaged in the installation of commercial automatic sprinkler systems for the past ten years.
- B. Materials and Equipment: All equipment and devices shall be of a make and type listed by UL and approved by FM, or other nationally recognized testing laboratory for the specific purpose for which it is used. All materials, devices, and equipment shall be approved by the VA.
- C. Submittals: Submit as one package in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES. Prepare detailed working drawings that are signed by a NICET Level III or Level IV Sprinkler Technician or stamped by a Registered Professional Engineer practicing in the field of Fire Protection Engineering. As Government review is for technical adequacy only, the installer remains responsible for correcting any conflicts with other trades and building construction that arise during installation. Partial submittals will not be accepted. Material submittals shall be approved prior to the purchase or delivery to the job site. Suitably bind submittals in notebooks or binders and provide index referencing the appropriate specification section. Submittals shall include, but not be limited to, the following:
  - 1. Qualifications:

- a. Provide a copy of the installing contractors fire sprinkler and state contractor's license.
  - b. Provide a copy of the NICET certification for the NICET Level III or Level IV Sprinkler Technician who prepared and signed the detailed working drawings unless the drawings are stamped by a Registered Professional Engineer practicing in the field of Fire Protection Engineering.
2. Drawings: Submit detailed 1:100 (1/8 inch) scale (minimum) working drawings conforming to NFPA 13.
3. Manufacturers Data Sheets:
  - a. Provide for materials and equipment proposed for use on the system. Include listing information and installation instructions in data sheets. Where data sheet describes items in addition to that item being submitted, clearly identify proposed item on the sheet.
4. Calculation Sheets: Submit hydraulic calculation sheets in tabular form conforming to the requirements and recommendations of NFPA 13.
5. Final Document Submittals: Provide as-built drawings, testing and maintenance instructions in accordance with the requirements in Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES. Submittals shall include, but not be limited to, the following:
  - a. One complete set of reproducible as-built drawings showing the installed system with the specific interconnections between the waterflow switch or pressure switch and the fire alarm equipment.
  - b. Complete, simple, understandable, step-by-step, testing instructions giving recommended and required testing frequency of all equipment, methods for testing all equipment, and a complete trouble shooting manual. Provide maintenance instructions on replacing any components of the system including internal parts, periodic cleaning and adjustment of the equipment and components with information as to the address and telephone number of both the manufacturer and the local supplier of each item.
  - c. Material and Testing Certificate: Upon completion of the sprinkler system installation or any partial section of the system, including testing and flushing, provide a copy of a completed Material and Testing Certificate as indicated in NFPA 13.
  - d. Certificates shall document all parts of the installation.
  - e. Instruction Manual: Provide one copy of the instruction manual covering the system in a flexible protective cover and mount in an accessible location adjacent to the riser.

D. Design Basis Information: Provide design, materials, equipment, installation, inspection, and testing of the automatic sprinkler system in accordance with the requirements of NFPA 13. Recommendations in appendices shall be treated as requirements.

1. Perform hydraulic calculations in accordance with NFPA 13 utilizing the Area/Density method. Do not restrict design area reductions permitted for using quick response sprinklers throughout by the required use of standard response sprinklers in the areas identified in this section.
2. Sprinkler Protection: To determining spacing and sizing, apply the following coverage classifications:
  - a. Light Hazard Occupancies: Patient care, treatment, and customary access areas.
  - b. Ordinary Hazard Group 1 Occupancies: Laboratories, Mechanical Equipment Rooms, Transformer Rooms, Electrical Switchgear Rooms, Electric Closets, Elevator Shafts, Elevator Machine Rooms, and Repair Shops.
  - c. Ordinary Hazard Group 2 Occupancies: Storage rooms, trash rooms, clean and soiled linen rooms, pharmacy and associated storage, laundry, kitchens, kitchen storage areas, retail stores, retail store storage rooms, storage areas, building management storage, boiler plants, energy centers, warehouse spaces, file storage areas for the entire area of the space up to 140 square meters (1500 square feet) and Supply Processing and Distribution (SPD).
  - d. Request clarification from the Government for any hazard classification not identified.
3. Hydraulic Calculations: Calculated demand including hose stream requirements shall fall no less than 10 percent below the available water supply curve.
4. Zoning:
  - a. For each sprinkler zone provide a control valve, flow switch and a test and drain assembly with pressure gauge.
  - b. Sprinkler zones shall conform to the smoke barrier zones shown on the drawings.

#### 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 Fire Protection Association (NFPA):  
13-2002.....Installation of Sprinkler Systems

101-22003.....Safety to Life from Fire in Buildings and  
Structures (Life Safety Code)

170-1999.....Fire Safety Symbols

C. Underwriters Laboratories, Inc. (UL):

Fire Protection Equipment Directory - 2001

D. Factory Mutual Engineering Corporation (FM):

Approval Guide - 2001

E. Uniform Building Code - 1997

F. Foundation for Cross-Connection Control and Hydraulic Research-2005

## **PART 2 PRODUCTS**

### **2.1 PIPING & FITTINGS**

A. Sprinkler systems in accordance with NFPA 13. No copper piping shall be used.

### **2.2 VALVES**

A. Valves in accordance with NFPA 13.

B. Do not use quarter turn ball valves for 50 mm (2 inch) or larger drain valves.

C. The wet system control valve shall be a listed indicating type valve. Control valve shall be UL Listed and FM Approved for fire protection installations. System control valve shall be rated for normal system pressure but in no case less than 175 PSI. (No Substitutions Allowed).

D. Automatic Ball Drips: Cast brass 20 mm (3/4 inch) in-line automatic ball drip with both ends threaded with iron pipe threads.

### **2.3 SPRINKLERS**

A. All sprinklers except shall be FM approved. Provide quick response sprinklers in all areas, except where specifically prohibited by their listing or approval. (Note: Provide 'cages' to protect sprinkler heads from breakage/damage when the elevation of the head is less than 7 feet 6 inches above finished floor (mechanical rooms, janitor closets, etc)).

B. Temperature Ratings: In accordance with NFPA 13, except as follows:

1. Sprinklers in elevator shafts, elevator pits, and elevator machine rooms: Intermediate temperature rated.

2. Sprinklers in Generator Rooms: High temperature rated.

### **2.4 SPRINKLER CABINET**

Provide sprinkler cabinet with the required number of sprinkler heads of all ratings and types installed, and a sprinkler wrench for each system. Locate adjacent to the riser. Sprinkler heads shall be installed in center of tile or center to center.

## **2.5 IDENTIFICATION SIGNS/HYDRAULIC PLACARDS**

Plastic, steel or aluminum signs with white lettering on a red background with holes for easy attachment. Enter pertinent data for each system on the hydraulic placard.

## **2.6 SWITCHES:**

- A. Contain in a weatherproof die cast/red baked enamel, oil resistant, aluminum housing with tamper resistant screws, 13 mm (1/2 inch) conduit entrance and necessary facilities for attachment to the valves. Provide two SPDT switches rated at 2.5 amps at 24 VDC.
- B. Valve Supervisory Switches for Ball and Butterfly Valves: May be integral with the valve.

## **2.7 GAUGES**

Provide gauges as required by NFPA 13.

## **2.8 PIPE HANGERS AND SUPPORTS**

Supports, hangers, etc., of an approved pattern placement to conform to NFPA 13. System piping shall be substantially supported to the building structure. The installation of hangers and supports shall adhere to the requirements set forth in NFPA 13, Standard for Installation of Sprinkler Systems. Materials used in the installation or construction of hangers and supports shall be listed and approved for such application. Hangers or supports not specifically listed for service shall be designed and bear the seal of a professional engineer.

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

Provide chrome plated steel escutcheon plates for exposed piping passing through walls, floors or ceilings.

# **PART 3 - EXECUTION**

## **3.1 INSTALLATION**

- A. Installation shall be accomplished by the licensed contractor. Provide a qualified technician, experienced in the installation and operation of the type of system being installed, to supervise the installation and testing of the system.
- B. Installation of Piping: Accurately cut pipe to measurements established by the installer and work into place without springing or forcing. In any situation where bending of the pipe is required, use a standard pipe-bending template. Install concealed piping in spaces that have finished ceilings. Where ceiling mounted equipment exists, such as in operating and radiology rooms, install sprinklers so as not to obstruct the movement or operation of the equipment. Sidewall heads may need to be utilized. Locate piping in stairways as near to the ceiling as possible to prevent tampering by unauthorized personnel, and to provide

a minimum headroom clearance of 2250 mm (seven feet six inches). To prevent an obstruction to egress, provide piping clearances in accordance with NFPA 101.

- C. Welding: Conform to the requirements and recommendations of NFPA 13.
- D. Drains: Pipe drains to discharge at safe points outside of the building or to sight cones attached to drains of adequate size to readily carry the full flow from each drain under maximum pressure. Do not provide a direct drain connection to sewer system or discharge into sinks. Install drips and drains where necessary and required by NFPA 13.
- E. Supervisory Switches: Provide supervisory switches for sprinkler control valves.
- F. Affix cutout disks, which are created by cutting holes in the walls of pipe for flow switches and non-threaded pipe connections to the respective waterflow switch or pipe connection near to the pipe from where they were cut.
- G. Sleeves: Provide for pipes passing through masonry or concrete. Provide space between the pipe and the sleeve in accordance with NFPA 13. Seal this space with a UL Listed through penetration fire stop material in accordance with Section 07 84 00, FIRESTOPPING. Where core drilling is used in lieu of sleeves, also seal space. Seal penetrations of walls, floors and ceilings of other types of construction, in accordance with Section 07 84 00, FIRESTOPPING.
- H. Provide pressure gauge at each water flow alarm switch location and at each main drain connection.
- I. For each fire department connection, provide the symbolic sign given in NFPA 170 and locate 2400 to 3000 mm (8 to 10 feet) above each connection location. Size the sign to 450 by 450 mm (18 by 18 inches) with the symbol being at least 350 by 350 mm (14 by 14 inches).
- J. Firestopping shall comply with Section 07 84 00, FIRESTOPPING.
- K. Securely attach identification signs to control valves, drain valves, and test valves. Locate hydraulic placard information signs at each sectional control valve where there is a zone water flow switch.
- L. Repairs: Repair damage to the building or equipment resulting from the installation of the sprinkler system by the installer at no additional expense to the Government.
- M. Interruption of Service: There shall be no interruption of the existing sprinkler protection, water, electric, or fire alarm services without prior permission of the Contracting Officer. Contractor shall develop an interim fire protection program where interruptions involve in occupied

spaces. Request in writing at least one week prior to the planned interruption.

### 3.2 INSPECTION AND TEST

- A. Preliminary Testing: Flush newly installed systems prior to performing hydrostatic tests in order to remove any debris which may have been left as well as ensuring piping is unobstructed. Hydrostatically test system, including the fire department connections, as specified in NFPA 13, in the presence of the Contracting Officers Technical Representative (COTR) or his designated representative. Test and flush underground water line prior to performing these hydrostatic tests.
- B. Final Inspection and Testing: Subject system to tests in accordance with NFPA 13, and when all necessary corrections have been accomplished, advise COTR/Resident Engineer to schedule a final inspection and test. Connection to the fire alarm system shall have been in service for at least ten days prior to the final inspection, with adjustments made to prevent false alarms. Furnish all instruments, labor and materials required for the tests and provide the services of the installation foreman or other competent representative of the installer to perform the tests. Correct deficiencies and retest system as necessary, prior to the final acceptance. Include the operation of all features of the systems under normal operations in test.

### 3.3 INSTRUCTIONS

Furnish the services of a competent instructor for not less than two hours for instructing personnel in the operation and maintenance of the system, on the dates requested by the COTR/Resident Engineer.

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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 07 84 00, FIRESTOPPING.
- D. Section 07 60 00, FLASHING AND SHEET METAL: Flashing for Wall and Roof Penetrations.
- E. Section 07 92 00, JOINT SEALANTS.
- F. Section 09 91 00, PAINTING.
- G. Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.
- H. Section 23 07 11, HVAC, PLUMBING, AND BOILER PLANT INSULATION.
- I. Section 23 09 23, DIRECT DIGITAL CONTROLS FOR HVAC.

**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.
  - 3. Fire stopping materials.
  - 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. Interstitial space.

3. Hangers, inserts, supports, and bracing.
4. Pipe sleeves.
5. 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. The interior of all tanks shall be cleaned prior to delivery and beneficial use by the Government. All piping shall be tested in

accordance with the specifications and the International Plumbing Code (IPC), latest edition. All filters, strainers, fixture faucets shall be flushed of debris prior to final acceptance.

4. 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 of Mechanical Engineers (ASME):

Boiler and Pressure Vessel Code (BPVC):

SEC IX-2007.....Boiler and Pressure Vessel Code; Section IX,  
Welding and Brazing Qualifications.

C. 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

D. 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

E. National Electrical Manufacturers Association (NEMA):

MG1-2003, Rev. 1-2007...Motors and Generators

C. International Code Council, (ICC):

IBC-06, (R 2007).....International Building Code

IPC-06, (R 2007).....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 LIFTING ATTACHMENTS**

Equipment shall be provided 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.

## 2.5 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.

## 2.8 FIRE STOPPING

- A. Section 07 84 00, FIRESTOPPING specifies an effective barrier against the spread of fire, smoke and gases where penetrations occur for piping. Refer to Section 23 07 11, HVAC, PLUMBING, AND BOILER PLANT INSULATION, for pipe insulation.

## 2.9 GALVANIZED REPAIR COMPOUND

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

## 2.10 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. Submittals based on the International Building Code (IBC), latest edition 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.
- 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. For Attachment to Wood Construction: Wood screws or lag bolts.
- 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.

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.

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.
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.
- I. 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 cold water shall have insulation that extends a minimum of one inch past the sheet metal.
    - b. The insulated calcium silicate shield shall support the maximum allowable water filled span as indicated in MSS-SP 69. To support the load, the shields shall 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.

## **2.11 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.

## **2.12 TOOLS AND LUBRICANTS**

- A. Furnish, and turn over to the Resident Engineer, special 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. Tool Containers: metal, permanently identified for intended service and mounted, or located, where directed by the Resident Engineer.
- D. Lubricants: A minimum of 0.95 L (1 quart) of oil, and 0.45 kg (1 pound) of grease, of equipment manufacturer's recommended grade and type, in unopened containers and properly identified as to use for each different application.

## **2.13 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.

## **2.14 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.
  - 3. Waterproof membrane shall not be penetrated. Pipe floor penetration block outs shall be provided outside the extents of the waterproof membrane.
- 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. Concrete and Grout: Concrete and shrink compensating grout 25 MPa (3000 psi) minimum shall be used for all pad or floor mounted equipment. Gages, thermometers, valves and other devices shall be installed with due regard for ease in reading or operating and maintaining said devices. Thermometers and gages shall be located and positioned to be easily read by operator or staff standing on floor or walkway provided. Servicing shall not require dismantling adjacent equipment or pipe work.
- J. 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.
- K. 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
- 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 cause the least interfere with normal operation of the facility.
- M. Work in Animal Research Areas: Seal all pipe penetrations with silicone sealant to prevent entrance of insects.

- N. Work in bathrooms, restrooms, housekeeping closets: All pipe penetrations behind escutcheons shall be sealed with plumbers putty.
- O. Switchgear 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.
- P. 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:

1. Provide concrete bases, concrete anchor blocks and pedestals, and structural steel systems for support of equipment and piping. Concrete bases and structural systems shall be anchored and doweled to resist forces under operating and seismic conditions (if applicable) without excessive displacement or structural failure.
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.

**3.5 LUBRICATION**

- A. All equipment and devices requiring lubrication shall be lubricated prior to initial operation. All devices and equipment shall be field checked for proper lubrication.
- B. All devices and equipment shall be equipped with required lubrication fittings. 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 shall be provided. All materials shall be delivered to RE/COTR in unopened containers that are properly identified as to application.
- C. A separate grease gun with attachments for applicable fittings shall be provided for each type of grease applied.
- D. All lubrication points shall be accessible without disassembling equipment, except to remove access plates.
- E. All lubrication points shall be extended to one side of the equipment.

**3.6 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.

### 3.7 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. 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 gages and thermometers.
    - j. Glass.
    - k. 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.

### 3.8 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.

### **3.9 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.

### **3.10 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 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.

### **3.11 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.

**3.12 INSTRUCTIONS TO VA PERSONNEL**

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

- - - 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.
  4. 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 1012-02.....Backflow Preventer with Intermediate Atmospheric Vent  
ASSE 1013-05.....Reduced Pressure Principle Backflow Preventers and Reduced Pressure Fire Protection Principle Backflow Preventers
- D. International Code Council (ICC)  
IPC-06 (R 2007).....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-70-06.....Cast Iron Gate Valves, Flanged and Threaded  
Ends.  
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
  - 5. Set butterfly valves closed or slightly open.
  - 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.
- C. Valves in insulated piping shall have 50 mm or DN50 (2 inch) stem extensions and extended handles of non-thermal conductive material that allows operating the valve without breaking the vapor seal or disturbing the insulation. Memory stops shall be fully adjustable after insulation is applied.
- D. Exposed Valves over 65 mm or DN65 (2-1/2 inches) installed at an elevation over 3.6 meters (12 feet) shall have a chain-wheel attachment to valve hand-wheel, stem, or other actuator.

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, Hot and Re-circulating Hot Water:

- a. 50 mm or DN50 (2 inches) and smaller: Ball, MSS SP-72, SP-110, Ball valve shall be 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,
- b. Greater than 2 inches, but less than 4 inches: Butterfly shall have an iron body with EPDM seal and aluminum bronze disc. The butterfly valve shall meet MSS SP-67, type I standard. The butterfly valve shall have a SWP rating of 1380 kPa (200 psig). The valve design shall be lug type suitable for bidirectional dead-end service at rated pressure. The body material shall meet ASTM A 536, ductile iron.

G. Balancing:

1. Hot Water Re-circulating, 80 mm or DN80 (3 inches) and smaller manual balancing valve shall be of bronze body, brass ball construction with glass and carbon filled TFE seat rings and designed for positive shutoff. The manual balancing valve shall have differential pressure read-out ports across the valve seat area. The read out ports shall be fitting with internal EPT inserts and check valves. The valve body shall have 8 mm or DN8 NPT (¼" NPT) tapped drain and purge port. The valves shall have memory stops that allow the valve to close for service and then reopened to set point without disturbing the balance position. All valves shall have calibrated nameplates to assure specific valve settings.
2. Larger than 80 mm or DN80 (3 inches): Manual balancing valves shall be of heavy duty cast iron flanged construction with 862 kPa (125 psi) flange connections. The flanged manual balancing valves shall have either a brass ball with glass and carbon filled TFE seal rings or fitted with a bronze seat, replaceable bronze disc with EPDM seal

insert and stainless steel stem. The design pressure shall be 1207 kPa (175) at 121 deg C (250 deg F).

H. 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.
2. Larger than 100 mm or DN100 (4 inches and larger):
  - a. Check valves shall be class 125, iron swing check valve with lever and weight closure control. The check valve shall meet MSS SP-71 Type I standard. The check valve shall have a CWP rating of 1380 kPa (200 psig). The check valve shall have a clear or full waterway body design with gray iron body material conforming to ASTM A 126, bolted bonnet, flanged ends, bronze trim.
  - b. All check valves on the discharge side of submersible sump pumps shall have factory installed exterior level and weight with sufficient weight to prevent the check valve from hammering against the seat when the sump pump stops.

I. 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, TPTFE or TFE disc, malleable iron hand wheel.
2. Larger than 80 mm or DN80 (3 inches): Similar to above, except with cast iron body and bronze trim, class 125, iron globe valve. The globe valve shall meet MSS SP-85, Type 1 standard. The globe valve shall have a CWP rating of 1380 kPa (200 psig). The valve material shall be gray iron with bolted bonnet conforming to ASTM A 126 with flanged ends, bronze trim, malleable iron handwheel.

## 2.2 WATER PRESSURE REDUCING VALVE AND CONNECTIONS

- A. 80 mm or DN80 (3 inches) or smaller: The pressure reducing valve shall consist of a bronze body and bell housing, a separate access cover for the plunger, and a bolt to adjust the downstream pressure. The bronze bell housing and access cap shall be threaded to the body and shall not require the use of ferrous screws. The assembly shall be of the balanced piston design and shall reduce pressure in both flow and no flow conditions. The assembly shall be accessible for maintenance without having to remove the body from the line.
- B. The regulator shall have a tap for pressure gauge.
- C. The regulator shall have a temperature rating of 100° C (210° F) for hot water or hot water return service. Pressure regulators shall have accurate pressure regulation to 6.9-kPa (+/- 1 psig).
- D. Setting: Entering water pressure, discharge pressure, capacity, size, and related measurements shall be as shown on the drawings.
- E. Connections Valves and Strainers: shut off valves shall be installed on each side of reducing valve and a bypass line equal in size to the regulator inlet pipe shall be installed with a normally closed globe valve. A strainer shall be installed on inlet side of, and same size as pressure reducing valve. A pressure gage shall be installed on the low pressure side of the line.

## 2.3 BACKFLOW PREVENTERS

- A. A backflow prevention assembly shall be installed at any point in the plumbing system where the potable water supply comes in contact with a potential source of contamination. The backflow prevention assembly shall be ASSE 1013 listed and certified.
- B. Reduced pressure backflow preventers shall be installed in the following applications.
  - 1. Water make up to heating systems, condenser water system, chilled water system, and similar equipment consuming water.
  - 2. Atmospheric Vacuum Breaker: ASSE 1001
    - a. Hose bibs.
- C. The reduced pressure principle backflow prevention assembly shall be ASSE listed 1013 with full port OS&Y gate valves and an integral relief monitor switch. The main body and access cover shall be epoxy coated duct iron conforming to ASTM A536 grade 4. The seat ring and check valve shall be Noryl (NSF listed). The stem shall be stainless steel

conforming to ASTM A276. The seat disc elastomer shall be EPDM. The checks and the relief valve shall be accessible for maintenance without removing the device from the line. An epoxy coated wye type strainer with flanged connections shall be installed on the inlet.

- D. The atmospheric vacuum breaker shall be ASSE listed 1001. The main body shall be either cast bronze. All internal polymers shall be NSF listed. The seat disc elastomer shall be silicone. The device shall be accessible for maintenance without removing the device from the service line. The installation shall not be in a concealed or inaccessible location or where the venting of water from the device during normal operation is deemed objectionable.
- E. The double check detector backflow prevention assembly shall be ASSE listed 1048 and supply with full port OS&Y gate valves. The main body and access cover shall be epoxy coated ductile iron conforming to ASTM A536 grade. The seat ring and check valve shall be Noryl (NSF listed). The stem shall be stainless steel conforming to ASTM A 276. The seat disc elastomers shall be EPDM. The first and second check valve shall be accessible for maintenance without removing the device from the line.

## **2.5 CHAINWHEELS**

- A. Valve chain wheel assembly with sprocket rim brackets and chain shall be constructed according to the following:
1. Brackets: type, number, size, and fasteners required to mount actuator on valve.
  2. Attachment: For connection to valve stem.
  3. Sprocket rim with chain guides: ductile or cast iron of type and size required for valve with zinc coating.
  4. Chain: hot dipped galvanized steel of size required to fit sprocket rim.

## **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. Mating flange faces shall be examined for conditions that might cause leakage. Bolting shall be checked for proper size, length, and material. Gaskets shall be verified for proper size and that its material composition is suitable for service and free from defects and damage.
- E. Do not attempt to repair defective valves; replace with new valves.

### 3.2 VALVE INSTALLATION

- A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- B. 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.
- E. Install chain wheels on operators for ball, butterfly, gate, and globe valves NPS 100 mm or DN100 (4 inches) and larger and more than 10 feet above floor. Chains shall be extended to 60 inches above finished floor.
- F. 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.

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

**PART 1 - GENERAL**

**1.1 RELATED DOCUMENTS**

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

**1.2 SUMMARY**

- A. Section refers contractors to commissioning process requirements for plumbing systems, assemblies, and equipment found in related division 01 sections.
- B. Related Sections:
  - 1. Division 01 Section 019113 "Commissioning Requirements" for definitions, roles and responsibilities, and process requirements for all systems to be commissioned.

**1.3 DESCRIPTION**

- A. Commissioning is a systematic process of ensuring that all building systems perform interactively according to the design intent and the owner's operational needs. This is achieved by beginning in the design phase and documenting design intent and continuing through construction, acceptance and the warranty period with actual verification of performance. The commissioning process shall encompass and coordinate the traditionally separate functions of system documentation, equipment startup, control system calibration, testing and balancing, performance testing and training. Commissioning during the construction phase is intended to achieve the following specific objectives according to the Contract Documents:
  - 1. Verify that applicable equipment and systems are installed according to the manufacturer's recommendations and to industry accepted minimum standards and that they receive adequate operational checkout by installing contractors.
  - 2. Verify and document proper performance of equipment and systems.
  - 3. Verify that the Owner's operating personnel are adequately trained.
- B. The commissioning process does not take away from or reduce the responsibility of the system designers or installing contractors to provide a finished and fully functioning product.

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

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

---END---

SECTION 22 11 00  
FACILITY WATER DISTRIBUTION

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

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

**1.2 RELATED WORK**

- A. Penetrations in rated enclosures: Section 07 84 00, FIRESTOPPING.
- B. Preparation and finish painting and identification of piping systems: Section 09 91 00, PAINTING.
- C. Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING.
- D. Pipe Insulation: Section 23 07 11, HVAC, PLUMBING, AND BOILER PLANT INSULATION.

**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. Strainers.
  - 3. 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. Federal Specifications (Fed. Spec.):
  - A-A-1427C.....Sodium Hypochlorite Solution
  - A-A-59617.....Unions, Brass or Bronze Threaded, Pipe Connections and Solder-Joint Tube Connections
- C. American National Standards Institute (ANSI):
  - American Society of Mechanical Engineers (ASME): (Copyrighted Society)
  - A13.1-96.....Scheme for Identification of Piping Systems
  - B16.3-98.....Malleable Iron Threaded Fittings ANSI/ASME
  - B16.4-98.....Cast Iron Threaded Fittings Classes 125 and 250 ANSI/ASME
  - B16.9-01.....Factory-Made Wrought Steel Buttwelding Fittings ANSI/ASME

B16.11-01.....Forged Steel Fittings, Socket-Welding and  
Threaded ANSI/ASME

B16.12-98.....Cast Iron Threaded Drainage Fittings ANSI/ASME

B16.15-85(R 1994).....Cast Bronze Threaded Fittings ANSI/ASME

B16.18-01.....Cast Copper Alloy Solder-Joint Pressure  
Fittings ANSI/ASME

B16.22-01.....Wrought Copper and Copper Alloy Solder Joint  
Pressure Fittings ANSI/ASME  
Element ANSI/ASME

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

A47-99.....Ferritic Malleable Iron Castings Revision 1989

A53-02.....Pipe, Steel, Black And Hot-Dipped, Zinc-coated  
Welded and Seamless

A74-03.....Cast Iron Soil Pipe and Fittings

A183-83(R1998).....Carbon Steel Track Bolts and Nuts

A312-03.....Seamless and Welded Austenitic Stainless Steel  
Pipe

A536-84(R1999) E1.....Ductile Iron Castings

A733-03.....Welded and Seamless Carbon Steel and Austenitic  
Stainless Steel Pipe Nipples

B32-03.....Solder Metal

B61-02.....Steam or Bronze Castings

B62-02.....Composition Bronze or Ounce Metal Castings

B75-99(Rev A).....Seamless Copper Tube

B88-03.....Seamless Copper Water Tube

B584-00.....Copper Alloy Sand Castings for General  
Applications Revision A

B687-99.....Brass, Copper, and Chromium-Plated Pipe Nipples

C564-03.....Rubber Gaskets for Cast Iron Soil Pipe and  
Fittings

D2000-01.....Rubber Products in Automotive Applications

D4101-03b Propylene Plastic Injection and Extrusion  
Materials

D2447-93.....Polyethylene (PE) Plastic Pipe, Schedule 40 and  
80, Based on Outside Diameter

D2564-94.....Solvent Cements for Poly (Vinyl Chloride) (PVC)  
Plastic Pipe and Fittings

- D2665-94 Revision A.....Poly (Vinyl Chloride) (PVC) Plastic Drain,  
Waste, and Vent Pipe and Fittings
- D4101-03b.....Propylene Plastic Injection and Extrusion  
Materials
- E1120.....Standard Specification For Liquid Chlorine
- E1229.....Standard Specification For Calcium Hypochlorite
- E. American Water Works Association (AWWA):
- C110-03/ A21.10-03.....Ductile Iron and Gray Iron Fittings - 75 mm  
thru 1200 mm (3 inch thru 48 inches) for Water  
and other liquids AWWA/ ANSI
- C151-00/ A21.51-02.....Ductile-Iron Pipe, Centrifugally Cast in Metal  
Molds or Sand-Lined Molds, for Water or Other  
Liquids AWWA/ ANSI
- C203-02.....Coal-Tar Protective Coatings and Linings for  
Steel Water Pipelines - Enamel and Tape - Hot  
Applied AWWA/ ANSI
- C651-99.....Disinfecting Water Mains
- F. American Welding Society (AWS):
- A5.8-92.....Filler Metals for Brazing
- G. National Association of Plumbing - Heating - Cooling Contractors  
(PHCC):
- National Standard Plumbing Code - 1996
- H. International Association of Plumbing and Mechanical Officials (IAPMO):
- Uniform Plumbing Code - 2000
- IS6-93.....Installation Standard
- I. Manufacturers Standardization Society of the Valve and Fittings  
Industry, Inc. (MSS):
- SP-72-99.....Ball Valves With Flanged or Butt Welding For  
General Purpose
- SP-110-96.....Ball Valve Threaded, Socket Welding, Solder  
Joint, Grooved and Flared Ends
- J. American Society of Sanitary Engineers (ASSE):
- 1001-02.....Pipe Applied Atmospheric Type Vacuum Breakers
- 1018-01.....Performance for trap seal primer valve-water  
supply fed
- 1020-04.....Vacuum Breakers, Anti-Siphon, Pressure Type
- K. Plumbing and Drainage Institute (PDI):

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

## **PART 2 - PRODUCTS**

### **2.1 INTERIOR DOMESTIC WATER PIPING**

- A. Pipe: Copper tube, ASTM B88, Type K or L, drawn. For pipe 150 mm (6 inches) and larger, stainless, steel ASTM A312, schedule 10 may be used.
- 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.
  - 2. Grooved fittings, 50 to 150 mm (2 to 6 inch) wrought copper ASTM B75 C12200, 125 to 150 mm (5 to 6 inch) bronze casting ASTM B584, CDA 844. Mechanical grooved couplings, ductile iron, ASTM A536 (Grade 65-45-12), or malleable iron, ASTM A47 (Grade 32510) housing, with EPDM gasket, steel track head bolts, ASTM A183, coated with copper colored alkyd enamel.
  - 3. Mechanically formed tee connection: 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. Braze joints.
- C. Fittings for Stainless Steel:
  - 1. Stainless steel butt-welded fittings, Type 316, Schedule 10, conforming to ANSI B16.9.
  - 2. Grooved fittings, stainless steel, Type 316, Schedule 10, conforming to ASTM A403. Segmentally fabricated fittings are not allowed. Mechanical grooved couplings, ductile iron, ASTM A536 (Grade 65-45-12), or Malleable iron, ASTM A47 (Grade 32510) housing, with EPDM gasket, steel track head bolts, ASTM A183, coated with copper colored alkyd enamel.
- 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.

## 2.2 EXPOSED WATER PIPING

- A. Finished Room: Use full iron pipe size chrome plated brass piping for exposed water 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. Pipe: Fed. Spec. WW-P-351, standard weight.
  - 2. Fittings: ANSI B16.15 cast bronze threaded fittings with chrome finish, (125 and 250).
  - 3. Nipples: ASTM B 687, Chromium-plated.
  - 4. Unions: Mss SP-72, SP-110, Brass or Bronze with chrome finish.  
Unions 65 mm (2-1/2 inches) and larger shall be flange type with approved gaskets.

## 2.3 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.

## 2.4 WATERPROOFING

- A. Provide at points where pipes pass through membrane waterproofed floors or walls in contact with earth.
- B. Floors: Provide cast iron stack sleeve with flashing device and a underdeck clamp. After stack is passed through sleeve, provide a waterproofed caulked joint at top hub.

## 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.

## 2.6 DIELECTRIC FITTINGS

Dielectric unions shall not be installed. Where dissimilar metals join, provide brass fitting.

## 2.7 STERILIZATION CHEMICALS

- A. Liquid Chlorine: ASTM E1120.
- B. Hypochlorite: ASTM E1229, or Fed. Spec. AA-1427C, grade B.

## **2.9 WATER HAMMER ARRESTER:**

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 Dow Corning No. 11 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). Unit shall be as manufactured by Precision Plumbing Products Inc., Watts, Sioux Chief or equal. Provide water hammer arrestors at all solenoid valves, at all groups of two or more flush valves, at all quick opening or closing valves, and at all medical washing equipment.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. General: Comply with the PHCC National Standard Plumbing Code and the following:
  - 1. Install branch piping for water from the piping system and connect to all fixtures, valves, cocks, outlets, casework, cabinets and equipment, 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 of the National Standard Plumbing Code, Chapter No. 8.
    - 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, 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) Rollers: Cast iron.
  - 9) Self-drilling type expansion shields shall be "Phillips" type, with case hardened steel expander plugs.
  - 10) 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.
  - 11) 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.
6. Install cast 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. Where possible, grade all lines to facilitate drainage. Provide drain valves at bottom of risers. All unnecessary traps in circulating lines shall be avoided.
- 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 equipment, 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. Special 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 either liquid chlorine or hypochlorite for sterilization.

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**SECTION 22 13 00**  
**FACILITY SANITARY SEWERAGE**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

Sanitary sewerage systems, including piping, equipment and all necessary accessories as designated in this section.

**1.2 RELATED WORK**

- A. Penetrations in rated enclosures: Section 07 84 00, FIRESTOPPING.
- B. Preparation and finish painting and identification of piping systems:  
Section 09 91 00, PAINTING.
- C. Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING.
- D. Pipe Insulation: Section 23 07 11, HVAC, PLUMBING, AND BOILER PLANT INSULATION.

**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. Cleanouts.
  - 3. 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 National Standards Institute (ANSI):
  - American Society of Mechanical Engineers (ASME): (Copyrighted Society)
  - A112.1.1M-91.....Floor Drains ANSI/ASME
  - A13.1-96.....Scheme for Identification of Piping Systems
  - B16.3-98.....Malleable Iron Threaded Fittings ANSI/ASME
  - B16.4-98.....Cast Iron Threaded Fittings Classes 125 and 250  
ANSI/ASME
  - B16.12-98.....Cast Iron Threaded Drainage Fittings ANSI/ASME
  - B16.15-85(R 1994).....Cast Bronze Threaded Fittings ANSI/ASME  
Element ANSI/ASME

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

A47-99.....Ferritic Malleable Iron Castings Revision 1989  
A53-02.....Pipe, Steel, Black And Hot-Dipped, Zinc-coated  
Welded and Seamless  
A74-03.....Cast Iron Soil Pipe and Fittings  
A183-83(R1998).....Carbon Steel Track Bolts and Nuts  
A536-84(R1999) E1.....Ductile Iron Castings  
B32-03.....Solder Metal  
B75-99(Rev A).....Seamless Copper Tube  
B306-02.....Copper Drainage Tube (DWV)  
B584-00.....Copper Alloy Sand Castings for General  
Applications Revision A  
C564-03.....Rubber Gaskets for Cast Iron Soil Pipe and  
Fittings  
D2000-01.....Rubber Products in Automotive Applications  
D2564-94.....Solvent Cements for Poly (Vinyl Chloride) (PVC)  
Plastic Pipe and Fittings  
D2665-94 Revision A.....Poly (Vinyl Chloride) (PVC) Plastic Drain,  
Waste, and Vent Pipe and Fittings

D. National Association of Plumbing - Heating - Cooling Contractors  
(PHCC):

National Standard Plumbing Code - 1996

E. Cast Iron Soil Pipe Institute (CISPI):

301-04.....Hubless Cast Iron Soil and Fittings

F. International Association of Plumbing and Mechanical Officials (IAPMO):  
Uniform Plumbing Code - 2000

IS6-93.....Installation Standard

G. American Society of Sanitary Engineers (ASSE):

1018-01.....Performance for trap seal primer valve-water  
supply fed

H. Factory Mutual (FM):

a. Coupling Used in Hubless Cast Iron Systems for Drains, Waste and  
Vent Systems.

I. Plumbing and Drainage Institute (PDI):

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

**PART 2 - PRODUCTS**

**2.1 SANITARY PIPING**

- A. Cast Iron Soil Pipe and Fittings: Used for pipe buried in or in contact with earth and for extension of pipe to a distance of approximately 1500 mm (5 feet) outside of building walls and interior waste and vent piping above grade. Pipe shall be bell and spigot, modified hub, or plain end (no-hub) as required by selected jointing method:
1. Material, (Pipe and Fittings): ASTM A74, C1SP1-301, Service Class.
  2. Joints: Provide any one of the following types to suit pipe furnished.
    - a. Lead and oakum and caulked by hand.
    - b. Double seal, compression-type molded neoprene gasket. Gaskets shall suit class of pipe being jointed.
    - c. Mechanical: Heavy-duty coupling band. Sealing clamps shall be torqued to a minimum of 80 in-lbs and have bands of 305 stainless steel with 3/8" hex head/shoulder screws.
    - d. Mechanical Grooved Couplings: Shall consist of ductile iron (ASTM A536, Grade 65-45-12), or malleable iron (ASTM A47, Grade 32510) housings, a pressure responsive elastomeric gasket (ASTM D2000), and steel track head bolts. Shall be for use on pipe and fittings grooved to the manufacturer's specifications. Couplings and fittings to be of the same manufacturer.
    - e. Adapters: Where service weight pipe is connected to extra heavy pipe and extra heavy fittings of chair carriers, provide adapters or similar system to make tight, leak proof joints.

**2.2 EXPOSED WASTE PIPING**

- A. Finished Room: Use full iron pipe size chrome plated brass piping 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. Pipe: Fed. Spec. WW-P-351, standard weight.
  2. Fittings: ANSI B16.15 cast bronze threaded fittings with chrome finish, (125 and 250).
  3. Nipples: ASTM B 687, Chromium-plated.
  4. Unions: Brass or Bronze with chrome finish. Unions 65 mm (2-1/2 inches) and larger shall be flange type with approved gaskets.

- B. Unfinished Rooms, Mechanical Rooms and Kitchens: Chrome-plated brass piping is not required. Paint piping systems as specified in Section 09 91 00, PAINTING.

## **2.3 CLEANOUTS**

- A. Same size as the pipe, up to 100 mm (4 inches); not less than 100 mm (4 inches) for larger pipe. Cleanouts shall be easily accessible and shall be gastight and watertight. Provide a minimum clearance of 600 mm (24 inches) for the rodding.
- B. In Floors: Floor cleanouts shall have cast iron body and frame with square adjustable scoriated secured nickel bronze top. Unit shall be vertically adjustable for a minimum of 50 mm (2 inches). When a waterproof membrane is used in the floor system, provide clamping collars on the cleanouts. Cleanouts shall consist of "Y" fittings and 3 mm (1/8 inch) bends with brass or bronze screw plugs. Cleanouts in the resilient tile floors, quarry tile and ceramic tile floors shall be provided with square top covers recessed for tile insertion. In the carpeted areas, provide carpet cleanout markers. Provide two way cleanouts where indicated on drawings.
- C. Provide cleanouts 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. Extend the cleanouts to the wall access cover. Cleanout shall consist of sanitary tees. Furnish nickel-bronze square frame and stainless steel cover with minimum opening of 150 by 150 mm (6 by 6 inches) at each wall cleanout. Where the piping is concealed, a fixture trap or a fixture with integral trap, readily removable without disturbing concealed roughing work, shall be accepted as a cleanout equivalent providing the opening to be used as a cleanout opening is the size required by the NPHCC National Standard Plumbing Code.
- D. In horizontal runs above grade, cleanouts shall consist of cast brass tapered screw plug in fitting or caulked/no hub cast iron ferrule. Plain end (no-hub) piping in interstitial space or above ceiling may use plain end (no-hub) blind plug and clamp.

## **2.4 FLOOR DRAINS**

- A. ANSI A112.21.1. Provide a caulking flange for connection to cast iron pipe, screwed or no hub outlets for connection to steel pipe, and side

outlet when shown. Provide membrane clamp and extensions 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, provide a 2.2 kg (16-ounce) soft copper membrane, 600 mm (24 inches) square.

- B. Type E: Heavy, cast iron body, double drainage pattern, heavy non-tilting ductile iron grate not less than 300 mm (12 inches) square, removable sediment bucket. Clearance between body and bucket shall be ample for free flow of waste water.

## **2.5 TRAPS**

Provide 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 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.

## **2.6 TRAP PRIMERS**

- A. Trap Primer (TP-1): Hydraulic.
  - 1. Fifteen millimeter (1/2 inch) Inlet/ fifteen millimeter (1/2 inch) Outlet fully automatic, all brass trap primer valve, activated by a drop in building water pressure, no adjustment required.

## **2.7 WATERPROOFING**

- A. Provide at points where pipes pass through membrane waterproofed floors or walls in contact with earth.
- B. Floors: Provide cast iron stack sleeve with flashing device and a underdeck clamp. After stack is passed through sleeve, provide a waterproofed caulked joint at top hub.
- C. Walls: See detail shown on drawings.

## **2.8 DIELECTRIC FITTINGS**

Dielectric fittings shall not be installed. Where dissimilar metals join, brass fittings shall be provided.

**PART 3 - EXECUTION**

**3.1 INSTALLATION**

A. General: Comply with the PHCC National Standard Plumbing Code and the following:

1. Install branch piping 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.
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 valves with stem in horizontal position whenever possible. All valves shall be easily accessible. Install valve in each water connection to fixture.
5. All gravity waste drain lines inside the building with vertical drops over 6 m (20 feet) shall be provided with joint restraint on the vertical drop and horizontal offset or branch below the vertical drop. Joint restraint shall be accomplished by threaded, soldered, lead and oakum or grooved joints or a combination of pipe clamps and tie-rods as detailed in NFPA 24. Vertical joint restraint shall be provided from the fitting at the bottom of the vertical drop through every joint up to the riser clamp at the floor penetration of the floor above. Horizontal joint restraint shall be provided from the same fitting at the bottom of the vertical drop through every joint on the horizontal offset or branch for a minimum of 18 m (60 feet) or to anchoring point from the building structure. Joint restraint below ground shall be accomplished by thrust blocks detailed in NFPA 24.
6. Pipe Hangers, Supports and Accessories:
  - a. All piping shall be supported per of the National Standard Plumbing Code, Chapter No. 8.
  - 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, 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) Rollers: Cast iron.
  - 9) Self-drilling type expansion shields shall be "Phillips" type, with case hardened steel expander plugs.
  - 10) 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.
  - 11) 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.
7. Install cast escutcheon with set screw at each wall, floor and ceiling penetration in exposed finished locations and within cabinets and millwork.
8. 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. Waste and Vent Drain to main stacks:

Pipe Size	Minimum Pitch
80 mm (3 inches) and smaller	1 : 50 (1/4" to the foot).
80 mm (4 inches) and larger	1 : 100 (1/8" to the foot).

### 3.2 TESTS

- A. General: Test system either in its entirety or in sections.
- B. Waste Systems: Conduct before trenches are backfilled or fixtures are connected. Conduct water test or air test, as directed.
  1. Water Test: If entire system is tested, tightly close all openings in pipes except highest opening, and fill system with water to point of overflow. If 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. Keep water in system, or in portion under test, for at least 15 minutes before inspection starts. System shall then be tight at all joints.
  2. Air Test: Maintain air pressure of 35 kPa (5 psi) gage for at least 15 minutes without leakage. Use force pump and mercury column gage.
  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 (one inch of water) with a smoke machine. Chemical smoke is prohibited.
    - b. Peppermint Test: Introduce (two ounces) of peppermint into each line or stack.

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**SECTION 22 14 00  
FACILITY STORM DRAINAGE**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

Storm drainage systems, including piping and all necessary accessories as designated in this section.

**1.2 RELATED WORK**

- A. Penetrations in rated enclosures: Section 07 84 00, FIRESTOPPING.
- B. Preparation and finish painting and identification of piping systems: Section 09 91 00, PAINTING.
- C. Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING.
- D. Pipe Insulation: Section 23 07 11, HVAC, PLUMBING, AND BOILER PLANT INSULATION.

**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. Roof Drains.
  - 3. Cleanouts.
  - 4. All items listed in Part 2 - Products.
- C. Detailed shop drawing of clamping device and extensions when required in connection with the waterproofing membrane.

**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. Federal Specifications (Fed. Spec.):
  - A-A-59617.....Unions, Brass or Bronze Threaded, Pipe Connections and Solder-Joint Tube Connections
- C. American National Standards Institute (ANSI):
  - American Society of Mechanical Engineers (ASME): (Copyrighted Society)
  - A13.1-96.....Scheme for Identification of Piping Systems
  - B16.3-98.....Malleable Iron Threaded Fittings ANSI/ASME
  - B16.9-01.....Factory-Made Wrought Steel Buttwelding Fittings ANSI/ASME

- B16.11-01.....Forged Steel Fittings, Socket-Welding and  
Threaded ANSI/ASME
- B16.12-98.....Cast Iron Threaded Drainage Fittings ANSI/ASME
- B16.15-85(R 1994).....Cast Bronze Threaded Fittings ANSI/ASME
- B16.18-01.....Cast Copper Alloy Solder-Joint Pressure  
Fittings ANSI/ASME
- B16.22-01.....Wrought Copper and Copper Alloy Solder Joint  
Pressure Fittings ANSI/ASME
- D. American Society for Testing and Materials (ASTM):
- A47-99.....Ferritic Malleable Iron Castings Revision 1989
- A53-02.....Pipe, Steel, Black And Hot-Dipped, Zinc-coated  
Welded and Seamless
- A74-03.....Cast Iron Soil Pipe and Fittings
- A183-83(R1998).....Carbon Steel Track Bolts and Nuts
- A312-03.....Seamless and Welded Austenitic Stainless Steel  
Pipe
- A536-84(R1999) E1.....Ductile Iron Castings
- A733-03.....Welded and Seamless Carbon Steel and Austenitic  
Stainless Steel Pipe Nipples
- B32-03.....Solder Metal
- B61-02.....Steam or Bronze Castings
- B62-02.....Composition Bronze or Ounce Metal Castings
- B75-99(Rev A).....Seamless Copper Tube
- B88-03.....Seamless Copper Water Tube
- B306-02.....Copper Drainage Tube (DWV)
- B584-00.....Copper Alloy Sand Castings for General  
Applications Revision A
- B687-99.....Brass, Copper, and Chromium-Plated Pipe Nipples
- C564-03.....Rubber Gaskets for Cast Iron Soil Pipe and  
Fittings
- D2000-01.....Rubber Products in Automotive Applications
- D4101-03b Propylene Plastic Injection and Extrusion  
Materials
- D2447-93.....Polyethylene (PE) Plastic Pipe, Schedule 40 and  
80, Based on Outside Diameter
- D2564-94.....Solvent Cements for Poly (Vinyl Chloride) (PVC)  
Plastic Pipe and Fittings

D2665-94 Revision A.....Poly (Vinyl Chloride) (PVC) Plastic Drain,  
Waste, and Vent Pipe and Fittings

D4101-03b.....Propylene Plastic Injection and Extrusion  
Materials

E. American Welding Society (AWS):

A5.8-92.....Filler Metals for Brazing

F. National Association of Plumbing - Heating - Cooling Contractors  
(PHCC):

National Standard Plumbing Code - 1996

G. Cast Iron Soil Pipe Institute (CISPI):

301-04.....Hubless Cast Iron Soil and Fittings

H. International Association of Plumbing and Mechanical Officials (IAPMO):  
Uniform Plumbing Code - 2000

IS6-93.....Installation Standard

I. Manufacturers Standardization Society of the Valve and Fittings  
Industry, Inc. (MSS):

SP-72-99.....Ball Valves With Flanged or Butt Welding For  
General Purpose

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

J. Factory Mutual (FM):

a. Coupling Used in Hubless Cast Iron Systems for Drains, Waste and  
Vent Systems.

**PART 2 - PRODUCTS**

**2.1 STORM WATER DRAIN AND VENT PIPING**

A. Cast Iron Soil Pipe and Fittings: Used for pipe buried in or in contact  
with earth and for extension of pipe to a distance of approximately  
1500 mm (5 feet) outside of building walls and interior waste and vent  
piping above grade. Pipe shall be bell and spigot for buried pipe, or  
plain end (no-hub) for interior pipe:

1. Material, (Pipe and Fittings): ASTM A74, C1SP1-301, Service Class.

2. Joints: Provide any one of the following types to suit pipe  
furnished.

a. Lead and oakum and caulked by hand.

b. Double seal, compression-type molded neoprene gasket. Gaskets  
shall suit class of pipe being jointed.

- c. Mechanical: Meet the requirements and criteria for pressure, leak, deflection and shear tests as outlined in Factory Mutual No. 1680 for Class 1 couplings.
    - 1) Heavy duty coupling (husky). Sealing clamps shall be torqued to a minimum 80in-lbf and have 308 stainless steel bands with 3/8 inch hex-head shoulder screws.
  - d. Adapters: Where service weight pipe is connected to extra heavy pipe and extra heavy fittings of chair carriers, provide adapters or similar system to make tight, leakproof joints.
- B. Polyvinyl Chloride (PVC): Schedule 40. Shall not be used where waste temperature may exceed 60°C (140°F), such as mechanical equipment rooms, SPD, and sterilizer areas. PVC shall not be used in waste risers due to higher noise than other specified material.
- 1. Pipe: Shall be manufactured from Type I normal impact resins in conformance with ASTM D2665 and ASTM B16.12.
  - 2. Fittings:
    - a. Solvent Welded Socket Type: Use solvent cement, ASTM D2564.
    - b. Threaded Type: Molded threads only. Use tape or lubricant specifically intended for use with PVC plastic pipe.

## 2.2 CLEANOUTS

- A. Same size as the pipe, up to 100 mm (4 inches); not less than 100 mm (4 inches) for larger pipe. Cleanouts for chemical waste drain pipe shall be of same material as the pipe. Cleanouts shall be easily accessible and shall be gastight and watertight. Provide a minimum clearance of 600 mm (24 inches) for the rodding.
- B. In Floors: Floor cleanouts shall have cast iron body and frame with square adjustable scoriated secured nickel bronze top. Unit shall be vertically adjustable for a minimum of 50 mm (2 inches). When a waterproof membrane is used in the floor system, provide clamping collars on the cleanouts. Cleanouts shall consist of "Y" fittings and 3 mm (1/8 inch) bends with brass or bronze screw plugs. Cleanouts in the resilient tile floors, quarry tile and ceramic tile floors shall be provided with square top covers recessed for tile insertion. In the carpeted areas, provide carpet cleanout markers. Provide two way cleanouts where indicated on drawings.
- C. Provide cleanouts 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. Extend the cleanouts to the wall access cover. Cleanout shall consist of sanitary tees. Furnish nickel-bronze square frame and stainless steel cover with minimum opening of 150 by 150 mm (6 by 6 inches) at each wall cleanout. Where the piping is concealed, a fixture trap or a fixture with integral trap, readily removable without disturbing concealed roughing work, shall be accepted as a cleanout equivalent providing the opening to be used as a cleanout opening is the size required by the NPHCC National Standard Plumbing Code.

- D. In horizontal runs above grade, cleanouts shall consist of cast brass tapered screw plug in fitting or caulked/no hub cast iron ferrule. Plain end (no-hub) piping in interstitial space or above ceiling may use plain end (no-hub) blind plug and clamp.

### **2.3 ROOF DRAINS AND CONNECTIONS**

- A. Roof Drains: Cast iron with clamping device for making watertight connection. Free openings through strainer shall be twice area of drain outlet. For roof drains not installed in connection with a waterproof membrane, provide a soft copper membrane 300 mm (12 inches) in diameter greater than outside diameter of drain collar. Provide an integral gravel stop for drains installed on roofs having built-up roofing covered with gravel or slag. Provide integral no-hub, soil pipe gasket or threaded outlet connection.

1. Flat Roofs: Beehive or dome shaped strainer with integral flange not less than 300 mm (12 inches) in diameter. For insulated roofs, provide a roof drain with an adjustable drainage collar, which can be raised or lowered to meet required insulation heights, sump receiver and deck clamp. Bottom section shall serve as roof drain during construction before insulation is installed.
2. Protective Roof Membrane Insulation Assembly: Perforated stainless steel extension filter, non-puncturing clamp ring, large sump with extra wide roof flange and deck clamp.
  - a. Non-pedestrian Roofs: Large polypropylene or aluminum locking dome.
  - b. Pedestrian Roof: Bronze promenade top 350 mm (14 inches) square, set in square secured frame support collar.

- B. Expansion Joints: Heavy cast iron with cast brass or copper expansion sleeve having smooth bearing surface working freely against a packing ring held in place and under pressure of a bolted gland ring, forming a water and air tight flexible joint. Asbestos packing is prohibited.
- C. Interior Downspouts: Provide an expansion joint, specified above, at top of run on straight, vertical runs of downspout piping 12 m (40 feet) long or more.
- D. Downspout Nozzle: The nozzle fitting shall be of brass, unfinished, with internal pipe thread for connection to downspout.

## **2.4 WATERPROOFING**

- A. Provide at points where pipes pass through membrane waterproofed floors or walls in contact with earth.
- B. Floors: Provide cast iron stack sleeve with flashing device and a underdeck clamp. After stack is passed through sleeve, provide a waterproofed caulked joint at top hub.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. General: Comply with the PHCC National Standard Plumbing Code and the following:
  - 1. Install branch piping from the piping system and connect to all fixtures, valves, cocks, outlets, casework, cabinets and equipment, 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. All gravity waste drain lines inside the building with vertical drops over 6 m (20 feet) shall be provided with joint restraint on the vertical drop and horizontal offset or branch below the vertical drop. Joint restraint shall be accomplished by threaded, soldered, lead and oakum or grooved joints or a combination of pipe clamps and tie-rods as detailed in NFPA 24. Vertical joint restraint shall be

provided from the fitting at the bottom of the vertical drop through every joint up to the riser clamp at the floor penetration of the floor above. Horizontal joint restraint shall be provided from the same fitting at the bottom of the vertical drop through every joint on the horizontal offset or branch for a minimum of 18 m (60 feet) or to anchoring point from the building structure. Joint restraint below ground shall be accomplished by thrust blocks detailed in NFPA 24.

6. Pipe Hangers, Supports and Accessories:

- a. All piping shall be supported per of the National Standard Plumbing Code, Chapter No. 8.
- 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, 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) Rollers: Cast iron.
- 9) Self-drilling type expansion shields shall be "Phillips" type, with case hardened steel expander plugs.
- 10) 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.
- 11) 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.

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

8. 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. Storm Water Drain and Vent Drain to main stacks:

Pipe Size	Minimum Pitch
80 mm (3 inches) and smaller	1 : 50 (1/4" to the foot).
80 mm (4 inches) and larger	1 : 100 (1/8" to the foot).

2. Exhaust Vent: Extend separately through roof. Sanitary vents shall not connect to exhaust vents.

**3.2 TESTS**

- A. General: Test system either in its entirety or in sections.
- B. Storm Water Drain: Conduct before trenches are backfilled or fixtures are connected. Conduct water test or air test, as directed.
  1. Water Test: If entire system is tested, tightly close all openings in pipes except highest opening, and fill system with water to point of overflow. If 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. Keep water in system, or in portion under test, for at least 15 minutes before inspection starts. System shall then be tight at all joints.
2. Air Test: Maintain air pressure of 35 kPa (5 psi) gage for at least 15 minutes without leakage. Use force pump and mercury column gage.
  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 (one inch of water) with a smoke machine. Chemical smoke is prohibited.
    - b. Peppermint Test: Introduce (two ounces) of peppermint into each line or stack.

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**SECTION 22 31 11  
WATER SOFTENERS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION:**

Water softening piping services.

**1.2 RELATED WORK:**

- A. Preparation and finish painting: Section 09 91 00, PAINTING.
- B. 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. Accessories including pressure gages and test kit.
  - 2. Piping.
- C. Complete detailed layout, setting, arrangement, and installation drawings including electrical/pneumatic controls. Drawings shall also show all parts of the apparatus including relative positions, dimensions, and sizes and general arrangement of connecting piping.

**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. Federal Specifications (Fed. Spec.):
  - A-A-694D.....Sodium Chloride, Technical
- C. American Society of Mechanical Engineers (ASME):
  - B16.1-1998.....Cast Iron Pipe Flanges and Flanged Fittings
  - B16.3-1998.....Malleable-Iron Threaded Fittings
  - B40.100-1998.....Pressure Gages and Gage Attachments
  - Boiler and Pressure Vessel Code, Section VIII, Pressure Vessels, 2004
- D. ASTM International (ASTM):
  - A53/A53M-04b.....Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
  - D2665-04ae2.....Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Piping and Fittings.
- E. American Water Works Association (AWWA):
  - B300-04.....Hypochlorites
  - B301-04.....Liquid Chlorine

C651-99.....Disinfecting Water Mains

F. National Electrical Manufacturers Association (NEMA):

ICS-6-1993(R2001).....Industrial Control and Systems: Enclosures

G. Department of Health and Human Services, Food and Drug Administration  
(FDA):

CFR 21, Chapter 1, Part 173.25, Ion-Exchange Resins

CFR 21, Chapter 1, Part 175.300, Resinous and Polymeric Coatings

## **PART 2 - PRODUCTS**

### **2.1 EXTERNAL SOFTENER PIPING:**

A. Pipe: ASTM A53, galvanized, Schedule 40.

B. Fittings: Malleable iron, ASME B16.3, or coated cast iron, ASME B16.1,  
class 125.

A. Flanges: ASME B16.1, Class 125.

D. Threaded Joints: Shall be made with ends reamed out. Apply bituminous  
base lubricant or fluorocarbon resin tape to male threads only.

### **2.2 VALVES**

Ball: Carbon steel body, stainless steel trim, reinforced Teflon seat  
and seal, full port, threaded ends.

### **2.3 PRESSURE GAGES**

ASME B40.100, Grade A, 1% accuracy, 110 mm (4-1/2 inches) diameter, all  
metal case, bottom connected. White dials, black hands, graduated from 0  
to 700 kPa (0 to 100 psi) and identity labeled. Provide gages with gage  
cocks at softener hard water inlet and soft water outlet to show  
pressure drop thru softener.

### **2.4 BACKFLOW PREVENTER:**

Provide on suction side of water softener serving boilers. Parts shall  
be made of corrosion-resistant materials and shall be of heavy duty  
construction, 850 kPa (125 pounds) class minimum. Units shall operate  
automatically on line pressure without any manual control or assistance.  
Failure of any part vital to prevention of backflow shall be indicated  
by a continuous discharge for relief valve opening. Moving parts shall  
be easily removed and replaced without disconnecting backflow preventer,  
shall operate on "reduced pressure" principle and incorporate a zone  
where pressure is always less than supply pressure. Pressure  
differentials shall be maintained by two spring-load vertical check  
valves and one spring-load, diaphragm-actuated, differential pressure  
relief valve.

**PART 3 - EXECUTION**

**3.1 REQUIRED TECHNICAL SERVICES:**

Provide services of a qualified manufacturer's representative to check complete installation for conformance to manufacturer's recommendation, put system into service, make all adjustments required for full conformance to design and specified requirements, and perform all demonstrations and tests.

**3.2 FLUSHING AND DISINFECTING:**

- A. Flush and disinfect new water lines in accordance with AWWA C651.
- B. Material:
  - 1. Liquid chlorine: AWWA B301.
  - 2. Hypochlorite: AWWA B300.

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**SECTION 23 05 11**  
**COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION**

**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. RE: Resident Engineer
  - 4. COTR: Contracting Officer's Technical Representative.

**1.2 RELATED WORK**

- A. Section 01 00 00, GENERAL REQUIREMENTS.
- B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- C. Section 07 84 00, FIRESTOPPING.
- D. Flashing for Wall and Roof Penetrations: Section 07 60 00, FLASHING AND SHEET METAL.
- E. Section 07 92 00, JOINT SEALANTS.
- F. Section 09 91 00, PAINTING.
- G. Section 23 08 00, COMMISSIONING OF MECHANICAL SYSTEMS.
- H. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS
- I. Section 26 29 11, LOW-VOLTAGE MOTOR STARTERS.
- J. Section 01 91 13, COMMISSIONING REQUIREMENTS.
- K. Section 01 92 13, RETRO-COMMISSIONING REQUIREMENTS.

**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 or steam boiler plant construction, as applicable.
- 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 and 23 05 51, NOISE AND VIBRATION CONTROL FOR

BOILER PLANT. 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. 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.
2. Refer to Section 23 09 11, INSTRUMENTATION AND CONTROL FOR BOILER PLANT, for quality assurance requirements for boiler plant computer workstation software.
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. 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 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.

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 reasonably close to the site.
  2. Boiler Plants: Service organizations, authorized and trained by manufacturers of the equipment supplied, shall be located within 100 miles of the project. These organizations shall come to the site and provide acceptable service to restore boiler plant 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. Submit names, mail and e-mail addresses and phone numbers of service organizations providing service under these conditions for (as applicable to the project): burners, burner control systems, boiler control systems, pumps, critical instrumentation, computer workstation and programming.
- 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. Boiler Plant Welding: Refer to Sections 23 21 11, BOILER PLANT PIPING SYSTEMS.
- H. 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 RE/COTR for resolution. Provide written hard copies or computer files of manufacturer's installation instructions to the RE/COTR 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. All items that require access, such as for operating, cleaning, servicing, maintenance, and calibration, shall be easily and safely accessible by persons standing at floor level, or standing on permanent platforms, without the use of portable ladders. Examples of

these items include, but are not limited to: all types of valves, filters and strainers, transmitters, control devices. Prior to commencing installation work, refer conflicts between this requirement and contract drawings to the RE/COTR for resolution.

3. Provide complete layout drawings required by Paragraph, SUBMITTALS. Do not commence construction work on any system until the layout drawings have been approved.

#### 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. 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.
- F. 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 installation. Final review and approvals will be made only by groups.
- G. Submittal "Groups" for boiler plant work are defined in the following checklist:
  1. Group I (Burner Fuel Oil Tank Systems):
    - a. Oil tanks and accessories.
    - b. Tank oil level instrumentation systems.
    - c. Leak detection systems.
    - d. Tank oil heater, temperature control valves, steam traps.
  2. Group II (Burner Fuel Oil Systems):

- a. Fuel oil pumping system.
  - b. Pressure control and relief valves.
3. Group III: Boilers, burners including forced draft fan and motor controls, boiler accessories (trim), fuel valve trains, atomizing media valve trains, economizers and accessories (when provided), stacks and breeching.
4. Group IV (Boiler/Burner Controls and Boiler Plant Controls and Instrumentation): Boiler control system, burner management (flame safeguard) systems (may be included with Group III), flow measuring systems, control and instrument panels and accessories, feedwater deaerator and condensate storage tank water level control systems, instruments and accessories, computer workstation and software, instrumentation, tools.
5. Group V (Condensate Storage):
  - a. Condensate storage tank and accessories.
  - b. Concrete foundation and anchorage.
6. Group VI (Condensate Transfer and Feedwater System):
  - a. Condensate transfer pumps, motors, accessories.
  - b. Water level control valves for feedwater deaerator.
  - c. Feedwater deaerator and storage tank and accessories.
  - d. Boiler feed pumps, couplings, motors, motor controls and accessories.
  - e. Water level control valve at boilers as approved in Group III.
7. Group VII (Temporary Boiler Plant Equipment):
  - a. Boilers.
  - b. Burners.
  - c. Controls.
  - d. Instruments.
  - e. Other Equipment.
- H. Ungrouped submittal items for boiler plants, which may be submitted individually, include, but are not limited to:
  1. Pipe, valves and fittings identified as to service application.
  2. Strainers.
  3. Safety valves and drip pan ells.
  4. Temperature control valves, sensors.
  5. Steam pressure reducing valves and pilots.
  7. Continuous blow off control system, valves - boilers.
  8. Sight flow indicators, oil and water.
  9. Steam traps with orifice sizes and pressure ratings.
  10. Steam exhaust silencer.

11. Thermometers and pressure gauges and accessories.
  12. Chemical feeders.
  13. Sample coolers.
  14. Blowdown tank and accessories.
  15. Gas pressure regulators, relief valves, and filters.
  16. Flexible connectors, hose, braided.
  17. Dielectric fittings and unions.
  18. Quick-couple hose fittings and steam hose.
  19. Heating and ventilating equipment.
  20. Condensate pump sets.
  21. Compressed air system.
  22. Vibration isolators - air, water, oil.
  23. Supports and braces for pipe, stacks, breeching; load, size, movement calculations.
  24. Pressure gauge test kit.
  25. Insulation, field-applied.
  26. Boiler plant building dangerous gas detection system.
- I. 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.
- J. Layout Drawings:
1. Submit complete consolidated and coordinated layout drawings for all new systems, and for existing systems that are in the same areas.
  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.
- K. 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 Resident Engineer.
  - 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. For boiler plants, refer to Section 23 21 11, BOILER PLANT PIPING SYSTEMS, for additional requirements.
  - 6. Wall, floor, and ceiling plates.
- L. 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.
- M. Boiler Plant Maintenance Data and Operating Instructions:
  - 1. Provide four bound copies. Deliver to RE/COTR not less than 30 days prior to completion of a phase or final inspection.
  - 2. Include all new and temporary equipment and all elements of each assembly.
  - 3. Data sheet on each device listing model, size, capacity, pressure, speed, horsepower, pump impeller size, other data.
  - 4. Manufacturer's installation, maintenance, repair, and operation instructions for each device. Include assembly drawings and parts lists. Include operating precautions and reasons for precautions.
  - 5. Lubrication instructions including type and quantity of lubricant.
  - 6. Schematic diagrams and wiring diagrams of all control systems corrected to include all field modifications.
  - 7. Description of boiler firing and operating sequence including description of relay and interlock positions at each part of the sequence.
  - 8. Set points of all interlock devices.

9. Trouble-shooting guide for control systems.
  10. Operation of the combustion control system.
  11. Emergency procedures.
  12. Control system programming information for parameters, such as set points, that do not require services of an experienced technician.
- M. 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 and Refrigeration Institute (ARI):  
430-99.....Central Station Air-Handling Units
- C. American National Standard Institute (ANSI):  
B31.1-2004.....Power Piping
- D. Rubber Manufacturers Association (ANSI/RMA):  
IP-20-2007.....Drives Using Classical V-Belts and Sheaves  
IP-21-1991(1997).....Drives Using Double-V (Hexagonal) Belts  
IP-22-2007.....Drives Using Narrow V-Belts and Sheaves
- E. Air Movement and Control Association (AMCA):  
410-96.....Recommended Safety Practices for Air Moving  
Devices
- F. American Society of Mechanical Engineers (ASME):  
Boiler and Pressure Vessel Code (BPVC):  
Section I-2007.....Power Boilers  
Section IX-2007.....Welding and Brazing Qualifications  
Code for Pressure Piping:  
B31.1-2004.....Power Piping, with Amendments
- G. American Society for Testing and Materials (ASTM):  
A36/A36M-05.....Carbon Structural Steel  
A575-96(2002).....Steel Bars, Carbon, Merchant Quality, M-Grades R  
(2002)  
E84-07.....Standard Test Method for Burning Characteristics  
of Building Materials  
E119-07.....Standard Test Method for Fire Tests of Building  
Construction and Materials
- H. Manufacturers Standardization Society (MSS) of the Valve and Fittings Industry, Inc:  
SP-58-2002.....Pipe Hangers and Supports-Materials, Design and  
Manufacture

SP 69-2003.....Pipe Hangers and Supports-Selection and  
Application

SP 127-2001.....Bracing for Piping Systems, Seismic - Wind -  
Dynamic, Design, Selection, Application

J. National Electrical Manufacturers Association (NEMA):

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

K. National Fire Protection Association (NFPA):

31-06.....Standard for Installation of Oil-Burning  
Equipment

54-06.....National Fuel Gas Code

70-08.....National Electrical Code

85-07.....Boiler and Combustion Systems Hazard Code

90A-02.....Installation of Air Conditioning and Ventilating  
Systems

101-06.....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 RE/COTR. 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 - WORK IN EXISTING BOILER PLANT**

- A. Plant Operation: Government employees will be continuously operating and managing all plant facilities, including temporary facilities, that serve the steam and condensate requirements of the medical center.
- B. Maintenance of Steam Supply and Condensate Return Service: Schedule all work to permit continuous steam and condensate service at pressures and flow rates as required by the medical center. At all times there shall be one spare boiler available and one spare pump for each service available, in addition to those required for serving the load demand. The spare boiler and pumps must be capable of handling the loads that may be imposed if the operating boiler or pump fails.
- 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 RE/COTR during periods when the steam demands are not critical to the operation of the medical center. These non-critical periods are limited to between 8 pm and 5 am during the non-heating season. Provide at least one week advance notice to the RE/COTR.
- D. Phasing of Work: Comply with all requirements shown on drawings or specified.
- E. Plant Working Environment: Maintain the architectural and structural integrity of the plant building and the working environment at all times. Maintain the interior of plant 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.

## **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**

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.
5. Minimum Diameter of V-Belt Sheaves (ANSI/RMA recommendations) in millimeters and inches:

Fractional Horsepower		Standard		High Capacity	
Cross Section	Min. od mm (in)	Cross Section	Min. od mm (in)	Cross Section	Min. od mm (in)
2L	20 (0.8)	A	83 (3.25)	3V	67 (2.65)
3L	38 (1.5)	B	146 (5.75)	4V	180 (7.10)
4L	64 (2.5)	C	239 (9.40)	5V	318 (12.50)
5L	89 (3.5)	D	345 (13.60)		
		E	554 (21.80)		

I. Drive Types, Based on ARI 435:

1. Provide adjustable-pitch or fixed-pitch drive as follows:
  - a. Fan speeds up to 1800 RPM: 7.5 kW (10 horsepower) and smaller.
  - b. Fan speeds over 1800 RPM: 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

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 motors as scheduled. Unless otherwise specified for a particular application use electric motors with the following requirements.
- B. Single-phase Motors: Capacitor-start type for hard starting applications. Motors for centrifugal fans and pumps may be split phase or permanent split capacitor (PSC).
- C. Poly-phase Motors: NEMA Design B, Squirrel cage, induction type. Each two-speed motor shall have two separate windings. Provide a time- delay (20 seconds minimum) relay for switching from high to low speed.
- D. Rating: Continuous duty at 100 percent capacity in an ambient temperature of 40 degrees centigrade (104 degrees F); minimum horsepower as shown on drawings; maximum horsepower in normal operation not to exceed nameplate rating without service factor.
- E. 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-ready" per NEMA Standard, MG1, Part 31.4.4.2. Provide motor shaft grounding apparatus that will protect bearings from damage from stray currents.
  - F. Motor Efficiency and Power Factor: All motors, when specified as "high efficiency" by the project specifications on driven equipment, shall conform to efficiency and power factor requirements in Section 23 05 12, GENERAL MOTOR REQUIREMENTS FOR HVAC AND STEAM GENERATION EQUIPMENT, with no consideration of annual service hours. Motor manufacturers generally define these efficiency requirements as "NEMA premium efficient" and the requirements generally exceed those of the Energy Policy Act of 1992 (EPACT). Motors not specified as "high efficiency" shall comply with EPACT.
  - G. Insulation Resistance: Not less than one-half meg-ohm between stator conductors and frame, to be determined at the time of final inspection.
- 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 energy efficient 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.

## **2.8 BOILER PLANT CONTROLS AND INSTRUMENTATION, COMPUTER WORKSTATION**

- A. Provide, and place into proper operation, complete systems as specified in Section 23 50 11, BOILER PLANT MECHANICAL EQUIPMENT; and Section 23 09 11, INSTRUMENTATION AND CONTROL FOR BOILER PLANT. Furnish all hardware, software and programming to properly accomplish specified functions.
- B. Pneumatic Systems: If pneumatic actuators/drive units are furnished, provide two complete instrument-quality compressed air systems (primary system and standby system). Each system shall be as specified in Section 23 50 11, BOILER PLANT MECHANICAL EQUIPMENT, and as shown on the drawings. Air supply to each actuator, drive unit or other compressed air-using device shall include filters, moisture separators, and pressure regulator, all designed for the service. Provide all interconnections between elements of the system. Loss of air pressure shall result in immediate automatic burner shut down and closure of pneumatically operated feedwater control valves.
- C. Electronic Systems: Provide complete, protected power supplies as specified. Power supplies shall protect computers, controls, instruments and accessories from damage due to spikes, surges, transients, and overloads in the incoming power supply. Provide all interconnections between elements of the system. Entire installation shall conform to NFPA 70.

## **2.9 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. 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.
- 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: Label all temperature and humidity sensors, controllers and control dampers. Identify and label each item as they appear on the control diagrams.
- E. Valve Tags and Lists:
  - 1. HVAC and Boiler Plant: 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.

## **2.10 FIRESTOPPING**

Section 07 84 00, FIRESTOPPING specifies an effective barrier against the spread of fire, smoke and gases where penetrations occur for piping and ductwork. Refer to Section 23 07 11, HVAC, PLUMBING, AND BOILER PLANT INSULATION, for firestop pipe and duct insulation.

## **2.11 GALVANIZED REPAIR COMPOUND**

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

## **2.12 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. Pipe Hangers and Supports for Boiler Plant: Refer to Section 23 21 11, BOILER PLANT PIPING SYSTEMS.
- C. Supports for Roof Mounted Items:
  - 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.
- D. Pipe Supports: Comply with MSS SP-58. Type Numbers specified refer to this standard. For selection and application comply with MSS SP-69.
- E. 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 Resident Engineer 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 Resident Engineer for each job condition.
- F. 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.
- G. Attachment to Wood Construction: Wood screws or lag bolts.
- 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 or glass 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.
  4. Convertor and Expansion Tank Hangers: May be Type 1 sized for the shell diameter. Insulation where required will cover the hangers.
- 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.

## **2.13 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, 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: 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.

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

- A. Furnish, and turn over to the RE/COTR, special 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. Tool Containers: Hardwood or metal, permanently identified for intended service and mounted, or located, where directed by the Resident Engineer.
- D. 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. Use also where insulation ends on exposed water supply pipe drop from overhead. Provide a watertight joint in spaces where brass or steel pipe sleeves are specified.

## **2.16 ASBESTOS**

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. Boiler Control Panel Locations: Locate and orient panels so that operating personnel standing in front of boilers can view the control switches and displays on the panel face.
- D. Boiler and Economizer Access Platforms: Arrange piping and equipment to allow access by a person standing on the platforms to all valves located above the boilers, to boiler manways located on top of the boilers, and to all economizer valves and access panels.

- E. Equipment and Piping Support: Coordinate structural systems necessary for pipe and equipment support with pipe and equipment locations to permit proper installation.
- F. Location of pipe sleeves, trenches and chases shall be accurately coordinated with equipment and piping locations.
- G. 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 RE/COTR 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 RE/COTR. If the Contractor considers it necessary to drill through structural members, this matter shall be referred to RE/COTR for approval.
  - 3. Do not penetrate membrane waterproofing.
- H. Interconnection of Instrumentation or Control Devices: Generally, electrical and pneumatic interconnections are not shown but must be provided.
- I. Minor Piping: Generally, small diameter pipe runs from drips and drains, water cooling, and other service are not shown but must be provided.
- J. Electrical and Pneumatic 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.
- K. 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. 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.
- L. Concrete and Grout: Use concrete and shrink compensating grout 25 MPa (3000 psi) minimum, specified in Section 03 30 53.

- M. 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.
- N. Install steam piping expansion joints as per manufacturer's recommendations.
- O. 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.
- P. Work in Animal Research Areas: Seal all pipe and duct penetrations with silicone sealant to prevent entrance of insects.
- Q. Switchgear 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.
- R. 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 Para. 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 RE/COTR 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 RE/COTR.
- 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.

### **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 RE/COTR. 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 plant, 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 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.

### 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. Boilers, Burners, Fuel Trains and Accessories: Retain manufacturer's factory finish. Touch up or recoat as necessary to provide smooth, even-colored and even-textured finish.

6. Temporary Facilities: Apply paint to surfaces that do not have existing finish coats.
7. Paint shall withstand the following temperatures without peeling or discoloration:
  - a. Boiler stack and breeching -- 65 degrees C (150 degrees F) on insulation jacket surface and 315 degrees C (600 degrees F) on metal surface of stacks and breeching.
  - b. Condensate and feedwater -- 38 degrees C (100 degrees F) on insulation jacket surface and 120 degrees C (250 degrees F) on metal pipe surface.
  - c. Steam -- 52 degrees C (125 degrees F) on insulation jacket surface and 190 degrees C (375 degrees F) on metal pipe surface.
8. 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. Boiler Plant Instrumentation Panel: Refer to Section 23 09 11.
- D. Boiler Control Panels: Refer to Section 23 09 11, INSTRUMENTATION AND CONTROL FOR BOILER PLANT
- E. 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 RE/COTR 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 STARTUP AND TEMPORARY OPERATION**

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.

### **3.11 OPERATING AND PERFORMANCE TESTS**

- A. Prior to the final inspection, perform required tests as specified in Section 01 00 00, GENERAL REQUIREMENTS, Article, TESTS, and Section 23 08 11, DEMONSTRATIONS AND TESTS FOR BOILER PLANT, and submit the test reports and records to the RE/COTR.
- 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.

### **3.12 DEMONSTRATIONS AND TESTS, TEMPORARY BOILER PLANT EQUIPMENT**

- A. Test prior to placing in service.
- B. Demonstrate to RE/COTR the proper operation of all equipment, instruments, operating and safety controls, and devices.
- C. Demonstrate to RE/COTR the proper operation of burners.
  - 1. Emissions within limits specified for new boilers on this project.
  - 2. Stable flame at all operating points with no pulsations.
  - 3. Smooth flame light off, with no delays, puffs or flashbacks.
  - 4. Turndown capability as specified.
- D. Develop full steam output capacity required.
- E. New Boilers Installed in Temporary Location:
  - 1. Perform all tests required by boiler specification.

2. Perform complete retest after boiler is placed in its permanent location.

**3.13 INSTRUCTIONS TO VA PERSONNEL**

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

- - - E N D - - -

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

**PART 1 - GENERAL**

**1.1 DESCRIPTION:**

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 that are 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. Other sections specifying motor driven equipment in Division 23.

**1.3 SUBMITTALS:**

- A. In accordance with Section, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, submit the following:
- B. Shop Drawings:
  - 1. Sufficient information, clearly presented, shall be included to determine compliance with drawings and specifications.
  - 2. Include electrical ratings, dimensions, mounting details, materials, horsepower, 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 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 properly applied, installed, adjusted, lubricated, and tested.

**1.4 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. National Electrical Manufacturers Association (NEMA):
  - MG 1-98.....Motors and Generators

MG 2-01.....Safety Standard and Guide for Selection,  
Installation and Use of Electric Motors and  
Generators

C. National Fire Protection Association (NFPA):

70-02.....National Electrical Code (NEC)

## **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. 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 74.6 kW (100 HP), connected to 240 volt or 480 volt systems: 230/460 volts, dual connection.
    - c. Motors, 74.6 kW (100 HP) or larger, connected to 240-volt systems: 230 volts.
    - d. Motors, 74.6 kW (100 HP) or larger, connected to 480-volt systems: 460 volts.
    - e. Motors connected to high voltage systems: Shall conform to NEMA Standards for connection to the nominal system voltage shown on the drawings.
- C. Number of phases shall be as follows:
  - 1. Motors, less than 373 W (1/2 HP): Single phase.
  - 2. Motors, 373 W (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.
- D. Horsepower ratings shall be adequate for operating the connected loads continuously in the prevailing ambient temperatures in areas where the motors are installed, without exceeding the NEMA standard temperature rises for the motor insulation.

- E. Motor designs, as indicated by the NEMA code letters, shall be coordinated with the connected loads to assure adequate starting and running torque.
- F. Motor Enclosures:
1. Shall be the NEMA types shown on the drawings for the motors.
  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.
  3. Enclosures shall be primed and finish coated at the factory with manufacturer's prime coat and standard finish.
- G. Additional requirements for specific motors, as indicated in other sections, shall also apply.
- H. Energy-Efficient Motors (Motor Efficiencies): All permanently wired polyphase motors of 746 Watts or more shall meet the minimum full-load efficiencies as indicated in the following table, and as specified in this specification. 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.

Minimum Efficiencies Open Drip-Proof				Minimum 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%

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

J. All motors shall be premium efficiency type.

**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**

Megger all motors after installation, before start-up. All shall test free from grounds.

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

PART 1 - GENERAL

1.1 DESCRIPTION

Noise criteria, vibration tolerance and vibration isolation for HVAC and plumbing work.

1.2 RELATED WORK

- A. 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.
- B. Section 23 22 13, STEAM AND CONDENSATE HEATING PIPING: Requirements for flexible pipe connectors to reciprocating and rotating mechanical equipment.
- C. Section 23 73 01, CUSTOM AIR-HANDLING UNIT COMPONENTS: Requirements for optional Air Handling Unit internal vibration isolation.
- 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.

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
Audio Speech Pathology	25
Audio Suites	25
Auditoriums, Theaters	35
Bathrooms and Toilet Rooms	40
Chapels	35
Conference Rooms	35
Corridors (Nurse Stations)	40
Corridors(Public)	40
Dining Rooms, Food Services/ Serving	35
Examination Rooms	35

Gymnasiums	50
Kitchens	50
Laboratories	45
Laundries	50
Lobbies, Waiting Areas	40
Locker Rooms	50
Offices, large open (3 or more occupants)	40
Offices, small private (2 or fewer occupants)	35
Operating Rooms	40
Patient Rooms	35
Phono/ Cardiology	25
Recreation Rooms	50
Shops	50
SPD	35
Therapeutic Pools	45
Treatment Rooms	35
Warehouse	50
X-Ray & 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. 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. Thrust restraints
  2. Bases.
  3. Acoustical enclosures.
- C. Isolator manufacturer shall furnish with submittal load calculations for selection of isolators, including supplemental bases, based on lowest operating speed of equipment supported.

#### 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):  
2005.....Fundamentals Handbook, Chapter 7, Sound and Vibration
- C. American Society for Testing and Materials (ASTM):  
A123/A123M-02.....Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products  
A307-04.....Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength  
D2240-05.....Standard Test Method for Rubber Property - Durometer Hardness

## D. Manufacturers Standardization (MSS):

SP-58-02.....Pipe Hangers and Supports-Materials, Design and  
Manufacture

## E. Occupational Safety and Health Administration (OSHA):

29 CFR 1910.95.....Occupational Noise Exposure

**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. Uniform Loading: Select and locate isolators to produce uniform loading and deflection even when equipment weight is not evenly distributed.
- D. Color code isolators by type and size for easy identification of capacity.

**2.2 VIBRATION ISOLATORS**

## A. Floor Mountings:

- 1. Double Deflection Neoprene (Type N): Shall include neoprene covered steel support plated (top and bottom), friction pads, and necessary bolt holes.
- 2. 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.
- 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. // Isolators shall have a minimum seismic rating of one G. //
- 4. Pads (Type D), Washers (Type W), and Bushings (Type L): Pads shall be felt, cork, neoprene waffle, neoprene and cork sandwich, neoprene and fiberglass, neoprene and steel waffle, or reinforced duck and neoprene. Washers and bushings shall be reinforced duck 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. Spring Position Hanger (Type HP): Similar to combination neoprene and spring hanger except hanger shall hold piping at a fixed elevation during installation and include a secondary adjustment feature to transfer load to spring while maintaining same position.
  3. 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.
  4. 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.
  5. Hanger supports for piping 50 mm (2 inches) and larger shall have a pointer and scale deflection indicator.
- C. Thrust Restraints (Type THR): Restraints shall provide a spring element contained in a steel frame with neoprene pads at each end attachment. Restraints shall have factory preset thrust and be field adjustable to allow a maximum movement of 6 mm (1/4 inch) when the fan starts and stops. Restraint assemblies shall include rods, angle brackets and other hardware for field installation.

## 2.4 BASES

- A. Rails (Type R): Design rails with isolator brackets to reduce mounting height of equipment and cradle machines having legs or bases that do not require a complete supplementary 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 (4 inches). Where rails are used

with neoprene mounts for small fans or close coupled pumps, extend rails to compensate overhang of housing.

- B. 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).
- C. Inertia Base (Type I): Base shall be a reinforced concrete inertia base. Pour concrete into a welded steel channel frame, incorporating prelocated equipment anchor bolts and pipe sleeves. Level the concrete to provide a smooth uniform bearing surface for equipment mounting. Provide grout under uneven supports. Channel depth shall be a minimum of 1/12 of longest dimension of base but not less than 150 mm (six inches). Form shall include 13-mm (1/2-inch) reinforcing bars welded in place on minimum of 203 mm (eight inch) centers running both ways in a layer 40 mm (1-1/2 inches) above bottom. Use height saving brackets in all mounting locations. Weight of inertia base shall be equal to or greater than weight of equipment supported to provide a maximum peak-to-peak displacement of 2 mm (1/16 inch).
- D. Curb Mounted Isolation Base (Type CB): Fabricate from aluminum to fit on top of standard curb with overlap to allow water run-off and have wind and water seals which shall not interfere with spring action. Provide resilient snubbers with 6 mm (1/4 inch) clearance for wind resistance. Top and bottom bearing surfaces shall have sponge type weather seals. Integral spring isolators shall comply with Spring Isolator (Type S) requirements.

### **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.

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.

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**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>REFRIGERATION MACHINES</b>																
CENTRIFUGAL		B	D	---	B	SP	1.0	---	SP	1.7	B	SP	1.7	B	SP	3.5
<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	---	---	---	I	S	1.0	I	S	1.0	I	S	1.7	I	S	1.7
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	1.0	I	S	1.7	I	S	1.7	I	S	1.7
	50 HP & OVER	I	S	1.0	I	S	1.0	I	S	1.7	I	S	2.5	I	S	2.5

**SECTION 23 05 51**  
**NOISE AND VIBRATION CONTROL FOR BOILER PLANT**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

This section specifies the application of noise and vibration control techniques to boiler plant rotating equipment including pumps, fans, compressors, and motors.

**1.2 RELATED WORK**

- A. Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION.
- B. Vibration isolators: Section 23 21 11, BOILER PLANT PIPING SYSTEMS.
- C. Section 23 08 11, DEMONSTRATIONS AND TESTS FOR BOILER PLANT.

**1.3 SUBMITTALS**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Noise and Vibration Control Devices; include with the equipment submittals.

**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 basic designation only.
- B. American Boiler Manufacturers Association (ABMA):  
ABMA-BOILER 304-1995....Measurement of Sound from Steam Generators

**PART 2 - PRODUCTS**

(Part 2 - (Not Used)).

**PART 3 - EXECUTION**

**3.1 BALANCING AND ALIGNMENT OF ROTATING EQUIPMENT**

Statically and dynamically balance all pumps, fans, compressors and drivers. Align shafts of pumps, fans, and drivers to limit noise and vibration to specified values. Level and anchor equipment as necessary to achieve and maintain alignment.

**3.2 VIBRATION TESTS ON ROTATING EQUIPMENT**

- A. Perform vibration tests on all pumps, fans, compressors and drivers during the pretest of the equipment. Refer to Section 23 08 11, DEMONSTRATIONS AND TESTS FOR BOILER PLANT. Tests shall be conducted by an experienced technician in the presence of the Resident Engineer (RE)/Contracting Officers Technical Representative (COTR).
- B. Perform tests at each bearing in axial, horizontal, and vertical positions.
- C. RMS vibration velocity shall not exceed 0.0025 m/s (0.10-inch per second). Correct the cause of excessive vibration and provide retest.

D. Test instruments furnished by contractor:

1. Portable, with output capability to print data.
2. Frequency range, 600-150,000 CPM minimum.
3. Amplitude range, 2.54 m/s (0-100 inches per second).
4. Sensitivity, 0.00013 m/s (0.005-inch per second).
5. Frequency filter "out" for tests.

E. Submit tabulated vibration readings to the RE/COTR.

**3.3 SOUND LEVELS**

- A. Sound level limitations apply to all burners, fans, blowers, pumps, compressors, control valves, pressure reducing valves, and motors.
- B. Sound levels shall not exceed 85 DBA when measured 1400 mm (4.5-feet) above the floor and 910 mm (3-feet) horizontally from each surface of the smallest imaginary rectangular box which could completely enclose the entire unit which contains the sound source. Sound level limitations apply to the operation of the equipment at all loads within the equipment requirements.
- C. Tests will be performed by the Government using a standard sound level meter on the "A" scale, slow response. At the option and expense of the Government, a testing company may be employed to conduct tests using methods conforming to the referenced ABMA publication.
- D. If sound levels exceed requirements, modify or replace the equipment as necessary to achieve required sound levels and other specified requirements.
  1. Submit all proposed modifications or replacements for review prior to starting the work.
  2. After completing the work, provide complete retest of equipment operation and performance.

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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 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, condenser water, heating hot water and glycol-water systems.
6. Air Systems: Includes all outside air, supply air, return air, exhaust air and relief 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 AND STEAM GENERATION: 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 64 00, PACKAGED WATER CHILLERS: Testing Refrigeration Equipment.
- F. Section 23 31 00, HVAC DUCTS AND CASINGS: Duct Leakage.
- G. Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC: Controls and Instrumentation Settings.

### 1.3 QUALITY ASSURANCE

- A. Refer to Articles, Quality Assurance and Submittals, in Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION.
- 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.
- 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 90 percent of final 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. Exhaust hoods/cabinets: 0 percent to plus 10 percent.
  - d. Minimum outside air: 0 percent to plus 10 percent.
  - e. Individual room air outlets and inlets, and air flow rates not mentioned above: Minus 2 percent to plus 10 percent except if the air to a space is 100 CFM or less the tolerance would be 0 to plus 5 percent.
  - f. Heating hot water pumps and hot water coils: Minus 5 percent to plus 5 percent.
  - g. Chilled water and condenser water pumps: 0 percent to plus 5 percent.
  - h. Chilled water coils: 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) 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):  
2003.....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  
1<sup>st</sup> Edition 1994 .....Procedural Standards for the Measurement and Assessment of Sound and Vibration  
2<sup>nd</sup> Edition 1999 .....Procedural Standards for Building Systems Commissioning
- 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**

Provide plastic plugs to seal holes drilled in ductwork for test purposes.

**2.2 INSULATION REPAIR MATERIAL**

See Section 23 07 11, HVAC, PLUMBING, 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**

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**

See paragraphs "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. Inspect each System to ensure that it is complete including installation and operation of controls.
- B. 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.
- 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 any phased construction completion requirements for the project. Provide TAB reports for each phase of the project prior to partial final inspections of each phase of the project.
- D. Allow sufficient 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, fan coil units, room diffusers/outlets/inlets, computer room AC units, and laboratory fume hoods and cabinets.

1. Artificially load air filters by partial blanking to produce air pressure drop of at least 90 percent of the design final 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 AND STEAM GENERATION.
  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. 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.
  5. Record final measurements for air handling equipment performance data sheets.
- F. Water Balance and Equipment Test: Include circulating pumps, convertors, coils, coolers and condensers:
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-secondary (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 properly.
  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 AND STEAM GENERATION. 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 five 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:
- Perform steps 1.a. thru 1.d., as above.
  - 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.
  - 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.

### 3.10 MARKING OF SETTINGS

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**

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.

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SECTION 23 07 11  
HVAC, PLUMBING, 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.
  2. Plumbing piping and equipment.
  3. Boiler plant mechanical systems but excluding outside steam distribution.
- 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, interstitial space, and pipe spaces.
  5. Exposed: Piping, ductwork, and equipment exposed to view in finished areas including mechanical, Boiler Plant and electrical equipment rooms or exposed to outdoor weather. Attics and crawl spaces where air handling units are located are considered to be mechanical rooms. Shafts, chases, interstitial spaces, unfinished attics, crawl spaces 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 and plumbing equipment or piping handling media above 41 degrees C (105 degrees F); Boiler Plant breechings and stack temperature range 150-370 degrees C (300-700 degrees F) and piping media and equipment 32 to 230 degrees C (90 to 450 degrees F)
  8. Density:  $\text{kg/m}^3$  - 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. HPS: High pressure steam (415 kPa [60 psig] and above).
- 13. HPR: High pressure steam condensate return.
- 14. MPS: Medium pressure steam (110 kPa [16 psig] thru 414 kPa [59 psig]).
- 15. MPR: Medium pressure steam condensate return.
- 16. LPS: Low pressure steam (103 kPa [15 psig] and below).
- 17. LPR: Low pressure steam condensate gravity return.
- 18. PC: Pumped condensate.
- 19. HHWS: Hot water heating supply.
- 20. HHWR: Hot water heating return.
- 21. CS: Condenser water supply.
- 22. CR: Condenser water return.
- 23. FWPD: Feedwater pump discharge.
- 24. FWPS: Feedwater pump suction.
- 25. CTPD: Condensate transfer pump discharge.
- 26. CTPS: Condensate transfer pump suction.
- 27. CPD: Condensate pump discharge.
- 28. R: Pump recirculation.
- 29. FOS: Fuel oil supply.
- 30. FOR: Fuel oil return.
- 31. CW: Cold water.
- 32. SW: Soft water.
- 33. HW: Hot water.
- 34. CHWS: Chilled water supply.
- 35. CHWR: Chilled water return.
- 36. PCHWS: Process chilled water supply.
- 37. PCHWR: Process chilled water return.
- 38. RS: Refrigerant suction.
- 39. 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 AND STEAM GENERATION: General mechanical requirements and items, which are common to more than one section of Division 23.
- C. Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION: General requirements pertaining to mechanical Boiler Plant work.
- D. Section 23 21 11, BOILER PLANT PIPING SYSTEMS: Boiler plant piping.
- E. Section 22 05 23, GENERAL-DUTY VALVES FOR PLUMBING PIPING: Hot and cold water piping.
- F. Section 23 64 00, PACKAGED WATER CHILLERS: Compressor, evaporator and piping.
- G. Section 23 21 13, HYDRONIC PIPING and Section 23 22 13, STEAM AND CONDENSATE HEATING PIPING: Piping and equipment.
- H. Section 23 21 13, HYDRONIC PIPING: Chilled water piping.
- I. Section 23 31 00, HVAC DUCTS AND CASINGS: Ductwork, plenum and fittings.
- J. Section 02 82 13.13, GLOVEBAG ASBESTOS ABATEMENT: Insulation containing asbestos material.

## 1.3 QUALITY ASSURANCE

- A. Refer to article QUALITY ASSURANCE, in Section 23 05 11, COMMON WORK RESULTS FOR HVAC 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 4.3.3.1.2 or 4.3.3.1.3, 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.

**4.3.3.1.3** Smoke detectors required by **6.4.4** shall not be required to meet flame spread index or smoke developed index requirements.

**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.

4.3.10.2.6.3 Nonferrous fire sprinkler piping 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 1887, Standard for Safety Fire Test of Plastic Sprinkler Pipe for Visible 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.

4.3.10.2.6.5 Loudspeakers and recessed lighting fixtures, including their assemblies and accessories, shall be permitted in the ceiling cavity plenum where listed as having a maximum peak optical density of 0.5 or less, an average optical density of 0.15 or less, and a peak heat release rate of 100 kW or less when tested in accordance with UL 2043, Standard for Safety Fire Test for Heat and Visible Smoke Release for Discrete Products and Their Accessories Installed in Air-Handling Spaces.

4.3.10.2.6.6 Supplementary materials for air distribution systems shall be permitted when complying with the provisions of 4.3.3.

4.3.10.2.6.7 Smoke detectors shall not be required to meet the provisions of this section.

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)-91.....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.....Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip

B209-04.....Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate

C411-97.....Standard test method for Hot-Surface Performance of High-Temperature Thermal Insulation

C449-00.....Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement

C533-04.....Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation

C534-05.....Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form

C547-06.....Standard Specification for Mineral Fiber pipe Insulation

- C552-03.....Standard Specification for Cellular Glass  
Thermal Insulation
- C553-02.....Standard Specification for Mineral Fiber  
Blanket Thermal Insulation for Commercial and  
Industrial Applications
- C585-90.....Standard Practice for Inner and Outer Diameters  
of Rigid Thermal Insulation for Nominal Sizes  
of Pipe and Tubing (NPS System) R (1998)
- C612-04.....Standard Specification for Mineral Fiber Block  
and Board Thermal Insulation
- C1126-04.....Standard Specification for Faced or Unfaced  
Rigid Cellular Phenolic Thermal Insulation
- C1136-06.....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
- E84-06.....Standard Test Method for Surface Burning  
Characteristics of Building  
Materials
- E119-05a.....Standard Test Method for Fire Tests of Building  
Construction and Materials
- E136-04.....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-02.....Installation of Air Conditioning and  
Ventilating Systems
- 96-04.....Standards for Ventilation Control and Fire  
Protection of Commercial Cooking Operations
- 101-06.....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 08/03

G. Manufacturer's Standardization Society of the Valve and Fitting  
Industry (MSS):

SP58-2002.....Pipe Hangers and Supports Materials, Design,  
and Manufacture

## **PART 2 - PRODUCTS**

### **2.1 MINERAL FIBER**

- A. ASTM C612 (Board, Block), Class 1 or 2,  $k = 0.037$  Watt per meter, per degree C (0.26), external insulation for temperatures up to 204 degrees C (400 degrees F).
- B. ASTM C553 (Blanket, Flexible) Type I, Class B-5, Density  $32 \text{ kg/m}^3$  (2 pcf),  $k = 0.04$  (0.27), for use at temperatures up to 204 degrees C (400 degrees F)
- C. ASTM C547 (Pipe Fitting Insulation and Preformed Pipe Insulation), Class 1,  $k = 0.037$  (0.26) for use at temperatures 230 degrees C (450 degrees F).

### **2.2 MINERAL WOOL OR REFRACTORY FIBER**

- 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), for temperatures up to 121 degrees C (250 degrees F) with vapor retarder and all service jacket with polyvinyl chloride premolded fitting covering.
- B. Equipment and Duct Insulation, ASTM C 1126, type II, grade 1,  $k = 0.021$  (0.15), for temperatures up to 121 degrees C (250 degrees F) with rigid cellular phenolic insulation and covering, vapor retarder and all service jacket.

### **2.4 CELLULAR GLASS CLOSED-CELL**

- A. Comply with Standard ASTM C177, C518, density  $120 \text{ kg/m}^3$  (7.5 pcf) nominal,  $k = 0.033$  (0.29) at 0 degrees C (75 degrees F).
- B. Pipe insulation for temperatures up to 200 degrees C (400 degrees F).

### **2.5 POLYISOCYANURATE CLOSED-CELL RIGID**

- A. Preformed (fabricated) pipe insulation, ASTM C591, type IV,  $K=0.027$ (0.19), for use at temperatures up to 149 degree C (300 degree

F) with factory applied PVDC or all service jacket vapor retarder with polyvinyl chloride premolded fitting covers.

- B. Equipment and duct insulation, ASTM C 591, type IV, K=0.027(0.19), for use at temperatures up to 149 degrees C (300 degrees F) with PVDC or all service jacket vapor retarder jacket.

## 2.6 FLEXIBLE ELASTOMERIC CELLULAR THERMAL

- A. ASTM C177, C518, k = 0.039 Watt per meter, per degree C (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.

## 2.7 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

## 2.8 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 5 units, Suitable for painting without sizing. Jackets shall have minimum 40 mm (1-1/2 inch) lap on longitudinal joints and minimum 100 mm (4 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. 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.
- E. Factory composite materials may be used provided that they have been tested and certified by the manufacturer.
- F. 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.
- G. Aluminum Jacket-Piping systems and circular breeching and stacks: 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 20 mm (0.75 inch) wide on 450 mm (18 inch) centers. System shall be weatherproof if utilized for outside service.
- H. Aluminum jacket-Rectangular breeching: 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.

## 2.9 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).
- C. Boiler Plant Pipe supports: MSS SP58, Type 39. Apply at all pipe support points, except where MSS SP58, Type 3 pipe clamps provided as part of the support system.

## 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 tin-coated or fiber washer, or clips. Pin diameter shall be as recommended by the insulation manufacturer.
- B. Staples: Outward clinching monel or stainless 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: 20 mm (3/4 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**

Other than pipe and duct insulation, refer to Section 07 84 00  
FIRESTOPPING.

## **2.14 FLAME AND SMOKE**

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. Where removal of insulation of piping, ductwork and equipment is required to comply with Section 02 82 11, TRADITIONAL ASBESTOS ABATEMENT and Section 02 82 13.13, GLOVEBAG ASBESTOS ABATEMENT, such areas shall be reinsulated to comply with this specification.
- D. 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 duct heaters (NFPA 90A). Vapor retarders shall be continuous and uninterrupted throughout systems with operating temperature 16 degrees C (60 degrees F) and below. Lap and seal vapor barrier 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).
- E. Install vapor stops at all insulation terminations on either side of valves, pumps and equipment and particularly in straight lengths of pipe insulation.
- F. 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.
- G. 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.

H. 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.

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, flash tanks, hot water pumps.
5. In hot piping: Unions, flexible connectors, control valves, PRVs, safety valves and discharge vent piping, vacuum breakers, thermostatic vent valves, steam traps 20 mm (3/4 inch) and smaller, exposed piping through floor for convectors and radiators. Insulate piping to within approximately 75 mm (3 inches) of uninsulated items.

J. Plumbing work not to be insulated:

1. Piping and valves of fire protection system.
2. Chromium plated brass piping.
3. Water piping in contact with earth.
4. Piping in pipe basement serving wall hydrants.
5. Small horizontal cold water branch runs in partitions to individual fixtures may be without insulation for maximum distance of 900 mm (3 feet).
6. Distilled water piping.

K. Boiler plant work not to be insulated:

1. Pipes, valves and fittings:
  - a. Gas fuel
  - b. Oil unheated
  - c. Compressed Air
  - d. Flowmeter sensing piping and blowdown
  - e. Level sensor piping and blowdown
  - f. Tank drains
  - g. Vents-tank, safety and back pressure valves except protective.
  - h. Continuous blowdown and boiler water sampling except protective.
  - i. Threaded valves
  - j. Check valves
  - k. Unions

- l. Orifice flanges
  - m. Dielectric flanges and unions
  - n. Steam header drains
  - o. Non-return stop and check valve drains
  - p. Pneumatic controls
  - q. Pressure transmission to gages
  - r. Piping in control panels
  - s. Tube cleaning piping
  - t. Chemical feed from pump-type feeders
  - u. Condensate piping from flash tank to condensate return pump
2. Boilers:
- a. Water column, piping and blowdown
  - b. Auxiliary low water cutoff, piping and blowdown
  - c. Remote water level indicators and piping blowdown
  - d. Steam gage piping
  - e. Soot blower and piping
  - f. Safety valves and drip pan ells
  - g. Water level sensors and piping except where required by equipment manufacturer
  - h. Control piping and devices or interlocks
  - i. Drum heads (watertube boilers)
3. Equipment:
- a. Condensate return pump units
  - b. Vacuum return pump units
  - c. Pumps-inlet to outlet
  - d. Flash tanks
  - e. Safety valves
  - f. Water meters
  - g. Oil meters
  - h. Air compressors and tanks
  - i. Refrigerated or desiccant air drier
  - j. Chemical feeders
  - k. Boiler and feedwater sampler
  - l. All nameplates
4. Specialties:
- a. Pressure reducing valves
  - b. Control valves-water and steam

- c. Level sensors-piping, valves and blowdown
  - d. Back pressure regulators-oil and steam
  - e. Strainers under 65 mm (2-1/2 inch) pipe size
  - f. Expansion bellows
  - g. Flexible connectors
  - h. Ball joints except piping between joints
- L. Apply insulation materials subject to the manufacturer's recommended temperature limits. Apply adhesives, mastic and coatings at the manufacturer's recommended minimum coverage.
- M. 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.
- N. 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
- O. Freeze protection of above grade outdoor piping (over heat tracing tape): 20 mm (0.75) thick insulation, for all pipe sizes 75 mm(3 inches) and smaller and 25 mm(1inch) thick insulation for larger pipes. Provide metal jackets for all pipes. Provide for cold water make-up to cooling towers and condenser water piping and chilled water piping as described in Section 23 21 13, HYDRONIC PIPING (electrical heat tracing systems).
- P. Provide metal jackets over insulation as follows:
- a. All piping and ducts exposed to outdoor weather.
  - b. 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. Outside air intake ducts: 25 mm (one inch) thick insulation faced with ASJ.
- 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.
  - b. Pneumatic, cold storage water and surge tanks.
- 5. Hot equipment: 40 mm (1-1/2 inch) thick insulation faced with ASJ.
  - a. Convertors, air separators, steam condensate pump receivers.
- B. Flexible Mineral Fiber Blanket:
  - 1. Adhere insulation to metal with 100 mm (4 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: 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 above ceilings at a roof level, unconditioned areas, and in chases with external wall or containing steam piping; 40 mm (1-1/2 inch) thick, insulation faced with FSK. Concealed return air ductwork in other locations need not be insulated.
  - 5. Return air duct in interstitial spaces: 40 mm (1-1/2 inch thick insulation faced with FSK.
  - 6. Concealed outside air duct: 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 table below, for piping above ground:

Nominal Thickness of Molded Mineral Fiber Insulation				
Nominal Pipe Size, millimeters (inches):	25 (1) & below	32- 75 (1-1/4- 3)	100-150 (4-6)	200 (8) and above
a. 122-177 degrees C (251-350 F) (HPS, MPS,)	50 (2.0)	65 (2.5)	90 (3.5)	90 (3.5)

Nominal Thickness of Molded Mineral Fiber Insulation				
Nominal Pipe Size, millimeters (inches):	25 (1) & below	32- 75 (1-1/4- 3)	100-150 (4-6)	200 (8) and above
b. 100-121 degrees C HPR, MPR (212-250 degrees F) (Vent piping from PRV safety valves, condensate receivers, and flash tanks)	25 (1.0)	50 (2.0)	50 (2.0)	50 (2.0)
c. 38-99 degrees C (100- 211 degrees F) (LPR, PC, HHWS, HHWR)	25 (1.0)	40 (1.5)	50 (2.0)	50 (2.0)
d. Domestic hot water supply and return	15 (0.5)	20(0.75)	25 (1.0)	40 (1.5)

D. Cellular Glass Insulation:

1. Pipe and tubing, covering nominal thickness in millimeters and inches as tabulated below for chilled water and refrigerant piping.

Nominal Thickness of Cellular Glass Insulation				
Millimeters (inches)	Thru 38 (1 1/2)	50- 150 (2-6)	200-300 (8-12)	over 350 (14)
1. 4-16 degrees C (40-60 degrees F) (CS, CR, CHWS, CHWR, PCHWS, and PCHWR within chiller room and pipe chase and underground)	50 (2.0)	80 (3.0)	80 (3.0)	100 (4.0)
2. 4-16 degrees C (40-60 degrees F) (CS, CR, CHWS, CHWR, PCHWS, and PCHWR outside chiller room)	40 (1.5)	50 (2.0)	50 (2.0)	65 (2.5)

2. Cold equipment: 50 mm (2 inch) thick insulation faced with ASJ for chilled water pumps, water filters, chemical feeder pots or tanks, expansion tanks, air separators and air purgers.

E. Polyisocyanurate Closed-Cell Rigid Insulation:

1. Polyisocyanurate closed-cell rigid insulation (PIR) may be provided for piping, equipment and ductwork for temperature up to 149 degree C (300 degree F) provided insulation thickness requirement does not exceed 38 mm (1.5 inches).

2. Install insulation, vapor retarder 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 retarder 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 retarder shall be installed in a continuous manner. No staples, rivets, screws or any other attachment device capable of penetrating the vapor retarder shall be used to attach the vapor retarder or jacketing. No wire ties capable of penetrating the vapor retarder 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 retarder on elbows/fittings shall be either mastic-fabric-mastic or 2 mil thick PVDC vapor retarder 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. Underground piping: Follow instructions for above ground piping but the vapor retarder jacketing shall be 6 mil thick PVDC or minimum 30 mil thick rubberized bituminous membrane. Sand bed and backfill shall be a minimum of 150 mm (6 inches) all around insulated pipe.
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 table below,  
for piping:

Nominal Thickness of Polyisocyanurate Rigid Insulation				
Nominal Pipe Size millimeters(inches):	25(1) & below	32-75 (1 1/4- 3)	100-150 (4-6)	200-300 (8-12)
1. 122-149 degree C(251-300 degree F) (HPS, MPS)	40 (1.5)	--	--	--
2. 100-121 degrees C (211-250 degrees F), HPR, MPR, LPS, Vent piping from receivers and flash tanks	20 (0.75)	40(1.5)	40(1.5)	40(1.50)
3. 38-99 degrees C (100-211 degrees F), LPR, PC, HHWS, HHWR	20 (0.75)	25(1.0)	40(1.5)	40(1.50)

12. Condensation control insulation: Minimum 20 mm (0.75 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.
  - b. Plumbing piping as follows:
    - 1) Body of roof and overflow drains and horizontal runs and  
offsets (including elbows) of interior downspout piping in all  
areas above pipe basement.
    - 2) Cold Water Piping.

### 3.3 APPLICATION -BOILER PLANT, PIPE, VALVES, STRAINERS AND FITTINGS:

- A. Temperature range 120 to 230 degrees C (251 to 450 degrees F);
  1. Application; Steam service 110 kpa (16 psig nominal) and higher,  
high pressure condensate to trap assembly, boiler bottom blowoff  
from boiler to blowoff valve closest to boiler.
  2. Insulation and Jacket:
    - a. Calcium silicate for piping from zero to 1800 mm (6 feet) above  
boiler room floor, feedwater heater mezzanine floor or access  
platform and any floors or platforms on which tanks or pumps are  
located.

- b. Mineral fiber for remaining locations.
  - c. ASJ with PVC premolded fitting coverings.
  - d. Aluminum jacket from zero to 1800 mm (6 feet) above floor on atomizing steam and condensate lines at boilers and burners.
3. Thickness:

Nominal Thickness Of Calcium Silicate Insulation (Boiler Plant)	
Pipe Diameter mm (in)	Insulation Thickness mm (in)
25 (1) and below	50 (2)
32 to 80 (1 1/4 to 3)	63 (2-1/2)
100 (4) and above	88 (3-1/2)

- B. Temperature range 100 to 121 degrees C (211 to 250 degrees F):
- 1. Application: Steam service 103 kpa (15 psig) and below, trap assembly discharge piping, boiler feedwater from feedwater heater to boiler feed pump recirculation, feedwater heater overflow, heated oil from oil heater to burners.
  - 2. Insulation and Jacket:
    - a. Calcium silicate for piping from zero to 1800 mm (0 to 6 feet) above boiler room floor, feedwater heater mezzanine floor and access platform, and any floors or access platforms on which tanks or pumps are located.
    - b. Mineral Fiber or rigid closed cell phenolic foam for remaining locations.
    - c. ASJ with PVC premolded fitting coverings.
    - d. Aluminum jacket from zero to 1800 mm (6 feet) above floor on condensate lines at boilers and burners.
  - 3. Thickness-calcium silicate and mineral fiber insulation:

Nominal Thickness Of Insulation	
Pipe Diameter mm (in)	Insulation Thickness mm (in)
25 (1) and below	25 (1)
32 to 80 (1-1/4 to 3)	50 (2)
100 (4) and above	50 (2)

4. Thickness-rigid closed-cell phenolic foam insulation:

Nominal Thickness Of Insulation	
Pipe Diameter mm (in)	Insulation Thickness mm (in)
25 (10 and below)	19 (0.75)
32 to 80 (1-1/4 to 30)	25 (1)
100 (4) and above	25 (1)

C. Temperature range 32 to 99 degrees C (90 to 211 degrees F):

1. Application: Pumped condensate, vacuum heating return, gravity and pumped heating returns, condensate transfer, condensate transfer pump recirculation, heated oil system to heaters and returns from burners, condensate return from convertors and heated water storage tanks.
2. Insulation Jacket:
  - a. Calcium silicate for piping from zero to 1800 mm (six feet above boiler room floor, feedwater heater mezzanine floor and access platform and any floor or access platform on which tanks or pumps are located.
  - b. Mineral fiber or rigid closed-cell phenolic foam for remaining locations.
  - c. ASJ with PVC premolded fitting coverings.
3. Thickness-calcium silicate and mineral fiber insulation:

Nominal Thickness Of Insulation	
Pipe Diameter mm (in)	Insulation Thickness mm (in)
25 (1) and below	25 (1)
32 to 80 (1-1/4 to 3)	38 (1-1/2)
100 (40 and above)	50 (2)

4. Thickness-rigid closed-cell phenolic foam insulation:

Nominal Thickness Of Insulation	
Pipe Diameter mm (in)	Insulation Thickness mm (in)
25 (1) and below	19 (0.75)
32 to 80 (1-1/4 to 3)	19 (0.75)
100 (4) and above	25 (1)

D. Protective insulation to prevent personnel injury:

1. Application: Piping from zero to 1800 mm (6 feet) above all floors and access platforms including continuous blowoff, feedwater and boiler water sample, blowoff tank vent, flash tank vents and condensater tank vent, shot-type chemical feed, fire tube boiler bottom blowoff after valves, valve by-passes.
2. Insulation thickness: 25 mm (1 inch).
3. Insulation and jacket: Calcium silicate with ASJ except provide aluminum jacket on piping at boilers within 1800 mm (6 feet) of floor. Use PVC premolded fitting coverings when all service jacket is utilized.

E. Installation:

1. At pipe supports, weld pipe covering protection saddles to pipe, except where MS-SP58, type 3 pipe clamps are utilized.
2. Insulation shall be firmly applied, joints butted tightly, mechanically fastened by stainless steel wires on 300 mm (12 inch) centers.
3. At support points, fill and thoroughly pack space between pipe covering protective saddle bearing area.
4. Terminate insulation and jacket hard and tight at anchor points.
5. Terminate insulation at piping facilities not insulated with a 45 degree chamfered section of insulating and finishing cement covered with jacket.
6. On calcium silicate, mineral fiber and rigid closed-cell phenolic foam systems, insulated flanged fittings, strainers and valves with sections of pipe insulation cut, fitted and arranged neatly and firmly wired in place. Fill all cracks, voids and coat outer surface with insulating cement. Install jacket. Provide similar construction

- on welded and threaded fittings on calcium silicate systems or use premolded fitting insulation.
7. On mineral fiber systems, insulate welded and threaded fittings more than 50 mm (2 inches) in diameter with compressed blanket insulation (minimum 2/1) and finish with jacket or PVC cover.
  8. Insulate fittings 50 mm (2 inches) and smaller with mastic finishing material and cover with jacket.
  9. Insulate valve bonnet upto valve side of bonnet flange to permit bonnet flange removal without disturbing insulation.
  10. Install jacket smooth, tight and neatly finish all edges. Over wrap ASJ butt strips by 50 percent. Secure aluminum jacket with stainless steel bands 300 mm (12 inches) on center or aluminum screws on 200 mm (4 inch) centers.
  11. Do not insulate basket removal flanges on strainers.

#### **3.4 APPLICATION-BOILER FLUE GAS SYSTEMS**

- A. Temperature range 150 to 370 degrees C (300 to 700 degrees F):
  1. Application: Transitions, stacks and breechings from boiler outlet to stack outlet; induced draft fans (if provided); flue gas recirculation fans and ductwork (if provided).
  2. Thickness:
    - a. Single-wall duct systems: 50 mm (2 inches).
    - b. Double-wall factory-fabricated duct systems with air space between walls: None.
  3. Insulation and jacket: Calcium Silicate with aluminum sheet metal jacket.
- B. Protective Insulation to Prevent Personnel Injury:
  1. Application: Double wall factory-fabricated duct system with uninsulated air space between walls within 900 mm (3 feet) horizontally and 1800 mm (6 feet) vertically of platform or floor.
  2. Insulation thickness; 25 mm (1 inch).
  3. Insulation and jacket: Calcium Silicate with aluminum sheet metal jacket.
- C. Insulating:
  1. Provide attachment facilities such as angles, welded studs, clip angles.
  2. Apply insulation with joints tightly butted and staggered. Seal joints with high temperature cement.

3. Provide metal corner beads.
4. Band insulation firmly in place to provide a smooth surface. Maximum band spacing shall not be more than 300 mm (12 inches).
5. Install jacket. All surfaces outside of building must be weather tight. At termination of stub stacks, provide metal closure system which is connected and sealed to perimeter of stack to prevent water penetration of insulation.

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**SECTION 23 08 00**  
**COMMISSIONING OF MECHANICAL SYSTEMS**

**PART 1 - GENERAL**

**1.1 RELATED DOCUMENTS**

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

**1.2 SUMMARY**

- A. Section refers contracts to commissioning process requirements for mechanical systems, assemblies, and equipment found in related division 01 sections.
- B. Related Sections:
  - 1. Division 01 Section 019113 "Commissioning Requirements" for definitions, roles and responsibilities, and process requirements for all systems to be commissioned.

**1.3 DESCRIPTION**

- A. Commissioning is a systematic process of ensuring that all building systems perform interactively according to the design intent and the owner's operational needs. This is achieved by beginning in the design phase and documenting design intent and continuing through construction, acceptance and the warranty period with actual verification of performance. The commissioning process shall encompass and coordinate the traditionally separate functions of system documentation, equipment startup, control system calibration, testing and balancing, performance testing and training. Commissioning during the construction phase is intended to achieve the following specific objectives according to the Contract Documents:
  - 1. Verify that applicable equipment and systems are installed according to the manufacturer's recommendations and to industry accepted minimum standards and that they receive adequate operational checkout by installing contractors.
  - 2. Verify and document proper performance of equipment and systems.
  - 3. Verify that the Owner's operating personnel are adequately trained.
- B. The commissioning process does not take away from or reduce the responsibility of the system designers or installing contractors to provide a finished and fully functioning product.

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

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

---END---

**SECTION 23 08 11**  
**DEMONSTRATIONS AND TESTS FOR BOILER PLANT**

**PART 1 - GENERAL**

**1.1 REQUIREMENTS INCLUDED**

- A. Procedures for on-site demonstration and testing of equipment and systems, including temporary facilities.
- B. Instruction of Government operating personnel.
- C. All demonstrations, instructions and testing must be completed prior to Government acceptance for beneficial use.
- D. Plumbing and emergency power systems are not included.

**1.2 DEFINITIONS**

- A. Start-Up: Initial inspection, cleaning, lubrication, adjustment, and operation of equipment and systems by the contractor with the assistance of the representatives of the equipment manufacturers.
- B. Pre-Tests: The final stage of the start-up procedure. This occurs after all adjustments have been made except for minor fine-tuning that can be done during the pre-test. Serves as verification that the systems are ready for the final test. Witnessing of pre-test by Resident Engineer (RE)/Contracting Officers Technical Representative (COTR) is not required.
- C. Final Tests: Tests, witnessed by the RE/COTR or their representative, which demonstrate that all equipment and systems are in compliance with requirements. At VA expense, VA may utilize the services of an independent testing organization or consultant to witness the tests.

**1.3 RELATED REQUIREMENTS**

- A. Operating and maintenance manuals: Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION.
- B. Demonstration, instructions and testing of temporary equipment: Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION.
- C. Sound and vibration levels; sound tests and vibration testing of rotating equipment: Section 23 05 51, NOISE AND VIBRATION CONTROL FOR BOILER PLANT.
- D. Leak testing of piping systems, pressure testing of non-boiler safety valves: Section 23 21 11, BOILER PLANT PIPING SYSTEMS.
- E. Demonstration and testing of water tube steam generator, burners, controls and accessories, Section 23 52 34, STEAM GENERATOR.
- F. Demonstration and testing of feedwater deaerator: Section 23 50 11, BOILER PLANT MECHANICAL EQUIPMENT.

- G. Demonstration and testing of boiler plant instrumentation, controls and computer work station: Section 23 09 11, INSTRUMENTATION AND CONTROL FOR BOILER PLANT.

#### 1.4 QUALITY ASSURANCE

- A. Experienced, trained technical service personnel who are representatives of the equipment manufacturers and system designers shall demonstrate, provide instructions, pre-test and final test, as specified, the following equipment:
1. Boilers and economizers
  2. Burners
  3. Control systems.
  4. Instrumentation.
- B. Experienced technicians shall demonstrate and provide instructions on the following equipment:
1. Pumps and piping systems
  2. Ventilation, combustion air, and heating systems
  3. Compressed air systems
  4. Control and safety valves
- C. The person responsible for programming the computer workstation shall demonstrate and provide instructions on hardware, software and programming.
- D. The RE/COTR, upon request, will provide a list of personnel to receive instructions and will coordinate their attendance at agreed-upon times.

#### 1.5 SUBMITTALS

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Names and qualifications of personnel performing demonstrations, instructions and tests.
- C. Certification that pre-testing is complete. Copies of boiler-burner pre-test data as specified.
- D. Preliminary schedule of all demonstrations, instructions and final tests two weeks prior to proposed dates.
- E. Provide reports within three weeks after satisfactory completion of demonstrations, instructions, and tests. List date, type of work, persons participating, amount of time, test results, calculations of test results, test data.

**PART 2 - PRODUCTS (NOT USED)**

**PART 3 - EXECUTION**

**3.1 PREPARATION FOR FINAL TESTS, DEMONSTRATIONS, AND INSTRUCTIONS**

- A. Verify that equipment and systems are fully operational. Complete all start-up and pre-test activities for all equipment and systems. Complete all construction and finish work.
- B. Arrange for all test personnel for all equipment to be continuously present during one period of time so that all equipment and systems can be tested in their interrelated functions. For instance, feedwater deaerator will be tested during the boiler testing, and instrumentation performance will be evaluated in conjunction with boiler testing.
- C. Deliver maintenance and operating manuals four weeks prior to instruction period.
- D. Furnish all special tools.

**3.2 FINAL TESTS**

- A. Demonstrate proper operation of each equipment and system.
- B. Provide tests on equipment as specified in the individual specification sections.

**3.3 DEMONSTRATIONS AND INSTRUCTION**

- A. Demonstrate operation and maintenance of equipment and systems to Government personnel no more than four weeks prior to scheduled Government operation of the plant.
- B. Use operation and maintenance manuals as basis of instruction. Review contents of manuals with personnel in detail to explain all aspects of operation and maintenance.
- C. Demonstrate start-up, operation, control, adjustment, trouble-shooting, servicing, maintenance, and shut-down of each item of equipment. Allow Government personnel to practice operating the equipment under supervision of instructors.
- D. Prepare and insert additional data in operations and maintenance manuals when need for additional data becomes apparent during instructions.
- E. Provide video with audio of all instructions given orally to VA personnel. Provide four copies in DVD format.

**3.4 TIME ALLOCATED FOR DEMONSTRATIONS AND INSTRUCTIONS**

- A. At least 32 total instructor hours to include boilers, economizers, burners, burner controls, combustion controls, instrumentation.
- B. At least 16 total instructor hours to include computer workstation and programs.
- C. At least eight total instructor hours to include other equipment.

D. Do not exceed three trainees per session, one-four hour session, per day, per trainee.

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**SECTION 23 09 11**  
**INSTRUMENTATION AND CONTROL FOR BOILER PLANT**

**PART 1 - GENERAL:**

**1.1 DESCRIPTION:**

Automatic controls, instruments, monitoring and data management systems and accessories for the boilers, burners and other boiler plant mechanical equipment. The specification classifies the systems into automatic boiler and burner control systems, burner management systems (flame safeguard), and data management and instrumentation systems.

**1.2 RELATED WORK:**

- A. Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATIONB. Section 23 05 51, NOISE AND VIBRATION CONTROL FOR BOILER PLANT.
- B. Piping for controls and instrumentation panel: Section 23 21 11, BOILER PLANT PIPING SYSTEMS.
- C. Instrumentation furnished with steam generator: Section 23 52 34, STEAM GENERATOR.
- D. Air compressors and accessories for pneumatic control: Section 23 50 11, BOILER PLANT MECHANICAL EQUIPMENT.
- E. Section 23 08 11, DEMONSTRATIONS AND TESTS FOR BOILER PLANT.

**1.3 QUALITY ASSURANCE:**

- A. The boiler and burner control, monitoring, data gathering, instrumentation and associated systems specified in this section shall be provided by one company that has been in business at least three years engineering, designing and servicing industrial and institutional boiler control and instrumentation systems similar to those specified herein, as a primary business. That company shall furnish all components and provide complete calibration, programming, start-up, testing, demonstrations, instructions and training services.
- B. Submit documented evidence, including start-up and acceptance test data, and references, that the company has performed satisfactory work on at least six systems similar to those specified. For instance, submit experience information on systems involving parallel positioning combustion control and on variable speed forced draft fan drives, if these systems are specified.
- C. The burner manufacturer shall be responsible for the burner management system (flame safeguard), including interlocks, all accessories and for coordination with other control and monitoring systems.
- D. Equipment Experience Requirements: Refer to Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION.
- E. Code Approval:

1. All burner management and combustion control systems and devices shall comply with NFPA 85. Locations and arrangements of safety devices on fuel trains shall comply with diagrams included in "Annex A" in the code.
  2. All burner management controls and interlock devices shall be UL listed and FM approved. All controllers that include burner management functions shall be UL listed and FM approved.
  3. Parallel positioning combustion control systems shall comply with UL 1998.
  4. Computer-based electronic equipment shall conform to the requirements of FCC Part 15, Subpart J, for Class A computing devices governing radio frequency electromagnetic interference (EMI) while continuing to operate normally.
  5. All electrical wiring shall be in accordance with NFPA 70.
- F. Personnel: All work shall be done by properly trained, skilled technicians who are regularly employed and qualified in the installation, programming, start-up, calibration, and testing of the systems provided, and who will be directed by experienced engineers employed by the equipment supplier. Personnel must have three years minimum experience with industrial and institutional boiler plant controls and instruments similar to those being furnished for this project.

**1.4 SUBMITTALS:**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Certificates of compliance with Article, QUALITY ASSURANCE.
- C. Submit information sufficient to verify compliance with all contract requirements as specified and shown on project drawings.
- D. Automatic Boiler Control and Burner Management and Safety Interlock Systems:
  1. Catalog cuts and specification sheets providing description and performance data on: Controllers, control and indicating stations, sensors and transmitters, signal conditioners, electric switches and relays, indicators and annunciators, safety interlock devices, drive units and actuators, control valves, mechanical linkage systems, compressed air filters and regulators.
  2. Statement from controller manufacturer that the type and model submitted is the current generation and that the manufacturer will support the units with parts and service for at least ten years.

3. Information on all the specific systems that is sufficient to allow complete troubleshooting. As a minimum this should include explanation of the control logic, and wiring diagrams of equipment and systems.
  4. Hardware systems schematics showing field and panel equipment interface block diagram.
  5. Location of interlock devices on the burners, boilers, fuel trains and accessory equipment.
- E. Boiler Plant Instrumentation:
1. Catalog cuts and specification sheets providing description and performance data on instruments and accessories.
  2. Installation and troubleshooting instructions for all equipment in bound sets shipped with equipment.
  3. List of ranges of recorder displays or charts. For paper chart recorders, submit ranges for charts that will be furnished.
  4. Flow meter primary element design, size, performance, and sizing calculation. Steam flow performance data for flow meters verifying project performance requirements.
  5. Complete wiring and piping diagrams for all equipment and systems.
  6. Wiring and piping materials.
- F. Instrumentation and Control Panels:
1. Drawing showing arrangement of instruments and controls on panels.
  2. Drawing showing panel arrangements, construction, door swing clearance allowance, dimensions, finishes.
  3. Description of panel construction.
- G. As-built Logic and Wiring Diagrams: One set of reproducible prints and CAD disks delivered to Resident Engineer (RE)/Contracting Officers Technical Representative (COTR) prior to turning systems over to VA for operation. Supply revised drawings if changes are made during the startup and commissioning process.
- H. Fluid Flow Meters:
1. Catalog cuts and drawings with description, specifications and dimensions of meters and accessories.
  2. Design and construction of meters and accessories.
  3. Performance data including flow, pressure drop, accuracy over the metering range of the actual fluids to be metered.
  4. Pressure and temperature limitations.
  5. Manufacturer's installation instructions.
  6. Arrangement of register face and remote indicator (if provided).
- I. Pressure Gages and Thermometers:

1. Catalog cuts showing design, construction, dimensions of gages and accessories.
2. Accuracy.
3. Pressure and temperature limitations of gages and accessories.
4. List of scale ranges to be provided.

**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 National Standards Institute (ANSI):  
INCITS 154-1988(R2004)..Office Machines and Supplies - Alphanumeric  
Machines - Keyboard Arrangements
- C. American Society of Mechanical Engineers (ASME):  
B16.36-2006.....Orifice Flanges  
B31.1-2007.....Code for Pressure Piping, Power Piping, with  
Addenda  
B40.100-2005.....Pressure Gauges and Gauge Attachments  
PTC 4-2008.....Performance Test Code, Fired Steam Generators
- D. National Fire Protection Association (NFPA):  
70-2008.....National Electrical Code  
85-2007.....Boiler and Combustion Systems Hazards Code
- E. National Electrical Manufacturers Association (NEMA):  
ICS 6-93(R2001, R2006)..Industrial Control and Systems Enclosures  
WC 63.2-1996(R2003).....Performance Standard for Coaxial Premise Data  
Communications Cables
- F. Underwriters Laboratories Inc. (UL):  
508-06.....Industrial Control Equipment  
1449-09.....Transient Voltage Surge Suppressors, Second  
Edition  
1998-09.....Software in Programmable Components

**PART 2 - PRODUCTS:**

**2.1 AUTOMATIC BOILER/BURNER CONTROL SYSTEM, NOT INCLUDING BURNER MANAGEMENT (FLAME SAFEGUARD) :**

- A. Basic Description of Controllers and Control Functions:
  1. Controllers shall be industrial-process-grade multi-loop programmable microprocessor or PLC.
  2. Controllers shall be manufactured separate from and shall be separate assemblies from the Burner Management (Flame Safeguard System)
  3. Control functions:
    - a. Control of burner firing rates to maintain steam header pressure.

- b. Parallel-positioning combustion control (air/fuel ratio, excess air) with flue gas oxygen trim.
- c. Flue gas recirculation (FGR).
- d. Boiler water level, 3 element system.
- 4. Control features:
  - a. Operator interface on controller faceplates and touch screens. Operator interface shall include manual/automatic selection, manual loading, and displays that show set point, process variable, signal to actuator, process status and controller status. Touch screens have additional display requirements; refer to paragraph below.
  - b. Provide separate dedicated controllers for boiler and for the master steam pressure control. Fuel/air control loops, including flue gas recirculation (FGR) and oxygen trim may be incorporated into one station for each boiler. Boiler/economizer outlet draft and boiler water level control shall have separate stations for each item on each boiler.
  - c. Variable frequency drives on forced draft fan motors.
- 5. Refer to the paragraphs which follow for complete detailed requirements.
- 6. Refer to Par. 2.2 for burner management controls.
- B. Controllers: Multiple-loop programmable microprocessor or programmable logic (PLC) proportional-integral-derivative (PID) solid state electronic controllers shall control all functions except burner management.
  - 1. Accuracy: 0.1% analog inputs and outputs.
  - 2. Resolution: 16 bit input and output.
  - 3. Environment: 0 to 50 degrees C, 15% to 95% RH, non-condensing.
  - 4. As a minimum, each controller shall have capability for four analog and four digital inputs, two analog and four digital outputs, and two PID loops.
  - 5. Memory retention for twelve months minimum for power failure or for storage as spare parts.
  - 6. Push buttons with tactile feedback.
  - 7. Displays shall be a combination of English language, color graphics, and digital with 0.5 percent resolution, visible from wide angle.
  - 8. Bumpless manual/automatic transfer.
  - 9. High and low alarms for all inputs.
  - 10. Programming: Controllers shall have capability for quick (5 - 10 minutes) reloading of memory by operating personnel upon memory loss.

- Provide all software and hardware necessary to allow field downloading of configuration memory to the microprocessors.
11. Password Protection: Provide levels of password protection for all safety related options and parameters including all commissioning programming. Provide all passwords to Resident Engineer (RE)/Contracting Officers Technical Representative (COTR).
  12. In the event of a controller fault, the controller shall have a dedicated relay output that results in the shut down of the boiler and provides an alarm to a panel-mounted light and audible alarm. Failure of control system for one boiler shall not affect automatic and manual operation of other boilers.
  13. Controllers and software that operate variable frequency drives shall be manufactured and tested in accordance with UL 508.
  14. Controllers shall provide serial RS232/RS485 Modbus communication with computer workstation running latest Microsoft Windows-based operating system. This includes data gathering and processing, report generation, monitoring, annunciation and control. It shall be possible to defeat the remote control from the front panel of each individual controller, preventing any status changes from being initiated at the computer workstation.
  15. All controllers, including those assigned to data processing, shall be same model and series.
  16. Controllers shall be the current generation product that will be supported by the manufacturer, with parts and service, for a minimum of ten years from time of installation.
  17. All controllers shall be mounted within specified control panels.
- C. Power Supplies: Provide separate uninterrupted power supply for boiler control group. Any signal that is common to all boilers, such as plant master control signals, shall be isolated from all other boilers so that failure in one boiler circuit will not affect other boilers.
- D. Drive Units and Actuators for Dampers, Fuel Flow Control Valves, Feedwater Flow Control Valves:
1. Electric drive units are required except pneumatic actuators are allowed for feedwater valves.
  2. Electric drive units shall have continuous modulating duty cycle without any duty cycle or thermal motor limitations. Shall start instantaneously at full rated torque, stop instantaneously without coast or overshoot. Shall smoothly operate all connected devices without overload. Provide 100 percent duty cycle maintenance free motors that never overheat or burnout under stalled conditions.

- Gearing shall eliminate backlash. Movement shall be constant speed and shall be coordinated with the controlled process so that performance parameters remain within specified limits.
3. Additional Requirements for Electric Drive Units on Parallel-Positioning Combustion Control Systems:
- a. Drive units shall have precise positioning and repeatability to provide air-fuel positioning ratios with a maximum hysteresis of 2%.
  - b. Provide continuous precise feedback signals from drive units to controllers.
  - c. Provide auxiliary contacts to prove low and high fire positions. All systems compared should be modern and new systems. Comparing the current aged system to modern systems is not comparing apples to apples. Performance of modern boilers, burners, economizers, heat exchangers, and new distribution systems should be used in the comparison. . Belt-type drive units not permitted.
  - e. Drive unit shafts shall be keyed to fuel flow control valves and damper shafts to eliminate the possibility of slipping.
  - f. Drive units shall be industrial rated.
  - g. All gearing shall be brass or better, no plastic gears of any kind are permitted.
- E. Variable Frequency Drives (VFD) for Forced Draft Fans:
- 1. Refer to Section 26 29 11, MOTOR STARTERS, for electrical requirements. In addition, there shall be a VFD mounted operator interface unit that allows configuration of drive parameters and displays diagnostic information for troubleshooting.
  - 2. Provide feedback system including motor speed and direction of rotation to combustion controller. Feedback transmitter must have no-drift guarantee. Feedback system shall not be affected by position of H-O-A switch on motor control system.
  - 3. Provide noise filters.
  - 4. The VFD shall automatically limit the rate of fan speed increase to that which will prevent an over-current trip in the event of a "step" speed increase of 0 - 100%.
  - 5. Provide constant speed feature and operator-selectable air/fuel program in the controller for constant speed operation maintaining specified air/fuel ratios (excess air).
  - 6. Forced draft fan damper operation is required in conjunction with operation of the VFD at the lower firing rates.

F. Transmitters: See Paragraphs, PRESSURE SENSORS AND TRANSMITTERS, TEMPERATURE SENSORS AND TRANSMITTERS.

G. Final Control Elements:

1. Fuel flow control valves, forced draft fan dampers, flue gas recirculation (FGR) dampers (if provided), variable frequency forced draft fan drives (VFD) (if provided), feedwater control valves: Refer to Section 23 52 34, STEAM GENERATOR.
2. Dampers in stacks and breechings: Refer to Section 23 51 00, BREECHINGS, CHIMNEYS, AND STACKS.

H. Uninterrupted Power Supplies:

1. Provide separate complete protected power conditioners for each boiler control and for master control. Power supply shall protect all computers, controls, instruments and accessories from damage due to ground leakage, spikes, sags, surges, transients and overloads in the incoming power supply.
2. Line interactive, UL 1449-rated, interactive digital display. Automatic internal bypass. Smooth sine wave output.
3. Suitable for ambient temperature of 44 degrees C (110 degrees F) in boiler room panel.
4. Hot swappable batteries.
5. Audible and visual alarms to signal failure of power supply.
6. This UPS system can be deleted from the project if controls furnished have integral protection from power supply irregularities listed above, and if software can be immediately reloaded by plant personnel.

I. Spare Parts and Tools:

1. Master control steam pressure transmitter: One complete unit, calibrated for the service.
2. Hardware and software sufficient for downloading and uploading all programming configurations with all the controllers.
3. Electric power drive unit: One of each size and type used

J. Detailed Control Functions:

1. Control of Burner Firing Rates to Maintain Steam Header Pressure:
  - a. Automatic modulation of burner firing rates on all boilers to maintain set pressure of main steam header. Master controller receives signal from header pressure transmitter, processes and transmits signal to submaster controller for each boiler/burner. Submaster controls fuel flow and combustion air flow.
  - b. Set Points and Performance: Accuracy plus or minus two percent of the set pressure when steam load changes do not exceed 20 percent

of the maximum continuous rating of the largest boiler in service in a sixty second period. System oscillations shall be minimal. Set point 125 psi. Second set point 85 psi.

Individual set point adjustment range: +/- 140 kPa (20 psi).

- c. Control Stations: Individual control stations for master and submaster controllers. Locate control stations on main instrumentation panel unless otherwise shown. Master controller shall have capability for two set points with easy selection.
  - d. Low fire hold capability and user definable optimum ignition position.
  - e. Interface with burner management system for automatic positioning of forced draft fan damper, forced draft fan speed, and fuel flow control valves during pre-purge, ignition, shutdown and post-purge.
  - f. Interlocks to prove proper positions of forced draft fan damper, forced draft fan speed, boiler/economizer outlet damper and fuel flow control valves for ignition and running cycles. Refer to paragraph, BURNER MANAGEMENT SYSTEM WITH SAFETY INTERLOCKS AND ACCESSORIES.
2. Parallel-Positioning Combustion Control (Air/Fuel Ratio, Excess Air):
- a. Boiler/burner submaster controller provides firing rate signals to separate drive units (actuators) for forced draft fan dampers and for each of the fuel flow control valves and to the variable frequency drive (VFD) of the forced draft fan. Air/fuel ratio maintained by firmware and software programming of the submaster controller. Software shall be factory-programmed for the specific application. Only tuning and scaling shall be performed in the field.
  - b. Hardware, firmware and software shall comply with UL 1998. Incorporate cross-limiting (air leading fuel on load increases, fuel leading air on load decreases) and deviation limiting (allowable tolerances on air/fuel ratio). Provide automatic burner shut down if deviation exceeds programmed limits or if there is a controller failure.
  - c. Provide feedback signals from drives and actuators. Fuel flow shall not increase until appropriate combustion air flow increase is proven. Combustion air flow shall not decrease until appropriate fuel flow decrease is proven. VFD feedback transmitters shall have "no-drift" guarantee.

- d. Accuracy of control of drive units shall result in fuel-air positioning ratios that are specified by the burner manufacturer for efficient and safe operation with a maximum hysteresis of 2 percent. Excess air in flue gas shall conform to limits given below.
  - e. Manual control function accessible to operating personnel shall be confined to base loading the firing rate of the burner and shall not permit separate control of fuel or combustion air. All other manual functions shall be password protected intended to be accessible only to qualified technicians. If system is improperly placed in a manual control mode, the system shall shut down the boiler or maintain safe excess air levels at all times, within parameters that limit the carbon monoxide emissions to specified limits.
  - f. From low fire to high fire the air/fuel ratio (excess air) shall be programmed over at least ten evenly spaced increments of fuel input.
  - g. Control positions and display indications shall be linear in relation to firing rate. For example, 20% control position shall be 20% firing rate (20% of full load).
  - h. Mechanical connections between drive units and dampers and valves shall not have hysteresis and shall be keyed to eliminate slippage. Use of linkage systems must be minimized and submitted for approval as a deviation to the contract.
  - i. Excess Air and Emissions Limits - New Burners: Refer to the boiler and burner specification.
3. Automatic Flue Gas Oxygen Trim System:
- a. Boiler/burner submaster air/fuel controller shall utilize signal from flue gas oxygen analyzer and vary the combustion air flow to maintain the specified air/fuel ratio (excess air) at all firing rates 20 percent of maximum firing rate and greater.
  - b. Operation and Performance:
    - 1) Separate characterized set point curves for each fuel, minimum ten points per fuel. A single curve with biasing for the other fuel is not acceptable. Automatic change over of set point curves when type of fuel being fired is changed.
    - 2) Maximum deviations from set points shall not exceed ten percent at any firing rate. Combustion shall not generate carbon monoxide (CO) in excess of 200 parts per million (ppm) at any time.

- 3) At firing rates below 10 percent of maximum steam flow, trim shall automatically return to null position (no trim).
- 4) Variable gain to decrease output sensitivity at low loads.
- 5) Adjustable high and low trim limiting. Excessive high or low trim correction, low excess air, or oxygen analyzer failure shall actuate audible and visual alarm on the boiler submaster air/fuel ratio controller. Analyzer failure shall cause system to go to null position.
- 6) Manual trim output shall revert to null setting when system is placed in automatic control.
- c. During burner start-up and adjustment of air/fuel ratios (excess air) by service technician, trim shall be on manual control at null position.
- d. Refer to Paragraph, FLUE GAS OXYGEN ANALYZERS.
4. Flue Gas Recirculation (FGR) Control:
  - a. Automatic operation of FGR damper to control NOx emissions to required limits and to provide purging of combustibles from the FGR ducts during the pre-purge cycle.
  - b. Automatically disable FGR during burner start-up cycle due to potential for flame instability. Automatically enable the FGR after the boiler flue gas outlet temperature reaches a minimum of 150 degrees C (300 degrees F).
  - c. Interface with burner management system with interlocks to prove FGR dampers in proper position for pre-purge prior to ignition. Refer to Paragraph, BURNER MANAGEMENT SYSTEMS WITH SAFETY INTERLOCKS AND ACCESSORIES.
5. Boiler Water Level Control:
  - a. Automatically modulate the position of feedwater control valve on each boiler to maintain the water level in the boiler within plus or minus 50 mm (2 inches) of set point with instantaneous load swings of 20 percent of boiler capacity. Adjustable set point.
  - b. Type of System:
    - 1) Three-Element System: Utilize boiler steam flow signal, boiler water level signal and boiler feedwater header pressure signal. Adjustable signal gain. Provide single-element (drum level) operation from low fire to 20 percent of maximum boiler load. Provide automatic switchover from single-element to three-element operation and vice-versa at 20 percent load.
  - c. Boiler Water Level Sensors:

- 1) Differential Pressure Transmitters: Provide on water tube boilers. Refer to Paragraph, PRESSURE SENSORS AND TRANSMITTERS.
- 2) Water Level Sensing and Safety Control Systems: Provide on fire tube boilers. Refer to Section 23 52 34, STEAM GENERATOR.
- 3) Probe-Type Capacitance Systems: Optional control for fire tube and water tube boilers. Dual probes mounted in water column controlled by microprocessor system. Provisions to compensate for shrink and swell of water level due to load changes. Self-checking function comparing the signals from each probe and causing burner shutdown if water level movement is not detected.
- d. Steam Flow Sensors: Refer to Paragraph, FLOW METERS.
- e. Feedwater Pressure Sensors: Refer to Paragraph, PRESSURE SENSORS AND TRANSMITTERS.
- f. Controller: Controllers for two and three element systems shall include: manual/auto control station and indicators showing signal level to actuator, set point and actual water level, steam flow rates and totals and boiler feedwater flow rates and totals if flow meters are included. Locate on main instrumentation panel unless otherwise shown. For controller requirements for fire tube boilers, refer to Section 23 52 34, STEAM GENERATOR, for control panel requirements.
- g. Set point position as recommended by boiler manufacturer.
6. Boiler and Economizer Efficiency Calculation and Display: If not provided on the computer work station, provide continuous automatic calculations and indication of heat-loss combustion efficiency based on flue gas outlet temperature of economizer (or boiler if economizer is not provided), flue gas oxygen, and type of fuel in use. Base calculation method on ASME Performance Test Code Form Number 4.1b, HEAT LOSS EFFICIENCY, with no consideration for boiler radiation and unaccounted losses.

## **2.2 BURNER MANAGEMENT (FLAME SAFEGUARD CONTROL) SYSTEM WITH SAFETY INTERLOCKS AND ACCESSORIES**

- A. Complete automatic safety control and monitoring system for burner ignition sequencing, operating cycle, and shut-down sequencing. System shall include microprocessor programmer, self-checking ultraviolet (UV) flame scanner and amplifier (see below for limited exceptions), burner cycle display, first-out diagnostic annunciation display, burner safety shut down interlocks, communication with monitoring systems, and accessories. Mount controllers, control switches and displays in and on individual boiler control panels. Refer to Paragraph, BOILER/BURNER

CONTROL PANELS. All interlock devices shall be designed to permit periodic operational testing, including set points and trip points, without changing set points or programming.

1. Controller shall be manufactured separately from the Burner Control System controller.
  2. Controller shall be a separate and individual assembly from any other controller.
  3. Controller shall have its own mounting and wiring base to permit the controller to be replaced without disturbing any wiring or other components.
- B. Code Compliance: Conform to NFPA 85. All components UL listed, FM approved.
- C. Operate on 102 to 132 volts; 60 Hertz AC. Operating ambient temperature range 0 °C to 52 °C (32 °F to 125 °F).
- D. Flame Scanners: Provide self-checking ultraviolet (UV) scanners except where burner manufacturer provides documentation that burner design precludes reliable operation with UV. When UV is unreliable, provide infrared scanners with "learn function" of unique flame characteristics.
1. Self-checking UV scanners shall have minimum checking frequency six times per minute. Position scanners so that they do not view the ignition spark. Scanner sight tubes must be non-reflective to avoid the scanner detecting the reflection of the ignition spark. UV non-self-checking scanners are not permitted because they can fail in an unsafe mode on continuously operated burners.
  2. Infrared (IR) systems must have a "learn function" that can be programmed on site for the particular pilot and main flame characteristics including amplitude and radiation levels and to reject background radiation. Submit layout drawings showing that scanners will be positioned to not view refractory or any element of the furnace that can radiate IR wavelengths. The Fireye BurnerLogix® system is an example of this technology.
- E. Control Features:
1. Interrupted ignition.
  2. Early spark termination on UV systems.
  3. Flame failure response time four seconds maximum.
  4. Ten seconds trial for ignition except 15 seconds permitted on heavy oil fuel.
  5. Pre-purge timing set for 8 air changes on water tube boilers per NFPA 85. The exact timing must be determined by the boiler manufacturer. For example, typical pre-purge timing with wide open forced draft

damper and forced draft fan at full speed has been 30 seconds for packaged fire tube boilers and 2 minutes for packaged water tube boilers.

- F. Provide components that can be easily removed from the panel without disturbing wiring.
- G. Memory storage and self-diagnostics of at least six most recent causes of burner shutdown, which can be accessed by operating and service personnel. Diagnostics shall include all individual interlocks.
- H. Provide Modbus RS232/RS485 and modem interface to allow remote access to memory. Provide interface with SCADA software on computer workstation to allow access to burner management memory and to current operating information.
- I. Burner cycle indication on face of panel: Show instantaneous status of start up, run and shut down program. Provide indicator for control power on, ignition, main fuel valve open, and flame failure.
- J. Reset button on face of panel.
- K. Annunciator Display and Alarm:
  - 1. Locate display on outside face of panel between 1200 mm and 1500 mm (4 feet and 5 feet) above the floor.
  - 2. English language read-out with individual identification of specific interlocks. Where two or more interlocks serve the same function, individual display of each interlock is not required.
  - 3. Indicate burner status in English messages: control on, pre-purge, trial for ignition, igniter flame signal, main flame signal, post purge, burner off.
  - 4. Continuously indicate flame signal strength.
  - 5. Provide first-out annunciation, including English language message, and audible alarm (horn) for each of the following interlocks:
    - a. Flame failure.
    - b. Purge airflow low.
    - c. Combustion air low.
    - d. False combustion air (switch activated with combustion air flow).
    - e. High main gas fuel pressure.
    - f. Low main gas fuel pressure.
    - g. High oil pressure.
    - h. Low oil pressure.
    - i. Low igniter (pilot) gas pressure.
    - j. Low oil temperature (heated oil systems only).
    - k. Fuel safety shut-off valves not closed prior to ignition cycle.
    - l. Low fire position not attained prior to ignition cycle.

- m. Low atomizing media (steam or air) static pressure at atomizing media service connection to burner piping.
  - n. Low atomizing steam/oil differential pressure. Where burner does not maintain differential pressure provide low atomizing media pressure at burner.
  - o. High steam pressure.
  - p. Low water cutoff.
  - q. Low control air pressure (if pneumatic feedwater control valve drive units or other controls are furnished).
  - r. Flue gas recirculation (if provided) improper damper position.
  - s. Low flue gas oxygen.
  - t. High furnace pressure (if outlet draft control system furnished).
  - u. Building combustion air intake louver closed or make-up air ventilation system not operating.
6. Audible alarm (horn): Sounds upon all burner shutdowns except automatic recycle shutdowns on steam pressure. Provide silencing control, which automatically resets when burner control is reset.
- L. Pre-Purge Timing: Integral with the programmer. Non-adjustable after initially set to suit boiler pre-purge requirements.
- M. Auxiliary relays: Industrial type rated for the service, enclosed contacts.
- N. Selector switches, push buttons and control switches: Heavy duty, industrial type.
- O. Safety shut down and manual reset required for, but not limited to:
- 1. Flame signal detected prior to ignition cycle.
  - 2. Pre-ignition interlock open during pre-purge.
  - 3. High fire purge interlock fails to close within ten minutes or less after firing rate drive unit is commanded to drive to high fire.
  - 4. Low fire interlock fails to close within ten minutes or less after firing rate drive unit is commanded to drive to low fire.
  - 5. Igniter (pilot) or main burner fails to ignite.
  - 6. Malfunction of flame detector.
  - 7. Malfunction of programmer.
  - 8. Malfunction of flame signal amplifier.
  - 9. Combustion air proving switch actuated prior to start-up of forced draft fan.
  - 10. Lock-out interlock open during pre-purge (after 15 seconds), ignition or run period.
  - 11. Interlock open.
  - 12. Flame failure.

13. Building combustion air intake louvers closed or make up air ventilation system not operating.

P. Burner Safety Shut Down Interlock Devices:

1. Basic Requirements:

- a. Adjustable Set Points.
- b. Maximum Set Point Deviation: 5% of full scale.
- c. Minimum Repeatability: 2% of full scale.
- d. Minimum Set Point Accuracy: 10% of full scale or 20% of set point.
- e. Scale range shall allow set points to be within 30 to 70% of full scale.
- f. Safety interlock devices shall be separate from operating control elements, such as feedback devices. This is to avoid having the failure of an operating control device preventing the operation of the safety device.

2. Provisions for Testing of Interlocks:

- a. Installation of all interlock devices shall permit testing of set points and control operation without removing or disconnecting the devices and without adjusting set points of devices. Provide permanent connection points for test instruments, such as manometers and pressure gages, on sensing piping and tubing. Where necessary, provide lockable valves to allow temporary isolation of device from the service to allow testing of the device.
- b. All interlock device wiring shall start out at and end at a terminal strip in the main cabinet. No device shall be wire directly to another device in series without returning to the main cabinet's terminal strip first. All series wiring will take place at the terminal strip.
- c. Provide all necessary control system passwords, wiring diagrams, and step-by-step written instructions specific to that facility to COTR to facilitate all interlock testing required by the latest edition of the VHA Boiler Plant Safety Device Testing Manual.

3. Forced Draft Fan Motor Operation Interlock: Provide current relays on each phase of power circuits to fan motor. For variable speed drives, provide signals to control system from VFD fault and run contacts and signals from VFD shaft speed feedback to prove proper fan speed for purging, low fire ignition, and for each burner load point. Any disconnects or other power shut-off devices between the location of the interlock devices and the motor shall also shut down the power supply to the burner management control system.

4. Atomizing Air Compressor (when provided) Motor Energized Interlock:  
Provide current relays on each phase of power circuits to the motor.  
In the power supply to the motor there shall be no disconnects or other power shut-off devices between the location of the interlock devices and the motor.
5. Forced Draft Fan Damper, Boiler Or Economizer Flue Gas Outlet Damper (if provided) Pre-Purge Position Interlock: Prove dampers wide open for pre-purge. Actuate sealed snap-action switches by levers attached directly to dampers or to damper linkages, which are pinned to prevent slippage. Parallel positioning systems may have the interlock switches in the drive units.
6. Flue Gas Recirculation (FGR) Dampers (if provided) Position Interlock: Prove dampers positioned as required by burner manufacturer for pre-purge and firing. Actuate sealed snap-action switches by levers attached directly to dampers or to damper linkages, which are pinned to prevent slippage.
7. Pre-Purge Airflow Interlock:
  - a. Sense differential pressure between two points in combustion air system where the differential pressure at high fire is significant, such as several inches water column. There must be no intervening dampers. This is typically between the windbox and boiler outlet.
  - b. Diaphragm-actuated snap-action switch designed for maximum system pressure, adjustable set point, graduated set point indicating scales.
  - c. UL listed, FM approved.
  - d. Provide air pressure sensing connections for test manometer so that air flow switch settings can be verified.
  - e. Trip point shall prove at least 70% of maximum airflow.
8. Combustion Air Proving Interlock:
  - a. Sense differential air pressure across the forced draft fan with no intervening dampers.
  - b. Diaphragm-actuated snap-action switch designed for maximum system pressure, adjustable set point, graduated set point indicating scales.
  - c. UL listed, FM approved. Provide switch designed for "false combustion air" feature on start-up interlock.
  - d. Provide air pressure sensing connections for test manometer so that switch settings can be verified. Demonstrate that trip point

is within 10% of minimum differential pressure over the firing range of the burner.

9. High And Low Main Burner Fuel (Gas and Oil) And Low Igniter (Pilot) Gas Pressure Interlocks:
  - a. Solid-state sensor, mercury switch, automatic reset. Provide graduated set point indicator, switch position indicator, adjustable set point coordinated with burner requirements either on the switch or as a part of the controller. Switch movements shall have bushings to eliminate metal-to-metal wear.
  - b. Gas pressure switch ratings: Sustained pressure capability shall exceed two times lock-up of nearest upstream regulator.
  - c. Oil pressure switch ratings: Sustained pressure capability shall exceed set pressure, plus accumulation, of oil pump safety relief valve. On heated oil system, sustained temperature capability shall exceed maximum operating temperature.
  - d. Low gas pressure switches shall include impulse dampener to reduce the effects of pressure dips during start-up.
  - e. Mechanical movements shall have bushings to eliminate wear of metal parts.
  - f. Approvals: UL listed, FM approved.
  - g. Switch Locations: Must be located where pressure is constant, as controlled by pressure regulator (if provided) on fuel train. Must be upstream of modulating fuel flow control valves.
  - h. Set points shall be within 20% of the normal operating pressure.
  - i. High pressure switches shall be piped to the service with lockable isolation valve and valved test connection so that switch can be set and tested using compressed air.
10. Low Oil Temperature Interlock (Heated Oil Only):
  - a. Type: Solid-state sensor or sealed snap-acting switch, automatic reset. Provide graduated set point indicator, switch position indicator, adjustable set point coordinated with burner requirement either on the switch or as part of the controller.
  - b. Ratings: Sustained temperature capability shall exceed maximum oil temperature requirement.
  - c. Approvals: UL listed.
  - d. Location: Ahead of safety shut off valves.
11. Low Atomizing Media Pressure, Differential Pressure And Flow Interlocks:
  - a. Type: Mercury switches, graduated set point indicator, switch position indicator, adjustable set point coordinated with burner

- requirements, automatic reset. Switch movements shall have bushings to eliminate metal-to-metal wear.
- b. Rating: Shall exceed pressure setting of nearest upstream relief valve.
  - c. Provide siphon on steam connection to protect sensing element from live steam.
  - d. Approvals: UL listed.
  - e. Locations and types of switches on atomizing media piping: Two switches required for each burner, a static pressure switch on atomizing media supply ahead of differential pressure control valve, and differential pressure flow switch with flow meter orifice on atomizing piping adjacent to burner. On burners that maintain an approximately constant differential pressure between the atomizing steam and oil, provide a steam/oil differential pressure switch instead of the flow switch at the oil burner. Burners with individual air compressors for air atomization shall be provided with one air pressure switch and compressor motor interlocks as specified above.
12. Main Fuel (Gas And Oil) Automatic Safety Shut-Off Valves Proof-Of-Closure (Over Travel) Interlocks. Provide on all automatic safety shut off valves to prove closure prior to igniter (pilot) ignition. Provide manually-actuated test circuits through the proof-of-closure switches that will demonstrate that the switches close and open properly and that the circuit is connected to the burner management system.
13. Low Fire Position of Fuel Flow Control Valves Interlocks: Sealed snap-acting switches. Actuate switches by levers attached directly to fuel valves. As an option, the switch lever may be pinned to the jackshaft to which the fuel valve proportioning cams are also pinned or provide UL listed and FM approved position sensor on the motor which positions the jackshaft to which all the operating levers are pinned.
14. High Boiler Steam Pressure Limit and Interlock: Operating limit switch allowing burner recycling and safety shut down interlock switch. Refer to Paragraph, BOILER TRIM, in Section 23 52 34, STEAM GENERATOR.
15. Low Boiler Water Level Interlocks: Primary and auxiliary low water burner shut down interlocks. Refer to Paragraph, BOILER TRIM, in Section 23 52 34, STEAM GENERATOR. Operation of auxiliary low water

- cutoff shall interrupt the power supply to the burner management control system.
16. Boiler Control Compressed Air Pressure Interlock (Pneumatic Control Systems):
- a. Type: Mercury switch, graduated set point indicator, switch position indicator, adjustable set point coordinated with burner requirements, automatic reset.
  - b. Rating: Shall exceed maximum relief pressure of nearest upstream relief valve.
  - c. Approvals: UL listed.
17. Low Flue Gas Oxygen Alarm and Interlock: Signals from flue gas oxygen analyzer providing low oxygen alarm and low oxygen burner shut down. Refer to Paragraph, BOILER FLUE GAS OXYGEN ANALYZER SYSTEMS.
18. High Furnace Pressure Interlock:
- a. Required only for boilers that have boiler outlet draft control system.
  - b. Sense static pressure in furnace.
  - c. Diaphragm-actuated snap-action switch, adjustable set point, set point indicating scale, designed for maximum system pressure.
  - d. UL listed, FM approved.
  - e. Connect to the service with a lockable isolation valve and valved test connection to allow the switch to be set and tested with pressurized air source.
19. Building Combustion Air Intake Interlock: Provide devices to prove outside air building wall louvers are open and H&V unit is in operation.
- Q. Automatic Programming Sequence:
- 1. After personnel select the fuel to be burned and operate the burner start switch, the control system shall automatically perform the following operations:
  - 2. Prove proper operation of all interlocks except purging interlocks or prevent further progress.
  - 3. Open all air dampers fully. This includes all dampers (if provided) in the boiler outlet breeching and stack system.
  - 4. Position flue gas recirculation damper (if provided) as required by burner manufacturer to purge flue gas from recirculation duct.
  - 5. Prove 70% of maximum air flow through the boiler and prove all air dampers open wide and flue gas recirculation damper (if provided) in proper position.

6. Pre-purge eight air changes for water tube boilers and four air changes for fire tube boilers.
  7. Return forced draft fan dampers and fuel flow control valves to low fire position.
  8. If boiler outlet damper is provided, retain outlet damper wide open. If outlet draft damper modulating control system is provided and excessive draft due to wide-open damper is incompatible with the burner, automatically position the outlet damper to an acceptable position for burner ignition.
  9. Prove low fire start position.
  10. Sensing of flame prior to this shall cause shutdown.
  11. Energize igniter and open igniter fuel automatic safety shut-off valves. Prove igniter flame in ten seconds or provide shutdown.
  12. On systems with ultraviolet flame scanners, terminate ignition spark five seconds before main fuel valves open.
  13. Open main fuel safety shut-off valves for fuel selected. Close igniter fuel valves within ten seconds after main fuel valves open (15 seconds on heated oil).
  14. Prove main flame or provide shutdown.
  15. Place flue gas recirculation damper (if provided) in modulating or in fixed position as required by design of burner furnished.
  16. If provided, release boiler/economizer outlet draft control damper to modulation.
  17. Release burner from low fire position to automatic or manual firing rate control.
  18. Provide 15 second post purge at end of burner firing cycle.
  19. Close all dampers upon completion of post purge.
- R. Spare Parts:
1. One flame control programmer chassis complete.
  2. One flame control amplifier complete.
  3. One flame scanner complete with connecting leads.
  4. Twelve lamps for each type of replaceable lamp.
  5. Two of each type of relay and timer.

## **2.3 MAIN INSTRUMENTATION AND CONTROL PANEL:**

- A. Modify existing main instrumentation and control panel located in boiler operator's station.
- B. Master Steam Pressure Control Station: Refer to Paragraph, AUTOMATIC BOILER AND BURNER CONTROL SYSTEMS. Unit shall be flush mounted on panel front.

- C. Boiler/Burner Submaster Control Stations: Refer to Paragraph, AUTOMATIC BOILER AND BURNER CONTROL SYSTEMS. Units shall be flush mounted on panel front.
- D. Pressure Gages: Flush mounted, ½ percent accuracy, 150 mm (6-inch) dial diameter, micrometer adjustable pointer, solid front, blow-out disk in rear, back connected, and of indicated range. Provide gage cock within panel for each gage. Provide gages for steam header pressure, boiler feed header pressure for each boiler, fuel header pressures.
- E. Push Button Stations and Indication Lights for Pump Control: Refer to Section 26 29 11, LOW-VOLTAGE MOTOR STARTERS. Lights shall be oil-tight, standard industrial construction, 120-volt, utilizing lamps which are readily available. Lenses shall be red and green colored, held in place by threaded ring. Push button stations shall be flush mounting, oil tight, momentary contact. Provide non-latching lamp test control on main panel.
- F. Boiler Economizer Temperature Indicator Systems:
1. RTD system measuring temperature at four points: feedwater in and out, flue gas in and out. Separate indicators, graduated 0 - 600 °F
  2. Accuracy: Plus or minus 5 °F.
  3. Mounting: Mount indicators on instrumentation panel.
  4. Include Modbus communication with computer workstation (present or future).
- G. Annunciator:
1. Provide system for monitoring alarm functions listed below.  
Annunciator shall include alarm lights, alarm bell, integral test and acknowledge push buttons. Include Modbus communications for use with computer workstation.
  2. Operating Sequence:
    - a. Condition Normal: Bell and light off.
    - b. Condition Abnormal: Bell on; light flashing.
    - c. Acknowledge: Bell off; light on steady.
    - d. Condition Returns to Normal: Bell and light off.
    - e. Test: Bell on; light flashing.
  3. Alarm Sensing Systems: Provide complete wiring, controls, conduits, and accessories.
    - a. High, Excessive High, and Low Steam Header Pressure: Actuated by adjustable automatic reset UL listed pressure switches. Range of adjustable set point 40-180 psi, 5 psi maximum differential.  
Provide steam siphon loops, shut-off valves.

- b. Low Excess Air - Boiler (1 function per boiler): Actuated by flue gas oxygen analyzers. Refer to Paragraph, AUTOMATIC BOILER AND BURNER CONTROL SYSTEMS.
- c. LP Igniter (Pilot) Gas in Use - For Emergency Only: Actuated by adjustable, automatic reset, UL listed, FM approved, high pressure switch mounted on LPG header. Range of set point 1-10 psi, emergency rating 30 psi.
- d. Low feedwater pressure (1 function per header): Actuated by pressure switches on feedwater headers.
- e. Input/Output (I/O) Modules: Provide 20% (2 minimum) installed spare I/O of each type for computer data acquisition system.
- H. Nameplates: Provide engraved plastic laminated nameplates for all devices on front of panel. Nameplates shall match letter and background colors currently used in boiler plant. Mount with screws or rivets. List equipment title and identification number, such as "BOILER FEED PUMP P-1." Do not use abbreviations.
- I. Auxiliary relays: Industrial type rated for the service, enclosed contacts.
- J. Selector switches, push buttons and control switches: Heavy duty, industrial type.
- K. Wiring and Piping Methods:
  - 1. All devices mounted in and on panel shall be factory-wired and piped.
  - 2. All electrical contacts shall switch the phase conductor.
  - 3. Electric wiring: Conform to NFPA-70, all wiring in troughs, terminations in industrial class terminal blocks, terminals numbered for identification, 20 percent extra terminals. All wiring color coded and numbered using numbering system that identifies the destination. There shall be no exposed wiring connections exceeding 120 volts inside the panels. Refer to Section 23 21 11, BOILER PLANT PIPING SYSTEMS, and Section 26 05 21, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW).
  - 4. Piping: Stainless steel tubing, securely mounted, terminate in fittings at top of the cabinets.
- L. Spare Parts Required:
  - Lamps: Six of each type in panel and instruments.
  - Touch-up paint for panel: One pint.

**2.4 BOILER/BURNER CONTROL PANELS:**

- A. Refer to specification Section 23 52 34, STEAM GENERATOR.

**2.5 COMPUTER WORK STATION AND PROGRAMMING:**

- A. Modify the existing computer workstation and software to accept the new boiler.
- B. Supervisory Control and Data Acquisition (SCADA) Software:
  - 1. Functions shall be available to support the following:
    - a. Analog and Digital Input/Output.
    - b. Analog and Digital Alarm.
    - c. Analog and Digital Register.
    - d. Boolean Logic.
    - e. Calculation: Includes add, subtract, multiply, divide, parentheses, absolute value, square root, exponentiation, logs, relational operations, change floating point values to integers.
    - f. Device Control.
    - g. Event Action.
    - h. Fanout.
    - i. Multi-state Digital Input.
    - j. Program: Sequencing, monitoring, process control.
    - k. Real-time Trend.
    - l. Text.
    - m. Timer.
    - n. Totalizer.
  - 2. Wherever possible, the device communications program will perform error checking on messages. This will include lost response and data error. Should communications errors be detected, the software shall automatically indicate that the data is no longer valid and identify the invalid data. The system shall automatically attempt to re-establish communications, and, if successful, shall then replace the characters with valid data without any user programs or other actions to implement.
  - 3. The system shall include a diagnostic program capable of running on-line or off-line that can monitor message rates from the communication program. The diagnostic will display the number of new messages, retries, time-outs, and any occurrences of error.
  - 4. The system must support third-party objects and controls to be plugged in via OLE and Active X support.
  - 5. Support of accessing data to and from the process database and historical archive to another (future) database using Structured Query Language (SQL) as a standard language.
  - 6. Graphics Capabilities:

- a. Color object-oriented graphic displays for monitoring and controlling the process, which show the actual configuration of the process. Real-time values from various field devices shall be displayed in a variety of user-configurable formats. Displays shall be standard MS Windows files. Graphic screens shall be based on objects and not individual pixels.
- b. Interactive object-oriented editor or workspace that allows creation and editing of graphics using a mouse. Capability of making changes to the graphics without shutting down the system.
- c. Graphic screens that are opened in configuration mode must support tiling and cascading. Tiling must have horizontal and vertical support and no overlapping when the graphic screens are viewed.
- d. Size will be based on logical units; not pixels and any logical unit may be used. A design at one resolution must be able to run at a different resolution. Provide full screen option and the ability to add sizing borders to any graphic screen. Provide title bar enabled/disabled option.
- e. Support 256 colors. Color changes must be selectable from editing the individual foreground, background, or edge color property for each object.
- f. Provide configurable toolboxes that the user can customize as to what tools it contains and their position in the toolboxes. Provide a method to describe the function of each tool when the cursor is positioned on a particular tool.
- g. As a minimum, support the following object drawing tools: rectangle, square, rounded rectangle/square, oval/circle, straight line, polylines, polygons, arcs, chords, pie shapes, text.
- h. Operations that may be performed on objects or groups of objects must include: select/select all, deselect/deselect all, change color, move, nudge, cut, copy, paste, clear, duplicate, group/ungroup, align, space vertically/horizontally, grid, snap-to-grid, reshape, zoom in/out, send-to-back/bring-to-front, choice of line and fill styles, flip, search and replace tag names, undo, cursor position, rotation, space objects evenly, make objects same size, layers.
- i. Provide ability to dynamically update elements in the picture. Dynamic link elements shall include: data, time, date, system information, alarm summary, pushbutton, multi-pen chart, OLE objects.

- j. Multiple-pen chart link shall include: unlimited number of pens, display run time and historical data on same chart, configurable time span, configurable trend direction, configurable zoom, scrolling grid, invert high and low limits, minimum of five line styles for pens, minimum of three prebuilt line makers and a customizable line marker.
- k. Dynamic properties for objects must include: color changes (foreground, edge, background), fill percentage (horizontal, vertical), position/animation (horizontal, vertical, rotate, scale), script language (commands on down, up, mouse click, mouse double click, mouse move, edit), fill style (solid, hollow, horizontal, vertical, diagonal, cross hatch), edge style (solid, hollow, dash, dot, dash-dot, dash-dot-dot, null, inside frame). Provide capability to assign more than one dynamic property to an object.
- l. For properties other than commands, configuration shall be by the mouse. Scripting or programming shall not be required. When building object dynamics, properties must support configuration from a dialog box, pop-up menu and user customizable dialog boxes or forms. Positioning property changes must support a method to get screen coordinates and automatically fill in the required coordinates for positioning. The user customizable dialog boxes or forms must be customizable through VBA. The system must supply the following pre-built forms: fill, rotate, position, scale, visibility, edge color, foreground color, background color, data entry, open/close picture, replace picture, open/close digital tag, toggle digital tag, acknowledge alarm.
- m. The refresh rate shall be user-definable on a per object basis with the fastest being fifty milliseconds.
- n. The animation of the graphics and objects shall be able to be linked to: Data acquired and stored by the system, data acquired and stored by a networked system, variables declared in the command language scripts, local and networked relational databases using SQL/ODBC.
- o. Provide a wild card supported filter for assigning a data source. Provide a mathematical expression builder that is accessible from the graphic workspace.
- p. Provide for easy reuse of graphic objects or groups of objects. The objects shall be intelligent Windows wizard-like objects. A

- library of objects shall be included: pipes, valves (manual and automatic types), pumps, motors, tanks.
- q. The system must allow for bitmaps created by other systems to be imported into the graphics. Bitmaps must support a transparent mode and Metafiles must import as objects, not just bitmaps. As a minimum, the system must import .bmp, .msp, .jpg, wmf, pcx, ico, cur, psd, epr, and wpg.
  - r. MS Word and Excel documents must be able to live within a graphic screen, running with the graphic, not as an external call. Word and Excel toolbars must be inserted as part of the graphic toolbars.
  - s. Printing of graphic displays in color and black and white shall be supported via the standard MS Windows print manager in both the graphics development and runtime environments.
  - t. Operator entry methods shall be a flexible MS Windows NT method. Item selection and data entry shall be done with mouse or keyboard and the selected item shall be highlighted. The following data entry methods shall be supported: numeric, slider, pushbutton, ramp value, alphanumeric.
  - u. The system shall print a descriptive message with time stamp and user ID on the alarm printer or to an alarm file (as selected by user) whenever any of the following events occur: alarm, alarm acknowledgement, data entry into tag, reloading database file, saving database file, restarting the system.
  - v. The scripting language used by the system must be MS Visual Basic for Applications (VBA) or equivalent with one of the software packages specified. Scripts shall allow users to automate operator tasks, and create automations solutions. The scripting language must use MS IntelliSense feature, exposing all methods and properties of graphic objects. Editing will be with the Visual Basic Editor (VBE), which is part of VBA. Scripting language requirements include: animation of objects, automatic generation of objects, read write and create database blocks, automatically run other applications, incorporate custom security features, create custom prompts and messages, incorporate and communicate with third party and custom Active X controls, trap bad Active X controls, write custom wizards, scripts become part of the graphic screen, the VBE must allow import and export capability, there must be a link from the graphic editor to the VBE, VBA or VBE is launched from within the system without any commands, all

properties method and event of Graphic object created within the graphic editor of third party Active X controls used in the graphic screen must be exposed to VBA.

7. Alarms and Message Handling:

- a. The system shall be capable of detecting alarm conditions based on the states and values of the various sensed variables whether or not the variables causing the alarms are on display. Alarm set points shall be enterable by the user upon configuration and during run time. Alarm types shall include: high high, high, low, low low, bad input from I/O, alarm disable, off scan, deadband, change of state, open, close. Support at least three priorities for each alarm type: high, medium, low.
- b. Message enabling and disabling must be controlled at the block level. The system must be capable of sending messages based on the following events: an operator event occurs, process database event occurs. In addition to alarms, the following types of blocks must be able to generate messages that report to any transactions to and from the hardware: digital input, digital output, digital register, analog output, analog register, text.
- c. The system must generate applications messages that describe database-related activity or operator entry. These messages shall be logged to alarm areas. Types of messages include: operator changes a process value, loads process database, logs into the system; any recipe upload, download or save condition; send information from a VBA script to all enabled alarm destinations; send a message from the database to all alarm destinations.
- d. The system shall provide a means for placing an alarm message in one or more of the following locations: alarm summary display, alarm printer, alarm message file on disk, alarm history window.
- e. Alarm messages shall be independently user-configurable as to what information is provided and its sequence within the message. The following shall be available choices: time of the alarm occurrence, name of tag causing the alarm, engineering units value, descriptor text assigned to the tag, engineering units of the tag.
- f. When a new alarm condition is detected, an alarm message will be generated. If the alarm condition code text for the block is on the current display, then the text will flash until the alarm is acknowledged. Alarm acknowledgement will be performed from the keyboard or with the mouse and shall require no more than one

keystroke or mouse click. The software shall include the following capabilities: alarm suspension which allows the user to specify digital tags that, when closed, cause alarms not to be generated for alarm conditions; re-alarm time which allows the system to re-generate an alarm after a user-configurable amount of time; alarm delay time which allows the user to specify a period of time for which an alarm condition must remain before an alarm is generated; close contact on alarm which allows user to specify digital tags that become closed when certain alarm conditions occur or reopened under certain conditions to allow operation of audible and visual alarms in the plant.

- g. Provide an alarm summary display as a dynamic link within the graphics package. This must show a list of the pending alarms in the system. As new alarms are detected, entries are made to the display list. Placement of alarm information and color codes shall be configurable. Alarms can be acknowledged from the summary display either individually or for all alarms in the queue.

8. Services:

- a. Training: An interactive tutorial shall be provided as part of the software to teach the basic operations of the system, including graphics and tag development. The tutorial shall demonstrate the configuration operations using interactive on-screen instructions. Standard classroom courses for operators of the system that cover the configuration and use of the system shall be available.
- b. Customer Support: Programming staff shall provide 24/7 support via telephone and email. Field service by programmer, or programmer-trained distributor, shall be available on two-day notice.
- c. Quality Assurance: The vendor must have a formal and documented set of quality assurance procedures that are applied to the engineering design, development, and documentation of the software. The software shall have been in use by customers for at least three years.

9. Remote Operation of Controllers

- a. Provide capability to operate controllers locally at the control and indicating stations and, except for burner management (flame safety) controls, remotely at the computer workstation. For safety, it shall be possible to defeat the remote control from the front panel of each individual controller, preventing any status changes from being initiated at the computer workstation. The controllers include: master steam pressure, boiler/burner sub-

- master, burner fuel/combustion air, boiler draft, burner oxygen trim, boiler feedwater level, deaerator water level, condensate storage tank water level.
- b. The operating personnel, when controllers are so enabled, shall have remote control of the following functions from the computer work station:
- 1) Select manual/automatic mode.
  - 2) Set point (requiring use of high-level password).
  - 3) Controller output when in manual mode.
  - 4) Proportional/integral/derivative tuning parameters (requiring use of high-level password).
  - 5) Controller analog output values.
  - 6) Controller discrete output values.
- c. The monitor display shall provide a facsimile of the controller front plates with clearly labeled English language and engineering unit display of the control parameters.
- d. No special programming skills shall be required for any routine operating sequence.
10. Graphics: As a minimum, the following pictorial "screens" shall be available for observation:
- a. Individual boilers with economizers showing:
- 1) Main flame proven and approximate firing rate as shown by flame size depiction.
  - 2) Steam output instantaneous flow rate (pressure compensated), lb/hr.
  - 3) Steam output flow totalization (pressure compensated), lb. This is total production starting from time, day, month and year as set by operating personnel. Calculation shall be accomplished in control or instrumentation system, not in the SCADA software.
  - 4) Steam header pressure, psi.
  - 5) Boiler flue gas outlet temperature, °F.
  - 6) Boiler flue gas oxygen percent. Set point of oxygen trim system.
  - 7) Boiler stack opacity (if opacity monitors are provided).
  - 8) Boiler flue gas outlet draft (if outlet draft control system is provided), inches WC.
  - 9) Economizer flue gas outlet temperature, °F.
  - 10) Economizer feedwater inlet temperature, °F.
  - 11) Boiler feedwater inlet (economizer outlet) temperature, °F.

- 12) Signal to feedwater control valve.
  - 13) Water level in boiler plus or minus inches from normal level.
  - 14) Boiler plus economizer "Heat Loss" combustion efficiency not including radiation and unaccounted losses.
  - 15) Fuel flow rate and totalization if individual boiler fuel meters are provided scfh; gpm; gal. Totalization calculations shall be accomplished at the meters, not in the SCADA software.
  - 16) Feedwater flow rate and totalization if boiler feedwater flow meters are provided gpm; gallons. Totalization calculations shall be accomplished at the meters, not in the SCADA software.
  - 17) Trends of all flow, pressure and temperature data as listed above.
11. Specific Requirements - Alarm Monitoring and Operation Log:
- a. Alarm Monitoring Sequence:
    - 1) Alarm occurs:
      - a) Monitor flashes alarm on all displays where point is shown.
      - b) Display screen point or group flashes.
      - c) Audible alarm sounds.
      - d) Identification of alarm point is displayed at bottom of monitor screen.
      - e) Printer logs alarm.
    - 2) Operator acknowledges alarm:
      - a) Audible alarm is silenced.
      - b) Alarm display stops flashing but remains highlighted.
    - 3) Point in alarm returns to normal after acknowledgment:
      - a) Alarm display clears.
      - b) Printer and email logs return to normal.
  - b. Alarm Summary Display: The alarm sequence summary display shall alert the operator when points are in alarm. The time of occurrence, point identification, type of alarm, engineering value, and point description shall appear on the display. The most recent alarm shall be shown at the top of the display, with time of occurrence displayed in hours, minutes, and seconds.
  - c. Operation Log: In addition to alarm conditions, this log shall also print status of pumps and burners (in service or out of service), status changes such as a transfer from auto to manual, set point change, etc., so that the resultant printout is a true and complete log of plant operations.
  - d. Alarm points shall include:
    - 1) Burner management safety control system alarms.

- 2) Boilers high and low water level.
  - 3) Boilers low flue gas oxygen.
  - 4) Boilers high stack opacity (if opacity monitors are provided).
  - 5) High and low steam header pressure.
  - 6) High and low natural gas header pressure.
  - 7) High and low fuel oil header pressure.
  - 8) Propane igniter gas header pressurized (normal is zero pressure).
  - 9) Control system faults.
12. Communication with Burner Management (Flame Safeguard) Control Systems: Provide means to communicate with each burner safety control system to determine status, operating hours, flame signal strength, history of lockouts, number of short circuit events, other data necessary for remote trouble-shooting.
13. Monitor Screen Printout: Any display on the screen shall be able to be printed as required to provide hard-copy record.
- D. Sensors and Transmitters: Provide as necessary to satisfy programming requirements. Refer to Articles, PRESSURE SENSORS AND TRANSMITTERS, and TEMPERATURE SENSORS AND TRANSMITTERS.

## **2.6 FLUE GAS OXYGEN ANALYZERS:**

- A. Oxygen content of flue gases of each boiler measured by zirconium-oxide in-situ systems with probe mounted in stack or breeching. Output to boiler/burner control panel for oxygen trim. Single range, 0 to 10 percent oxygen.
- B. Performance:  
Minimum accuracy of plus or minus 2 percent of reading.  
Speed of response eight seconds or less to 90 percent accurate reading.  
Resolution 0.1 percent oxygen.  
These performance requirements are minimums and must be increased if necessary to suit the requirements of the oxygen trim system.
- C. Field-replaceable cell, heater, and cell temperature sensor. RE/COTR has the option of accepting long-term guarantee of unit exchange at favorable cost in lieu of capability of field-replacement of components.
- D. Reference and Calibration Air (if required by units furnished):  
Provide refrigerated air dryer and instrument quality compressed air supply to each unit. Coalescing color-change filter and pressure regulator at each analyzer.
- E. Automatic Calibration System: In-stack using bottled calibration gas mixtures containing oxygen and nitrogen. Number of mixtures and composition as recommended by analyzer manufacturer. See Article, TOOLS.

Selectable manual/automatic calibration, which will operate at preprogrammed intervals and upon power-up.

Calibration gas piping system with permanently installed stop valves, pressure and flow regulators, pressure gages, and flow meters to permit connection of gas bottles to unit. Locate all gas bottle connections, regulators, gages and valves accessible from floor without use of ladders.

- F. Analyzer Displays: Operating parameters, process and diagnostic data, including percent oxygen, cell temperature, and set points of alarms and burner cutouts.
- G. Analyzer Outputs:
  - 1. Analog output compatible with boiler/burner control panel for flue gas oxygen trim and the computer workstation.
  - 2. Low flue gas oxygen alarm on computer workstation. Set point adjustable 0.5 to 3.0 percent oxygen. Interface with burner management system to provide low oxygen shutdown of burner. Refer to Paragraph, BURNER MANAGEMENT SYSTEMS WITH SAFETY INTERLOCKS AND ACCESSORIES.

## **2.7 FLOW METERS:**

- A. Vortex Flow Meters with Transmitters:
  - 1. Provide vortex-shedding flow meters designed for accurate measurement of flow rate ranges shown at required pressures. Minimum turndown capability shall be as scheduled. Meters shall have digital readout of pressure-compensated flow rate and totalization located at transmitter and transmit flow rate and totalization digital signals to computer workstation. As an option, pressure compensation and the compensated flow rate may be performed and displayed by a boiler plant controller receiving signals from the flow meter and from a pressure transmitter. Refer to Paragraph, PRESSURE SENSORS AND TRANSMITTERS.
  - 2. Programmable microprocessor electronics with on-board programming. Output signals immune to ambient temperature swings. Continuous self-diagnostic routines that identify electronics problems and provide a warning. Electronics replaceable in the field without affecting metering accuracy. Provide power supply as recommended by meter manufacturer. Mount electronics separate from meter body in position accessible from platform or floor without the use of a portable ladder.
  - 3. All welded wafer-type or flanged stainless steel meter body with no seals. No sensor parts exposed to the flow stream. Provide alignment

rings with wafer-type meters to assure proper centering in the pipeline. Trapezoidal shedder bar, sensing by detecting stresses in the shedder bar caused by vortices, dual piezoelectric crystals located outside the process flow sense the shed vortices, dual crystal alignment cancels effects of noise and vibration. Designed for Schedule 40 piping.

4. Transmitted signal accuracy plus or minus 1.5% of flow rate. Repeatability 0.2% of actual flow rate. Meter designed to minimize vibration effect and to provide elimination of this effect.

B. Water Flow Meters:

1. Type: Continuous duty positive displacement disk or turbine type with meter-mounted totalizing registers.
2. Service: Provide individual meters to measure volume of cold water, soft water as shown.
3. Performance: Conform to scheduled flow range, accuracy, maximum pressure drop, maximum static pressure and temperature for the liquid shown. Minimum accuracy plus or minus 0.5% of flowrate over 10/1 turndown.
4. Meter Construction:
  - a. Bronze or iron cases, threaded pipe connections, designed for 1025 kPa (150 psi) maximum pressure.
  - b. Registers: Hermetically sealed, magnetic coupling, digital flow rate readout or sweep hand registering one or ten gallons per revolution and digital register for totalizer with at least five digits. Provide horizontal register box with gasketed viewing glass and hinged cover. Register shall have capability of being positioned to any of the four cardinal points for readability. Transmit flow data to computer work station.

C. Fuel Oil Meters:

1. Type: Positive displacement screw type, cast iron cases, nitrided steel spindles, Viton seals, threaded pipe connections, designed for pressure exceeding set pressure, plus 25 percent, of nearest upstream relief valve. Rated for 120 degrees C (250 degrees F) if utilized for heated oil. Accuracy plus or minus 0.1% of flow rate over required flow range.
2. Meter Registers: Hermetically sealed flow computer with digital flow rate readout and digital register for totalizer with at least five digits located at meter, positioned for easy viewing. Transmit flow data to computer workstation.

D. Turbine-Type Natural Gas Flow Meters:

1. Type: Turbine-type with volume totalizing digital readout that is continuously updated and corrected for the line pressure and temperature. Meter readouts shall be located on meter on main instrument panel. Meter shall be designed for natural gas at job site characteristics.
2. Performance: Maximum flow rate as scheduled. Pressure drop shall not exceed 1.25 kPa (5 inches WC). Accurate flow minimum turndown range shall be 10/1 with minimum accuracy one percent of flow rate over the entire range.
3. Construction:
  - a. Meter: Design for 850 kPa (125 psi). Pipe connections flanged 850 or 1025 kPa (125 or 150 psi) ANSI. All bearings and gearing shall be in areas sealed from contaminants. Metering transducers operated through magnetic coupling. The measuring devices shall be contained within a module that can be removed from the meter body for service and calibration without breaking the main gas piping connections. Corrosion-resistant material of construction or coating.
  - b. Indication Devices on Meter: Electronic type which provides a totalized continuous volume flow digital indication in cubic feet automatically continuously corrected to the local contract base temperature and pressure from actual varying line temperatures and pressures. Unit shall also display a totalized uncorrected volume flow indication. The display shall show actual line temperature and pressure at the meter and pressure-temperature correction factor. Smallest corrected flow indication shall be one thousand cubic feet, and indicator shall have at least six digits. Unit shall be watertight where drawings show an outdoor location.
4. Calibration: Factory calibrated. Furnish three-point curve spanning required flow range on actual meter furnished.
5. Accessories:
  - a. Remote Digital Register: Provide a remote digital register system including pulse generator and all wiring and accessories for proper functioning. Remote register shall have a digital cubic feet volume readout corrected to the local contract base temperature and pressure from actual varying line conditions. Smallest indication shall be one thousand cubic feet, and indicator shall have at least six digits. Provide 120-volt power supply from panel. Main plant register shall be located on main

instrument panel; individual boiler registers shall be located on boiler control panels.

- b. Straightening Vanes: Provide as recommended by the meter manufacturer for the actual installation arrangement.
- c. Filter: Shall have replaceable glass-fiber or cellulose cartridge with ten micron or smaller particle retention. Filter enclosure shall be the pipe size of the meter or larger as required by pressure drop considerations. Static pressure capability shall be at least twice lockup pressure of service supply regulators. Maximum pressure loss 1.25 kPa (5 inches WC) at maximum design flow rate of meter. Plug all drains or instrumentation outlets. Provide vent with cock for relieving pressure in filter.

## **2.8 BOILER STACK OPACITY MONITORS:**

- A. Provide complete microprocessor-controlled system for each boiler with sensor mounted on boiler stack or breeching, separate control unit mounted in accessible location, and panel-mounted display. Electronics shall have RS485 Modbus communications and an analog output for input to the combustion control panel. Electronics shall have automatic and manual calibration via the front panel of the opacity monitor.
- B. Light source shall have life expectancy greater than one year. System shall automatically compensate for lamp aging and voltage variations.
- C. Provide panel-mounted display which shows the opacity and alarm and maintenance functions. These alarms and functions shall include:
  - 1. Pre-emission.
  - 2. Over-emission.
  - 3. Lamp out.
  - 4. Purge blower failure.
- D. Provide alarm bell on front panel, with silencing control, to sound when over-emissions or other alarm condition occurs.
- E. Mount control panel on the panel that includes the combustion controllers.
- F. Purge air system with blower, provided by manufacturer of opacity monitor, to reduce build-up of dirt on lenses. System shall include disposable air filters.
- G. Printer: Provide strip chart opacity recorder with date and time stamp. Connect to opacity monitor output.
- H. Spare Parts Required:
  - 1. Lamp for opacity monitor.
  - 2. Six air filters for opacity monitor air purge unit.
  - 3. Three months supply of chart paper for strip chart opacity recorder.

**2.9 PRESSURE SENSORS AND TRANSMITTERS:**

- A. Transmitters for gage pressure, differential pressure, fluid level, and draft utilized for instrumentation, computer workstation, and controls.
- B. "Smart" programmable electronics, sealed diaphragms, direct-sensing electronics, no mechanical force or torque transfer devices, non-interactive external span and zero adjustment, solid-state plug-in circuit boards. Minimum accuracy plus or minus 0.1 percent of calibrated span. 40:1 minimum rangeability. Communication system shall be compatible with boiler plant controls and instrumentation.
- C. Shut-off and blowdown valves on all transmitters. Equalizing/calibration manifold valves on all differential pressure and fluid level transmitters. Connection points to permit calibration of system with a portable pressure calibrator.
- D. Reservoirs for transmitter piping connections where an interface between liquid and steam is present, such as boiler water level sensing and differential pressure steam flow meter applications.
- E. Provide and deliver to Resident Engineer (RE) or Contracting Officers Technical Representative (COTR) all hardware and software necessary for field calibrating and programming all transmitters.
- F. Spare Parts: One transmitter of each type utilized in the project.

**2.10 BOILER DRAFT GAGES:**

- A. Provide gages for windbox, furnace, boiler outlet, and economizer outlet.
- B. Type: Analog, multiple vertical scale, dry diaphragm, balanced pointers, semi-flush-mounted, zero adjustment.
- C. Scales: Internally illuminated, minimum length 120 mm (5 inches), scale ranges coordinated with equipment furnished and actual operating conditions, scales labeled for the service. If, in operation, indicators go under-range or over-range, the gages shall be replaced with greater ranges, at no additional cost to the Government. Scales for furnace, boiler outlet, and economizer outlet gages must be combination negative and positive pressure.
- D. 3-way cock for each gage to permit shut-off, connection to service, connection to atmosphere.
- E. Mount on boiler/burner control panel and main instrumentation panel.

**2.11 TEMPERATURE SENSORS AND TRANSMITTERS:**

- A. Provide thermocouples.
- B. Provide transmitters or panel-mounted indicator transmitters, transducers, and receivers compatible with the system including the boiler control panel and computer workstation.

- C. Minimum accuracy one percent of actual temperature.
- D. Boiler and economizer flue gas temperature sensors shall be averaging type and shall extend across width of stack or breeching.

**2.12 GAGES, PRESSURE AND COMPOUND, PIPE OR TANK-MOUNTED:**

- A. Construction:
  - 1. Case: Solid armored front between measuring element and dial, blowout back, bottom connection, phenol turret type.
  - 2. Dial: Non-corrosive, 110 mm (4-1/2 inch) diameter face with black markings on white background.
  - 3. Measuring Element: Bourdon tube designed for the required service. Provide bellows designed for service for pressure ranges under 100 kPa (15 psi).
  - 4. Movement: Stainless steel, rotary.
  - 5. Pointer: Micrometer adjustable, black color.
  - 6. Window: Plastic.
  - 7. Liquid Filled Gages: Provide at inlet and outlet of all pumps, on compressed air systems, and on fuel and atomizing media lines at locations closest to burners where bourdon tube gages are utilized. Gage filling shall be glycerin or silicone oil. Purpose of filling is to provide pulsation dampening. As an option to liquid filling, provide dry gages that have built-in fluid clutch dampeners that are not vulnerable to plugging due to foreign material.
- B. Accuracy: ASME B40.100, Grade 2A, ½ percent, on all gages; except Grade A, one percent permitted on diaphragm actuated gages, liquid filled gages, and compound gages.
- C. Accessories:
  - 1. Red set hands on gages located at automatic pressure regulator valve outlets.
  - 2. Needle valve or gage cock rated for the service.
  - 3. Syphon on all steam gages.
  - 4. Pulsation snubbers on diaphragm-type gages located adjacent to gas burners.
- D. Scale Ranges: Provide English scales:
  - 1. Low pressure steam to 100 kPa (15 psi): 0 to 30 psi.
  - 2. Medium pressure steam to 407 kPa (59 psi): 0 to 100 psi.
  - 3. High pressure steam above 407 kPa (59 psi): 0 to 200 psi.
  - 4. Natural and LP gas: 0 to 30 psi.
  - 5. LP gas at tanks: 0 to 300 psi.
  - 6. Gas burner, 125 percent of full load pressure, inches WC.
  - 7. Oil pump suction: 30 inches Hg vacuum to 15 psi.

8. Oil pump discharge: 0 to 200 psi.
  9. Oil burner, 125 percent of full load pressure, psi.
  10. Compressed air, 345 kPa & higher (50 psi & higher): 0 to 160 psi.
  11. Feedwater pump discharge: 0 to 300 psi.
  12. Feedwater pump suction: 30 inches Hg vacuum to 30 psi.
  13. Other services, 200 percent of maximum operating pressure.
- E. Boiler Steam Pressure Gages: Refer to Section 23 52 34, STEAM GENERATOR.
- F. Panel-mounted Gages: Refer to Article, MAIN INSTRUMENTATION AND CONTROL PANEL.

**2.13 THERMOMETERS, PIPE OR TANK-MOUNTED:**

- A. General: Thermometer locations are shown on the drawings.
- B. Construction:
1. Industrial type, separable well and socket, union connected.
  2. Scales: Red reading mercury combination 30 to 300 degrees Fahrenheit/0 to 150 degrees Celsius scales, unless otherwise shown. Scale length 220 mm (9 inch) except 170 mm (7 inch) scale length acceptable on oil burner piping. Mercury sealed under pressure with inert gas to prevent oxidation and separation of column.
  3. Case: Corrosion resistant with glass or plastic front.
  4. Form: Straight or back form except thermometers located more than 2100 mm (7 feet) above floor or platform shall be adjustable angle.
  5. Wells: Sized to suit pipe diameter without restricting flow. Provide snug sliding fit between socket and well.
  6. Accuracy: One percent of scale range.

**PART 3 - EXECUTION**

**3.1 INSTALLATION, BOILER PLANT INSTRUMENTATION, AUTOMATIC BOILER CONTROL SYSTEMS, BURNER MANAGEMENT SYSTEMS, COMPUTER WORK STATION (IF PROVIDED):**

- A. General:
1. Nameplates, Labels and Identification: Refer to Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION.
  2. Electrical Work and Safety Requirements: Comply with NFPA 70 and referenced electrical sections of these specifications.
  3. Electrical Wiring: Comply with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS; Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS; Section 26 05 21, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW); and Section 26 27 26, WIRING DEVICES. The term "wiring" includes furnishing of wire, conduit, miscellaneous material and labor to install a complete working system as specified.

4. All devices plumbing and wiring shall comply with and be arranged as shown in the most recent edition of the "VHA Boiler Plant Safety Device Testing Manual".
4. Protect all circuits to avoid interruption of service or damage to equipment due to short-circuiting or other conditions. Line-protect from lightning and static electricity all wiring that comes from external sources.
5. Except for short apparatus connections, run conduit and pneumatic tubing parallel to or at right angles to the building structure.
6. Run tubing and wire connecting devices in control cabinets parallel with the sides of the cabinets neatly racked to permit tracing. Rack wiring bridging a cabinet door along the hinge side and protect from damage. Provide grommets, sleeves or vinyl tape to protect plastic tubing or wires from sharp edges of panels, conduit, and other items. Fit all equipment contained in cabinets or panels with service loops; each loop shall be at least 300 mm (12 inches) long. Equipment for fiber optic systems shall be self-supporting, code gage steel enclosure.
7. Permanently mark terminal blocks for identification. Label or code each wire at each end. 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. Cables:
  - a. Keep cable runs as short as possible. Allow extra length for connecting to the terminal board.
  - b. Do not bend flexible coaxial cables in a radius less than ten times the cable outside diameter.
  - c. Cables shall be supported for minimum sag.
  - d. Splices in shielded and coaxial cables shall consist of terminations and shielded cable couplers. Terminations shall be in accessible location. Cables shall be harnessed with cable ties.
- B. Pressure, Temperature, Level and Flow Transmitters: Mount in locations accessible from floor or platform without use of portable ladders. Provide separate conduit for each transmitter signal if recommended by manufacturer. Protect sensor or controller on steam or water service by an adequate water seal at all times and provide blowdown facilities to permit blowdown of sensing lines. Install temperature sensors with entire temperature sensing surface immersed in media being measured. Provide isolation valves on all transmitters connected to fluid systems.

Locate isolation valves so that transmitter can be isolated while main sensing line is being blown down. Provide equalizing valves on all differential pressure transmitters. Provide valved drains on all fluid lines. Valves shall be rated for minimum of 150 percent of system pressure and temperature.

- C. Steam Flow Meter Primary Elements (In-Line Flow Sensors) including Vortex-Shedding Type: Provide straight runs of piping upstream and downstream as recommended by manufacturer to achieve maximum accuracy and rangeability. Verify that stresses in piping system do not exceed allowable stress of flow meter body. Locate meter electronics including read-out devices accessible from floor or platform without the use of portable ladders.
- D. Flue Gas Oxygen Analyzers:
1. Mounting: Provide freestanding floor-mounted steel rack for mounting control panels and read-outs. Position panels and readouts 1500 mm (5 feet) above the boiler room floor.
  2. Sampling point shall be upstream of smoke density monitor in non-turbulent area. Locate probe within 4.5 meters (15 feet) of floor or accessible from platform.
  3. Reference Air: Provide dry, filtered, pressure-regulated compressed air service to each unit. Provide isolating valve at each unit.
  4. Calibration Gases: Provide permanently installed valved piping connections, pressure regulators and gages in flue gas sampling system for connection of required calibration gases. Locate within 1200 mm (4 feet) of main floor.
  5. Interconnection of Instruments: Provide shielded wiring as recommended by instrument manufacturer.
  6. Power Circuits: Provide dedicated circuits from a plant panel.  
Analyzers shall remain powered when burner control is off.
- E. Wiring and Piping: Is generally not shown on the drawings. All wiring and piping must be provided in accordance with NFPA 70 and ASME B31.1.
- F. Combustion Control Linkage Systems: After completion of burner adjustments, counter sink all lever set screws into shafts or pin levers to shafts to prevent levers from slipping on the shafts.
- G. Boiler Stack Opacity Monitors (if provided): Locate downstream from oxygen sensing systems so that opacity monitor air purge does not affect flue gas oxygen reading. Locate sensor within 4.5 m (15 feet) of floor or accessible from platform without use of portable ladder. Locate air purge blower unit within 2400 mm (eight feet) of floor or accessible from platform without use of portable ladder.

H. Compressed Air Filters: Pipe drain to nearest floor drain.

**3.2 INSTALLATION, NATURAL GAS FLOW METERS:**

Entire installation shall conform to recommendations of the meter manufacturer for obtaining the most accurate flow measurements. Arrange meter readout so that it is visible from nearest walkway or service platform.

**3.3 INSTALLATION, PRESSURE GAGES:**

Orient gages so that dials are upright and visible from the nearest walkway or access platform. Install gages with gage cocks. Provide pig-tail syphons on steam service. Provide compound gages on all pump suction lines and on feedwater deaerator; provide pressure gages elsewhere. Install liquid-filled or equivalent (as specified) gages at inlet and outlet of all pumps, on compressed air systems, and on fuel and atomizing media lines at locations closest to burners. If diaphragm-type gages are used, provide pulsation dampeners instead of liquid-filling.

**3.4 INSTALLATION, THERMOMETERS:**

Arrange thermometers so that scales are upright and visible from nearest walkway or access platform. Provide adjustable angle thermometers on applications more than 2100 mm (7 feet) above floor or platform. Tilt the angle type thermometers for proper view from floor or platform. Locate wells in flow stream.

**3.5 INSTALLATION-WATER AND OIL FLOWMETERS:**

Provide strainer upstream with 80-mesh screen liner. Refer to Section 23 21 11, BOILER PLANT PIPING SYSTEMS. Position register for upright viewing from nearest walkway.

**3.6 TESTING, BOILER PLANT INSTRUMENTATION, AUTOMATIC BOILER CONTROL SYSTEMS, BURNER MANAGEMENT SYSTEMS, COMPUTER WORKSTATION (IF PROVIDED):**

- A. Representatives of the designer of the system shall demonstrate proper operation and calibration of all components, computer programs, and entire systems to the Resident Engineer (RE)/Contracting Officers Technical Representative (COTR). If the project includes boiler/burner testing, the demonstration involving boiler/burner data shall be conducted during the boiler/burner tests. Furnish personnel, instrumentation, and equipment necessary to perform calibration and testing. All calibration work must be completed prior to the testing.
- B. Burner Management (Safety Control) Systems: All test shall be based on the most recent edition of the "VHA Boiler Plant Safety Device Testing Manual", also Refer to Section 23 52 34, STEAM GENERATOR.

- C. Steam Flow Measuring: Demonstrate proper calibration of each flow rate signal and indication and each totalizer signal and indication to RE/COTR or their representative prior to the start of the final boiler testing.
- D. Pressure test all pneumatic control tubing at one and one-half times the normal operating pressure.
- E. Testing shall demonstrate proper calibration of input and output devices, the proper operation of all equipment, proper execution of the sequence of operation, proper tuning of control loops and maintaining of all set points.
- F. Document all tests with detailed report of test results. Explain in detail the nature of each failure and corrective action taken.
- G. During and after completion of the pretests, and again after the final acceptance tests, identify, determine causes, replace, repair and calibrate equipment that fails to comply with contract requirements or the standards of the manufacturer. Provide written report to RE/COTR.
- H. Demonstrate safety and operating interlocks.
- I. Demonstrate that programming is not lost and that the control and instrumentation system performs the correct sequence of control and instrument functions after a loss of power.
- J. Furnish to RE/COTR graphed trends of control loops to demonstrate that the control loops are stable and that set points are maintained. Trend data shall be instantaneous and the time between data points shall not be greater than one minute.
- K. Signal Transmission System Equipment:
  - 1. Ground Rod Tests: Before any wire is connected to the ground rods, use a portable ground testing instrument to test each ground or group of grounds.
  - 2. Coaxial Cable Tests: Implement NEMA WC 63.2 as a minimum.

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**SECTION 23 09 23**  
**CONTROLS AND INSTRUMENTATION (DDC)**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. The control system(s) shall be as indicated on the project documents, point list, drawings and described in these specifications. This scope of work shall include a complete and working system including all engineering, programming, controls and installation materials, installation labor, commissioning and start-up, training, final project documentation and warranty.
- B. Engineering Control Center (ECC) shall include:
  - 1. Operator Workstation Web-Browser User Interface (UI).
  - 2. Ethernet, IP Supervisory Network.
  - 3. Graphic Operational Interface.
  - 4. Software Configuration Tools (SCT).
  - 5. Scheduling and Alarm Management software.
  - 6. Local ACC-LON or Infinet-2 networks.
  - 7. Network Area Controllers (NAC).
  - 8. Unitary Control Units (UCU).
  - 9. Connected I/O devices.
  - 10. Third party system Data Integration.
- C. The Controls Contractor's work 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 by the Contract for the complete and fully functional Controls Systems.
- D. Following control devices and systems shall be used to provide the functional requirements of HVAC equipment and systems.
  - 1. Direct Digital Control (DDC) of HVAC equipment and systems.
  - 2. Terminal units and similar units for control of room environment conditions may be equipped with integral controls furnished and installed by the equipment manufacturer or field mounted. Refer to equipment specifications and as indicated in project documents.
- E. Base bid includes the tying into ECC and the installation of new DDC controls as indicated on the temperature control diagrams and the I/O Points List.

- F. Connect the new work to the new ECC system operator workstation located in the new mechanical room. 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. Modify the existing ECC, if necessary, to accommodate the additional control points.
- G. The control subcontractor shall supply as required, the necessary equipment to interface between any existing and new system Network Area Controllers (NAC) as part of this contract. Number of area controllers required is dependent on the type and quantity of devices, hardware and software points provided. Network area controllers are same as remote controller units (RCU).
- H. The control systems shall be designed such that each mechanical system shall operate under stand-alone mode. Temperature Controls contractor 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.
- I. The Top End of the NAC shall communicate using American Society of Heating and Refrigerating Engineers/American National Standards Institute (ASHRAE/ANSI) Standard 135(BACnet) protocol. The NAC shall reside on the IP Ethernet (ISO 8802-3) local area network, and provide information via standard object types and application services. The Bottom End of the NAC, the unit level controllers and all other field devices shall reside on the ACC-LON or Infinet-2 networks, and provide data using standard network variable types and configuration properties.
- J. The intent of this specification is to provide a peer-to peer networked, stand-alone, distributed control system.
- K. The control system shall accommodate simultaneously multiple user operation and the access to the system should be limited only by operator password.

## 1.2 RELATED WORK

- A. Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION.
- B. Section 23 21 13, HYDRONIC PIPING.
- C. Section 23 31 00, HVAC DUCTS AND CASINGS.

- D. Section 23 05 93, TESTING, ADJUSTING, AND BALANCING FOR HVAC.
- E. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.
- F. Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS.
- G. Section 26 05 21, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW).
- H. Section 26 27 26, WIRING DEVICES.

### 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. ACU: Auxiliary Control Unit (ACU) used for controls of air handling units, reports to RCU.
- C. Analog: A continuously varying signal value (e.g., temperature, current, velocity etc.
- D. BACnet: Building Automation Control Network Protocol, ASHRAE Standard 135.
- E. 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).
- F. 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.
- G. 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.
- H. Bus Topology: A network topology that physically interconnects workstations and network devices in parallel on a network segment.
- I. 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. In this specification, there are three types of control units are used; Unitary Control Unit (UCU), Auxiliary Control Unit (ACU), and Remote Control Unit (RCU).
- J. 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).
- K. 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.

- L. 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.
- M. 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.
- N. 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.
- O. DXF: An AutoCAD 2-D graphics file format. Many CAD systems import and export the DXF format for graphics interchange.
- P. 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.
- Q. 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.
- R. 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.
- S. Ethernet: A trademark for a system for exchanging messages between computers on a local area network using coaxial, fiber optic, or twisted-pair cables.
- T. Firmware: Firmware is software programmed into read only memory (ROM) chips. Software may not be changed without physically altering the chip.
- U. FTT-10A: Echelon Transmitter-Free Topology Transceiver.
- V. GIF: Abbreviation of Graphic interchange format.
- W. 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.
- X. Graphic Sequence of Operation: It is a graphical representation of the sequence of operation, showing all inputs and output logical blocks.

- Y. 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.
- Z. I/P: Internet Protocol-global network, connecting workstations and other host computers, servers etc. to share the information.
- AA. JPEG: A standardized image compression mechanism stands for Joint Photographic Experts Group, the original name of the committee that wrote the standard.
- BB. Local Area Network (LAN): A communication bus that interconnects operator workstation and digital controllers for peer-to-peer communications, sharing resources and exchanging information.
- CC. LonMark: An association comprising of suppliers and installers of LonTalk products. The Association provides guidelines for the implementation of the LonTalk protocol to ensure interoperability through Standard implementation.
- DD. LonTalk: An open standard protocol developed by the Echelon Corporation that uses a "Neuron Chip" for communication.
- EE. LonWorks: Network technology developed by the Echelon Corporation.
- FF. Network: A set of computers or other digital devices communicating with each other over a medium such as wire, coax, fiber optics cable etc.
- GG. Network Area Controller: Digital controller, supports a family of auxiliary control units and unitary control units, and communicates with peer-to-peer network for transmission of global data.
- HH. Network Repeater: A device that receives data packet from one network and rebroadcasts to another network. No routing information is added to the protocol.
- II. MS/TP: Master-slave/token-passing.
- JJ. Operating system (OS): Software, which controls the execution of computer application programs.
- KK. 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.
- LL. Peripheral: Different components that make the control system function as one unit. Peripherals include monitor, printer, and I/O unit.
- MM. Peer-to-Peer: A networking architecture that treats all network stations as equal partners.
- NN. PICS: Protocol Implementation Conformance Statement.

OO. UCU: Unitary Control Unit, digital controller, dedicated to a specific piece of equipment, such as VAV boxes, chillers, fan coil units, heat exchangers etc.

#### 1.4 QUALITY ASSURANCE

##### A. Criteria:

1. The core control system equipment shall be compatible with the existing control system (existing control system by Andover Continuum by Schneider Electric). Compatibility includes communication between existing and new controls and visibility and/or control of all new and existing points.
2. The Controls and Instrumentation System Contractor shall be a primary equipment manufacturer's partner that is regularly engaged in the engineering, programming, installation and service of total integrated Facility Management Systems of similar size, scope and complexity to the EEC specified in this Contract. Distributors and wholesalers will not be acceptable.
3. Single Source Responsibility of subcontractor: The Contractor shall obtain hardware and software supplied under this Section and delegates 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.
4. 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.
5. The controls subcontractor shall provide a list of no less than ten 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.
6. The controls subcontractor shall have (minimum of ten 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 five years. Failure to disclose this information will be a ground for disqualification of the supplier.

7. The controls subcontractor shall have in-place facility within 70 miles with technical staff, spare parts inventory for the next five (5) years, and necessary test and diagnostic equipment to support the control systems.
8. 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, Class A or CFR 47 Part 15, Governing Radio Frequency Electromagnetic Interference, and be so labeled.
3. Peer-to-peer controllers, unitary controllers shall conform to the requirements of UL/CUL 916, FCC CFR 47 Part 15, ICES-003, EN55022, AS/NZS 3548, Class A, CE.

**1.5 PERFORMANCE**

A. The system shall conform to the following:

1. Graphic Display: The system shall display up to 4 graphics on a single screen with a minimum of (~~20~~ 75) dynamic points per graphic. All current data shall be displayed within (10) seconds of the request.
2. Graphic Refresh: The system shall update all dynamic points with current data within (10) 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 (10) seconds. Analog objects shall start to adjust within (3) 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 (10) 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. Performance: Programmable Controllers shall be able to execute DDC PID control loops at a selectable frequency from at least once every five (5) seconds. The controller shall scan and update the process value and output generated by this calculation at this same frequency.
8. Multiple Alarm Annunciations: All workstations on the network shall receive alarms within (5) seconds of each other.
9. Reporting Accuracy: Listed below are minimum acceptable reporting accuracies for all values reported by the specified system:

Measured Variable	Reported Accuracy
Space temperature	±0.5 degrees C (±1 degrees F)
Ducted air temperature	±1.0 degrees C [±2 degrees F]
Outdoor air temperature	±1.0 degrees C [±2 degrees F]
Water temperature	±0.5 degrees C [±1 degrees F]
Relative humidity	±2 percent RH
Water flow	±5 percent of full scale
Air flow (terminal)	±10 percent of reading
Air flow (measuring stations)	±5 percent of reading
Air pressure (ducts)	±25 Pa [±0.1 "W.G.]
Air pressure (space)	±3 Pa [±0.001 "W.G.]
Water pressure	±2 percent of full scale *Note 1
Electrical Power	5 percent of reading

Note 1: for both absolute and differential pressure

#### 1.6 WARRANTY

- A. 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.
- B. The on-line support service shall allow the Controls supplier to dial out over telephone lines to 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.

- C. 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. Installation instructions for smoke dampers and combination smoke/fire dampers, if furnished.
  5. Catalog cut sheets of all equipment used. This includes, but is not limited to 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.
- C. Product Certificates: Compliance with Article, QUALITY ASSURANCE.

D. 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.

E. 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. Licenses, guaranty, and other pertaining documents for all equipment and systems.
  - h. 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.

F. Submit Performance Report to Resident Engineer prior to final inspection.

## 1.8 INSTRUCTIONS

- A. Instructions to VA operations personnel: Perform in accordance with Article, INSTRUCTIONS, in Specification Section 01 00 00, GENERAL REQUIREMENTS, and as noted below.
1. First Phase: Formal instructions to the VA facilities personnel for a total of 24 hours (in 4 hour increments), 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 48 hours of instructions 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.

## 1.9 PROJECT CONDITIONS (ENVIRONMENTAL CONDITIONS OF OPERATION)

- A. The ECC and peripheral devices and system support equipment shall be designed to operate in ambient condition of 20 to 35 degrees C (65 to 90 degrees F) at a relative humidity of 20 to 80 percent non-condensing.
- B. The CUs and associated equipment used in controlled environment shall be mounted in NEMA 1 enclosures for operation at 0 to 49 degrees C (32 to 120 degrees F) at a relative humidity of 10 to 95 percent non-condensing.
- C. The CUs used outdoors shall be mounted in NEMA 4 waterproof enclosures, and shall be rated for operation at -40 to 65 degrees C (-40 to 150 degrees F).
- D. All electronic equipment shall operate properly with power fluctuations of plus 10 percent to minus 15 percent of nominal supply voltage.
- E. 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):  
135-01.....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):  
B32-02.....Specification for Solder Metal  
B88-02.....Specifications for Seamless Copper Tube  
B88M-99.....Specification for Seamless Copper Tube (Metric)  
B280-02.....Specification for Seamless Copper Tube for Air-Conditioning and Refrigeration Field Service  
D2737-03.....Specification for Polyethylene Tube
- E. Federal Communication Commission (FCC):  
Rules and Regulations Volume II-July, Part A Radio Frequency Devices.
- F. Institute of Electrical and Electronic Engineers (IEEE):  
802.3-03.....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)
- G. Instrument Society of America (ISA):  
S7.0.01-00.....Quality Standard for Instrument Air
- H. National Fire Protection Association (NFPA):  
70-05.....National Electric Code  
90A-03.....Standard for Installation of Air-Conditioning and Ventilation Systems
- I. Underwriter Laboratories Inc (UL):  
94-01.....Test for Flammability of Parts and Devices and Appliances  
294-01.....Access Control System Units  
486A-01.....Wire Connectors and Soldering Lugs for Use with Copper Conductors  
486B-01.....Wire Connectors for use with Aluminum Conductors  
555S-03.....Leakage Ratings for Dampers for Use in Smoke Control Systems  
916-02.....Energy Management  
1076-99.....Proprietary Burglar Alarm Units and Systems

**PART 2 - PRODUCTS**

**2.1 CONTROLS SYSTEM ARCHITECTURE**

A. General

1. The Controls System shall consist of multiple Nodes and associated equipment connected by industry standard digital and communication network arrangements.
2. The Operator Workstations, Servers and principal network computer 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. Provide licenses for all software residing on and used by the Controls Systems and transfer these licenses to the Owner prior to completion.
4. The networks shall, at minimum, comprise, as necessary, the following:
  - a. Operator Workstations - fixed and portable as required by the Specifications.
  - b. Network computer processing, data storage and communication equipment including Servers and digital data processors.
  - c. Routers, bridges, switches, hubs, modems, interfaces and the like communication equipment.
  - d. Active processing network area controllers connected to programmable field panels and controllers together with their power supplies and associated equipment.
  - e. Addressable elements, sensors, transducers and end devices.
  - f. Third-party equipment interfaces as 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 System Application network shall utilize an open architecture capable of each and all of the following:
  - a. Utilizing standard Ethernet communications and operate at a minimum speed of 10/100 Mbps.

2. The networks shall utilize only copper and optical fiber communication media as appropriate and to comply with the applicable codes, ordinances and regulations.
3. All necessary telephone lines, ISDN lines and internet Service Provider services and connections will be provided by the owner.
4. The Controls Contractor shall provide all IT interfacing equipment and cabling to a detail coordinated with the Owner.

D. Third Party Interfaces:

1. The Controls Systems shall include necessary hardware, equipment and software to allow data communications between the Controls Systems and building systems supplied by other trades.
2. The other manufacturers and contractors supplying other associated systems and equipment will provide their necessary hardware, software and start-up at their cost and will cooperate fully with the Controls Contractor in a timely manner and at their cost to ensure complete functional integration.

E. Servers

1. Utilize new Controls System Application Server(s) to archive historical data including trends, alarm and event histories and transaction logs.
2. Access to all information on the Controls Systems Server(s) shall be through the same browser Operator Interface functionality used to access individual nodes. When logged onto a Server the Operator will be able to also interact with any other NAC on the Controls As required for the functional operation of the Controls Systems, the Controls Contractor shall provide all necessary digital processor programmable Server(s). 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 the like. These Server(s) shall utilize IT industry standard data base platforms such as Microsoft Windows 2000 Server or Windows Server 2003, with Microsoft SQL Server 2000.

**2.2 DIRECT DIGITAL CONTROLLERS**

- A. (NAC) Network Area Controllers shall be stand-alone, multi-tasking, multi-user, real-time digital processor complete with all hardware, software, and communications interfaces, power supplies. The Controls System shall be designed and implemented entirely for use and operation on the Internet. NACs shall have access to data within the industry

standard IT network to the Data Server and other NACs as needed to accomplish required global control strategies.

1. NACs shall provide both standalone and networked direct digital control of mechanical and electrical building system controllers as required by the Specifications. The primary NAC shall support a minimum of [5,000] field points together with all associated features, sequences, schedules, applications required for a fully functional distributed processing operation.
2. NACs shall monitor and report communication status to the Controls Systems Application. The Controls Systems shall provide a system advisory upon communication failure and restoration.
3. All NACs on the network shall be equipped with all software functionality necessary to operate the complete user interface, including graphics, via a Browser connected to the Node on the network or directly via a local port on the NAC.
4. All NAC shall be provided with face mounted LED type annunciation to continually display its operational mode, power and communications.
5. The controllers shall reside on the Ethernet local area network and provide Read (Initiate) and Write (Execute) services as defined in Clauses 15.5 and 15.8. Objects supported shall include: Analog input, analog output, analog value, binary input, binary output, binary value, and device.
6. Each NAC shall be provided with the necessary un-interruptible power facilities to ensure its continued normal operation during periods of line power outages of, at minimum, 1-minute duration. Normal functionality shall include all normal software processing, communication with powered field devices and network communications with other powered Controls Systems NAC, Data Servers and OWS. Each NAC shall report its communication status to the Application. The Application shall provide a system advisory upon communication failure and restoration. Each NAC shall retain program, control algorithms, and set point information in non-volatile memory in the event of a power failure, and shall return to normal operation upon restoration of power.
7. All NACs shall have sufficient memory to support its operating system, database, and program requirements, including the following:
  - a. Device and network management.
  - b. Data sharing.
  - c. Alarm and event management including custom alarm messages for each level alarm for the points noted in the I/O Schedule.
  - d. Energy management.

- e. Historical trend data for points specified.
  - f. Maintenance report.
  - g. Scheduling.
  - h. Dial up and network communications.
  - i. Manual override monitoring.
8. Each NAC shall support firmware upgrades without the need to replace hardware and shall have a minimum of 15 percent spare capacity of secondary system controllers, point capacity and programming functions.
9. Each NAC shall continuously perform self-diagnostics, communication diagnosis, and provide both local and remote annunciation of any detected component failures, low battery condition; and upon failure shall assume the predetermined failure mode.
10. Each NAC shall monitor the status of all overrides and inform the operator that automatic control has inhibited, and allow the operator to manually override automatic or centrally executed command.
11. Provide the capability to generate and modify the Controls Systems Application software-based sequences, database elements, associated operational definition information and user-required revisions to same at any designated Workstation together with the means to download same to the associated System Controllers.
12. In the event of loss of normal power, there shall be orderly shut down of the controllers to prevent the loss of database or software programming. When power is restored flash memory, battery backup or super capacitor will be automatically loaded into non-volatile flash memory and shall be incorporated for all programming data.
- B. Auxiliary Control Units (ACUs) shall be stand-alone, multi-tasking, multi-user, real time digital processor complete with all hardware, software and communication interfaces, power supplies, and input/output modular devices.
- 1. ACUs shall either reside on the ACC-LON or Infinet-2 networks.
  - 2. All ACUs shall be provided with LED type annunciation to continually display its operational mode, power and communications.
  - 3. Each ACU shall have sufficient memory to support its operating system, database including the following:
    - a. Data sharing.
    - b. Device and network management.
    - c. Alarm and event management.
    - d. Scheduling.
    - e. Energy Management.

4. Each ACU shall support firmware upgrades without the need to replace hardware and shall have a minimum of 15 percent spare capacity of I/O functions. The type of spares shall be in the same proportion as the implemented functions on the controller, but in no case there shall be less than one point of each implemented I/O type.
  5. Each ACU shall continuously perform self-diagnostics, communication diagnosis, and provide both local and remote annunciation of any detected component failures, low battery condition; and upon failure shall assume the predetermined failure mode.
  6. In the event of loss of normal power, there shall be orderly shut down of the controllers to prevent the loss of database or software programming. When power is restored flash memory, battery backup or super capacitor will be automatically loaded into non-volatile flash memory and shall be incorporated for all programming data.
- C. Unitary Control Units (UCUs) shall be capable of stand-alone, microprocessor-based and shall continue to provide control functions.
1. Unitary Control Units shall either reside on the ACC-LON or Infinet-2 networks.
  2. Each UCU shall have sufficient memory to support its own operating system, including data sharing.
  3. All UCUs shall be provided with LED type annunciation to continually display its operational mode, power and communications.
  4. In the event of loss of normal power, there shall be orderly shut down of the controllers to prevent the loss of database or software programming. When power is restored flash memory, battery backup or super capacitor will be automatically loaded into non-volatile flash memory and shall be incorporated for all programming data.
- D. Provide I/O module that connects sensors and actuators onto the field bus network for use by the direct digital controllers. I/O devices shall support the communication technology specified for each controller.
1. Analog input shall allow the monitoring of low voltage (0-5 VDC, 0-10 VDC), current (4-20 ma), or resistance signals (thermistor, 0-10,000 Ohm) Analog input shall be compatible with, and field configurable to commonly available sensing devices. Analog output shall provide a modulating signal for these control devices.
  2. Binary inputs shall allow the monitoring of on/off signals from remote devices. Binary inputs shall provide a wetting current of at least 12 milliamps to be compatible with commonly available control devices. Binary outputs shall provide on/off operation, or a pulsed low voltage signal for pulse width modulation control. Outputs shall be selectable for either normally open or normally closed operation.

3. Binary outputs on remote and auxiliary controllers shall have 3-position (on/off/auto) override switches and status lights. Analog outputs on remote and auxiliary controllers shall have status lights and a 3-position (on/off/auto) switch and manually adjustable potentiometer for manual override.
4. Each output point shall be provided with a light emitting diode (LED) to indicate status of outputs.

E. Communication Ports:

1. NACs controllers in the DDC systems shall be connected in a system local area network using IP/Ethernet protocol.
2. The control supplier shall provide connectors, repeaters, hubs, and routers necessary for inter-network communication.
3. Minimum baud rate between the peer-to-peer controllers in the system LAN shall be maintained at the rate of 10/100 Mbps. Minimum baud for the low level controllers between UCUs and ACUs, ACUs and NAC's shall be maintained at the rate of 19,200 Kbps.
4. Database, such as points; status information, reports, system software, custom programs of any one controller shall be readable by any other controller on the network.

F. Electric Outlet: Provide a single phase, 120 VAC electrical receptacles inside or within 2 meters (6 feet) of the NAC and ACU enclosures for use with test equipment.

G. Spare Equipment:

1. Provide spare digital controller (CU) boards and spare I/O boards as required. It shall be possible for trained hospital personnel to replace CU boards and load software via the ECC.
2. Provide a minimum of one spare digital controller board of each type and associated parts including batteries to make at least one complete set of DDC control equipment spares.
3. If I/O boards are separate from the CU boards, provide two spare I/O boards for each spare CU board provided above.

### 2.3 DIRECT DIGITAL CONTROLLER SOFTWARE

- A. 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 Microsoft Windows 2000 or Windows XP.
- B. All points shall be identified by up to 96-character point name and ~~16~~ 32-character point descriptor. The same names shall be used at the operator workstation.
- C. 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.

- D. All CU's 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 workstation. Each ACU and RCU shall have capability for local readouts of all functions. The UCUs shall be read remotely.
- E. All DDC control loops shall be able to utilize any of the following control modes:
  - 1. Two position (on-off, slow-fast) control.
  - 2. Proportional control.
  - 3. Proportional plus integral (PI) control.
  - 4. 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.
  - 5. Automatic tuning of control loops.
- F. 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 1,024 levels of security for operator access shall be provided. System shall be capable of unlimited passwords/users.
- G. Application Software: The CUs 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 operator workstation or via a portable workstation, when it is necessary, to access directly the programmable unit. System shall have a non-compile program editor.
  - 1. 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 to time.

2. Night Setback/Morning Warm up Control: The system shall provide the ability to automatically adjust set points for this mode of operation.
3. 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 operate on both outside weather conditions as well as inside zone conditions. The program shall automatically assign longer lead times for weekend and holiday shutdowns. Space temperature input is to be the highest value of zones served in the cooling mode and the lowest of zones served in the heating mode. 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 operator's workstation.
4. 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:
  - a. Time, day.
  - b. Commands such as on, off, auto.
  - c. Time delays between successive commands.
  - d. Manual overriding of each schedule.
  - e. Allow operator intervention.
5. 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 appropriate workstations 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.

6. Remote Communications: The system shall have the ability to dial out in the event of an alarm to workstations 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.
7. 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.

#### **2.4 SENSORS (AIR, WATER AND STEAM)**

##### **A. Temperature and Humidity Sensors:**

1. Electronic Sensors: Provide all remote sensors as required for the systems. All sensors shall be vibration and corrosion resistant for wall, immersion, and/or duct mounting.
  - a. Temperature Sensors: Thermistor type for terminal units and Resistance Temperature Device (RTD) with an integral transmitter type for all other sensors.
    - 1) 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.
    - 2) 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.
    - 3) Space sensors shall be equipped with set-point adjustment, override switch, display, and/or communication port as shown on the drawings. Locking cover where required.
    - 4) Outdoor air temperature sensors shall have watertight inlet fittings and shielded from direct sunlight.
    - 5) Room security sensors shall have stainless steel cover plate with insulated back and security screws.
    - 6) Wire: Twisted, non-shielded pair cable.

- 7) Output Signal: 10,000 Ohms.
- b. Humidity Sensors: Bulk polymer sensing element type.
  - 1) 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. Sensors shall be capable of being calibrated in the field.
  - 2) Outdoor humidity sensors shall be furnished with element guard and mounting plate and have a sensing range of 0 to 100 percent RH.
  - 3) 4-20 ma, 0-5 VDC or 0-10 VDC continuous output signal.
- c. Static Pressure Sensors: Non-directional, temperature compensated.
  - 1) 4-20 ma, 0-5 VDC or 0-10 VDC output signal.
  - 2) 0 to 5 inches wg for duct static pressure range.
  - 3) -0.25 to 0.25 inch wg for Building static pressure range.
- B. Water Flow Sensors:
  1. Sensor shall be insertion turbine type with turbine element, retractor and preamplifier/transmitter mounted on a two-inch full port isolation valve; assembly easily removed or installed as a single unit under line pressure through the isolation valve without interference with process flow; calibrated scale shall allow precise positioning of the flow element to the required insertion depth within plus or minus 1 mm (0.05 inch); wetted parts shall be constructed of stainless steel. Operating power shall be nominal 24 VDC. Local instantaneous flow indicator shall be LED type in NEMA 4 enclosure with 3-1/2 digit display, for wall or panel mounting.
  2. Performance characteristics:
    - a. Ambient conditions: -40 to 60 degrees C (-40 to 140 degrees F), 5 to 100 percent humidity.
    - b. Operating conditions: 850 kPa (125 psig), 0 to 120 degrees C (30 to 250 degrees 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. Overall accuracy plus or minus one percent of reading.
    - e. Repeatability: plus or minus 0.25 percent of reading.
    - f. Preamplifier mounted on meter shall provide 4-20 ma divided pulse output or switch closure signal for units of volume or mass per a time base. Signal transmission distance shall be a minimum of 1,800 meters (6,000 feet). Preamplifier for bi-directional flow measurement shall provide a directional contact closure from a relay mounted in the preamplifier.

- g. Pressure Loss: Maximum 1 percent of the line pressure in line sizes above 100 mm (4 inches).
  - h. Ambient temperature effects, less than 0.005 percent calibrated span per degree C (degree F) temperature change.
  - i) RFI effect - flow meter shall not be affected by RFI.
  - j) Power supply effect less than 0.02 percent of span for a variation of plus or minus 10 percent power supply.
- C. Steam Flow Sensor/Transmitter:
- 1. Sensor: Vortex shedder incorporating wing type sensor and amplification technology for high signal-to-noise ratio, carbon steel body with 316 stainless steel working parts, 24 VDC power, NEMA 4 enclosure.
    - a. Ambient conditions, -40 to 80 degrees C (-40 to 175 degrees F).
    - b. Process conditions, 900 kPa (125 psig) saturated steam.
    - c. Turn down ratio, 20 to 1.
    - d. Accuracy, plus or minus 1.0 percent of span.
    - e. Repeatability, plus or minus 0.1 percent.
    - f. Output signal, 4-20 ma, 0-5 VDC or 0-10 VDC.
    - g. Processor/Transmitter, NEMA 4 enclosure with keypad program selector and six digit LCD output display of instantaneous flow rate or totalized flow, solid state switch closure signal shall be provided to the nearest DDC panel for totalization.
      - 1) Ambient conditions, -20 to 50 degrees C (0-120 degrees F), 0 95 percent non-condensing RH.
      - 2) Power supply, 24 VAC/VDC.
      - 3) Internal battery, provided for 24-month retention of RAM contents when all other power sources are removed.
    - h. Sensor on all steam lines shall be protected by pigtail siphons installed between the sensor and the line, and shall have an isolation valve installed between the sensor and pressure source.
- D. 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.
- E. 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.

## **2.5 ENGINEERING CONTROL CENTER (ECC)—OPERATOR'S WORKSTATION**

- A. Operator workstation(s) shall utilize standard Microsoft 2000 or Windows XP software and be able to access data from all the digital controllers distributed throughout the control systems via Andover Continuum Cyberstation. These workstations shall reside on the same high-speed network as the Network Area Controllers with the ability to remote dial or internet access to the system.
- B. Operator workstation(s) shall qualify as a native BACnet Operator Workstation (B-OWS), per ASHRAE BACnet Standard.

## **2.6 CONTROL CABLES**

As specified in Division 26.

## **2.7 THERMOSTATS AND HUMIDISTATS**

- A. Strap-on thermostats shall be enclosed in a dirt-and-moisture proof housing with fixed temperature switching point and single pole, double throw switch.
- B. Freeze stats 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.

## **2.8 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. Power Operated Control Dampers (other than VAV Boxes): Factory fabricated, balanced type dampers. All modulating dampers shall be opposed blade type and gasketed. Blades for two-position, duct-mounted dampers shall be parallel, airfoil (streamlined) type for minimum noise generation and pressure drop.
  - 1. Leakage: Maximum leakage in closed position shall not exceed 7 L/S (15 CFMs) differential pressure for outside air and exhaust dampers and 200 L/S/ square meter (40 CFM/sq. ft.) at 50 mm (2 inches) differential pressure for other dampers.
  - 2. Frame shall be galvanized steel channel with seals as required to meet leakage criteria.

3. Blades shall be galvanized steel or aluminum, 200 mm (8 inch) maximum width, with edges sealed as required.
  4. Bearing shall be nylon, bronze sleeve or ball type.
  5. Hardware shall be zinc-plated steel. Connected rods and linkage shall be non-slip. Working parts of joints shall be brass, bronze, nylon or stainless steel.
- D. Smoke Dampers and Combination Fire/Smoke Dampers: These dampers shall be classified as a Class II/III leakage rated damper for use in smoke control systems under the latest version of UL 555S, and shall bear a UL Label attesting to same. Smoke dampers shall be suitable for 120 degrees C (250 degrees F).
- E. Operators shall be electric as required for proper operation.
1. Dampers that require manual reset or link replacement after actuation shall not be acceptable. See drawings for required control operation.
  2. Metal parts shall be aluminum, mill finish galvanized steel, or zinc plated steel or stainless steel.
  3. Maximum air velocity and pressure drop through free area the dampers:
    - a. Smoke damper in air handling unit; 210 meter per minute (700 fpm).
    - b. Duct mounted damper; 600 meter per minute (2000 fpm).
    - c. Maximum static pressure loss, 50 Pascal (0.20 inches water gage).
- F. 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 valves shall have a linear relation or equal percentage relation of flow versus valve position.
    - b. Two-way valves position versus flow relation shall be linear for steam and equal percentage for water flow control.
  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.

d. Two position water valves shall be line size.

G. Damper and Valve Operators and Relays:

1. Electric damper operator shall provide full modulating control of dampers. 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.

**2.9 AIR FLOW CONTROL**

A. Airflow and static pressure shall be controlled via digital controller (CUs) with inputs from airflow control measuring stations and static pressure inputs as specified. Controller outputs shall be true analog output signals to DDC positioners or variable frequency drives. Pulse width modulation outputs are not acceptable. The CUs 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 Type:

1. Airflow measuring stations shall measure airflow by the pitot tube traverse method. Each unit shall consist of the following:
  - a. Air Volume Transducer: with square root extractor, scaling multiplier, and output filter.
    - 1) Provide individual airflow transducers selected for the required design airflow rate of the primary element served. Each transducer shall be selected for its respective duty. Supply and Return Airflow Transducers shall provide analog output signal linear to air volume that are factory set for a full scale value equal to 110% of the maximum design capacity of the airflow measuring element served for variable air volume applications, or 200% of the design operating value for constant volume applications.
    - 2) The transducer(s) shall be solid state electronic type, with infinite output resolution, capable of performing dedicated air volume measurement. Microprocessor based transducers with time sharing of multiple square root extractors and/or controllers are not acceptable.
    - 3) Each transducer's output shall not be affected by direction of mounting (attitude) or external vibrations, and shall be furnished with a factory calibrated span that matches the application.
    - 4) Transducer performance shall be equal to or better than the following:

Accuracy: 0.5% F.S. (Terminal Point) 0.35%/ F.S. (BFSL)

Temperature Effects: <0.03% F.S./°F

Over-pressure: 5 PSIG Proof / 10 PSIG Burst

Response: <0.25 seconds for full span input

Noise Filtration: Low Pass Filter, factory set @ 3.2Hz

- b. Insertion Type Airflow Sensing Element: Multiple elements shall be manifolded together, external to the ductwork.
- 1) Provide where indicated and/or scheduled airflow traverse elements capable of continuously monitoring the duct air volumes they serve.
  - 2) Each element shall be designed and built to comply with, and provide results in accordance with, accepted practice for duct system traversing as defined in the ASHRAE Handbook of Fundamentals, AMCA publication #203, as well as the Industrial Ventilation Handbook. The number of sensing ports on each element, and the quantity of elements utilized at each installation, shall comply with ASHRAE Standard #111 for equal area duct traversing.
  - 3) Each element shall be of a dual integral chambered design. Each airflow measuring element shall contain multiple total and static pressure sensing ports placed along the leading edge of the cylinder. The static pressure chamber shall incorporate dual offset static taps on opposing sides of the averaging chamber, so as to be insensitive to flow angle variations of as much as  $\pm 20$  degrees in the approaching airstream.
  - 4) The airflow traverse elements shall be capable of producing steady, non-pulsating signals of true total and static pressure, with an accuracy of 2% of actual flow for operating velocities as low as 100 feet per minute (fpm). Signal amplifying sensors requiring flow correction (K factors) for field calibration are not acceptable.
  - 5) The airflow traverse elements shall not induce a measurable pressure drop, greater than 0.18 inch at 4,000 fpm. The units shall have a self-generated sound rating of less than NC40 and the sound level within the duct shall not be amplified, nor shall additional sound be generated.
  - 6) Where primary flow elements are located outside of the manufacturer's published installation guidelines the manufacturer shall be consulted, and approve of any special configurations, such as air equalizers and/or additional and strategically placed measuring points, as may be required.
2. Each station shall contain noncombustible sensors, which shall be incapable of producing toxic gases or fumes in the event of elevated duct temperatures.
  3. Each air flow measuring station shall be installed to meet at least the manufacturer's minimum installation conditions and shall not amplify the sound level within the duct.
  4. Differential pressure transducers shall measure and transmit pressure signals to the direct digital controller CU.
  5. Electronics Panel:
    - a. Electronics panel shall consist of a surface mounted enclosure complete with solid-state microprocessor and software.

- b. Electronic panel shall be A/C powered 120 VAC 24 VAC and shall have the capability to transmit signals of 0-5 VDC, 0-10 VCD or 4-20 ma for use in control of the HVAC Systems.
- 6. Flow sensors and its electronics shall be installed as per manufacturer's instructions. The number of sensors shall be such that accuracy of the total flow rate shall no way be different than what is specified in Article 1.5 above.
  - a. Static/Total Pressure Sensors: A network of total and static pressure sensors shall be positioned on the equal traverse principle, with a maximum of 0.02 square meters (36 square inches) per total pressure sensor and 0.10 square meter (144 square inches) per static pressure sensor on units. Interconnecting sensor manifolds shall average and relate each type of sensor measurement into one total pressure and one static pressure metering port. The manifold mounting hardware shall not penetrate the manifold tubes and shall be so constructed as to eliminate any possible violation of the integrity of the total or static pressure measurements. The meter tubing for the averaged total static pressure shall not be exposed to internal duct conditions.
  - b. Static Pressure Control: Systems 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 duct, 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 CU.
    - 3) The CU 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.
- C. Constant Volume Control: Systems shall consist of a differential pressure transmitter along with such relays and auxiliary devices as required to produce a complete functional system. The transmitter shall receive its primary total pressure and static pressure signal from the flow measuring station and shall have a span not exceeding three times this differential pressure at 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.
- D. Airflow Synchronization:
1. Systems shall consist of a differential pressure transmitter for each supply and return ducts, the CU and such relays, as required, to provide a complete functional system that will maintain a constant difference between supply and return air to meet the accuracy specified below. In systems where there is no suitable location for a flow measuring station that will sense total supply or return flow, provide multiple flow stations with a differential pressure transmitter for each station. Signals from the multiple transmitters shall be added through the CU such that the resultant signal is a true representative of total flow.
  2. The total flow signals from supply and return air shall be the input signals to the CU. This CU shall track the return air fan capacity in proportion to the supply air flow under all conditions.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

- A. General:
1. Examine project plans for control devices and equipment locations; and report any discrepancies, conflicts, or omissions to Resident Engineer for resolution before proceeding for installation.
  2. Install equipment, piping, wiring /conduit parallel to or at right angles to building lines.
  3. Install all equipment and piping in readily accessible locations. Do not run tubing and conduit concealed under insulation or inside ducts.

4. Mount control devices, tubing and conduit located on ducts and apparatus with external insulation on standoff support to avoid interference with insulation.
5. Provide sufficient slack and flexible connections to allow for vibration of piping and equipment.
6. Run tubing and wire connecting devices on or in control cabinets parallel with the sides of the cabinet neatly racked to permit tracing.
7. Install equipment level and plumb.

B. Electrical Wiring Installation:

1. Install conduits and wiring in accordance with Specification Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.
2. Install signal and communication cables in accordance with Specification Section 26 05 21, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW).
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. All wiring shall be installed in conduits.
4. 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.
5. Conceal cables, except in mechanical rooms and areas where other conduits and piping are exposed.

6. 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.
  7. Grounding: ground electrical systems per manufacturer's written requirements for proper and safe operation.
- C. Install Sensors and Controls:
1. Temperature Sensors:
    - a. Install all sensors and instrumentation according to manufacturer's written instructions. Temperature sensor locations shall be readily accessible, permitting quick replacement and servicing of them without special skills and tools.
    - b. Calibrate sensors to accuracy specified, if not factory calibrated.
    - c. Use of sensors shall be limited to its duty, e.g., duct sensor shall not be used in lieu of room sensor.
    - d. Install room sensors permanently supported on wall frame. They shall be mounted at 1.5 meter (5.0 feet) above the finished floor.
    - e. Mount sensors rigidly and adequately for the environment within which the sensor operates.
    - f. Sensors used in mixing plenum, and hot and cold decks shall be of the averaging of type. Averaging sensors shall be installed in a serpentine manner horizontally across duct. Each bend shall be supported with a capillary clip.
    - g. All pipe mounted temperature sensors shall be installed in wells.
    - h. All wires attached to sensors shall be air sealed in their conduits or in the wall to stop air transmitted from other areas affecting sensor reading.
    - i. Permanently mark terminal blocks for identification. Protect all circuits to avoid interruption of service due to short-circuiting or other conditions. Line-protect all wiring that comes from external sources to the site from lightning and static electricity.
  2. Pressure Sensors:
    - a. Install duct static pressure sensor tips facing directly downstream of airflow.
    - b. Install high-pressure side of the differential switch between the pump discharge and the check valve.
    - c. Install snubbers and isolation valves on steam pressure sensing devices.
  3. Actuators:

- a. Mount and link damper and valve actuators according to manufacturer's written instructions.
  - b. Check operation of damper/actuator combination to confirm that actuator modulates damper smoothly throughout stroke to both open and closed position.
  - c. Check operation of valve/actuator combination to confirm that actuator modulates valve smoothly in both open and closed position.
4. Flow Switches:
  - a. Install flow switch according to manufacturer's written instructions.
  - b. Mount flow switch a minimum of 5 pipe diameters up stream and 5 pipe diameters downstream or 600 mm (2 feet) whichever is greater, from fittings and other obstructions.
  - c. Assure correct flow direction and alignment.
  - d. Mount in horizontal piping-flow switch on top of the pipe.
- D. Installation of Network:
  1. Ethernet:
    - a. The network shall employ Ethernet LAN architecture, as defined by IEEE 802.3. The Network Interface shall be fully Internet Protocol (IP) compliant allowing connection to currently installed IEEE 802.3, Compliant Ethernet Networks.
    - b. The network shall directly support connectivity to a variety of cabling types. As a minimum provide the following connectivity:  
10 Base 2 (ThinNet RG-58 A/U Coaxial cabling with BNC connectors),  
10 Base T (Twisted-Pair RJ-45 terminated UTP cabling).
  2. Third Party Interfaces: Contractor shall integrate real-time data from building systems by other trades and databases originating from other manufacturers as specified and required to make the system work as one system.
- E. Installation of Digital Controllers and Programming:
  1. Provide a separate digital controller 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 air handling unit, fan, pumping unit etc. These graphics shall show all points dynamically as specified in the point list.

F. Field Test and Inspection:

1. General:

- a. Engage a factory-authorized representative and furnish personnel, instrumentation, and equipment necessary to perform complete testing of the installed HVAC systems, including piping and electrical connections. Field test will demonstrate proper calibration of input and output devices, and the operation of specific equipment.
- b. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment, and retest.
- c. Observe HVAC systems in shut down condition. Check dampers and valves for normal position.
- d. Contractor shall schedule the performance verification test with the Resident Engineer.
- e. During and after completion of the field tests, contractor shall determine causes, calibrate, repair, or replace equipment that fails to meet contract requirements, and subsequently deliver a written report to the VA.

2. Field Performance Tests:

- a. Perform tests in accordance with Articles-Quality Assurance and Performance.
- b. Test and adjust controls and safeties.
- c. Test application software for its ability to communicate with digital controllers, operator workstation, and uploading and downloading of control programs.
- d. Demonstrate the software ability to edit the control program off-line.
- e. Demonstrate reporting of alarm conditions for each alarm and ensure that these alarms receive at the assigned location, including operator workstations.
- f. Demonstrate ability of software program that it functions for the intended applications-trend reports, change in status etc.
- g. 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.

- h. 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.
  - i. Demonstrate to the VA graphed trends of control loops to demonstrate that the control loop is stable and the set points are maintained.
  - j. Control loop shall respond to set points and stabilize in one (1) minute. Control loop trend data shall be instantaneous and the time between data points shall not be greater than one (1) minute.
3. Performance Verification Test:

The contractor shall verify the performance of the control systems by running a continuous test, after the system has been completely tested and debugged, for 80 hours and submit the report to the VA.

----- END -----

**SECTION 23 21 11**  
**BOILER PLANT PIPING SYSTEMS**

**PART 1 - GENERAL:**

**1.1 DESCRIPTION:**

All boiler plant piping systems, except plumbing and sanitary, including piping supports. Piping located outside of the boiler plant building is not included except for gas regulator and meter stations.

**1.2 RELATED WORK:**

- A. Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION
- B. Section 23 05 51, NOISE AND VIBRATION CONTROL FOR BOILER PLANT.
- C. Section 23 07 11, HVAC, PLUMBING, AND BOILER PLANT INSULATION.
- D. Section 22 05 23, GENERAL-DUTY VALVES FOR PLUMBING PIPING .
- E. Control valves: Section 23 52 34, STEAM GENERATOR.
- F. Control valves: Section 23 50 11, BOILER PLANT MECHANICAL EQUIPMENT.
- G. Flow Meters: Section 23 09 11, INSTRUMENTATION AND CONTROL FOR BOILER PLANT.
- H. Section 23 08 11, DEMONSTRATIONS AND TESTS FOR BOILER PLANT.

**1.3 QUALITY ASSURANCE:**

- A. Entire installation shall comply with ASME Power Piping Code, ASME B31.1 and appendices.
- B. Boiler External Piping, as defined in the ASME Boiler and Pressure Vessel Code, Section I, is required to be constructed and inspected in conformance with the ASME Code.
- C. Mechanics shall be skilled in their work or trade. Welders on pressure vessels or piping shall show evidence of qualification in accordance with the ASME Power Piping Code and the ASME Boiler and Pressure Vessel Code. Certify that each welder has passed American Welding Society (AWS) qualification tests for the welding processes involved, and that certification is current. Each welder shall utilize a stamp to identify all work performed by the welder. The Government reserves the right to reject any personnel found unqualified in the performance of work for which they are employed.

**1.4 SUBMITTALS:**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Piping:
  - 1. ASTM material specification number.
  - 2. Grade, class or type, schedule number.
  - 3. Manufacturer.
- C. Pipe Fittings, Unions, Flanges:

1. ASTM material specification number.
  2. ASME standards number.
  3. Catalog cuts.
  4. Pressure and temperature ratings.
- D. Valves - Gate, Globe, Check, Plug, Butterfly, Ball:
1. Catalog cuts showing design and construction.
  2. Pressure and temperature ratings.
  3. Materials of construction.
  4. Accessories.
- E. Sight flow indicators:
1. Catalog cuts showing design and construction.
  2. Pressure and temperature ratings.
  3. Materials of construction.
- F. Quick-Couple Hose Connectors and Steam Hose:
1. Catalog cuts showing design and construction.
  2. Pressure and temperature ratings.
  3. Materials of construction.
  4. Type of seal between couplings.
  5. Flexibility of steam hose.
- G. Pressure Reducing and Regulating Valves, Back Pressure Relief Valves, Safety Valves, Relief Valves:
1. Catalog cuts showing design and construction.
  2. Service limitations (type of fluid, maximum pressure and temperatures).
  3. Materials of construction.
  4. Flow capacity at required set pressure.
  5. Predicted sound levels, at operating condition, for steam pressure reducing valves.
- H. Strainers:
1. Catalog cuts showing design and construction.
  2. Pressure and temperature ratings.
  3. Materials of construction.
  4. Strainer basket or liner mesh.
  5. Pressure loss and flow rate data.
- I. Emergency Gas Safety Shutoff Valves, Automatic Earthquake Gas Valves:
1. Catalog cuts showing design and construction.
  2. Maximum pressure rating.
  3. Material of construction.
  4. Pressure loss and flow rate data.
- J. Steam Traps:

1. Catalog cuts showing design and construction.
2. Service limitations (maximum pressures and temperatures).
3. Materials of construction.
4. Flow rates at differential pressures shown on drawings.
5. Orifice size for each trap.

**K. Flexible Connectors:**

1. Catalog cuts showing design and construction.
2. Pressure and temperature ratings.
3. Materials of construction.
4. Maximum allowable lateral and axial movements.
5. Description of type of movement permitted, intermittent offset or continuous vibration.

**L. Pipe Support Systems:**

1. Credentials of technical personnel who will design the support systems.
2. Validation of computer program for pipe support selection.
3. Input and output data for pipe support selection program for all piping systems with pipe sizes 60 mm (2-1/2 inches) and above.
3. Steam nozzle (pipe connection) allowable and actual forces and moments imposed by connecting piping.
4. Hanger load calculation methods and results for piping systems with pipe sizes 50 mm (2 inches) and below.
5. Piping layouts showing location and type of each hanger and support.
6. Catalog cuts showing design and construction of each hanger and support and conformance of hangers and supports to MSS standards.
7. Drawings showing arrangement and sizes of all components comprising each spring-type hanger and support assembly.
8. Load rating and movement tables for all spring hangers, and seismic shock absorbing devices.

**1.5 PRODUCT DELIVERY, STORAGE AND HANDLING:**

All piping shall be stored and kept free of foreign material and shall be internally and externally cleaned of all oil, dirt, rust and foreign material. Deliver and store valves and pipe hangers in sealed shipping containers with labeling in place. Storage must be in dry, protected location.

**1.6 INFORMATION ON PRESSURE-TEMPERATURE DESIGN OF PIPING SYSTEMS:**

- A. Steam service pressures are selected to provide optimum pressure to the facilities served by the boiler plant. Main steam header pressure shall be controlled at approximately 125 psi. Maximum pressure capability of steam systems between boilers and through first pressure reducing valve

protected by a safety valve shall be governed by the pressure/temperature relationship of the highest safety valve setting shown for the boilers.

- B. Steam distribution systems protected by safety valves following pressure reducing stations or protected by safety valves on the boilers shall be governed by the pressure/temperature relationship developed by the maximum setting of the safety valve on that system.
- C. Boiler feedwater systems between boiler feed pumps, economizers (if provided), and boilers are designed for a normal maximum temperature of 138 °C (280 °F), and emergency temperature of 213 °C (415 °F) (if economizers are provided and economizer safety relief valve setting is 1896 kPa (275 psi)). Design pressure is the greater of: boiler feed pump shut off head; or 1896 kPa (275 psi) set pressure, plus accumulation, of economizer (if provided) relief valve.
- D. Condensate collection and transfer systems to suction of boiler feed pumps are designed for maximum temperatures to 100 °C (212 °F), and pressures 276 kPa (40 psi).
- E. Natural gas fuel systems are designed and materials and equipment are applied to prevent failure under gas pressure of 12 psi entering Government property. LP gas systems for igniters (pilots) are designed for maximum LP tank pressure of 1725 kPa (250 psig).
- F. Fuel oil system pressures are determined by the requirements of the burners and fuel trains. No. 2 oil systems are designed for maximum temperatures of 55 °C (130 °F), and pressures of 1025 kPa (150 psi).
- G. Drips, drains, blowdown, water sampling, and chemical treatment are designed, and materials and equipment are applied in accordance with the maximum pressure and temperature of the system with which they are associated.
- H. Low pressure steam, condensate, vacuum and vents are designed for service pressures and temperatures equivalent to 103 kPa (15 psi) saturated steam.
- I. Compressed air systems are designed to accommodate a maximum pressure of 850 kPa (125 psi).
- J. Instrumentation and control piping shall be provided for the service and pressure characteristics of the systems to which they are connected.

#### **1.7 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. ASTM International (ASTM):

A47/A47M-99(2004).....Ferritic Malleable Iron Castings  
A48/A48M-03.....Gray Iron Castings  
A53/A53M-06a.....Pipe, Steel, Black and Hot-Dipped, Zinc-Coated,  
Welded and Seamless  
A105/A105M-05.....Carbon Steel Forgings for Piping Applications  
A106-06a.....Seamless Carbon Steel Pipe For High Temperature  
Service  
A126-04.....Gray Iron Castings for Valves, Flanges and Pipe  
Fittings  
A193/A193M-07.....Alloy-Steel and Stainless Steel Bolting  
Materials for High Temperature Service  
A194/A194M-07a.....Carbon and Alloy Steel Nuts for Bolts for High-  
Pressure or High-Temperature Service, or Both  
A197/A197M-00(2006).....Cupola Malleable Iron  
A216/A216M-07.....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  
A269-07.....Seamless and Welded Austenitic Stainless Steel  
Tubing for General Service  
A395/A395M-99(2004).....Ferritic Ductile Iron Pressure-Retaining  
Castings for use at Elevated Temperatures  
A536-84(2004).....Ductile Iron Castings  
B61-02.....Steam or Valve Bronze Castings  
B62-02.....Composition Bronze or Ounce metal Castings  
B88/B88M-05.....Seamless Copper Water Tube

C. American Society of Mechanical Engineers (ASME):

Boiler and Pressure Vessel Code: 2007 Edition with current Addenda  
Section I.....Power Boilers  
Section IX.....Welding and Brazing Qualifications  
B16.3-2006.....Malleable Iron Threaded Fittings  
B16.4-2000.....Gray Iron Threaded Fittings  
B16.5-2003.....Pipe Flanges and Flanged Fittings: NPS ½ Through  
24  
B16.9-2003.....Factory Made Wrought Buttwelding Fittings  
B16.11-2005.....Forged Fittings, Socket-Welding and Threaded  
B16.22-2001.....Wrought Copper and Copper Alloy Solder Joint  
Pressure Fittings

- B31.1-2004.....Code for Pressure Piping: Power Piping with  
current Addenda
- D. Manufacturers Standardization Society of the Valve and Fittings Industry  
(MSS):
- SP-45-2003.....Bypass and Drain Connections
- SP-58-2002.....Pipe Hangers and Supports-Materials, Design and  
Manufacturing
- SP-69-2003.....Pipe Hangers and Supports-Selection and  
Application
- SP-80-2003.....Bronze, Gate, Globe, Angle and Check Valves
- SP-89-2003.....Pipe Hangers and Supports-Fabrication and  
Installation Practices
- SP-90-2000.....Guidelines on Terminology for Pipe Hangers and  
Supports
- SP-97-2006.....Integrally Reinforced Forged Branch Outlet  
Fittings - Socket Welding, Threaded and  
Buttwelding Ends
- SP-127-2001.....Bracing for Piping Systems Seismic - Wind -  
Dynamic Design, Selection, Application
- E. National Fire Protection Association (NFPA):
- 30-2008.....Flammable and Combustible Liquids
- 31-2006.....Installation of Oil Burning Equipment
- F. American Welding Society (AWS):
- B2.1-05.....Welding Procedure and Performance Qualification
- G. Pipe Fabrication Institute (PFI):
- ES24-RA04.....Pipe Bending Methods, Tolerances, Process and  
Material Requirements

## **PART 2 - PRODUCTS:**

### **2.1 STEAM PIPING:**

- A. Pipe: Carbon steel, ASTM A53 Grade B or ASTM A106 Grade B, seamless or electric resistance welded (ERW). Schedule 40 for piping with welded ends, Schedule 80 for piping with threaded ends, standard weight permitted for pipe sizes 300 mm (12 inches) and above.
- B. Joints:
1. Pipe sizes 65 mm (2-1/2 inches) and above: Butt-welded
  2. Pipe sizes 50 mm (2 inches) and below: Threaded, butt-welded, or socket-welded.
- C. Fittings:
1. Welded joints: Steel, ASTM A234, Grade B, ASME B16.9, same schedule as adjoining pipe, all elbows long radius.

2. Threaded joints: Forged steel, ASME B16.11, 13,790 kPa (2000 psi class; or malleable iron, ASTM A47 or A197, ASME B16.3, 2050 kPa (300 psi) class.
3. Socket-welded joints: Forged steel, ASME B16.11, 13,790 kPa (2000 psi) class.
- D. Unions on Threaded Piping: Forged steel, 13,800 kPa (2000 psi) class or 20,680 kPa (3000 psi) class; or malleable iron, 2050 kPa (300 psi) on piping 50 mm (2 inches) and under.
- E. Flanges and Bolts: Forged steel weld neck, ASME B16.5, ASTM A105, 1025 kPa (150 psi) pressure class, except 2050 kPa (300 psi) class required adjacent to 1725 kPa (250 psi) and 2050 kPa (300 psi) class valves. Bolts shall be high strength steel ASTM A193, Class 2, Grade B8. Nuts shall be ASTM A194.

## **2.2 STEAM CONDENSATE PIPING:**

- A. Includes all gravity, drip return, pumped and vacuum systems. Does not include piping system between boiler feed pumps and boilers.
- B. Pipe: Carbon steel, ASTM A53 Grade B or ASTM A106 Grade B, seamless or ERW, Schedule 80.
- C. Joints:
  1. Pipe sizes 65 mm (2-1/2 inches) and above: Butt-welded.
  2. Pipe sizes 50 mm (2 inches) and below: Threaded, butt-welded or socket-welded.
- D. Fittings:
  1. Welded joints: Steel, ASTM A234, Grade B, ASME B16.9, same schedule as adjoining pipe.
  2. Threaded joints: Forged steel, ASME B16.11, 13,790 kPa (2000 psi class; or malleable iron, ASTM A47 or A197, ASME B16.3, 2050 kPa (300 psi) class.
  3. Socket-welded joints: Forged steel, ASME B16.11, 13,800 kPa (2000 psi) class.
- E. Unions on Threaded Piping: Forged steel, 13,800 kPa (2000 psi) class or 20,680 kPa (3000 psi) class; or malleable iron, 2050 kPa (300 psi). On piping 50 mm (2 inches) and under.
- F. Flanges: Forged steel weld neck, ASTM A105, ASME B16.5, 1025 kPa (150 psi).

## **2.3 FUEL PIPING:**

- A. Natural gas, LP gas (propane), fuel oil (No. 2) for main burner and igniter (pilot) fuels, gas vent piping. Comply with ASME B31.1.

- B. Piping: Carbon steel, ASTM A53 Grade B or ASTM A106 Grade B, seamless or ERW, Schedule 40. Fuel oil piping shall be seamless downstream of burner automatic shutoff valves.
- C. Joints:
  - 1. Pipe sizes 65 mm (2-1/2 inches) and above: Butt-welded.
  - 2. Pipe sizes 50 mm (2 inches) and below: Socket-welded or butt-welded.
- D. Fittings:
  - 1. Butt-welded joints: Steel, ASTM A234, Grade B, ASME B16.9, same schedule as adjoining pipe.
  - 2. Socket-welded joints: Forged steel, ASME B16.11, 13,790 kPa (2000 psi class).
- E. Unions on piping 50 mm (2 inches) and under: Forged steel, 13,800 kPa (2000 psi) class or 20,680 kPa (3000 psi) class.
- F. Flanges: Forged steel weld neck, ASME B16.5, ASTM A105, 1025 kPa (150 psi).
- G. Companion flanges: Flanges and bolting shall conform to ASME B16.5.
- H. Burner Piping: Furnished as part of the factory-assembled burners may be manufacturer's standard materials and assembly. Comply with ASME B31.1, for the actual operating conditions.
- I. Igniter (Pilot) Piping: Furnished as part of the factory assembled burners may have 2050 kPa (300 psi) ASTM A47, ASME B16.3 malleable iron threaded fittings in lieu of welded steel. If threaded fittings are provided, piping shall be Schedule 80.

#### **2.4 BOILER FEEDWATER PIPING:**

- A. Piping from boiler feedwater pump discharge to inlet of boilers.
- B. Pipe: Carbon steel, ASTM A53 Grade B or ASTM A106 Grade B, seamless or ERW. Piping with threaded joints shall be Schedule 80; welded joints Schedule 40.
- C. Joints:
  - 1. Pipe sizes 65 mm (2-1/2 inches) and above: Butt-welded.
  - 2. Pipe sizes 50 mm (two inches) and below: Threaded, butt-welded, or socket-welded.
- D. Fittings:
  - 1. Butt-welded Joints: Steel, ASTM A234, Grade B, ASME B16.9, same schedule as adjoining pipe.
  - 2. Threaded Joints: Forged steel, ASME B16.11, 13,790 kPa (2000 psi class; or malleable iron, ASTM A47, ASME B16.3, 2050 kPa (300 psi) class.
  - 3. Socket-welded joints: Forged steel, ASME B16.11, 13,800 kPa (2000 psi) class.

- E. Unions: Forged steel, 13,800 kPa (2000 psi) class or 20,680 kPa (3000 psi) class; or malleable or ductile iron, 2050 kPa (300 psi) class.
- F. Flanges and Bolts: Forged steel weld neck, ASME B16.5, ASTM A105, 2050 kPa (300 psi) pressure class. Bolts shall be High strength ASTM A193, Class 2, Grade B8. Nuts shall be ASTM A194.

**2.5 BOILER BLOWOFF PIPING:**

- A. From boiler bottom blowoff connection to blowoff tank. Connections between boiler accessories drain valves and blowoff lines.
- B. Pipe: Carbon steel, ASTM A106, Grade B, seamless, Schedule 80.
- C. Joints: Butt-welded.
- D. Fittings: Steel, ASTM A234, Grade B, ASME B16.9, same schedule as adjoining pipe, all elbows long radius, no tees or crosses permitted.
- E. Flanges: Forged steel weld neck, ASME B16.5, ASTM A105, 2050 kPa (300 psi).

**2.6 DRAIN PIPING FROM BOILER ACCESSORIES TO DRAIN VALVE:**

- A. Drain piping from water column, low water cutoffs, gage glass, water level sensor, remote water level devices (where applied).
- B. Pipe: Carbon steel, ASTM A106, seamless, Schedule 40.
- C. Joints: Threaded.
- D. Fittings: Forged steel, ASME B16.11, 13,790 kPa (2000 psi class); or malleable iron, ASTM A47 or A197, ASME B16.3, 2050 kPa (300 psi) class.
- E. Unions: Forged steel, 13,800 kPa (2000 psi) class or 20,680 kPa (3000 psi) class; or malleable iron, 2050 kPa (300 psi) class.

**2.7 VENT LINES FROM TANKS AND SAFETY AND RELIEF VALVES:**

- A. Pipe: Carbon steel, ASTM A53 Grade B or A106 Grade B, seamless or ERW, Schedule 40.
- B. Joints:
  - 1. Pipe sizes 65 mm (2-1/2 inches) and above: Butt-welded.
  - 2. Pipe sizes 50 mm (2 inches) and below: Threaded or butt-welded.
- C. Fittings:
  - 1. Welded Joints: Steel, ASTM A234 Grade B, ASME B16.9, same schedule as adjoining pipe.
  - 2. Threaded Joints: Cast iron, ASME B16.4, 850 kPa (125 psi).
- D. Unions: Forged steel, 13,800 kPa (2000 psi) class or 20,680 kPa (3000 psi) class; or malleable iron, 1025 kPa (150 psi) class.
- E. Flanges: Forged steel weld neck, ASME B16.5, ASTM A105, 1025 kPa (150 psi).

**2.8 COLD WATER PIPING:**

- A. Soft Water: See Section 22 31 11, WATER SOFTENERS.
- B. City Water: See Section 22 11 00, FACILITY WATER DISTRIBUTION.

**2.9 COMPRESSED AIR PIPING (FUEL OIL ATOMIZING SERVICE) :**

- A. Pipe: Carbon steel, , ASTM A53 Grade B or ASTM A106 Grade B, seamless or ERW Schedule 40.
- B. Joints: Threaded.
- C. Fittings: Forged steel, ASME B16.11, 13,790 kPa (2000 psi class); or malleable iron ASTM A47 or A197, ASME B16.3, 1025 kPa (150 psi) class.
- D. Unions: Forged steel, 13,800 kPa (2000 psi) class or 20,680 kPa (3000 psi) class; or malleable iron, 1025 kPa (150 psi) class.

**2.10 COMPRESSED AIR AND BOILER DRAFT GAGE PIPING (PNEUMATIC CONTROL AND INSTRUMENTATION) :**

- A. Air drier to utilization point; draft gage sensing lines.
- B. Copper tubing, hard drawn, ASTM B88, Type L.
- C. Fittings: Wrought copper, ASME B16.22, soldered.
- D. Draft Gage Piping: 6 mm (1/4 inch) pipe size minimum.

**2.11 BOILER WATER SAMPLING, CONTINUOUS BLOWDOWN:**

- A. Pipe: Steel, ASTM A106 Grade B, seamless, Schedule 80.
- B. Joints: Threaded.
- C. Fittings: Forged steel, ASME B16.11, 13,790 kPa (2000 psi class); or malleable iron, ASTM A47 or A197, ASME B16.3, 2050 kPa (300 psi) class. Fittings between boiler and first stop valve must be forged steel, ASME B16.11, 13,790 kPa (2000 psi) or 20,700 kPa (3000 psi) class.
- D. Unions: Malleable iron, 2050 kPa (300 psi) class.

**2.12 FEEDWATER SAMPLING AND CHEMICAL FEED PIPING:**

- A. Pipe: Stainless steel tubing, ASTM A269, Type 316.
- B. Fittings: Stainless steel Type 316 welding fittings.

**2.13 MISCELLANEOUS PIPING:**

- A. Instrument and Control Piping (Sensing Point to Transmitter, Controller, or Other Instrument): Construction shall be same as specified for main service.
- B. Drain Piping (All Drain Piping Discharging to Floor Drain-From Drain Valve to Floor Drain):
  - 1. Pipe: Carbon steel, ASTM A53 Grade B or ASTM A106 Grade B, seamless or ERW, Schedule 40.
  - 2. Fittings and Unions: Forged steel, ASME B16.11, 13,790 kPa (2000 psi class); or malleable iron, 1025 kPa (150 psi), threaded.
- C. Pump Recirculation:
  - 1. Pipe: Carbon steel, ASTM A53 Grade B or ASTM A106 Grade B, seamless or ERW, double extra strong. Schedule 40 permitted on all lines 1500 mm (5 feet) or more from the recirculation orifice.
  - 2. Joints: Threaded.

3. Fittings: Forged steel, ASME B16.11, 13,790 kPa (2000 psi class); or malleable iron, ASTM A47 or A197, ASME B16.3, 2050 kPa (300 psi) class, except 1025 kPa (150 psi) class permitted on all lines 1500 mm (5 feet) or more from the recirculation orifice.
4. Unions: Forged steel, 13,800 kPa (2000 psi) class or 20,680 kPa (3000 psi) class; or malleable iron, ASTM A47 or A197, same pressure class as nearest fittings.

**2.14 DIELECTRIC FITTINGS:**

Provide threaded dielectric unions for pipe sizes 50 mm (2 inches) and under. For 65 mm (2-1/2 inches) and above, provide copper and steel flanges electrically isolated at gasket and by sleeves at bolts. Fittings on cold water and soft water lines shall be rated for 690 kPa (100 psi), 27 °C (80 °F). Fittings on steam condensate lines shall be rated at 510 kPa (75 psi), 120 °C (250 °F). Fittings on other services shall be rated for the maximum pressure and temperature conditions of the service.

**2.15 VALVES; GATE, GLOBE, PLUG, CHECK, BALL, BUTTERFLY, VENT COCKS:**

- A. Valves for particular services are generally specified as Type Numbers. The Type Numbers are defined below. All valves of the same type shall be the products of a single manufacturer. Comply with MSS SP-45, MSS SP-80, and ASME B31.1. Design valves for the service fluids and conditions. Pressure-temperature ratings listed are minimum requirements. Packing and gaskets shall not contain asbestos.
- B. Valve Type Designations:
  1. Gate Valves:
    - a. Type 101: Cast steel body ASTM A216 WCB, rated for 1025 kPa at 260 °C (150 psi at 500 °F), 11-1/2 to 13 percent chromium stainless steel flexible wedge and hard faced (stellite) or nickel copper alloy seats, 1025 kPa (150 psi) ASME flanged ends, OS&Y, rising stem, bolted bonnet.
      - 1) Provide factory installed globe-valved warm-up bypass when main valve is 75 mm (3 inch) pipe size or greater and serves steam main longer than 6 m (20 feet). Conform to MSS SP-45.
      - 2) Drill and tap bosses for connection of drains. Conform to MSS SP-45.
    - b. Type 102: Cast iron body ASTM A126 Class B, rated for 1725 kPa (250 psi) saturated steam, 3440 kPa (500 psi) WOG, bronze wedge and seats, 1725 kPa (250 psi) ASME flanged ends, OS&Y, rising stem, bolted bonnet, renewable seat rings.

- 1) Provide factory installed globe-valved bypass when main valve is 75 mm (3 inch) pipe size or greater and serves steam main longer than 6 m (20 feet). Conform to MSS SP-45.
  - 2) Drill and tap bosses for connection of drains if valve is in steam service. Conform to MSS SP-45.
  - c. Type 103: Cast iron body ASTM A126 Class B, rated for 850 kPa (125 psi) saturated steam, 1375 kPa (200 psi) WOG, bronze or bronze faced wedge and seats, 850 kPa (125 psi) ASME flanged ends, OS&Y, rising stem, bolted bonnet, renewable seat rings.
    - 1) Provide factory installed globe-valved bypass when main valve is 75 mm (3 inch) pipe size or greater and serves steam main longer than 6 m (20 feet). Conform to MSS SP-45.
    - 2) Drill and tap bosses for connection of drains if valve is in steam service. Conform to MSS SP-45.
  - d. Type 104: Bronze body ASTM B61, rated for 1375 kPa (200 psi) saturated steam, 2750 kPa (400 psi) WOG, bronze wedges and Monel or stainless steel seats, threaded ends, rising stem, union bonnet.
  - e. Type 105: Forged steel body ASTM A105, rated for 2050 kPa at 216 °C (300 psi at 420 °F) minimum, Class 4130 kPa (600 psi) or Class 5500 kPa (800 psi), hardened stainless steel or stellite wedge and seats, threaded ends, OS&Y, rising stem, bolted bonnet.
2. Globe Valves:
- a. Type 201: Cast steel body ASTM A216 WCB, rated for 1025 kPa at 260 °C (150 psi at 500 °F), 11-1/2 to 13 percent chromium stainless steel or stellite disc and seat, 1025 kPa (150 psi) ASME flanged ends, OS&Y, rising stem, bolted bonnet, renewable seat rings. Drill and tap bosses for connection of drains where shown. Conform to MSS SP-45.
  - b. Type 202: Cast iron body ASTM A126 Class B, rated for 1725 kPa (250 psi) saturated steam, 3440 kPa (500 psi) WOG, bronze or bronze faced disc and seat, 1725 kPa (250 psi) ASME flanged ends, OS&Y, rising stem, bolted bonnet, renewable seat rings. Drill and tap bosses for connection of drains where shown. Conform to MSS SP-45.
  - c. Type 203: Cast iron body ASTM A126 Class B, rated for 850 kPa (125 psi) saturated steam, 1375 kPa (200 psi) WOG, bronze or bronze-faced disc (Teflon or composition facing permitted) and seat, 850 kPa (125 psi) ASME flanged ends, OS&Y, rising stem, bolted bonnet, renewable seat rings.

- d. Type 204: Bronze body ASTM B61, rated for 1375 kPa (200 psi) saturated steam, 2750 kPa (400 psi) WOG, hardened stainless steel disc and seat, threaded ends, rising stem, union bonnet, renewable seat rings.
- e. Type 205: Forged steel body ASTM A105, rated for 2050 kPa at 216 °C (300 psi at 420 °F) minimum, Class 4130 kPa (600 psi) or Class 5500 kPa (800 psi), stainless steel disc, stellite seat, threaded ends, OS&Y, rising stem, bolted bonnet.
- 3. Plug Valves: Cast iron body ASTM A126 Class B, rated for 1200 kPa (175 psi) WOG, one-fourth turn to open. 850 kPa (125 psi) ASME flanged ends for pipe sizes above 50 mm (2 inches), threaded ends for pipe sizes 50 mm (2 inches) and under. All components designed for service to which applied: natural gas, LP gas (propane), or fuel oil. Furnish lever handle for each valve.
  - a. Type 301: Two-way valves up through 100 mm (4 inches) pipe size. Eccentric action, non-lubricated plug with resilient seal molded into groove on plug face providing bubble-tight shut off. O-ring stem seal, corrosion-resistant bearings, corrosion-resistant seat coating, seal materials as recommended by valve manufacturer for the service. Valves on natural gas service AGA approved.
  - b. Type 302: Two-way valves 125 mm (5 inches) pipe size and above, all sizes of three way valves. Lubricated full-port plug type with lubricant for intended service. Reinforced Teflon stem seal, valve plug floated on Teflon surfaces, lubricant injection system that has sufficient pressure to fully lubricate all sealing surfaces. Provide laminated plastic label attached to each valve stating, "Lubricate with (Insert appropriate description) once a year".
- 4. Check Valves:
  - a. Type 401: Not used.
  - b. Type 402: Swing-type, cast iron body ASTM A126 Class B, rated for 1725 kPa (250 psi) saturated steam, 3440 kPa (500 psi) WOG, bronze or bronze-faced disc and seat, 1725 kPa (250 psi) ASME flanged ends, bolted cover, renewable disc and seat.
  - c. Type 403: Swing-type, cast iron body ASTM A126 Class B, rated for 850 kPa (125 psi) saturated steam, 1375 kPa (200 psi) WOG, bronze or bronze-faced disc and seat, 850 kPa (125 psi) ASME flanged ends, bolted cover, renewable disc and seat.
  - d. Type 404: Swing-type, bronze body ASTM B61, rated for 1375 kPa (200 psi) saturated steam, 2750 kPa (400 psi) WOG, bronze disc, threaded ends, regrinding disc.

- e. Type 405: Lift-type, forged steel body ASTM A105, rated for 2050 kPa at 216 °C (300 psi at 420 °F) minimum (Class 4130 kPa (600 psi) or 5500 kPa (800 psi)), hardened stainless steel disc, hard faced seat, bolted cover, threaded ends.
- f. Type 406: Swing-type, Type 316 stainless steel body, disc and hanger, rated for 1725 kPa at 182 °C (250 psi at 360 °F) minimum.
- g. Type 407: Silent spring-loaded wafer type, cast iron body ASTM A48 or A126 Class B, rated for 850 kPa (125 psi) water, 121 °C (250 °F).
- h. Type 408: Silent spring-loaded wafer type, cast steel ASTM A216 WCB or cast iron ASTM A48 or A126 body, rated for 2050 kPa (300 psi) water, 121 °C (250 °F), stainless steel trim.
- 5. Ball Valves: Reduced port permitted for bypass (throttling) service; full port required for all other services, one-fourth turn to open.
  - a. Type 501: Type 316 stainless steel body, ball and stem, rated for 1025 kPa at 185 °C (150 psi at 365 °F), 4130 kPa at 93 °C (600 psi at 200 °F); reinforced TFE seat, stem seal and thrust washer; end entry, threaded ends.
  - b. Type 502: Bronze body, rated for 1025 kPa at 185 °C (150 psi at 365 °F), 1725 kPa at 121 °C (250 psi at 250 °F), reinforced TFE seat, stem seal and thrust washer; end entry, threaded ends, UL-listed for natural or LP gas shut off service when used on those services.
  - c. Type 503: Carbon steel or ASTM B61 bronze body, steam service, rated for 1380 kPa at 200 °C (200 psi at 390 °F), stainless steel ball and stem, Polyfil seat, live-loaded or adjustable stem seal, threaded ends.
  - d. Type 504: Carbon steel or ASTM A536 ductile iron body, saturated steam service, rated for 1030 kPa (150 psi), stainless steel ball and stem, Polyfil seat, live-loaded stem seal, ASME flanged ends.
- 6. Butterfly Valves:
  - a. Type 601: Ductile iron body ASTM A395 or A536, wafer style, rated for 850 kPa at 120 °C (125 psi at 250 °F), bronze disc, stainless steel stem, EPDM liner, EPDM stem seal and body seal, neck extending beyond pipe insulation, lever operator.
  - b. Type 602: Carbon steel body, triple-offset design, lug or flanged type, rated for steam service at 1025 kPa at 260 °C (150 psi at 500 °F), stainless steel nitrided disc, stainless steel seat,

stainless steel shaft, stainless steel/graphite laminated seal ring, neck extending beyond pipe insulation, geared handwheel operator for valves 100 mm (4 inch) pipe size and over, lever operator for valves 75 mm (3 inch) pipe size and under.

7. Gas Vent Cocks:

Type 701: Bronze body, tee handle, rated for 205 kPa at 38 °C (30 psi at 100 °F), ground plug, rated for tight shut-off on fuel gas service.

C. Boiler Valves:

1. Steam Non-Return Stop Check Valves:

- a. Type: Straight-way Y-pattern, with dash-pot and piston and tapped drain openings, OS&Y, bolted bonnet, rising stem. Provide angle pattern only if shown on the contract drawings.
- b. Construction: Cast steel body ASTM A216 WCB, rated for 2050 kPa (300 psi) saturated steam, stellite faced steel disc, alloy steel seat, 2050 kPa (300 psi) ASME flanged ends.
- c. Operation: Valves shall automatically close tightly when boiler steam pressure becomes less than that of the steam header. Valves shall operate without sticking or chattering.

2. Stop Valves for Soot Blower, Steam Vents on Boiler Drums and Steam Lead, Steam Pressure Gage:

- a. Installation of steam pressure gage shut-off valves shall conform to ASME Boiler and Pressure Vessel Code, Section I.
- b. Soot blower angle stop valves (water tube boilers), OS&Y, chain operated, cast or forged steel, 1375 kPa (200 psi) steam rating, renewable seat and disc.
- c. Gate valves, two inches and under: Type 105.

3. Valves in Drain Lines from Steam Stop-Check Valve, Water Column, Gage Glass, Low Water Cut-offs, Soot Blower:

- a. Gate valves, two inches and under: Type 105.
- b. Check valves, two inches and under: Type 405.

4. Bottom Blowoff Valves:

- a. Type: Seatless, sliding plunger, OS&Y, designed for blowoff service. Sliding disc-type or globe-type valves are not permitted.
- b. Construction: ASTM A216 WCB cast steel body, rated for 2050 kPa (300 psi) saturated steam, 2050 kPa (300 psi) ANSI flanged ends. Valves shall have handwheel with rotating handle.
- c. Conform to ASME B31.1.

- D. Steam above 100 kPa (15 psi), all valves in steam pressure reducing stations:
1. Gate valves, 50 mm (2 inches) and under: Type 105.
  2. Gate valves, 65 mm (2-1/2 inches) and above: Type 101.
  3. Globe valves, 50 mm (2 inches) and under: Type 205.
  4. Globe valves, 65 mm (2-1/2 inches) and above: Type 201.
  5. Butterfly valves, 75 mm (3 inches) and above: Type 602.
  6. Ball valves, 50 mm (2 inches) and under: Type 503.
  7. Ball valves, 65 mm (2-1/2 inches) and above: Type 504.
- E. Steam 100 kPa (15 psi) and under:
1. Gate Valves, 50 mm (2 inches) and under: Type 104.
  2. Gate valves, 65 mm (2-1/2 inches) and above: Type 103.
  3. Globe valves, 50 mm (2 inches) and under: Type 204.
  4. Globe valves, 65 mm (2-1/2 inches) and above: Type 203.
  5. Butterfly valves, 75 mm (3 inches) and above: Type 602.
  6. Ball valves, 50 mm (2 inches) and under: Type 503.
  7. Ball valves, 65 mm (2-1/2 inches) and above: Type 504.
- F. Boiler Feedwater from Pumps to Boilers, Recirculation:
1. Gate valves, 50 mm (2 inches) and under: Type 105.
  2. Gate valves, 65 mm (2-1/2 inches) and above: Type 102.
  3. Globe valves, 50 mm (2 inches) and under: Type 204 or 205.
  4. Globe valves, 65 mm (2-1/2 inches) and above: Type 202.
  5. Check valves, at boiler feed pump discharge: Type 408.
  6. Check valves, at boiler, 50 mm (2 inches) and under: Type 405.
  7. Check valves, at boiler, 65 mm (2-1/2 inches) and above: Type 402.
- G. Condensate, Condensate Transfer, Boiler Feedwater from Feedwater Deaerator to Boiler Feed Pump Suction, Overflow, Control and Instrument Piping for Condensate Storage Tank and for Feedwater Deaerator:
1. Gate valves, 50 mm (2 inches) and under: Type 104.
  2. Gate valves, 65 mm (2-1/2 inches) and above: Type 103.
  3. Globe valves, 50 mm (2 inches) and under: Type 204.
  4. Globe valves, 65 mm (2-1/2 inches) and above: Type 203.
  5. Butterfly valves, 65 mm (2-1/2 inches) and above Type 601.
  6. Ball valves, 50 mm (2 inches) and under: Type 502.
  7. Ball valves, 65 mm (2-1/2 inches) and above: Type 504.
  8. Check valves 50 mm (2 inches) and under: Type 404.
  9. Check valves, 65 mm (2-1/2) inches and above: Type 403.
  10. Check valves on pump discharge, all sizes: Type 407.
- H. Boiler Water Sampling, Continuous Blowdown:
1. Gate Valves, 50 mm (2 inches) and under: Type 104.

2. Globe valves, 50 mm (2 inches) and under: Type 204.
  3. Check valves, 50 mm (2 inches) and under: Type 404.
  4. Ball valves, 50 mm (2 inches) and under: Type 502.
  5. Continuous Blowdown Flow Control Valve: Bronze or forged steel angle-type body, rated for 2050 kPa at 288 °C (300 psi at 550 °F), hardened stainless steel disc and seat, threaded ends, rising stem, union bonnet, graduated micrometer-type dial and pointer showing amount of valve opening. Furnish valve blowdown chart showing flow rate versus valve opening based on 850 kPa (125 psi) boiler drum pressure.
- I. Feedwater Sampling:
1. Ball valves, 50 mm (2 inches) and under: Type 501.
  2. Check valves, 50 mm (2 inches) and under: Type 406.
- J. Chemical Feed System (including inlet and drain valves on shot type chemical feeders):
1. Ball valves, 50 mm (2 inches) and under: Type 501.
  2. Check valves, 50 mm (2 inches) and under: Type 406.
- K. Fuel Oil: Discharge side of pumps. Conform to NFPA Code Nos. 30 and 31.
1. Gate valves, 50 mm (2 inches) and under: Type 104.
  2. Gate Valves, 65 mm (2-1/2 inches) and above: Type 101 or 102.
  3. Globe valves, 50 mm (2 inches) and under: Type 204.
  4. Plug valves, 100 mm (4 inches) and under: Type 301. (Tank isolating valve on return line.)
  5. Check valves, 50 mm (2 inches) and under: Type 404 or 408.
  6. Check valves, 65 mm (2-1/2 inches) and above: Type 402 or 408.
  7. Ball valves, 50 mm (2 inches) and under: Type 502.
- L. Fuel Oil: Suction side of pumps and tank fill lines where tank is below fill point. Conform to NFPA Code Nos. 30 and 31.
1. Gate valves, 50 mm (2 inches) and under: Type 104.
  2. Gate valves, 65 mm (2-1/2 inches) and above: Type 103.
  3. Plug valves, 100 mm (4 inches) and under: Type 301.
  4. Check valves, 50 mm (2 inches) and under: Type 404.
  5. Check valves, 65 mm (2-1/2 inches) and above: Type 403.
  6. Ball valves, 50 mm (2 inches) and under: Type 502.
- M. Fuel Gas: Main fuel and igniter (pilot) systems.
1. Plug valves, 100 mm (4 inches) and under: Type 301.
  2. Ball valves, 50 mm (2 inches) and under: Type 502. May be applied where plug valves are shown.
  3. Plug valves, 125 mm (5 inches) and above: Type 302.
  4. Plug valves, three-way, all sizes: Type 302.

5. Check valves, 50 mm (2 inches) and under: Type 404.

6. Vent cocks, 15 mm (1/2 inch) and under: Type 701.

N. Compressed Air:

1. Gate valves, 50 mm (2 inches) and under: Type 104.

2. Ball valves, 50 mm (2 inches) and under: Type 502.

O. City (Cold) Water: See Section 22 11 00, FACILITY WATER DISTRIBUTION.

P. Soft Water: See Section 22 31 11, WATER SOFTENERS.

Q. Instrumentation and Control Piping:

Ball valves, 50 mm (2 inches) and under: Type 502.

R. Non-Boiler Blowdowns, Drains, Flow Sensing Lines:

1. Gate valves, 50 mm (2 inches) and under: Type 104.

2. Ball valves, 50 mm (2 inches) and under: Type 503

**2.16 SIGHTFLOW INDICATORS:**

A. Provide, where shown, to allow observation of flow in piping systems.

B. Type: In line, dual portholes on opposite sides, with safety shield, with or without rotor as shown on the drawings. Where provided, rotor shall have minimum of three vanes.

C. Construction: Cast iron or bronze body, tempered borosilicate window, PTFE seals (except Buna-N on oil service), threaded ends on pipe sizes under 65 mm (2-1/2 inches), flanged ends on sizes 65 mm (2-1/2 inches) and above. Pressure and temperature ratings shall be equivalent to requirements for valves on the same pipelines.

D. Safety Shield: Transparent wrap-around overlap covering entire sightflow indicator, designed to protect personnel from failure of indicator. Shield shall fit the indicator tightly and be suitable for 1030 kPa, 150 °C (150 psi, 300 °F).

**2.17 SAFETY VALVES, RELIEF VALVES, SAFETY RELIEF VALVES AND ACCESSORIES:**

A. Provide valves and accessories to protect piping systems and pressure vessels from over-pressure. All valves shall comply with ASME Boiler and Pressure Vessel Code (Section I and VIII). Flow capacities shall be certified by National Board of Boiler and Pressure Vessel Inspectors (NB).

B. Boiler and Economizer Service: Refer to Section 23 52 34, STEAM GENERATOR.

C. Steam Service (Pressure Vessels and Piping Systems): Refer to schedules on drawings for set pressures and capacities. Provide lifting levers, stainless steel trim, lapped seats on cast iron valves, EPDM o-rings on bronze valves.

D. Fuel Oil Service: Refer to Section 23 50 11, BOILER PLANT MECHANICAL EQUIPMENT.

- E. Compressed Air Service: Refer to Section 23 50 11, BOILER PLANT MECHANICAL EQUIPMENT.
- F. Drip Pan Ells: Cast iron factory-built safety valve discharge fitting with pipe-within-pipe slip-type connection to vertical vent pipe, basin for collecting condensate from vent pipe, drain connections on basin and at base of ell.

## **2.18 STEAM PRESSURE REDUCING VALVES**

- A. Type: Single-seated, diaphragm operated, spring-loaded, steam pilot-controlled, normally closed, packless, adjustable set pressure. Pilot shall sense controlled pressure downstream of main valve.
- B. Service: Provide controlled reduced pressure to steam piping systems. Design for saturated steam at pressures shown on drawings or equipment requirements.
- C. Performance: Pressure control shall be smooth, continuous. Maximum 10 percent deviation from set pressure over an 18/1 turndown. Refer to schedules on drawings for flow and pressure requirements. Maximum flow capability of each valve shall not exceed capacity of downstream safety valves.
- D. Construction:
  - 1. Main Valve: Cast iron body rated for 1725 kPa (250 psi), threaded ends, for pipe sizes 50 mm (2 inches) and under. Cast steel body rated for 1025 kPa (150 psi) ASME flanged ends, or cast iron body 1725 kPa (250 psi) ASME flanged ends, for pipe sizes above 50 mm (2 inches). Valve plug and seat shall be replaceable, Type 316 stainless steel or Monel. Stainless steel stem.
  - 2. Pilot Valve: Valve plug and seat shall be replaceable, stainless steel or Monel.
- E. Pneumatically-Controlled Valves: May be furnished in lieu of steam operation. All specification requirements for steam-operated valves apply. Valves shall close on failure of air supply.
- F. Sound Levels: Refer to requirements in Section 23 05 51, NOISE AND VIBRATION CONTROL FOR BOILER PLANT.

## **2.19 STRAINERS, SIMPLEX BASKET TYPE**

- A. Provide on condensate lines where shown. Refer to Section 23 50 11, BOILER PLANT MECHANICAL EQUIPMENT, for duplex basket strainers at oil pumps.
- B. Type: Simplex cylindrical basket type, clamp cover, closed-bottom, removable basket, drain at bottom with threaded plug.
- C. Service: Water at 100 °C (212 °F), 100 kPa (15 psi) maximum pressure.
- D. Construction:

1. Body: Cast iron rated for 850 kPa (125 psi) ASME flanged ends, flow arrows cast on side.
2. Basket: Stainless steel, 3 mm (0.125-inch) perforations. Ratio of screen open area to cross section of pipe; four to one minimum.

## **2.20 STRAINERS, Y-TYPE**

- A. Provide as shown on steam, water and compressed air piping systems.
- B. Type: Open-end removable cylindrical screen. Threaded blow-off connection.
- C. Construction:
  1. Steam Service 420 to 1025 kPa (61 to 150 psi): Cast steel rated for 1025 kPa (150 psi) saturated steam with 1025 kPa (150 psi) ASME flanged ends, or cast iron with 1725 kPa (250 psi) ASME flanged ends, for pipe sizes above 50 mm (2 inches). Cast iron or bronze, rated for saturated steam at 1025 kPa (150 psi) threaded ends, for pipe sizes 50 mm (2 inches) and under.
  2. Steam Service 415 kPa (60 psi) and under, water (except boiler feed between feedwater pumps and boilers), compressed air: Cast iron rated for 850 kPa (125 psi) saturated steam, 1200 kPa (175 psi) WOG, with 850 kPa (125 psi) ASME flanged ends for pipe sizes above 50 mm (2 inches). Cast iron or bronze, threaded ends, rated for 850 kPa (125 psi) saturated steam, 1200 kPa (175 psi) WOG, for pipe sizes 50 mm (2 inches) and under.
  3. Boiler Feed between Feedwater Pumps and Boilers: Cast steel rated for 1725 kPa at 232 °C (250 psi at 450 °F) with 2050 kPa (300 psi) ASME flanged ends, or cast iron with 1725 kPa (250 psi) ASME flanged ends, for pipe sizes above 50 mm (2 inches). Cast iron or bronze, threaded ends, rated for 1725 kPa at 232 °F (250 psi at 450 °F) for pipe sizes 50 mm (2 inches) and under.
- D. Screen: Monel or stainless steel, free area not less than 2-1/2 times flow area of pipe. For strainers 80 mm (3 inch) pipe size and smaller, diameter of openings shall be 0.8 mm (0.033 inch) or less on steam service, 1.3 mm (0.05 inch) or less on water service, 0.3 mm (0.01-inch) or less on compressed air service. For strainers 100 mm (4 inch) pipe size and greater, diameter of openings shall be 1.3 mm (0.05 inch) on steam service, 3 mm (0.125 inch) on water service. Provide 80 mesh stainless steel screen liner on all strainers installed upstream of water meters or control valves.
- E. Accessories: Gate or ball valve and quick-couple hose connection on all blowoff connections. These items are specified elsewhere in this section.

## **2.21 LIQUID PETROLEUM TANKS GAS PRESSURE REGULATORS**

- A. Type: Single stage or two-stage designed to reduce tank pressure to LPG header pressure (35 kPa) (5 psi). Outlet pressure shall be adjustable. Design for LPG (propane) service. Valve shall be weatherproof for outside installation. Valve body shall be designed for 1725 kPa (250 psi). Provide internal relief valve set at 69 kPa (10 psi).
- B. Performance: Valve shall provide steady outlet pressure of 35 kPa (5 psi) with flow rate required by igniters (pilots) furnished, with tank pressure variation from 1725 to 140 kPa (250 to 20 psi).

## **2.22 STEAM TRAPS**

- A. Application: Steam line drip points and heat exchangers. Each type furnished by a single manufacturer.
- B. Type: Inverted bucket type with thermostatic vent in bucket except closed float-thermostatic on discharge side of pressure reducing stations and on all heat exchangers. Refer to the drawings for trap locations, capacity and size, differential operating pressures, and design pressure.
- C. Bodies: Cast iron or stainless steel. Construction shall permit ease of removal and servicing working parts without disturbing connected piping.
- D. Floats: Stainless steel.
- E. Valves: Hardened chrome-steel.
- F. Mechanism and Thermostatic Elements: Stainless steel mechanisms. Bimetallic strip air vent on inverted bucket traps.
- G. Provision for Future Trap Monitoring System: All traps shall include ports for future installation of monitoring devices. Ports shall be plugged. To facilitate future removal of the plugs, install them with Teflon tape on the threads.
- H. Identification: Label each trap at the factory with an identification number keyed to number that is shown on the drawings. Label shall be a metal tag permanently affixed to the trap.
- I. Factory-Packaged Trap Station: As an option for drip points requiring isolating valves, strainer, trap, trap monitoring device or ports for future monitoring device, and valved test ports, provide factory-packaged trap station including these features.

## **2.23 FLEXIBLE CONNECTORS**

- A. Provide flexible connectors as shown to allow differential movements of pumps and piping systems subject to thermal expansion, to serve as vibration isolators between air compressors and piping systems, and to allow connection of steam or compressed air atomizing media for oil burners on water tube boilers.

B. Units for Water Service

1. Service: Refer to schematic diagrams for pressure, temperature and movement requirements. If requirements are not shown on the drawings, units shall be designed for maximum system pressure, temperature, axial movement and lateral movement.
2. Construction
  - a. Teflon Bellows Type: Molded Teflon bellows with metal reinforcing rings, flanged ends, bolted limit rods.
  - b. Stainless Steel Bellows Type: Multi-ply stainless steel with flanged ends, bolted limit rods.
  - c. Flexible Metal Hose Type: Corrugated stainless steel or bronze hose wrapped with wire braid sheath. Ends shall be threaded, with union connectors, for pipe sizes 50 mm (2 inches) and below, flanged for pipe sizes 65 mm (2-1/2 inches) and greater.

C. Units for Compressed Air Service Only:

1. Service: Designed for 93 °C (200 °F), 1025 kPa (150 psi), 13 mm (1/2-inch) intermittent offset.
2. Construction. Flexible corrugated stainless steel or bronze hose wrapped with wire braid sheath. Provide threaded ends with union connectors.

D. Units for Atomizing Media Service(Steam, Compressed Air) and Steam Safety Valve Drip Pan Ell Drains:

1. Service: Designed for saturated steam at set pressure of boiler safety valves or for set pressure of compressor relief valve, whichever is greater. Hose shall be designed for bend radii to suit location of connection points to burner piping system. Hose shall also be designed for intermittent flexing.
2. Construction: Flexible corrugated stainless steel or bronze hose wrapped with wire braid sheath. Provide threaded ends with union connectors.

**2.24 PIPING SUPPORT SYSTEMS**

- A. Provide an engineered piping support system with all hangers, supports and anchors designed and located by experienced technical pipe support specialists, utilizing piping system design and analysis software. The system design must be completely documented and submitted for review.
- B. All pipe hangers and supports, and selection and installation shall comply with MSS SP-58, SP-69, SP-89, SP-90, SP-127.
- C. All pipe hanger and support devices must be in compliance with specified MSS SP-58 type numbers, have published load ratings, and be products of engineered pipe support manufacturers.

- D. All pipe stresses and forces and moments on connecting equipment and structures shall be within the allowances of the ASME B31.1 code, applicable building codes, and equipment manufacturer's design limits.
- E. Piping that expands and contracts horizontally including steam, steam condensate, boiler feed, condensate transfer, shall be supported by roller or sliding type hangers and supports except when long vertical hanger rods permit sufficient horizontal movement with the vertical angles of the rods less than 4 degrees.
- F. Piping that expands and contracts vertically including steam, steam condensate, boiler feed, condensate transfer, shall be supported by engineered variable spring and spring cushion hangers. Utilize MSS SP-69 selection requirements and guidelines. Vibration isolator hanger types are not permitted.
- G. Piping system anchors shall be engineered and located to control movement of piping that is subject to thermal expansion.
- H. Prior to construction, submit complete engineering calculation methods and results, descriptions of all devices with MSS numbers, sizes, load capabilities and locations. Submit calculations on all moments and forces at anchors and guides, all hanger loads, all pipe stresses that are within 20% of the code allowable or exceed the ASME B31.1 code allowable, all pipe movements at supports.
- I. Detailed Design Requirements:
  - 1. Piping system design and analysis software shall be current state of the art that performs B31.1 Code analyses, and shall be utilized to analyze pipe movement and deflection, pipe stresses, pipe support forces and moments, and for selection of pipe support types and sizes.
  - 2. Each support for piping 60 mm (2-1/2 inches) and above shall be completely engineered to include location, type and size, hot and cold loads and movement. Submit layout drawings showing precise support locations and submit individual drawings for each support assembly showing all components, sizes, loadings.
  - 3. Supports for piping 50 mm (2 inches) and below shall be engineered in general terms with approximate locations, typical support types and sizes, approximate movements. Submit layout drawings showing general locations and support types and sizes.
  - 4. Obtain permissible loadings (forces and moments) for equipment nozzles (pipe connections) from the manufacturer of the boilers, the feedwater deaerator and any other equipment as necessary.

- Professional structural engineer shall verify capability of building structure to handle piping loads.
5. The project drawings may show locations and types of resilient supports including rollers and springs, and may also show special supports including anchors, guides and braces. Comply with the drawing requirements unless it is determined that piping may be overstressed or supports overloaded. Refer conflicts to the COTR.
  6. Variable spring hangers conforming the MSS SP-58, Type 51, shall support all piping that expands vertically from thermal effects which may include connected equipment, such as boilers. Spring rates must be selected to avoid excessive load transfer to the connected equipment as the piping expands vertically. Vibration-type spring isolators are not acceptable. Light duty spring hangers, MSS SP-58, Type 48, may be utilized on loads of 90 kg (200 lb) or less, and vertical movement of 3 mm (0.125 inches) or less. Spring cushion hangers, MSS SP-58, Type 49, may be utilized for vertical movement of 3 mm (0.125 inches) or less.
  7. Locate supports to permit removal of valves and strainers from pipelines without disturbing supports.
  8. If equipment and piping arrangement differs from that shown on the drawings, support locations and types shall be revised at no cost to the Government.
- J. Hangers and Supports - Products:
1. Factory-built products of a manufacturer specializing in engineered pipe supports. All components must have published load ratings. All spring type supports shall have published spring rates and movement limits. All support assemblies shall include threaded connections that permit vertical position adjustment. Supports shall comply with MSS SP-58 Type Numbers as listed below.
  2. Upper Attachments to Building Structure: Types 18, 20, 21, 22, 23, 29, and 30.
  3. Roller Supports: Types 41, 43, and 46. Provide vertical adjustment for Type 41 with threaded studs and nuts adjacent to the roller.
  4. Variable Spring Hanger Assembly:
    - a. Type 51 variable spring, with Type 3 pipe clamp or Type 1 clevis. Type 53 variable spring trapeze may also be used. Locate Type 51 variable spring within 300 mm (1 foot) above pipe attachment. Attach rod to top of variable spring with Type 14 clevis.
    - b. Typical features of variable spring hangers include spring rates under 150 lb/in, enclosed spring, load and travel indicator, sizes

available with load capabilities ranging from 50 lb to multiples of 10,000 lb.

5. Spring Cushion Hanger Assembly: Double Rod: Type 41 and 49.
6. Light Duty Spring Hanger Assembly: Type 48 light duty spring, with Type 3 pipe clamp or Type 1 clevis. Locate Type 48 light duty spring within 300 mm (1 foot) above pipe attachment.
7. Clevis Hangers: Type 1.
8. Wall Brackets: Type 31, 32, and 33.
9. Pipe Stands: Type 38.
10. Riser Clamps: Type 42.
11. Roller Guides: Type 44. Construct guides to restrain movement perpendicular to the long axis of the piping. All members shall be welded steel.
12. Trapeze Supports: May be used where pipes are close together and parallel. Construct with structural steel channels or angles. Bolt roller supports to steel to support piping subject to horizontal thermal expansion. Attach other piping with U-bolts.
13. Pipe Covering Protection Saddles: Type 39. Provide at all support points on insulated pipe except where Type 3 pipe clamp is provided. Insulation shields are not permitted. Refer to Section 23 07 11, HVAC, PLUMBING, AND BOILER PLANT INSULATION.
14. Sliding Supports: Type 35. Welded steel attachments to pipe and building structure with Teflon or graphite sliding surfaces bonded to the attachments. Provide steel guides, except at expansion bends, to prevent lateral movement of the pipe.
15. Piping Anchors: Provide engineered designs to accommodate the calculated loads.

## **2.25 PIPE AND VALVE FLANGE GASKETS**

Non-asbestos, designed for the service conditions. On steam service utilize 3 mm (1/8 inch) thick Class 300 spiral-wound with Type 304 stainless steel and mica/graphite filler and carbon steel gauge ring.

## **2.26 THREAD SEALANTS:**

As recommended by the sealant manufacturer for the service.

## **2.27 PIPE SLEEVES:**

- A. Service: For pipes passing through floors, walls, partitions.
- B. Construction: Steel pipe, schedule 10 minimum.
- C. Sleeve Diameter: Not less than 25 mm (1 inch) larger than the diameter of the enclosed pipe and thermal insulation, vapor barrier, and protective covering for insulated pipe; sleeves for un-insulated pipe

shall be not less than 25 mm (1 inch) larger than the diameter of the enclosed pipe.

### **PART 3 - EXECUTION**

#### **3.1 ARRANGEMENT OF PIPING**

- A. The piping arrangement shown is a design based on currently available equipment. The plans show typical equipment to scale and show practical arrangement. Modification will be necessary during construction, at no additional cost to the Government, to adapt the equipment layout and piping plans to the precise equipment purchased by the Contractor. Accessibility for operation and maintenance must be maintained.
- B. All piping shall be installed parallel to walls and column centerlines (unless shown otherwise). Fully coordinate work of each trade to provide the designed systems without interference between systems. All piping shall be accurately cut, true, and beveled for welding. Threaded piping shall be accurately cut, reamed and threaded with sharp dies. Copper piping work shall be performed in accordance with best practices requiring accurately cut clean joints and soldering in accordance with the recommended practices for the material and solder employed.
- C. All piping shall be pitched for drainage at a constant slope of 25 mm in 12 m (1 inch in 40 feet). Steam, condensate, trap discharge, drip, drain, air, gas and blowdown piping shall pitch down in direction of flow. Service water, pumped condensate, pumped boiler feedwater, oil, shall pitch up in direction of flow. Provide valved air vents at top of rise and valved drains at low points. Gas piping may be run level as it is presumed to be dry, but dirt pockets shall be provided at base of risers.
- D. Valves shall be located and stems oriented to permit proper and easy operation and access to valve bonnet for maintenance of packing, seat and disc. Valve stems shall not be below centerline of pipe. Refer to plans for stem orientation. Where valves are more than 2100 mm (7 feet) above the floor or platform, stems shall be horizontal unless shown otherwise. Gate and globe valves more than 3 m (10 feet) above floor or platform, shall have chain wheel and chain for operation from floor or platform. Provide hammer-blow wheel on any valve that cannot be opened or tightly closed by one person. Steam line gate and butterfly type isolation valves 750 mm (3 inch) pipe size and above shall have factory or field-fabricated 20 mm or 25 mm (3/4 or one inch) globe-valved warm-up bypasses if the steam line length is 6 m (20 feet) or longer.
- E. Provide union adjacent to all threaded end valves.
- F. Bolt wafer-type butterfly valves between pipe flanges.

- G. Provide valves as necessary to permit maintenance of a device or sub-system without discontinuing service to other elements of that service or system.
- H. Do not install any piping within 600 mm (2 feet) of boiler side or top casings.

### **3.2 WELDING**

- A. The contractor is entirely responsible for the quality of the welding and shall:
  - 1. Conduct tests of the welding procedures used by his organization, determine the suitability of the procedures used, determine that the welds made will meet the required tests, and also determine that the welding operators have the ability to make sound welds under standard conditions.
  - 2. Comply with ASME B31.1 and AWS B2.1.
  - 3. Perform all welding operations required for construction and installation of the piping systems.
- B. Qualification of Welders: Rules of procedure for qualification of all welders and general requirements for fusion welding shall conform with the applicable portions of ASME B31.1, and AWS B2.1, and also as outlined below.
- C. Examining Welder: Examine each welder at job site, in the presence of the Resident Engineer (RE)/Contracting Officer's Technical Representative (COTR), to determine the ability of the welder to meet the qualifications required. Test welders for piping for all positions, including welds with the axis horizontal (not rolled) and with the axis vertical. Each welder shall be allowed to weld only in the position in which he has qualified and shall be required to identify his welds with his specific code marking signifying his name and number assigned.
- D. Examination Results: Provide the RE/COTR with a list of names and corresponding code markings. Retest welders who fail to meet the prescribed welding qualifications. Disqualify welders, who fail the second test, for work on the project.
- E. Beveling: Field bevels and shop bevels shall be done by mechanical means or by flame cutting. Where beveling is done by flame cutting, surfaces shall be thoroughly cleaned of scale and oxidation just prior to welding. Conform to specified standards.
- F. Alignment: Utilize split welding rings or approved alternate method for joints on all pipes above 50 mm (two-inches) to assure proper alignment, complete weld penetration, and prevention of weld spatter reaching the interior of the pipe.

- G. Erection: Piping shall not be split, bent, flattened, or otherwise damaged before, during, or after installation. If the pipe temperature falls to 0 degrees C (32 degrees F) or lower, the pipe shall be heated to approximately 38 degrees C (100 degrees F) for a distance of 300 mm (one foot) on each side of the weld before welding, and the weld shall be finished before the pipe cools to 0 degrees C (32 degrees F).
- H. Non-Destructive Examination of Piping Welds:
1. The RE/COTR may require up to ten percent of the welded piping joints to be examined using radiographic testing. If defective welds are discovered the RE/COTR may require examination of all pipe joint welds.
  2. An approved independent testing firm regularly engaged in radiographic testing shall perform the radiographic examination of pipe joint welds. All radiographs shall be reviewed and interpreted by an ASNT Certified Level III radiographer, employed by the testing firm, who shall sign the reading report.
  3. Comply with ASME B31.1. Furnish a set of films showing each weld inspected, a reading report evaluating the quality of each weld, and a location plan showing the physical location where each weld is to be found in the completed project. The RE/COTR reserves the right to review all inspection records.
- I. Defective Welds: Replace and reinspect defective welds. Repairing defective welds by adding weld material over the defect or by peening will not be permitted. Welders responsible for defective welds must be requalified.
- J. Electrodes: Electrodes shall be stored in a dry heated area, and be kept free of moisture and dampness during the fabrication operations. Discard electrodes that have lost part of their coating.

### 3.3 PIPING JOINTS

- A. All butt-welded piping shall be welded at circumferential joints, flanges shall be weld neck type; slip-on flanges, screwed flanges may be applied only with written approval of the RE/COTR.
- B. Companion flanges at equipment or valves shall match flange construction of equipment or valve. Raised face shall be removed at all companion flanges when attached to flanges equipped for flat face construction.
- C. Gaskets and bolting shall be applied in accordance with the recommendations of the gasket manufacturer and bolting standards of ASME B31.1. Strains shall be evenly applied without overstress of bolts. Gaskets shall cover entire area of mating faces of flanges.

- D. Screw threads shall be made up with Teflon tape except gas and oil piping joints shall utilize specified "GRIPP" joint compound.
- E. Solder joints shall be made up in accordance with recommended practices of the materials applied. Apply 95/5 tin and antimony on all copper piping.

### 3.4 BRANCH INTERSECTION CONNECTIONS

- A. Factory-built reinforced tees and laterals are required.
- B. Factory-built integrally-reinforced forged steel branch outlet fittings may be used on reduced size connections upon approval of RE/COTR. They must comply with MSS-SP-97.

### 3.5 EXPANSION AND FLEXIBILITY

The design includes provision for piping expansion due to pressure, thermal, weight and seismic (where applicable) effects. It is the Contractor's responsibility to avoid reduction in flexibility and increase in stress in piping systems. Major deviation will be shown by submittal for review of scale working drawings and stress calculations for the piping systems. Contractor shall provide any necessary additional construction and materials to limit stresses to safe values as directed by the RE/COTR and at no additional cost to the Government.

### 3.6 PIPE BENDING

Pipe bending shall be in accordance with the recommended practices of PFI ES24. Only ASTM A106 seamless pipe may be bent. Sizes below 50 mm (2 inches) may be bent in field; sizes 65 mm (2-1/2 inches) and larger shall have factory fabricated bends. Minimum radii and tangent lengths for field bent piping are shown in the following table:

Size	Minimum Radius	Minimum Tangent
1/2 inch	2-1/2 inches	1-1/2 inches
3/4 inch	2-3/4 inches	1-3/4 inches
1-inch	5-inches	2-inches
1-1/4 inches	6-1/4 inches	2-inches
1-1/2 inches	7-1/2 inches	2-1/2 inches

### 3.7 SIZE CHANGES

Piping size changes shall be accomplished by use of line reducers, reducing ell, reducing tee. Apply eccentric reduction in all piping requiring continuous drainage; steam, condensate, vacuum, blowdown. Concentric reduction may be applied in run of piping involving pressure

water systems except at pump inlets. Use concentric increasers where flow is in direction of increased size. Eccentric reduction, top flat, at all pump connections.

### **3.8 ADDITIONAL DRIPS AND TRAPS**

Where additional rises or drops in steam or gas lines are provided, provide additional drip pockets with steam trap assemblies on steam lines and additional dirt pockets on gas lines.

### **3.9 MINOR PIPING**

Minor piping associated with instrumentation and control is generally not shown. Interconnection of sensors, transducers, control devices, instrumentation panels, combustion control panel, burner control panels is the responsibility of the contractor. Small piping associated with water cooling, drips, drains and other minor piping may not be shown to avoid confusion in the plan presentation but shall be provided as part of contract work.

### **3.10 DIELECTRIC CONNECTION**

Where copper piping is connected to steel piping provide dielectric connections.

### **3.11 INSTALLATION - BOILER EXTERNAL STEAM PIPING FROM BOILER TO MAIN HEADER**

- A. From Boiler to Second Stop Valve: Fabricate from boiler nozzle through second stop valve under the rules for boiler external piping of the ASME Boiler and Pressure Vessel Code, Section I. Full compliance will be required, including qualification of welders, Code inspection, and certification with ASME Form P4A. Deliver original of Form P4A properly executed to COTR or RE.
- B. Construction shall include: non-return stop and check valve at the boiler, welding coupling for 20 mm (3/4-inch) vent, second stop valve, steam flowmeter primary element, welding coupling for IPT calorimeter connection located to provide clear space and access for temporary test calorimeter, and header stop valve. Second stop valve may be deleted if the entire steam line from the non-return valve to the header valve is constructed in accordance with the rules for boiler external piping, ASME Section I.
- C. Companion flange at 2050 kPa (300 psi) valves shall be 2050 kPa (300 psi) weld neck; at 1025 kPa (150 psi) valves shall be 1025 kPa (150 psi) weld neck.
- D. Equip header stop valve with factory applied warm-up bypass connected to drilled and tapped bosses in valve body located above and below valve wedge. Connect valved drain to header valve body boss located above valve wedge.

- E. Equip steam pipe with 20 mm (3/4-inch) vent, 1375 kPa (200 psi) bronze gate valve, as specified.
- F. Support and slope boiler steam line to drain; apply variable spring hangers (MSS-SP58, Type 51 or 53).
- G. Provide screwed fitting for calorimeter (temporary test instrument) on side of pipe as shown. Allow 600 mm (2 feet) horizontal and vertical clearance for calorimeter.
- H. Handwheel and drain valve on non-return stop-check valve shall be within easy reach of boiler platform.
- I. Disassemble, clean and reassemble entire mechanism of non-return stop check valve after conclusion of boiler testing.

### **3.12 INSTALLATION - MAIN STEAM HEADER**

- A. The header shall be the connection point for steam piping from all boilers and for steam distribution piping. The boiler plant steam pressure control transmitter shall be connected to the header.
- B. Steam header shall be assembly of tees, pipe sections, and weld neck flanges.
- C. Factory-fabricated forged steel integrally reinforced branch outlet welding fittings, standard weight, ASTM A105 Grade 2, may be applied in lieu of tees for all branch outlets less than the full size of the header. Comply with fitting manufacturer's recommendations and requirements of ASME B31.1 and MSS-SP-97.
- D. Provide header supports and anchor as shown; apply insulation saddles for insulation thickness as required in Section 23 07 11, HVAC, PLUMBING, AND BOILER PLANT INSULATION.
- E. Weld neck flange bolt position shall conform to required valve, stem, and bypass orientation as shown.
- F. Header construction as specified, includes the entire header and branches to first valve.
- G. Anchor and guide header to resist thermal and weight forces and also seismic forces where required.
- H. All valves must be accessible without the use of ladders or chain-wheels.

### **3.13 INSTALLATION - BOILER BOTTOM BLOWOFF PIPING**

Fabricate with long radius ells, Y-form laterals. Tees and crosses are not permitted.

### **3.14 INSTALLATION - EXHAUST HEAD MOUNTED ABOVE ROOF**

Provide drain line from connection on exhaust head to roof drain.  
Provide pipe size same as drain connection size.

**3.15 INSTALLATION - SIGHT FLOW INDICATORS**

Locate to permit view from floor or platform.

**3.16 INSTALLATION - PRESSURE AND TEMPERATURE REGULATORS, CONTROL VALVES, SAFETY SHUT-OFF VALVES**

Provide sufficient clearance on all sides of valve to permit replacement of working parts without removing valve from pipeline.

**3.17 INSTALLATION - FLEXIBLE CONNECTORS**

Install units for water and compressed air service in a straight run of pipe. Units for atomizing media service may be installed with bends if necessary. Designer of atomizing media piping must coordinate hose connection points with allowable bend radius of hose.

**3.18 INSTALLATION - SAFETY VALVES, RELIEF VALVES AND SAFETY-RELIEF VALVES**

- A. Orient valves so that lifting levers are accessible from nearest walkway or access platform. Valves must be removable without requiring disassembling of vents, except where otherwise specifically provided.
- B. Provide a drip pan elbow at discharge of each steam or economizer valve with slip joint in vent discharge line, arranged to prevent vent line from imposing any force on valve and to prevent any moisture accumulation in valve. Connected drip pan ell drains to drain piping to floor drain. Provide flexible connector on drain line, adjacent to drip pan ell.
- C. Support vent line from above. Each steam valve must have separate vent line to atmosphere unless shown otherwise.

**3.19 INSTALLATION - Y-TYPE STRAINERS ON STEAM SERVICE**

Install with basket level with the steam pipe so that condensate is not trapped in the strainer.

**3.20 INSTALLATION - QUICK COUPLE HOSE CONNECTORS**

Install male plugs on each piping drain. Connect socket to one end of steam hose.

**3.21 INSTALLATION - VIBRATION ISOLATORS IN PIPING**

- A. Install on all air lines and water supply lines to air compressors.
- B. Also install on pump connections as shown.

**3.22 INSTALLATION - PIPE SLEEVES**

- A. Accurately locate and securely fasten sleeves to forms before concrete is poured; install in walls or partitions during the construction of the walls.
- B. Sleeve ends shall be flush with finished faces of walls and partitions.
- C. Pipe sleeves passing through floors shall project 25 mm (1 inch) minimum above the finished floor surface and the bottom of the sleeve shall be flush with the underside of the floor slab.

### **3.23 INSTALLATION - PIPE SUPPORT SYSTEMS**

- A. Coordinate support locations with building structure prior to erection of piping. Also refer to approved shop drawings of equipment and approved piping layout and hanger layout drawings when locating hangers. Arrangement of supports shall facilitate operating, servicing and removal of valves, strainers, and piping specialties. Hanger parts must be marked at the factory with a numbering system keyed to hanger layout drawings. Layout drawings must be available at the site.
- B. Upper attachments to Building Structure:
  - 1. Existing Reinforced Concrete Construction: Upper attachment welded or clamped to steel clip angles (or other construction shown on the drawings) which are expansion-bolted to the concrete. Expansion bolting shall be located so that loads place bolts in shear.
  - 2. Steel Deck and Structural Framing: Upper attachments welded or clamped to structural steel members.
- C. Expansion Fasteners and Power Set Fasteners: In existing concrete floor, ceiling and wall construction, expansion fasteners may be used for hanger loads up to one-third the manufacturer's rated strength of the expansion fastener. Power set fasteners may be used for loads up to one-fourth of rated load. When greater hanger loads are encountered, additional fasteners may be used and interconnected with steel members combining to support the hanger.
- D. Special Supports:
  - 1. Secure horizontal pipes where necessary to prevent vibration or excess sway.
  - 2. Where hangers cannot be adequately secured as specified, (for example, support for flow metering sensing lines, pneumatic tubing, control piping) special provisions shall be made for hanging and supporting pipe as directed by the RE/COTR.
  - 3. Pipe supports, hangers, clamps or anchors shall not be attached to equipment unless specifically permitted by the specifications for that equipment or unless RE/COTR gives written permission. No attachments to boiler casings permitted.
- E. Spring Hangers: Locate spring units within one foot of the pipe, breeching or stack attachment except in locations where spring assemblies interfere with pipe insulation. Adjust springs to loads calculated by hanger manufacturer.

### **3.24 CLEANING OF PIPING AFTER INSTALLATION**

Flush all piping sufficiently to remove all dirt and debris. Fill piping completely. Velocity shall be equivalent to that experienced during

normal plant operation at maximum loads. During flushing, all control valves, steam traps and pumps must be disconnected from the system. After cleaning is complete, remove, clean and replace all strainer baskets and elements. Reconnect all equipment. Provide safe points of discharge for debris blown from pipes.

### 3.25 TESTING

- A. Testing of piping components is not required prior to installation. Valves and fittings shall be capable of withstanding hydrostatic shell test equal to twice the primary design service pressure except as modified by specifications on fittings, ASME B16.5. This test capability is a statement of quality of material. Tests of individual items of pipe, fittings or equipment will be required only on instruction of COTR or RE and at Government cost.
- B. After erection, all piping systems shall be capable of withstanding a hydrostatic test pressure of 1.5 times design pressure, as stipulated in ASME B31.1. Hydrostatic tests will be required only on boiler external steam piping, utilizing water as the test medium. Hydrostatic tests will be required on other piping when operating tests described are unsatisfactory, or when inspection of welds shows poor workmanship and is subject to question by the RE/COTR. When hydrostatic tests show leaks, the RE/COTR will require necessary welding repairs, in accordance with ASME B31.1, at the Contractor's cost.
- C. Perform operating test as follows:
  - 1. All steam piping prior to insulation shall be subjected to steam at final operating pressure. Inspect all joints for leaks and workmanship. Corrections shall be made as specified.
  - 2. Test main gas piping with compressed air at twice the service pressure entering VA property from utility service. Test LP gas piping at the maximum tank pressure, 1725 kPa (250 psig), with compressed air. Test joints with soap solution, check thoroughly for leaks.
  - 3. Test boiler feedwater, condensate, vacuum and service water systems under service conditions and prove tight.
  - 4. Test oil and compressed air systems under service conditions at pressure equal to highest setting of safety and relief valves in the individual systems.
  - 5. Make corrections and retests to establish systems that have no leaks. Replace or recut any defective fittings or defective threads. Soldered material shall be thoroughly cleaned prior to resoldering. Back welding of threads will not be permitted.

- D. Hydrostatically test boiler external steam piping from boiler to header in approved manner with water of same time boiler is hydrostatically tested under the supervision of RE/COTR. Prior to hydrostatic test, remove all valves not rated for hydrostatic test pressure. Replace valves after tests are satisfactorily completed. Hydrostatic test pressure shall be 1.5 times design pressure and performed in accordance with ASME Boiler and Pressure Vessel Code, Section I.
- E. Generally, insulation work should not be performed prior to testing of piping. Contractor may, at own option and hazard, insulate piping prior to test, but any damaged insulation shall be replaced with new quality as specified for original installation at Contractor's cost and time.
- F. Safety, Safety-Relief, Relief Valves: After installation, test under pressure in presence of RE/COTR. Test operation, including set pressure, flow, and blowdown in accordance with ASME Boiler and Pressure Vessel Code. Any deficiencies must be corrected and retest performed. Refer to Section 23 52 34, STEAM GENERATOR for boiler safety valve test requirements.

- - - E N D - - -

**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, condenser water, heating hot water and drain piping.
  - 2. Extension of domestic water make-up piping.
  - 3. Glycol-water 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 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.
- D. Section 23 21 23, HYDRONIC PUMPS: Pumps.
- E. Section 23 07 11, HVAC, PLUMBING, AND BOILER PLANT INSULATION: Piping insulation.
- F. Section 23 21 11, BOILER PLANT PIPING SYSTEMS: Boiler piping.
- G. Section 23 25 00, HVAC WATER TREATMENT: Water treatment for open and closed systems.
- H. Section 23 21 13, HYDRONIC PIPING: Underground chilled water piping.
- I. Section 23 82 00, CONVECTION HEATING AND COOLING UNITS: Unit Heaters.
- J. Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC: Temperature and pressure sensors and valve operators.

**1.3 QUALITY ASSURANCE**

- A. Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION, which includes welding qualifications.
- B. Design Working Pressure for Chilled Water Piping: 861 kPa (125 psig).
- C. 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.

**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. Flexible connectors for water service.
  8. Pipe alignment guides.
  9. Expansion joints.
  10. Expansion compensators.
  11. All specified hydronic system components.
  12. Water flow measuring devices.
  13. Gages.
  14. Thermometers and test wells.
  15. Electric heat tracing systems.
- C. Manufacturer's certified data report, Form No. U-1, for ASME pressure vessels:
1. Convertors.
  2. Air separators.
  3. Expansion tanks.
  4. Flash tanks.
- D. 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.
- 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. One wall-mounted stick file with complete set of prints. Mount stick file in the chiller plant or control room along with control diagram stick file.
  2. One complete set of reproducible drawings.
  3. One complete set of drawings in electronic format (Autocad format).

#### **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 (ASME):

B1.20.1-83.....Pipe Threads, General Purpose (Inch)  
B16.1-98.....Cast Iron Pipe Flanges and Flanged Fittings  
B16.3-98.....Malleable Iron Threaded Fittings  
B16.4-98.....Gray Iron Threaded Fittings  
B16.5-03.....Pipe Flanges and Flanged Fittings  
B16.9-03.....Factory-Made Wrought Buttwelding Fittings  
B16.11-05.....Forged Fittings, Socket-Welding and Threaded  
B16.14-91.....Ferrous Pipe Plugs, Bushings, and Locknuts with  
Pipe Threads  
B16.22-01.....Wrought Copper and Copper Alloy Solder-Joint  
Pressure Fittings  
B16.23-02.....Cast Copper Alloy Solder Joint Drainage  
Fittings  
B16.24-01.....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  
B16.42-98.....Ductile Iron Pipe Flanges and Flanged Fittings:  
Classes 150 and 300  
B31.1-01.....Power Piping  
B31.9-04.....Building Services Piping  
B40.100-05.....Pressure Gauges and Gauge Attachments

C. American National Standards Institute, Inc. (ANSI):

B16.1 00.....Cast Iron Pipe Flanges and Flanged Fittings,  
Class 25, 125 and 250  
B16.3 00.....Malleable Iron Threaded Fittings Classes 150  
and 300  
B16.5 03.....Pipe Flanges and Flanged Fittings NPS ½ through  
NPS 24  
B16.9 03.....Factory Made Wrought Butt Welding Fittings  
B16.11 01.....Forged Fittings, Socket Welding and Threaded  
B16.14 91.....Ferrous Pipe Plugs, Bushings and Locknuts with  
Pipe Threads  
B16.18-01.....Cast Copper Alloy Solder joint Pressure  
fittings

- B16.22 00.....Wrought Copper and Bronze Solder Joint Pressure  
Fittings
- B16.24 01.....Cast Copper Alloy Pipe Fittings and Flanged  
Fittings: Class 150, 300, 400, 600, 900, 1500  
and 2500
- B31.1 01.....Power Piping
- D. American Society for Testing and Materials (ASTM):
- A47/A47M-99 (2004).....Ferritic Malleable Iron Castings
- A53/A53M-06.....Standard Specification for Pipe, Steel, Black  
and Hot-Dipped, Zinc-Coated, Welded and  
Seamless
- A106/A106M-06.....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
- A181/A181M-01.....Standard Specification for Carbon Steel  
Forgings, for General-Purpose Piping
- A183-03 ..... Standard Specification for Carbon Steel Track  
Bolts and Nuts
- A216/A216M-04 ..... Standard Specification for Steel Castings,  
Carbon, Suitable for Fusion Welding, for High  
Temperature Service
- A234/A234M 04 ..... Piping Fittings of Wrought Carbon Steel and  
Alloy Steel for Moderate and High Temperature  
Service
- A307-04 ..... Standard Specification for Carbon Steel Bolts  
and Studs, 60,000 PSI Tensile Strength
- A536-84 (2004) ..... Standard Specification for Ductile Iron Castings
- A 615/A 615M-04 ..... Deformed and Plain Carbon Steel Bars for  
Concrete Reinforcement
- A653/A 653M-04 ..... Steel Sheet, Zinc-Coated (Galvanized) or Zinc-  
Iron Alloy Coated (Galvannealed) By the Hot-Dip  
Process
- B32-04 ..... Standard Specification for Solder Metal
- B61-02 ..... Standard Specification for Steam or Valve Bronze  
Castings
- B62-02 ..... Standard Specification for Composition Bronze or  
Ounce Metal Castings

- B88-03 ..... Standard Specification for Seamless Copper Water  
Tube
- B209 04 ..... Aluminum and Aluminum Alloy Sheet and Plate
- C177 97 ..... Standard Test Method for Steady State Heat Flux  
Measurements and Thermal Transmission Properties  
by Means of the Guarded Hot Plate Apparatus
- C478-03 ..... Precast Reinforced Concrete Manhole Sections
- C533 03 ..... Calcium Silicate Block and Pipe Thermal  
Insulation
- C552 03 ..... Cellular Glass Thermal Insulation
- D 3350-02 ..... Polyethylene Plastics Pipe and Fittings  
Materials
- C591-01 ..... Unfaced Preformed Rigid Cellular  
Polyisocyanurate Thermal Insulation
- D1784 03 ..... Rigid Poly (Vinyl Chloride) (PVC) Compounds and  
Chlorinated Poly (Vinyl Chloride) (CPVC)  
Compounds
- D1785 03 ..... Poly (Vinyl Chloride) (PVC) Plastic Pipe,  
Schedules 40, 80 and 120
- D2241 04 ..... Poly (Vinyl Chloride) (PVC) Pressure Rated Pipe  
(SDR Series)
- D2464 99 ..... Threaded Poly (Vinyl Chloride) (PVC) Plastic  
Pipe Fittings, Schedule 80.
- D3139 98 ..... Joints for Plastic Pressure Pipes Using Flexible  
Elastomeric Seals
- 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
- F477-02 ..... Elastomeric Seals Gaskets) for Joining Plastic  
Pipe
- E. American Water Works Association (AWWA):
- C110/03.....Ductile Iron and Grey Iron Fittings for Water
- C203 00.....Coal Tar Protective Coatings and Linings for  
Steel Water Pipe Lines Enamel and Tape Hot  
Applied
- F. American Welding Society (AWS):
- A5.8/A5.8M-04.....Specification for Filler Metals for Brazing and  
Braze Welding

- B2.1-02.....Standard Welding Procedure Specification
- G. Copper Development Association, Inc. (CDA):  
CDA A4015-95.....Copper Tube Handbook
- H. Expansion Joint Manufacturer's Association, Inc. (EJMA):  
EMJA-2003.....Expansion Joint Manufacturer's Association  
Standards, Eighth Edition
- I. 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-72-99.....Ball Valves with Flanged or Butt-Welding Ends  
for General Service  
SP-78-05.....Cast Iron Plug Valves, Flanged and Threaded  
Ends  
SP-80-03.....Bronze Gate, Globe, Angle and Check Valves  
SP-85-02.....Cast Iron Globe and Angle Valves, Flanged and  
Threaded Ends
- J. National Sanitation Foundation (NSF):  
14 03.....Plastic Piping System Components and Related  
Materials
- K. Tubular Exchanger Manufacturers Association: TEMA 8th Edition, 2000
- L. Sheet Metal and Air Conditioning Contractors National Association  
(SMACNA):  
HVAC Duct Construction Standards, 2nd Edition 1997

## **PART 2 - PRODUCTS**

### **2.1 PIPE AND EQUIPMENT SUPPORTS, PIPE SLEEVES, AND WALL AND CEILING PLATES**

Provide in accordance with Section 23 05 11, COMMON WORK RESULTS FOR  
HVAC AND STEAM GENERATION.

### **2.2 PIPE AND TUBING**

- A. Chilled Water (above ground), Condenser Water (above ground), Heating  
Hot Water, Glycol-Water, and Vent Piping:  
1. Steel: ASTM A53 Grade B, seamless or ERW, Schedule 40.
- 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.
2. From fan coil or other terminal units: Copper water tube, ASTM B88, Type L for runouts and Type M for mains.

D. Chemical Feed Piping for Condenser Water Treatment: Chlorinated polyvinyl chloride (CPVC), Schedule 80, ASTM F441.

E. 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. 65 mm (2-1/2 inches) and Larger: Welded or flanged joints. Mechanical couplings and fittings are optional for water piping in mechanical spaces and sub-basement 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: Convoluted, 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.

B. 50 mm (2 inches) and Smaller: Screwed or welded. Mechanical couplings are optional for water piping in mechanical spaces and sub-basement only.

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.

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. 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. Mechanical Pipe Couplings and Fittings are only are only allowed within mechanical spaces and the sub-basement.

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 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. 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.

#### **2.5 FITTINGS FOR PLASTIC PIPING**

- A. Schedule 80, socket type for solvent welding.
- B. Polypropylene drain piping: Flame retardant, drainage pattern.
- C. Chemical feed piping for condenser water treatment: Chlorinated polyvinyl chloride (CPVC), Schedule 80, ASTM F439.

#### **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).

#### **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. Provide gate and globe valves with packing that can be replaced with the valve under full working pressure.
- C. Provide chain operators for valves 100 mm (4 inches) and larger when the centerline is located 2400 mm (8 feet) or more above the floor or operating platform.
- D. Gate Valves:
  - 1. 50 mm (2 inches) and smaller: MSS-SP80, Bronze, 1034 kPa (150 lb.), wedge disc, rising stem, union bonnet.
  - 2. 65 mm (2 1/2 inches) and larger: Flanged, outside screw and yoke.
    - a. MSS-SP 70, iron body, bronze mounted, 861 kPa (125 psig) wedge disc.
- E. Globe, Angle and Swing Check Valves:
  - 1. 50 mm (2 inches) and smaller: MSS-SP 80, bronze, 1034 kPa (150 lb.)  
Globe and angle valves shall be union bonnet with metal plug type disc.
  - 2. 65 mm (2 1/2 inches) and larger: 861 kPa (125 psig), flanged, iron body, bronze trim, MSS-SP-85 for globe valves and MSS-SP-71 for check valves.
- F. 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.
  - 1. Body: Cast iron, ASTM A126, Class B, or steel, ASTM A216, Class WCB, or ductile iron, ASTM 536, flanged, grooved, or wafer type.
  - 2. Seat, disc and spring: 18-8 stainless steel, or bronze, ASTM B62.  
Seats may be elastomer material.
- G. Butterfly Valves: May be used in lieu of gate valves in water service except for direct buried pipe. Provide stem extension to allow 50 mm (2 inches) of pipe insulation without interfering with valve operation.
  - 1. MSS-SP 67, flange lug type (for end of line service) or grooved end rated 1205 kPa (175 psig) working pressure at 93 degrees C (200 degrees F).

- 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.
- H. Ball Valves: Brass or bronze body with chrome-plated ball with full port and Teflon seat at 4140 kPa (600 psig) working pressure rating. Screwed or solder connections. Provide stem extension to allow operation without interfering with pipe insulation.
- I. Water Flow Balancing Valves: For flow regulation and shut-off. Valves shall be line size rather than reduced to control valve size and be one of the following types.
  - 1. Butterfly valve as specified herein with memory stop.
  - 2. Eccentric plug valve: Iron body, bronze or nickel-plated iron plug, bronze bearings, adjustable memory stop, operating lever, rated 861 kPa (125 psig) and 121 degrees C (250 degrees F).
- J. Circuit Setter Valve: 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. Provide a readout kit including flow meter, readout probes, hoses, flow charts or calculator, and carrying case.
- K. 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.

L. Manual Radiator/Convactor Valves: Brass, packless, with position indicator.

## **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. Venturi Type: Bronze, steel, or cast iron with bronze throat, with valved pressure sensing taps upstream and at the throat.
- C. Wafer Type Circuit Sensor: Cast iron wafer-type flow meter equipped with readout valves to facilitate the connecting of a differential pressure meter. Each readout valve shall be fitted with an integral check valve designed to minimize system fluid loss during the monitoring process.
- D. Self-Averaging Annular Sensor Type: Brass or stainless steel metering tube, shutoff valves and quick-coupling pressure connections. Metering tube shall be rotatable so all sensing ports may be pointed down-stream when unit is not in use.
- E. Flow Measurement/Balance Valves: A system comprised of two valves of bronze and stainless steel metallurgy designed for 1205 kPa (175 psig) pressure at 121 degrees C (250 degrees F), with thermal insulation sleeve.
  1. Measurement and shut-off valve: An on/off ball valve with integral high regain venturi and dual quick connect valves with integral

- check valves and color coded safety caps for pressure/temperature readout.
2. A butterfly balancing valve as specified herein, with memory stop and quick connect valve for pressure/temperature readout.
- F. Insertion Turbine Type Sensor: Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC.
- G. 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).
- H. Portable Water Flow Indicating Meters:
1. Minimum 150 mm (6 inch) diameter dial, forged brass body, beryllium-copper bellows, designed for 1205 kPa (175 psig) working pressure at 121 degrees C (250 degrees F).
  2. Bleed and equalizing valves.
  3. Vent and drain hose and two 3000 mm (10 feet) lengths of hose with quick disconnect connections.
  4. Factory fabricated carrying case with hose compartment and a bound set of capacity curves showing flow rate versus pressure differential.
  5. Provide one portable meter for each range of differential pressure required for the installed flow devices.
- I. Permanently Mounted Water Flow Indicating Meters: Minimum 150 mm (6 inch) diameter, or 450 mm (18 inch) long scale, for 120 percent of design flow rate, direct reading in lps (gpm), with three valve manifold and two shut-off valves.

## **2.10 STRAINERS**

- A. Basket or Y Type. Tee type is acceptable for water service.
- B. 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.
  2. 100 mm (4 inches) and larger: 3.2 mm (0.125 inch) diameter perforations.
- C. Suction Diffusers: Specified in Section 23 21 23, HYDRONIC PUMPS.

## **2.11 FLEXIBLE CONNECTORS FOR WATER SERVICE**

- A. Flanged Spool Connector:

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 EXPANSION JOINTS**

- A. Factory built devices, inserted in the pipe lines, designed to absorb axial cyclical pipe movement which results from thermal expansion and contraction. This includes factory-built or field-fabricated guides located along the pipe lines to restrain lateral pipe motion and direct the axial pipe movement into the expansion joints.
- B. Manufacturing Quality Assurance: Conform to Expansion Joints Manufacturers Association Standards.
- C. Bellows - Internally Pressurized Type:
  1. Multiple corrugations of Type 304 or Type A240-321 stainless steel.
  2. Internal stainless steel sleeve entire length of bellows.
  3. External cast iron equalizing rings for services exceeding 340 kPa (50 psig).
  4. Welded ends.
  5. Design shall conform to standards of EJMA and ASME B31.1.
  6. External tie rods designed to withstand pressure thrust force upon anchor failure if one or both anchors for the joint are at change in direction of pipeline.
  7. Integral external cover.
- D. Bellows - Externally Pressurized Type:
  1. Multiple corrugations of Type 304 stainless steel.
  2. Internal and external guide integral with joint.
  3. Design for external pressurization of bellows to eliminate squirm.

4. Welded ends.
  5. Conform to the standards of EJMA and ASME B31.1.
  6. Threaded connection at bottom, 25 mm (one inch) minimum, for drain or drip point.
  7. Integral external cover and internal sleeve.
- E. Expansion Compensators:
1. Corrugated bellows, externally pressurized, stainless steel or bronze.
  2. Internal guides and anti-torque devices.
  3. Threaded ends.
  4. External shroud.
  5. Conform to standards of EJMA.
- F. Expansion Joint Identification: Provide stamped brass or stainless steel nameplate on each expansion joint listing the manufacturer, the allowable movement, flow direction, design pressure and temperature, date of manufacture, and identifying the expansion joint by the identification number on the contract drawings.
- G. Guides: Provide factory-built guides along the pipe line to permit axial movement only and to restrain lateral and angular movement. Guides must be designed to withstand a minimum of 15 percent of the axial force which will be imposed on the expansion joints and anchors. Field-built guides may be used if detailed on the contract drawings.

## **2.13 HYDRONIC SYSTEM COMPONENTS**

- A. Converter: Shell and tube type, U-bend removable tube bundle, steam in shell, water in tubes, equipped with support cradles.
1. Maximum tube velocity: 2.3 m/s (7.5 feet per second).
  2. Tube fouling factor: TEMA Standards, but not less than 0.001.
  3. Materials:
    - a. Shell: Steel.
    - b. Tube sheet and tube supports: Steel or brass.
    - c. Tubes: 20 mm (3/4 inch) OD copper.
    - d. Head or bonnet: Cast iron or steel.
  4. Construction: In accordance with ASME Pressure Vessel Code for 861 kPa (125 psig) working pressure for shell and tubes. Provide manufacturer's certified data report, Form No. U-1.
- B. Optional Heat Transfer Package: In lieu of field erected individual components, the Contractor may provide a factory or shop assembled

package of converters, pumps, and other components supported on a welded steel frame.

- C. Air Purger: Cast iron or fabricated steel, 861 kPa (125 psig) water working pressure, for in-line installation.
- D. Tangential Air Separator: ASME Pressure Vessel Code construction for 861 kPa (125 psig) working pressure, flanged tangential inlet and outlet connection, internal perforated stainless steel air collector tube designed to direct released air into expansion tank, bottom blowdown connection. Provide Form No. U-1. If scheduled on the drawings, provide a removable stainless steel strainer element having 5 mm (3/16 inch) perforations and free area of not less than five times the cross-sectional area of connecting piping.
- E. Diaphragm 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).
- F. 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).
- G. 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.
- H. 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. Pipe air outlet to drain.

#### **2.14 WATER FILTERS AND POT CHEMICAL FEEDERS**

See section 23 25 00, HVAC WATER TREATMENT, Article 2.2, CHEMICAL TREATMENT FOR CLOSED LOOP SYSTEMS.

#### **2.15 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).

#### **2.16 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, norden 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.

#### **2.17 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 may be slightly greater than shown to meet manufacturer's standard. Required ranges in degrees C (F):

Chilled Water and Glycol-Water 0 to 38 degrees C (32-100 degrees F)	Hot Water and Glycol-Water -1 to 116 degrees C (30 to 240 degrees F).
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## **2.18 FIRESTOPPING MATERIAL**

Refer to Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION.

## **2.19 VACUUM AND AIR RELIEF VALVES**

Vacuum and air relief valves shall be iron body with bronze trim, and stainless steel floats.

# **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 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. Provide manual air vent at all piping system high points and drain valves at all low points.
- I. 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.
- J. 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.
- K. 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.
- L. 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.
- E. Solvent Welded Joints: As recommended by the manufacturer.

### **3.3 EXPANSION JOINTS (BELLOWS AND SLIP TYPE)**

- A. Anchors and Guides: Provide type, quantity and spacing as recommended by manufacturer of expansion joint and as shown. A professional engineer shall verify in writing that anchors and guides are properly designed for forces and moments which will be imposed.
- B. Cold Set: Provide setting of joint travel at installation as recommended by the manufacturer for the ambient temperature during the installation.
- C. Preparation for Service: Remove all apparatus provided to restrain joint during shipping or installation. Representative of manufacturer shall visit the site and verify that installation is proper.
- D. Access: Expansion joints must be located in readily accessible space. Locate joints to permit access without removing piping or other devices. Allow clear space to permit replacement of joints and to permit access to devices for inspection of all surfaces and for adding packing.

### **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. 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.

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**SECTION 23 21 23  
HYDRONIC PUMPS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. Hydronic pumps for Heating, Ventilating and Air Conditioning.
- B. Definitions:
  - 1. Capacity: Liters per second (L/s) (Gallons per minute (GPM)) of the fluid pumped.
  - 2. Head: Total dynamic head in kPa (feet) of the fluid pumped.
  - 3. Flat head-capacity curve: Where the shutoff head is less than 1.16 times the head at the best efficiency point.

**1.2 RELATED WORK**

- A. Section 01 00 00, GENERAL REQUIREMENTS.
- B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- C. Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION.
- D. Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING AND EQUIPMENT.
- E. Section 23 21 13, HYDRONIC PIPING.
- F. Section 23 05 12, GENERAL MOTOR REQUIREMENTS FOR HVAC AND STEAM GENERATION EQUIPMENT.
- G. 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. The head for pumps submitted for pumping through condensers and through chilled water coils and evaporators shall be increased, if necessary, to match the equipment approved for the project.
  5. Pump Driver: Furnish with pump. Size shall be non-overloading at any point on the head-capacity curve including one pump operation in a parallel or series pumping installation.
  6. Provide all pumps with motors, impellers, drive assemblies, bearings, coupling guard and other accessories specified. Statically and dynamically balance all rotating parts.
  7. 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.
  8. Test all pumps before shipment. The manufacturer shall certify all pump ratings.
  9. After completion of balancing, provide replacement of impellers or trim impellers to provide specified flow at actual pumping head, as installed.
  10. Furnish one spare seal and casing gasket for each pump to the Resident Engineer.
- 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.....Safety Standard for Mechanical Power  
Transmission Apparatus  
ANSI B16.1-00.....Cast Iron Pipe Flanges and Flanged Fittings,  
Class 25, 125, 250 and 800
- D. American Society for Testing and Materials (ASTM):  
A48-98.....Gray Iron Castings  
B62-02.....Composition Bronze or Ounce Metal Castings
- E. Maintenance and Operating Manuals in accordance with Section 01 00 00, General Requirements.

## PART 2 - PRODUCTS

### 2.1 CENTRIFUGAL PUMPS, BRONZE FITTED

- In-Line Type, Base Mounted End Suction or Double Suction Type:
- A. Casing and Bearing Housing: Close-grained cast iron, ASTM A48.
- B. Casing Wear Rings: Bronze.
- C. Suction or Discharge 65 mm (2-1/2 inches) and Larger: Plain face flange, 850 kPa (125 psig), ANSI B16.1.
- D. Casing Vent: Manual brass cock at high point.
- E. Casing Drain and Gage Taps: 15 mm (1/2-inch) plugged connections minimum size.
- F. Bearings: Regreaseable ball or roller type. Provide lip seal and slinger outboard of each bearing.
- G. Impeller: Bronze, ASTM B62, enclosed type, keyed to shaft.
- H. Shaft: Steel, AISI Type 1045 or stainless steel.
- I. Shaft Seal: Manufacturer's standard mechanical type to suit pressure and temperature and fluid pumped.
- J. Shaft Sleeve: Bronze or stainless steel.
- K. Motor: Furnish with pump. Refer to Section 23 05 12, GENERAL MOTOR REQUIREMENTS FOR HVAC AND STEAM GENERATION EQUIPMENT.
- L. Base Mounted Pumps:
1. Designed for disassembling for service or repair without disturbing the piping or removing the motor.
  2. Impeller Wear Rings: Bronze.

3. Shaft Coupling: Non-lubricated steel flexible type or spacer type with coupling guard, ANSI B15.1, bolted to the baseplate.
4. Base: Cast iron or fabricated steel for common mounting to a concrete base.
5. Suction Diffuser:
  - 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.
6. Suction Strainer, "Y" Type: Section 23 21 13, HYDRONIC PIPING.
  - a. May be furnished in lieu of a suction diffuser at the Contractor's option. Provide equivalent support of pump suction piping.

M. Variable Speed Pumps:

1. The pumps shall be the type shown on the drawings and specified herein flex coupled to an open drip-proof motor. Provide motors 30 kW (40 horsepower) and larger with thermal overload switches.
2. 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.
3. Pump operation and speed control shall be as shown on the drawings.

**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. Support piping adjacent to pump such that no weight is carried on pump casing. First 3 hangers for each pipe shall be spring and neoprene type.
- C. Permanently support in-line pumps by the connecting piping only, not from the casing or the motor eye bolt.
- D. Sequence of installation for base-mounted pumps:
  1. Level and shim the unit base and grout to the concrete pad.
  2. Shim the driver and realign the pump and driver. Correct axial, angular or parallel misalignment of the shafts.
  3. Connect properly aligned and independently supported piping.
  4. Recheck alignment.

- E. Provide drains for bases and seals for base mounted pumps, piped to and discharging into floor drains.
- F. 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. Perform field mechanical balancing if necessary to meet specified vibration tolerance.
- 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.

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**SECTION 23 22 13**  
**STEAM AND CONDENSATE HEATING PIPING**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. Steam, condensate and vent piping inside buildings.

**1.2 RELATED WORK**

- A. 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.
- B. Piping insulation: Section 23 07 11, HVAC, PLUMBING, AND BOILER PLANT INSULATION.
- C. Water treatment for open and closed systems: Section 23 25 00, HVAC WATER TREATMENT.
- D. Temperature and pressure sensors and valve operators: Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC.

**1.3 QUALITY ASSURANCE**

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. Flexible connectors.
  - 8. Pipe alignment guides.
  - 9. Expansion joints.
  - 10. Expansion compensators.
  - 11. Flexible ball joints: Catalog sheets, performance charts, schematic drawings, specifications and installation instructions.
  - 12. All specified steam system components.
  - 13. Gages.
  - 14. Thermometers and test wells.
- C. Manufacturer's certified data report, Form No. U-1, for ASME pressure vessels:

1. Convertors.
  2. Air separators.
  3. Expansion tanks.
  4. Flash tanks.
- D. Coordination Drawings: Refer to Article, SUBMITTALS of Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION.
- E. As-Built Piping Diagrams: Provide drawing as follows for steam and steam condensate piping and other central plant equipment.
1. One wall-mounted stick file for prints. Mount stick file in the chiller plant or adjacent control room along with control diagram stick file.
  2. One set of reproducible 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 National Institute Standard (ANSI):
- B1.20.1-01.....Pipe Threads, General Purpose (Inch)
- C. American Society of Mechanical Engineers (ASME):
- B16.1-98.....Cast Iron Pipe Flanges and Flanged Fittings
- B16.3-98.....Malleable Iron Threaded Fittings
- B16.4-98.....Gray Iron Threaded Fittings
- B16.9-01.....Factory-Made Wrought Buttwelding Fittings
- B16.11-02.....Forged Fittings, Socket-Welding and Threaded
- B16.14-91.....Ferrous Pipe Plugs, Bushings, and Locknuts with  
Pipe Threads
- B16.22-98.....Wrought Copper and Copper Alloy Solder-Joint  
Pressure Fittings
- B16.23-92.....Cast Copper Alloy Solder Joint Drainage Fittings
- B16.24-01.....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
- B31.1-01.....Power Piping
- B31.9-96.....Building Services Piping
- B40.100-98.....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  
A53-01.....Pipe, Steel, Black and Hot-Dipped, Zinc-Coated,  
Welded and Seamless  
A106-99.....Seamless Carbon Steel Pipe for High-Temperature  
Service  
A126-01.....Standard Specification for Gray Iron Castings  
for Valves, Flanges, and Pipe Fittings  
A181-01.....Carbon Steel Forgings, for General-Purpose  
Piping  
A183-98 ..... Carbon Steel Track Bolts and Nuts  
A216-98 ..... 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  
A307-00 ..... Carbon Steel Bolts and Studs, 60,000 PSI Tensile  
Strength  
A516-01 ..... Pressure Vessel Plates, Carbon Steel, for  
Moderate-and- Lower Temperature Service  
A536-99 ..... Standard Specification for Ductile Iron Castings  
B32-00 ..... Solder Metal  
B61-93 ..... Steam or Valve Bronze Castings  
B62-93 ..... Composition Bronze or Ounce Metal Castings  
B88-99 ..... Seamless Copper Water Tube  
F439-01 ..... Socket-Type Chlorinated Poly (Vinyl Chloride)  
(CPVC) Plastic Pipe Fittings, Schedule 80  
F441-99 ..... Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic  
Pipe, Schedules 40 and 80

E. American Welding Society (AWS):

A5.8-92.....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**

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 Piping:

1. Steel, ASTM A53, Grade B, Seamless or ERW, or A106 Grade B Seamless,  
Schedule 80.

**2.3 FITTINGS FOR STEEL PIPE**

A. 65 mm (2-1/2 inches) and Larger: Welded or flanged joints. Mechanical  
couplings and fittings are optional for 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. 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.

c. Flange bolting: Carbon steel machine bolts or studs and nuts, ASTM  
A307, Grade B.

B. 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 are 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.

C. Welded Branch and Tap Connections: Forged steel weldolets, or branchlets and thredolets 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.

#### **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.

#### **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. Provide gate and globe valves with packing that can be replaced with the valve under full working pressure.

C. Provide chain operators for valves 100 mm (4 inches) and larger when the centerline is located 2400 mm (8 feet) or more above the floor or operating platform.

D. Gate Valves:

1. 50 mm (2 inches) and smaller: MSS-SP80, Bronze, 1034 kPa (150 lb.), wedge disc, rising stem, union bonnet.

2. 65 mm (2 1/2 inches) and larger: Flanged, outside screw and yoke.
  - a. 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 factory installed bypass with globe valve on valves 100 mm (4 inches) and larger.
  - b. All other services: MSS-SP 70, iron body, bronze mounted, 861 kPa (125 psig) wedge disc.
- E. Globe, Angle and Swing Check Valves:
  1. 50 mm (2 inches) and smaller: MSS-SP 80, bronze, 1034 kPa (150 lb.) Globe and angle valves shall be union bonnet with metal plug type disc.
  2. 65 mm (2 1/2 inches) and larger:
    - a. 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.
    - b. All other services: 861 kPa (125 psig), flanged, iron body, bronze trim, MSS-SP-85 for globe valves and MSS-SP-71 for check valves.
- F. 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.
  1. Body: Cast iron, ASTM A126, Class B, or steel, ASTM A216, Class WCB, or ductile iron, ASTM 536, flanged, grooved, or wafer type.
  2. Seat, disc and spring: 18-8 stainless steel, or bronze, ASTM B62. Seats may be elastomer material.
- G. Butterfly Valves: May be used in lieu of gate valves in water service except for direct buried pipe. Provide stem extension to allow 50 mm (2 inches) of pipe insulation without interfering with valve operation.
  1. MSS-SP 67, flange lug type (for end of line service) or grooved end rated 1205 kPa (175 psig) working pressure at 93 degrees C (200 degrees F).
    - 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.

## 2.8 STRAINERS

- A. Basket or Y Type. Tee type is acceptable for water service.
- B. High Pressure Steam: Rated 1034 kPa (150 psig) saturated steam.
  - 1. 65 mm (2-1/2 inches) and larger: Flanged cast steel or 1723 kPa (250 psig) cast iron.
  - 2. 50 mm (2 inches) and smaller: Iron, ASTM A116 Grade B, or bronze, ASTM B-62 body with screwed connections (250 psig).
  - 3. Mechanical coupled pipe: Grooved end, ductile iron.
- C. All Other Services: Rated 861 kPa (125 psig) saturated steam.
  - 1. 65 mm (2-1/2 inches) and larger: Flanged, iron body.
  - 2. 50 mm (2 inches) and smaller: Cast iron or bronze.
- 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 EXPANSION JOINTS

- A. Factory built devices, inserted in the pipe lines, designed to absorb axial cyclical pipe movement which results from thermal expansion and contraction. This includes factory-built or field-fabricated guides located along the pipe lines to restrain lateral pipe motion and direct the axial pipe movement into the expansion joints.
- B. Minimum Service Requirements:
  - 1. Pressure Containment:
    - a. Steam Service 35-200 kPa (5-30 psig): Rated 345 kPa (50 psig) at 148 degrees C (298 degrees F).
    - b. Steam Service 214-850 kPa (31-125 psig): Rated 1025 kPa (150 psig) at 186 degrees C (366 degrees F).

- c. Steam Service 869-1025 kPa (126-150 psig): Rated 1375 kPa (200 psig) at 194 degrees C (382 degrees F).
  - d. Condensate Service: Rated 690 kPa (100 psig) at 154 degrees C (310 degrees F).
- 2. Number of Full Reverse Cycles without failure: Minimum 1000.
- 3. Movement: As shown on drawings plus recommended safety factor of manufacturer.
- C. Manufacturing Quality Assurance: Conform to Expansion Joints Manufacturers Association Standards.
- D. Bellows - Internally Pressurized Type:
  - 1. Multiple corrugations of Type 304 or Type A240-321 stainless steel.
  - 2. Internal stainless steel sleeve entire length of bellows.
  - 3. External cast iron equalizing rings for services exceeding 340 kPa (50 psig).
  - 4. Welded ends.
  - 5. Design shall conform to standards of EJMA and ASME B31.1.
  - 6. External tie rods designed to withstand pressure thrust force upon anchor failure if one or both anchors for the joint are at change in direction of pipeline.
  - 7. Integral external cover.
- E. Bellows - Externally Pressurized Type:
  - 1. Multiple corrugations of Type 304 stainless steel.
  - 2. Internal and external guide integral with joint.
  - 3. Design for external pressurization of bellows to eliminate squirm.
  - 4. Welded ends.
  - 5. Conform to the standards of EJMA and ASME B31.1.
  - 6. Threaded connection at bottom, 25 mm (one inch) minimum, for drain or drip point.
  - 7. Integral external cover and internal sleeve.
- F. Expansion Joint Identification: Provide stamped brass or stainless steel nameplate on each expansion joint listing the manufacturer, the allowable movement, flow direction, design pressure and temperature, date of manufacture, and identifying the expansion joint by the identification number on the contract drawings.
- G. Guides: Provide factory-built guides along the pipe line to permit axial movement only and to restrain lateral and angular movement. Guides must be designed to withstand a minimum of 15 percent of the axial force which will be imposed on the expansion joints and anchors. Field-built guides may be used if detailed on the contract drawings.

## 2.10 FLEXIBLE BALL JOINTS

- A. Design and Fabrication: One piece component construction, fabricated from steel with welded ends, designed for a working steam pressure of 1720 kPa (250 psig) and a temperature of 232 degrees C (450 degrees F). Each joint shall provide for 360 degrees rotation in addition to a minimum angular flexible movement of 30 degrees for sizes 6 mm (1/4 inch) to 150 mm (6 inch) inclusive, and 15 degrees for sizes 65 mm (2-1/2 inches) to 750 mm (30 inches). Joints through 350 mm (14 inches) shall have forged pressure retaining members; while size 400 mm (16 inches) through 760 mm (30 inches) shall be of one piece construction.
- B. Material:
1. Cast or forged steel pressure containing parts and bolting in accordance with Section II of the ASME Boiler Code or ASME B31.1. Retainer may be ductile iron ASTM A536, Grade 65-45-12, or ASME Section II SA 515, Grade 70.
  2. Gaskets: Steam pressure molded composition design for a temperature range of from minus 10 degrees C (50 degrees F) to plus 274 degrees C (525 degrees F).
- C. Certificates: Submit qualifications of ball joints in accordance with the following test data:
1. Low pressure leakage test: 41 kPa (6psig) saturated steam for 60 days.
  2. Flex cycling: 800 Flex cycles at 3445 kPa (500 psig) saturated steam.
  3. Thermal cycling: 100 saturated steam pressure cycles from atmospheric pressure to operating pressure and back to atmospheric pressure.
  4. Environmental shock tests: Forward certificate from a recognized test laboratory, that ball joints of the type submitted has passed shock testing in accordance with Mil. Spec MIL-S-901.
  5. Vibration: 170 hours on each of three mutually perpendicular axis at 25 to 125 Hz; 1.3 mm to 2.5 mm (0.05 inch to 0.1 inch) double amplitude on a single ball joint and 3 ball joint off set.

## 2.11 STEAM SYSTEM COMPONENTS

- A. Steam Pressure Reducing Valves in PRV Stations:
1. Type: Single-seated, diaphragm operated, spring-loaded, external or internal steam pilot-controlled, normally closed, adjustable set pressure. Pilot shall sense controlled pressure downstream of main valve.
  2. Service: Provide controlled reduced pressure to steam piping systems.

3. Pressure control shall be smooth and continuous with maximum drop of 10 percent. Maximum flow capability of each valve shall not exceed capacity of downstream safety valve(s).
4. Main valve and pilot valve shall have replaceable valve plug and seat of stainless steel, monel, or similar durable material.
  - a. Pressure rating for high pressure steam: Not less than 1034 kPa (150 psig) saturated steam.
  - b. Connections: Flanged for valves 65 mm (2-1/2 inches) and larger; flanged or threaded ends for smaller valves.
5. Select pressure reducing valves to develop less than 85 dbA at 1500 mm (5 feet) elevation above adjacent floor, and 1500 mm (5 feet) distance in any direction. Inlet and outlet piping for steam pressure reducing valves shall be Schedule 80 minimum for required distance to achieve required levels or sound attenuators shall be applied.
6. Pneumatically controlled valve: May be furnished in lieu of steam-operation. All specification requirements for steam operated valves apply. Valves shall close on failure of air supply.
- B. 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.
- C. Steam PRV for Individual Equipment: Cast iron or bronze body, screwed ends, rated 861 kPa (125 psig) working pressure. Single-seated, diaphragm operated, spring loaded, adjustable range, all parts renewable.
- D. Flash Tanks: Horizontal or vertical vortex type, constructed of copper bearing steel, ASTM A516 or ASTM A285, for a steam working pressure of 861 kPa (125 psig) to comply with ASME Code for Unfired Pressure Vessels and stamped with "U" symbol. Perforated pipe inside tank shall be ASTM A53 Grade B, Seamless or ERW, or A106 Grade B Seamless, Schedule 80. Corrosion allowance of 1.6 mm (1/16 inch) may be provided in lieu of the copper bearing requirement. Provide data Form No. U-1.
- E. Steam Trap: Each type of trap shall be the product of a single manufacturer. Provide trap sets at all low points and at 61 m (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: 1.7 kPa (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 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.
5. Mechanism: Brass, stainless steel or corrosion resistant alloy.
6. Floats: Stainless steel.
7. Inverted bucket traps: Provide bi-metallic thermostatic element for rapid release of non-condensables.
- F. Thermostatic Air Vent (Steam): Brass or iron body, balanced pressure bellows, stainless steel (renewable) valve and seat, rated 861 kPa (125 psig) working pressure, 20 mm (3/4 inch) screwed connections. Air vents shall be balanced pressure type that responds to steam pressure-temperature curve and vents air at any pressure.

## 2.12 GAGES, PRESSURE AND COMPOUND

- A. ASME B40.1, Accuracy Grade 1A, (pressure, vacuum, or compound), 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. 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 to 103 kPa(15 psig)	0 to 207 kPa (30 psig).
Medium pressure steam nominal 413 kPa (60 psig)	0 to 689 kPa (100 psig).
High pressure steam nominal 620 kPa to 861 kPa (90 to 125 psig)	0 to 1378 kPa (200 psig).

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## **2.13 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, norden 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, , 762 mm (30 inches) Hg to 689 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.

## **2.14 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. 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. 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. 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.

### 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.
- D. Solvent Welded Joints: As recommended by the manufacturer.

### **3.3 EXPANSION JOINTS (BELLOWS AND SLIP TYPE)**

- A. Anchors and Guides: Provide type, quantity and spacing as recommended by manufacturer of expansion joint and as shown. A professional engineer shall verify in writing that anchors and guides are properly designed for forces and moments which will be imposed.
- B. Cold Set: Provide setting of joint travel at installation as recommended by the manufacturer for the ambient temperature during the installation.
- C. Preparation for Service: Remove all apparatus provided to restrain joint during shipping or installation. Representative of manufacturer shall visit the site and verify that installation is proper.
- D. Access: Expansion joints must be located in readily accessible space. Locate joints to permit access without removing piping or other devices. Allow clear space to permit replacement of joints and to permit access to devices for inspection of all surfaces and for adding packing.

### **3.4 STEAM TRAP PIPING**

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.

### **3.5 LEAK TESTING**

- A. Inspect all joints and connections for leaks and workmanship and make corrections as necessary, to the satisfaction of the Resident Engineer. 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. 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 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.

**3.8 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 systems.
  - 3. Glycol water 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; and direct and perform chemical limit control during construction period. Minimum service during construction/start-up shall be 8 hours.

**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. Chemical treatment for open loop systems, including installation and operating instructions.
  - 4. 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):  
70-05.....National Electric Code (NEC)

### 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 proprietary 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.
- E. Sidestream Water Filter for Closed Loop Systems: Stainless steel housing, and polypropylene filter media with stainless steel core. Filter media shall be compatible with antifreeze and water treatment chemicals used in the system. Replaceable filter cartridges for sediment removal service with minimum 20 micrometer particulate at 98 percent efficiency for approximately five (5) percent of system design flow rate. Filter cartridge shall have a maximum pressure drop of 13.8 kPa (2 psig) at design flow rate when clean, and maximum pressure drop of 172 kPa (25 psig) when dirty. A constant flow rate valve shall be provided in the piping to the filter. Inlet and outlet pressure gauges shall be provided to monitor filter condition.

### 2.3 GLYCOL-WATER SYSTEM

- A. Propylene glycol shall be inhibited with 1.75 percent dipotassium phosphate. Do not use automotive anti-freeze because the inhibitors used are not needed and can cause sludge precipitate that interferes with heat transfer.
- B. Provide required amount of glycol to obtain the percent by volume for glycol-water systems as follows and to provide one-half tank reserve supply: 30 percent propylene-glycol for condenser water system.
- C. Glycol-Water Make-up System:
  - 1. Glycol-Water storage tank: Self supporting polyethylene, minimum 90 mil thickness, with removable cover or black steel with 90 mil polyethylene insert. Capacity shall be 213 L (55 gallons), with approximate diameter of 584 mm (23 inches) and height of 914 mm (36 inches). Reinforced threaded pipe connections shall be provided for all connections. Provide identification for tank showing name of the contents.

2. Glycol-Water make-up pump: Bronze fitted, self-priming, high head type suitable for pumping a 33 percent to 50 percent glycol-water solution in intermittent service. The pump shall be provided with a mechanical shaft seal and be flange connected to a 1750 rpm NEMA type C motor. The pump capacity shall be per equipment schedule.
3. Back pressure regulating valve: Spring loaded, diaphragm actuated type with bronze or steel body, stainless steel trim with capacity to relieve 100 percent of pump flow with an allowable rise in the regulated pressure of 69 kPa (10 psig) above the set point. Set point shall be 103 kPa (15 psig) above system PRV setting.
4. Low water level control: Steel or plastic float housing, stainless steel or plastic float, positive snap-acting SPST switch mechanism, rated 10 amps-120 volt AC, in General Purpose (NEMA 1) enclosure. The control shall be rated for pressures to 1034 kPa (150 psig) and make alarm circuit on low water level. The alarm circuit shall be wired to an alarm light on the nearest local Temperature Control panel (LTCP). Provide remote output relay to indicate alarm condition at the Building Control System specified under Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC.

#### **2.4 EQUIPMENT AND MATERIALS IDENTIFICATION**

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.
  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 DN 25 (1 IN) Schedule 80 PVC piping for the flow assembly piping to the main control panel and accessories.
  - a. The inlet piping shall connect to the discharge side of the circulating water pump.
  - b. The outlet piping shall connect to the water piping serving the cooling tower downstream of the heat source.
  - c. Provide inlet PVC wye strainer and PVC ball valves to isolate and service main control panel and accessories.
4. Install PVC injection nozzles with corporation stops in the water piping serving the cooling tower downstream of the heat source.
5. Provide Schedule 80 PVC piping for corrosion monitor rack per manufacturer's installation instructions. Provide PVC ball valves to isolate and service rack.
6. Provide installation supervision, start-up and operating instruction by manufacturer's technical representative.
- C. 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.
- D. Do not valve in or operate system pumps until after system has been cleaned.
- E. 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.
- F. Perform tests and report results in accordance with Section 01 00 00, GENERAL REQUIREMENTS.
- G. After cleaning is complete, and water PH is acceptable to manufacturer of water treatment chemical, add manufacturer-recommended amount of chemicals to systems.
- H. Instruct VA personnel in system maintenance and operation in accordance with Section 01 00 00, GENERAL REQUIREMENTS.

- - - E N D - - -

**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, and relief systems.
- 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 weather.

**1.2 RELATED WORK**

- A. Fire Stopping Material: Section 07 84 00, FIRESTOPPING.
- B. General Mechanical Requirements: Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION.
- C. Noise Level Requirements: Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING AND EQUIPMENT.
- D. Duct Insulation: Section 23 07 11, HVAC, PLUMBING, AND BOILER PLANT INSULATION
- E. Plumbing Connections: Section 22 11 00, FACILITY WATER DISTRIBUTION
- F. Supply Air Fans: Section 23 73 01, CUSTOM AIR-HANDLING UNIT COMPONENTS.
- G. Air Filters and Filters' Efficiencies: Section 23 40 00, HVAC AIR CLEANING DEVICES.
- H. Duct Mounted Instrumentation: Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC.
- I. Testing and Balancing of Air Flows: Section 23 05 93, TESTING, ADJUSTING, AND BALANCING FOR HVAC.

**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. Sealants and gaskets.
    - c. Access doors.
  - 2. Round and flat oval duct construction details:
    - a. Manufacturer's details for duct fittings.
    - b. Sealants and gaskets.
    - c. Access sections.
    - d. Installation instructions.
  - 3. Volume dampers, back draft dampers.
  - 4. Upper hanger attachments.
  - 5. Fire dampers, fire doors, 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.
  - 10. Details and design analysis of alternate or optional duct systems.
- C. 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. Air Moving and Conditioning Association (AMCA):
  - 500D-98.....Laboratory Method of Testing Dampers for Rating

- 500L-99.....Laboratory Method of Testing Louvers for Rating
- C. American Society of Civil Engineers (ASCE):
- ASCE7-98.....Minimum Design Loads for Buildings and Other Structures
- D. American Society for Testing and Materials (ASTM):
- A167-99.....Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet and Strip
- A653-01.....Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy coated (Galvannealed) by the Hot-Dip process
- A1011-02.....Standard Specification for Steel Sheet and Strip Hot rolled Carbon structural, High-Strength Low-Alloy and High Strength Low-Alloy with Improved Formability
- B209-01.....Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
- C1071-00.....Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material)
- E84-01.....Standard Test Method for Surface Burning Characteristics of Building Materials
- E. National Fire Protection Association (NFPA):
- 90A-99.....Standard for the Installation of Air Conditioning and Ventilating Systems
- 96-01.....Ventilation Control and Fire Protection of Commercial Cooking Operations
- F. Sheet Metal and Air Conditioning Contractors National Association (SMACNA):
- 2nd Edition - 1995.....HVAC Duct Construction Standards, Metal and Flexible
- 1st Edition, 1985.....HVAC Air Duct Leakage Test Manual
- 6th Edition - 1992.....Fibrous Glass Duct Construction Standards
- G. Underwriters Laboratories, Inc. (UL):
- 33-93.....UL Standard for Safety Heat Responsive Links for Fire Protection Service
- 181-96.....UL Standard for Safety Factory-Made Air Ducts and Connectors
- 555-02 .....Fire Dampers
- 555S-02 .....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 A527, 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 such as DUCTMATE SYSTEM may be used.

### **2.2 DUCT CONSTRUCTION AND INSTALLATION**

- A. Follow SMACNA HVAC Duct Construction Standards.
- B. Duct Pressure Class: All supply duct mains from air handling unit to terminal units shall be constructed to SMACNA 6 in wg duct pressure class. All return/exhaust duct mains shall be constructed to SMACNA 4 in wg duct pressure class. Unless otherwise noted on drawings, other ductwork shall be 2 in wg pressure class.
- C. Seal Class: As shown on the drawings and in accordance with SMACNA HVAC Air Duct Leakage Test Manual.
- D. Round and Flat Oval Ducts: Furnish duct and fittings made by the same manufacturer to insure good fit of slip joints. When submitted and approved in advance, round and flat oval 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 Resident Engineer.
  - E. 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.
  - F. Duct Hangers and Supports: Refer to SMACNA Standards Section IV. Avoid use of trapeze hangers for round duct.

### **2.3 DUCT ACCESS DOORS, PANELS AND SECTIONS**

- A. Provide access doors, sized and located for maintenance work, upstream and downstream, in the following locations:
  1. Each duct mounted coil and humidifier.
  2. Each fire damper (for link service), smoke damper and automatic control damper.
  3. Each duct mounted smoke detector.
  4. At 20 feet intervals of straight duct and at each change in duct direction.
  5. Each turning vane.
- 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 and flat oval duct: Refer to SMACNA HVAC duct Construction Standards (Figure 2-11).

#### **2.4 FLEXIBLE AIR DUCT CONNECTORS**

- 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. Flexible duct shall only be used on branch run-outs to supply diffusers. No flexible duct to be used on system serving Surgery Department.
- F. 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.

#### **2.5 FLEXIBLE CONNECTIONS**

Where duct connections are made to fans 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.

## **2.6 PREFABRICATED ROOF CURBS**

Galvanized steel or extruded aluminum 300 mm (12 inches) above finish roof service, continuous welded corner seams, treated wood nailer, 40 mm (1-1/2 inch) thick, 48 kg/cubic meter (3 pound/cubic feet) density rigid mineral fiberboard insulation with metal liner, built-in cant strip (except for gypsum or tectum decks). For surface insulated roof deck, provide raised cant strip (recessed mounting flange) to start at the upper surface of the insulation. Curbs shall be constructed for pitched roof or ridge mounting as required to keep top of curb level.

## **2.7 FIRESTOPPING MATERIAL**

Refer to Section 07 84 00, FIRESTOPPING.

## **2.8 THERMOMETER (AIR)**

Refer to Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC.

## **2.9 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. Seal openings around duct penetrations of floors and fire rated partitions with fire stop material as required by NFPA 90A.
- E. 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.
- F. Control Damper Installation:
1. Provide necessary blank-off plates required to install dampers that are smaller than duct size. Provide necessary transitions required to install dampers larger than duct size.
  2. Assemble multiple sections dampers with required interconnecting linkage and extend required number of shafts through duct for external mounting of damper motors.
  3. Provide necessary sheet metal baffle plates to eliminate stratification and provide air volumes specified. Locate baffles by experimentation, and affix and seal permanently in place, only after stratification problem has been eliminated.
  4. Install all damper control/adjustment devices on stand-offs to allow complete coverage of insulation.

- G. Air Flow Measuring Devices (AFMD): Install units with minimum straight run distances, upstream and downstream as recommended by the manufacturer.
- H. 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. Leak testing company shall be independent of the sheet metal company employed by General Contractor.
- B. Ductwork leak test shall be performed for the entire air distribution supply, return, exhaust system Section by Section including fans, coils and filter Section designated as static pressure class 750 Pa (3 inch W.G.) and above. All supply ductwork less than 500 Pa (3 inch W.G.) shall also be tested where there is no air terminal units employed in the system.
- 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 DUCTWORK EXPOSED TO WIND VELOCITY**

Provide additional support and bracing to all exposed ductwork installed on the roof or outside the building.

**3.4 TESTING, ADJUSTING AND BALANCING (TAB)**

Refer to Section 23 05 93, TESTING, ADJUSTING, AND BALANCING FOR HVAC.

**3.5 OPERATING AND PERFORMANCE TESTS**

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 52.1 for definitions of face velocity, net effective filtering area, media velocity, resistance pressure drop), atmospheric dust spot efficiency and dust-holding capacity. ASHRAE Standard 52.1 measures arrestance, dust spot efficiency and dust holding capacity of filters.
- C. Refer to ASHRAE Standard 52.2 for definitions of MERV (Minimum Efficiency Reporting Value), PSE (Particle Size Efficiency) and particle size ranges for each MERV number. ASHRAE Standard 52.2 measures particle size efficiency (PSE).

**1.2 RELATED WORK**

- A. 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.
- B. Filter housing and racks: Section 23 73 01, CUSTOM AIR-HANDLING UNIT COMPONENTS.

**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 Standards 52.1 and 52.2 for type filter under test and acceptable to Resident Engineer, indicating that filters comply with the requirements of this specification. 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. Within the first 6-12 weeks of service a filter may be pulled out of service and sent to an independent laboratory for ASHRAE Standard 52.2 testing for initial efficiency only. If this filter fails to meet the minimum level of efficiency shown in the previously submitted reports, the filter manufacturer/distributor shall take

- back all filters and refund the owner all monies paid for the filters, cost of installation, cost of freight and cost of testing.
- 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 586 for flame test.
- D. Nameplates: Each filter shall bear a label or name plate indicating manufacturer's name, filter size, rated efficiency, and UL classification.

#### 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. Identify locations.
  3. Quantities.
  4. HEPA filters.
- 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):
- 52.1-92R.....Gravimetric and Dust-Spot procedures for Testing  
Air Cleaning Devices Used in General Ventilation  
for Removing Particulate Matter
- 52.2-2007.....Method of Testing General Ventilation Air-  
Cleaning Devices for Removal Efficiency by  
Particle Size
- C. American Society of Mechanical Engineers (ASME):
- NQA-1-2008.....Quality Assurance Requirements for Nuclear  
Facilities Applications
- D. Underwriters Laboratories, Inc. (UL):
- 586;Amendment 20 March 2000 High-Efficiency, Particulate, Air Filter  
Units
- 900;Revision 15 July 2009 Test Performance of Air Filter Units

## PART 2 - PRODUCTS

### 2.1 REPLACEMENT FILTER ELEMENTS TO BE FURNISHED

- A. Provide one complete set of filters to be installed as replacements for dirty units or turned over to VA for future use as replacements at the owners discretion.

### 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 dust-load limit is reached as indicated by maximum (final) pressure drop.
- B. Filter Classification: UL approved Class 1 or Class 2 conforming to UL Standard 900.
- C. Filter Grades, Percent, Average ASHRAE Efficiency and Controlled Containment:

Table 2.2C

Filter Grades				
MERV Value ASHRAE 52.2	Application	Dust-Spot Efficiency ASHRAE 52.1	Particle Size	Thickness /Type
7	Pre-Filter	25 to 30%	3 to 10 Microns	50 mm (2-inch) Throwaway
8	Pre-Filter	30 to 35%	3 to 10 Microns	50 mm (2-inch) Throwaway
11	After-Filter	60 to 65%	1 to 3 Microns	150 mm (6-inch) Rigid Cartridge
13	After-Filter	80 to 90%	0.3 to 1 Micron	300 mm (12-inch) Rigid Cartridge
14	After-Filter	90 to 95%	0.3 to 1 Micron	300 mm (12-inch) Rigid Cartridge
17	Final-Filter	99.97%	0.3 Microns	HEPA - IEST A

#### D. Filter Media:

- MERV 11, 13, and 14 Supported (Rigid Pleated) Type: Media shall be composed of high density glass fibers or other suitable fibers. Fastening methods used to maintain pleat shape, (metal backing or aluminum separators) shall be sealed in a proper enclosing frame to

- insure no air leakage for life of filter. Staples and stays are prohibited.
2. MERV 7 and 8 (Pleated) Type: Media shall be composed of synthetic/natural fibers. Media shall maintain uniform pleat shape and stability for proper air flow and maximum dust loading. The media frame shall be constructed of aluminized steel. Bond the pleated media pack on all four edges to insure no air leakage for the life of the filter. Staples and stays are prohibited.
- E. Filter Efficiency and Arrestance: Efficiency and arrestance of filters shall be determined in accordance with ASHRAE Standard 52.1, and MERV value in accordance with ASHRAE Standard 52.2.
- F. Maximum initial resistance, recommended change over pressure drop, and maximum recommended final resistance, PA (inches of water), for each filter cartridge when operated at 150 m/min (500 feet per minute) face velocity shall be as specified in Table 2.2.F:

Table 2.2.F

Filter Initial and Final Resistance			
	Initial Resistance	Maximum Recommended Change Over Pressure Drop	Maximum Final Resistance
MERV 7 (2-inch deep)	78 (0.31)	156 (0.62)	250 (1.00)
MERV 8 (2-inch deep)	95 (0.38)	190 (0.76)	250 (1.00)
MERV 11 (12-inch deep)	60 (0.24)	120 (0.48)	375 (1.50)
MERV 13 (12-inch deep)	125 (0.50)	250 (1.00)	375 (1.50)
MERV 14 (12-inch deep)	170 (0.68)	340 (1.36)	375 (1.50)

G. Side Servicing Housings:

1. Minimum 1.6 mm (16 Gauge) galvanized steel, or aluminum, completely factory assembled with upstream and downstream flanges for connection into the duct system. Furnish housing length sufficient to provide for fully extended operating filter elements.
2. Access doors: Double wall insulated, located on one side of the housing; with continuous gasketing on the perimeter and positive locking devices. Design doors to withstand a minimum positive/negative 1.0 kPa (4 inch WG) static pressure. Furnish access doors that are the full size of the housing.
3. Filter slide channels: Channels shall incorporate a positive-sealing gasket material to seal the top and bottom of the filter cartridge

frames to prevent bypass. Provide factory installed gasketing to prevent leakage between cartridges, and between cartridges and doors.

### **2.3 HEPA FILTERS (MERV 17)**

- A. High Efficiency Particulate Air (HEPA) filters shall be individually tested and certified to be 99.97 percent minimum efficient meeting minimum MERV value of 17 when handling 0.3 micron or smaller particles in accordance with DOP test method. Filters shall be factory scanned. The DOP efficiency along with filter serial number and name of manufacturer shall be marked on the filter. HEPA filter shall have a maximum initial filter resistance of 250 Pa (1 inch W.G.) and a maximum recommended final resistance of 500 Pa (2 inch WG) with operate when operating at 125 m/s (250 ft/min) face velocity. The Maximum recommended change over pressure drop shall be no greater than twice the actual initial pressure drop.
- B. Filter media: Factory constructed by pleating a continuous sheet of media into closely spaced pleats with kraft or aluminum separators. Sealer shall be self-extinguishing.
- C. Enclosing frame shall be 16 gauge galvanized steel. Provide pre-filters in the same housing with a separate removal assembly that operates independently from the HEPA filters.
- D. Pre-filter: MERV 7 and 8, 2 inches deep. See Paragraph 2.2.

### **2.4 CARBON FILTERS**

- A. Factory fabricated activated Carbon filters for odor control with multiple cells of porous activated carbon media.
- B. Media impregnated with a high density of granular 60 percent minimum activity.
- C. Frame constructed of high strength, moisture resistant and constructed to prevent air leakage and spilling of media.
- D. Initial resistance of 2.50 m/s (500 FPM) air velocity not to exceed 180 Pa (0.76 inch WG) with rated average arrestance of 80 percent.
- E. Filter performance data shall conform to ASHRAE Standard 52.1 and pads classified as Class 2 as per testing performed according to UL Standard 900.
- F. Provide side service housing containing pre-filters, carbon filters and after-filters (outside) rated to 1495 Pa (6.0 inch WG).
- G. Nominal Dimensions: 305 mm or 610 mm (12 inches or 24 inches) high by 610 mm (24 inches) wide. 1 m (3'-4") (maximum) depth.

## **PART 3 - EXECUTION**

**3.1 INSTALLATION**

- A. Install filters 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. Install or deliver replacement filter units as directed by the Resident Engineer.

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**SECTION 23 50 11**  
**BOILER PLANT MECHANICAL EQUIPMENT**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

Fuel oil pumping systems and other equipment that supports the operation of the boilers.

**1.2 RELATED WORK**

- A. Section 09 91 00, PAINTING.
- B. Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION.
- C. Section 23 05 51, NOISE AND VIBRATION CONTROL FOR BOILER PLANT.
- D. Section 23 07 11, HVAC, PLUMBING, AND BOILER PLANT INSULATION.
- E. Section 23 21 11, BOILER PLANT PIPING SYSTEMS.
- F. Section 23 08 11, DEMONSTRATIONS AND TESTS FOR BOILER PLANT.

**1.3 SUBMITTALS**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Fuel Oil Pumping Equipment:
  - 1. Drawings with overall dimensions and arrangement of pumps, motors, couplings, bases, drip pans, duplex strainer, relief valves, back-pressure control valve, and all accessories.
  - 2. Catalog data and specification sheets on the design and construction of pumps, motors, couplings, bases, drip pans, duplex strainer, relief valves, back pressure control valves, all valves and accessories.
  - 3. Motor efficiency and power factor at full load.
  - 4. Pressure and temperature limitations of pumps, duplex strainer, relief valves, back pressure control valve and all valves.
  - 5. ASTM number and pressure rating of pipe and fittings.
  - 6. Performance data on pumps including discharge head, flow, suction lift and motor power required at viscosity range shown. Refer to drawings for requirements.
  - 7. Sound level test data on similar pump in similar installation. Refer to Section 23 05 51, NOISE AND VIBRATION CONTROL FOR BOILER PLANT.
  - 8. Performance data on relief valves and back-pressure control valves.
- C. Automatic Continuous Blowdown Control System:
  - 1. Drawings with arrangement and dimensions of entire unit. Include locations and sizes of all pipe connections.
  - 2. Catalog data and specification sheets on design and construction of conductivity sensor, control valves, controller.
  - 3. Performance data on control valves.

4. Pressure and temperature limitations of valves and conductivity sensor.

D. Test Data - Acceptance Tests, On-Site: Four copies all specified tests.

#### 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):

A53/A53M-05.....Pipe, Steel, Black and Hot-Dipped, Zinc-Coated,  
Welded and Seamless

A106/A106M-05.....Seamless Carbon Steel Pipe for High Temperature  
Service

A234/A234M-05a.....Piping Fittings of Wrought Carbon Steel and  
Alloy Steel for Moderate and High Temperature  
Service

A285/A285M-03.....Pressure Vessel Plates, Carbon Steel, Low and  
Intermediate-Tensile Strength

A414/A414M-05.....Steel, Sheet, Carbon, for Pressure Vessels

A515/A515M-03.....Pressure Vessel Plates, Carbon Steel, for  
Intermediate- and Higher-temperature Service

A516/A516M-05e1.....Pressure Vessel Plates, Carbon Steel, for  
Moderate-and Lower-Temperature Service

C. American Society of Mechanical Engineers (ASME):

Boiler and Pressure Vessel Code: 2004 Edition with Amendments.

Section VIII.....Pressure Vessels, Division I and II. Performance  
Test Code:

PTC 12.3-1997.....Deaerators

B16.9-2003.....Factory Made Wrought Steel Butt Welding Fittings

B16.34-2004.....Valves, Flanged, Threaded and Welding End

D. National Board of Boiler and Pressure Vessel Inspectors:

NB-23-2004.....Inspection Code

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

ASHRAE Handbook.....2004 HVAC Systems and Equipment

F. Society for Protective Coatings (SSPC):

SP 5-2000(R2004).....White Metal Blast Cleaning

G. Underwriters Laboratories (UL):

574-03.....Standard for Electric Oil Heaters

**PART 2 - PRODUCTS**

**2.1 FUEL OIL PUMPING PACKAGE EQUIPMENT (BURNER FUEL)**

A. Pump and Motors:

1. Type: Packaged, full factory assembled, duplex, rotary gear, horizontal shaft, flexible-coupled, motor-driven, base-mounted.
2. Service: Pumps, motors and accessories shall be designed for continuous fuel oil service as shown on the drawings.
3. Performance: Refer to schedules on the drawings. Vendor shall submit complete data to certify that pumps offered will perform in accordance with requirements for suction lift, discharge pressure, sound level limitations and flow rate at viscosity range shown.
4. Pump Construction:
  - a. Pump Casing: Cast iron or steel designed for 1025 kPa (150 psi) minimum. Casing shall have removable bolted sections to allow access to internal parts.
  - b. Power Rotor: Ductile iron.
  - c. Idler Rotors: Cast iron.
  - d. Shaft Seals and Bearing: Provide mechanical seals and ball bearings as recommended by pump manufacturer for the service.
  - e. Internal Relief Valves: Shall not be provided.
5. Electric Motor Drives: High efficiency, inverter ready, totally enclosed fan cooled, foot mounted, NEMA frame, UL. Select motor sizes so that motors are not overloaded under all operating conditions.  
Motors shall be designed for 40 °C ambient temperature. For efficiency and power factor requirements, refer to Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION.
6. Mounting: Common steel baseplate shall be made of heavy gauge steel plate with 1-1/2" high drip-lip and 1/2" NPT drain. Align pumps and motors at the factory.
7. Shaft Couplings: Shall be all metal, grid-type, flexible design that permits parallel, angular, and axial misalignment. Coupling shall be sufficiently flexible to reduce transmission of shock loads significantly. Coupling size selection shall be based on manufacturer's recommendation for service. Provide OSHA coupling guard bolted to base plate.
8. Sound and Vibration: Each combination of pump and driver shall conform to sound and vibration limits specified in Section 23 05 51, NOISE AND VIBRATION CONTROL FOR BOILER PLANT.

- B. Suction Line Equipment in 1-1/2" header size: Provide duplex, basket-type strainers designed to allow one basket to be removed for

cleaning while the other is in service. Strainer shall include diverter valve with handle that will select the strainer to be in use. Operation of the diverter valve shall not stop the flow of fluid. Basket covers shall be clamp-type. Strainer baskets shall be stainless steel. Provide 40 mesh basket liners for No. 2 fuel oil. Strainers on suction side of pumps shall be 345 kPa (50 psi), 93 °C (200 °F) minimum design. Provide two ball valves, 600 PSI pressure rated, full port, two piece bronze body, PTFE seat, UL listed. Provide two 30" Hg-0-30 PSI, compound gauges, 2.5" face, bronze internals, stainless steel case, liquid filled. Provide two gage valves - 1/4" ball valves, 600 PSI, full port, two piece bronze body, PTFE seat, UL listed. Schedule 40 carbon steel piping and nipples, 150 PSI malleable iron screwed fittings; Class 125/150 flanges.

- C. Discharge Line Equipment in 1-1/2" header size: Provide three spring check valves, 400 PSI pressure rated, bronze body, PTFE poppet. Provide two ball valves, 600 PSI pressure rated, full port, two piece bronze body, PTFE seat, UL listed. Provide two in-line relief valves, continuous bypass type, cast iron body, stainless steel spring. Provide two pressure gauges, 2.5" dial, bronze internals, stainless steel case, liquid filled, 0-200 range. Provide two gage valves - 1/4" ball valves, 600 PSI, full port, two piece bronze body, PTFE seat, UL listed. Schedule 40 carbon steel piping and nipples, 150 PSI malleable iron screwed fittings; Class 125/150 flanges.
- D. Coating: Unit shall be coated with vinyl toluene alkyd, quick dry enamel.
- E. Arrangement: Provide drip pan for each pump and for the duplex strainers. Construct each drip pan of 3 mm (1/8-inch) thick steel with 50 mm (2 inch) high vertical sides. Provide threaded 13 mm (1/2-inch) plugged openings for draining. Pumps and strainers shall be suitable for the space available for rigging and placement.
- F. Spare Parts: Complete mechanical seal for one oil pump. Complete set of casing gaskets for one oil pump. Back pressure control valve, complete.
- G. Controls: Provide manufacturer's fuel oil pump package control panel, shipped loose, contractor-field installed. NEMA 1 enclosure UL listed. Provide with individual disconnect switches, motor protectors, and transformer with through the door operation and control circuit fuse. Provide with magnetic motor starters, hand-off-auto selector switches, and run pilot lights for each pump. Provide with power on pilot light. Provide with terminal strip, control circuit fuse, P1-Auto-P2 alternating selector switch. Provide with lead pump failure pilot light

and manual reset, lag pump start. Provide devices to signal boiler operator computer workstation alarms and pumps in operation. Provide with high pressure cut-out, low pressure cut-out, high pressure alarm signal, and low pressure alarm signal.

## **2.2 AUTOMATIC CONTINUOUS BOILER BLOWDOWN CONTROL SYSTEM**

- A. Type: One factory-assembled system per boiler to automatically sense boiler water conductivity and operate automatic electric-powered blowdown valve to maintain desired total dissolved solids content in boiler water. Micrometer-type adjustable manual blowdown valve piped to bypass the automatic blowdown valve and conductivity sensor.
- B. Service: Design valves, sensors and piping for steam and water at 1035 kPa (150 psi), 186 °C (366 °F) minimum. Controller shall be suitable for 50 °C (120 °F) ambient and resist splashing water. Design automatic and manual blowdown valves for maximum blowdown flow rate equivalent to two percent of boiler steam output. System shall automatically maintain boiler water total dissolved solids at any set point between 1000 ppm and 4000 ppm.
- C. Operation: Programmable timer cycles to intermittently operate the blowdown valve to obtain conductivity samples, and to maintain the valve open for a time period until the conductivity of the boiler water reaches the set point. Provide an automatic temperature compensating circuit.
- D. Controller: Shall be microprocessor-based sealed unit mounted at the boiler.
  - 1. Indicators on Panel Front: One-half inch high digital display showing conductivity and indicating normal or out-of-range conditions. Valve status indicators.
  - 2. Membrane Keypad on Panel Front: Allows manual operation of the blowdown valve, setting of conductivity set points and alarm set points, setting of timers, calibration data input.
- E. Automatic Valve Construction: Carbon steel body, Type 316 stainless steel ball and stem, TFE coated stainless steel body seal. Electric actuator with NEMA-1 enclosure. Rated for 1025 kPa (150 psi) minimum saturated steam.
- F. Manual Valve Construction: Bronze or forged steel angle-type body, hardened stainless steel disc and seat, threaded ends, rising stem, union bonnet, graduated micrometer-type dial and pointer showing amount of valve opening. Rated for 1025 kPa (150 psi) minimum saturated steam. Furnish valve blowdown chart showing flow rate versus valve opening based on 125 psi boiler pressure.

- G. Provide gate valves and unions at inlet of conductivity sensor and outlet of automatic control valve so that these items can be removed from the system while maintaining the manual control valve in service. Comply with Section 23 21 11, BOILER PLANT PIPING SYSTEMS.

**PART - 3 EXECUTION**

**3.1 INSTALLATION**

- A. Fuel Oil Pumping Package Equipment and Accessories: Locate equipment to permit access to all valves and controls, and to permit removal and cleaning of system. Provide all additional wiring from control panel to boiler operator workstation.
- B. Automatic Continuous Boiler Blowdown Control System: Locate controller on floor-supported angle at four feet above the floor at the boiler adjacent to the continuous blowdown valves. Keypad and indicator must face aisle.

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**SECTION 23 51 00**  
**BREECHINGS, CHIMNEYS, AND STACKS**

**PART 1 - GENERAL:**

**1.1 DESCRIPTION:**

This section specifies flue gas exhaust system and all accessories from the boiler outlet to the stack outlet to the atmosphere. Flue gas recirculation (FGR) ductwork (if required by burners furnished) is also specified.

**1.2 RELATED WORK:**

- A. Roof Penetrations: Section 07 60 00, FLASHING AND SHEET METAL.
- B. Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION.
- C. Section 23 05 51, NOISE AND VIBRATION CONTROL FOR BOILER PLANT.
- D. Section 23 07 11, HVAC, PLUMBING, AND BOILER PLANT INSULATION.
- E. Economizers: Section 23 52 34, STEAM GENERATOR.
- F. Boiler Draft Control System: Section 23 09 11, INSTRUMENTATION AND CONTROL FOR BOILER PLANT.

**1.3 QUALITY ASSURANCE:**

- 1. Provide scale drawings showing nominal dimensions and weight of the systems.
- 2. Boiler and burner manufacturer shall review complete system from boiler flue gas outlet to stack outlet to atmosphere and advise the Government of any changes required to meet boiler and burner performance requirements. Note the altitude of plant site.
- 3. If a double wall, factory-fabricated, positive pressure breeching and stack system is provided, the manufacturer shall completely engineer the entire system and provide all components. Manufacturer's representative shall provide installation instructions prior to start of construction, train the installers and certify in writing to the Resident Engineer (RE)/Contracting Officers Technical Representative (COTR) that the entire installation complies with the official standards of the manufacturer and with the project specifications.
- 4. Flue gas recirculation ductwork shall be designed and provided by the burner manufacturer.

**1.4 SUBMITTALS:**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Design, materials, weights, construction, pressure and temperature limitations of breeching and stack systems, flue gas recirculation system.
- C. Drawings showing all components, system arrangement and dimensions.

- D. Design, construction, allowable movements, movement forces, pressure and temperature limitations of expansion joints.
- E. Damper design, construction, pressure and temperature limitations, pressure loss at design flow, and leakage of closed damper.
- F. Support designs, locations and loads for entire assembly.
- G. Written statement from boiler/burner manufacturer that the design of the system is satisfactory to achieve the required boiler/burner performance.

**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 Institute of Steel Construction (AISC):  
Manual for Steel Construction, Load and Resistance Factor Design, Third Edition.
- C. ASTM International (ASTM):  
A36/A36M-05.....Carbon Structural Steel  
A242/A242M-04e1.....High-Strength Low-Alloy Structural Steel  
A307-07a.....Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength  
A563-07.....Carbon and Alloy Steel Nuts  
A568/A568M-07.....Steel, Sheet, Carbon, and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, General Requirements For
- D. American Welding Society (AWS):  
D1.1/D1.1M-2008.....Structural Welding Code-Steel
- E. Manufacturer's Standardization Society of the Valves and Fittings Industry (MSS):  
SP-58-2002.....Pipe Hangers and Supports - Materials, Designs and Manufacturing

**PART 2 - PRODUCTS:**

**2.1 BREECHING, STACKS, FGR DUCTWORK:**

- A. Refer to drawings for arrangement and dimensions, except FGR ductwork shall be designed by the burner manufacturer. Connections to boilers and economizers must comply with the written recommendations of the boiler and economizer manufacturers. Ninety-degree tee sections are not permitted. Intersections must be made with lateral tees.

- B. Service: Design for continuous 315 °C (600 °F), 12 kPa (50 inches WC) positive and negative internal pressure, wind-loading for outside stacks.
- C. Pre-engineered, Pre-Fabricated, Double-Wall System:
1. Complete factory-built system, all components and installation engineered and provided by manufacturer of system.
  2. Corrosion-resistant steel, double-wall, circular cross section, positive pressure, blanket insulation between walls.
  3. Factory-built standard sections, connected in the field with joining system designed and provided by system manufacturer. Designed to be pressure and vacuum-tight, no deformation, at the service conditions specified.
  4. System manufacturer's engineered support system, attached to structural members of the building, with expansion joints between rigid supports. Thermal expansion shall be handled by expansion joints and variable spring hangers. Thermal expansion and weight of system shall not impose loads in excess of that allowed by manufacturer of boiler, economizer, or any other equipment, or exceed capabilities of building structure. Spring hangers shall conform to MSS SP-58, Type 51, variable spring.
  5. Inner Wall: Stainless steel, Type 304, 0.9 mm (0.035-inch) minimum thickness for diameters 900 mm (36 inches) and smaller and 1.2 mm (0.048 inches) minimum thickness for diameters greater than 900 mm (36 inches) and 1200 mm (48 inches) and less.
  6. Outer Wall: Aluminized or galvanized steel except 304 stainless steel outside of building, 0.6 mm (0.025 inch) minimum thickness for inner wall diameter 800 mm (32 inches) and less, 0.9 mm (0.034 inch) minimum thickness for inner wall diameter over 800 mm (32 inches) and 1200 mm (48 inches) and less.
  7. Insulation Between Walls: Fiberglass or mineral wool, 315 °C (600 °F). Minimum thickness 50 mm (2 inches).
  8. Bands for Joining Sections: Same material as section being joined. Utilize sealant provided by system manufacturer.
  9. Roof penetrations shall be manufacturer's standard ventilated thimble. Conform to Section 07 60 00, FLASHING AND SHEET METAL.
  10. Stack Outlet: Provide as shown, double cone rain cap or other type termination designed by manufacturer of the stack system.
  11. Drain Section: Provide inside building below roof to drain rain water from stack. Extend drain pipe to floor drain.

12. Guys: Provide stack guy wires above roof, with spring-loaded tensioners, in accordance with printed instructions of stack manufacturer.

## 2.2 EXPANSION JOINTS

- A. Provide sufficient types, quantities, and locations of expansion joints to completely absorb all thermal expansion of the system without imposing excessive loads on equipment or building structure. Fabric joints shall be used on single-wall stack and breeching system. On factory-fabricated double wall stack or breeching system, use slip-type, bellows-type, or fabric expansion joints engineered by designer of the stack and breeching system.
- B. Service: Design for 300 °C (575 °F), 5 kPa (20 inches) WC positive and negative internal pressure, continuous duty.
- C. Construction, Fabric Joints:
  1. Fabric: High strength, designed for dewpoint service.
  2. Internal Baffles: Carbon steel with stiffeners. Designed to protect interior surfaces of fabric from wiping action of the flue gases.
  3. Welded frame, 6 mm (1/4 inch) thick ASTM A568 steel with 100mm (4 inch) minimum flange height, flat-belt design, fabricated by expansion joint manufacturer. Fabric element bolting, 9 mm (3/8 inch) diameter, 150 mm (6 inch) maximum centers.
- D. Construction, Factory-Fabricated Double-Wall System Joints:
  1. Materials: Same as factory-fabricated breeching system.
  2. Packing Gland: High temperature rating. Provide seal between sliding and fixed portions of joint.

## 2.3 ACCESSORIES

- A. Drains: Provide threaded pipe connection to allow drainage at all low points and drain connections in stack and breeching systems. Slope piping system to the drain. Pipe size shall be 25 mm (1 inch) minimum.
- B. Instrument Ports: Locate on individual stack or breeching serving boiler. Locate in non-turbulent zone within 3600 mm (12 feet) of boiler room floor between boiler and economizer (when economizer is provided) or locate accessible from platform. Provide separate ports for the following:
  1. Flue gas oxygen analyzer: Coordinate with analyzer furnished.
  2. Opacity monitor (if required): Coordinate with sensor furnished. Locate downstream from oxygen analyzer.
  3. Stack temperature sensor: Coordinate with sensor furnished.
  4. Draft gauge: 25 mm (1 inch) diameter coupling, plugged.
  5. Test instruments: 25 mm (1 inch) diameter coupling, plugged.

- C. Access Doors: Bolted, gasketed, insulated, with handles. Provide where shown. Minimum opening 400 mm x 400 mm (16 inches x 16 inches).

**PART 3 - EXECUTION**

**3.1 INSTALLATION - PRE-ENGINEERED, PRE-FABRICATED DOUBLE WALL SYSTEM**

- A. Supports: Completely support all systems from the building structure without overloading the building structure or the connected equipment. Support system shall be engineered by the system manufacturer and shall accommodate thermal expansion.
- B. Factory-Fabricated Stack or Breeching System:
1. Install in accordance with manufacturer's printed instructions.
  2. Deliver a copy of the instructions to the RE/COTR prior to commencing the installation.
  3. Representative of manufacturer shall provide field training on all installation techniques to all installers.
- C. Connect 25 mm (1 inch) minimum pipes with ball valves to breeching and stack drains. Extend to floor drain.
- D. Boiler or Economizer Outlet Dampers: Locate so that there is no restriction in the flow of flue gas recirculation (if provided).

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**SECTION 23 52 34**  
**STEAM GENERATOR**

**PART 1 - GENERAL**

**1.1 DESCRIPTION:**

This section specifies packaged water tube steam generating boiler with trim (accessories), dual fuel (natural gas and fuel oil) burner, fuel trains, and flue gas economizer.

**1.2 RELATED WORK:**

- A. Section 09 91 00, PAINTING.
- B. Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION.
- C. Section 23 05 51, NOISE AND VIBRATION CONTROL FOR BOILER PLANT.
- D. Valves for boiler trim, non-return stop-check valve, piping for fuel and feedwater trains: Section 23 21 11, BOILER PLANT PIPING SYSTEMS.
- E. Boiler outlet damper systems, breechings, stacks, flue gas recirculation (FGR) ductwork: Section 23 51 00, BREECHINGS, CHIMNEYS, AND STACKS.
- F. Burner controls, combustion control system, boiler water level control, pressure gages, thermometers: Section 23 09 11, INSTRUMENTATION AND CONTROL FOR BOILER PLANT.
- G. Section 23 08 11, DEMONSTRATIONS AND TESTS FOR BOILER PLANT.

**1.3 QUALITY ASSURANCE:**

- A. Coordinate all new and existing equipment and conditions. This includes, but is not limited to: boiler, boiler trim, burner, fuel trains, gas pressure regulators and available gas pressure, fuel oil header back pressure regulator on house oil pump set and available fuel oil pressure, burner control system, combustion control system, economizer (if provided), breeching and stacks.
- B. Provide written certification that the entire assembly has been coordinated to achieve the required performance and to provide the required features.
- C. The model and size of the proposed burner shall have been previously applied to at least three boilers that are similar in size, proportion, and arrangement to the proposed boiler. In each of the three installations, burner performance shall have conformed to requirements listed in Part 2. Provide list of these installations, and name, address and telephone number of person familiar with each project who will serve as a reference source.
- D. Regardless of fuel input rating, the equipment, installation and operation shall conform to NFPA 85. Where conflicts exist between NFPA 85 and this specification, this specification will govern.

**1.4 SUBMITTALS:**

- A. Before executing any work, submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Boiler:
  - 1. Complete catalog information and outline drawing of boiler and accessories with dimensions.
  - 2. Arrangement and description of construction of pressure parts, casings, drum internals, drum handhole covers and yokes, and support frame.
  - 3. Piping connection sizes, locations, construction.
  - 4. Technical data including temperature ratings and arrangement of refractory and insulation.
  - 5. Amount of heating surface, combustion volume.
  - 6. Weight of boiler and burner assembly, empty and flooded.
  - 7. Design pressures and temperatures.
  - 8. Loading diagram of support frame. Evidence that boiler support requirements have been coordinated with foundation design.
  - 9. Recommended anchorage of boiler support frame to foundation.
  - 10. Furnace viewport construction, locations.
  - 11. Dimensioned location of normal water line, lowest and highest permissible water level, set points of water level alarms and cutoffs.
  - 12. Predicted surface temperature at front, rear and sides of boiler.
- C. Boiler Trim: Includes bottom blowoff valves, water column with conductivity probe assembly, water level gage with illuminator, auxiliary low water cutoff, piping, all valves and fittings furnished by boiler manufacturer, feedwater control valve, safety valves, steam pressure gage, steam pressure switches.
  - 1. Design, construction, arrangement on the boiler.
  - 2. Pressure and temperature limitations.
  - 3. ASTM numbers and schedule numbers of piping.
  - 4. Type and pressure ratings of pipe fittings.
  - 5. Flow and pressure drop data on feedwater control valve.
  - 6. Scale ranges of gages, thermometers, and pressure switches.
  - 7. Location of water level sensing and indicating devices in relation to normal water line of boiler and highest and lowest permissible water lines of boiler.
  - 8. Set pressure and capacity of safety valves.
- D. Burner and Fuel Trains:

1. Catalog data and drawings showing construction of burner parts and assembly of complete system.
2. Drawings, with dimensions, showing burner over all size and mounting on the boiler.
3. Catalog data and outline drawings of forced draft fan, flue gas recirculation ductwork (if provided), dampers, motors and sound attenuators on fan intake or discharge.
4. Drawings showing assembly of throat refractory into furnace refractory wall.
5. Type and temperature rating of throat refractory.
6. Drawings and catalog data on all equipment in igniter (pilot) train, main fuel trains, atomizing media train. Include data on pressure and temperature ratings, flow vs. pressure drop, performance characteristics, and inspection agency approvals.
7. ASTM number and schedule numbers on all piping.
8. Type and pressure ratings of pipe fittings.
9. Burner flow and pressure data:
  - a. Main burner fuel and atomizing media pressures and flows at maximum required firing rate.
  - b. Igniter (pilot) fuel flow and burner pressure.
  - c. Natural gas main fuel pressure at outlet of burner-mounted pressure regulator.
  - d. Igniter fuel pressures (natural gas and LP gas) at outlet of burner-mounted pressure regulators.
  - e. Forced draft fan static pressure, power and air flow at maximum firing rate. Amount of flue gas recirculation.
10. Full load efficiency and power factor of all motors.
11. Predicted sound level at maximum firing rate.
12. Weight of burner assembly.
13. Drawings showing location and arrangement of drive units and jackshaft system (if provided) for controlling fuel and air flow.
14. Weight of burner assembly.
- E. Burner Management (Flame Safeguard) Control System: Refer to Section 23 09 11, INSTRUMENTATION AND CONTROL FOR BOILER PLANT.
- F. Flue Gas Economizer:
  1. Drawings showing arrangement and dimensions of unit and all accessories.
  2. Design and construction of unit and accessories including soot blowers, safety relief valve.
  3. Weight of entire unit, empty and flooded.

4. Pressure and temperature limitations of unit and accessories.
  5. Performance data on safety relief valve.
  6. Drawing showing tube arrangement, clearance for tube removal and soot blower nozzle locations. Written recommendations of soot blower manufacturer on number of elements and locations of nozzles for this economizer design and size.
- G. Boiler and Burner Predicted Performance Data, for Each Fuel, Site Altitude:
1. At Maximum Required Output With and Without Economizer In Service, at 15 Percent Excess Air: Fuel and steam flow, boiler flue gas outlet temperature, economizer flue gas outlet temperature, steam quality, boiler efficiency, windbox and furnace pressures, predicted boiler radiation and unaccounted losses, feedwater and flue gas pressure losses in the economizer.
  2. At Low Fire, 25%, 50% and 75% of Maximum Firing Rate: Percent excess air, carbon monoxide (CO) ppm and NOx ppm.
- H. ASME "P" Forms, Manufacturer's Data Report, on boiler and economizer construction.
- I. Pretest Data - Boiler, Burner, Controls: As required by Part 3.
- J. Final Test Report - Boiler, Burner, Controls: As required by Part 3.

**1.5 PROJECT CONDITIONS:**

- A. Fuels to be Fired, Main Burner: Natural gas and No. 2 fuel oil.
- B. Igniter (Pilot) Fuels: Natural Gas and LP gas (propane).
- C. Natural Gas: Pressure provided to the inlet of the boiler-mounted regulators will be 12 psi as maintained by the main gas regulator station.
- D. Fuel Oil: Will be furnished under Government contract. Refer to Section 23 50 11, BOILER PLANT MECHANICAL EQUIPMENT. Oil grade (No. 2) refers to ASTM D396.
- E. Oil Atomizing Media:
  1. Steam Atomizing Burners: Compressed air (0.8 standard cubic meters per minute at 550 kPa) (30 SCFM at 80 psi) is available (from plant compressor).
- F. LP Gas (Propane): Furnished to the Government for igniter (pilot) fuel by a local supplier. Regulators at tank areas will be set at 35 kPa (5 psi). Serves as igniter fuel when there is an interruption to the natural gas supply.

## 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. American Society for Testing and Materials (ASTM):
- A106/A106M-06a.....Seamless Carbon Steel Pipe for High Temperature Service
  - A178/A178M-02.....Electric Resistance Welded Carbon Steel Boiler Tubes
  - A269-07.....Seamless and Welded Austenitic Stainless Steel Tubing
  - C612-04.....Mineral Fiber Block and Board Thermal Insulation
  - D396-07.....Fuel Oils
- C. American Society of Mechanical Engineers (ASME):
- Boiler and Pressure Vessel Code: 2007 Edition with Amendments.
  - Section I.....Power Boilers
  - Section II.....Material Specifications
  - Section VII.....Recommended Rules for Care of Power Boilers
  - Section IX.....Welding and Brazing Qualifications
  - Performance Test Code:
  - PTC 4-1998.....Fired Steam Generators
  - Code for Pressure Piping:
  - B31.1-2004.....Power Piping with addenda
- D. National Fire Protection Association (NFPA):
- 70-2008.....National Electric Code
  - 85-2007.....Boiler and Combustion Systems Hazards Code
- E. National Board of Boiler and Pressure Vessel Inspectors (NB):
- NB-23 (2004).....National Board Inspection Code
- F. Fluid Controls Institute (FCI):
- 70-2-2003.....Control Valve Seat Leakage
- G. Department of Health and Human Services, Food and Drug Administration (FDA):
- CFR 21, 173.310,.....Boiler Water Additives Permitted in Plants Where Steam Contacts Food
- H. Environmental Protection Agency (EPA):
- CFR 40, PART 60, Appendix A, Method 9, Visual Determination of the Opacity of Emissions from Stationary Sources

## **PART 2 - PRODUCTS**

### **2.1 BOILER**

- A. The hot water generator with remote separator shall be ASME approved and shall be registered with National Board.
- B. The hot water generator with remote separator shall be of recirculating, forced circulation, multiple coil, watertube, skid mounted type. Each unit shall be capable of achieving full rated output within five (5) minutes from a cold start without the possibility of thermal shock. Low fire hold controls are not an acceptable alternate.
- C. The hot water generator with remote separator shall be designed such that water that does not flash to steam in the steam separator shall be recirculated through the hot water generator without returning to the deaerator or feedwater source. A semi-closed receiver shall be supplied with once-through type boilers.
- D. Licensed operators in the State of Ohio shall not be required to operate or maintain the equipment.
- E. The hot water generator with remote separator shall be constructed in accordance with the following applicable codes:
  - 1. National Bureau of Standards Handbook #H-28 Screw-Thread Standard for Federal Services
  - 2. National Electrical Manufacturers' Association NEMA Standards
  - 3. American Society of Mechanical Engineers ASME Power Boiler Code - Section 1
  - 4. Industrial Risk Insurers (IRI) insurance requirements
  - 5. UL listed electrical components
- F. The hot water generator with remote separator shall incorporate a fully modulating, forced draft burner with 8:1 turndown ratio. There shall be no difference in steam quality across the entire operating range of the hot water generator with remote separator.
- G. The hot water generator shall be installed within an air casing pressurized by the combustion air blower. Feedwater, fuel, and air will be metered to the hot water generator with remote separator as a function of steam pressure in the remote steam separator.
- H. The hot water generator with remote separator will be equipped with an electronic excess steam pressure control, burner, and automatic ignition. The convection heat transfer section will be removable from the back of the unit. The hot water generator with remote separator, auxiliaries, and controls will be mounted on a common base, all components on the base will be piped and wired. Components furnished include the circulating pump, forced draft blower, steam drum, pressure

control instruments, temperature control instruments, pressure gauges, motor starters and push-buttons, control transformer, pneumatic feedwater controls, steam safety valves, thermocouple, and other components required for a complete package.

I. Components:

1. Hot water generator with remote separator:

- a. The hot water generator with remote separator will consist of a combustion chamber, the coils, convection type heat transfer section, and steam drum.
- b. The combustion chamber shall consist of pre-cured refractory bricks to minimize repair time and costs.
- c. Tube materials in the heat transfer sections will be in accordance with ASME specifications. The convection heat transfer section shall consist of four (4) identical parallel-connected individual coils. The individual coils shall be 1000 psig design pressure and 750° F design temperature. The individual coils will be hydrotested at 1500 psig. The coils shall be 2.875" OD with 0.178 minimum wall thickness. The boiler shell shall be insulated with 2" thick insulation. This insulation is in addition to combustion air preheating space.
- d. The multiple coils shall be removable from the back end of the generator and removal clearance shall not affect overall height of the steam generator.

2. Pressure control:

- a. The pressure control will automatically adjust fuel and air to suit steam demand. The accuracy of this control shall be plus or minus three percent (3%) of the pressure adjustment range.
- b. The steam pressure control shall have programmable set points for modulating steam pressure. A high limit manual reset for burner cutoff on excess steam pressure shall be provided.

3. Safety:

- a. All features of the design will be such as to ensure safe and reliable operation. Installed controls will shut off the fire if temperature, pressure, or both exceed preset limits. The hot water generator with remote separator will fail-safe in the event of power failure. Fuel and combustion air systems will be electrically interlocked to shut fuel to the burner in case of combustion air failure.
- b. The hot water generator with remote separator will have an electronic steam pressure control, which requires a manual reset

located on the boiler control panel. This steam pressure control will extinguish the fire in the hot water generator with remote separator in the event that steam pressure reaches a preset point.

- c. Each individual coil in the convection heat transfer section shall have overheat protection. This shall consist of a thermocouple, which, due to its placement, directly monitors the maximum possible outlet temperature of each coil. Weld pad thermocouples are not acceptable. Each thermocouple must have continuous digital readout and limit controls mounted on the control panel. This coil temperature control will extinguish the fire in the hot water generator with remote separator in the event that coil temperature reaches a preset point.
- d. The hot water generator with remote separator will have an electronic stack temperature control, which requires a manual reset located on the boiler control panel. The stack thermocouple must have continuous digital readout and limit controls mounted on the control panel. This stack temperature control will extinguish the fire in the hot water generator with remote separator in the event that stack temperature reaches a preset point.

4. Piping:

- a. All pressure piping will be designed and constructed in accordance with applicable provisions of the ASME Boiler and Pressure Vessel Code for Power Boilers.

5. Recirculating pump:

- a. A centrifugal type pump will be supplied and driven by an electric motor. The pump will have a top horizontal discharge for efficient elimination of possible vapors in the fluid, enclosed impeller for high efficiency, oil lubricated standard ball bearings for long life and low maintenance, graphite ribbon packing or tungsten carbide mechanical seals depending on operating pressures, cooling water jacket on medium and high pressure units, alloy steel shaft, and stainless steel sleeve and impeller bolt.
- b. The recirculating pump shall be belt driven. This allows for thermal expansion and contraction witnessed during normal operation of the boiler.
- c. The pump shall have a pumping capacity of at least two (2) times the maximum steaming rate.

6. Combustion air blower:

- a. The hot water generator with remote separator is equipped with a motor driven centrifugal combustion air blower. The blower will be of the non-overloading, backward curve type.
  - b. The combustion air blower shall be mounted on the top side of the boiler so as to eliminate tripping hazard for maintenance personnel.
  - c. Combustion air shall enter the unit at the midpoint of the boiler body to allow for combustion air preheating in order to maximize efficiency.
  - d. Manufacturer to provide blower silencer.
7. Burners:
- a. The hot water generator with remote separator will be equipped with a forced draft burner for combination firing. The burner shall be located at the end of a horizontal combustion chamber. Top mounted and bottom mounted burners are not acceptable.
    1. The natural gas burner will be a multi-nozzle, gas pilot ignited burner, fully modulating.
    2. The number 2 fuel oil burner will be a wide range burner of the air atomizing type, gas pilot, fully modulating.
    3. The combination burner will incorporate features of both the oil and gas burners to allow it to burn either oil or gas.
  - b. Burner control system shall include automatic burner sequencing, flame supervision, status indication, first-out annunciation, and self-diagnosis.
  - c. The combustion control system shall provide for a minimum of two totally separate fuel/air ratio curves, one per fuel.
  - d. The fully modulating combustion control system shall be microprocessor based and mechanical linkages must not be used. Individual parallel positioning motors shall be supplied for the combustion air blower damper control, natural gas control valve, and number 2 fuel oil control valve.
  - e. An ultraviolet sensitive flame detector shall be used to monitor the flame in the combustion chamber of the hot water generator with remote separator.
  - f. A rear door sight glass shall be available to allow for flame inspection from the rear of the unit.
  - g. A sight glass shall also be supplied to view the flame from the front of the unit.
8. Steam drum:

- a. The steam drum will be constructed in accordance with the latest AMSE requirements. The drum will be designed in such a manner as to separate water from steam so that the steam quality will be ninety-nine and one half percent (99.5%) or greater. The drum will be insulated and covered with metal sheathing.
  - b. The steam drum shall serve as the feedwater entry point to the boiler. The steam drum will serve as a mixing chamber for boiler feedwater and water that has not yet flashed to steam.
  - c. The steam supply outlet connection shall be a 6" flanged connection.
  - d. An inspection opening in the head at the rear of the steam drum shall be provided as a 2½" steel plug.
  - e. Two (2) handhole inspection openings will be provided in the side of the steam drum.
9. Steam drum blowdown:
- a. The steam drum shall be equipped with automatic drum bottom blowdown. The method of control shall be a pneumatic ball valve operated by an adjustable automatic timer. A manual override button shall be located on the control panel.
  - b. The steam drum shall be equipped with continuous drum surface blowdown. The method of control shall be a conductivity controller with automatic valve and manual adjustable metering valve.
10. Pneumatic feedwater control valve:
- a. The modulating feedwater control valve shall be a pneumatic control valve with associated steam drum water level control. The customer connection shall be 1¼". The valve shall be manufactured by Spence.
  - b. A three valve manual bypass is required.
  - c. An automatic secondary feedwater valve shall be provided ahead of the modulating feedwater valve. This valve is to be wired such that when there is a high level condition in the steam drum, the valve closes.
  - d. After the modulating feedwater control valve an economizer three valve bypass shall be provided.
11. Water level control:
- a. The modulating feedwater control shall sense water level in the steam drum and provide a pneumatic signal to a positioner then the modulating feedwater control valve.

- b. The modulating feedwater control shall be a pneumatic feedwater level controller.
  - c. The modulating feedwater controller shall have a field adjustable proportional band, zeroing, and level adjustment.
12. Water level indication:
- a. Gauge glass shall be a flat glass type.
  - b. Means of level indication shall be independent of any make-up level control device.
13. Low water level protection:
- a. Low water protection shall consist of a probe type low water level cutoff switch, wired into the burner control circuit preventing burner operation if steam drum water level falls below the designated safe level and will allow for automatic restart when the water level returns to normal.
  - b. Low-low water level burner cutoff switch shall be a probe type low-low water level cutoff switch wired into the burner control circuit preventing burner operation if boiler water falls below designated safe level and will require manual resetting of burner flame safeguard control before allowing restart and further automatic operation.
14. Control panel:
- a. All electrical components shall comply with UL requirements.
  - b. Mounted in/on a NEMA 12 control panel shall be motor starters, flame safeguard controller, control switches, control voltage transformer, control circuit fuse, terminal strips for all entering and/or leaving wiring, operating and alarm lights, single point auxiliary contact for remote alarm indication of combustion safety failure, single point 120 volt auxiliary contact for proof of boiler operation.
  - c. The control panel will have the following annunciators at a minimum:
    - 1. Control power on indicator.
    - 2. Burner on light.
    - 3. Flame out light and audible alarm.
    - 4. High coil temperature light and audible alarm.
    - 5. Low combustion air and audible alarm.
    - 6. Low atomizing air and audible alarm.
    - 7. High water light.
15. Combustion safeguard & burner control system:

- a. The fully modulating combustion control system shall be microprocessor based and mechanical linkages must not be used. Individual parallel positioning motors shall be supplied for the combustion air blower damper control, gas control valve, and oil control valve.
- b. The combustion control system shall provide independent fuel/air ratio curves for each fuel and shall be programmable from the panel mounted AZL display module or via laptop/PC.
- d. The system shall have a fuel/air ratio controller. The manufacturer shall provide any software and/or passwords required for programming.
- e. An operator touchscreen interface with PLC shall be provided. The touchscreen shall include display of all boiler data and alarm conditions listed below.
- f. All data from the control system and operator touch screen shall be available for monitoring and control from a remote location via ModBus communications.
- g. The fuel trains are to consist of the following controls and devices at a minimum:
  - 1. Pilot gas train:
    - a. Pilot gas pressure regulator (natural gas)
    - b. Pilot gas pressure regulator (propane)
    - c. Pilot gas solenoid valve(s) as required by code
    - d. Test connection
    - e. Three way valve for natural gas or propane
  - 2. Main gas train:
    - a. Main gas pressure regulator
    - b. Double block and bleed valves, fully automatic with proof of closure
    - c. Gas vent valve solenoid
    - d. High and low gas pressure switches
    - e. Fuel metering valve
    - f. Main gas shutoff cock - lubricated plug valve
    - g. Test connection
  - 3. Fuel oil train
    - a. Fuel oil filter
    - b. Low fuel oil pressure switch
    - c. Dual safety burner solenoid valves with proof of closure switch
    - d. Fuel metering valve

J. Finish: Provide surface preparation, heat resistant prime and finish coats using standard color of boiler manufacturer as specified in Section 09 91 00, PAINTING.

**2.2 BOILER TRIM (ACCESSORIES) :**

- A. Conform to ASME Boiler and Pressure Vessel Code, Section I. Refer to Section 23 09 11, INSTRUMENTATION AND CONTROL FOR BOILER PLANT, for operation of water level and steam pressure controls.
- B. Steam Safety Valves:
  - 1. Provide two or three on boiler. Capacities certified by National Board of Boiler and Pressure Vessel Inspectors (NB).
  - 2. Type: Angle pattern, flanged or threaded inlet, flanged or threaded side outlet, lifting lever, bronze or cast iron bodies, stainless steel trim, dual control rings. Valves with bronze bodies shall have EPDM O-ring seat seals. Valves with cast iron bodies shall have lapped seats.
  - 3. Settings and Adjustments: Factory set, sealed, and stamped on nameplate. Set pressures as shown. Lowest set pressure shall not exceed normal operating pressure by more than 210 kPa (30 psi). Provide 30 kPa (5 psi) difference in setting between each of the valves.
- C. Steam Pressure Gage:
  - 1. Construction:
    - a. Case: Surface-mounting, bottom or back connection, threaded ring, blowout disc in rear.
    - b. Dial: 200 mm (8 inch) minimum diameter, non-corrosive, black markings on white background.
    - c. Measuring Element: Bourdon tube designed for steam service.
    - d. Movement: Stainless steel, rotary.
    - e. Pointer: Micrometer adjustable, black color.
    - f. Window: Laminated safety glass, or plastic.
  - 2. Accuracy: Full span, 1/2 percent.
  - 3. Range: 0-300 psi.
  - 4. Installation: Stop valve, steel piping, valved blowdown, siphon, union at gage, valved connection for inspector's gage. Mount gage on sheet metal panel affixed to front of boiler. Use spacers between panel and gage to permit operation of blow-out disc.

**2.3 BURNER MANAGEMENT CONTROL (FLAME SAFEGUARD) SYSTEM AND ACCESSORIES:**

- A. Refer to Section 23 09 11, INSTRUMENTATION AND CONTROL FOR BOILER PLANT.
- B. Control Panel: Controls shall be mounted in free standing NEMA 4 enclosure. There shall be no power wiring in this enclosure.

- C. Factory Testing: Install controls on boiler and burner at factory and test operation of all devices.

**2.4 FLUE GAS ECONOMIZER:**

- A. Heat exchangers to transfer heat from boiler flue gases to boiler feedwater.
- B. Type: Rectangular configuration, light weight, replaceable finned tubes, up flow flue gas, parallel flow water, insulated casing with removable panels allowing access to all tubes for cleaning and replacement. Arrange tube to permit lane-type soot blowing.
- C. Performance: Refer to schedules shown on the drawings. Coordinate input flue gas temperatures with data from boiler manufacturer.
- D. Construction:
1. Comply with ASME Boiler and Pressure Vessel Code, Section I. Design unit to permit operation with no water in the tubes at the temperature listed below.
  2. Design Pressure:
    - a. Water tubes, 2050 kPa (300 psi) minimum.
    - b. Inner casing, 2.5 kPa (10 inches water column) minimum.
  3. Design temperature 370 °C (700 °F) minimum.
  4. Tubes: ASTM A269 Type 316 stainless steel tubing. Helical-wound non-serrated Type 316 fins continuously welded to tubes. Headers of Type 316 seamless carbon steel tubing, Schedule 40 minimum. 2050 kPa (300 psi) flanged piping connections. Gravity drainage. Return bend areas shall be exposed to the bulk temperature of the flue gas. Headers shall be external to the casing. Fin density shall not exceed 157 fins per meter (48 fins per foot). Maximum fin height 13 mm (0.5 inches). Tube to header joint shall be compression tube fittings requiring no welding for fast and easy tube removal.
  5. Casing: Inner and outer casing with insulation between. 80 mm (3 inch) angle flanges on flue gas inlet and outlet for attachment of breeching and stack. Hinged doors for access openings.
    - a. Inner Casing, 3.5 mm (10 gage) thick Type 316 stainless steel, all welded. Stainless steel angles for breeching attachment to casing. Entire casing system must be gas tight.
    - b. Insulation: Mineral fiber, ASTM C612, 50 mm (2 inches) thick.
    - c. Outer Casing: Galvanized or painted steel, 0.4 mm (27 gage) thick.
    - d. Access and Inspection Openings: Insulated, 400 mm (16 inches) square minimum.
  6. Design to permit field replacement of tubes without removing unit from stack. Provide bolted access doors for tube replacement.

**E. Accessories:**

1. Safety Relief Valve: Valve designed for steam and water service, ASME - National Board certified, selected by economizer manufacturer in accordance with ASME Code requirements. Set pressure 1900 kPa (275 psi) gage.
2. Soot Blowers: Steam-operated, rotating valve-in-head. Provide sufficient number of blowers to clean all tube areas. Location, arrangement and quantity based on recommendations of soot blower manufacturer for type and size of economizer furnished. Soot blowing shall be lance-type.
3. Inlet and Outlet Transitions: Designed and furnished by economizer manufacturer.

F. Factory Test and Inspections: Inspect the completed economizer assembly in accordance with the ASME Boiler and Pressure Vessel Code, Section I. Certify the inspection and submit four copies of the completed ASME Form P-3 for each economizer.

**2.5 TOOLS:**

- A. Oil Burner Vise and Wrenches: Deliver to the Contracting Officers Technical Representative COTR for mounting by VA personnel. Furnish only if burner requires wrench not found in commercial hardware store.
- B. Device for Hanging Oil Burner Guns: Space for total number of guns furnished. Deliver to the COTR for mounting by VA personnel. Furnish only if oil gun must be removed from burner when firing gas.

**2.6 SPARE PARTS**

**A. Fuel Trains:**

1. One assembly of electrodes, transformer, and high voltage cable with end connectors for the igniter.
2. One of each type and size of main and pilot fuel motorized and solenoid automatic safety shut-off valves and automatic vent valves.
3. One atomizing steam admission solenoid valve.
4. Complete set of filter elements and gaskets for each gas filter for each boiler.
5. Complete set of all gaskets for each edge-type oil filter for each boiler.
6. One gas solenoid valve for each type and size for igniters.

**B. Boiler, Burner, Trim, Feedwater Control Valve:**

1. Drum handhole gaskets, three complete sets for each boiler.
2. One clear lens and one tinted lens for each furnace and burner observation port on each boiler.

3. Sufficient glass inserts and gaskets to re-equip all water level gage glasses on one boiler.
4. One set of drive belts for each belt-driven apparatus on each boiler.
5. One set of all gaskets for each type of oil gun.
6. One oil gun and nozzle of each type and size utilized.
7. One positioner for pneumatically-operated feedwater flow control valve. Valve and actuator complete for electrically-operated feedwater control valve.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

- A. Refer to Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION.
- B. Boiler, Burner and Economizer Access Openings: Arrange all equipment and piping to allow access to openings without disassembly of equipment or piping.
- C. Drainage Facilities for Boiler Water Column, Gage Glass, Low Water Cutoffs, Water Level Alarms:
  1. Refer to Articles, BOILER and BOILER TRIM. After individual drain valves, combine all drains into one pipe with a sight flow indicator, gate valve and check valve. Pipe to boiler blowoff line.
  2. Locate and orient sight flow indicator on common drain line so that one person can view the fluid flow while simultaneously operating drain valves and low water cutoff shunt switch.
- D. Boiler Casing Flashing: Flash or seal all pipe penetrations in casing at steam drum to prevent leakage of water into boiler insulation.
- E. Air and steam hose connections for selection of atomizing media shall be within 1800 mm (6 feet) of the floor.

#### **3.2 CLEANING AND PROTECTION FROM CORROSION**

- A. Refer to Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION.
- B. Boiler Cleaning:
  1. Upon completion of installation, the initial firing of the burner shall be performed to boil out, under supervision of boiler manufacturer, all internal surfaces with chemical solution recommended by boiler manufacturer, to remove all mill scale, corrosion products and other foreign material. Following boil out, boiler shall be washed and flushed until water leaving the boiler is clear. Inspect internal surfaces for cleanliness. Then, drain and refill boiler with softened and treated water or place boiler in dry storage as specified below.

2. Refer to the paragraph at the end of PART 3, Article, INSPECTION AND TESTS "Internal Inspection of Pressure Parts and Furnace", for the requirements for cleaning the boiler after the operational tests are completed.

C. Protection from Corrosion:

1. Protect the boilers from fireside and waterside corrosion at all times.
2. Dry Storage: When the boilers are not filled with water, protect the watersides and firesides with a dry storage method recommended by either the boiler manufacturer or the ASME Code, Section VII.
3. Wet Storage: If, after water is placed in the boilers, they are not fired for equipment adjustment or testing for more than two weeks, the boilers shall be protected with a wet storage method recommended either by the boiler manufacturer or the ASME Code, Section VII. If boilers are not fired for equipment adjustment and testing for more than one month, drain the boilers and place in dry storage.
4. Chemical Treatment: The quality of the water in the boilers shall be maintained by a professional water treatment organization. This organization shall provide on-site supervision to maintain the required water quality during periods of boiler storage, operating, standby and test conditions. Furnish monthly reports, by the water treatment organization, to the Contracting Officers Technical Representative (COTR)/Resident Engineer (RE). The Contractor shall provide all chemicals, labor and professional services until the boilers have been accepted by the Government for operation. All chemicals utilized must conform to FDA Regulation CFR 21, 173.310, guidelines applicable for steam used in food preparation.

**3.3 INSPECTIONS AND TESTS**

- A. The following tests and demonstrations, except pretests, must be witnessed by the COTR/RE or their representative and must prove that boilers, economizers, burners, controls, instruments, and accessories comply with requirements specified. Refer to Section 23 08 11, DEMONSTRATIONS AND TESTS FOR BOILER PLANT for general requirements. When test results are not acceptable, corrections must be made and the test repeated at no additional cost to the Government. Pretests do not require the presence of the COTR/RE.
- B. Condition of Boiler and Economizer After Delivery, Rigging, Placement: After setting boiler on foundation and placing economizer on supports, and prior to making any connections to boiler and economizer, Contractor and COTR/RE jointly will inspect interior and exterior for damage.

Correct damage by repair or replacement to achieve a like new condition. After completion of repairs, perform air pressure test of the boiler casing. The Contractor shall conduct these tests at no cost to the Government.

C. Hydrostatic Tests:

1. Boiler, Economizer: Conduct tests after the equipment is installed and connected for operation and prior to initial firing. Contractor shall provide inspector certified by National Board of Boiler and Pressure Vessel Inspectors (NB). Test pressure shall be 150% of the design pressure of the boiler held for a period required by the inspector. Provide written certification of the satisfactory test, signed by the inspector. Correct any deficiencies discovered during the testing, and retest equipment until satisfactory results are achieved and are accepted by the inspector.
2. Boiler External Piping (as defined by ASME B31.1, Power Piping):
  - a. Refer to Section 23 21 11, BOILER PLANT PIPING SYSTEMS.
  - b. Test may be conducted concurrently with boiler and economizer testing.
3. Identify and remove any connecting equipment which is not rated for the test pressure. Cap the openings left by the disconnected equipment. Reinstall the equipment after the tests are complete.

D. Boiler Steam Safety Valves:

1. Test each safety valve set pressure and blowdown pressure with boiler steam pressure. Perform accumulation test to verify that safety valves have sufficient capacity to relieve full boiler output at maximum firing rate of burner. Tests shall be performed with boiler isolated from the main steam header and all generated steam exhausting through the safety valves.
2. Valve Popping Tolerance: Plus or minus three percent of set pressure for set pressures over 480 kPa (70 psi).
3. Valve Blowdown Tolerance: Reset at not less than six percent below set pressure of valve with the lowest set pressure. Minimum blowdown two percent of the set pressure.
4. Accumulation Test: With burner at high fire, the boiler pressure shall not rise more than six percent above the set pressure of the safety valve with the highest pressure setting and no more than six percent above the maximum allowable working pressure of the boiler.
5. Make repairs and adjustments in manner recommended by National Board (NB) Inspection Code, NB-23. Retest valves after completion of repairs and adjustments.

E. Burner Management Control (Flame Safeguard) System:

1. Demonstrate set points and operation of all control, interlock, monitoring and indicating functions. Refer to Section 23 09 11, INSTRUMENTATION AND CONTROL FOR BOILER PLANT.
2. Prior to scheduling final test, submit certification that all control, indicating and interlock devices have been pretested (Refer to Section 23 08 11, DEMONSTRATIONS AND TESTS FOR BOILER PLANT.
3. Conduct final test immediately prior to boiler-burner tests.
4. Experienced personnel representing the manufacturer of the system shall conduct the tests.

F. Performance Testing of Boiler, Burner, Economizer, Combustion Control, Boiler Plant Instrumentation:

1. Perform tests on boiler on all main burner fuels.
2. If required by local emissions authorities, provide the services of a testing firm to determine the NOx and carbon monoxide at boiler loads as required by the emissions authorities. Test firm shall be acceptable to emissions authorities.
3. Test No. P-1:
  - a. Operate boiler on each fuel, with economizer (if provided) in service, and record data for at least six evenly spaced steam outputs between low fire start and 100 percent of full steam output, and in the same sequence back to low fire. Demonstrate performance required by paragraphs under the Article, BURNER AND FUEL TRAINS and ECONOMIZER in Part 2 and by boiler and economizer equipment list shown on the drawings.
  - b. Demonstrate proper operation of combustion controls, draft controls (if provided), feedwater level controls, instrumentation and computer workstation programming (if provided). Refer to Section 23 09 11, INSTRUMENTATION AND CONTROL FOR BOILER PLANT.
  - c. When flue gas oxygen trim is provided, conduct tests with trim control on manual at the zero trim (null) position. Refer to Section 23 09 11, INSTRUMENTATION AND CONTROL FOR BOILER PLANT.
4. Test No. P-2:
  - a. Demonstrate sound level of burner system and atomizing air compressor (if provided).
  - b. Test point shall be at pre-purge, and firing at 100 percent of maximum boiler load.
  - c. Refer to sound level requirements in Section 23 05 51, NOISE AND VIBRATION CONTROL FOR BOILER PLANT.

5. Test No. P-3:
  - a. Check current draw of forced draft fan motor at pre-purge and at 100 percent of maximum boiler load with combustion air control at maximum position.
  - b. Current draw shall not exceed full load current stamped on the motor nameplates.
  - c. This test may be combined with Test No. P-1.
6. Test No. P-4: Operate boiler on both fuels, flue gas oxygen trim in service on automatic control, and record data at a minimum of 6 evenly spaced steam output points between low fire start and full steam output and in the same sequence back to low fire. Demonstrate oxygen trim control performance required by Section 23 09 11, INSTRUMENTATION AND CONTROL FOR BOILER PLANT.
7. Test No. P-5: Operate boiler on one fuel, flue gas oxygen trim in service on automatic control, and record data at the following load points: Low fire start, 13, 20, 40, 60, 80, 100, 80, 60, 40, 20 and 13 percent of full steam output. Demonstrate oxygen trim control performance required by Section 23 09 11, INSTRUMENTATION AND CONTROL FOR BOILER PLANT.
8. Test Methods:
  - a. Utilize permanent instrumentation systems for data. All instrumentation systems shall be operational and in calibration.
  - b. Provide portable thermocouple pyrometer furnished and retained by the Contractor to measure stack temperature as a verification of permanent stack temperature instrumentation.
  - c. Use portable electronic flue gas analyzer furnished by Contractor to determine constituents of flue gas and stack temperature. Analyzer shall be capable of measuring oxygen in percent with accuracy of plus or minus 0.5 percent and carbon monoxide in parts per million (ppm) with accuracy of plus or minus 5 percent of reading (Range 0-1000 ppm). Obtain oxygen and carbon monoxide readings at each test point. Instrument shall have been calibrated with certified test gases within three months prior to use and immediately after cell replacement.
  - d. In Test Nos. P-1, 2 and 5, retain boiler at each load point for a time period sufficient to permit stabilization of flue gas temperature and other parameters.
  - e. Steam loads for test may be furnished by the VA Medical Center hospital systems, by operation of the steam silencer vent system, or by a combination of the above. If variable hospital loads

interfere with the testing, conduct tests at night or on weekends when the loads are more stable.

- f. Provide dry bulb and wet bulb thermometers furnished and retained by Contractor for checking combustion air.
- g. Smoke testing shall be by visual observation of the stack and by smoke density monitor (permanent instrument - if provided). If smoke density monitor is not provided, utilize Bacharach Model 21-7006 Smoke Test Kit. If there is disagreement with the results of these tests, provide qualified observation person and tests in compliance with EPA Reference Method 9 (CFR 40, Part 60, Appendix A).
- h. Sound level instruments will be Government furnished.
- i. NOx emissions shall be tested with electronic analyzer reading in parts per million. Analyzer shall be calibrated at with certified test gas within three months prior to use and immediately after cell replacement. Analyzer shall be accurate to plus or minus 5 percent of reading.

9. Pretesting:

- a. Perform pretest at the final stage of the burner fine-tuning process.
- b. Prior to scheduling final test, submit evidence of pretest. Evidence shall consist of data sheet signed and dated by personnel representing burner manufacturer, combustion controls manufacturer, burner controls manufacturer.
- c. Pretest data sheets shall list the following data for each fuel and each screw on the fuel flow valve characterization cam starting at the minimum position, proceeding to the maximum position and returning to the minimum position.
  - 1) Fuel valve screw number or actuator position.
  - 2) Steam flow rate (at minimum, 50 percent, maximum firing position only).
  - 3) Steam pressure: At boiler drum, and at header (at minimum, 50 percent, maximum firing position only).
  - 4) Fuel Pressures: At burner and also upstream of fuel flow control valve.
  - 5) Fuel flow rate.
  - 6) Boiler feed pressure, upstream of feedwater regulator (at minimum, 50 percent and maximum firing positions only).
  - 7) Boiler feed temperature (at minimum, 50 percent, maximum firing positions only).

- 8) Stack temperature: Boiler outlet, economizer outlet.
  - 9) Flue gas oxygen and carbon monoxide (utilize instrument which has been calibrated with certified test gases).
  - 11) Flue gas NOx.
  - 12) Percent excess air.
  - 13) Opacity of flue gas.
  - 14) Submaster position.
  - 15) Flame shape: Note and describe any flame contact with refractory or heating surface.
  - 16) Combustion air temperature-dry bulb and wet bulb.
  - 17) Barometric pressure (one reading).
  - d. Calibrate all pressure gages prior to the pretest.
- G. Capacity - Efficiency Test of Boiler and Burner:
1. Perform test on one of each size boiler in the project, selected by COTR/RE, on all main burner fuels.
  2. Test No. E-1: Test boiler on each fuel, with no water in economizer, at full load. Demonstrate performance required by paragraphs under the Article, BOILER in Part 2 and by boiler equipment list shown on the drawings.
  3. Test Methods:
    - a. Conform to ASME Performance Test Code PTC 4.1. Use abbreviated input-output and heat balance methods. Utilize ASME Test Forms PTC 4.1-a, 4.1-b.
    - b. Test Meters and Instruments:
      - 1) Feedwater Flow Meter: Vortex or turbine-type, totalizing in increments of 10 gallons or less, pressure rating exceeding feed pump no flow shut-off pressure, temperature rating exceeding normal feedwater temperature, calibrated immediately prior to test by independent laboratory. Calibrate at three points, ten percent above, ten percent below, and at the required flow rate at high fire. Furnish calibration data. Remove meter from the line and deliver to COTR/RE after tests are accepted.
      - 2) Fuel Oil Flow Meters: Displacement type, totalizing, smallest reading one liter (one gallon), pressure rating exceeding oil pump safety relief valve set pressure plus accumulation, 120 °C (250 °F) (if heated oil), calibrated immediately prior to test by independent laboratory. Calibrate at three points: Ten percent above, ten percent below, and at the required flow rate

at high fire. Furnish calibration data. Remove meter from the line and deliver to COTR/RE after tests are accepted.

- 3) Natural Gas Flow Meter: Utilize permanent meter serving boiler plant.
- 4) Steam Calorimeter (for measuring steam quality): Throttling, U-path, temporary instrument, furnished and retained by Contractor, with thermometer that has been calibrated immediately prior to test. Provide one spare calibrated thermometer.
- 5) Portable electronic flue gas analyzer as specified for the performance testing.
- 6) Thermocouple Pyrometer (for measuring flue gas temperature): Temporary instrument furnished and retained by Contractor, 100 - 400 °C (200 - 800 °F) range, automatic ambient temperature compensation.
- 7) Thermometers: Utilize contractor-furnished and retained temporary thermometers and permanent thermometers to measure fuel and air temperatures. All must be calibrated immediately prior to test. Furnish calibration data.
- 8) Pressure Gages: Utilize permanent gages. Calibrate each gage immediately prior to test. Furnish calibration data.
- 9) Plant Instruments and Computer Work Station (if provided): Must be calibrated, programmed and in proper operation.

c. Fuel Analyses: The Government will furnish analysis of natural gas. The Contractor must obtain an ultimate type analysis of fuel oil prior to the final boiler tests. Fuel oil analysis must include heating value, specific gravity, viscosity and percent carbon, hydrogen, sulfur, ash, oxygen, and nitrogen. Test by independent laboratory.

d. Duration of each test will be four hours after all systems and measured parameters have stabilized.

e. Water quality in the boiler shall be checked immediately prior to the start of the tests. Solids and alkalinity must be adjusted prior to the test to conform to limits listed in Paragraph, BOILER in Part 2.

4. Pretesting: None required.

H. Internal Inspection of Pressure Parts and Furnace:

1. After all operational tests are satisfactorily completed, a Government retained licensed boiler inspector will determine if the boiler is free from corrosion and any other type of damage or defect.

2. In preparation for the inspection, open all drum handholes and the furnace access opening, drain and clean the interior of all pressure parts and clean all soot and debris from the furnace.
  3. Any corrosion, damage or defect shall be corrected to a like new condition in the judgment of the boiler inspector.
  4. Hard carbonaceous deposits on heating surface or refractory are evidence of flame impingement and are not permitted. Remove all deposits, make corrections to burners and provide complete retest of boiler and burner performance.
  5. After the boiler inspector has approved the boiler, all handholes and furnace access openings shall be closed with new gaskets.
  6. Hard carbonaceous deposits in the furnace are evidence of flame impingement. Within one year after acceptance of the boiler for Government operation, the Government will inspect the furnace for the carbonaceous deposits. If deposits are present, the Contractor shall remove them. If tubes or refractory are damaged, the Contractor shall replace them to achieve a like new condition. The Contractor shall make corrections to burners to eliminate the conditions that have caused the problems and shall provide complete retest of boiler and burner performance.
- I. Report: Furnish complete written report (three copies) that includes test data, calculations, results compared with requirements, list of personnel, and other pertinent information. Furnish report within three weeks after completion of tests.

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**SECTION 23 64 00**  
**PACKAGED WATER CHILLERS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. Centrifugal water-cooled chillers, complete with accessories.

**1.2 RELATED WORK**

- A. Section 01 00 00, GENERAL REQUIREMENTS.
- B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- C. Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION.
- D. Section 23 21 23, HYDRONIC PUMPS.
- E. Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING AND EQUIPMENT.
- F. Section 23 21 13, HYDRONIC PIPING.
- G. Section 23 31 00, HVAC DUCTS AND CASINGS
- H. Section 23 05 12, GENERAL MOTOR REQUIREMENTS FOR HVAC AND STEAM GENERATION EQUIPMENT.
- I. Section 26 29 11, LOW-VOLTAGE MOTOR STARTERS.

**1.3 DEFINITION**

- A. 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.
- B. BACNET: Building Automation Control Network Protocol, ASHRAE Standard 135.
- C. Ethernet: A trademark for a system for exchanging messages between computers on a local area network using coaxial, fiber optic, or twisted-pair cables.
- D. FTT-10: Echelon Transmitter-Free Topology Transceiver.
- E. LonMark: An association comprising of suppliers and installers of LonTalk products. The Association provides guidelines for the implementation of the LonTalk protocol to ensure interoperability through Standard implementation.
- F. LonTalk: An open standard protocol developed by the Echelon Corporation that uses a "Neuron Chip" for communication.
- G. LonWorks: Network technology developed by the Echelon Corporation.

**1.4 QUALITY ASSURANCE**

- A. Refer to Paragraph, QUALITY ASSURANCE, in Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION, and comply with the following.
- B. Refer to PART 3 herein after and Section 01 00 00, GENERAL REQUIREMENTS for test performance.

- C. Comply with ARI requirements for testing and certification of the chillers.
- D. Refer to WARRANTY as noted below:
1. A 5-year motor/transmission/compressor warranty shall be provided based upon the RPM of the compressor as follows:

Compressor RPM	Warranty Term
0-5000	1 year from start up
5001-10,000	5 years from start up
10,001 and above	5 years plus annual oil analysis
  2. Warranty shall include parts and labor for one year after start-up or 18 months from shipment, whichever occurs first.
- E. Refer to OSHA 29 CFR 1910.95(a) and (b) for Occupational Noise Exposure Standard.
- F. Equipment and installation shall be in compliance with ANSI/ASHRAE 15 (latest edition).
- G. Refer to ASHRAE Standard 15, Safety Standard for Refrigeration System, for refrigerant vapor detectors and monitor.
- H. Chiller shall be designed and constructed to meet UL requirements and have labels appropriately affixed.

#### 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 Refrigeration Institute (ARI):
- 210/ 240-03.....Unitary Air Conditioning and Air-Source Heat Pump Equipment
  - 370-01.....Sound Rating of Large Outdoor Refrigerating and Air-Conditioning Equipment
  - 495-99.....Refrigerant Liquid Receivers
  - 550/590-03.....Standard for Water Chilling Packages Using the Vapor Compression Cycle
  - 560-00.....Absorption Water Chilling and Water Heating Packages
  - 575-94.....Methods for Measuring Machinery Sound within Equipment Space
- C. American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE):
- 15-02.....Safety Standard for Mechanical Refrigeration Systems

- 3-96.....Guidelines for Reducing Emission of Halogenated  
Refrigerants in Refrigeration and Air-  
Conditioning Equipment and Systems
- D. American Society of Mechanical Engineers (ASME):  
1998 .....ASME Boiler and Pressure Vessel Code, Section  
VIII, "Rules for Constructive Pressure Vessels"
- E. American Society of Testing Materials (ASTM):  
C 534-03.....Preformed, Flexible Elastomeric Cellular Thermal  
Insulation in Sheet and Tubular Form  
C 612-04.....Mineral-fiber Block and Board Thermal Insulation
- F. National Electrical Manufacturing Association (NEMA):  
250-03.....Enclosures for Electrical Equipment (1000 Volts  
Maximum)
- G. National Fire Protection Association (NFPA):  
70-05.....National Electrical Code
- H. Underwriters Laboratories, Inc. (UL):  
1995-99..... Heating and Cooling Equipment

#### 1.6 SUBMITTALS

- A. Submit in accordance with Specification Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Manufacturer's Literature and Data.
1. Centrifugal water chillers, including motor starters, control panels, and vibration isolators, and remote fluid cooler data shall include the following:
    - a. Rated capacity.
    - b. Pressure drop.
    - c. Efficiency at full load and part load without applying any tolerance indicated in the ARI 550/590/Standard.
    - d. Refrigerant.
    - e. Accessories.
    - f. Installation instructions.
    - g. Start up procedures.
    - h. Wiring diagrams, including factor-installed and field-installed wiring.
    - i. Noise data report. Manufacturer shall provide noise ratings. Noise warning labels shall be posted on equipment.
- C. Maintenance and operating manuals for each piece of equipment in accordance with Section 01 00 00, GENERAL REQUIREMENTS.
- D. Run test report for all chillers.

- E. Product Certificate: Signed by chiller manufacturer certifying that chillers furnished comply with ARI requirements. The test report shall include calibrated curves, calibration records, and data sheets for the instrumentation used in factory tests.

## **PART 2 - PRODUCTS**

### **2.1 CENTRIFUGAL CHILLERS**

- A. General: Factory assembled, single piece, liquid chiller shall consist of compressor, motor, starter or variable frequency drive, lubrication system, cooler, condenser, initial oil and refrigerant operating charges, microprocessor control system, and documentation required prior to start-up. An compressor motor VFD shall be mounted on the chiller, wired, and tested by the chiller manufacturer.
- B. Compressor: One centrifugal compressor of the high performance, single-stage type.
1. Compressor, motor, and transmission shall be hermetically sealed into a common assembly and arranged for easy field servicing.
  2. Internal compressor parts must be accessible for servicing without removing the compressor base from the chiller. Connections to the compressor casing shall use O-rings instead of gaskets to reduce the occurrence of refrigerant leakage. Connections to the compressor shall be flanged or bolted for easy disassembly.
  3. All sensors shall have quick disconnects to allow replacement of the sensor without replacement of the entire sensor wire. Pressure transducers shall be capable of field calibration to ensure accurate readings and to avoid unnecessary transducer replacement. Transducers shall be serviceable without the need for refrigerant charge removal or isolation.
  4. Transmission shall be single ratio, single helical, parallel shaft speed increaser. Gears shall conform to AGMA Standards, Quality II.
  5. Journal bearings shall be of the steel backed babbitt lined type. Aluminum journal bearings are not acceptable. The thrust bearing shall be tilting pad or rolling element type.
  6. Centrifugal compressors shall use variable inlet guide vanes to provide capacity modulation while also providing pre-whirl of the refrigerant vapor entering the impeller for more efficient compression at all loads.
  7. Centrifugal compressors shall be provided with a factory-installed lubrication system to deliver oil under pressure to bearings and transmission. Included in the system shall be:

- a. Hermetic driven rotary vane oil pump with factory-installed motor contactor with overload protection.
  - b. Refrigerant-cooled oil cooler. Water-cooled oil coolers are not acceptable.
  - c. Oil pressure regulator.
  - d. Oil filter with isolation valves to allow filter change without removal of refrigerant charge.
  - e. Oil sump heater controlled from unit microprocessor.
  - f. Oil reservoir temperature sensor with main control center digital readout.
  - g. All wiring to oil pump, oil heater, and controls shall be pre-wired in the factory.
  - h. Compressor shall be fully field serviceable. Compressors which must be removed and returned to the factory for service shall be unacceptable.
- C. Motor: Compressor motor shall be of the semi-hermetic, liquid refrigerant cooled, squirrel cage, induction type suitable for voltage shown on the equipment schedule.
- 1. Motors shall be suitable for operation in a refrigerant atmosphere and shall be cooled by atomized refrigerant in contact with the motor windings.
  - 2. Motor stator shall be arranged for service or removal with only minor compressor disassembly and without removing main refrigerant piping connections.
  - 3. Full load operation of the motor shall not exceed nameplate rating.
  - 4. One motor winding temperature sensor (and one spare) shall be provided.
- D. Cooler: Cooler shall be of shell and tube type construction, each in separate shells. Units shall be fabricated with high-performance tubing, minimum 1/4-inch steel shell and tube sheets with fabricated steel waterboxes.
- 1. Waterbox shall be nozzle-in-head waterbox (150 psig).
  - 2. Waterbox shall have standard Victaulic grooves.
- E. Condenser shall be of shell and tube type construction, each in separate shells. Units shall be fabricated with high-performance tubing, minimum 1/4-inch steel shell and tube sheets with fabricated steel waterboxes.
- 1. Waterbox shall be nozzle-in-head (150 psig).
  - 2. Waterbox shall have standard Victaulic grooves.
- F. Waterboxes shall have vents, drains, and covers to permit tube cleaning within the space shown on the drawings. A thermistor type temperature

sensor with quick connects shall be factory installed in each water nozzle.

- G. Tubes shall be individually replaceable from either end of the heat exchanger without affecting the strength and durability of the tube sheet and without causing leakage in adjacent tubes.
- H. Tubing shall be copper, high-efficiency type, with integral internal and external enhancement unless otherwise noted. Tubes shall be nominal 3/4-in. OD with nominal wall thickness of 0.025 in. measured at the root of the fin at the enhanced areas and nominal wall thickness of 0.049 in. where the tubes are in contact with the end tube sheets unless otherwise noted. Tubes shall be rolled into tube sheets and shall be individually replaceable. Tube sheet holes shall be double grooved for joint structural integrity.
- I. Cooler shall be designed to prevent liquid refrigerant from entering the compressor. Devices that introduce pressure losses (such as mist eliminators) shall not be acceptable because they are subject to structural failures that can result in extensive compressor damage.
- J. The condenser shell shall include a flash subcooler which cools the condensed liquid refrigerant to a reduced temperature, thereby increasing the refrigeration cycle efficiency.
- K. A reseating type pressure relief valve shall be installed on each heat exchanger. If a non-reseating type is used, a backup reseating type shall be installed in series.
- L. Refrigerant Flow Control: To improve part load efficiency, liquid refrigerant shall be metered from the condenser to the cooler using a float-type metering valve to maintain the proper liquid level of refrigerant in the heat exchangers under both full and part load operating conditions. By maintaining a liquid seal at the flow valve, bypassed hot gas from the condenser to the cooler is eliminated. The float valve chamber shall have a bolted access cover to allow field inspection and the float valve shall be field serviceable.
- M. Controls, Safeties, and Diagnostics:
  - 1. Controls:
    - a. The chiller shall be provided with a factory installed and wired microprocessor control center. The control center shall include a 16-line by 40-character liquid crystal display, 4 function keys, stop button, and alarm light. The microprocessor can be configured for either English or SI units.
    - b. All chiller and starter monitoring shall be displayed at the chiller control panel.

- c. The controls shall make use of non-volatile memory.
- d. The chiller control system shall have the ability to interface and communicate directly to the building control system. Chiller control panel shall either reside on the "LonTalk FTT-10a network", and provide data using LonMark standard network variable types and configuration properties, or BACnet interworking using ARCNET or MS/TP physical data link layer protocol for communication with building automation control system.
- e. The default standard display screen shall simultaneously indicate the following minimum information:
  - 1) date and time of day
  - 2) 24-character primary system status message
  - 3) 24-character secondary status message
  - 4) chiller operating hours
  - 5) entering chilled water temperature
  - 6) leaving chilled water temperature
  - 7) evaporator refrigerant temperature
  - 8) entering condenser water temperature
  - 9) leaving condenser water temperature
  - 10) condenser refrigerant temperature
  - 11) oil supply pressure
  - 12) oil sump temperature
  - 13) percent motor Rated Load Amps (RLA)
- f. In addition to the default screen, status screens shall be accessible to view the status of every point monitored by the control center including:
  - 1) evaporator pressure
  - 2) condenser pressure
  - 3) bearing oil supply temperature
  - 4) compressor discharge temperature
  - 5) motor winding temperature
  - 6) number of compressor starts
  - 7) control point settings
  - 8) discrete output status of various devices
  - 9) compressor motor starter status
  - 10) optional spare input channels
  - 11) line current and voltage for each phase
  - 12) frequency, kW, kW-hr, demand kW
- g. Schedule Function: The chiller controls shall be configurable for manual or automatic start-up and shutdown. In automatic operation

mode, the controls shall be capable of automatically starting and stopping the chiller according to a stored user programmable occupancy schedule. The controls shall include built-in provisions for accepting:

- 1) A minimum of two 365-day occupancy schedules.
  - 2) Minimum of 8 separate occupied/unoccupied periods per day.
  - 3) Daylight savings start/end.
  - 4) 18 user-defined holidays.
  - 5) Means of configuring an occupancy timed override.
  - 6) Chiller start-up and shutdown via remote contact closure.
- h. Service Function: The controls shall provide a password protected service function which allows authorized individuals to view an alarm history file which shall contain the last 25 alarm/alert messages with time and date stamp. These messages shall be displayed in text form, not codes.
- i. Network Window Function: Each chiller control panel shall be capable of viewing multiple point values and statuses from other like controls connected on a common network, including controller maintenance data. The operator shall be able to alter the remote controller's set points or time schedule and to force point values or statuses for those points that are operator forcible. The control panel shall also have access to the alarm history file of all like controllers connected on the network.
- j. Pump Control: Upon request to start the compressor, the control system shall start the chilled water pump, condenser water pumps and verify that flows have been established.
- k. Ramp Loading: A user-configurable ramp loading rate, effective during the chilled water temperature pulldown period, shall control the rate of guide vane opening to prevent a rapid increase in compressor power consumption. The controls shall allow configuration of the ramp loading rate in either degrees/minute of chilled water temperature pulldown or percent motor amps/minute. During the ramp loading period, a message shall be displayed informing the operator that the chiller is operating in ramp loading mode.
- l. Chilled Water Reset: The control center shall allow reset of the chilled water temperature set point based on any one of the following criteria:
- 1) Chilled water reset based on an external 4 to 20 mA signal.

- 2) Chilled water reset based on a remote temperature sensor (such as outdoor air).
  - 3) Chilled water reset based on water temperature rise across the evaporator.
  - m. Demand Limit: The control center shall limit amp draw of the compressor to the rated load amps or to a lower value based on one of the following criteria:
    - 1) Demand limit based on a user input ranging from 40% to 100% of compressor rated load amps.
    - 2) Demand limit based on external 4 to 20 mA signal.
  - n. Controlled Compressor Shutdown: The controls shall be capable of being configured to soft stop the compressor. When the stop button is pressed or remote contacts open with this feature active, the guide vanes shall close to a configured amperage level and the machine shall then shut down. The display shall indicate "shutdown in progress."
  - o. The chiller control panel shall provide a relay output to initiate system changeover to free cooling (heat exchanger). This relay shall be energized upon initiation of free cooling at the chiller control panel.
2. Safeties:
- a. Unit shall automatically shut down when any of the following conditions occur: (Each of these protective limits shall require manual reset and cause an alarm message to be displayed on the control panel screen, informing the operator of the shutdown cause.)
    - 1) motor overcurrent
    - 2) over voltage\*
    - 3) under voltage\*
    - 4) single cycle dropout\*
    - 5) bearing oil high temperature
    - 6) low evaporator refrigerant temperature
    - 7) high condenser pressure
    - 8) high motor temperature
    - 9) high compressor discharge temperature
    - 10) low oil pressure
    - 11) prolonged surge
    - 12) loss of chilled water flow
    - 13) loss of condenser water flow
    - 14) starter fault

- \*Shall not require manual reset or cause an alarm if auto-restart after power failure is enabled.
- b. The control system shall detect conditions that approach protective limits and take self-corrective action prior to an alarm occurring. The system shall automatically reduce chiller capacity when any of the following parameters are outside their normal operating range:
    - 1) high condenser pressure
    - 2) high motor temperature
    - 3) low evaporator refrigerant temperature
    - 4) high motor amps.
  - c. During the capacity override period, a pre-alarm (alert) message shall be displayed informing the operator which condition is causing the capacity override. Once the condition is again within acceptable limits, the override condition shall be terminated and the chiller shall revert to normal chilled water control. If during either condition the protective limit is reached, the chiller shall shut down and a message shall be displayed informing the operator which condition caused the shutdown and alarm.
  - d. Internal built-in safeties shall protect the chiller from loss of water flow. Differential pressure switches shall not be allowed to be the only form of freeze protection.
  - e. In the event of a communication loss between the chiller and its control panel, a signal must be transmitted to Energy Control Center for this communication loss.
  - f. Provide contacts for remote start/stop, alarm for abnormal operation or shut down, and for Engineering Control Center (ECC) interface.
3. Diagnostics and Service: A self diagnostic controls test shall be an integral part of the control system to allow quick identification of malfunctioning components. Once the controls test has been initiated, all pressure and temperature sensors shall be checked to ensure they are within normal operating range. A pump test shall automatically energize the chilled water pump, condenser water pump, and oil pump. The control system shall confirm that water flow and oil pressure have been established and require operator confirmation before proceeding to the next test. A guide vane actuator test shall open and close the guide vanes to check for proper operation. The operator manually acknowledges proper guide vane operation prior to proceeding to the next test. In addition to the automated controls test, the

controls shall provide a manual test which permits selection and testing of individual control components and inputs. A thermistor test and transducer test shall display on the ICVC (International Chiller Visual Controller) screen the actual reading of each transducer and each thermistor installed on the chiller. All out-of-range sensors shall be identified.

4. Multiple Chiller Control: The chiller controls shall be supplied as standard with a two chiller lead/lag system. The control system shall automatically start and stop a lag or second chiller on a two chiller system. If one of the two chillers on line goes into a fault mode, the lag chiller shall be automatically started. The two chiller lead/lag system shall allow manual rotation of the lead chiller, include load balancing if configured, and a staggered restart of the chillers after a power failure.

N. Electrical Requirements:

1. Electrical contractor shall supply and install main electrical power line, disconnect switches, circuit breakers, and electrical protection devices per local code requirements and as indicated necessary by the chiller manufacturer.
2. Electrical contractor shall wire the chilled water pumps and condenser water pumps to the chiller control circuit.
3. Electrical contractor shall supply and install electrical wiring and devices required to interface the chiller controls with the building control system if applicable.
4. Electrical power shall be supplied to the unit at the voltage, phase, and frequency listed in the equipment schedule.

- O. Piping Requirements – Instrumentation and Safeties: Mechanical contractor shall supply and install pressure gages in readily accessible locations in piping adjacent to the chiller such that they can be easily read from a standing position on the floor. Scale range shall be such that design values shall be indicated at approximately mid-scale. Gages shall be installed in the entering and leaving water lines of the cooler and condenser.

- P. Vibration Isolation: Chiller manufacturer shall furnish neoprene isolator pads for mounting equipment on a level concrete surface.

Q. Start-up:

1. The chiller manufacturer shall provide a factory-trained representative, employed by the chiller manufacturer, to perform the start-up procedures as outlined in the Start-up, Operation and Maintenance manual provided by the chiller manufacturer.

2. Manufacturer shall supply the following literature:

- a. Start-up, operation and maintenance instructions.
- b. Installation instructions.
- c. Field wiring diagrams.
- d. One complete set of certified drawings.

R. Special Features:

1. Spring Isolators Accessory: Field furnished and selected for the desired degree of isolation.
2. Refrigerant Charge: The chiller shall ship from the factory fully charged with R-134a refrigerant and oil.
3. Thermal Insulation: Unit manufacturer shall insulate the cooler shell, economizer low side compressor suction elbow, motor shell and motor cooling lines. Insulation shall be 3/4 in. (19 mm) thick with a thermal conductivity not exceeding 0.28 (Btu in.)/hr ft<sup>2</sup> F and shall conform to UL standard 94, classification 94 HBF.
4. Automatic Hot Gas Bypass: Hot gas bypass valve and piping shall be factory furnished to permit chiller operation for extended periods of time.
5. Flanged Water Nozzles: Unit manufacturer shall furnish standard flanged piping connections on the cooler and/ or condenser.
6. Hinges: Unit manufacturer shall furnish hinges on waterboxes to facilitate tube cleaning.
7. Compressor Discharge Isolation Valve and Liquid Line Ball Valve: These items shall be factory installed to allow isolation of the refrigerant charge in the condenser for servicing the compressor.
8. Unit-Mounted Variable Frequency Drive (VFD) with Built-in Harmonic Filter:
  - a. Design:
    - 1) VFD shall be refrigerant cooled, microprocessor based, pulse width modulated (PWM) design. Water-cooled designs are not acceptable.
    - 2) Input and output power devices shall be insulated gate bipolar transistors (IGBTs).
    - 3) Active rectifier shall convert incoming voltage / frequency to DC voltage. Input current and voltage shall be regulated.
    - 4) Transistorized inverter and control regulator shall convert DC voltage to a sinusoidal PWM waveform.
    - 5) Integrated chiller controls shall coordinate motor speed and guide vane position to optimize chiller performance over all chiller operating conditions.

- 6) Surge prevention and surge protection algorithms shall take action to prevent surge and move chiller operation away from surge.
- b. Enclosure:
- 1) Pre-painted unit mounted, NEMA 1 cabinet shall include hinged, lockable doors and removable lifting lugs.
  - 2) VFD shall have a short circuit interrupt and withstand rating of at least 65,000 amps (35,000 amps for 575-v units).
  - 3) Provisions to padlock main disconnect handle in the "Off" positions shall be provided. Mechanical interlock to prevent opening cabinet door with disconnect in the "On" position or moving disconnect to the "ON" position while the door is open shall be provided.
  - 4) Provisions shall be made for top entry of incoming line power cables.
- c. Heat Sink:
- 1) The heat sink shall be refrigerant cooled. Heat sink and mating flange shall be suitable for ASME design working pressure of 185 psig.
  - 2) Refrigerant cooling shall be metered by microprocessor control solenoid valve to maintain heat sink temperature within acceptable limits for ambient temperature.
  - 3) Water-cooled heat exchangers requiring cleaning shall not be acceptable.
- d. VFD Rating:
- 1) Drive shall be suitable for continuous operation at nameplate voltage  $\pm 10\%$ .
  - 2) Drive shall be suitable for continuous operation at 100% of nameplate amps and 150% of nameplate amps for 5 seconds.
  - 3) Drive shall comply with applicable ANSI, NEMA, UL and NEC standards.
  - 4) Drive shall be suitable for operation in ambient temperatures between 40 and 104 F, 95% humidity (non-condensing) for altitudes up to 6000 feet above sea level. Specific drive performance at jobsite ambient temperature and elevation shall be provided by the manufacturer.
- e. User Interface: A single display shall provide interface for programming and display of VFD and chiller parameters. Viewable parameters include:
- 1) Operating, configuration and fault messages

- 2) Frequency in hertz
  - 3) Load and line side voltage and current (at the VFD)
  - 4) kW (line and load side)
  - 5) IGBT temperatures
- f. VFD Performance:
- 1) VFD Voltage Total Harmonic Distortion (THD) and Harmonic Current Total Demand Distortion (TDD) shall not exceed IEEE-519 requirements using the VFD circuit breaker input terminals as the point of common coupling (PCC).
  - 2) VFD full load efficiency shall meet or exceed 97% at 100% VFD Rated Ampacity.
  - 3) Active rectifier shall regulate unity displacement power factor to 0.99 or higher at full load.
  - 4) Voltage boost capability to provide full motor voltage at reduced line voltage conditions.
  - 5) Soft start, linear acceleration, coast to stop.
  - 6) Base motor frequency shall be either 50 or 60 hertz. Adjustable frequency range from 38 to 60 hertz or 32.5 to 50 hertz.
- g. VFD Electrical Service (single point power):
- 1) VFD shall have input circuit breaker with minimum 65,000 amp interrupt capacity.
  - 2) VFD shall have standard 15 amp branch circuit breaker to provide power for chiller oil pump.
  - 3) VFD shall have standard 3 kva control power transformer with circuit breaker provides power for oil heater, VFD controls and chiller controls.
  - 4) The branch oil pump circuit breaker and control power transformer shall be factory wired.
  - 5) Nameplate voltage shall range between 380 to 460  $\pm 10$  percent, 3 phase, 50/ 60 Hz,  $\pm 2\%$  Hz.
- h. Discrete Outputs: 115 v discrete contact outputs shall be provided for field wired:
- 1) Chilled water pump
  - 2) Condenser water pump
  - 3) Alarm status
  - 4) Fluid cooler fan
- i. Analog Output: An analog (4 to 20 mA) output for head pressure reference shall be provided. This signal shall be suitable to control a 2-way or 3-way water regulating valve in the condenser piping.

j. Protection (the following shall be supplied):

- 1) Under-voltage
- 2) Over voltage
- 3) Phase loss
- 4) Phase reversal
- 5) Ground fault
- 6) Phase unbalance protection
- 7) Single cycle voltage loss protection
- 8) Programmable auto re-start after loss of power
- 9) Motor overload protection (NEMA Class 10)

k. VFD Testing: VFD shall be factory mounted, wired and tested on the chiller prior to shipment.

## **2.2 FLUID COOLERS**

- A. General: Air-cooled fluid coolers, arranged for vertical air flow. Suitable for roof-mounted installation.
- B. Unit Casing: Heavy-gauge, embossed aluminum for corrosion resistance. Multiple fan units shall be divided by full width baffles to separate individual fan sections, prevent air bypass and provide additional casing reinforcement.
- C. Provide assembled units with lifting eyes for rigging. Unit shall have 10 gauge galvanized steel legs.
- D. Fluid coil: Coils shall be constructed of 1/2-inch seamless copper tubing with copper fins. Headers shall be supplied with vents and drains. All coils shall be factory pressure tested to 400 PSI.
- E. Fans: All fans shall be aluminum propeller blade type with painted steel hubs. Fans shall be dynamically balanced and factory tested before shipping to ensure quiet operation. Fan diameters shall not exceed 30 inches.
- F. Fan Guards: Heavy-gauge, close meshed steel wire with vinyl coating for maximum rigidity and long life.
- G. Fan Motors: Fan motors shall be heavy duty PSC or three phase ODP type with permanently lubricated ball bearings and built-in overload protection. All motors shall be factory wired with leads terminating in a weathertight enclosure located opposite the header end of the unit. Leads on units shall terminate at a power block.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

Examine roughing-in for concrete equipment bases, anchor-bolt sizes and locations, piping and electrical to verify actual locations and sizes before chiller installation and other conditions that might effect

chiller performance, maintenance, and operation. Equipment locations shown on drawings are approximate. Determine exact locations before proceeding with installation.

### **3.2 EQUIPMENT INSTALLATION**

- A. Install chiller on concrete base with isolation pads or vibration isolators.
  - 1. Concrete base is specified in Section 03 30 53.
  - 2. Vibration isolator types and installation requirements are specified in Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING AND EQUIPMENT
  - 3. Anchor chiller to concrete base according to manufacturer's written instructions.
  - 4. Charge the chiller with refrigerant, if not factory charged.
  - 5. Install accessories and any other equipment furnished loose by the manufacturer, including VFD, remote control panel, and remote flow switches, according to the manufacturer written instructions and electrical requirements.
  - 6. Chillers shall be installed in a manner as to provide easy access for tube pull and removal of compressor and motors etc.
  - 7. Chillers shall be installed so as to allow future chiller and pump installations as indicated on drawings.
- B. Install refrigerant piping as specified in ASHRAE Standard 15.
- D. Install thermometers and gages as recommended by the manufacturer and/or as shown on drawings.
- C. Piping Connections:
  - 1. Make piping connections to the chiller for chilled water, condenser water, and other connections as necessary for proper operation and maintenance of the equipment.
  - 2. Make equipment connections with flanges and couplings for easy removal and replacement of equipment from the equipment room.
  - 3. Extend vent piping from the relief valve and purge system to the outside.

### **3.3 STARTUP AND TESTING**

- A. Engage manufacturer's factory-trained representative to perform startup and testing service.
- B. Inspect, equipment installation, including field-assembled components, and piping and electrical connections.
- C. After complete installation startup checks, according to the manufacturers written instructions, do the following to demonstrate to the VA that the equipment operate and perform as intended.

1. Check refrigerant charge is sufficient and chiller has been tested for refrigerant leak.
  2. Check bearing lubrication and oil levels.
  3. Verify proper motor rotation.
  4. Verify pumps associated with chillers are installed and operational.
  5. Verify thermometers and gages are installed.
  6. Verify purge system, if installed, is functional and relief piping is routed outdoor.
  7. Operate chiller for run-in-period in accordance with the manufacturer's instruction and observe its performance.
  8. Check and record refrigerant pressure, water flow, water temperature, and power consumption of the chiller.
  9. Test and adjust all controls and safeties. Replace or correct all malfunctioning controls, safeties and equipment as soon as possible to avoid any delay in the use of the equipment.
  10. Prepare a written report outlining the results of tests and inspections, and submit it to the VA.
- D. Engage manufacturer's certified factory trained representative to provide training for 4 hours for the VA maintenance and operational personnel to adjust, operate and maintain equipment, including self-contained breathing apparatus.

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**SECTION 23 73 01**  
**AIR HANDLING UNIT COMPONENTS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. Air handling unit integral components specified herein.
- B. Definitions: Air Handling Unit (AHU): 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, dehumidifying, and/or mixing of air. Design capacities of units shall be as scheduled on the drawings.
- C. This section of the work includes the design, fabrication, testing, cleaning and packaging, shipment, final assembly and installation of components in existing custom built-up air handling units by the contractor in complete accordance with the following specification.

**1.2 RELATED WORK**

- A. 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.
- B. Sound and vibration requirements: Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING AND EQUIPMENT.
- C. Commissioning: Section 23 08 00, COMMISSIONING OF MECHANICAL SYSTEMS, Section 01 91 13, COMMISSIONING REQUIREMENTS, and Section 01 92 13, RETRO-COMMISSIONING REQUIREMENTS.
- D. Piping and duct insulation: Section 23 07 11, HVAC, PLUMBING, AND BOILER PLANT INSULATION.
- E. Piping and valves: Section 23 21 13 HYDRONIC PIPING and 23 22 13 STEAM AND CONDENSATE HEATING PIPING.
- F. Requirements for flexible duct connectors, sound attenuators and sound absorbing duct lining, and air leakage: Section 23 31 00, HVAC DUCTS AND CASINGS.
- G. Air filters and filters' efficiency: Section 23 40 00, HVAC AIR CLEANING DEVICES.
- H. HVAC controls: Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC.
- I. Testing, adjusting and balancing of air and water flows: Section 23 05 93, TESTING, ADJUSTING, AND BALANCING FOR HVAC.
- J. Types of motors: Section 23 05 12, GENERAL MOTOR REQUIREMENTS FOR HVAC AND STEAM GENERATION EQUIPMENT.

### 1.3 QUALITY ASSURANCE

- A. Refer to Article, Quality Assurance, in Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION.
- B. Air Handling Units Certification: Certify air-handling units in accordance with ARI 430.
- C. Heating, Cooling, and Air Handling Capacity and Performance Standards: ARI 430, ARI 410, ASHRAE 51, AMCA 210 and NFPA 90A.
- D. Performance Criteria:
  - 1. The fan schedule indicates design cubic meter per minute (cubic feet per minute) and design static pressure. Scheduled fan motors 375 watts (1/2 horsepower) and larger, are sized for the maximum of design cubic meter per minute (cubic feet per minute) at 110 percent design static pressure, but not to exceed 187 Pa (3/4 inch water gage) additional pressure.
  - 2. Fans and motors shall be capable of stable operation at design conditions, cubic meters per minute (cubic feet per minute) and 110 percent pressure, as stated above.
  - 3. Lower than design pressure drop of approved individual components may allow use of a smaller fan motor and still provide the safety factor. When submitted as a deviation, a smaller motor may be approved in the interest of energy conservation. Such a deviation shall not qualify for any value engineering incentive claim or reward.
  - 4. Select fan operating point to right hand side of peak static pressure point and near the peak of static efficiency.
  - 5. Operating Limits: AMCA 99.
- E. Equipment shall be UL or ETL listed where applicable.

### 1.4. SUBMITTALS:

- A. The contractor shall, in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES, furnish a complete submission for all air handling 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 AHUs shall include outside/return air dampers, filters, and all other related components and accessories. Unit manufacturer shall also submit performance data including performance test results, charts, curves or certified computer selection data; data sheets; fabrication and insulation details; and 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.
- 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.

#### 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 (ARI):
  - 260-01.....Sound Rating of Ducted Air Moving and Conditioning Equipment
  - 410-01.....Standard for Forced-Circulation Air-Heating and Air-Cooling Coils
  - 430-89.....Standard for Central Station Air Handling Units
  - ARI-DCAACP.....Directory of Certified Applied Air Conditioning Products
- C. Air Moving and Conditioning Association (AMCA):
  - 210-00.....Laboratory Methods of Testing Fans for Rating
- D. Anti-Friction Bearing Manufacturer's Association, Inc. (AFBMA):
  - 9-90.....Load Ratings and Fatigue life for Ball Bearings
- E. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE):
  - 51-01.....Standard, Laboratory Methods of Testing Fans for Rating
- F. American Society for Testing and Materials (ASTM):
  - A653/653M-02.....Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
  - B117-97.....Salt Spray (Fog) Testing

- C1071-00.....Thermal and Acoustical Insulation (Mineral  
Fiber, Duct Lining Material)
- D1654-00.....Standard Method for Evaluation of Painted or  
Coated Specimens Subjected to Corrosive  
Environments
- D1735-97.....Water Resistance of Coatings Using Water Fog  
Apparatus
- D3359-95.....Standard Test Methods for Measuring Adhesion by  
Tape Test
- E84-01.....Surface Burning Characteristics of Building  
Materials
- G. Anti-Friction Bearing Manufacturer's Association, Inc. (AFBMA):  
9-90.....Load Ratings and Fatigue life for Ball Bearings
- H. Military Specifications (Mil. Spec.):  
DOD-P-21035A-77.....Paint, High Zinc Dust Content, Galvanizing  
Repair
- I. National Fire Protection Association (NFPA):  
90A-99.....Installation of Air Conditioning and Ventilating  
Systems

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

- A. Thoroughly clean equipment, components and subassemblies of water, dirt, debris, weld splatter, grease, oil and other foreign matter prior to shipment.
- B. Seal and protect all openings in unit casings, housings and enclosures with wood, plastic or sheet metal closure sheets. Seal closures, caps and plugs dust-tight and moisture-tight. Protect pipe flanges and threads with plastic end caps or plugs. Protect machined surfaces with suitable, easily removable rust preventive. Provide full charge of proper lubrication for grease lubricated bearings.
- C. Components delivered with scratched, dented, or dirty surfaces or damage of any type shall be restored to "as new" condition as directed by the Architect/Engineer at no cost to Owner.
- D. If equipment is to be stored before use, the shipping protection provided by the unit manufacturer shall remain on the unit until the unit is installed. In addition, manufacturer shall submit written recommendations for field storage, both indoor and outdoor. Field storage method shall be pre-approved by Architect/Engineer and VA COTR.
- E. Provide non-corrosive nameplate permanently attached to each piece of equipment containing the following information at a minimum:
1. Manufacturer's project number

2. Plant name and location
3. Equipment number
4. Date of manufacture

#### **1.7 WARRANTY**

- A. All equipment, materials and workmanship shall be warranted for twelve (12) months from startup or owner acceptance, except as noted below:
  1. Variable frequency drives for fan motors shall be warranted parts and labor for all equipment, materials and workmanship for a period of two (2) years.
  2. All compressors shall be warranted parts and labor for all equipment, materials and workmanship for a period of five (5) years.
- B. If equipment is shipped six (6) months or longer prior to start-up, contractor shall provide extended warranty so that equipment will be under warranty for twelve (12) full months from startup.
- C. During the warranty period, the manufacturer shall repair or replace, at no additional cost to the Owner, any equipment, material or workmanship in which defects may develop.

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

##### **2.1 GENERAL:**

- A. The AHU components shall be of the configuration, capacity and style as indicated on the drawings and Equipment Schedule and as specified herein.
- B. The units shall be constructed for indoor installation.
- C. The units shall consist of (in general, see the project drawings for each individual unit's component sections): intake sections for return and outside air, return air sound attenuator section, return air fan section, mixing section with dampers for outside air, return air and exhaust air, relief air section, pre-filter section, preheat coil section, cooling coil section, supply air fan section, supply air sound attenuator section, final filter section, humidifier section and discharge section.
- D. Provide safing between internal components and unit casing to prevent air bypass. Safing material shall match unit interior. All seams or voids between safing, components and unit casing shall be caulked and sealed airtight.

- E. Provide hygienic unit design with interior suitable for washing down. The use of support members framed within the unit casing which will allow for trapping of debris between the supports and casing will not be allowed. Unit insulation must be completely encapsulated.
- F. The component sizes shown on drawings are based on existing drawings, contractor shall field verify all sizes prior to ordering components.

## **2.2 UNIT CASING**

- A. Casing system shall be guaranteed to assure that system capacity, performance, and cleanliness standards specified are not compromised. Unit leakage to be guaranteed at no more than 1% of the design volume at 1-1/2 times the design operating pressure or 30 CFM, whichever is greater.
- B. Any equipment flashing, internal partitions or other attachments to the casing shall be made in such a way as to ensure a permanent leak-tight connection. Attachments that are bolted, screwed, or welded to or through the casing creating air bypass, air leakage or rust propagation areas are not acceptable.
- C. All ductwork penetrations through unit envelope shall be provided with framed openings of size and arrangement as indicated on drawing. Openings to be provided with flanged duct connections of same material as casing interior extending a minimum of 4" from surface of unit casing.
- D. Pipe and conduit penetrations through the unit casings shall be provided by the unit manufacturer and be properly sealed prior to leaving the factory. Penetrations sealed by simply caulking around extension are not acceptable. Penetrations for field supplied systems shall be coordinated during construction at the factory.

## **2.3 DAMPERS**

- A. Dampers shall be low leakage, opposed blade design capable of withstanding 8" wg differential pressure at 2,000 fpm approach velocity. Leakage rate not to exceed 6 CFM per ft.<sup>2</sup> at 4" wg differential pressure and 2,000 fpm approach velocity.
- B. Damper frames shall be made of extruded aluminum. Damper blades shall be extruded aluminum airfoil shape to withstand high velocities and static pressures. Dampers shall be provided with stainless steel blade end seals and flexible synthetic blade edge seals.
- C. Damper actuators shall be electric low voltage DDC, furnished and installed by the Temperature Control Contractor.

## **2.4 AIR FLOW MEASUREMENT**

- A. At each unit, provide electronic airflow traverse probes and transmitters for the purpose of continuously monitoring duct airflow volume where shown on the drawings. Provide probes and transmitters to measure the flow at the inlet to each fan.
- B. The airflow measurement system shall consist of multiple probes with velocity measuring sensors. Sensors shall be immune to the effects of changing temperature, humidity, static pressure, and primary sensor output shall not drift over time. Sensors shall not be affected by the presence of dirt or dust in the air stream. Stations shall be differential pressure type capable of continuously measuring air volume utilizing multiple total and suction pressure measurements with an accuracy within 2%.
  - 1. All probes shall interface with DDC Controls. See Section 23 09 23.

## **2.5 FILTERS**

- A. Provide all prefilters and final filters of number, size and capacity as required for complete replacement for each air handling unit that is being upgraded and as defined in Section 23 40 00, HVAC AIR CLEANING DEVICES.

## **2.6 INTEGRAL FACE & BYPASS HEATING COILS**

- A. Damper motor to be provided and installed in field by Temperature Control Contractor. Coordinate with supplier of damper motor to assure proper mounting bracket is provided with the coil.
- B. Valves, fittings, and accessories shall be piped per piping detail as part of unit manufacturing. All control devices shall conform to Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC.

## **2.7 HUMIDIFIERS:**

- A. Humidifier is to be provided with operator, F&T traps as required and Y-type strainer for steam supply line. Valves, fittings, and accessories shall be piped per piping detail as part of unit manufacturing. Control devices shall conform to Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC.

## **2.8 ELECTRICAL**

- A. All electrical work shall be installed in full compliance with the National Electric Code, and all local codes and requirements. Where applicable, components shall be UL approved. All wiring and components inside air handling plenums shall be weatherproof and rated for such use. All equipment shall contain a grounding conductor.

1. WIRING: 600 volt rated, type #12 THHN copper (minimum size).
2. CONDUIT: EMT conduit utilizing compression type fittings. All conduit penetrations in the unit housing and penetrations across the cooling coil sections and humidifier sections shall be internally sealed with foam sealant to prevent the migration of water vapor in the conduit.

### **PART 3 -- EXECUTION**

#### **3.1 UNIT TESTING:**

- A. Unit manufacturer shall provide tests at the factory and in the field to insure structural integrity, as well as compliance with this specification.
1. The unit fan shall be operated at the design RPM and a complete vibration spectrum shall be conducted. Readings shall be taken in the horizontal, vertical, and axial direction at each fan and motor bearing.
  2. The heating and cooling coils, as well as any other piping included with the air handling units shall be pressure tested. Coils shall be A.R.I. certified.
  3. The entire electrical system shall be functionally checked including motors, lights, utility outlets, etc. for proper operation.
  4. The casing leakage test shall verify that unit casing leakage is less than 1% of design air flow at 1-1/4 times the design static pressure. The unit shall be sealed; pressure sections shall be put under positive pressure and suction sections shall be put under negative pressure. The leakage shall be measured in each section using a calibrated orifice plate. The total casing leakage (positive plus negative) shall be considered the sum of the positive and negative leakage. Casing leakage test shall be performed by contractor in the field after all components are assembled.
- B. Testing shall assure the VA Project Manager that any potential system performance concerns are addressed. Any unit modifications necessary as a result of testing not meeting specified performance levels shall be done by the unit manufacturer at no additional cost to the owner.

- C. The VA Project Manager shall have the option to witness all tests. The manufacturer shall notify the VA Project Manager four weeks prior to the scheduled factory test. VA Project Manager will inform the manufacturer if a representative will witness the tests.
- D. A formal written report including test results shall be submitted to the VA Project Manager.

**3.2 PRE-VALIDATION/INSPECTION:**

- A. The unit manufacturer shall inspect the unit to assure conformance to this specification. The inspections shall be verified by the VA Project Manager. A formal inspection report including the VA Project Manager's verification shall be submitted by the unit manufacturer to the VA Project Manager.
- B. Inspections shall include but not be limited to the following inspection requirements.
  - 1. Verify materials of construction including material type, finish and thickness; perform magnet tests to confirm stainless steel material.
  - 2. Visually inspect weld quality. Check for proper weld size, contour and freedom from undercut (less than 1/32"), burn through, lack of fusion or full penetration, cracks, porosity, weld splatter, arc strikes, etc.
  - 3. Dimensionally inspect component and overall dimensions to confirm the accuracy of vendor records. Concentrate on field connection and mounting dimensions.
  - 4. Visually inspect surface finish as specified. Check freedom from sharp corners and edges; verify surfaces are smooth and snag-free.
  - 5. Visually inspect surface preparation prior to coating, plating, or painting. All mill scale, oil, weld slag, splatter, burrs, sharp edges, saw cut flashing, etc. must be removed.
  - 6. Visually inspect final assemble quality. Check paint, plating, or coating finish, thickness, and workmanship.  
Check for any distortion on welded components.
  - 7. Verify that the proper quantity, type, model no. and construction of bill of material and specification items are provided, including electrical components.
  - 8. Witness functional operation of all adjustable components.

**3.3 INSTALLATION:**

- A. Component manufacturer shall provide complete and detailed written instructions for installing the equipment, assembly of components and joining all sections. Written requirements for locations of supporting members and floor-flatness tolerances shall be provided with submittal drawings.
- B. The component manufacturer shall coordinate unit shipping and installation schedule with mechanical contractor. Mechanical contractor shall be responsible for the rigging, hoisting and coordination of the entire custom built-up air handling unit installation. Lifting and rigging instructions are to be provided by the unit manufacturer with the submittal drawings.
- C. Mechanical contractor shall make all final ductwork and piping connections required for a complete operating system.
- D. Electrical contractor shall provide connection of 460V/3Ph/60Hz power from motor control device to fan disconnect located on unit exterior. Electrical contractor shall also provide connection of 120V/1Ph/60Hz power from the building system to the lighting circuit provided with the unit.
- E. The temperature controls contractor shall install temperature controls and panel, including, pneumatic tubing, control wiring, etc., required for a complete and operating control system. Electrical contractor shall make final connections to the temperature control panel after the unit is installed.

**3.4 START-UP AND OWNER ORIENTATION:**

- A. Air handling unit equipment start-up and owner maintenance orientation shall be the responsibility of the contractor in order to activate equipment warranty and assure that the Owner and his facility personnel are comfortable and familiar with equipment maintenance. Manufacturer shall include a minimum of two (2) hours per unit for start-up - one (1) hour per unit for owner maintenance training and orientation.

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SECTION 23 82 00  
CONVECTION HEATING AND COOLING UNITS

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

Unit heaters.

**1.2 RELATED WORK**

- A. 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.
- B. Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING AND EQUIPMENT: Noise requirements.
- C. Section 23 08 00, COMMISSIONING OF MECHANICAL SYSTEMS.
- D. Section 23 21 13, HYDRONIC PIPING: Heating hot water and chilled water piping.
- E. Section 23 31 00, HVAC DUCTS AND CASINGS: Ducts and flexible connectors.
- F. Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC: Valve operators.
- G. Section 23 05 93, TESTING, ADJUSTING, AND BALANCING FOR HVAC: Flow rates adjusting and balancing.
- H. Section 01 91 13, COMMISSIONING REQUIREMENTS
- I. Section 01 92 13, RETRO-COMMISSIONING REQUIREMENTS.

**1.3 QUALITY ASSURANCE**

Refer to Paragraph, QUALITY ASSURANCE, in Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION.

**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. Unit heaters.
- D. Certificates:
  - 1. Compliance with paragraph, QUALITY ASSURANCE.
  - 2. Compliance with specified standards.
- E. Operation and Maintenance Manuals: Submit in accordance with paragraph, INSTRUCTIONS, in Section 01 00 00, GENERAL REQUIREMENTS.

## 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 (ARI):  
440-05.....Room Fan Coils
- C. National Fire Protection Association (NFPA):  
90A-02.....Standard for the Installation of Air  
Conditioning and Ventilating Systems  
70-05.....National Electrical Code
- D. Underwriters Laboratories, Inc. (UL):  
181-05.....Standard for Factory-Made Air Ducts and Air  
Connectors  
1995-05.....Heating and Cooling Equipment

## 1.6 WARRANTY

In accordance with FAR clause 52.246-21.

## PART 2 - PRODUCTS

### 2.1 UNIT HEATERS

- A. General: Horizontal discharge type for steam heating medium.
- B. Casing: Steel sheet, phosphatized to resist rust and finished in baked enamel. Provide hanger supports.
- C. Fan: Propeller type, direct driven by manufacturer's standard electric motor. Provide resilient mounting. Provide fan guard for horizontal discharge units.
- D. Discharge Air Control:
  - 1. Horizontal discharge: Horizontal, adjustable louvers.
- E. Steam Coil: Aluminum fins bonded to seamless copper tubing by mechanical expansion of the tubing, designed for 517 kPa (75 psig) steam working pressure.
- F. Controls:
  - 1. Provide normally open low voltage steam control valve wired to remote stat.
  - 2. Fan magnetic contactor: Factory installed with low voltage relay for remote pilot duty thermostat operation.

3. Remote low voltage thermostat control with adjustment range between -1 to 32 degree C (30-90 degrees F), and manually set "Off" position.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

- A. Work shall be installed as shown and according to the manufacturer's diagrams and recommendations.
- B. Handle and install units in accordance with manufacturer's written instructions.
- C. Support units rigidly so they remain stationary at all times. Cross-bracing or other means of stiffening shall be provided as necessary. Method of support shall be such that distortion and malfunction of units cannot occur.

#### **3.2 OPERATIONAL TEST**

Refer to Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION.

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**SECTION 26 05 11**  
**REQUIREMENTS FOR ELECTRICAL INSTALLATIONS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, applies to all sections of Division 26.
- B. Furnish and install electrical wiring, systems, equipment and accessories in accordance with the specifications and drawings. Capacities and ratings of motors, transformers, cable, switchboards, switchgear, panelboards, motor control centers, and other items and arrangements for the specified items are shown on drawings.
- C. Electrical service entrance equipment (arrangements for temporary and permanent connections to the power company's system) shall conform to the power company's requirements. Coordinate fuses, circuit breakers and relays with the power company's system, and obtain power company approval for sizes and settings of these devices.
- D. Wiring ampacities specified or shown on the drawings are based on copper conductors, with the conduit and raceways accordingly sized. Aluminum conductors are prohibited.

**1.2 MINIMUM REQUIREMENTS**

- A. References to the National Electrical Code (NEC), Underwriters Laboratories, Inc. (UL) and National Fire Protection Association (NFPA) are minimum installation requirement standards.
- B. Drawings and other specification sections shall govern in those instances where requirements are greater than those specified in the above standards.

**1.3 TEST STANDARDS**

- A. All materials and equipment shall be listed, labeled or certified by a nationally recognized testing laboratory to meet Underwriters Laboratories, Inc., standards where test standards have been established. Equipment and materials which are not covered by UL Standards will be accepted provided equipment and material is listed, labeled, certified or otherwise determined to meet safety requirements of a nationally recognized testing laboratory. Equipment of a class which no nationally recognized testing laboratory accepts, certifies, lists, labels, or determines to be safe, will be considered if inspected or tested in accordance with national industrial standards, such as NEMA, or ANSI. Evidence of compliance shall include certified test reports and definitive shop drawings.
- B. Definitions:

1. Listed; equipment or device of a kind mentioned which:
  - a. Is published by a nationally recognized laboratory which makes periodic inspection of production of such equipment.
  - b. States that such equipment meets nationally recognized standards or has been tested and found safe for use in a specified manner.
2. Labeled; equipment or device is when:
  - a. It embodies a valid label, symbol, or other identifying mark of a nationally recognized testing laboratory such as Underwriters Laboratories, Inc.
  - b. The laboratory makes periodic inspections of the production of such equipment.
  - c. The labeling indicates compliance with nationally recognized standards or tests to determine safe use in a specified manner.
3. Certified; equipment or product is which:
  - a. Has been tested and found by a nationally recognized testing laboratory to meet nationally recognized standards or to be safe for use in a specified manner.
  - b. Production of equipment or product is periodically inspected by a nationally recognized testing laboratory.
  - c. Bears a label, tag, or other record of certification.
4. Nationally recognized testing laboratory; laboratory which is approved, in accordance with OSHA regulations, by the Secretary of Labor.

#### **1.4 QUALIFICATIONS (PRODUCTS AND SERVICES)**

- A. Manufacturers Qualifications: The manufacturer shall regularly and presently produce, as one of the manufacturer's principal products, the equipment and material specified for this project, and shall have manufactured the item for at least three years.
- B. Product Qualification:
  1. Manufacturer's product shall have been in satisfactory operation, on three installations of similar size and type as this project, for approximately three years.
  2. The Government reserves the right to require the Contractor to submit a list of installations where the products 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 MANUFACTURED PRODUCTS

- A. Materials and equipment furnished shall be of current production by manufacturers regularly engaged in the manufacture of such items, for which replacement parts shall be available.
- B. When more than one unit of the same class of 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 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 VA through the COTR a minimum of 15 working days prior to the manufacturers making the factory tests.
  - 2. Four copies of certified test reports containing all test data shall be furnished to the COTR prior to final inspection and not more than 90 days after completion of the tests.
  - 3. When equipment fails to meet factory test and re-inspection is required, the contractor shall be liable for all additional expenses, including expenses of the Government.

### 1.6 EQUIPMENT REQUIREMENTS

Where variations from the contract requirements are requested in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES, 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.

### 1.7 EQUIPMENT PROTECTION

- A. Equipment and materials shall be protected during shipment and storage against physical damage, dirt, moisture, cold and rain:
  - 1. During installation, enclosures, equipment, controls, controllers, circuit protective devices, and other like items, shall be protected

- against entry of foreign matter; and be vacuum cleaned both inside and outside before testing and operating and repainting if required.
2. Damaged equipment shall be, as determined by the COTR, placed in first class operating condition or be returned to the source of supply for repair or replacement.
  3. Painted surfaces shall be protected with factory installed removable heavy kraft paper, sheet vinyl or equal.
  4. Damaged paint on equipment and materials shall be refinished with the same quality of paint and workmanship as used by the manufacturer so repaired areas are not obvious.

#### **1.8 WORK PERFORMANCE**

- A. All electrical work must comply with the requirements of NFPA 70 (NEC), NFPA 70B, NFPA 70E, OSHA Part 1910 subpart J, OSHA Part 1910 subpart S and OSHA Part 1910 subpart K 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. Electricians must wear personal protective equipment while working on energized systems in accordance with NFPA 70E.
  3. Before initiating any work, a job specific work plan must be developed by the contractor with a peer review conducted and documented by the COTR and Medical Center staff. The work plan must include procedures to be used on and near the live electrical equipment, barriers to be installed, safety equipment to be used and exit pathways.
  4. Work on energized circuits or equipment cannot begin until prior written approval is obtained from the Director of the Medical Center.
- D. For work on existing stations, arrange, phase and perform work to assure electrical service for other buildings at all times. 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 and carefully. 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 interferences.

#### **1.9 EQUIPMENT INSTALLATION AND REQUIREMENTS**

- A. Equipment location shall be as close as practical to locations shown on the drawings.
- B. Working spaces shall not be less than specified in the NEC for all voltages specified.
- C. Inaccessible Equipment:
  - 1. Where the Government determines that the Contractor has installed equipment not conveniently accessible for operation and maintenance, the equipment shall be removed and reinstalled as directed at no additional cost to the Government.
  - 2. "Conveniently accessible" is defined as being capable of being reached without the use of ladders, or without climbing or crawling under or over obstacles such as, but not limited to, motors, pumps, belt guards, transformers, piping, ductwork, conduit and raceways.

#### **1.10 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 panelboards, cabinets, motor controllers (starters), safety switches, separately enclosed circuit breakers, individual breakers and controllers in switchboards, switchgear and motor control assemblies, control devices and other significant equipment.
- B. Nameplates shall be laminated black phenolic resin with a white core with engraved lettering, a minimum of 6 mm (1/4 inch) high. Secure nameplates with screws. Nameplates that are furnished by manufacturer as a standard catalog item, or where other method of identification is herein specified, are exceptions.

#### **1.11 SUBMITTALS**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. The Government's approval shall be obtained for all equipment and material before delivery to the job site. Delivery, storage or installation of equipment or material which has not had prior approval will not be permitted at the job site.

- C. All submittals shall include adequate descriptive literature, catalog cuts, shop drawings and other data necessary for the Government to ascertain that the proposed equipment and materials comply with specification requirements. Catalog cuts submitted for approval shall be legible and clearly identify 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, pictures, nameplate data and test reports as required.
  2. Elementary and interconnection wiring diagrams for communication and signal systems, control system and equipment assemblies. All terminal points and wiring shall be identified on wiring diagrams.
  3. Parts list which shall include those replacement parts recommended by the equipment manufacturer, quantity of parts, current price and availability of each part.
- F. Manuals: Submit in accordance with Section 01 00 00, GENERAL REQUIREMENTS.
1. Maintenance and Operation Manuals: Submit as required for systems and equipment specified in the technical sections. Furnish four copies, bound in hardback binders, (manufacturer's standard binders) or an approved equivalent. Furnish one complete manual as specified in the technical section but in no case later than prior to performance of systems or equipment test, and furnish the remaining manuals prior to contract completion.
  2. Inscribe the following identification on the cover: the words "MAINTENANCE AND OPERATION MANUAL," the name and location of the system, equipment, building, name of Contractor, and contract 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 system 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 and maintenance instructions.
  - e. Safety precautions.
  - f. Diagrams and illustrations.
  - g. Testing methods.
  - h. Performance data.
  - i. Lubrication schedule including type, grade, temperature range, and frequency.
  - j. 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 parts, and name of servicing organization.
  - k. Appendix; list qualified permanent servicing organizations for support of the equipment, including addresses and certified qualifications.
- G. Approvals will be based on complete submission of manuals together with shop drawings.
- H. After approval and prior to installation, furnish the COTR with one sample of each of the following:
  1. A 300 mm (12 inch) length of each type and size of wire and cable along with the tag from the coils of reels from which the samples were taken.
  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, outlet box, manual motor starter, device plate, engraved nameplate, wire and cable splicing and terminating material and single pole molded case circuit breaker.
  6. Each type of light fixture specified in Section 26 51 00, INTERIOR LIGHTING or shown on the drawings.

**1.12 SINGULAR NUMBER**

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.

**1.13 TRAINING**

- A. Training shall be provided in accordance with Article, INSTRUCTIONS, of Section 01 00 00, GENERAL REQUIREMENTS.
- B. Training shall be provided for the particular equipment or system as required in each associated specification.
- C. A training schedule shall be developed and submitted by the contractor and approved by the COTR at least 30 days prior to the planned training.

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**SECTION 26 05 21**  
**LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW)**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

This section specifies the furnishing, installation, and connection of the low voltage power and lighting wiring.

**1.2 RELATED WORK**

- A. Sealing around penetrations to maintain the integrity of time rated construction: Section 07 84 00, FIRESTOPPING.
- B. General electrical requirements that are common to more than one section in Division 26: Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.
- C. Conduits for cables and wiring: Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS.
- D. Requirements for personnel safety and to provide a low impedance path for possible ground fault currents: Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS.

**1.3 SUBMITTALS**

- A. In accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES, furnish the following:
  - 1. Manufacturer's Literature and Data: Showing each cable type and rating.
  - 2. Certificates: Two weeks prior to final inspection, deliver to the COTR four copies of the certification that the material is in accordance with the drawings and specifications and has been properly installed.

**1.4 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 the basic designation only.
- B. American Society of Testing Material (ASTM):
  - D2301-04.....Standard Specification for Vinyl Chloride Plastic Pressure Sensitive Electrical Insulating Tape
- C. Federal Specifications (Fed. Spec.):
  - A-A-59544-00.....Cable and Wire, Electrical (Power, Fixed Installation)
- D. National Fire Protection Association (NFPA):

70-05.....National Electrical Code (NEC)

E. Underwriters Laboratories, Inc. (UL):

44-02.....Thermoset-Insulated Wires and Cables

83-03.....Thermoplastic-Insulated Wires and Cables

467-01.....Electrical Grounding and Bonding Equipment

486A-01.....Wire Connectors and Soldering Lugs for Use with  
Copper Conductors

486C-02.....Splicing Wire Connectors

486D-02.....Insulated Wire Connector Systems for Underground  
Use or in Damp or Wet Locations

486E-00.....Equipment Wiring Terminals for Use with Aluminum  
and/or Copper Conductors

493-01.....Thermoplastic-Insulated Underground Feeder and  
Branch Circuit Cable

514B-02.....Fittings for Cable and Conduit

1479-03.....Fire Tests of Through-Penetration Fire Stops

**PART 2 - PRODUCTS**

**2.1 CABLE AND WIRE (POWER AND LIGHTING)**

A. Cable and Wire shall be in accordance with Fed. Spec. A-A-59544, except as hereinafter specified.

B. Single Conductor:

1. Shall be annealed copper.

2. Shall be stranded for sizes No. 8 AWG and larger, solid for sizes No. 10 AWG and smaller.

3. Shall be minimum size No. 12 AWG, except where smaller sizes are allowed herein.

C. Insulation:

1. THW, XHHW, or dual rated THHN-THWN shall be in accordance with UL 44, and 83.

2. Direct burial: UF or USE shall be in accordance with UL 493.

3. Isolated power system wiring: Type XHHW with a dielectric constant of 3.5 or less.

D. Color Code:

1. Secondary service, feeder and branch circuit conductors shall be color coded as follows:

208/120 volt	Phase	480/277 volt
Black	A	Brown
Red	B	Orange

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Blue	C	Yellow
White	Neutral	Gray *
* or white with colored (other than green) tracer.		

- a. The lighting circuit "switch legs" and 3-way switch "traveling wires" shall have color coding unique and distinct (i.e. pink and purple) from the color coding indicated above. The unique color codes shall be solid and in accordance with the NEC. Field coordinate for a final color coding with the COTR.
2. Use solid color compound or solid color coating for No. 12 AWG and No. 10 AWG branch circuit conductors and neutral sizes.
3. Phase conductors No. 8 AWG and larger shall be color-coded using one of the following methods:
  - a. Solid color compound or solid color coating.
  - b. Stripes, bands, or hash marks of color specified above.
  - c. Color as specified using 19 mm (3/4 inch) wide tape. Apply tape in half overlapping turns for a minimum of 75 mm (three inches) for terminal points, and in junction boxes, pull boxes, troughs, manholes, and handholes. 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.
4. For modifications and additions to existing wiring systems, color coding shall conform to the existing wiring system.
5. Color code for isolated power system wiring shall be in accordance with the NEC.

## 2.2 SPLICES AND JOINTS

- A. In accordance with UL 486A, C, D, E and NEC.
- B. Branch circuits (No. 10 AWG and smaller):
  1. Connectors: Solderless, screw-on, reusable pressure cable type, 600 volt, 105 degree C with integral insulation, approved for copper and aluminum conductors.
  2. The integral insulator shall have a skirt to completely cover the stripped wires.
  3. The number, size, and combination of conductors, as listed on the manufacturers packaging shall be strictly complied with.
- C. Feeder Circuits:
  1. Connectors shall be indent, hex screw, or bolt clamp-type of high conductivity and corrosion-resistant material.

2. Field installed compression connectors for cable sizes 250 kcmil and larger shall have not less than two clamping elements or compression indents per wire.
3. Insulate splices and joints with materials approved for the particular use, location, voltage, and temperature. Insulate with not less than that of the conductor level that is being joined.
4. Plastic electrical insulating tape: ASTM D2304 shall apply, flame retardant, cold and weather resistant.

### **2.3 CONTROL WIRING**

- A. Unless otherwise specified in other sections of these specifications, control wiring shall be as specified for power and lighting wiring, except the minimum size shall be not less than No. 14 AWG.
- B. Control wiring shall be large enough so that the voltage drop under inrush conditions does not adversely affect operation of the controls.

### **2.4 WIRE LUBRICATING COMPOUND**

- A. Suitable for the wire insulation and conduit it is used with, and shall not harden or become adhesive.
- B. Shall not be used on wire for isolated type electrical power systems.

### **2.5 FIREPROOFING TAPE**

- A. The tape shall consist of a flexible, conformable fabric of organic composition coated one side with flame-retardant elastomer.
- B. The tape shall be self-extinguishing and shall not support combustion. It shall be arc-proof and fireproof.
- C. The tape shall not deteriorate when subjected to water, gases, salt water, sewage, or fungus and be resistant to sunlight and ultraviolet light.
- D. The finished application shall withstand a 200-ampere arc for not less than 30 seconds.
- E. Securing tape: Glass cloth electrical tape not less than 0.18 mm (7 mils) thick, and 19 mm (3/4 inch) wide.

### **2.6 WARNING TAPE**

- A. The tape shall be standard, 76 mm (3 inch) wide, 4-Mil polyethylene detectable type.
- B. The tape shall be red with black letters indicating "CAUTION BURIED ELECTRIC LINE BELOW".

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION, GENERAL**

- A. Install in accordance with the NEC, and as specified.
- B. Install all wiring in raceway systems, except where direct burial or HCF Type AC cables are used.

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- C. Splice cables and wires only in outlet boxes, junction boxes, pull boxes, manholes, or handholes.
- D. Wires of different systems (i.e. 120V, 277V) shall not be installed in the same conduit or junction box system.
- 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. For panelboards, cabinets, wireways, switches, and equipment assemblies, neatly form, train, and tie the cables in individual circuits.
- G. Seal cable and wire entering a building from underground, between the wire and conduit where the cable exits the conduit, with a non-hardening approved compound.
- H. Wire Pulling:
  - 1. Provide installation equipment that will prevent the cutting or abrasion of insulation during pulling of cables.
  - 2. Use ropes made of nonmetallic material for pulling feeders.
  - 3. Attach pulling lines for feeders by means of either woven basket grips or pulling eyes attached directly to the conductors, as approved by the COTR.
  - 4. Pull in multiple cables together in a single conduit.
- I. No more than (3) single-phase branch circuits shall be installed in any one conduit.
- J. The wires shall be derated in accordance with NEC Article 310. Neutral wires, under conditions defined by the NEC, shall be considered current-carrying conductors.

### **3.2 INSTALLATION IN MANHOLES**

- A. Install and support cables in manholes on the steel racks with porcelain or equal insulators. Train the cables around the manhole walls, but do not bend to a radius less than six times the overall cable diameter.

### **3.3 SPLICE INSTALLATION**

- A. Splices and terminations shall be mechanically and electrically secure.
- B. Where the Government determines that unsatisfactory splices or terminations have been installed, remove the devices and install approved devices at no additional cost to the Government.

### **3.4 CONTROL AND SIGNAL WIRING INSTALLATION**

- A. Unless otherwise specified in other sections, install wiring and connect to equipment/devices to perform the required functions as shown and specified.

- B. Except where otherwise required, install a separate power supply circuit for each system so that malfunctions in any system will not affect other systems.
- C. Where separate power supply circuits are not shown, connect the systems to the nearest panelboards of suitable voltages, which are intended to supply such systems and have suitable spare circuit breakers or space for installation.
- D. Install a red warning indicator on the handle of the branch circuit breaker for the power supply circuit for each system to prevent accidental de-energizing of the systems.
- E. System voltages shall be 120 volts or lower where shown on the drawings or as required by the NEC.

### **3.5 CONTROL AND SIGNAL SYSTEM 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.
- D. In each manhole and handhole, install embossed brass tags to identify the system served and function.

### **3.6 FEEDER IDENTIFICATION**

- A. In each interior pulbox and junction box, install metal tags on each circuit cables and wires to clearly designate their circuit identification and voltage.
- B. In each manhole and handhole, provide tags of the embossed brass type, showing the cable type and voltage rating. Attach the tags to the cables with slip-free plastic cable lacing units.

### **3.7 DIRECT BURIAL CABLE INSTALLATION**

- A. Tops of the cables:
  - 1. Below the finished grade: Minimum 600 mm (24 inches) unless greater depth is shown.
  - 2. Below road and other pavement surfaces: In conduit as specified, minimum 750 mm (30 inches) unless greater depth is shown.
  - 3. Do not install them under railroad tracks.
- B. Under road and paved surfaces: Install cables in concrete encased galvanized steel rigid conduits. Size as shown on plans, but not less than 50 mm (two inch) trade size with bushings at each end of each conduit run. Provide size/quantity of conduits required to accommodate cables plus one spare.
- C. Work with extreme care near existing ducts, conduits, cables and other utilities to prevent any damage.

D. Cut the trenches neatly and uniformly:

1. Place a 75 mm (3 inch) layer of sand in the trenches before installing the cables.
2. Place a 75 mm (three inch) layer of sand over the installed cables.
3. Install continuous horizontal, 25 mm by 200 mm (1 inch by 8 inch) preservative impregnated wood planking 75 mm (three inches) above the cables before backfilling.

E. Provide horizontal slack in the cables for contraction during cold weather.

F. Install the cables in continuous lengths. Splices within cable runs will not be accepted.

G. Connections and terminations shall be submersible type designed for the cables being installed.

H. Warning tape shall be continuously placed 300 mm (12 inches) above the buried cables.

### 3.8 EXISTING WIRING

Unless specifically indicated on the plans, existing wiring shall not be reused for the new installation. Only wiring that conforms to the specifications and applicable codes may be reused. If existing wiring does not meet these requirements, existing wiring may not be reused and new wires shall be installed.

### 3.9 FIELD TESTING

A. Feeders and branch circuits shall have their insulation tested after installation and before connection to utilization devices such as fixtures, motors, or appliances.

B. Tests shall be performed by megger and conductors shall test free from short-circuits and grounds.

C. Test conductor phase-to-phase and phase-to-ground.

D. The Contractor shall furnish the instruments, materials, and labor for these tests.

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**SECTION 26 05 26**  
**GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section specifies general grounding and bonding requirements of electrical equipment operations and to provide a low impedance path for possible ground fault currents.
- B. "Grounding electrode system" refers to all electrodes required by NEC, as well as including made, supplementary, lightning protection system grounding electrodes.
- C. The terms "connect" and "bond" are used interchangeably in this specification and have the same meaning.

**1.2 RELATED WORK**

- A. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements and items that are common to more than one section of Division 26.
- B. Section 26 05 21, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW): Low Voltage power and lighting wiring.

**1.3 SUBMITTALS**

- A. Submit in accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.
- B. Shop Drawings:
  - 1. Sufficient information, clearly presented, shall be included to determine compliance with drawings and specifications.
  - 2. Include the location of system grounding electrode connections and the routing of aboveground and underground grounding electrode conductors.
- C. Test Reports: Provide certified test reports of ground resistance.
- D. Certifications: Two weeks prior to final inspection, submit four copies of the following to the COTR:
  - 1. Certification that the materials and installation is in accordance with the drawings and specifications.
  - 2. Certification, by the Contractor, that the complete installation has been properly installed and tested.

**1.4 APPLICABLE PUBLICATIONS**

Publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the

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extent referenced. Publications are referenced in the text by the basic designation only.

- A. American Society for Testing and Materials (ASTM):
- B1-2001.....Standard Specification for Hard-Drawn Copper Wire
  - B8-2004.....Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
- B. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
- 81-1983.....IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System
- C. National Fire Protection Association (NFPA):
- 70-2005.....National Electrical Code (NEC)
  - 99-2005.....Health Care Facilities
- D. Underwriters Laboratories, Inc. (UL):
- 44-2005 .....Thermoset-Insulated Wires and Cables
  - 83-2003 .....Thermoplastic-Insulated Wires and Cables
  - 467-2004 .....Grounding and Bonding Equipment
  - 486A-486B-2003 .....Wire Connectors

## **PART 2 - PRODUCTS**

### **2.1 GROUNDING AND BONDING CONDUCTORS**

- A. Equipment grounding conductors shall be UL 83 insulated stranded copper, except that sizes 6 mm<sup>2</sup> (10 AWG) and smaller shall be solid copper. Insulation color shall be continuous green for all equipment grounding conductors, except that wire sizes 25 mm<sup>2</sup> (4 AWG) and larger shall be permitted to be identified per NEC.
- B. Bonding conductors shall be ASTM B8 bare stranded copper, except that sizes 6 mm<sup>2</sup> (10 AWG) and smaller shall be ASTM B1 solid bare copper wire.
- C. Isolated Power System: Type XHHW-2 insulation with a dielectric constant of 3.5 or less.
- D. Electrical System Grounding: Conductor sizes shall not be less than what is shown on the drawings and not less than required by the NEC, whichever is greater.

## **2.2 GROUND RODS**

- A. Copper clad steel, 19 mm (3/4-inch) diameter by 3000 mm (10 feet) long, conforming to UL 467.
- B. Quantity of rods shall be as required to obtain the specified ground resistance.

## **2.3 SPLICES AND TERMINATION COMPONENTS**

Components shall meet or exceed UL 467 and be clearly marked with the manufacturer, catalog number, and permitted conductor size(s).

## **2.4 GROUND CONNECTIONS**

- A. Below Grade: Exothermic-welded type connectors.
- B. Above Grade:
  - 1. Bonding Jumpers: compression type connectors, using zinc-plated fasteners and external tooth lockwashers.
  - 2. Ground Busbars: Two-hole compression type lugs using tin-plated copper or copper alloy bolts and nuts.
  - 3. Rack and Cabinet Ground Bars: one-hole compression-type lugs using zinc-plated or copper alloy fasteners.

## **2.5 EQUIPMENT RACK AND CABINET GROUND BARS**

Provide solid copper ground bars designed for mounting on the framework of open or cabinet-enclosed equipment racks with minimum dimensions of 4 mm thick by 19 mm wide (3/8 inch x ¾ inch).

## **2.6 GROUND TERMINAL BLOCKS**

At any equipment mounting location (e.g. backboards and hinged cover enclosures) where rack-type ground bars cannot be mounted, provide screw lug-type terminal blocks.

## **2.7 SPLICE CASE GROUND ACCESSORIES**

Splice case grounding and bonding accessories shall be supplied by the splice case manufacturer when available. Otherwise, use 16 mm<sup>2</sup> (6 AWG) insulated ground wire with shield bonding connectors.

# **PART 3 - EXECUTION**

## **3.1 GENERAL**

- A. Ground in accordance with the NEC, as shown on drawings, and as hereinafter specified.
- B. System Grounding:
  - 1. Secondary service neutrals: Ground at the supply side of the secondary disconnecting means and at the related transformers.

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 structures (including ductwork and building steel), 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. Special Grounding: For patient care area electrical power system grounding, conform to NFPA 99, and NEC.

### **3.2 INACCESSIBLE GROUNDING CONNECTIONS**

Make grounding connections, which are buried or otherwise normally inaccessible (except connections for which periodic testing access is required) by exothermic weld.

### **3.3 MEDIUM-VOLTAGE EQUIPMENT AND CIRCUITS**

- A. Switchgear: Provide a bare grounding electrode conductor from the switchgear ground bus to the grounding electrode system.
- B. Duct Banks and Manholes: Provide an insulated equipment grounding conductor in each duct containing medium or high voltage conductors, sized per NEC except that minimum size shall be 25 mm<sup>2</sup> (2 AWG). Bond the equipment grounding conductors to the switchgear ground bus, to all manhole hardware and ground rods, to the cable shielding grounding provisions of medium or high voltage cable splices and terminations, and equipment enclosures.
- C. Pad Mounted Transformers:
1. Provide a driven ground rod and bond with a grounding electrode conductor to the transformer grounding pad metal steel.
  2. Ground the secondary neutral.
- D. Lightning Arresters: Connect lightning arresters to the equipment ground bus or ground rods as applicable.
- E. Outdoor Metallic Fences Around Electrical Equipment: Fences shall be grounded as indicated. Drive ground rods until the top is 300 mm (12 inches) below grade. Attach a 25 mm<sup>2</sup> (4 AWG) copper conductor, by exothermic weld to the ground rods and extend underground to the immediate vicinity of fence post. Lace the conductor vertically into 300 mm (12 inches) of fence mesh and fasten by two approved bronze compression fittings, one to bond wire to post and the other to bond

wire to fence. Each gate section shall be bonded to its gatepost by a 3 by 25 mm (1/8 by one inch) flexible braided copper strap and ground post clamps. Clamps shall be of the anti-electrolysis type.

- F. Metallic Conduit: 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 bare grounding conductor to the equipment ground bus.

### **3.4 SECONDARY EQUIPMENT AND CIRCUITS**

- A. Main Bonding Jumper: Bond the secondary service neutral to the ground bus in the service equipment.
- B. Metallic Piping, Building Steel, and Supplemental Electrode(s):
1. Provide a grounding electrode conductor sized per NEC between the service equipment ground bus and all metallic water and gas pipe systems, building steel, and supplemental or made electrodes. Jumper insulating joints in the metallic piping. All connections to electrodes shall be made with fittings that conform to UL 467.
  2. Provide a supplemental ground electrode and bond to the grounding electrode system.
- C. Service Disconnect (Separate Individual Enclosure): Provide a ground bar bolted to the enclosure with lugs for connecting the various grounding conductors.
- D. Switchgear, Switchboards, Unit Substations, and Motor Control Centers:
1. Connect the various feeder equipment grounding conductors to the ground bus in the enclosure with suitable pressure connectors.
  2. For service entrance equipment, connect the grounding electrode conductor to the ground bus.
  3. Connect metallic conduits, which terminate without mechanical connection to the housing, by grounding bushings and grounding conductor to the equipment ground bus.
- E. Transformers:
1. Exterior: Exterior transformers supplying interior service equipment shall have the neutral grounded at the transformer secondary. Provide a grounding electrode at the transformer.
  2. 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.

F. Conduit Systems:

1. Ground all metallic conduit systems. All metallic conduit systems shall contain an equipment grounding conductor.
2. Non-metallic conduit systems shall contain an equipment grounding conductor, except that non-metallic feeder conduits which carry a grounded conductor from exterior transformers to interior or building-mounted service entrance equipment need not contain an equipment grounding conductor.
3. Conduit containing only a grounding conductor, and which is provided for mechanical protection of the conductor, shall be bonded to that conductor at the entrance and exit from the conduit.

G. Feeders and Branch Circuits: Install equipment grounding conductors with all feeders and power and lighting branch circuits.

H. 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.
3. Provide ground bars in panelboards, bolted to the housing, with sufficient lugs to terminate the equipment grounding conductors.

I. Motors and Starters: Provide lugs in motor terminal box and starter housing or motor control center compartment to terminate equipment grounding conductors.

J. Receptacles shall not be grounded through their mounting screws. Ground with a jumper from the receptacle green ground terminal to the device box ground screw and the branch circuit equipment grounding conductor.

K. Ground lighting fixtures to the equipment grounding conductor of the wiring system when the green ground is provided; otherwise, ground the fixtures through the conduit systems. 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.

L. Fixed electrical appliances and equipment shall be provided with a ground lug for termination of the equipment grounding conductor.

- M. Raised Floors: Provide bonding of all raised floor components. See details on the drawings.
- N. Panelboard Bonding: The equipment grounding terminal buses of the normal and essential branch circuit panelboards serving the same individual patient vicinity shall be bonded together with an insulated continuous copper conductor not less than 16 mm<sup>2</sup> (10 AWG). These conductors shall be installed in rigid metal conduit.

### **3.5 CORROSION INHIBITORS**

When making ground and ground 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 building 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 gases and suction piping, at the outlets, directly to the room or patient ground bus.

### **3.7 LIGHTNING PROTECTION SYSTEM**

Bond the lightning protection system to the electrical grounding electrode system.

### **3.8 ELECTRICAL ROOM GROUNDING**

Building Earth Ground Busbars: Provide ground busbar hardware at each electrical room and connect to pigtail extensions of the building grounding ring.

### **3.9 WIREWAY GROUNDING**

- A. Ground and Bond Metallic Wireway Systems as follows:
  - 1. Bond the metallic structures of wireway to provide 100 percent electrical continuity throughout the wireway system by connecting a 16 mm<sup>2</sup> (6 AWG) bonding jumper at all intermediate metallic enclosures and across all section junctions.
  - 2. Install insulated 16 mm<sup>2</sup> (6 AWG) bonding jumpers between the wireway system bonded as required in paragraph 1 above, and the closest building ground at each end and approximately every 16 meters (50 feet).

3. Use insulated 16 mm<sup>2</sup> (6 AWG) bonding jumpers to ground or bond metallic wireway at each end at all intermediate metallic enclosures and cross all section junctions.
4. Use insulated 16 mm<sup>2</sup> (6 AWG) bonding jumpers to ground cable tray to column-mounted building ground plates (pads) at each end and approximately every 15 meters.

### 3.10 GROUND RESISTANCE

- A. Grounding system resistance to ground shall not exceed 5 ohms. Make necessary modifications or additions to the grounding electrode system for compliance without additional cost to the Government. Final tests shall assure that this requirement is met.
- B. 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 and shall be made in normally dry conditions not less than 48 hours after the last rainfall. Resistance measurements of separate grounding electrode systems shall be made before the systems are bonded together below grade. 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. Services at power company interface points shall comply with the power company ground resistance requirements.
- D. Below-grade connections shall be visually inspected by the COTR prior to backfilling. The Contractor shall notify the COTR 24 hours before the connections are ready for inspection.

### 3.11 GROUND ROD INSTALLATION

- A. Drive each rod vertically in the earth, not less than 3000 mm (10 feet) in depth.
- B. Where permanently concealed ground connections are required, make the connections by the exothermic process to form solid metal joints. Make accessible ground connections with mechanical pressure type ground connectors.
- C. Where rock prevents the driving of vertical ground rods, install angled ground rods or grounding electrodes in horizontal trenches to achieve the specified resistance.

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**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. Sealing around penetrations to maintain the integrity of fire rated construction: Section 07 84 00, FIRESTOPPING.
- B. Fabrications for the deflection of water away from the building envelope at penetrations: Section 07 60 00, FLASHING AND SHEET METAL.
- C. Sealing around conduit penetrations through the building envelope to prevent moisture migration into the building: Section 07 92 00, JOINT SEALANTS.
- D. Identification and painting of conduit and other devices: Section 09 91 00, PAINTING.
- E. General electrical requirements and items that is common to more than one section of Division 26: Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.
- F. Requirements for personnel safety and to provide a low impedance path for possible ground fault currents: Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS.

**1.3 SUBMITTALS**

In accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES, furnish the following:

- A. Shop Drawings:
  - 1. Size and location of main feeders;
  - 2. Size and location of panels and pull boxes
  - 3. Layout of required conduit penetrations through structural elements.
  - 4. The specific item proposed and its area of application shall be identified on the catalog cuts.
- B. Certification: Prior to final inspection, deliver to the COTR four copies of the certification that the material is in accordance with the drawings and specifications and has been properly installed.

#### 1.4 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 the basic designation only.
- B. National Fire Protection Association (NFPA):  
70-05.....National Electrical Code (NEC)
- C. Underwriters Laboratories, Inc. (UL):  
1-03.....Flexible Metal Conduit  
5-01.....Surface Metal Raceway and Fittings  
6-03.....Rigid Metal Conduit  
50-03.....Enclosures for Electrical Equipment  
360-03.....Liquid-Tight Flexible Steel Conduit  
467-01.....Grounding and Bonding Equipment  
514A-01.....Metallic Outlet Boxes  
514B-02.....Fittings for Cable and Conduit  
514C-05.....Nonmetallic Outlet Boxes, Flush-Device Boxes and  
Covers  
651-02.....Schedule 40 and 80 Rigid PVC Conduit  
651A-03.....Type EB and A Rigid PVC Conduit and HDPE Conduit  
797-03.....Electrical Metallic Tubing  
1242-00.....Intermediate Metal Conduit
- D. National Electrical Manufacturers Association (NEMA):  
TC-3-04.....PVC Fittings for Use with Rigid PVC Conduit and  
Tubing  
FB1-03.....Fittings, Cast Metal Boxes and Conduit Bodies  
for Conduit, Electrical Metallic Tubing and  
Cable

#### PART 2 - PRODUCTS

##### 2.1 MATERIAL

- A. Conduit Size: In accordance with the NEC, but not less than 3/4 inch unless otherwise shown. Where permitted by the NEC, 3/4 inch flexible conduit may be used for tap connections to recessed lighting fixtures.
- B. Conduit:
1. Rigid galvanized steel: Shall Conform to UL 6, ANSI C80.1.
  2. Rigid aluminum: Shall Conform to UL 6A, ANSI C80.5.
  3. Rigid intermediate steel conduit (IMC): Shall Conform to UL 1242, ANSI C80.6.

4. Electrical metallic tubing (EMT): Shall Conform to UL 797, ANSI C80.3. Maximum size not to exceed 105 mm (4 inch) and shall be permitted only with cable rated 600 volts or less.
  5. Flexible galvanized steel conduit: Shall Conform to UL 1.
  6. Liquid-tight flexible metal conduit: Shall Conform to UL 360.
  7. Direct burial plastic conduit: Shall conform to UL 651 and UL 651A, heavy wall PVC or high density polyethylene (PE).
  8. Surface metal raceway: Shall Conform to UL 5.
- C. Conduit Fittings:
1. Rigid steel and IMC conduit fittings:
    - a. Fittings shall meet the requirements of UL 514B and ANSI/ NEMA FB1.
    - b. Standard threaded couplings, locknuts, bushings, 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. Rigid aluminum conduit fittings:
    - a. Standard threaded couplings, locknuts, bushings, and elbows: Malleable iron, steel or aluminum alloy materials; Zinc or cadmium plate iron or steel fittings. Aluminum fittings containing more than 0.4 percent copper are prohibited.
    - b. Locknuts and bushings: As specified for rigid steel and IMC conduit.
    - c. Set screw fittings: Not permitted for use with aluminum conduit.

3. Electrical metallic tubing fittings:
  - a. Fittings shall meet the requirements of UL 514B and ANSI/ NEMA FB1.
  - b. Only steel or malleable iron materials are acceptable.
  - c. Couplings and connectors: Concrete tight and rain tight, with connectors having insulated throats. Use gland and ring compression type couplings and connectors for conduit sizes 50 mm (2 inches) and smaller. Use set screw type couplings with four set screws each for conduit sizes over 50 mm (2 inches). Use set screws 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 steel 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 ANSI/ 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:
  - a. Fittings shall meet the requirements of UL 514C and NEMA TC3.
  - b. As recommended by the conduit manufacturer.
7. Surface metal raceway fittings: As recommended by the raceway manufacturer.
8. Expansion and deflection couplings:
  - a. Conform to UL 467 and UL 514B.
  - b. Accommodate, 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 fault currents in accordance with UL 467, and the NEC code tables for ground 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 by 38 mm (1-1/2 by 1-1/2 inch), 12 gage steel, cold formed, lipped channels; with not less than 9 mm (3/8 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. Cast metal where required by the NEC or shown, and equipped with rustproof boxes.
  - 3. Sheet metal boxes: Galvanized steel, except where otherwise shown.
  - 4. Flush mounted wall or ceiling boxes shall be installed with raised covers so that 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.
- F. Wireways: Equip with hinged covers, except where removable covers are shown.
- G. Warning Tape: Standard, 4-Mil polyethylene 76 mm (3 inch) wide tape detectable type, red with black letters, and imprinted with "CAUTION BURIED ELECTRIC LINE BELOW".

### **PART 3 - EXECUTION**

#### **3.1 PENETRATIONS**

- A. Cutting or Holes:
  - 1. Locate holes in advance where they are proposed in the structural sections such as ribs or beams. Obtain the approval of the COTR prior to drilling through structural sections.
  - 2. Cut holes through concrete and masonry in new and existing structures with a diamond core drill or concrete saw. Pneumatic hammer, impact electric, hand or manual hammer type drills are not allowed, except where permitted by the COTR as required by limited working space.
- B. Fire Stop: 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, with rock wool fiber or silicone foam sealant only. Completely fill and seal clearances between raceways and openings with the fire stop material.

- C. Waterproofing: At floor, exterior wall, and roof conduit penetrations, completely seal clearances around the conduit and make watertight as specified in Section 07 92 00, JOINT SEALANTS.

### 3.2 INSTALLATION, GENERAL

- A. In accordance with UL, NEC, as shown, and as hereinafter specified.
- B. Essential (Emergency) raceway systems shall be entirely independent of other raceway systems, except where specifically "accepted" by NEC Article 517.
- C. Install conduit as follows:
1. In complete runs before pulling in cables or wires.
  2. Flattened, dented, or deformed conduit is not permitted. Remove and replace the damaged conduits with new undamaged material.
  3. Assure conduit installation does not encroach into the ceiling height head room, walkways, or doorways.
  4. Cut square with a hacksaw, ream, remove burrs, and draw up tight.
  5. Mechanically and electrically continuous.
  6. Independently support conduit at 8'0" on center. Do not use other supports i.e., (suspended ceilings, suspended ceiling supporting members, lighting fixtures, conduits, mechanical piping, or mechanical ducts).
  7. Support within 300 mm (1 foot) of changes of direction, and within 300 mm (1 foot) of each enclosure to which connected.
  8. Close ends of empty conduit with plugs or caps at the rough-in stage to prevent entry of debris, until wires are pulled in.
  9. Conduit installations under fume and vent hoods are prohibited.
  10. Secure conduits to cabinets, junction boxes, pull boxes and outlet boxes with bonding type locknuts. For rigid 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.
  11. Flashing of penetrations of the roof membrane is specified in Section 07 60 00, FLASHING AND SHEET METAL.
  12. Do not use aluminum conduits in wet locations.

13. Unless otherwise indicated on the drawings or specified herein, all conduits shall be installed concealed within finished walls, floors and ceilings.

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.
2. Deviations: Make only where necessary to avoid interferences and only after drawings showing the proposed deviations have been submitted approved by the COTR.

**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 when the following occurs:
  - a. Where shown on the structural drawings.
  - b. As approved by the COTR 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 1/3 of the slab thickness is prohibited.
  - b. Space between conduits in slabs: Approximately six conduit diameters apart, except 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 (3/4 inch) of concrete around the conduits.
5. Make couplings and connections watertight. Use thread compounds that are UL approved conductive type to insure low resistance ground continuity through the conduits. Tightening set screws with pliers is prohibited.

B. Furred or Suspended Ceilings and in Walls:

1. Conduit for conductors above 600 volts:
  - a. Rigid steel or rigid aluminum.

- b. Aluminum conduit mixed indiscriminately with other types in the same system is prohibited.
- 2. Conduit for conductors 600 volts and below:
  - a. Rigid steel, IMC, rigid aluminum, or EMT. Different type conduits mixed indiscriminately in the same system is prohibited.
- 3. Align and run conduit parallel or perpendicular to the building lines.
- 4. Connect recessed lighting fixtures to conduit runs with maximum 1800 mm (six feet) of flexible metal conduit extending from a junction box to the fixture.
- 5. Tightening set screws with pliers is prohibited.

### **3.4 EXPOSED WORK INSTALLATION**

- A. Unless otherwise indicated on the drawings, exposed conduit is only permitted in mechanical and electrical rooms.
- B. Conduit for conductors above 600 volts:
  - 1. Rigid steel or rigid aluminum.
  - 2. Aluminum conduit mixed indiscriminately with other types in the same system is prohibited.
- C. Conduit for Conductors 600 volts and below:
  - 1. Rigid steel, IMC, rigid aluminum, or EMT. Different type of conduits mixed indiscriminately 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 2400 mm (eight foot) intervals.
- G. Surface metal raceways: Use only where shown.
- H. Painting:
  - 1. Paint exposed conduit as specified in Section 09 91 00, PAINTING.
  - 2. Paint all conduits containing cables rated over 600 volts safety orange. Refer to Section 09 91 00, PAINTING for preparation, paint type, and exact color. In addition, paint legends, using 50 mm (two inch) high black numerals and letters, showing the cable voltage rating. Provide legends where conduits pass through walls and floors and at maximum 6000 mm (20 foot) intervals in between.

### **3.5 DIRECT BURIAL INSTALLATION**

- A. Exterior routing of Lighting Systems and Other Branch circuits (600 Volt and Less, and 1500 mm (5 feet) from the buildings):
  - 1. Conduit: Thick wall PVC or high density PE, unless otherwise shown.

2. Mark conduit at uniform intervals to show the kind of material, direct burial type, and the UL approval label.
3. Install conduit fittings and terminations as recommended by the conduit manufacturer.
4. Tops of conduits shall be as follows unless otherwise shown:
  - a. Not less than 600 mm (24 inches) below finished grade.
  - b. Not less than 750 mm (30 inches) below road and other paved surfaces.
5. Work with extreme care near existing ducts, conduits, cables, and other utilities to avoid damaging them.
6. Seal conduits, including spare conduits, at building entrances and at outdoor terminations for equipment with a suitable compound that prevents the entrance of moisture and gases.
7. Where metal conduit is shown, install threaded heavy wall rigid steel galvanized conduit or type A20 rigid steel galvanized conduit coated with .5 mm (20 mil) bonded PVC, or rigid steel or IMC, PVC coated or standard coated with bituminous asphaltic compound.
8. Warning tape shall be continuously placed 300 mm (12 inches) above conduits or electric lines.

### 3.6 HAZARDOUS LOCATIONS

- A. Use rigid steel conduit only, notwithstanding requirements otherwise specified in this or other sections of these specifications.
- B. Install UL approved sealing fittings, that prevent passage of explosive vapors, in hazardous areas equipped with explosive proof lighting fixtures, switches, and receptacles, as required by the NEC.

### 3.7 WET OR DAMP LOCATIONS

- A. Unless otherwise shown, use conduits of rigid steel or IMC.
- 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. Unless otherwise shown, use rigid steel or IMC conduit within 1500 mm (5 feet) of the exterior and below concrete building slabs in contact with soil, gravel, or vapor barriers. Conduit shall include an outer factory coating of .5 mm (20 mil) bonded PVC or field coat with asphaltum before installation. After installation, completely coat damaged areas of coating.

### **3.8 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. Provide liquid-tight flexible metal conduit for installation in exterior locations, moisture or humidity laden atmosphere, corrosive atmosphere, water or spray wash-down operations, inside (air stream) of HVAC units, and locations subject to seepage or dripping of oil, grease or water. Provide a green ground wire with flexible metal conduit.

### **3.9 EXPANSION JOINTS**

- A. Conduits 75 mm (3 inches) 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 inches) with junction boxes on both sides of the expansion joint. Connect conduits to junction boxes with sufficient slack of flexible conduit to produce 125 mm (5 inch) vertical drop midway between the ends. Flexible conduit shall have a copper green ground bonding jumper installed. In lieu of this flexible conduit, expansion and deflection couplings as specified above for 375 mm (15 inches) and larger conduits are acceptable.
- C. Install expansion and deflection couplings where shown.

### **3.10 CONDUIT SUPPORTS, INSTALLATION**

- A. Safe working load shall not exceed 1/4 of proof test load of fastening devices.
- B. Use pipe straps or individual conduit hangers for supporting individual conduits. Maximum distance between supports is 2.5 m (8 foot) on center.
- 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 90 kg (200 pounds). 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 (1/4 inch) bolt size and not less than 28 mm (1-1/8 inch) embedment.

- b. Power set fasteners not less than 6 mm (1/4 inch) diameter with depth of penetration not less than 75 mm (3 inches).
- c. Use vibration and shock resistant anchors and fasteners for attaching to concrete ceilings.
- F. Hollow Masonry: Toggle bolts are permitted.
- 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.

### 3.11 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.
- C. Remove only knockouts as required and plug unused openings. Use threaded plugs for cast metal boxes and snap-in metal covers for sheet metal boxes.
- D. Outlet boxes in the same wall mounted back-to-back are prohibited. A minimum 600 mm (24 inch), center-to-center lateral spacing shall be maintained between boxes.)
- E. Minimum size of outlet boxes for ground fault interrupter (GFI) receptacles is 100 mm (4 inches) square by 55 mm (2-1/8 inches) deep, with device covers for the wall material and thickness involved.
- F. Stencil or install phenolic nameplates on covers of the boxes identified on riser diagrams; for example "SIG-FA JB No. 1".
- G. On all Branch Circuit junction box covers, identify the circuits with black marker.

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**SECTION 26 08 00**  
**COMMISSIONING OF ELECTRICAL SYSTEMS**

**PART 1 - GENERAL**

**1.1 RELATED DOCUMENTS**

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

**1.2 SUMMARY**

- A. Section refers contractors to commissioning process requirements for electrical systems, assemblies, and equipment found in related division 01 sections.
- B. Related Sections:
  - 1. Division 01 Section 019113 "Commissioning Requirements" for definitions, roles and responsibilities, and process requirements for all systems to be commissioned.

**1.3 DESCRIPTION**

- A. Commissioning is a systematic process of ensuring that all building systems perform interactively according to the design intent and the owner's operational needs. This is achieved by beginning in the design phase and documenting design intent and continuing through construction, acceptance and the warranty period with actual verification of performance. The commissioning process shall encompass and coordinate the traditionally separate functions of system documentation, equipment startup, control system calibration, testing and balancing, performance testing and training. Commissioning during the construction phase is intended to achieve the following specific objectives according to the Contract Documents:
  - 1. Verify that applicable equipment and systems are installed according to the manufacturer's recommendations and to industry accepted minimum standards and that they receive adequate operational checkout by installing contractors.
  - 2. Verify and document proper performance of equipment and systems.
  - 3. Verify that the Owner's operating personnel are adequately trained.
- B. The commissioning process does not take away from or reduce the responsibility of the system designers or installing contractors to provide a finished and fully functioning product.

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

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

**END OF SECTION 260800**

**SECTION 26 22 00**  
**LOW-VOLTAGE TRANSFORMERS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

This section specifies the furnishing, installation and connection of the dry type general-purpose transformers.

**1.2 RELATED WORK**

- A. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements and items that are common to more than one section of Division 26.
- B. Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS: Conduits and outlet boxes.
- C. Section 26 05 21, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW): 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 for possible ground fault currents.

**1.3 SUBMITTALS**

- A. In accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, submit the following:
- B. Shop Drawings:
  - 1. Sufficient information, clearly presented, shall be included to determine compliance with drawings and specifications.
  - 2. Include electrical ratings, impedance, dimensions, weight, mounting details, decibel rating, terminations, temperature rise, no load and full load losses, and connection diagrams.
  - 3. Complete nameplate data including manufacturer's name and catalog number.
- C. Manuals:
  - 1. Submit, simultaneously with the shop drawings, companion copies of complete maintenance and operating manuals including technical data sheets and wiring diagrams.
  - 2. If changes have been made to the originally submitted maintenance and operating manuals, then two weeks prior to final inspection submit four copies of updated maintenance and operating manuals to the COTR.
- D. Certifications: Two weeks prior to the final inspection, submit four copies of the following to the COTR:
  - 1. Certification by the manufacturer that the transformers conform to the requirements of the drawings and specifications.

2. Certification that the equipment has been properly installed and tested.

#### 1.4 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. National Fire Protection Association (NFPA):  
70-05.....National Electrical Code (NEC)
- C. National Electrical Manufacturers Association (NEMA):  
ST 20-97.....Dry-Type Transformers for General Applications

### PART 2 - PRODUCTS

#### 2.1 GENERAL PURPOSE DRY TYPE TRANSFORMERS

- A. Unless otherwise specified, dry type transformers shall be in accordance with NEMA, NEC and as shown on the drawings. Transformers shall be UL listed or labeled.
- B. Dry type transformers shall have the following features:
  1. Self-cooled by natural convection, isolating windings, indoor, dry type. Autotransformers will not be accepted.
  2. Rating and winding connections shall be as shown on the drawings.
  3. Transformers shall have copper windings.
  4. Ratings shown on the drawings are for continuous-duty without the use of cooling fans.
  5. Insulation systems:
    - a. Transformers 30 KVA and larger: UL rated 220 degrees C system having an average maximum rise by resistance of 150 degrees C in a maximum ambient of 40 degrees C.
    - b. Transformers below 30 KVA: Same as for 30 KVA and larger or UL rated 185 degrees C system having an average maximum rise by resistance of 115 degrees C in a maximum ambient of 40 degrees C.
  6. Core and coil assemblies:
    - a. Rigidly braced to withstand the stresses caused by short circuit currents and rough handling during shipment.
    - b. Cores shall be grain oriented, non-aging, and silicon steel.
    - c. Coils shall be continuous windings without splices except for taps.
    - d. Coil loss and core loss shall be minimum for efficient operation.
    - e. Primary and secondary tap connections shall be brazed or pressure type.
    - f. Coil windings shall have end fillers or tie downs for maximum strength.

7. Certified sound levels determined in accordance with NEMA, shall not exceed the following:

Transformer Rating	Sound Level Rating
0 - 9 KVA	40 dB
10 - 50 KVA	45 dB
51 - 150 KVA	50 dB
151 - 300 KVA	55 dB
301 - 500 KVA	60 dB

8. Nominal impedance shall be as shown on the drawings. If not shown on drawings, nominal impedance shall be as permitted by NEMA.
9. Single phase transformers rated 15 KVA through 25 KVA shall have two, 5 percent full capacity taps below normal rated primary voltage. All transformers rated 30 KVA and larger shall have two, 2-1/2 percent full capacity taps above, and four, 2-1/2 percent full capacity taps below normal rated primary voltage.
10. Core assemblies shall be grounded to their enclosures by adequate flexible ground straps.
11. Enclosures:
- a. Not less than code gage steel.
  - b. Outdoor enclosures shall be NEMA 3R.
  - c. Temperature rise at hottest spot shall conform to NEMA Standards, and shall not bake and peel off the enclosure paint after the transformer has been placed in service.
  - d. Ventilation openings shall prevent accidental access to live components.
  - e. Thoroughly clean and paint enclosure at the factory with manufacturer's prime coat and standard finish.
12. Standard NEMA features and accessories including ground pad, lifting provisions and nameplate with the wiring diagram and sound level indicated on it.
13. Dimensions and configurations shall conform to the spaces designated for their installations.
14. Transformers shall meet the minimum energy efficiency values per NEMA TP1 as listed below:

kVA Rating	Output efficiency (%)
15	97
30	97.5
45	97.7
75	98
112.5	98.2
150	98.3
225	98.5
300	98.6
500	98.7
750	98.8

## 2.2 NONLINEAR TRANSFORMERS

- A. Transformers shall be designed to withstand the overheating effects caused by harmonics resulting from non-linear (non-sinusoidal) loads such as office equipment using solid-state switching power supplies (i.e. computers, laser printers and copiers).
- B. Copper coils' neutrals shall carry at least 200% of normal phase current.
- C. Minimum efficiency designed to supply circuits with a harmonic profile equal to or less than a K factor of 13 without exceeding specified temperature rise. Transformers with K factor of 13 shall be provided, if K factor is not shown on contract drawings. Table below applies to K-13 transformers only.

Harmonic		K-13 (%)
Fundamental		100
3 <sup>rd</sup>		70
5 <sup>th</sup>		42
7 <sup>th</sup>		5
9 <sup>th</sup>		3
11 <sup>th</sup>		3
13 <sup>th</sup>		1
15 <sup>th</sup>		0.7
17 <sup>th</sup>		0.6

**PART 3 - EXECUTION**

**3.1 INSTALLATION**

- A. Installation of transformers shall be in accordance with the NEC, as recommended by the equipment manufacturer and as shown on the drawings.
- B. Install the transformers with adequate clearance at a minimum of 100 mm (4 inches) from wall and adjacent equipment for air circulation to remove the heat produced by transformers.
- C. Install transformers on vibration pads designed to suppress transformer noise and vibrations.
- D. Use flexible metal conduit to enclose the conductors from the transformer to the raceway systems.

**3.2 SPARE PARTS**

- A. Deliver the following spare parts for the project to the COTR two weeks prior to final inspection:
  - 1. Six stand-off insulators.
  - 2. Six insulated protective caps.
  - 3. One spare set of high voltage fuses for each size fuse used in the project.

**3.3 TRAINING**

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain systems. Refer to Section 01 00 00 GENERAL REQUIREMENTS.
  - 1. Train Owner's management and maintenance personnel in interpreting and using monitoring displays and in configuring and using software and reports. Include troubleshooting, servicing, adjusting, and maintaining equipment. Provide a minimum of 8 hours' training.
  - 2. Training Aid: Use approved final versions of software and maintenance manuals as training aids.
  - 3. Test and troubleshoot the system.

- - - E N D - - -

**SECTION 26 24 11**  
**DISTRIBUTION SWITCHBOARDS****PART 1 - GENERAL****1.1 DESCRIPTION:**

This section specifies the furnishing, installation, and connection of the distribution switchboards.

**1.2 RELATED WORK:**

- A. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements and items that are common to more than one section of Division 26.
- B. Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS: Conduits and outlet boxes.
- C. Section 26 05 21, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW): 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 for possible fault currents.

**1.3 FACTORY TESTS:**

- A. Design Tests: Design tests shall have been performed on a type or style of switchboard similar to that being furnished for this project. Tests shall be in accordance with NEMA PB 2 and UL 891.
- B. Production Tests: Dielectric, mechanical operation, grounding of instrument transformer cases, electrical operation and control wiring, and ground fault sensing equipment tests shall be performed on the switchboards provided for this project. Tests shall be in accordance with NEMA PB 2 and UL 891.

**1.4 SUBMITTALS:**

Submit in accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS:

- A. Shop Drawings:
  - 1. Sufficient information, clearly presented, shall be included to determine compliance with drawings and specifications.
  - 2. Include electrical ratings, dimensions, mounting details, materials, required clearances, terminations, weight, temperature rise, wiring and connection diagrams, plan, front, side, and rear elevations, sectional views, bus work, circuit breaker frame sizes, trip and short-circuit rating, long-time, short-time, instantaneous and ground fault settings, coordinated breaker and fuse curves, accessories, and device nameplate data.

3. Show the size, ampere-rating, number of bars per phase and neutral in each bus run (horizontal and vertical), bus spacing, equipment ground bus, and bus material.

B. Manuals:

1. 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.
  - a. Wiring diagrams shall have their terminals identified to facilitate installation, maintenance, and operation.
  - b. Wiring diagrams shall indicate internal wiring for each item of equipment and the interconnection between the items of equipment.
  - c. Provide a clear and concise description of operation, which gives, in detail, the information required to properly operate the equipment.
  - d. Approvals will be based on complete submissions of manuals together with shop drawings.
2. Two weeks prior to final inspection, deliver four copies of the final updated maintenance and operating manuals to the COTR.
  - a. The manuals shall be updated to include any information necessitated by shop drawing approval.
  - b. Complete "As Installed" wiring and schematic diagrams shall be included which show all items of equipment and their interconnecting wiring.
  - c. Show all terminal identification.
  - d. Include information for testing, repair, trouble shooting, assembly, disassembly, and recommended maintenance intervals.
  - e. Provide a replacement parts list with current prices. Include a list of recommended spare parts, tools, and instruments for testing and maintenance purposes.
  - f. Furnish manuals in loose-leaf binder or manufacturer's standard binder.

C. Certifications:

1. Two weeks prior to final inspection, submit four copies of the following to the COTR:
  - a. Certification by the Contractor that the assemblies have been properly installed, adjusted and tested, including circuit breakers settings.
  - b. Certified copies of all of the factory design and production tests, field test data sheets and reports for the assemblies.

**1.5 APPLICABLE PUBLICATIONS:**

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.

- A. Institute of Engineering and Electronic Engineers (IEEE):
  - C37.13-95.....Low Voltage AC Power Circuit Breakers Used in Enclosures
  - C57.13-93.....Instrument Transformers
  - C62.41-95.....Surge Voltage in Low Voltage AC Power Circuits
  - C62.45-02.....Surge Testing for Equipment connected to Low-Voltage AC Power Circuits
- B. National Electrical Manufacturer's Association (NEMA):
  - PB-2-01.....Dead-Front Distribution Switchboards.
  - PB-2.1-02.....Instructions for Proper Handling, Installation, Operation, and Maintenance of Switchboards
  - AB-1-02.....Molded Case Circuit Breakers, Molded Case Switches and Circuit Breaker Enclosures
- C. National Fire Protection Association (NFPA):
  - 70-02.....National Electrical Code (NEC)
- D. Underwriters Laboratories, Inc. (UL):
  - 67-93.....Panelboards
  - 489-02.....Molded Case Circuit Breakers and Circuit Breakers Enclosures
  - 891-98.....Dead-Front Switchboards
  - 1283-98.....Electromagnetic Interference Filters
  - 1449-96.....Transient Voltage Surge Suppressors

**PART 2 - PRODUCTS****2.1 GENERAL:**

- A. Switchboards shall be in accordance with UL, NEMA, NEC, IEEE, and as shown on the drawings.
- B. Switchboards shall be provided complete, ready for operation including, but not limited to housing, buses, circuit breakers, instruments and related transformers, fuses, and wiring.
- C. Switchboard dimensions shall not exceed the space provided as shown on the drawings.
- D. Manufacturer's nameplate shall include complete ratings of switchboard in addition to the date of manufacture.

**2.2 BASIC ARRANGEMENT:**

- A. Type I: Switchboard shall be front accessible with the following features:
  - 1. Device mounting:
    - a. Main breaker: Individually mounted and compartmented or group mounted with feeder breakers.
    - b. Feeder breakers: Group mounted.
  - 2. Section alignment: As shown on the drawings.
  - 3. Accessibility:
    - a. Main section line and load terminals: Front and side.
    - b. Distribution section line and load terminals: Front.
    - c. Through bus connections: Front and end.
  - 4. Bolted line and load connections.
  - 5. Full height wiring gutter covers for access to wiring terminals.
  - 6. Short Circuit Current Rating: 42,000 amperes rms symmetrical, minimum, or as shown on the drawings, whichever is higher.

**2.3 HOUSING:**

- A. Provide a completely enclosed, free standing, steel enclosure not less than the gage required by the ANSI and UL standards. The enclosure is to consist of the required number of vertical sections bolted together to form one metal enclosed rigid switchboard. The sides, top and rear shall be covered with removable screw on sheet steel plates.
- B. Provide ventilating louvers where required to limit the temperature rise of current carrying parts. All openings shall be protected against entrance of falling dirt, water, or foreign matter.
- C. Group the meters and their control switches on a hinged front cover. Provide concealed hinges and latch.
- D. Enclosure shall be thoroughly cleaned, phosphate treated, and primed with rust-inhibiting paint. Final finish coat to be the manufacturers standard gray. Provide a quart of finish paint for touch-up purposes.

**2.4 BUSES:**

- A. General: Buses shall be arranged for 3 phase, 4 wire distribution. Main phase buses (through bus), full size neutral bus, and ground bus shall be full capacity the entire length of the switchboard. Provide for future extensions by means of bolt holes or other approved method. Brace the bus to withstand the available short circuit current at the particular location and as shown on the drawings. No magnetic material shall be used between buses to form a magnetic loop.
- B. Material and Size: Buses and connections shall be hard drawn copper of 98 percent conductivity. Bus temperature rise shall not exceed 65

degrees C (149 degrees F). Section busing shall be sized based on UL and NEMA Switchboard Standards.

- C. Bus Connections: All contact surfaces shall be copper. Provide a minimum of two plated bolts per splice. Where physical bus size permits only one bolt, provide a means other than friction to prevent turning, twisting or bending. Torque bolts to the manufacturer's recommended values.
- D. Neutral Bus: Provide bare or plated bus and mount on insulated bus supports. Provide neutral disconnect link to permit isolation of neutral bus from the common ground bus and service entrance conductors.
- E. Ground Bus: Provide an uninsulated 6 mm by 50 mm (1/4 inch by 2 inch) copper equipment ground bus bar sized per UL 891 the length of the switchboard and secure at each section.
- F. Main Bonding Jumper: Connect an uninsulated 6 mm by 50 mm (1/4 inch by 2 inch) copper bus between the neutral and ground buses to establish the system common ground point.

## **2.5 INTERNALLY INTEGRATED SURGE PROTECTIVE DEVICES:**

- A. Integral Surge Suppressor:
  - 1. SPD (Surge Protective Devices) shall be Component Recognized and listed in accordance with UL 1449 Second Edition to include Section 37.3 highest fault category testing on devices intended for service entrance use. SPD shall also be UL 1283 listed.
  - 2. SPD shall be UL 67 listed, installed by and shipped from the electrical distribution equipment manufacturer's factory.
  - 3. SPD shall provide surge current diversion paths for all modes of protection; L-N, L-G, N-G, in WYE systems, and L-L, L-G in DELTA systems.
  - 4. SPD shall be modular in design. Each mode shall be fused with a 200kAIC UL recognized surge rated fuse and incorporate a thermal cutout device.
  - 5. SPD shall be integrally mounted to the bus bars of the switchboard.
  - 6. Audible diagnostic monitoring shall be by way of audible alarm. This alarm shall activate upon a fault condition. An alarm on/off switch shall be provided to silence the alarm. An alarm push to test switch shall be provided as well.
  - 7. SPD shall meet or exceed the following criteria:
    - a. Maximum surge current capability (single pulse rated) per phase shall be:
      - 1) Service Entrance Switchboard 250 kA.
      - 2) Distribution Panelboards 160 kA
      - 3) Branch Panelboards 160 kA

- 4) Service Entrance MCC 240 kA specified.
- 5) Distribution Class MCC 160 kA
- b. UL 1449 Second Edition Listed and Recognized Component Suppression Voltage Ratings (SVR's) for Service Entrance and Distribution Location equipment shall not exceed the following:
- c. Voltage Let-Thru Values for Solidly Grounded Systems:

VOLTAGE	L-N	L-G	N-G
208Y/120	400V	400V	400V
480Y/277	800V	800V	800V

- 8. SPD shall have a minimum EMI/RFI filtering of -50Db at 100 kHz with an insertion ration of 50:1 using MIL-STD-220A methodology.
- 9. SPD shall have the following diagnostic features: transient counter, status lights on each phase, and one set of 1 NO and 1 NC auxiliary dry contacts for alarming.
- 10. SPD shall have a warranty for a period of five years, incorporating unlimited replacements of suppressor parts if transients destroy them during the warranty period. Warranty shall be the responsibility of the electrical distribution equipment manufacturer and shall be supported by their respective field service division.

#### 2.6 NAMEPLATES AND MIMIC BUS:

- A. Nameplates: Provide laminated black phenolic resin with white core with 6 mm (1/4 inch) high engraved lettered nameplates for each circuit breaker (switch) to indicate the feeder, panelboards and equipment served. Mount, with plated screws, on front of the breaker.
- B. Mimic Bus: Provide an approved mimic bus on the front of the switchboard. Color to be blue (480Y/277 volt) or black (208Y/120 volt), either factory painted, plastic, or metal strips. Plastic tape shall not be used. Use symbols similar to a one line diagram. (Refer to drawings). Plastic or metal strips shall be mounted with plated screws.

#### 2.7 PROVISION FOR FUTURE:

Where "provision for", "future", or "space" is noted on drawings, the space shall be equipped with bus connections to the future overcurrent device with suitable insulation and bracing to maintain proper short circuit rating and physical clearance. Provide buses for the ampere rating as shown for the future device.

#### 2.8 CONTROL WIRING:

Control wiring shall be 600 volt class B stranded SIS. Install all control wiring complete at the factory adequately bundled and protected.

Wiring across hinges and between shipping units shall be Class C stranded. Size in accordance with NEC. Provide control circuit fuses.

## **2.9 MAIN CIRCUIT BREAKERS:**

- A. Type I Switchboard: Provide UL listed and labeled molded case circuit breakers in accordance with NEC and as shown on the drawings. Circuit breakers shall be the solid state adjustable trip type.
  - 1. Trip units shall have field adjustable tripping characteristics as follows:
    - a. Ampere setting (continuous).
    - b. Long time band.
    - c. Short time trip point.
    - d. Short time delay.
    - e. Instantaneous trip point.
    - f. Ground fault trip point.
    - g. Ground fault trip delay.
  - 2. Trip settings shall be as indicated on the drawings. Final settings shall be as shown on the electrical system protective device study.
  - 3. Breakers, which have same rating, shall be interchangeable with each other.

## **2.10 FEEDER CIRCUIT BREAKERS:**

- A. Provide UL listed and labeled molded case circuit breakers, in accordance with the NEC, as shown on the drawings, and as herein specified.
- B. Below 225Amp Frame: Non-adjustable Trip Molded Case Circuit Breakers:
  - 1. Molded case circuit breakers shall have automatic, trip free, non-adjustable, inverse time, and instantaneous magnetic trips for 100 ampere frame size or less. Magnetic trip shall be adjustable from 3X to 10X for breakers with 600 ampere frame size and higher. Factory setting shall be LOW unless otherwise noted.
  - 2. Breaker features shall be as follows:
    - a. A rugged, integral housing of molded insulating material.
    - b. Silver alloy contacts.
    - c. Arc quenchers and phase barriers for each pole.
    - d. Quick-make, quick-break, operating mechanisms.
    - e. 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.
    - f. Electrically and mechanically trip free.
    - g. An operating handle which indicates ON, TRIPPED and OFF positions.
    - h. Line and load connections shall be bolted.

- i. Interrupting rating shall not be less than the maximum short circuit current available at the line.
  - j. An overload on one pole of a multipole breaker shall automatically cause all the poles of the breaker to open.
- C. 225Amp and larger Frame: Adjustable Trip Molded Case Circuit Breakers:
- 1. Provide molded case, solid state adjustable trip type circuit breakers.
  - 2. Trip units shall have field adjustable tripping characteristics as follows:
    - a. Ampere setting (continuous).
    - b. Long time band.
    - c. Short time trip point.
    - d. Short time delay.
    - e. Instantaneous trip point.
    - f. Ground fault trip point.
    - g. Ground fault trip delay.
  - 3. Trip settings shall be as indicated on the drawings. Final settings shall be shown on the electrical system protective device study.
  - 4. Breakers, which have same rating, shall be interchangeable with each other.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION:**

- A. Install switchboards in accordance with the NEC as shown on the drawings and as recommended by the manufacturer.
- B. Anchor switchboards to the floor with plated with 12.5 mm (1/2 inch) minimum anchor bolts as recommended by the manufacturer. Anchor the switchboards on two 100 mm (4 inch) minimum channel iron sills with plated 12.5 mm (1/2 inch) bolts. Furnish sills to suit the switchboards. Coordinate installation of sills with concrete pour of floor. Sills shall be level and grouted flush with floor.

#### **3.2 INSTRUCTIONS**

Furnish the services of a competent instructor for one 4 hour period for instructing personnel in the operation and maintenance of the switchboard on the date requested by the COTR.

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**SECTION 26 24 16**  
**PANELBOARDS****PART 1 - GENERAL****1.1 DESCRIPTION**

This section specifies the furnishing, installation and connection of panelboards.

**1.2 RELATED WORK**

- A. Section 09 91 00, PAINTING: Identification and painting of panelboards.
- B. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements and items that are common to more than one Section of Division 26.
- C. Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS: Conduits and outlet boxes.
- D. Section 26 05 21, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW): Cables and wiring.
- E. 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.

**1.3 SUBMITTALS**

- A. Submit in accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.
- B. Shop Drawings:
  - 1. Sufficient information, clearly presented, shall be included to determine compliance with drawings and specifications.
  - 2. Include electrical ratings, dimensions, mounting details, materials, wiring diagrams accessories and weights of equipment. Complete nameplate data including manufacturer's name and catalog number.
- C. Certification: Two weeks prior to final inspection, submit four copies of the following to the COTR:
  - 1. Certification that the material is in accordance with the drawings and specifications has been properly installed, and that the loads are balanced.

**1.4 APPLICABLE PUBLICATIONS**

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 the basic designation only.

- A. National Electrical Manufacturers Association (NEMA):
  - PB-1-2006.....Panelboards
  - AB-1-2002.....Molded Case Circuit Breakers, Molded Case  
Switches and Circuit Breaker Enclosures
- B. National Fire Protection Association (NFPA):
  - 70-2005 .....National Electrical Code (NEC)
  - 70E-2004.....Standard for Electrical Life Safety in the  
Workplace
- C. Underwriters Laboratories, Inc. (UL):
  - 50-2003.....Enclosures for Electrical Equipment
  - 67-2003.....Panel boards
  - 489-2006.....Molded Case Circuit Breakers and Circuit  
Breaker Enclosures

**PART 2 - PRODUCTS****2.1 PANELBOARDS**

- A. Panelboards shall be in accordance with UL, NEMA, NEC, and as shown on the drawings.
- B. Panelboards shall be standard manufactured products. All components of the panelboards shall be the product and assembly of the same manufacturer. All similar units of all panelboards to be of the same manufacturer.
- C. All panelboards shall be hinged "door in door" type with:
  - 1. Interior hinged door with hand operated latch or latches as required to provide access to circuit breaker operating handles only, not to energized ports.
  - 2. Outer hinged door shall be securely mounted to the panelboard box with factory bolts, screws, clips or other fasteners requiring a tool for entry, hand operated latches are not acceptable.
  - 3. Push inner and outer doors shall open left to right.
- D. All panelboards shall be completely factory assembled with molded case circuit breakers. Include one-piece removable, inner dead front cover independent of the panelboard cover.
- E. Panelboards shall have main breaker or main lugs, bus size, voltage, phase, top or bottom feed, and flush or surface mounting as scheduled on the drawings.

F. Panelboards shall conform to NEMA PB-1, NEMA AB-1 and UL 67 and have the following features:

1. Nonreduced size copper bus bars, complete with current ratings as shown on the panel schedules connection straps bolted together and rigidly supported on molded insulators.
2. Bus bar connections to the branch circuit breakers shall be the "distributed phase" or "phase sequence" type. Single-phase, three-wire panelboard busing shall be such that when any two adjacent single-pole breakers are connected to opposite phases, two-pole breakers can be installed in any location. Three-phase, four-wire busing shall be such that when any three adjacent single-pole breakers are individually connected to each of the three different phases, two-or three-pole breakers can be installed at any location. Current-carrying parts of the bus assembly shall be plated. Mains ratings shall be as shown.
3. Mechanical lugs furnished with panelboards shall be cast, stamped or machined metal alloys of sizes suitable for the conductors indicated to be connected thereto.
4. Neutral bus shall be 200% rated, mounted on insulated supports.
5. Grounding bus bar equipped with screws or lugs for the connection of grounding wires.
6. Buses braced for the available short circuit current, but not less than 22,000 amperes symmetrical for 120/208 volt and 120/240 volt panelboards, and 14,000 amperes symmetrical for 277/480-volt panelboards.
7. Branch circuit panels shall have buses fabricated for bolt-on type circuit breakers.
8. Protective devices shall be designed so that they can be easily replaced.
9. Where designated on panel schedule "spaces", include all necessary bussing, device support and connections. Provide blank cover for each space.
10. 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 panels, and with cable connections to the second

section. Panelboard sections with tapped bus or crossover bus are not acceptable.

11. Series rated panelboards are not permitted.

## **2.2 CABINETS AND TRIMS**

### **A. Cabinets:**

1. Provide galvanized steel cabinets to house panelboards. Cabinets for outdoor panels shall be factory primed and suitably treated with a corrosion-resisting paint finish meeting UL 50 and UL 67.
2. Cabinet enclosure shall not have ventilating openings.
3. Cabinets for panelboards may be of one-piece formed steel or of formed sheet steel with end and side panels welded, riveted, or bolted as required.

## **2.3 MOLDED CASE CIRCUIT BREAKERS FOR PANELBOARDS**

- ### **A. Breakers shall be UL 489 listed and labeled, in accordance with the NEC, as shown on the drawings, and as specified.**

- ### **B. Circuit breakers in panelboards shall be bolt on type on phase bus bar or branch circuit bar.**

1. Molded case circuit breakers for lighting and appliance branch circuit panelboards shall have minimum interrupting rating as indicated but not less than:
  - a. 120/208 Volt Panelboard: 22,000 amperes symmetrical.
  - b. 120/240 Volt Panelboard: 22,000 amperes symmetrical.
  - c. 277/480 Volt Panelboard: 14,000 amperes symmetrical.
2. Molded case circuit breakers shall have automatic, trip free, non-adjustable, inverse time, and instantaneous magnetic trips for 100-ampere frame or less. Magnetic trip shall be adjustable from 3X to 10X for breakers with 600 ampere frames and higher.

- ### **C. 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 ON, TRIPPED, and OFF positions.

- a. Line connections shall be bolted.
- b. Interrupting rating shall not be less than the maximum short circuit current available at the line terminals as indicated on the drawings.
- 8. An overload on one pole of a multipole breaker shall automatically cause all the poles of the breaker to open.
- 9. Shunt trips shall be provided where indicated
- 10. For circuit breakers being added to existing panelboards, coordinate the breaker type with existing panelboards. Modify the panel directory.

#### **2.4 SEPARATELY ENCLOSED MOLDED CASE CIRCUIT BREAKERS**

- A. Where separately enclosed molded case circuit breakers are shown on the drawings, provide circuit breakers in accordance with the applicable requirements of those specified for panelboards.
- B. Enclosures are to be of the NEMA types shown on the drawings. Where the types are not shown, they are to be the NEMA type most suitable for the environmental conditions where the breakers are being installed.

### **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. Coordinate the sizes of cabinets with designated closet space.
- C. In accordance with Section 09 91 00, PAINTING, paint the panelboard system voltage, and feeder sizes as shown on the riser diagram in 1 inch block lettering on the inside cover of the cabinet door. Paint the words "LIFE SAFETY BRANCH", "CRITICAL BRANCH", or "EQUIPMENT SYSTEM" as applicable and the panel designation in one inch block letters on the outside of the cabinet doors.
- D. Install a typewritten schedule of circuits in each panelboard after being submitted to and approved by the COTR. Schedules, after approval, shall be typed on the panel directory cards and installed in the appropriate panelboards, incorporating all applicable contract changes pertaining to that schedule. Include the room numbers and items served on the cards.

- E. Mount the panelboard fully aligned and such that the maximum height of the top circuit breaker above finished floor shall not exceed 1980 mm (78 inches). For panelboards that are too high, mount panelboard so that the bottom of the cabinets will not be less than 150 mm (6 inches) above the finished floor.
- F. For panelboards located in areas accessible to the public, paint the exposed surfaces of the trims, doors, and boxes with finishes to match surrounding surfaces after the panelboards have been installed.
- G. Directory-card information shall be typewritten to indicate outlets, lights, devices, and equipment controlled and final room numbers served by each circuit and shall be mounted in holders behind protective covering.
- H. Where new panels are to be installed in existing backboxes, backboxes shall have rust and scale removed from inside. Paint inside of backboxes with rust preventive paint before the new panel interior is installed. Provide new trim and doors for these panels. Covers shall fit tight to the box with no gaps between the cover and the box.
- I. Provide ARC flash identification per NFPA 70E.

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**SECTION 26 27 26**  
**WIRING DEVICES**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

This section specifies the furnishing, installation and connection 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: Conduits and outlets boxes.
- C. Section 26 05 21, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW): 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.

**1.3 SUBMITTALS**

- A. In accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, submit the following:
- B. Shop Drawings:
  - 1. Sufficient information, clearly presented, shall be included to determine compliance with drawings and specifications.
  - 2. Include electrical ratings, dimensions, mounting details, construction materials, grade and termination information.
- C. Manuals: Two weeks prior to final inspection, deliver four copies of the following to the COTR: Technical data sheets and information for ordering replacement units.
- D. Certifications: Two weeks prior to final inspection, submit four copies of the following to the COTR: Certification by the Contractor that the devices comply with the drawings and specifications, and have been properly installed, aligned, and tested.

**1.4 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):
  - 70-02.....National Electrical Code (NEC)

C. National Electrical Manufacturers Association (NEMA):

WD 1-99.....General Color Requirements for Wiring Devices  
WD 6-02 .....Wiring Devices - Dimensional Requirements

D. Underwriter's Laboratories, Inc. (UL):

5-96.....Surface Metal Raceways and Fittings  
20-00.....General-Use Snap Switches  
231-98.....Power Outlets  
467-93.....Grounding and Bonding Equipment  
498-01.....Attachment Plugs and Receptacles  
943-03.....Ground-Fault Circuit-Interrupters

**PART 2 - PRODUCTS**

**2.1 RECEPTACLES**

- A. General: All receptacles shall be listed by Underwriters Laboratories, Inc., as hospital grade (green dot identification) and conform to NEMA WD 1. (EXCEPTION - Receptacle types which have no listing as hospital grade but are listed by UL in their respective categories or receptacles indicated on the drawings as "not hospital grade").
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 min.) and side wiring from four captively held binding screws.
- B. Duplex receptacles shall be single phase, 20 ampere, 120 volts, 2-pole, 3-wire, and conform to the NEMA 5-20R configuration in NEMA WD 6. The duplex type shall have break-off feature for two-circuit operation. The ungrounded pole of each receptacle shall be provided with a separate terminal.
1. Bodies shall be ivory in color.
  2. Switched duplex receptacles shall be wired so that only the top receptacle is switched. The remaining receptacle shall be unswitched.
  3. Duplex Receptacles on Emergency Circuit:
    - a. Bodies shall be red in color. Wall plates shall be red with the word "EMERGENCY" engraved in 6 mm, (1/4 inch) white letters.
    - 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 suitable for mounting in a standard outlet box.
    - a. Ground fault interrupter shall be hospital grade and consist of a differential current transformer, solid state sensing circuitry

and a circuit interrupter switch. It shall be rated for operation on a 60 Hz, 120 volt, 20-ampere branch circuit. Device shall have nominal sensitivity to ground leakage current of five milliamperes and shall function to interrupt the current supply for any value of ground leakage current above five milliamperes (+ or - 1 milliamp) on the load side of the device. Device shall have a minimum nominal tripping time of 1/30th of a second. Devices shall meet UL 943.

5. Safety Type Duplex Receptacles:

- a. Bodies shall be gray in color.
- b. Shall be hospital grade, as above with the following additional requirements.
  - 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.
- c. Shall be installed in the following locations:
  - 1) Psychiatric rooms and wards, O.T. areas, PMR areas and other locations where psychiatric patients are not under constant supervision.
  - 2) Housekeeping quarters, buildings, waiting areas and lobbies where children might be present.

6. Isolated Ground Type Duplex Receptacles:

- a. Bodies shall be orange in color.
- b. Shall be hospital grade and UL listed as "Isolated Ground".

7. 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 phenolic compound supported by a plated steel mounting strap having plaster ears.
- b. Shall be NEMA WD 1 heavy duty type.

C. Receptacles; 20, 30 and 50 ampere, 250 volts: Shall be complete with appropriate cord grip plug. Devices shall meet UL 231.

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.

E. Lamp Receptacles for Outlet Box Mounting:

1. For use on standard 75 mm (3 inch) and 100 mm (4 inch) outlet boxes.
2. Keyless, porcelain body and skirt supporting a medium screw shell socket, and integral 3-wire grounding receptacle shall have screw terminals and a minimum rating of 600 watts.
3. Porcelain neck shall have shade holder groove.

**2.2 TOGGLE SWITCHES AND DIMMERS**

A. Toggle switches shall be totally enclosed tumbler type with bodies of phenolic compound. Toggle handles shall be ivory in color unless otherwise specified. The rocker type switch is not acceptable and will not be approved.

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. Shall be color coded for current rating, listed by Underwriters Laboratories, Inc., and meet the requirements of NEMA WD 1, Heavy-Duty and UL 20.
4. Ratings:
  - a. 120 volt circuits: 20 amperes at 120-277 volts AC.
  - b. 277 volt circuits: 20 amperes at 120-277 volts AC.
5. The switches shall be mounted on the striker plate side of doors.
6. Incorporate barriers between switches with multigang outlet boxes where required by the NEC.
7. Switches connected to isolated type electrical power systems shall be double pole.
8. All toggle switches shall be of the same manufacturer.

B. Dimmers: Incandescent modular dimming systems.

1. Incandescent dimming system shall be 2000 watt modular type, with capability for "slaving" larger loads from the "master". System shall have capability of adding additional "slaves", controlled from the original basic dimmer "master". All units shall track with "master". Control units shall be single-phase manual control as shown on the drawings. Dimmers shall have low and intensity adjustment and built-in transient voltage protection and fused on the load side. All remote mounted units shall be completely enclosed in integral metal housing. "Master", "Slaves" and controls shall be of the same

- manufacturer. All dimmers shall be listed by Underwriters Laboratories, Inc.
- C. Dimmers: Incandescent lamp loads. Wall-mounted incandescent dimmers shall be specification grade with capability of raising and lowering the lighting from completely off at extreme counter-clockwise rotation, to full intensity. Dimmers shall include an "off" position. Dimmers shall maintain full load rating even when two or more units are installed adjacent to one another. All wall-mounted dimmers shall be of the same manufacturer.
- D. Dimmers: Fluorescent lamp loads. Wall-mounted fluorescent lamp dimmers shall be specification grade with large control knob and shall be capable of raising and lowering the lighting from completely off at extreme counter-clockwise rotation, to full intensity. Dimmers shall include an "off" position. Dimmers shall have low end intensity adjustment and maintain full load rating even when two or more units are installed adjacent to one another. All wall-mounted dimmers shall be of the same manufacturer. Dimming ballast shall be provided for each F32 rapid start lamp or pair of lamps. Dimmers shall have adequate capacity for the load served and the environment in which installed.

### **2.3 WALL PLATES**

- A. Wall plates for switches and receptacles shall be type 302 stainless steel. Oversize plates are not acceptable.
- B. Wall plate for receptacles shall be labeled per receptacle wall plate detail on drawings.
- C. Standard NEMA design, so that products of different manufacturers will be interchangeable. Dimensions for openings in wall plates shall be accordance with NEMA WD1.
- D. For receptacles or switches mounted adjacent to each other, wall plates shall be common for each group of receptacles or switches.
- E. In psychiatric areas, wall plates shall have tamperproof screws and beveled edges.
- F. Wall plates for data, telephone or other communication outlets shall be as specified in the associated specification.

### **2.4 SURFACE MULTIPLE-OUTLET ASSEMBLIES**

- A. Assemblies shall conform to the requirements of NFPA 70 and UL 5.
- B. Shall have the following features:
1. Enclosures:
    - a. Thickness of steel shall be not less than 1 mm (0.040 inch) steel for base and cover. Nominal dimension shall be 40 by 70 mm (1-1/2 by 2-3/4 inches) with inside cross sectional area not less than 2250

- square mm (3.5 square inches). The enclosures shall be thoroughly cleaned, phosphatized and painted at the factory with primer and the manufacturer's standard baked enamel or lacquer 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, spacing of the receptacles along the strip shall be 600 mm (24 inches) on centers.
  4. Wires within the assemblies shall be not less than No. 12 AWG copper, with 600 volt ratings.
  5. Installation fittings shall be designed for the strips being installed including bends, offsets, device brackets, inside couplings, wire clips, and elbows.
  6. Bond the strips to the conduit systems for their branch supply circuits.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

- A. Installation shall be in accordance with the NEC and as shown as on the drawings.
- B. Ground terminal of each receptacle shall be bonded to the outlet box with an approved green bonding jumper, and also connected to the green equipment grounding conductor.

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**SECTION 26 29 11**  
**LOW-VOLTAGE MOTOR STARTERS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

All motor starters and motor control stations including installation and connection (whether furnished with the equipment specified in other Divisions or otherwise) shall meet these specifications.

**1.2 RELATED WORK**

- A. Other sections which specify motor driven equipment, except elevator motor controllers.
- B. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements and items that are common to more than one Section 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.

**1.3 SUBMITTALS**

Submit in accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS:

- A. Shop Drawings:
  - 1. Sufficient information, clearly presented, shall be included to determine compliance with drawings and specifications.
  - 2. Include electrical ratings, dimensions, weights, mounting details, materials, running over current protection, size of enclosure, over current protection, wiring diagrams, starting characteristics, interlocking and accessories.
- B. Manuals:
  - 1. 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.
    - a. Wiring diagrams shall have their terminals identified to facilitate installation, maintenance and operation.
    - b. Wiring diagrams shall indicate internal wiring for each item of equipment and interconnections between the items of equipment.
    - c. Elementary schematic diagrams shall be provided for clarity of operation.
  - 2. Two weeks prior to the project final inspection, submit four copies of the final updated maintenance and operating manual to the COTR.

(Update manual to include any information necessitated by shop drawing approval).

- C. Certification: Two weeks prior to final inspection, unless otherwise noted, submit four copies of the following certifications to the COTR:
1. Certification by the manufacturer that the controllers have passed the factory 24-hour operational test. (This certification must be furnished to the COTR prior to shipping the controller to the job site.)
  2. Certification by the manufacturer that high voltage motor controller(s) conforms to the requirements of the drawings and specifications. (This certification must be furnished to the COTR prior to shipping the controller to the job site.).
  3. Certification that the equipment has been properly installed, adjusted, and tested.

#### 1.4 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 Protective Relays and Relay Systems
- C. National Electrical Manufacturers Association (NEMA):
- ICS 1-00.....Industrial Control and Systems General  
Requirements
- ICS 1.1-03.....Safety Guidelines for the Application,  
Installation and Maintenance of Solid State  
Control
- ICS 2-00.....Industrial Control and Systems, Controllers,  
Contactors and Overload Relays Rated 600 Volts  
DC
- ICS 6-01.....Industrial Control and Systems Enclosures
- ICS 7-00.....Industrial Control and Systems Adjustable-Speed  
Drives
- ICS 7.1-00.....Safety Standards for Construction and Guide for  
Selection, Installation and Operation of  
Adjustable-Speed Drive Systems
- D. National Fire Protection Association (NFPA):

70-02.....National Electrical Code (NEC)

E. Underwriters Laboratories Inc. (UL):

508-99.....Industrial Control Equipment

## **PART 2 - PRODUCTS**

### **2.1 MOTOR STARTERS, GENERAL**

A. Motor starters shall be in accordance with the requirements of the IEEE, NEC, NEMA (ICS 1, ICS 1.1, ICS 2, ICS 6, ICS 7 and ICS 7.1) and UL.

B. Shall have the following features:

1. Separately enclosed unless part of another assembly.
2. Circuit breakers and safety switches within the motor controller enclosures shall have external operating handles with lock-open padlocking provisions and shall indicate the ON and OFF positions.
3. Motor control circuits:
  - a. Shall operate at not more than 120 volts.
  - b. Shall be grounded except as follows:
    - 1) Where isolated control circuits are shown.
    - 2) Where manufacturers of equipment assemblies recommend that the control circuits be isolated.
  - c. Incorporate a separate, heavy duty, control transformer within each motor controller enclosure to provide the control voltage for each motor operating over 120 volts.
  - d. Incorporate over current protection for both primary and secondary windings of the control power transformers in accordance with the NEC.
4. Overload current protective devices:
  - a. Overload relay thermal or induction type.
  - b. One for each pole.
  - c. Manual reset on the door of each motor controller enclosure.
  - d. Correctly sized for the associated motor's rated full load current.
  - e. Check every motor controller after installation and verify that correct sizes of protective devices have been installed.
  - f. Deliver four copies of a summarized list to the COTR, which indicates and adequately identifies every motor controller installed. Include the catalog numbers for the correct sizes of protective devices for the motor controllers.
5. Hand-Off-Automatic (H-O-A) switch is required unless specifically stated on the drawings as not required for a particular starter. H-O-A switch is not required for manual motor starters.

6. Incorporate into each control circuit a 120-volt, solid state 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.
7. Auxiliary contacts, pilot lights, pushbuttons and other devices and accessories as shown on the drawings or otherwise required.
8. Enclosures:
  - a. Shall be the NEMA types shown on the drawings for the motor controllers.
  - b. Shall be the NEMA types which are the most suitable for the environmental conditions where the motor controllers are being installed.
  - c. Doors mechanically interlocked to prevent opening unless the breaker or switch within the enclosure is open. Provision for padlock must be provided.
  - d. Enclosures shall be primed and finish coated at the factory with the manufacturer's prime coat and standard finish.
- C. Motor controllers incorporated with equipment assemblies shall also be designed for the specific requirements of the assemblies.
- D. For motor controllers being installed in existing motor control centers or panelboards, coordinate with the existing centers or panelboards.
- E. Additional requirements for specific motor controllers, as indicated in other sections, shall also apply.
- F. Provide a disconnecting means or safety switch near and within sight of each motor. Provide all wiring and conduit required to facilitate a complete and code complied installation.
- G. Refer to paragraph, MOTOR CONTROL STATIONS, in this section for additional requirements.

## **2.2 MANUAL MOTOR STARTERS**

- A. Shall be in accordance with applicable requirements of 2.1 above.
- B. Manual motor starters.
  1. Starters shall be AC, general-purpose Class A, manually operated type with full voltage controller for induction motors, rated in horsepower.
  2. Units shall include overload and low voltage protection, red pilot light, NO and NC auxiliary contacts and toggle operator.
- C. Fractional horsepower manual motor starters.
  1. Starters shall be AC, general-purpose Class A, manually operated with full voltage controller for fractional horsepower induction motors.

2. Units shall include thermal overload protection, red pilot light and toggle operator.

D. Motor starting switches.

1. Switches shall be AC, general-purpose Class A, manually operated type with full voltage controller for fractional horsepower induction motors.

2. Units shall include thermal overload protection, red pilot light, low voltage protection, NO and NC auxiliary contact and toggle operator.

**2.3 MAGNETIC MOTOR STARTERS**

A. Shall be in accordance with applicable requirements of 2.1 above.

B. Starters shall be AC, general-purpose, Class A magnetic controllers for induction motors rated in horsepower. Minimum size 0.

C. Where combination motor starters are used, combine starter with protective or disconnect device in a common enclosure.

D. Provide phase loss protection for each starter, with contacts to de-energize the starter upon loss of any phase.

**2.4 REDUCED VOLTAGE MOTOR CONTROLLERS**

A. Shall be in accordance with applicable portions of 2.1 above.

B. Shall be installed where shown for motors on the contract drawings.

C. Shall be the type shown on the drawings.

D. Shall have closed circuit transition for the types which can incorporate such transition.

E. Shall limit inrush currents to not more than 70 percent of the locked rotor currents.

F. Provide phase loss protection for each starter, with contacts to de-energize the starter upon loss of any phase.

**2.5 HIGH VOLTAGE MOTOR CONTROLLERS**

A. Shall be in accordance with applicable portions of 2.1 above.

B. Shall have the following additional features:

1. Metal enclosed, free-standing, air break, reduced voltage, primary reactor, drawout type combined with fused disconnect switch.

2. Shall include the following components:

a. Three pole, air break, drawout type, start contactor.

b. Three pole, air break, drawout type, run contactor. Primary reactor with taps for 50, 65 and 80 percent of line voltage.

d. Definite time transfer relay.

e. Three current limiting, power type fuses.

f. Control power transformer, protected with current limiting fuses.

g. Three current transformers and over current protective devices.

- h. Zero-sequence current transformers and associated devices for ground fault protection.
- i. Under voltage protection.
- j. Protection against single phasing.
- k. Stator thermal protection.
- l. Indicating type ammeter and selector switch.
- m. Red and green indicating lights.
- 3. A separate enclosure for each motor controller.
- 4. Shall be isolated by an externally operated mechanism. The secondary of the control power transformer shall also be opened by that device.
- 5. Suitable and adequate compartments and barriers for high voltage components. Isolate the power bus from the normally accessible compartments.
- 6. High voltage line receptacles shall be shuttered automatically when conductors are in the disconnected position and the disconnection shall be clearly indicated.
- 7. Interlocks shall include prevention of the following:
  - a. Inadvertent operation of the isolating mechanism under load.
  - b. Opening of the high voltage compartment before the controller is isolated.
  - c. Closing of the line contactor while the door is open.
- 8. Current and potential transformers for operating remote recording watt-hour and demand meters and the indicating meters at the motor controller.
- 9. Lock-open padlocking provisions.
- 10. Furnish accessories as recommended by the manufacturer of the motor controllers to facilitate convenient operation and maintenance of the controllers.
- C. Interrupting ratings shall be not less than the maximum short circuit currents available where the controllers are being installed or as indicated on the drawings.

## **2.6 VARIABLE SPEED MOTOR CONTROLLERS**

- A. Shall be in accordance with applicable portions of 2.1 above.
- B. Shall be solid state, micro processor-based with adjustable frequency and voltage, three phase output capable of driving standard NEMA B design, three phase alternating current induction motors at full rated speed. The drives shall utilize a full wave bridge design incorporating diode rectifier circuitry with pulse width modulation (PWM). Other control techniques are not acceptable. Silicon controlled rectifiers (SCR) shall not be used in the rectifying circuitry. The drives shall be

designed to be used on 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.

- C. Shall be rated for input power of 480 volts, three phase, 60 Hz. Unit shall be capable of operating within voltage parameters of plus 10 to minus 10 percent of line voltage, and be suitably rated for the full load amps of the maximum watts (HP) within its class.
- D. Each controller shall be factory tested at maximum watts (HP), rated full load current and at an ambient temperature of 40 degrees C for a period of not less than 24 hours. If a component fails, it shall be replaced and the test restarted for the full time period. A certified copy of the factory Test Report shall be furnished to the COTR prior to shipping the controller to the job site.
- E. Controllers shall have the following features:
  - 1. Isolated power for control circuits.
  - 2. Manually re-settable motor 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 30 seconds. (Set timers to the equipment manufacturer's recommended time in the above range.)
  - 5. Provide 4 to 20 ma current follower circuitry for interface with mechanical sensor devices.
  - 6. Automatic frequency adjustment from 20 Hz to 60 Hz.
  - 7. Provide circuitry to initiate an orderly shutdown when any of the conditions listed below occur. The controller shall not be damaged by any of these electrical disturbances and shall automatically restart when the conditions are corrected:
    - a. Incorrect phase sequence.
    - b. Single phasing.
    - c. Over voltage in excess of 10 percent.
    - d. Under voltage in excess of 10 percent.
    - e. Running over current above 110 percent (shall not automatically reset for this condition.)
    - f. Instantaneous overcurrent above 150 percent (shall not automatically reset for this condition).
    - g. Surge voltage in excess of 1000 volts.

- h. Short duration power outages of 12 cycles or less (i.e., distribution line switching, generator testing, and automatic transfer switch operations.)
- F. Minimum efficiency shall be 95 percent at 100 percent speed and 85 percent at 50 percent speed.
- G. The displacement power factor of the controller shall not be less than 95 percent under any speed or load condition.
- H. Controllers shall include a door interlocked fused safety disconnect switch or door interlocked circuit breaker switch which will disconnect all input power.
- I. Include a by-pass starter with circuitry to protect and isolate the variable speed controller. When the variable speed controller is in the by-pass mode, the solid-state components shall be isolated from the power supply on both the line and motor side.
- J. The following accessories are to be door mounted:
  - 1. AC Power on light.
  - 2. Ammeter (RMS motor current).
  - 3. HAND-OFF-AUTOMATIC switch.
  - 4. Manual speed control in HAND mode.
  - 5. System protection lights indicating that the system has shutdown and will not automatically restart.
  - 6. System protection light indicating that the system has shutdown but will restart when conditions return to normal.
  - 7. Manual variable speed controller by-pass switch.
  - 8. Diagnostic shutdown indicator lights for each shutdown condition.
  - 9. Provide two N.O. and two N.C. dry contacts rated 120 volts, 10 amperes, 60 HZ for remote indication of the following:
    - a. System shutdown with auto restart.
    - b. System shutdown without auto restart.
    - c. System running.
  - 10. Incorporate into each control circuit a 120-volt, time delay relay (ON delay), adjustable from 0.3-10 minutes, with transient protection. Provide transformer/s for the control circuit/s.
  - 11. Controller shall not add any current or voltage transients to the input AC power distribution system nor shall transients from other devices on the AC power distribution system affect the controller. Controllers shall be protected to comply with IEEE C37.90.1 and UL-508. Line noise and harmonic voltage distortion shall not exceed the values allowed by IEEE 519. Include Harmonic filter within the enclosure of the VFD.

## **2.7 MOTOR CONTROL STATIONS**

### **A. Shall have the following features:**

1. Designed for suitably fulfilling the specific control functions for which each station is being installed.
2. Coordinate the use of momentary contacts and maintained contacts with the complete motor control systems to insure safety for people and equipment.
3. Each station shall have two pilot lights behind red and green jewels and a circuit to its motor controller. Connect the lamps so they will be energized as follows:
  - a. Red while the motor is running.
  - b. Green while the motor is stopped.
4. Where two or more stations are mounted adjacent to each other, install a common wall plate, except where the designs of the stations make such common plates impracticable.
5. Identify each station with a permanently attached individual nameplate, of laminated black phenolic resin with a white core and engraved lettering not less than 6 mm (1/4-inch) high. Identify the motor by its number or other designation and indicate the function fulfilled by the motor.

### **B. Components of Motor Control Circuits:**

1. Shall also be designed and arranged so that accidental faulting or grounding of the control conductors will not be able to start the motors.
2. Use of locking type STOP pushbuttons or switches, which cause motors to restart automatically when the pushbuttons or switches are released, will not be permitted.

## **2.8 PROVIDE INTERNALLY INTEGRATED SURGE PROTECTIVE DEVICES FOR EACH CONTROLLER:**

### **A. Integral Surge Suppressor:**

1. SPD (Surge Protective Devices) shall be Component Recognized and listed in accordance with UL 1449 Second Edition to include Section 37.3 highest fault category testing on devices intended for service entrance use. SPD shall also be UL 1283 listed.
2. SPD shall be UL 67 listed, installed by and shipped from the electrical distribution equipment manufacturer's factory.
3. SPD shall provide surge current diversion paths for all modes of protection; L-N, L-G, N-G, in WYE systems, and L-L, L-G in DELTA systems.

4. SPD shall be modular in design. Each mode shall be fused with a 200kAIC; UL recognized surge rated fuse and incorporate a thermal cutout device.
5. SPD shall be integrally mounted to the bus bars of the switchboard.
6. Audible diagnostic monitoring shall be by way of audible alarm. This alarm shall activate upon a fault condition. An alarm on/off switch shall be provided to silence the alarm. An alarm push to test switch shall be provided as well.
7. SPD shall meet or exceed the following criteria:
  - a. Maximum surge current capability (single pulse rated) per phase shall be:
    - 1) Service Entrance Switchboard 250 kA.
    - 2) Distribution Panelboards 160 kA
    - 3) Branch Panelboards 160 kA
    - 4) Service Entrance MCC 240 kA specified.
    - 5) Distribution Class MCC 160 kA
  - b. UL 1449 Second Edition Listed and Recognized Component Suppression Voltage Ratings (SVR's) for Service Entrance and Distribution Location equipment shall not exceed the following:
  - c. Voltage Let-Thru values for Solidly Grounded Systems:

VOLTAGE	L-N	L-G	N-G
208Y/120	400V	400V	400V
480Y/277	800V	800V	800V

8. SPD shall have a minimum EMI/RFI filtering of -50Db at 100 kHz with an insertion ratio of 50:1 using MIL-STD-220A methodology.
9. SPD shall have the following diagnostic features: transient counter, status lights on each phase, and one set of 1 NO and 1 NC auxiliary dry contacts for alarming.
10. SPD shall have a warranty for a period of five years, incorporating unlimited replacements of suppressor parts if transients destroy them during the warranty period. Warranty shall be the responsibility of the electrical distribution equipment manufacturer and shall be supported by their respective field service division.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

- A. Install motor control equipment in accordance with manufacturer's recommendations, the NEC, NEMA and as shown on the drawings.

- B. Install Variable Speed Motor Controllers in accordance with manufacturers recommendations, the NEC, as shown on the drawings and in accordance with NEMA ICS 7.1.C.
- C. Furnish and install heater elements in motor starters to match the installed motor characteristics.

**3.2 SPARE PARTS**

Two weeks prior to the final inspection, provide one complete set of spare fuses (including heater elements) for each starter/controller installed on this project.

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**SECTION 26 29 21**  
**DISCONNECT SWITCHES**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

This section specifies the furnishing, installation and connection of low voltage disconnect switches.

**1.2 RELATED WORK**

- A. General electrical requirements and items that is common to more than one section of Division 26: Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.
- B. Conduits for cables and wiring: Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS.
- C. Cables and wiring: Section 26 05 21, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW.
- D. Motor rated toggle switches: Section 26 29 11, LOW-VOLTAGE MOTOR STARTERS.
- E. Requirements for personnel safety and to provide a low impedance path for possible ground faults: Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS.

**1.3 SUBMITTALS**

- A. Submit in accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.
- B. Shop Drawings:
  - 1. Include sufficient information, clearly presented to determine compliance with drawings and specifications.
  - 2. Include electrical ratings, dimensions, mounting details, materials, enclosure types, fuse type and class.
  - 3. Show the specific switch and fuse proposed for each specific piece of equipment or circuit.
- C. Manuals:
  - 1. Provide complete maintenance and operating manuals for disconnect switches, including technical data sheets, wiring diagrams, and information for ordering replacement parts. Deliver four copies to the COTR two weeks prior to final inspection.
  - 2. Identify terminals on wiring diagrams to facilitate maintenance and operation.
  - 3. Wiring diagrams shall indicate internal wiring and any interlocking.

- D. Certification: Two weeks prior to final inspection, deliver to the COTR four copies of the certification that the equipment has been properly installed, adjusted, and tested.

#### 1.4 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 the basic designation only.
- B. National Electrical Manufacturers Association (NEMA):  
KS 1-01.....Enclosed and Miscellaneous Distribution  
Equipment Switches (600 Volts Maximum)
- C. National Fire Protection Association (NFPA):  
70-05.....National Electrical Code (NEC)
- D. Underwriters Laboratories, Inc. (UL):  
98-98.....Enclosed and Dead-Front Switches  
198C-89.....High-Interrupting-Capacity Fuses, Current  
Limiting Types  
198E-94.....Class R Fuses  
977-99.....Fused Power-Circuit Devices

### PART 2 - PRODUCTS

#### 2.1 LOW VOLTAGE FUSIBLE SWITCHES RATED 600 AMPERES AND LESS

- A. Shall be quick-make, quick-break type in accordance with UL 98, NEMA KS 1 and NEC.
- B. Shall have a minimum duty rating, NEMA classification General Duty (GD) for 240 volts and NEMA classification Heavy Duty (HD) for 277/480 volts.
- C. Shall be horsepower rated.
- D. Shall have the following features:
1. Switch mechanism shall be the quick-make, quick-break type.
  2. Copper blades, visible in the OFF position.
  3. An arc chute for each pole.
  4. External operating handle shall indicate ON and OFF position and shall have lock-open padlocking provisions.
  5. Mechanical interlock shall permit opening of the door only when the switch is in the OFF position, defeatable by a special tool to permit inspection.
  6. Fuse holders for the sizes and types of fuses specified.
  7. Electrically operated switches shall only be installed where shown on the drawings.
  8. Solid neutral for each switch being installed in a circuit which includes a neutral conductor.

9. Ground Lugs: One for each ground conductor.

10. Enclosures:

- a. Shall be the NEMA types shown on the drawings for the switches.
- b. Where the types of switch enclosures are not shown, they shall be the NEMA types which are most suitable for the environmental conditions where the switches are being installed. Unless otherwise indicated on the plans, all outdoor switches shall be NEMA 3R.
- c. Shall be finished with manufacturer's standard gray baked enamel paint over pretreated steel (for the type of enclosure required).

## **2.2 LOW VOLTAGE UNFUSED SWITCHES RATED 600 AMPERES AND LESS**

Shall be the same as Low Voltage Fusible Switches Rated 600 Amperes and Less, but no fuses.

## **2.3 LOW VOLTAGE FUSIBLE SWITCHES RATED OVER 600 AMPERES TO 1200 AMPERES**

Shall be the same as Low Voltage Fusible Switches Rated 600 Amperes and Less, except for the minimum duty rating which shall be NEMA classification Heavy Duty (HD). These switches shall also be horsepower rated.

## **2.4 MOTOR RATED TOGGLE SWITCHES**

Refer to Section 26 29 11, LOW-VOLTAGE MOTOR STARTERS for motor rated toggle switches.

## **2.5 IDENTIFICATION SIGNS**

- A. Install nameplate identification signs on each disconnect switch to identify the equipment controlled.
- B. Nameplates shall be laminated black phenolic resin with a white core, with engraved lettering, a minimum of 6 mm (1/4-inch) high. Secure nameplates with screws.

# **PART 3 - EXECUTION**

## **3.1 INSTALLATION**

- A. Install disconnect switches in accordance with the NEC and as shown on the drawings.
- B. Fusible disconnect switches shall be furnished complete with fuses.

## **3.2 SPARE PARTS**

Two weeks prior to the final inspection, furnish one complete set of spare fuses for each fusible disconnect switch installed on the project. Deliver the spare fuses to the COTR.

- - - E N D - - -

**SECTION 26 51 00**  
**INTERIOR LIGHTING**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

This section specifies the furnishing, installation and connection of the interior lighting systems.

**1.2 RELATED WORK**

- A. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General requirements that are common to more than one section of Division 26.
- B. Section 26 05 21, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW): Cables and wiring.
- C. Section 26 27 26, WIRING DEVICES: Wiring devices used as part of the lighting systems.
- 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.

**1.3 QUALITY ASSURANCE**

- A. Refer to Paragraph, QUALIFICATIONS, in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

**1.4 SUBMITTALS**

- A. In accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, submit the following:
- B. Shop Drawings:
  - 1. Sufficient information, clearly presented, shall be included to determine compliance with drawings and specifications.
  - 2. Include electrical ratings, dimensions, mounting details, materials, required clearances, terminations, wiring and connection diagrams, photometric data, ballasts, lenses, louvers, lamps, and controls.
  - 3. When catalog data and/or shop drawings for fluorescent fixtures are submitted for approval, photometric data from an independent testing laboratory shall be included with the submittal, indicating average brightness and efficiency of the fixture, as specified in specification or as shown on the drawings. Coefficient of utilization data will not be considered a suitable substitute.
- C. Samples:
  - 1. Simultaneously with the shop drawing and catalog cut submittal, deliver to the COTR a sample of each lighting fixture types: A, B, C, F1, F3, G, N1, S1, Z, U4, Exit (single), Exit (Double) for approval. The approved samples shall be installed in the location directed by

the COTR and shall be removed, repackaged and turned over to the COTR after final inspection.

D. Manuals:

1. Submit, simultaneously with the shop drawings companion copies of complete maintenance and operating manuals including technical data sheets, and information for ordering replacement parts.
2. Two weeks prior to the final inspection, submit four copies of the final updated maintenance and operating manuals, including any changes, to the COTR.

E. Certifications:

1. Two weeks prior to final inspection, submit four copies of the following certifications to the COTR:
  - a. Certification by the Contractor that the equipment has been properly installed, adjusted, and tested.
  - b. Include with shop drawings, certification from the manufacturers that all electronic high-frequency ballasts meet the transient protection required by IEEE C62.41, Cat. A. Include with initial shop drawing submittal.

**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):
- C78.1-91.....Fluorescent Lamps - Rapid-Start Types -  
Dimensional and Electrical Characteristics
  - C78.2-91.....Fluorescent Lamps - Preheat-Start Types -  
Dimensional and Electrical Characteristics
  - C78.3-91.....Fluorescent Lamps - Instart Start and Cold-Cathode Types - Dimensional and Electrical Characteristics
  - C78.376-91.....Chromaticity of Fluorescent Lamps (ANSI/NEMA C78/376-96)
- C. Certified Ballast Manufacturers Association (CBM):
- Requirements for Ballast Certification.
- D. Institute of Electrical and Electronic Engineers (IEEE):
- C62.41-91.....Recommended Practice on Surge Voltage in Low Voltage AC Power Circuits
- E. National Fire Protection Association (NFPA):
- 70-02.....National Electrical Code (NEC)
  - 101-00.....Life Safety Code

F. National Electrical Manufacturer's Association (NEMA)

C82.1-97.....Ballasts for Fluorescent Lamps - Specifications

C82.2-02.....Method of Measurement of Fluorescent Lamp  
Ballasts

C82.4-02.....Ballasts for High-Intensity-Discharge and Low-  
Pressure Sodium Lamps

C82.11-02.....High Frequency Fluorescent Lamp Ballasts

G. Underwriters Laboratories, Inc. (UL):

496-96.....Edison-Base Lampholders

542-99.....Lampholders, Starters, and Starter Holders for  
Fluorescent Lamps

844-95.....Electric Lighting Fixtures for Use in Hazardous  
(Classified) Locations

924-95.....Emergency Lighting and Power Equipment

935-01.....Fluorescent-Lamp Ballasts

1029-94.....High-Intensity-Discharge Lamp Ballasts

1598-00.....Luminaires

H. Federal Communications Commission (FCC):

Code of Federal Regulations (CFR), Title 47, Part 18

**PART 2 - PRODUCTS**

**2.1 LIGHTING FIXTURES (LUMINAIRES)**

A. Shall be in accordance with NFPA 70, UL 1598 and shall be as shown on drawings and as specified.

B. Sheet Metal:

1. Shall be formed to prevent warping and sagging. Housing, trim and lens frame shall be true, straight (unless intentionally curved) and parallel to each other as designed.

2. Wireways and fittings shall be free of burrs and sharp edges and shall accommodate internal and branch circuit wiring without damage to the wiring.

3. Where lighting fixtures are detailed with minimum 20 gauge housing, minimum 22 gauge housings will be acceptable provided they have strengthening embossed rib and break formations, which give the equivalent rigidity of a 20 gauge housing.

4. When installed, any exposed fixture housing surface, trim frame, door frame and lens frame shall be free of light leaks; lens doors shall close in a light tight manner.

5. Hinged door closure frames shall operate smoothly without binding when the fixture is in the installed position, and latches shall function easily by finger action without the use of tools.

- C. Ballasts shall be serviceable while the fixture is in its normally installed position, and shall not be mounted to removable reflectors or wireway covers unless so specified.
- D. Lamp Sockets:
  - 1. Fluorescent: Lampholder contacts shall be the biting edge type or phosphorous-bronze with silver flash contact surface type and shall conform to the applicable requirements of UL 542. Contacts for recessed double contact lampholders and for slimline lampholders shall be silver plated. Lampholders for bi-pin lamps, with the exception of those for "U" type lamps, shall be of the telescoping compression type, or of the single slot entry type requiring a one-quarter turn of the lamp after insertion.
  - 2. Incandescent: Shall have porcelain enclosures and conform to the applicable requirements of UL 496.
  - 3. High Intensity Discharge (H.I.D.): Shall have porcelain enclosures.
- E. Recessed incandescent fixtures mounted in an insulated ceiling shall be listed for use in insulated ceilings.
- F. Fluorescent fixtures with louvers or light transmitting panels shall have hinges, latches and safety catches to facilitate safe, convenient cleaning and relamping. Vapor tight fixtures shall have pressure clamping devices in lieu of the latches.
- G. Mechanical Safety: Lighting fixture closures (lens doors, trim frame, hinged housings, etc.) shall be retained in a secure manner by captive screws, chains, captive hinges or fasteners such that they cannot be accidentally dislodged during normal operation or routine maintenance.
- H. Metal Finishes:
  - 1. The manufacturer shall apply his standard finish (unless otherwise specified) over a corrosion resistant primer, after cleaning to free the metal surfaces of rust, grease, dirt and other deposits. Edges of pre-finished sheet metal exposed during forming, stamping or shearing processes shall be finished in a similar corrosion resistant manner to match the adjacent surface(s). Fixture finish shall be free of stains or evidence of rusting, blistering, or flaking.
  - 2. Interior light reflecting finishes shall be white with not less than 85 percent reflectances, except where otherwise shown on the drawing.
  - 3. Exterior finishes shall be as shown on the drawings.
- I. Provide all lighting fixtures with a specific means for grounding their metallic wireways and housings to an equipment grounding conductor.
- J. Light Transmitting Components for Fluorescent Fixtures:

1. Shall be 100 percent virgin acrylic plastic or water white, annealed, crystal glass.
  2. Flat lens panels shall have not less than 3.2 mm (1/8 inch) of average thickness. The average thickness shall be determined by adding the maximum thickness to the minimum unpenetrated thickness and dividing the sum by 2.
  3. Unless otherwise specified, lenses, diffusers and louvers shall be retained firmly in a metal frame by clips or clamping ring in such a manner as to allow expansion and contraction of the lens without distortion or cracking.
- K. Lighting Fixtures in Hazardous Areas: Fixtures shall be suitable for installation in flammable atmospheres (Class and Group) as defined in NFPA 70 and shall comply with UL 844.
- L. Compact fluorescent fixtures shall be manufactured specifically for compact fluorescent lamps with ballasts integral to the fixture. Assemblies designed to retrofit incandescent fixtures are prohibited except when specifically indicated for renovation of existing fixtures. Fixtures shall be designed for lamps as specified.

## **2.2 FLUORESCENT LAMP BALLASTS**

- A. Where applicable, fluorescent lamps and ballasts shall comply with the National Energy Policy Act of 1992.
- B. Ballasts shall comply with NEMA 82.1, 82.2 and 82.11, NFPA 70, and UL 935 unless otherwise specified.
- C. Lamp types F32T8 and F32T8/U shall be operated by electronic, high frequency ballasts. All other fluorescent lamp types shall be operated by the standard energy saving electromagnetic core-and-coil ballasts. For these applications, the lamps shall be operated by core-and-coil ballasts where specifically required on the drawings as "core-and-coil".
- D. Electronic high-frequency ballasts:
  1. Ballasts shall operate the lamps at a frequency between 20 and 60 KHz from an input frequency of 60Hz.
  2. Ballast package:
    - a. Size: The ballast case shall be sized to be physically interchangeable with standard core-and-coil ballasts and suitable for standard mounting in new or existing lighting fixtures.
    - b. Case marking: Mark the ballast to indicate the required supply voltage, frequency, RMS current, current surge during starting, input watts, and power factor at the design center voltage, open circuit voltage, crest factor and efficacy.
  3. Performance:

- a. Light output:
  - 1) At the design voltage, the light output shall be at least equal to that obtained by a core-and-coil ballasted system meeting ANSI, NEMA and CBM standards. The comparison test shall be measured in the same fixture at 25 degrees C (plus or minus one degree) ambient room temperature.
  - 2) Tests shall be made in fixtures designed only for the number of lamps being tested.
  - 3) For other applications (higher ambients, etc.) the tests should be operated with equivalent lamp wall temperatures plus or minus 4 degrees C.
- b. Efficacy: The efficacy of the high-frequency, electronically ballasted system shall be at least 15 percent greater than the equivalent CBM core-and-coil ballasted system (see "Light output" above).
- c. Starting: The ballast shall be capable of starting and maintaining operation of lamps at an ambient temperature of 10 degrees C (50 degree F) or more for an input voltage of plus or minus 10 percent about the center design voltage unless otherwise indicated. The ballast shall never be started in the instant start mode at any temperature.
- d. Operation:
  - 1) The ballast shall safely and reliably operate in a room ambient temperature from 10 degrees C (50 degree F) to 40 degrees C (105 degree F).
  - 2) The light output shall not vary by more than plus or minus 5 percent for a plus or minus 10 percent variation of the input voltage about the center design voltage. Light output shall remain constant for a plus or minus 5 percent variation of the input voltage.
  - 3) The ballast shall operate the lamps in a manner that will not adversely curtail the normal life of the lamp.
- e. Transient protection: The ballast shall comply with IEEE C62.41, Cat. A.
- f. Flicker: The flicker shall be less than 5 percent and without visible flicker.
- g. Noise: The audible noise levels should be equivalent to or better than the Class A rating of CBM certified ballasts.
- h. Electromagnetic Interference (EMI) and Radio Frequency Interference (RFI): The EMI and RFI limits shall meet the

requirements of the Federal Communications Commission Rules and Regulations (CFR 47 Part 18).

- i. Rated life: The ballast shall have a rated life of 10 years or 30,000 hours (based on a 10 hour day).
  - j. The two-lamp ballast shall safely operate two F32T8 RS, 32- watt lamps or two F32T8/U lamps. The single lamp ballast shall safely operate one F32T8 RS, 32-watt lamp or one F32T8/U lamp.
  - k. Power factor: Not less than 95 percent.
  - l. Reliability:
    - 1) Labels: Ballasts must be labeled or listed by UL and CBM/ETL.
    - 2) Submit, simultaneously with shop drawings, a certified test report by an independent testing laboratory showing that the electronic ballasts meet or exceed all the performance requirements in this specification.
  - m. Total harmonic distortion (THD) shall be less than 10 percent.
- E. Core-and-coil ballasts (for lamps other than F32T8 and F32T8/U or where shown on drawings as "core-and-coil"):
- 1. Shall be rapid starting type.
  - 2. Shall comply with NEMA 82.1 and UL 935.
  - 3. Shall be UL Class P with automatic-resetting, internal, thermal protection.
  - 4. Shall be CBM/ETL certified.
  - 5. Power factor shall be not less than 95 percent. Capacitors in ballasts shall not contain PCB (Polychlorinated Biphenyl) fluids or other fluids recognized as hazardous when discharged into the environment.
  - 6. Sound ratings shall be Class A or better, except for ballast sizes which are not available with Class A ratings, as standard products from any manufacturer. Ballasts which are not available with Class A ratings shall have the quietest ratings available.
  - 7. Where core-and-coil ballasts are specified or detailed in lieu of the normally required electronic high-frequency types, two lamp ballasts shall be energy-saving type, UL listed to operate F40T12 rapid start lamps for both standard 40 watt lamps and the reduced wattage 35/34 watts energy-saving lamps. Lamp output shall be within 5 percent of nominal rating. When operating energy-saving lamps, the input watts to the ballast shall not exceed 78 watts at 120 V.A.C. or 79 watts at 277 V.A.C. Energy-saving type ballasts should not be used in ambient temperatures below manufacturer's recommendations.

- F. Ballasts for lighting fixtures controlled by dimming devices shall be the electronic, high frequency type as specified herein, equipped for dimming and conform to the recommendations of the manufacturer of the associated dimming devices to assure satisfactory operation of the lighting system.
- G. All ballasts serving straight or "U" type lamps shall be mounted by four non-turning studs (or captive bolts) equipped with lock washers and nuts or locking type nuts, or by four thread cutting (TC) sheet metal screws which are firmly secured against the fixture body (or wireway) to maximize dissipation of heat and minimize noise. Exception: electronic high-frequency ballasts may be mounted at a minimum of two points, one at each end of unit.
- H. Ballasts shall be serviceable while the fixture is in its normally installed position, and shall not be mounted to removable reflectors or wireway covers unless so specified.
- I. To facilitate multi-level lamp switching, lamps within fixture shall be wired with the outermost lamp at both sides of the fixture on the same ballast, the next inward pair on another ballast and so on to the innermost lamp (or pair of lamps). Within a given room, each switch shall uniformly control the same corresponding lamp (or lamp pairs) in all fixture units that are being controlled.
- J. Where three-lamp fixtures are indicated, unless switching arrangements dictate otherwise, utilize a common two-lamp ballast to operate the center lamp in pairs of adjacent units that are mounted in a continuous row. The ballast fixture and slave-lamp fixture shall be factory wired with leads or plug devices to facilitate this circuiting. Individually mounted fixtures and the odd fixture in a row shall utilize a single-lamp ballast for operation of the center lamp.

**2.3 BALLASTS FOR HIGH INTENSITY DISCHARGE FIXTURES:**

- A. Shall comply with NEMA 82.4 and UL 1029.
- B. Shall have individual overcurrent protection sized in accordance with the manufacturer's recommendations.
- C. Shall have integral thermal protection where the fixture is recessed in an interior ceiling.
- D. Shall be the constant wattage, high power factor type or the reactor high power factor type. Capacitors shall not contain PCB (Polychlorinated Biphenyl) fluids or other fluids recognized as hazardous when discharged into the environment.

- E. Shall have not less than Class B sound ratings for interior fixtures, when available. Ballasts which are not available with Class B ratings shall be of the next standard rating.

## 2.4 LAMPS

### A. Fluorescent Lamps:

1. Rapid start fluorescent lamps shall comply with ANSI C78.1; preheat-start type shall comply with ANSI C78.2; and instant-start and cold-cathode lamps shall comply with ANSI C78.3.
2. Chromacity of fluorescent lamps shall comply with ANSI C78.376.
3. The lamps shall include the F32T8, F32T8/U 32 watt energy saving type and EPACT approved F40T12 type if specifically required by contract drawings for special applications.
4. Except as indicated below, lamps shall be energy saving type, have a color temperature between 3500 and 4100°K, a Color Rendering Index (CRI) of not less than 75, and an initial lumen output not less than 2800. "U" tube lamps shall have the same color temperature and CRI limits as the above.
  - a. In utility areas (Electrical, Communication and Mechanical) Service rooms and closets), maintenance closets and non-medical storage spaces, utilize energy saving light-white lamps.
  - b. In areas with ambient temperatures below 60 degrees use the 40 watt version of the lamp above.
  - c. Over the beds in Intensive Care, Coronary Care, Recovery, Life Support, and Observation and Treatment areas; Electromyographic, Autopsy (Necropsy), Surgery, and certain dental rooms (Examination, Oral Hygiene, Oral Surgery, Recovery, Labs, Treatment, and X-Ray) use color corrected lamps having a CRI of 90 or above and a correlated color temperature between 5000 and 6000°K.
  - d. Other areas as indicated on the drawings.

- B. Incandescent lamps shall be the general service, inside frosted type rated 130 volts except where otherwise shown on the drawings.

### C. High Intensity Discharge Lamps:

1. Mercury vapor lamps shall be ANSI type "DX". Lamps in open or louvered fixtures mounted less than 4500 mm (15 feet) above the finished floor (or grade) shall be of the safety type in which the arc will automatically extinguish if the outer glass envelope becomes broken.
2. Multi-vapor lamps shall be as defined on the detail drawings.

3. High pressure sodium lamps shall be as defined on the detail drawings.

D. Compact Fluorescent Lamps: Shall be 3500°K, 10,000 hours average rated life, and as follows:

1. T4, twin tube, rated 5 watts, 250 initial lumens (min), 7 watts, 400 initial lumens (min), 9 watts, 600 initial lumens (min), 13 watts, 825 initial lumens (min), as indicated.
2. T4, double twin tube rated 13 watts, 900 initial lumens (min), 18 watts, 1200 initial lumens (min), 26 watts, 1800 initial lumens (min), as indicated.

## **2.5 OCCUPANT SENSOR LIGHTING CONTROL SYSTEMS**

- A. General: An active or passive sensor shall be utilized to control the "On-Off" actuation of fluorescent or incandescent lighting loads. It shall provide control of an isolated set of contacts on exposure to a perceived change in environmental conditions indicating the presence or absence of one or more persons. It shall maintain the contacts closed in the presence of continued changes (due to human presence) at similar intensity and rate. It shall open the contacts at a nominal time after the changes cease.
- B. Passive Sensor System: Sensor(s) shall react to changes of radiated infrared energy, indicating the activity of one or more human bodies in the area covered:
1. Range of detection: The sensor(s) shall provide effective coverage of a room, sensing the presence of one or more people in the room in order to turn the lights on. The ceiling mounted sensor's area of coverage shall be approximately a 4200 mm (14 feet) diameter circle at 1800 mm (6 feet) away. Provide sufficient units to give full coverage as measured 750 mm (30 inches) above the floor. A field-of-view adjustment feature shall be provided to allow orientation to various room operating conditions.
  2. Sensor placement: Locate the sensor(s) in accordance with the manufacturer's recommendations to maximize energy savings by avoiding nuisance activation due to sudden temperature or air flow changes. Locate the units within 1800 mm (6 feet) horizontally of work stations or major points of activity, including the center of room entrance doors.
- C. Active Sensor System: Sensor(s) shall react to reflective changes to generated ultrasonic radiation (crystal controlled, 24 to 42kHz), indicating the activity of one or more persons in the area covered.

1. Range of detection: On ceilings below 3600 mm (twelve feet) in height, a single direction sensor shall cover approximately a 9 x 9 m (30 feet x 30 feet) area; a two directional unit a 18 x 9 m (60 feet x 30 feet) area; and a two-way corridor unit a total distance of 27 m (90 feet). The sensors shall be equipped with a concealed but accessible sensitivity control to tune the unit to specific room conditions.
2. Sensor placement: Locate the sensor(s) in accordance with the manufacturer's recommendations to maximize energy savings by avoiding nuisance activation due to predictable non-human motion activities. Give particular attention to work station or major areas of activity and the coverage of room entrance doors.
- D. Timing/Function: Shall not be user adjustable. Lighting shall remain on with one or more persons within the covered area. The system shall be factory set to maintain lights on for a minimum of 8 minutes and not longer than 12 minutes after the area of coverage is vacated. For testing purposes, there shall be a means to change the pre-set time delay to 30 seconds or less.
- E. Control Unit: The system shall have a switching relay(s) capable of switching the fluorescent or incandescent loads as required. Contacts shall be rated at a minimum of 15 Amps at voltages to 277, with expected cycles of operation in excess of 100K. Power derived from a current limiting 24 volt transformer shall power the system and the unit must be packaged for installation on a standard 200 mm x 200 mm (4 inch x 4 inch) NEMA box enclosure. The unit shall be wired through a conventional wall switch to provide an over-ride system "Off" and active "Off-On" functioning.
- F. Field Wiring: The wiring between the control unit and sensor(s) shall be an insulated multi-conductor, #22 gauge Poly Vinyl Chloride (PVC) jacketed cable.

## **2.6 REMOTE CONTROL SWITCHING FOR INDOOR LIGHTING SYSTEMS**

- A. Shall be rated for continuous-duty service.
- B. Electric contacts shall be precious metal surface.
- C. Magnetic contactors and relays shall be electrically-operated and mechanically-held.
- D. Characteristics of the components and the total resistances of the circuits throughout the systems shall be such that the systems will operate satisfactorily in every respect while the branch circuit power supply voltage to each system is within a 105-130 volt range at 60 Hz.

- E. Wall switches shall be the momentary contact type suitable for mounting in a single gang outlet box space and compatible with the standard design wall plates as specified.
- F. Where shown on the drawings, incorporate the components in panelboards behind separate doors and mount them on sound absorbing materials.
- G. Install circuit breaker or fuse protection for the control circuits.
- H. Low voltage remote control system shall be DC type, operating at not greater than 30 volts, and meeting the requirements for Class 2 circuits in Article 725 of the NEC.

## **2.7 RADIO-INTERFERENCE-FREE FLUORESCENT FIXTURES**

- A. Shall be specially designed for suppressing radio-frequency energy produced within the fixtures. The Rules and Regulations of FCC (CFR 47, Part 18) shall apply.
- B. Lenses shall have a light-transparent layer of metal permanently bonded to them, and in positive contact with the steel housing or equal to prevent the radio-frequency interferences from passing through the lenses. The effective light transmittance of the lenses shall be not less than 75 percent.
- C. Install line filters within the body of the fixtures and wired in series with the supply circuit conductors to eliminate the transmission of radio frequency energy into the supply circuit.

## **2.8 FLUORESCENT BEDLIGHT FIXTURES**

- A. Requirements:
  - 1. Fixed or movable arms are not acceptable.
  - 2. Exposed surfaces shall remain cool to the touch.
  - 3. Major portion of the light shall be directed upwards and outwards through lenses. Balance of the light shall be directed downwards through lenses to produce low brightness surfaces with minimum contrast as viewed by the patients from their normal viewing angles in bed.
  - 4. Shall provide not less than 110 lx (10 footcandles) (average) of general room illumination measured 750 mm (30 inches) above the floor.
  - 5. Shall provide 330 lx (30 footcandles) on the reading surfaces for the patients while in a normal prone or normal sit-up position in bed.
- B. Provide 4-position, pull cord switch on the fluorescent bedlight within easy reach of the patient while in a normal prone position in bed. The switches shall enable the patient to control the upward and downward portion of the light separately and simultaneously, to include an off position, except in single bed rooms where the switch shall enable the

patient to energize and de-energize the downward light only. In the single bed rooms, provide a 2-position pull cord switch for "on-off" control of the downward lamps.

C. Bedlight fixtures shall be rated for 120 volt operation.

## **2.9 X-RAY FILM ILLUMINATORS**

A. Shall be the high-intensity type, flush-mounted in the walls. Multiples of the basic unit may be combined in a common housing.

B. Shall have the following features:

1. Fluorescent lighting, designed to provide uniform diffusion of the light.
2. Box dimensions approximately 525 mm (21 inches) high, 350 mm (14 inches) wide and 100 mm (4 inches) deep.
3. Frame shall be satin chrome-plated brass or stainless steel and shall extend approximately 40 mm (1-1/2 inches) from the edges of the box.
4. Viewing glass shall be the heat resistant, borosilicate type or 100 percent virgin acrylic plastic and not less than 3 mm (1/8 inch) thick.
5. Viewing glass shall have adequate dimensions so the films will not overlap the frame and will be positioned with respect to the light source for even illumination without shadows.
6. An ON-OFF switch.
7. Power supply voltage shall be 120 volts, 60 Hz.

C. Fluorescent lamps shall be the cool-white, rapid-start type.

D. Ballast shall be low leakage type with leakage not exceeding 30 microamperes.

## **2.10 EXIT LIGHT FIXTURES**

A. Exit light fixtures shall meet applicable requirements of NFPA 101 and UL 924.

B. Housing and Canopy:

1. Shall be made of cast or extruded aluminum, or rolled steel.
2. Optional steel housing shall be a minimum 20 gauge thick or equivalent strength aluminum.
3. Steel housing shall have baked enamel over corrosion resistant, matte black or ivory white primer.

C. Door frame shall be cast or extruded aluminum, and hinged with latch.

D. Finish shall be satin or fine-grain brushed aluminum.

E. There shall be no radioactive material used in the fixtures.

F. Fixtures:

1. Inscription panels shall be cast or stamped aluminum a minimum of 2.25 mm (0.090 inch) thick, stenciled with 150 mm (6 inch) high

- letters, baked with red color stable plastic or fiberglass. Lamps shall be luminous red Light Emitting Diodes (LED) mounted in center of letters on red color stable plastic or fiberglass. The LED shall be rated minimum 25 years life; maximum of 3.5 watts for single face and 7 watts for double-faced fixtures that do not use diffuser panels in front of the LEDs. LED exit light fixtures that use diffuser panels shall require a maximum of 1.0 watt per fixture for single or double face fixtures.
2. Double-Faced Fixtures: Provide double-faced fixtures where required or as shown on drawings.
  3. Directional Arrows: Provide directional arrows as part of the inscription panel where required or as shown on drawings. Directional arrows shall be the "chevron-type" of similar size and width as the letters and meet the requirements of NFPA 101.
- G. Voltages: Fixtures shall be wired for 120-volt or 277-volt operation as indicated on drawings.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

- A. Installation shall be in accordance with the NEC, manufacturer's instructions and as shown on the drawings or specified.
- B. Align, mount and level the lighting fixtures uniformly.
- C. Avoid interference with and provide clearance for equipment. Where the indicated locations for the lighting fixtures conflict with the locations for equipment, change the locations for the lighting fixtures by the minimum distances necessary as approved by the COTR.
- D. For suspended lighting fixtures, the mounting heights shall provide the clearances between the bottoms of the fixtures and the finished floors as shown on the drawings.
- E. Fluorescent bed light fixtures shall be attached to the studs in the walls. Attachment to gypsum board only is not acceptable.
- F. Lighting Fixture Supports:
  1. Shall provide support for all of the fixtures. Supports may be anchored to channels of the ceiling construction, to the structural slab or to structural members within a partition, or above a suspended ceiling.
  2. Shall maintain the fixture positions after cleaning and relamping.
  3. Shall support the lighting fixtures without causing the ceiling or partition to deflect.

4. Hardware for recessed fluorescent fixtures:
  - a. Where the suspended ceiling system is supported at the four corners of the fixture opening, hardware devices shall clamp the fixture to the ceiling system structural members, or plaster frame at not less than four points in such a manner as to resist spreading of the support members and safely lock the fixture into the ceiling system.
  - b. Where the suspended ceiling system is not supported at the four corners of the fixture opening, hardware devices shall independently support the fixture from the building structure at four points.
5. Hardware for surface mounting fluorescent fixtures to suspended ceilings:
  - a. In addition to being secured to any required outlet box, fixtures shall be bolted to a grid ceiling system at four points spaced near the corners of each fixture. The bolts shall be not less than 6 mm (1/4 inch) secured to channel members attached to and spanning the tops of the ceiling structural grid members. Non-turning studs may be attached to the ceiling structural grid members or spanning channels by special clips designed for the purpose, provided they lock into place and require simple tools for removal.
  - b. In addition to being secured to any required outlet box, fixtures shall be bolted to a plaster ceiling at four points spaced near the corners of each fixture. Pre-positioned 6 mm (1/4 inch) studs or threaded plaster inserts secured to ceiling structural members shall be used to bolt the fixtures to the ceiling. In lieu of the above, 6 mm (1/4 inch) toggle bolts may be used on new or existing ceiling provided the plaster and lath can safely support the fixtures without sagging or cracking.
- G. Furnish and install the specified lamps for all lighting fixtures installed and all existing lighting fixtures reinstalled under this project.
- H. Coordinate between the electrical and ceiling trades to ascertain that approved lighting fixtures are furnished in the proper sizes and installed with the proper devices (hangers, clips, trim frames, flanges), to match the ceiling system being installed.
- I. Bond lighting fixtures and metal accessories to the grounding system as specified in Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS.

J. At completion of project, relamp all fixtures which have failed/burned-out lamps. Clean all fixtures, lenses, diffusers and louvers that have accumulated dust/dirt during construction.

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