

A hand holding a pen points to a technical drawing of a boiler system. The drawing is a complex schematic with various lines, circles, and text labels. The background is a gradient of blue and green.

Louis A. Johnson VA Medical Center Boiler No. 3 Burner Replacement Specifications Issued For Construction

Clarksburg, WV

**DEPARTMENT OF VETERANS AFFAIRS
VHA MASTER SPECIFICATIONS**

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**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 Boiler No. 3 Burner Replacement Project as required by drawings and specifications.
- B. Visits to the site by Bidders may be made only by appointment with the Louis A Johnson VA Medical Center Contracting Officer (CO) or Contracting Officers Technical Representative (COTR)
- C. Offices of AECOM, 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. All Contact with AECOM shall be through COTR.
- D. Before placement and installation of work subject to tests by testing laboratory retained by Department of Veterans Affairs, 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 five 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. All employees of general contractor or subcontractors shall have the 10-hour OSHA certified Construction Safety course and /or other relevant competency training, as determined by VA CP with input from the ICRA team.

2. Submit training records of all such employees for approval before the start of work.

1.2 STATEMENT OF BID ITEM(S)

- A. ITEM I, GENERAL CONSTRUCTION and Boiler No. 3 Burner Replacement: Work includes general construction, alterations, mechanical and electrical work, necessary removal of existing structures and construction and certain other items.

1.3 SPECIFICATIONS AND DRAWINGS FOR CONTRACTOR

- A. AFTER AWARD OF CONTRACT, 1 CD set of specifications and drawings will be furnished. Hard Copy drawings and specifications will consist of those returned by prospective bidders. Prospective bidders are encouraged to return unused sets of documents for re-use.

Section B not used

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 14 days notice to the COTR 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.

D. 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 Louis A Johnson VAMC locksmith for permanent installation. See Section 08 71 00, DOOR HARDWARE and coordinate with the COTR, Locksmith and the Louis A. Johnson VAMC lock vendor.

E. Document Control:

1. Before starting any work, the General Contractor/Sub Contractors shall submit an electronic security memorandum describing the approach to following goals and maintaining confidentiality of "sensitive information".
2. The General Contractor is responsible for safekeeping of all drawings, project manual and other project information. This information shall be shared only with those with a specific need to accomplish the project.
4. Certain documents, sketches, videos or photographs and drawings may be marked "Law Enforcement Sensitive" or "Sensitive Unclassified". Secure such information in separate containers and limit the access to only those who will need it for the project. Return the information to the COR upon request.
5. These security documents shall not be removed or transmitted from the project site without the written approval of Contracting Officer.
6. All paper waste or electronic media such as CD's and diskettes shall be shredded and destroyed in a manner acceptable to the VA.
7. Notify the Contracting Officer and COTR immediately when there is a loss or compromise of "sensitive information".
8. All electronic information shall be stored in specified location following VA standards and procedures using an Engineering Document Management Software (EDMS).
 - a. Security, access and maintenance of all project drawings, both scanned and electronic shall be performed and tracked through the EDMS system.
 - b. "Sensitive information" including drawings and other documents may be attached to e-mail provided all VA encryption procedures are followed.

F. Motor Vehicle Restrictions

1. Vehicle authorization request shall be required for any vehicle entering the site and such request shall be submitted 36 hours before

the date and time of access. Access shall be restricted to picking up and dropping off materials and supplies.

2. Separate permits shall be issued for General Contractor and its employees for parking in designated areas only. Multiple vehicles will not be permitted at the Louis A. Johnson VAMC. Carpooling will be required of contractors.

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):

E84-2009.....Surface Burning Characteristics of Building
Materials

2. National Fire Protection Association (NFPA):

10-2010.....Standard for Portable Fire Extinguishers

30-2011.....Flammable and Combustible Liquids Code

51B-2009.....Standard for Fire Prevention During Welding,
Cutting and Other Hot Work

70-2011.....National Electrical Code

241-2009.....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 the COTR and Facility Fire Protection Officer 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.
- 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.
- 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 and Safety Officer.
- H. Egress Routes for Construction Workers: Maintain free and unobstructed egress. Inspect daily. Report findings and corrective actions weekly to the COTR and Safety Officer.
- 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.
- M. 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 COR. During construction, all sprinkler heads shall have extreme duty metal protective cages installed by the contractor.
- N. Smoke Detectors: Prevent accidental operation. Remove temporary covers at end of work operations each day. Coordinate with the
- O. Hot Work: Perform and safeguard hot work operations in accordance with NFPA 241 and NFPA 51B. Coordinate with COTR. Obtain permits from the COTR at least 48 hours in advance. Designate contractor's responsible project-site fire prevention program manager to permit hot work. This person shall be identified in the contractors written project safety plan.
- P. Fire Hazard Prevention and Safety Inspections: Inspect entire construction areas weekly. Coordinate with, and report findings and

corrective actions weekly to the COTR and Fire Protection Safety Officer.

- Q. 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.
- R. Dispose of waste and debris in accordance with NFPA 241. Remove from buildings daily.
- S. Perform other construction, alteration and demolition operations in accordance with 29 CFR 1926.
- T. 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.

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 in such a manner as to interfere as little as possible with work being done by others. Keep roads clear of construction materials, debris, standing construction equipment and vehicles at all times.
- G. 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 COR where required by limited working space. The contractor shall be flexible on daily scheduling due to surgeries, medical procedures or other services and may be required to stop tasks upon immediate notice to accommodate the medical center operations. Some project tasks may be required to take place during off hours or during weekends.
 - 1. Do not store materials and equipment in other than assigned areas.
 - 2. Schedule delivery of materials and equipment to immediate construction working areas within buildings in use by Department of Veterans Affairs in quantities sufficient for not more than two work days. Provide unobstructed access to Medical Center areas required to remain in operation.
 - 3. Where access by Medical Center personnel to vacated portions of buildings is not required, storage of Contractor's materials and equipment May be permitted subject to fire and safety requirements.
- H. Utilities Services: Where necessary to cut existing pipes, electrical wires, conduits, cables, etc., of utility services, or of fire protection systems or communications systems (except telephone), they shall be cut and capped at suitable places where shown; or, in absence of such indication, where directed by Resident Engineer. All such actions shall be coordinated with the Utility Company involved:
 - 1. 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.
- I. Phasing: To insure such executions, Contractor shall furnish the Resident Engineer 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 Resident Engineer two weeks in advance of the proposed date of starting work in each specific area of site, building or portion thereof. Arrange such phasing dates to insure accomplishment of this work in successive phases mutually agreeable to Medical Center Director, and Contractor, as follows:

All Phases: Contractor shall maintain two boilers (Boiler A and Boiler B) in operation at all times during construction. Boiler A will be the primary source of steam and Boiler B will be the redundant boiler as required by VHA regulations. Boiler C will be the boiler that is out of service. Boiler C must be fully operational and all testing and commissioning completed prior to turning off Boiler A or Boiler B. This will maintain two operable boilers on at all times. The same process will occur each time a completed boiler and the corresponding controls are ready for operation and another boiler is to be shut down.

No utility service such as water, gas, steam, sewers, electricity, fire protection systems, communications systems, medical gas, or other utilities may be interrupted without prior approval of Resident Engineer. Contractor shall submit a request to interrupt any such services to Resident Engineer, in writing, 14 calendar days in advance of proposed interruption. Request shall state reason, date, exact time of, and approximate duration of such interruption. 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.

- J. Building No.7 which includes the Boiler Plant will be occupied during performance of work.
1. Contractor shall take all measures and provide all material necessary for protecting existing equipment and property in affected areas of construction against dust and debris, so that equipment and affected areas to be used in the Medical Centers operations will not be hindered. Contractor shall permit access to Department of Veterans Affairs personnel and patients through other construction areas which serve as routes of access to such affected areas and equipment. Coordinate alteration work in areas occupied by Department of

Veterans Affairs so that Medical Center operations will continue during the construction period.

- K. 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 the COTR and Medical Center Fire Protection Specialist at least two weeks in advance of the proposed date of starting work in each specific work area or phase. The contractor may not begin work until the medical center fire protection specialist has approved the work area.
- L. Utilities Services: Maintain existing utility services for the 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 Resident Engineer.
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 the 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 Sections 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, 27 05 11 REQUIREMENTS FOR COMMUNICATIONS INSTALLATIONS and 28 05 11, REQUIREMENTS FOR ELECTRONIC SAFETY AND SECURITY INSTALLATIONS for additional requirements.
 2. Contractor shall submit a request to interrupt any such services to COTR, in writing, 14 days in advance of proposed interruption. Request shall state reason, date, exact time of, and approximate duration of such interruption.
 3. Contractor will be advised (in writing) of approval of request, or of which other date and/or time such interruption will cause least

- inconvenience to operations of the Medical Center. Interruption time approved by the Medical Center may occur at other than Contractor's normal working hours.
4. Major interruptions of any system must be requested, in writing, at least 15 calendar days prior to the desired time and shall be performed as directed by the 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.
- M. 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 are to be entirely removed,. The lines shall not be capped in finished areas, but shall be removed back to the source and sealed, capped or plugged. Lines that cannot be removed back to the source will be coordinated with the COTR.
- N. 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. Wherever excavation for new utility lines cross existing roads, at least one lane must be open to traffic at all times. Flag persons trained per requirements of the West Virginia Department of Transportation are required when traffic flow is affected.
 2. Method and scheduling of required cutting, altering and removal of existing roads, walks and entrances must be approved by the COTR.
- O. 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, the A&E and a representative of VA Supply Service, of the areas in which alterations occur and areas which are anticipated routes of access, and furnish a report, signed by all three, 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 the affected areas.
 2. Existence and conditions of items such as plumbing fixtures and accessories, electrical fixtures, equipment, venetian blinds, shades, etc., required by drawings to be either reused or relocated, or both.
 3. Shall note any discrepancies between drawings and existing conditions at site.
 4. Shall designate areas for working space, materials storage and routes of access to areas within buildings where alterations occur and which have been agreed upon by Contractor and COR.
- B. Any items required by drawings to be either reused or relocated or both, found during this survey to be nonexistent, or in opinion of COR and/or Supply Representative, to be in such condition that their use is impossible or impractical, shall be furnished and/or replaced by Contractor with new items in accordance with specifications which will be furnished by Government. Provided the contract work is changed by reason of this subparagraph B, the contract will be modified accordingly, under provisions of clause entitled "DIFFERING SITE CONDITIONS" (FAR 52.236-2) and "CHANGES" (FAR 52.243-4 and VAAR 852.236-88).
- C. Re-Survey: Thirty days before expected partial or final inspection date, the Contractor and COR together shall make a thorough re-survey of the areas of buildings involved. They shall furnish a report on conditions then existing, of resilient flooring, doors, windows, walls and other surfaces as compared with conditions of same as noted in first condition survey report:
1. Re-survey report shall also list any damage caused by Contractor to such flooring and other surfaces, despite protection measures; and, will form basis for determining extent of repair work required of Contractor to restore damage caused by Contractor's workmen in executing work of this contract.
- D. Protection: Provide the following protective measures:
1. Wherever existing roof surfaces are disturbed they shall be protected against water infiltration. In case of leaks, they shall be repaired immediately upon discovery.
 2. Temporary protection against damage for portions of existing structures and grounds where work is to be done, materials handled and equipment moved and/or relocated.
 3. Protection of interior of existing structures at all times, from damage, dust and weather inclemency. Wherever work is performed,

floor surfaces that are to remain in place shall be adequately protected prior to starting work, and this protection shall be maintained intact until all work in the area is completed.

1.8 INFECTION PREVENTION MEASURES

- A. 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.
- B. Establish and maintain a dust control program as part of the contractor's infection preventive measures in accordance with the guidelines provided by ICRA Group as specified here and indicated on the drawings. Prior to start of work, prepare a plan detailing project-specific dust protection measures, including periodic status reports, and submit to COTR and Facility ICRA team 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. All personnel working on the project are required to watch the video "Infection Control During Construction".
- C. 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 RE 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 depend on the location and type of activity. Upon notification, the contractor shall implement corrective measures to restore proper pressure differentials as needed. The contractor shall install negative air machines as directed by the COR and may be required to add machines as directed.
 - 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.

- D. In general, following preventive measures shall be adopted during construction to keep down dust and prevent mold.
1. Dampen debris to keep down dust and provide temporary construction partitions in existing structures where directed by Resident Engineer. 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. Construct the dust proof barrier with the same fire rating as the adjacent walls. Barriers shall be sealed and made presentable on hospital occupied side. Install a self-closing rated door in a metal frame, commensurate with the partition, to allow worker access. Maintain negative air at all times. A fire retardant polystyrene, 6-mil thick or greater plastic barrier meeting local fire codes may be used in certain circumstances where hard walls cannot be constructed and an agreement is reached with the COTR and Medical Center Fire Protection Specialist.
 - 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 directed by the COTR 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. Shop Vacs and

Vacuum cleaners shall utilize HEPA filtration. Maintain surrounding area frequently. Remove debris as they are created. Transport these outside the construction area in containers with tightly fitting lids.

- 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. Wheels and tires shall not track debris on floors outside the work zone.
 - 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 4 hours. Remove and dispose of porous materials that remain damp for more than 24 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.
- E. Final Cleanup:
- 1. Upon completion of project, or as work progresses, remove all construction debris from above ceiling, vertical shafts and utility chases that have been part of the construction.
 - 2. Perform HEPA vacuum cleaning of all surfaces in the construction area. This includes walls, ceilings, cabinets, furniture (built-in or free standing), partitions, flooring, etc.
 - 3. All new air ducts shall be cleaned prior to final inspection.

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 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 in
4. PCB Transformers and Capacitors : The Contractor shall be responsible for disposal of the Polychlorinated Biphenyl (PCB) transformers and capacitors. The transformers and capacitors shall be taken out of service and handled in accordance with the procedures of the Environmental Protection Agency (EPA) and the Department of Transportation (DOT) as outlined in Code of Federal Regulation (CFR), Titled 40 and 49 respectively. The EPA's Toxic Substance Control Act (TSCA) Compliance Program Policy Nos. 6-PCB-6 and 6-PCB-7 also apply. Upon removal of PCB transformers and capacitors for disposal, the "originator" copy of the Uniform Hazardous Waste Manifest (EPA Form 8700-22), along with the Uniform Hazardous Waste Manifest Continuation Sheet (EPA Form 8700-22A) shall be returned to the Contracting Officer who will annotate the contract file and transmit the Manifest to the Medical Center's Chief.
 - a. Copies of the following listed CFR titles may be obtained from the Government Printing Office:
 - 40 CFR 261.....Identification and Listing of Hazardous Waste
 - 40 CFR 262.....Standards Applicable to Generators of Hazardous Waste
 - 40 CFR 263.....Standards Applicable to Transporters of Hazardous Waste
 - 40 CFR 761.....PCB Manufacturing, Processing, Distribution in Commerce, and use Prohibitions
 - 49 CFR 172.....Hazardous Material tables and Hazardous Material Communications Regulations
 - 49 CFR 173.....Shippers - General Requirements for Shipments and Packaging
 - 49 CRR 173.....Subpart A General

49 CFR 173.....Subpart B Preparation of Hazardous Material for
Transportation

49 CFR 173.....Subpart J Other Regulated Material; Definitions
and Preparation

TSCA.....Compliance Program Policy Nos. 6-PCB-6 and
6-PCB-7

1.10 PROTECTION OF EXISTING VEGETATION, STRUCTURES, EQUIPMENT, UTILITIES, AND IMPROVEMENTS

- A. The Contractor shall preserve and protect all structures, equipment, and vegetation (such as trees, shrubs, and grass) on or adjacent to the work site, which are not to be removed and which do not unreasonably interfere with the work required under this contract. The Contractor shall only remove trees when specifically authorized to do so, and shall avoid damaging vegetation that will remain in place. If any limbs or branches of trees are broken during contract performance, or by the careless operation of equipment, or by workmen, the Contractor shall trim those limbs or branches with a clean cut and paint the cut with a tree-pruning compound as directed by the Contracting Officer.
- B. The Contractor shall protect from damage all existing improvements and utilities at or near the work site and on adjacent property of a third party, the locations of which are made known to or should be known by the Contractor. The Contractor shall repair any damage to those facilities, including those that are the property of a third party, resulting from failure to comply with the requirements of this contract or failure to exercise reasonable care in performing the work. If the Contractor fails or refuses to repair the damage promptly, the Contracting Officer may have the necessary work performed and charge the cost to the Contractor.

(FAR 52.236-9)

- C. Refer to Section 01 57 19, TEMPORARY ENVIRONMENTAL CONTROLS, for additional requirements on protecting vegetation, soils and the environment. Refer to Articles, "Alterations", "Restoration", and "Operations and Storage Areas" for additional instructions concerning repair of damage to structures and site improvements.

1.11 RESTORATION

- A. Remove, cut, alter, replace, patch and repair existing work as necessary to install new work. Except as otherwise shown or specified, do not cut, alter or remove any structural work, and do not disturb any ducts, plumbing, steam, gas, or electric work without approval of the COR. Existing work to be altered or extended and that is found to be

defective in any way, shall be reported to the COR before it is disturbed. Materials and workmanship used in restoring work, shall conform in type and quality to that of original existing construction, except as otherwise shown or specified.

- B. Upon completion of contract, deliver work complete and undamaged. Existing work (walls, ceilings, partitions, floors, mechanical and electrical work, lawns, paving, roads, walks, etc.) disturbed or removed as a result of performing required new work, shall be patched, repaired, reinstalled, or replaced with new work, and refinished and left in as good condition as existed before commencing work.
- C. At Contractor's own expense, Contractor shall immediately restore to service and repair any damage caused by Contractor's workmen to existing piping and conduits, wires, cables, etc., of utility services or of fire protection systems and communications systems (including telephone) which are 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 clause entitled "CHANGES" (FAR 52.243-4 and VAAR 852.236-88) and "DIFFERING SITE CONDITIONS" (FAR 52.236-2).

1.15 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 Resident Engineer within 15 calendar days after each completed phase and after the acceptance of the project by the Resident Engineer.
- D. Paragraphs A, B, & C shall also apply to all shop drawings.

1.16 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.

1.17 RESIDENT ENGINEER'S FIELD OFFICE- NOT USED

1.18 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. Boilers, pumps, feedwater heaters and auxiliary equipment must be operated as a complete system and be fully maintained by operating personnel. Boiler water must be given complete and continuous chemical treatment.
- B. Prior to final inspection, the equipment or parts used which show wear and tear beyond normal, shall be replaced with identical replacements, at no additional cost to the Government.

- C. This paragraph shall not reduce the requirements of the mechanical and electrical specifications sections.

1.21 TEMPORARY TOILETS

- A. Contractor and employees may use existing facilities.

1.22 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:
1. Obtain heat by connecting to the Medical Center heating distribution system.
 - a. Steam is available at no cost to Contractor.
- 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.
- H. Fuel: Natural and LP gas and burner fuel oil required for boiler cleaning, normal initial boiler-burner setup and adjusting, and for performing the specified boiler tests will be furnished by the Government. Fuel required for prolonged boiler-burner setup, adjustments, or modifications due to improper design or operation of boiler, burner, or control devices shall be furnished by the Contractor at Contractor's expense.

1.23 NEW TELEPHONE EQUIPMENT

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

1.24 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.

1.25 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 with one copy mailed to the A&E 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 instructors for every piece of component equipment in a system shall be available until instructions for all items included in the system have been completed. This is to assure proper instruction in the operation of inter-related systems. All instruction periods shall be at such times as scheduled by the 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.

1.26 GOVERNMENT-FURNISHED PROPERTY

- A. The Government shall deliver to the Contractor, the Government-furnished property shown on the // Schedule // 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.

1.27 RELOCATED EQUIPMENT ITEMS

- A. Contractor shall disconnect, dismantle as necessary, remove and reinstall in new location, all existing equipment and items indicated by symbol "R" or otherwise shown to be relocated by the Design Documents.
- 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. Not Used
- F. All service lines such as noted above for relocated equipment shall be in place at point of relocation ready for use before any existing equipment is disconnected. Make relocated existing equipment ready for operation or use immediately after reinstallation.

1.29 CONSTRUCTION SIGN

- A. Provide a Construction Sign where directed by the Resident Engineer. All wood members shall be of framing lumber. Cover sign frame with 0.7 mm (24 gage) galvanized sheet steel nailed securely around edges and on all bearings. Provide three 100 by 100 mm (4 inch by 4 inch) posts (or equivalent round posts) set 1200 mm (four feet) into ground. Set bottom of sign level at 900 mm (three feet) above ground and secure to posts with through bolts. Make posts full height of sign. Brace posts with 50 x 100 mm (two by four inch) material as directed.

- B. Paint all surfaces of sign and posts two coats of white gloss paint. Border and letters shall be of black gloss paint, except project title which shall be blue gloss paint.
- C. Maintain sign and remove it when directed by the Resident Engineer.
- D. Detail Drawing of construction sign showing required legend and other characteristics of sign is attached hereto and made a part of this specification.

1.30 SAFETY SIGN

- A. Provide a Safety Sign where directed by Resident Engineer. Face of sign shall be 19 mm (3/4 inch) thick exterior grade plywood. Provide two 100 mm by 100 mm (four by four inch) posts extending full height of sign and 900 mm (three feet) into ground. Set bottom of sign level at 1200 mm (four feet) above ground.
- B. Paint all surfaces of Safety Sign and posts with one prime coat and two coats of white gloss paint. Letters and design shall be painted with gloss paint of colors noted.
- C. Maintain sign and remove it when directed by Resident Engineer.
- D. Standard Detail Drawing Number SD10000-02(Found on VA TIL) of safety sign showing required legend and other characteristics of sign.
- E. Post the number of accident free days on a daily basis.

1.31 PHOTOGRAPHIC DOCUMENTATION

- A. During the construction period through completion, provide photographic documentation of construction progress and at selected milestones including electronic indexing, navigation, storage and remote access to the documentation, as per these specifications. The commercial photographer or the subcontractor used for this work shall meet the following qualifications:
 - 1. Demonstrable minimum experience of three (3) years in operation providing documentation and advanced indexing/navigation systems including a representative portfolio of construction projects of similar type, size, duration and complexity as the Project.
 - 2. Demonstrable ability to service projects throughout North America, which shall be demonstrated by a representative portfolio of active projects of similar type, size, duration and complexity as the Project.
- B. Photographic documentation elements:
 - 1. Each digital image shall be taken with a professional grade camera with minimum size of 6 megapixels (MP) capable of producing 200x250mm (8 x 10 inch) prints with a minimum of 2272 x 1704 pixels and 400x500mm (16 x 20 inch) prints with a minimum 2592 x 1944 pixels.

2. Indexing and navigation system shall utilize actual AUTOCAD construction drawings, making such drawings interactive on an on-line interface. For all documentation referenced herein, indexing and navigation must be organized by both time (date-stamped) and location throughout the project.
3. Documentation shall combine indexing and navigation system with inspection-grade digital photography designed to capture actual conditions throughout construction and at critical milestones. Documentation shall be accessible on-line through use of an internet connection. Documentation shall allow for secure multiple-user access, simultaneously, on-line.
4. Before construction, the building pad, adjacent streets, roadways, parkways, driveways, curbs, sidewalks, landscaping, adjacent utilities and adjacent structures surrounding the building pad and site shall be documented. Overlapping photographic techniques shall be used to insure maximum coverage. Indexing and navigation accomplished through interactive architectural drawings. If site work or pad preparation is extensive, this documentation may be required immediately before construction and at several pre-determined intervals before building work commences.
5. Construction progress for all trades shall be tracked at pre-determined intervals, but not less than once every thirty (30) calendar days ("Progressions"). Progression documentation shall track both the exterior and interior construction of the building. Exterior Progressions shall track 360 degrees around the site and each building. Interior Progressions shall track interior improvements beginning when stud work commences and continuing until Project completion.
6. As-built condition of pre-slab utilities and site utilities shall be documented prior to pouring slabs, placing concrete and/or backfilling. This process shall include all underground and in-slab utilities within the building(s) envelope(s) and utility runs in the immediate vicinity of the building(s) envelope(s). This may also include utilities enclosed in slab-on-deck in multi-story buildings. Overlapping photographic techniques shall be used to insure maximum coverage. Indexing and navigation accomplished through interactive site utility plans.
7. As-built conditions of mechanical, electrical, plumbing and all other systems shall be documented post-inspection and pre-insulation, sheet rock or dry wall installation. This process shall include all finished systems located in the walls and ceilings of all buildings

- at the Project. Overlapping photographic techniques shall be used to insure maximum coverage. Indexing and navigation accomplished through interactive architectural drawings.
8. As-built conditions of exterior skin and elevations shall be documented with an increased concentration of digital photographs as directed by the COTR in order to capture pre-determined focal points, such as waterproofing, window flashing, radiused steel work, architectural or Exterior Insulation and Finish Systems (EIFS) detailing. Overlapping photographic techniques shall be used to insure maximum coverage. Indexing and navigation accomplished through interactive elevations or elevation details.
 9. As-built finished conditions of the interior of each building including floors, ceilings and walls shall be documented at certificate of occupancy or equivalent, or just prior to occupancy, or both, as directed by the Resident Engineer. Overlapping photographic techniques shall be used to insure maximum coverage. Indexing and navigation accomplished through interactive architectural drawings.
 10. Miscellaneous events that occur during any Contractor site visit, or events captured by the Department of Veterans Affairs independently, shall be dated, labeled and inserted into a Section in the navigation structure entitled "Slideshows," allowing this information to be stored in the same "place" as the formal scope.
 11. Customizable project-specific digital photographic documentation of other details or milestones. Indexing and navigation accomplished through interactive architectural plans.
 12. Monthly (29 max) exterior progressions (360 degrees around the project) and slideshows (all elevations and building envelope). The slideshows allow for the inclusion of Department of Veterans Affairs pictures, aerial photographs, and timely images which do not fit into any regular monthly photopath.
 13. Weekly (21 Max) Site Progressions - Photographic documentation capturing the project at different stages of construction. These progressions shall capture underground utilities, excavation, grading, backfill, landscaping and road construction throughout the duration of the project.
 14. Regular (8 max) interior progressions of all walls of the entire project to begin at time of substantial framed or as directed by the COTR through to completion.
 15. Detailed Exact-Built of all Slabs for all project slab pours just prior to placing concrete or as directed by the Resident Engineer.

16. Detailed Interior exact built overlapping photos of the entire building to include documentation of all mechanical, electrical and plumbing systems in every wall and ceiling, to be conducted after rough-ins are complete, just prior to insulation and or drywall, or as directed by Resident Engineer.
 17. Finished detailed Interior exact built overlapping photos of all walls, ceilings, and floors to be scheduled by Resident Engineer prior to occupancy.
 18. In event a greater or lesser number of images than specified above are required by the COTR, adjustment in contract price will be made in accordance with clause entitled "CHANGES" (FAR 52.243-4 and VAAR 852.236-88).
- C. Images shall be taken by a commercial photographer and must show distinctly, at as large a scale as possible, all parts of work embraced in the picture.
 - D. Coordination of photo shoots is accomplished through Resident Engineer. Contractor shall also attend construction team meetings as necessary. Contractor's operations team shall provide regular updates regarding the status of the documentation, including photo shoots concluded, the availability of new Progressions or Exact-Built viewable on-line and anticipated future shoot dates.
 - E. Contractor shall provide all on-line domain/web hosting, security measures, and redundant server back-up of the documentation.
 - F. Contractor shall provide technical support related to using the system or service.
 - G. Upon completion of the project, final copies of the documentation (the "Permanent Record") with the indexing and navigation system embedded (and active) shall be provided in an electronic media format, typically a DVD or external hard-drive. Permanent Record shall have Building Information Modeling (BIM) interface capabilities. On-line access terminates upon delivery of the Permanent Record.

1.33 HISTORIC PRESERVATION

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

- - - E N D - - -

SECTION 01 32 16.15
PROJECT SCHEDULES

PART 1- GENERAL

1.1 DESCRIPTION:

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

1.2 CONTRACTOR'S REPRESENTATIVE:

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

1.3 CONTRACTOR'S CONSULTANT:

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

have their scheduling consultant approved prior to submitting any schedule for approval.

1.4 COMPUTER PRODUCED SCHEDULES

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

1.5 THE COMPLETE PROJECT SCHEDULE SUBMITTAL

- A. Within 45 calendar days after receipt of Notice to Proceed, the Contractor shall submit for the Contracting Officer's review; three blue line copies of the interim schedule on sheets of paper 765 x 1070 mm (30 x 42 inches) and an electronic file in the previously approved CPM schedule program. The submittal shall also include three copies of a computer-produced activity/event ID schedule showing project duration; phase completion dates; and other data, including event cost. Each activity/event on the computer-produced schedule shall contain as a minimum, but not limited to, activity/event ID, activity/event description, duration, budget amount, early start date, early finish date, late start date, late finish date and total float. Work activity/event relationships shall be restricted to finish-to-start or start-to-start without lead or lag constraints. Activity/event date constraints, not required by the contract, will not be accepted unless

submitted to and approved by the Contracting Officer. The contractor shall make a separate written detailed request to the Contracting Officer identifying these date constraints and secure the Contracting Officer's written approval before incorporating them into the network diagram. The Contracting Officer's separate approval of the Project Schedule shall not excuse the contractor of this requirement. Logic events (non-work) will be permitted where necessary to reflect proper logic among work events, but must have zero duration. The complete working schedule shall reflect the Contractor's approach to scheduling the complete project. **The final Project Schedule in its original form shall contain no contract changes or delays which may have been incurred during the final network diagram development period and shall reflect the entire contract duration as defined in the bid documents.** These changes/delays shall be entered at the first update after the final Project Schedule has been approved. The Contractor should provide their requests for time and supporting time extension analysis for contract time as a result of contract changes/delays, after this update, and in accordance with Article, ADJUSTMENT OF CONTRACT COMPLETION.

- B. Within 30 calendar days after receipt of the complete project interim Project Schedule and the complete final Project Schedule, the Contracting Officer or his representative, will do one or both of the following:
1. Notify the Contractor concerning his actions, opinions, and objections.
 2. A meeting with the Contractor at or near the job site for joint review, correction or adjustment of the proposed plan will be scheduled if required. Within 14 calendar days after the joint review, the Contractor shall revise and shall submit three blue line copies of the revised Project Schedule, three copies of the revised computer-produced activity/event ID schedule and a revised electronic file as specified by the Contracting Officer. The revised submission will be reviewed by the Contracting Officer and, if found to be as previously agreed upon, will be approved.
- C. The approved baseline schedule and the computer-produced schedule(s) generated there from shall constitute the approved baseline schedule until subsequently revised in accordance with the requirements of this section.
- D. The Complete Project Schedule shall contain approximately ____10____work activities/events.

1.6 WORK ACTIVITY/EVENT COST DATA

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

1.7 PROJECT SCHEDULE REQUIREMENTS

- A. Show on the project schedule the sequence of work activities/events required for complete performance of all items of work. The Contractor Shall:
 - 1. Show activities/events as:
 - a. Contractor's time required for submittal of shop drawings, templates, fabrication, delivery and similar pre-construction work.
 - b. Contracting Officer's and Architect-Engineer's review and approval of shop drawings, equipment schedules, samples, template, or similar items.
 - c. Interruption of VA Facilities utilities, delivery of Government furnished equipment, and rough-in drawings, project phasing and any other specification requirements.

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

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

1.8 PAYMENT TO THE CONTRACTOR:

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

1.9 PAYMENT AND PROGRESS REPORTING

- A. Monthly schedule update meetings will be held on dates mutually agreed to by the COTR and the Contractor. Contractor and their CPM consultant (if applicable) shall attend all monthly schedule update meetings. The Contractor shall accurately update the Project Schedule and all other data required and provide this information to the COTR three work days in advance of the schedule update meeting. Job progress will be reviewed to verify:
1. Actual start and/or finish dates for updated/completed activities/events.
 2. Remaining duration for each activity/event started, or scheduled to start, but not completed.
 3. Logic, time and cost data for change orders, and supplemental agreements that are to be incorporated into the Project Schedule.
 4. Changes in activity/event sequence and/or duration which have been made, pursuant to the provisions of following Article, ADJUSTMENT OF CONTRACT COMPLETION.
 5. Completion percentage for all completed and partially completed activities/events.
 6. Logic and duration revisions required by this section of the specifications.

7. Activity/event duration and percent complete shall be updated independently.
- B. After completion of the joint review, the contractor shall generate an updated computer-produced calendar-dated schedule and supply the Contracting Officer's representative with reports in accordance with the Article, COMPUTER PRODUCED SCHEDULES, specified.
- C. After completing the monthly schedule update, the contractor's representative or scheduling consultant shall rerun all current period contract change(s) against the prior approved monthly project schedule. The analysis shall only include original workday durations and schedule logic agreed upon by the contractor and resident engineer for the contract change(s). When there is a disagreement on logic and/or durations, the Contractor shall use the schedule logic and/or durations provided and approved by the resident engineer. After each rerun update, the resulting electronic project schedule data file shall be appropriately identified and submitted to the VA in accordance to the requirements listed in articles 1.4 and 1.7. This electronic submission is separate from the regular monthly project schedule update requirements and shall be submitted to the resident engineer within fourteen (14) calendar days of completing the regular schedule update. **Before inserting the contract changes durations, care must be taken to ensure that only the original durations will be used for the analysis, not the reported durations after progress. In addition, once the final network diagram is approved, the contractor must recreate all manual progress payment updates on this approved network diagram and associated reruns for contract changes in each of these update periods as outlined above for regular update periods. This will require detailed record keeping for each of the manual progress payment updates.**
- D. Following approval of the CPM schedule, the VA, the General Contractor, its approved CPM Consultant, RE office representatives, and all subcontractors needed, as determined by the SRE, shall meet to discuss the monthly updated schedule. The main emphasis shall be to address work activities to avoid slippage of project schedule and to identify any necessary actions required to maintain project schedule during the reporting period. The Government representatives and the Contractor should conclude the meeting with a clear understanding of those work and administrative actions necessary to maintain project schedule status during the reporting period. This schedule coordination meeting will occur after each monthly project schedule update meeting utilizing the resulting schedule reports from that schedule update. If the project is

behind schedule, discussions should include ways to prevent further slippage as well as ways to improve the project schedule status, when appropriate.

1.10 RESPONSIBILITY FOR COMPLETION

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

1.11 CHANGES TO THE SCHEDULE

- A. Within 30 calendar days after VA acceptance and approval of any updated project schedule, the Contractor shall submit a revised electronic file (s) and a list of any activity/event changes including predecessors and successors for any of the following reasons:
 - 1. Delay in completion of any activity/event or group of activities/events, which may be involved with contract changes, strikes, unusual weather, and other delays will not relieve the Contractor from the requirements specified unless the conditions are shown on the CPM as the direct cause for delaying the project beyond the acceptable limits.
 - 2. Delays in submittals, or deliveries, or work stoppage are encountered which make rescheduling of the work necessary.
 - 3. The schedule does not represent the actual prosecution and progress of the project.
 - 4. When there is, or has been, a substantial revision to the activity/event costs regardless of the cause for these revisions.
- B. CPM revisions made under this paragraph which affect the previously approved computer-produced schedules for Government furnished equipment, vacating of areas by the VA Facility, contract phase(s) and sub phase(s), utilities furnished by the Government to the Contractor, or

any other previously contracted item, shall be furnished in writing to the Contracting Officer for approval.

- C. Contracting Officer's approval for the revised project schedule and all relevant data is contingent upon compliance with all other paragraphs of this section and any other previous agreements by the Contracting Officer or the VA representative.
- D. The cost of revisions to the project schedule resulting from contract changes will be included in the proposal for changes in work as specified in FAR 52.243 - 4 (Changes) and VAAR 852.236 - 88 (Changes - Supplemental), and will be based on the complexity of the revision or contract change, man hours expended in analyzing the change, and the total cost of the change.
- E. The cost of revisions to the Project Schedule not resulting from contract changes is the responsibility of the Contractor.

1.12 ADJUSTMENT OF CONTRACT COMPLETION

- A. The contract completion time will be adjusted only for causes specified in this contract. Request for an extension of the contract completion date by the Contractor shall be supported with a justification, CPM data and supporting evidence as the COTR may deem necessary for determination as to whether or not the Contractor is entitled to an extension of time under the provisions of the contract. Submission of proof based on revised activity/event logic, durations (in work days) and costs is obligatory to any approvals. The schedule must clearly display that the Contractor has used, in full, all the float time available for the work involved in this request. The Contracting Officer's determination as to the total number of days of contract extension will be based upon the current computer-produced calendar-dated schedule for the time period in question and all other relevant information.
- B. Actual delays in activities/events which, according to the computer-produced calendar-dated schedule, do not affect the extended and predicted contract completion dates shown by the critical path in the network, will not be the basis for a change to the contract completion date. The Contracting Officer will within a reasonable time after receipt of such justification and supporting evidence, review the facts and advise the Contractor in writing of the Contracting Officer's decision.
- C. The Contractor shall submit each request for a change in the contract completion date to the Contracting Officer in accordance with the provisions specified under FAR 52.243 - 4 (Changes) and VAAR 852.236 - 88 (Changes - Supplemental). The Contractor shall include, as a part of each change order proposal, a sketch showing all CPM logic revisions,

duration (in work days) changes, and cost changes, for work in question and its relationship to other activities on the approved network diagram.

- D. All delays due to non-work activities/events such as RFI's, WEATHER, STRIKES, and similar non-work activities/events shall be analyzed on a month by month basis.

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

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

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

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

(Architect-Engineer)

(A/E P.O. Address)

(City, State and Zip Code)

- 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 Resident Engineer.

SPEC WRITER NOTE: Include following
paragraph only if samples are to be sent
to project site. If so, delete reference
to samples in Paragraph 1-10.

1-12. Samples // (except laboratory samples) // for approval shall be sent to
Architect-Engineer, in care of Resident Engineer, VA Medical Center,

(P.O. Address)

(City, State and Zip Code)

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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)

425 Eye Street N.W, (sixth floor)

Washington, DC 20001

Telephone Numbers: (202) 632-5249 or (202) 632-5178

Between 9:00 AM - 3:00 PM

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

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

AA Aluminum Association Inc.

<http://www.aluminum.org>

AABC	Associated Air Balance Council http://www.aabchq.com
AAMA	American Architectural Manufacturer's Association http://www.aamanet.org
AAN	American Nursery and Landscape Association http://www.anla.org
AASHTO	American Association of State Highway and Transportation Officials http://www.aashto.org
AATCC	American Association of Textile Chemists and Colorists http://www.aatcc.org
ACGIH	American Conference of Governmental Industrial Hygienists http://www.acgi.org
ACI	American Concrete Institute http://www.aci-int.net
ACPA	American Concrete Pipe Association http://www.concrete-pipe.org
ACPPA	American Concrete Pressure Pipe Association http://www.acppa.org
ADC	Air Diffusion Council http://flexibleduct.org
AGA	American Gas Association http://www.aga.org
AGC	Associated General Contractors of America http://www.agc.org
AGMA	American Gear Manufacturers Association, Inc. http://www.agma.org
AHAM	Association of Home Appliance Manufacturers http://www.aham.org
AISC	American Institute of Steel Construction http://www.aisc.org
AISI	American Iron and Steel Institute http://www.steel.org
AITC	American Institute of Timber Construction http://www.aitc-glulam.org
AMCA	Air Movement and Control Association, Inc. http://www.amca.org
ANLA	American Nursery & Landscape Association http://www.anla.org
ANSI	American National Standards Institute, Inc. http://www.ansi.org

APA	The Engineered Wood Association http://www.apawood.org
ARI	Air-Conditioning and Refrigeration Institute http://www.ari.org
ASAE	American Society of Agricultural Engineers http://www.asae.org
ASCE	American Society of Civil Engineers http://www.asce.org
ASHRAE	American Society of Heating, Refrigerating, and Air-Conditioning Engineers http://www.ashrae.org
ASME	American Society of Mechanical Engineers http://www.asme.org
ASSE	American Society of Sanitary Engineering http://www.asse-plumbing.org
ASTM	American Society for Testing and Materials http://www.astm.org
AWI	Architectural Woodwork Institute http://www.awinet.org
AWS	American Welding Society http://www.aws.org
AWWA	American Water Works Association http://www.awwa.org
BHMA	Builders Hardware Manufacturers Association http://www.buildershardware.com
BIA	Brick Institute of America http://www.bia.org
CAGI	Compressed Air and Gas Institute http://www.cagi.org
CGA	Compressed Gas Association, Inc. http://www.cganet.com
CI	The Chlorine Institute, Inc. http://www.chlorineinstitute.org
CISCA	Ceilings and Interior Systems Construction Association http://www.cisca.org
CISPI	Cast Iron Soil Pipe Institute http://www.cispi.org
CLFMI	Chain Link Fence Manufacturers Institute http://www.chainlinkinfo.org
CPMB	Concrete Plant Manufacturers Bureau http://www.cpmc.org

CRA	California Redwood Association http://www.calredwood.org
CRSI	Concrete Reinforcing Steel Institute http://www.crsi.org
CTI	Cooling Technology Institute http://www.cti.org
DHI	Door and Hardware Institute http://www.dhi.org
EGSA	Electrical Generating Systems Association http://www.egsa.org
EEI	Edison Electric Institute http://www.eei.org
EPA	Environmental Protection Agency http://www.epa.gov
ETL	ETL Testing Laboratories, Inc. http://www.etl.com
FAA	Federal Aviation Administration http://www.faa.gov
FCC	Federal Communications Commission http://www.fcc.gov
FPS	The Forest Products Society http://www.forestprod.org
GANA	Glass Association of North America http://www.cssinfo.com/info/gana.html/
FM	Factory Mutual Insurance http://www.fmglobal.com
GA	Gypsum Association http://www.gypsum.org
GSA	General Services Administration http://www.gsa.gov
HI	Hydraulic Institute http://www.pumps.org
HPVA	Hardwood Plywood & Veneer Association http://www.hpva.org
ICBO	International Conference of Building Officials http://www.icbo.org
ICEA	Insulated Cable Engineers Association Inc. http://www.icea.net
\ICAC	Institute of Clean Air Companies http://www.icac.com

IEEE	Institute of Electrical and Electronics Engineers http://www.ieee.org/
IMSA	International Municipal Signal Association http://www.imsasafety.org
IPCEA	Insulated Power Cable Engineers Association
NBMA	Metal Buildings Manufacturers Association http://www.mbma.com
MSS	Manufacturers Standardization Society of the Valve and Fittings Industry Inc. http://www.mss-hq.com
NAAMM	National Association of Architectural Metal Manufacturers http://www.naamm.org
NAPHCC	Plumbing-Heating-Cooling Contractors Association http://www.phccweb.org.org
NBS	National Bureau of Standards See - NIST
NBBPVI	National Board of Boiler and Pressure Vessel Inspectors http://www.nationboard.org
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
NWDA	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
PPI	The Plastic Pipe Institute http://www.plasticpipe.org
PEI	Porcelain Enamel Institute, Inc. http://www.porcelainenamel.com
PTI	Post-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
STI	Steel Tank Institute http://www.steeltank.com
SWI	Steel Window Institute http://www.steelwindows.com
TCA	Tile Council of America, Inc. http://www.tileusa.com
TEMA	Tubular Exchange Manufacturers Association http://www.tema.org

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

UBC The Uniform Building Code
 See ICBO

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

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

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

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

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

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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 Concrete Institute (ACI):
 - 506.4R-94 (R2004).....Guide for the Evaluation of Shotcrete
- D. American Society for Testing and Materials (ASTM):
 - A325-06.....Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
 - A370-07.....Definitions for Mechanical Testing of Steel Products
 - A416/A416M-06.....Steel Strand, Uncoated Seven-Wire for Prestressed Concrete
 - A490-06.....Heat Treated Steel Structural Bolts, 150 ksi Minimum Tensile Strength
 - 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
C138-07.....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
C172-07.....Sampling Freshly Mixed Concrete
C173-07.....Air Content of freshly Mixed Concrete by the
Volumetric Method
C330-05.....Lightweight Aggregates for Structural Concrete
C567-05.....Density Structural Lightweight Concrete
C780-07.....Pre-construction and Construction Evaluation of
Mortars for Plain and Reinforced Unit Masonry
C1019-08.....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
C1314-07.....Compressive Strength of Masonry Prisms
D698-07.....Laboratory Compaction Characteristics of Soil
Using Standard Effort
D1143-07.....Piles Under Static Axial Compressive Load
D1188-07.....Bulk Specific Gravity and Density of Compacted
Bituminous Mixtures Using Paraffin-Coated
Specimens
D1556-07.....Density and Unit Weight of Soil in Place by the
Sand-Cone Method
D1557-07.....Laboratory Compaction Characteristics of Soil
Using Modified Effort
D2166-06.....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
D2922-05.....Density of soil and Soil-Aggregate in Place by
Nuclear Methods (Shallow Depth)
D2974-07.....Moisture, Ash, and Organic Matter of Peat and
Other Organic Soils

D3666-(2002).....Minimum Requirements for Agencies Testing and
Inspection Bituminous Paving Materials
D3740-07.....Minimum Requirements for Agencies Engaged in the
Testing and Inspecting Road and Paving Material
E94-04.....Radiographic Testing
E164-03.....Ultrasonic Contact Examination of Weldments
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(R2008).....Determining FF Floor Flatness and FL Floor
Levelness Numbers

E. American Welding Society (AWS):

D1.1-07.....Structural Welding Code-Steel

1.3 REQUIREMENTS:

- A. Accreditation Requirements: Construction materials testing laboratories must be accredited by a laboratory accreditation authority and will be required to submit a copy of the Certificate of Accreditation and Scope of Accreditation. The laboratory's scope of accreditation must include the appropriate ASTM standards (i.e.; E 329, C 1077, D 3666, D3740, A 880, E 543) listed in the technical sections of the specifications. Laboratories engaged in Hazardous Materials Testing shall meet the requirements of OSHA and EPA. The policy applies to the specific laboratory performing the actual testing, not just the "Corporate Office."
- B. Inspection and Testing: Testing laboratory shall inspect materials and workmanship and perform tests described herein and additional tests requested by Resident Engineer. When it appears materials furnished, or work performed by Contractor fail to meet construction contract requirements, Testing Laboratory shall direct attention of Resident Engineer to such failure.
- C. Written Reports: Testing laboratory shall submit test reports to Resident Engineer, Contractor, unless other arrangements are agreed to in writing by the Resident Engineer. Submit reports of tests that fail to meet construction contract requirements on colored paper.
- D. Verbal Reports: Give verbal notification to Resident Engineer immediately of any irregularity.

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 Resident Engineer with concurrence of Contracting Officer and perform periodic inspections thereafter as determined by Resident Engineer.
2. Periodically inspect and test batch proportioning equipment for accuracy and report deficiencies to Resident Engineer.
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 m³ (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 Resident Engineer make three cylinders for each 80 m³ (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. Resident Engineer may require additional cylinders to be molded and cured under job conditions.
4. Perform slump tests in accordance with ASTM C143. Test the first truck each day, and every time test cylinders are made. Test pumped concrete at the hopper and at the discharge end of the hose at the beginning of each day's pumping operations to determine change in slump.
 5. Determine the air content of concrete per ASTM C173. For concrete required to be air-entrained, test the first truck and every 20 m³ (25 cubic yards) thereafter each day. For concrete not required to be air-entrained, test every 80 m³ (100 cubic yards) at random. For pumped concrete, initially test concrete at both the hopper and the discharge end of the hose to determine change in air content.
 6. If slump or air content fall outside specified limits, make another test immediately from another portion of same batch.
 7. Perform unit weight tests in compliance with ASTM C138 for normal weight concrete and ASTM C567 for lightweight concrete. Test the first truck and each time cylinders are made.
 8. Notify laboratory technician at batch plant of mix irregularities and request materials and proportioning check.
 9. Verify that specified mixing has been accomplished.
 10. Environmental Conditions: Determine the temperature per ASTM C1064 for each truckload of concrete during hot weather and cold weather concreting operations:
 - a. When ambient air temperature falls below 4.4 degrees C (40 degrees F), record maximum and minimum air temperatures in each 24 hour period; record air temperature inside protective enclosure; record minimum temperature of surface of hardened concrete.
 - b. When ambient air temperature rises above 29.4 degrees C (85 degrees F), record maximum and minimum air temperature in each 24 hour period; record minimum relative humidity; record maximum wind velocity; record maximum temperature of surface of hardened concrete.
 11. Inspect the reinforcing steel placement, including bar size, bar spacing, top and bottom concrete cover, proper tie into the chairs, and grade of steel prior to concrete placement. Submit detailed report of observations.
 12. Observe conveying, placement, and consolidation of concrete for conformance to specifications.

13. Observe condition of formed surfaces upon removal of formwork prior to repair of surface defects and observe repair of surface defects.
14. Observe curing procedures for conformance with specifications, record dates of concrete placement, start of preliminary curing, start of final curing, end of curing period.
15. Observe preparations for placement of concrete:
 - a. Inspect handling, conveying, and placing equipment, inspect vibrating and compaction equipment.
 - b. Inspect preparation of construction, expansion, and isolation joints.
16. Observe preparations for protection from hot weather, cold weather, sun, and rain, and preparations for curing.
17. Observe concrete mixing:
 - a. Monitor and record amount of water added at project site.
 - b. Observe minimum and maximum mixing times.
18. Measure concrete flatwork for levelness and flatness as follows:
 - a. Perform Floor Tolerance Measurements F_F and F_L in accordance with ASTM E1155. Calculate the actual overall F- numbers using the inferior/superior area method.
 - b. Perform all floor tolerance measurements within 48 hours after slab installation and prior to removal of shoring and formwork.
 - c. Provide the Contractor and the Resident Engineer with the results of all profile tests, including a running tabulation of the overall F_F and F_L values for all slabs installed to date, within 72 hours after each slab installation.
19. Other inspections:
 - a. Grouting under base plates.
 - b. 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 Resident Engineer. Compile laboratory test reports as follows: Compressive strength test shall be result of one cylinder, except when one cylinder shows evidence of improper sampling, molding or testing, in which case it shall be discarded and strength of spare cylinder shall be used.
2. Make weight tests of hardened lightweight structural concrete in accordance with ASTM C567.

3. Furnish certified compression test reports (duplicate) to Resident Engineer. 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 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.

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SECTION 01 57 19
TEMPORARY ENVIRONMENTAL CONTROLS

PART 1 - GENERAL

1.1 DESCRIPTION

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

7. Sanitary Wastes:

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

1.2 QUALITY CONTROL

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

1.3 REFERENCES

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

1.4 SUBMITTALS

- A. In accordance with Section, 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES, furnish the following:
 - 1. Environmental Protection Plan: After the contract is awarded and prior to the commencement of the work, the Contractor shall meet with the Resident Engineer to discuss the proposed Environmental Protection Plan and to develop mutual understanding relative to details of environmental protection. Not more than 20 days after the meeting, the Contractor shall prepare and submit to the COTR for approval, a written and/or graphic Environmental Protection Plan including, but not limited to, the following:
 - a. Name(s) of person(s) within the Contractor's organization who is (are) responsible for ensuring adherence to the Environmental Protection Plan.
 - b. Name(s) and qualifications of person(s) responsible for manifesting hazardous waste to be removed from the site.
 - c. Name(s) and qualifications of person(s) responsible for training the Contractor's environmental protection personnel.
 - d. Description of the Contractor's environmental protection personnel training program.
 - e. A list of Federal, State, and local laws, regulations, and permits concerning environmental protection, pollution control, noise control and abatement that are applicable to the Contractor's proposed operations and the requirements imposed by those laws, regulations, and permits.

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

1.5 PROTECTION OF ENVIRONMENTAL RESOURCES

- A. Protect environmental resources within the project boundaries and those affected outside the limits of permanent work during the entire period of this contract. Confine activities to areas defined by the specifications and drawings.
- B. Protection of Land Resources: Prior to construction, identify all land resources to be preserved within the work area. Do not remove, cut, deface, injure, or destroy land resources including trees, shrubs, vines, grasses, top soil, and land forms without permission from the Resident Engineer. Do not fasten or attach ropes, cables, or guys to trees for anchorage unless specifically authorized, or where special emergency use is permitted.
 - 1. Work Area Limits: Prior to any construction, mark the areas that require work to be performed under this contract. Mark or fence

- isolated areas within the general work area that are to be saved and protected. Protect monuments, works of art, and markers before construction operations begin. Convey to all personnel the purpose of marking and protecting all necessary objects.
2. Protection of Landscape: Protect trees, shrubs, vines, grasses, land forms, and other landscape features shown on the drawings to be preserved by marking, fencing, or using any other approved techniques.
 - a. Box and protect from damage existing trees and shrubs to remain on the construction site.
 - b. Immediately repair all damage to existing trees and shrubs by trimming, cleaning, and painting with antiseptic tree paint.
 - c. Do not store building materials or perform construction activities closer to existing trees or shrubs than the farthest extension of their limbs.
 3. Reduction of Exposure of Unprotected Erodible Soils: Plan and conduct earthwork to minimize the duration of exposure of unprotected soils. Clear areas in reasonably sized increments only as needed to use. Form earthwork to final grade as shown. Immediately protect side slopes and back slopes upon completion of rough grading.
 4. Handle and dispose of solid wastes in such a manner that will prevent contamination of the environment. Place solid wastes (excluding clearing debris) in containers that are emptied on a regular schedule. Transport all solid waste off Government property and dispose of waste in compliance with Federal, State, and local requirements.
 5. Store chemical waste away from the work areas in corrosion resistant containers and dispose of waste in accordance with Federal, State, and local regulations.
 6. Handle discarded materials other than those included in the solid waste category as directed by the Resident Engineer.
- C. Protection of Water Resources: Keep construction activities under surveillance, management, and control to avoid pollution of surface and ground waters and sewer systems. Implement management techniques to control water pollution by the listed construction activities that are included in this contract.
1. Washing and Curing Water: Do not allow wastewater directly derived from construction activities to enter water areas. Collect and place wastewater in retention ponds allowing the suspended material to settle, the pollutants to separate, or the water to evaporate.

2. Control movement of materials and equipment at stream crossings during construction to prevent violation of water pollution control standards of the Federal, State, or local government.
 3. Monitor water areas affected by construction.
- D. Protection of Air Resources: Keep construction activities under surveillance, management, and control to minimize pollution of air resources. Burning is not permitted on the job site. Keep activities, equipment, processes, and work operated or performed, in strict accordance with the State of West Virginia Air Quality Board and Federal emission and performance laws and standards. Maintain ambient air quality standards set by the Environmental Protection Agency, for those construction operations and activities specified.
1. Particulates: Control dust particles, aerosols, and gaseous by-products from all construction activities, processing, and preparation of materials (such as from asphaltic batch plants) at all times, including weekends, holidays, and hours when work is not in progress.
 2. Particulates Control: Maintain all excavations, stockpiles, haul roads, permanent and temporary access roads, plant sites, spoil areas, borrow areas, and all other work areas within or outside the project boundaries free from particulates which would cause a hazard or a nuisance. Sprinklering, chemical treatment of an approved type, light bituminous treatment, baghouse, scrubbers, electrostatic precipitators, or other methods are permitted to control particulates in the work area.
 3. Hydrocarbons and Carbon Monoxide: Control monoxide emissions from equipment to Federal and State allowable limits.
 4. Odors: Control odors of construction activities and prevent obnoxious odors from occurring.
- E. Reduction of Noise: Minimize noise using every action possible. Perform noise-producing work in less sensitive hours of the day or week as directed by the Resident Engineer. Maintain noise-produced work at or below the decibel levels and within the time periods specified.
1. Perform construction activities involving repetitive, high-level impact noise only between 8:00.m. and 6:00p.m unless otherwise permitted by local ordinance or the Resident Engineer. Repetitive impact noise on the property shall not exceed the following dB limitations:

Time Duration of Impact Noise	Sound Level in dB
More than 12 minutes in any hour	70

Less than 30 seconds of any hour	85
Less than three minutes of any hour	80
Less than 12 minutes of any hour	75

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

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

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

- b. Use shields or other physical barriers to restrict noise transmission.
- c. Provide soundproof housings or enclosures for noise-producing machinery.
- d. Use efficient silencers on equipment air intakes.
- e. Use efficient intake and exhaust mufflers on internal combustion engines that are maintained so equipment performs below noise levels specified.
- f. Line hoppers and storage bins with sound deadening material.
- g. Conduct truck loading, unloading, and hauling operations so that noise is kept to a minimum.
3. Measure sound level for noise exposure due to the construction at least once every five successive working days while work is being performed above 55 dB(A) noise level. Measure noise exposure at the property line or 15 m (50 feet) from the noise source, whichever is greater. Measure the sound levels on the A weighing network of a General Purpose sound level meter at slow response. To minimize the

effect of reflective sound waves at buildings, take measurements at 900 to 1800 mm (three to six feet) in front of any building face.

Submit the recorded information to the Resident Engineer noting any problems and the alternatives for mitigating actions.

- F. Restoration of Damaged Property: If any direct or indirect damage is done to public or private property resulting from any act, omission, neglect, or misconduct, the Contractor shall restore the damaged property to a condition equal to that existing before the damage at no additional cost to the Government. Repair, rebuild, or restore property as directed or make good such damage in an acceptable manner.
- G. Final Clean-up: On completion of project and after removal of all debris, rubbish, and temporary construction, Contractor shall leave the construction area in a clean condition satisfactory to the Resident Engineer. Cleaning shall include off the station disposal of all items and materials not required to be salvaged, as well as all debris and rubbish resulting from demolition and new work operations.

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SECTION 01 58 16
TEMPORARY INTERIOR SIGNAGE

PART 1 GENERAL

DESCRIPTION

This section specifies temporary interior signs.

PART 2 PRODUCTS

2.1 TEMPORARY SIGNS

- A. Fabricate from 50 Kg (110 pound) mat finish white paper.
- B. Cut to 100 mm (4-inch) wide by 300 mm (12 inch) long size tag.
- C. Punch 3 mm (1/8-inch) diameter hole centered on 100 mm (4-inch) dimension of tag. Edge of Hole spaced approximately 13 mm (1/2-inch) from one end on tag.
- D. Reinforce hole on both sides with gummed cloth washer or other suitable material capable of preventing tie pulling through paper edge.
- E. Ties: Steel wire 0.3 mm (0.0120-inch) thick, attach to tag with twist tie, leaving 150 mm (6-inch) long free ends.

PART 3 EXECUTION

3.1 INSTALLATION

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

3.2 LOCATION

- A. Install on doors that have room, corridor, and space numbers shown.
- B. Doors that do not require signs are as follows:
 - 1. Corridor barrier doors (cross-corridor) in corridor with same number.
 - 2. Folding doors or partitions.
 - 3. Toilet or bathroom doors within and between rooms.
 - 4. Communicating doors in partitions between rooms with corridor entrance doors.
 - 5. Closet doors within rooms.
- C. Replace missing, damaged, or illegible signs.

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SECTION 01 74 19
CONSTRUCTION WASTE MANAGEMENT

PART 1 - GENERAL

1.1 DESCRIPTION

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

1.2 RELATED WORK

- A. Section 02 41 00, DEMOLITION.
- B. Section 01 00 00, GENERAL REQUIREMENTS.

C. Lead Paint: Section 02 83 33.13, LEAD BASED PAINT REMOVAL AND DISPOSAL.

1.3 QUALITY ASSURANCE

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

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

1.4 TERMINOLOGY

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

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

1.5 SUBMITTALS

- A. In accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES, furnish the following:
- B. Prepare and submit to the Resident Engineer a written demolition debris management plan. The plan shall include, but not be limited to, the following information:
 - 1. Procedures to be used for debris management.
 - 2. Techniques to be used to minimize waste generation.
 - 3. Analysis of the estimated job site waste to be generated:

- a. List of each material and quantity to be salvaged, reused, recycled.
- b. List of each material and quantity proposed to be taken to a landfill.
4. Detailed description of the Means/Methods to be used for material handling.
 - a. On site: Material separation, storage, protection where applicable.
 - b. Off site: Transportation means and destination. Include list of materials.
 - 1) Description of materials to be site-separated and self-hauled to designated facilities.
 - 2) Description of mixed materials to be collected by designated waste haulers and removed from the site.
 - c. The names and locations of mixed debris reuse and recycling facilities or sites.
 - d. The names and locations of trash disposal landfill facilities or sites.
 - e. Documentation that the facilities or sites are approved to receive the materials.
- C. Designated Manager responsible for instructing personnel, supervising, documenting and administer over meetings relevant to the Waste Management Plan.
- D. Monthly summary of construction and demolition debris diversion and disposal, quantifying all materials generated at the work site and disposed of or diverted from disposal through recycling.

1.6 APPLICABLE PUBLICATIONS

- A Publications listed below form a part of this specification to the extent referenced. Publications are referenced by the basic designation only. In the event that criteria requirements conflict, the most stringent requirements shall be met.
- B. U.S. Green Building Council (USGBC):
LEED Green Building Rating System for New Construction

1.7 RECORDS

Maintain records to document the quantity of waste generated; the quantity of waste diverted through sale, reuse, or recycling; and the quantity of waste disposed by landfill or incineration. Records shall be kept in accordance with the LEED Reference Guide and LEED Template.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. List of each material and quantity to be salvaged, recycled, reused.
- B. List of each material and quantity proposed to be taken to a landfill.
- C. Material tracking data: Receiving parties, dates removed, transportation costs, weight tickets, tipping fees, manifests, invoices, net total costs or savings.

PART 3 - EXECUTION

3.1 COLLECTION

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

3.2 DISPOSAL

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

3.3 REPORT

- A. With each application for progress payment, submit a summary of construction and demolition debris diversion and disposal including beginning and ending dates of period covered.
- B. Quantify all materials diverted from landfill disposal through salvage or recycling during the period with the receiving parties, dates removed, transportation costs, weight tickets, manifests, invoices. Include the net total costs or savings for each salvaged or recycled material.
- C. Quantify all materials disposed of during the period with the receiving parties, dates removed, transportation costs, weight tickets, tipping fees, manifests, invoices. Include the net total costs for each disposal.

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Boiler No. 3 Burner Replacement

Project No:VA540-C-25010
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SECTION 01 81 11

SUSTAINABLE DESIGN REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

This Section describes general requirements and procedures to comply with the Guiding Principles for Leadership in High Performance and Sustainable Buildings Memorandum of Understanding incorporated in the Executive Orders 13423 and 13514; Energy Policy Act of 2005 (EPA 2005) and the Energy Independence and Security Act of 2007 (EISA 2007).

1.2 OBJECTIVES

- A. To obtain acceptable Indoor Air Quality (IAQ) for the completed project and minimize the environmental impacts of the construction and operation, the Contractor during the construction phase of this project shall implement the following procedures:
1. Select products that minimize consumption of non-renewable resources, consume reduced amounts of energy and minimize amounts of pollution to produce, and employ recycled and/or recyclable materials. It is the intent of this project to conform with EPA's Five Guiding Principles on environmentally preferable purchasing. The five principles are:
 - a. Include environmental considerations as part of the normal purchasing process.
 - b. Emphasize pollution prevention early in the purchasing process.
 - c. Examine multiple environmental attributes throughout a product's or service's life cycle.
 - d. Compare relevant environmental impacts when selecting products and services.
 - e. Collect and base purchasing decisions on accurate and meaningful information about environmental performance.
 2. Control sources for potential IAQ pollutants by controlled selection of materials and processes used in project construction in order to attain superior IAQ.
 3. Products and processes that achieve the above objectives to the extent currently possible and practical have been selected and included in these Construction Documents. The Contractor is responsible to maintain and support these objectives in developing means and methods for performing the work of this Contract and in

proposing product substitutions and/or changes to specified processes.

4. Use building practices that insure construction debris and particulates do not contaminate or enter duct work prior to system startup and turn over.

1.3 RELATED DOCUMENTS

- A. Section 01 74 19 CONSTRUCTION WASTE MANAGEMENT
- B. Section 01 81 09 TESTING FOR INDOOR AIR QUALITY (not written yet)
- C. Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS

1.4 DEFINITIONS

- A. Agrifiber Products: Composite panel products derived from agricultural fiber
- B. Biobased Product: As defined in the 2002 Farm Bill, a product determined by the Secretary to be a commercial or industrial product (other than food or feed) that is composed, in whole or in significant part, of biological products or renewable domestic agricultural materials (including plant, animal, and marine materials) or forestry materials
- C. Biobased Content: The weight of the biobased material divided by the total weight of the product and expressed as a percentage by weight
- D. Certificates of Chain-of-Custody: Certificates signed by manufacturers certifying that wood used to make products has been tracked through its extraction and fabrication to ensure that it was obtained from forests certified by a specified certification program
- E. Composite Wood: A product consisting of wood fiber or other plant particles bonded together by a resin or binder
- F. Construction and Demolition Waste: Includes solid wastes, such as building materials, packaging, rubbish, debris, and rubble resulting from construction, remodeling, repair and demolition operations. A construction waste management plan is to be provided by the Contractor as defined in Section 01 74 19.
- G. Third Party Certification: Certification of levels of environmental achievement by nationally recognized sustainability rating system.
- H. Light Pollution: Light that extends beyond its source such that the additional light is wasted in an unwanted area or in an area where it inhibits view of the night sky
- I. Recycled Content Materials: Products that contain pre-consumer or post-consumer materials as all or part of their feedstock

- J. Post-Consumer Recycled Content: The percentage by weight of constituent materials that have been recovered or otherwise diverted from the solid-waste stream after consumer use
- K. Pre-Consumer Recycled Content: Materials that have been recovered or otherwise diverted from the solid-waste stream during the manufacturing process. Pre-consumer content must be material that would not have otherwise entered the waste stream as per Section 5 of the FTC Act, Part 260 "Guidelines for the Use of Environmental Marketing Claims": www.ftc.gov/bcp/grnrule/guides980427
- L. Regional Materials: Materials that are extracted, harvested, recovered, and manufactured within a radius of 250 miles (400 km) from the Project site
- M. Salvaged or Reused Materials: Materials extracted from existing buildings in order to be reused in other buildings without being manufactured
- N. Sealant: Any material that fills and seals gaps between other materials
- O. Type 1 Finishes: Materials and finishes which have a potential for short-term levels of off gassing from chemicals inherent in their manufacturing process, or which are applied in a form requiring vehicles or carriers for spreading which release a high level of particulate matter in the process of installation and/or curing.
- P. Type 2 Finishes: "Fuzzy" materials and finishes which are woven, fibrous, or porous in nature and tend to adsorb chemicals offgas
- Q. Volatile Organic Compounds (VOCs): Any compound of carbon, excluding carbon monoxide, carbon dioxide, carbonic acid, metallic carbides or carbonates, and ammonium carbonate, which participates in atmospheric photochemical reactions. Compounds that have negligible photochemical reactivity, listed in EPA 40 CFR 51.100(s), are also excluded from this regulatory definition.

1.5 SUBMITTALS

- A. Sustainable Design Submittals:
 - 1 thru 6 Not Used
 - 7. Elimination of CFCs AND HCFCs: Provide manufacturer's cut sheets for all cooling equipment with manufacturer's product data, highlighting refrigerants; provide manufacturer's cut sheets for all fire-suppression equipment, highlighting fire-suppression agents; provide manufacturer's cut-sheets for all polystyrene insulation (XPS) and

- closed-cell spray foam polyurethane insulation, highlighting the blowing agent(s).
8. Appliances and Equipment: Provide copies of manufacturer's product data for all Energy Star eligible equipment and appliances, including office equipment, computers and printers, electronics, and commercial food service equipment (excluding HVAC and lighting components), verifying compliance with EPA's Energy Star program.
- 9 Thru 12 Not Used
13. Interior Adhesives and Sealants: Submittals for all field-applied adhesives and sealants, which have a potential impact on indoor air, must include manufacturer's MSDSs or other Product Data highlighting VOC content.
- a. Provide manufacturers' documentation verifying all adhesives used to apply laminates, whether shop-applied or field-applied, contain no urea-formaldehyde.
14. Thru 16 Not Used
17. Interior Paints and Coatings: Submittals for all field-applied paints and coatings, which have a potential impact on indoor air, must include manufacturer's MSDSs or other Product Data highlighting VOC content
18. Exterior Paints and Coatings: Submittals for all field-applied paints and coatings, which have a potential impact on ambient air quality, must include manufacturer's MSDSs or other manufacturer's Product Data highlighting VOC content.
- 19 Thru 23 Not Used
24. Mercury in Lighting: Provide manufacturer's cut sheets or product data for all fluorescent or HID lamps highlighting mercury content.
25. Lighting Controls: Provide manufacturer's cut sheets and shop drawing documentation highlighting all lighting controls systems components.
- 26 and 27 Not Used
28. Fiberglass Insulation: Provide manufacturer's cut sheets or product data verifying that fiberglass batt insulation contains no urea-formaldehyde.
- B. Not Used
- C. Construction Waste Management: See Section 01 74 19 "Construction Waste Management" for submittal requirements.
- D. Not Used

- E. Commissioning: See Section 01 91 00 "General Commissioning Requirements" for submittal requirements.
- F. Sustainable Design Progress Reports: Concurrent with each Application for Payment, submit reports for the following:
 - 1. Construction Waste Management: Waste reduction progress reports and logs complying with the requirements of Section 01 74 19 "Construction Waste Management."
 - 2. Construction IAQ Management: See details below under Section 3.2 Construction Indoor Air Quality Management for Construction IAQ management progress report requirements.

1.6 QUALITY ASSURANCE

- A. Preconstruction Meeting: After award of Contract and prior to the commencement of the Work, schedule and conduct meeting with Owner, Architect, and all Subcontractors to discuss the Construction Waste Management Plan, the required Construction Indoor Air Quality (IAQ) Management Plan, and all other Sustainable Design Requirements. The purpose of this meeting is to develop a mutual understanding of the Project's Sustainable Design Requirements and coordination of the Contractor's management of these requirements with the Contracting Officer and the Construction Quality Manager.
- B. Construction Job Conferences: The status of compliance with the Sustainable Design Requirements of these specifications will be an agenda item at all regular job meetings conducted during the course of work at the site.

PART 2 - PRODUCTS

2.1 PRODUCT ENVIRONMENTAL REQUIREMENTS

- A. Do not burn rubbish, organic matter, etc. or any material on the site. Dispose of legally in accordance with Specifications Sections 01 74 19.
- B. Elimination of CFCs AND HCFCs:
 - 1. Ozone Protection: Base building cooling equipment shall contain no refrigerants other than the following: HCFC-123, HFC-134a, HFC-245fa, HFC-407c, or HFC 410a.
 - 2. Fire suppression systems may not contain ozone-depleting substances.
 - 3. Extruded polystyrene insulation (XPS) and closed-cell spray foam polyurethane insulation shall not be manufactured with hydrochlorofluorocarbon (HCFC) blowing agents.
- C. Appliances and Equipment: All Energy Star eligible equipment and appliances, including office equipment, computers and printers,

electronics, and commercial food service equipment (excluding HVAC and lighting components), shall be qualified by EPA's Energy Star program.

D. Salvaged or Reused materials: There shall be no substitutions for specified salvaged and reused materials and products.

1. Salvaged materials: Use of salvaged materials reduces impacts of disposal and manufacturing of replacements.

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SECTION 01 91 00

GENERAL COMMISSIONING REQUIREMENTS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS shall form the basis of the construction phase commissioning process and procedures. The Commissioning Agent shall add, modify, and refine the commissioning procedures, as approved by the Department of Veterans Affairs (VA), to suit field conditions and actual manufacturer's equipment, incorporate test data and procedure results, and provide detailed scheduling for all commissioning tasks.
- B. Various sections of the project specifications require equipment startup, testing, and adjusting services. Requirements for startup, testing, and adjusting services specified in the, Division 23, Division 26, and Division 27 series sections of these specifications are intended to be provided in coordination with the commissioning services and are not intended to duplicate services. The Contractor shall coordinate the work required by individual specification sections with the commissioning services requirements specified herein.
- C. Where individual testing, adjusting, or related services are required in the project specifications and not specifically required by this commissioning requirements specification, the specified services shall be provided and copies of documentation, as required by those specifications shall be submitted to the VA and the Commissioning Agent to be indexed for future reference.
- D. Where training or educational services for VA are required and specified in other sections of the specifications, including but not limited to Division 23, Division 26, and Division 27 series sections of the specification, these services are intended to be provided in addition to the training and educational services specified herein.
- E. Commissioning is a systematic process of verifying that the building systems perform interactively according to the construction documents and the VA's operational needs. The commissioning process shall encompass and coordinate the system documentation, equipment startup, control system calibration, testing and balancing, performance testing and training. Commissioning during the construction, and post-occupancy

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

1. Verify that the applicable equipment and systems are installed in accordance with the contract documents and according to the manufacturer's recommendations.
 2. Verify and document proper integrated performance of equipment and systems.
 3. Verify that Operations & Maintenance documentation is complete.
 4. Verify that all components requiring servicing can be accessed, serviced and removed without disturbing nearby components including ducts, piping, cabling or wiring.
 5. Verify that the VA's operating personnel are adequately trained to enable them to operate, monitor, adjust, maintain, and repair building systems in an effective and energy-efficient manner.
 6. Document the successful achievement of the commissioning objectives listed above.
- F. The commissioning process does not take away from or reduce the responsibility of the Contractor to provide a finished and fully functioning product.
- G. The Commissioning Agent, both the firm and individual designated as the Commissioning Agent, shall be certified by at least one of the following entities: the National Environmental Balancing Bureau (NEBB), the Associated Air Balance Council Commissioning Group (AABC), and the Building Commissioning Association (BCA). Certification(s) shall be valid and active. Proof of certification(s) shall be submitted to the Contracting Officer and the Resident Engineer three (3) calendar days after the Notice to Proceed.

1.2 CONTRACTUAL RELATIONSHIPS

- A. For this construction project, the Department of Veterans Affairs contracts with a Contractor to provide construction services. The contracts are administered by the VA Contracting Officer and the Resident Engineer as the designated representative of the Contracting Officer. On this project, the authority to modify the contract in any way is strictly limited to the authority of the Contracting Officer and the Resident Engineer.
- B. In this structure, only two contract parties are recognized and communications on contractual issues are strictly limited to VA Resident Engineer and the Contractor. It is the practice of the VA to

require that communications between other parties to the contracts (Subcontractors and Vendors) be conducted through the Resident Engineer and Contractor. It is also the practice of the VA that communications between other parties of the project (Commissioning Agent and Architect/Engineer) be conducted through the Resident Engineer.

- C. Whole Building Commissioning is a process that relies upon frequent and direct communications, as well as collaboration between all parties to the construction process. By its nature, a high level of communication and cooperation between the Commissioning Agent and all other parties (Architects, Engineers, Subcontractors, Vendors, third party testing agencies, etc) is essential to the success of the Commissioning effort.
- D. With these fundamental practices in mind, the commissioning process described herein has been developed to recognize that, in the execution of the Commissioning Process, the Commissioning Agent must develop effective methods to communicate with every member of the construction team involved in delivering commissioned systems while simultaneously respecting the exclusive contract authority of the Contracting Officer and Resident Engineer. Thus, the procedures outlined in this specification must be executed within the following limitations:
1. No communications (verbal or written) from the Commissioning Agent shall be deemed to constitute direction that modifies the terms of any contract between the Department of Veterans Affairs and the Contractor.
 2. Commissioning Issues identified by the Commissioning Agent will be delivered to the Resident Engineer and copied to the designated Commissioning Representatives for the Contractor and subcontractors on the Commissioning Team for information only in order to expedite the communication process. These issues must be understood as the professional opinion of the Commissioning Agent and as suggestions for resolution.
 3. In the event that any Commissioning Issues and suggested resolutions are deemed by the Resident Engineer to require either an official interpretation of the construction documents or require a modification of the contract documents, the Contracting Officer or Resident Engineer will issue an official directive to this effect.
 4. All parties to the Commissioning Process shall be individually responsible for alerting the Resident Engineer of any issues that

they deem to constitute a potential contract change prior to acting on these issues.

5. Authority for resolution or modification of design and construction issues rests solely with the Contracting Officer or Resident Engineer, with appropriate technical guidance from the Architect/Engineer and/or Commissioning Agent.

1.3 RELATED WORK

- A. Section 01 00 00 GENERAL REQUIREMENTS.
- B. Section 23 08 00 COMMISSIONING OF HVAC SYSTEMS.

1.4 SUMMARY

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

1.5 DEFINITIONS

- A. Architect: Includes Architect identified in the Contract for Construction between the Department of Veterans Affairs and Contractor, plus consultant/design professionals responsible for design of fire suppression, plumbing, HVAC, controls for HVAC systems, electrical, communications, electronic safety and security, as well as other related systems.
- B. CxA: Commissioning Agent.
- C. Commissioning Plan: a document that is an overall plan that outlines the commissioning process, commissioning team responsibilities, schedule for commissioning activities, and commissioning documents.
- D. Commissioning Issue: a condition in the installation or function of a component, piece of equipment or system that affects the system operations, maintenance, and/or repair.
- E. Commissioning Observation: a condition in the installation or function of a component, piece of equipment or system that may not be in compliance with the Contract Documents, or may not be in compliance

with the manufacturer's installation instruction, or may not be in compliance with generally accepted industry standards.

- F. Systems Functional Performance Test: a test, or tests, of the dynamic function and operation of equipment and systems using manual (direct observation) or monitoring methods. Systems Functional Performance Testing is the dynamic testing of systems (rather than just components) under full operation (e.g., the chiller pump is tested interactively with the chiller functions to see if the pump ramps up and down to maintain the differential pressure setpoint). Systems are tested under various modes, such as during low cooling or heating loads, high loads, component failures, unoccupied, varying outside air temperatures, fire alarm, power failure, etc. The systems are run through all the control system's sequences of operation and components are verified to be responding as the sequences state. Traditional air or water test and balancing (TAB) is not Systems Functional Performance Testing, in the commissioning sense of the word. TAB's primary work is setting up the system flows and pressures as specified, while System Functional Performance Testing is verifying that the system has already been set up properly and is functioning in accordance with the Construction Documents. The Commissioning Agent develops the Systems Functional Performance Test Procedures in a sequential written form, coordinates, witnesses, and documents the actual testing. Systems Functional Performance Testing is performed by the Contractor. Systems Functional Performance Tests are performed after startups, control systems are complete and operational, TAB functions and Pre-Functional Checklists are complete.
- G. System: A system is defined as the entire set of components, equipment, and subsystems 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 component of an entire system which provides comfort conditions for a building. Other related components are return air, exhaust air, steam supply, chilled water supply, refrigerant supply, hot water supply, controls and electrical service, etc. Another example of a system which involves several components of different disciplines is a boiler installation. Efficient and acceptable boiler operation depends upon the coordination and proper operation of the fuel supply, combustion

air, controls, steam, feedwater supply, condensate return and other related components.

- H. Pre-Functional Checklist: a list of items provided by the Commissioning Agent to the Contractor that require inspection and elementary component tests conducted to verify proper installation of equipment. Pre-Functional Checklists are primarily static inspections and procedures to prepare the equipment or system for initial operation (e.g., belt tension, oil levels OK, labels affixed, gages in place, sensors calibrated, etc.). However, some Pre-Functional Checklist items entail simple testing of the function of a component, a piece of equipment or system (such as measuring the voltage imbalance on a three-phase pump motor of a chiller system). The term "Pre-Functional" refers to before Systems Functional Performance Testing. Pre-Functional Checklists augment and are combined with the manufacturer's startup checklist and the Contractor's Quality Control checklists.
- I. Seasonal Functional Performance Testing: a test or tests that are deferred until the system will experience conditions closer to their design conditions.
- J. VA: Includes the Contracting Officer, Resident Engineer, or other authorized representative of the Department of Veterans Affairs.
- K. TAB: Testing, Adjusting, and Balancing.

1.6 SYSTEMS TO BE COMMISSIONED

- A. Commissioning of a system or systems specified for this project is part of the construction process. Documentation and testing of these systems, as well as training of the VA's Operation and Maintenance personnel, is required in cooperation with the VA and the Commissioning Agent.
 - 1. Thru 3 Not Used
 - 4. HVAC (Division 23)
 - a. Steam System (Boilers, controls, gages and instrumentation, safety relief valves, combustion burners/fans/motors, fuel delivery pumps and motors, flues).
 - b. Direct Digital Control System (BACnet or similar Local Area Network (LAN), Operator Work Station hardware and software, building controller hardware and software, terminal unit controller hardware and software, all sequences of operation, system accuracy and response time).

5. Electrical (Division 26)

- a. Utility Service Entrance Switchgear (Fuses and circuit breaker settings, metering, mimic diagram, gages, and controls).
- b. Standby Generator Systems (Automatic transfer switches, fuel delivery pumps and motors, battery charging and instrumentation, muffler and exhaust system, and vibration isolation).

1.7 COMMISSIONING TEAM

A. Members Appointed by Contractor:

1. Contractor: The designated person, company, or entity that plans, schedules and coordinates the commissioning activities for the construction team.
2. Contractor's Commissioning Representative(s): Individual(s), each having authority to act on behalf of the entity he or she represents, explicitly organized to implement the commissioning process through coordinated actions. The commissioning team shall consist of, but not be limited to, representatives of Contractor, including Project Superintendent and subcontractors, installers, suppliers, and specialists deemed appropriate by the Department of Veterans Affairs (VA) and Commissioning Agent.

B. Members Appointed by VA:

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

1.8 VA'S COMMISSIONING RESPONSIBILITIES

- A. Appoint an individual, company or firm to act as the Commissioning Agent.
- B. Assign operation and maintenance personnel and schedule them to participate in commissioning team activities including, but not limited to, the following:
 1. Coordination meetings.
 2. Training in operation and maintenance of systems, subsystems, and equipment.
 3. Testing meetings.

4. Witness and assist in Systems Functional Performance Testing.
5. Demonstration of operation of systems, subsystems, and equipment.
- C. Provide the Construction Documents, prepared by Architect and approved by VA, to the Commissioning Agent and for use in managing the commissioning process, developing the commissioning plan, systems manuals, and reviewing the operation and maintenance training plan.

1.9 CONTRACTOR'S COMMISSIONING RESPONSIBILITIES

- A. The Contractor shall assign a Commissioning Manager to manage commissioning activities of the Contractor, and subcontractors.
- B. The Contractor shall ensure that the commissioning responsibilities outlined in these specifications are included in all subcontracts and that subcontractors comply with the requirements of these specifications.
- C. The Contractor shall ensure that each installing subcontractor shall assign representatives with expertise and authority to act on behalf of the subcontractor and schedule them to participate in and perform commissioning team activities including, but not limited to, the following:
 1. Participate in commissioning coordination meetings.
 2. Conduct operation and maintenance training sessions in accordance with approved training plans.
 3. Verify that Work is complete and systems are operational according to the Contract Documents, including calibration of instrumentation and controls.
 4. Evaluate commissioning issues and commissioning observations identified in the Commissioning Issues Log, field reports, test reports or other commissioning documents. In collaboration with entity responsible for system and equipment installation, recommend corrective action.
 5. Review and comment on commissioning documentation.
 6. Participate in meetings to coordinate Systems Functional Performance Testing.
 7. Provide schedule for operation and maintenance data submittals, equipment startup, and testing to Commissioning Agent for incorporation into the commissioning plan.
 8. Provide information to the Commissioning Agent for developing commissioning plan.

9. Participate in training sessions for VA's operation and maintenance personnel.
10. Provide technicians who are familiar with the construction and operation of installed systems and who shall develop specific test procedures to conduct Systems Functional Performance Testing of installed systems.

1.10 COMMISSIONING AGENT'S RESPONSIBILITIES

- A. Organize and lead the commissioning team.
- B. Prepare the commissioning plan. See Paragraph 1.11-A of this specification Section for further information.
- C. Review and comment on selected submittals from the Contractor for general conformance with the Construction Documents. Review and comment on the ability to test and operate the system and/or equipment, including providing gages, controls and other components required to operate, maintain, and test the system. Review and comment on performance expectations of systems and equipment and interfaces between systems relating to the Construction Documents.
- D. At the beginning of the construction phase, conduct an initial construction phase coordination meeting for the purpose of reviewing the commissioning activities and establishing tentative schedules for operation and maintenance submittals; operation and maintenance training sessions; Pre-Functional Checklists, Systems Functional Performance Testing; and project completion.
- E. Convene commissioning team meetings for the purpose of coordination, communication, and conflict resolution; discuss status of the commissioning processes. Responsibilities include arranging for facilities, preparing agenda and attendance lists, and notifying participants. The Commissioning Agent shall prepare and distribute minutes to commissioning team members and attendees within five workdays of the commissioning meeting.
- F. Observe construction and report progress, observations and issues. Observe systems and equipment installation for adequate accessibility for maintenance and component replacement or repair, and for general conformance with the Construction Documents.
- G. Prepare Project specific Pre-Functional Checklists and Systems Functional Performance Test procedures.
- H. Coordinate Systems Functional Performance Testing schedule with the Contractor.

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

1.11 COMMISSIONING DOCUMENTATION

- A. Commissioning Agent's Certification(s): Commissioning Agent shall submit evidence of valid and current certification(s), as required in Section 1.1(G), to the Contracting Officer.
- B. Commissioning Plan: A document, prepared by Commissioning Agent, that outlines the schedule, allocation of resources, and documentation requirements of the commissioning process, and shall include, but is not limited, to the following:
 - 1. Plan for delivery and review of submittals, systems manuals, and other documents and reports. Identification of the relationship of these documents to other functions and a detailed description of

submittals that are required to support the commissioning processes. Submittal dates shall include the latest date approved submittals must be received without adversely affecting commissioning plan.

2. Description of the organization, layout, and content of commissioning documentation (including systems manual) and a detailed description of documents to be provided along with identification of responsible parties.
 3. Identification of systems and equipment to be commissioned.
 4. Schedule of Commissioning Coordination meetings.
 5. Identification of items that must be completed before the next operation can proceed.
 6. Description of responsibilities of commissioning team members.
 7. Description of observations to be made.
 8. Description of requirements for operation and maintenance training.
 9. Schedule for commissioning activities with dates coordinated with overall construction schedule.
 10. Process and schedule for documenting changes on a continuous basis to appear in Project Record Documents.
 11. Process and schedule for completing prestart and startup checklists for systems, subsystems, and equipment to be verified and tested.
 12. Preliminary Systems Functional Performance Test procedures.
- C. Systems Functional Performance Test Procedures: The Commissioning Agent will develop Systems Functional Performance Test Procedures for each system to be commissioned, including subsystems, or equipment and interfaces or interlocks with other systems. Systems Functional Performance Test Procedures will include a separate entry, with space for comments, for each item to be tested. Preliminary Systems Functional Performance Test Procedures will be provided to the VA, Architect/Engineer, and Contractor for review and comment. The Systems Performance Test Procedure will include test procedures for each mode of operation and provide space to indicate whether the mode under test responded as required. Each System Functional Performance Test procedure, regardless of system, subsystem, or equipment being tested, shall include, but not be limited to, the following:
1. Name and identification code of tested system.
 2. Test number.
 3. Time and date of test.

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

resolution, and document how the issue was resolved. The Master Commissioning Issues Log will also track the status of unresolved issues.

1. Creating an Commissioning Issues Log Entry:

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

2. Documenting Issue Resolution:

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

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

will be used to evaluate systems, subsystems, and equipment and will serve as a future reference document during VA occupancy and operation. It shall describe components and performance that exceed requirements of the Contract Documents and those that do not meet requirements of the Contract Documents. The commissioning report will include, but is not limited to, the following:

1. Lists and explanations of substitutions; compromises; variances with the Contract Documents; record of conditions; and, if appropriate, recommendations for resolution. Design Narrative documentation maintained by the Commissioning Agent.
2. Commissioning plan.
3. Pre-Functional Checklists completed by the Contractor, with annotation of the Commissioning Agent review and spot check.
4. Systems Functional Performance Test Procedures, with annotation of test results and test completion.
5. Commissioning Issues Log.
6. Listing of deferred and off season test(s) not performed, including the schedule for their completion.

I. Addendum to Final Commissioning Report: The Commissioning Agent will prepare an Addendum to the Final Commissioning Report near the end of the Warranty Period. The Addendum will indicate whether systems, subsystems, and equipment are complete and continue to perform according to the Contract Documents. The Addendum to the Final Commissioning Report shall include, but is not limited to, the following:

1. Documentation of deferred and off season test(s) results.
2. Completed Systems Functional Performance Test Procedures for off season test(s).
3. Documentation that unresolved system performance issues have been resolved.
4. Updated Commissioning Issues Log, including status of unresolved issues.
5. Identification of potential Warranty Claims to be corrected by the Contractor.

J. Systems Manual: The Commissioning Agent will gather required information and compile the Systems Manual. The Systems Manual will include, but is not limited to, the following:

1. Design Narrative, including system narratives, schematics, single-line diagrams, flow diagrams, equipment schedules, and changes made throughout the Project.
2. Reference to Final Commissioning Plan.
3. Reference to Final Commissioning Report.
4. Approved Operation and Maintenance Data as submitted by the Contractor.

1.12 SUBMITTALS

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

- during Systems Functional Performance Testing. These Preliminary Systems Functional Performance procedures provide information on the level of testing rigor, and the level of Contractor support required during performance of system's testing.
- B. Final Commissioning Plan Submittal: Based on the Final Construction Documents and the Contractor's project team, the Commissioning Agent will prepare the Final Commissioning Plan as described in this section. The Commissioning Agent will submit three hard copies and three sets of electronic files of Final Commissioning Plan. The Contractor shall review the Commissioning Plan and provide any comments to the VA. The Commissioning Agent will incorporate review comments into the Final Commissioning Plan as directed by the VA.
- C. Systems Functional Performance Test Procedure: The Commissioning Agent will submit preliminary Systems Functional Performance Test Procedures to the Contractor, and the VA for review and comment. The Contractor shall return review comments to the VA and the Commissioning Agent. The VA will also return review comments to the Commissioning Agent. The Commissioning Agent will incorporate review comments into the Final Systems Functional Test Procedures to be used in Systems Functional Performance Testing.
- D. Pre-Functional Checklists: The Commissioning Agent will submit Pre-Functional Checklists to be completed by the Contractor.
- E. Test and Inspection Reports: The Commissioning Agent will submit test and inspection reports to the VA with copies to the Contractor and the Architect/Engineer.
- F. Corrective Action Documents: The Commissioning Agent will submit corrective action documents to the VA Resident Engineer with copies to the Contractor and Architect.
- G. Preliminary Commissioning Report Submittal: The Commissioning Agent will submit three electronic copies of the preliminary commissioning report. One electronic copy, with review comments, will be returned to the Commissioning Agent for preparation of the final submittal.
- H. Final Commissioning Report Submittal: The Commissioning Agent will submit four sets of electronically formatted information of the final commissioning report to the VA. The final submittal will incorporate comments as directed by the VA.
- I. Data for Commissioning:

1. The Commissioning Agent will request in writing from the Contractor specific information needed about each piece of commissioned equipment or system to fulfill requirements of the Commissioning Plan.
2. The Commissioning Agent may request further documentation as is necessary for the commissioning process or to support other VA data collection requirements, including Construction Operations Building Information Exchange (COBIE), Building Information Modeling (BIM), etc.

1.13 COMMISSIONING PROCESS

- A. The Commissioning Agent will be responsible for the overall management of the commissioning process as well as coordinating scheduling of commissioning tasks with the VA and the Contractor. As directed by the VA, the Contractor shall incorporate Commissioning tasks, including, but not limited to, Systems Functional Performance Testing (including predecessors) with the Master Construction Schedule.
- B. Within 30 days of contract award, the Contractor shall designate a specific individual as the Commissioning Manager (CM) to manage and lead the commissioning effort on behalf of the Contractor. The Commissioning Manager shall be the single point of contact and communications for all commissioning related services by the Contractor.
- C. Within 30 days of contract award, the Contractor shall ensure that each subcontractor designates specific individuals as Commissioning Representatives (CR) to be responsible for commissioning related tasks. The Contractor shall ensure the designated Commissioning Representatives participate in the commissioning process as team members providing commissioning testing services, equipment operation, adjustments, and corrections if necessary. The Contractor shall ensure that all Commissioning Representatives shall have sufficient authority to direct their respective staff to provide the services required, and to speak on behalf of their organizations in all commissioning related contractual matters.

1.14 QUALITY ASSURANCE

- A. Instructor Qualifications: Factory authorized service representatives shall be experienced in training, operation, and maintenance procedures for installed systems, subsystems, and equipment.

- B. Test Equipment Calibration: The Contractor shall comply with test equipment manufacturer's calibration procedures and intervals. Recalibrate test instruments immediately whenever instruments have been repaired following damage or dropping. Affix calibration tags to test instruments. Instruments shall have been calibrated within six months prior to use.

1.15 COORDINATION

- A. Management: The Commissioning Agent will coordinate the commissioning activities with the VA and Contractor. The Commissioning Agent will submit commissioning documents and information to the VA. All commissioning team members shall work together to fulfill their contracted responsibilities and meet the objectives of the contract documents.
- B. Scheduling: The Contractor will work with the Commissioning Agent and the VA to incorporate the commissioning activities into the construction schedule. The Commissioning Agent will provide sufficient information on commissioning activities to allow the Contractor and the VA to schedule commissioning activities. All parties shall address scheduling issues and make necessary notifications in a timely manner in order to expedite the project and the commissioning process. The Contractor shall update the Master Construction as directed by the VA.
- C. Initial Schedule of Commissioning Events: The Commissioning Agent will provide the initial schedule of primary commissioning events in the Commissioning Plan and at the commissioning coordination meetings. The Commissioning Plan will provide a format for this schedule. As construction progresses, more detailed schedules will be developed by the Contractor with information from the Commissioning Agent.
- D. Commissioning Coordinating Meetings: The Commissioning Agent will conduct periodic Commissioning Coordination Meetings of the commissioning team to review status of commissioning activities, to discuss scheduling conflicts, and to discuss upcoming commissioning process activities.
- E. Pretesting Meetings: The Commissioning Agent will conduct pretest meetings of the commissioning team to review startup reports, Pre-Functional Checklist results, Systems Functional Performance Testing procedures, testing personnel and instrumentation requirements.
- F. Systems Functional Performance Testing Coordination: The Contractor shall coordinate testing activities to accommodate required quality

assurance and control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspecting. The Contractor shall coordinate the schedule times for tests, inspections, obtaining samples, and similar activities.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

- A. The Contractor shall provide all standard and specialized testing equipment required to perform Systems Functional Performance Testing. Test equipment required for Systems Functional Performance Testing will be identified in the detailed System Functional Performance Test Procedure prepared by the Commissioning Agent.
- B. Data logging equipment and software required to test equipment shall be provided by the Contractor.
- C. All testing equipment shall be of sufficient quality and accuracy to test and/or measure system performance with the tolerances specified in the Specifications. If not otherwise noted, the following minimum requirements apply: Temperature sensors and digital thermometers shall have a certified calibration within the past year to an accuracy of 0.5 °C (1.0 °F) and a resolution of + or - 0.1 °C (0.2 °F). Pressure sensors shall have an accuracy of + or - 2.0% of the value range being measured (not full range of meter) and have been calibrated within the last year. All equipment shall be calibrated according to the manufacturer's recommended intervals and when dropped or damaged. Calibration tags shall be affixed or certificates readily available.

PART 3 - EXECUTION

3.1 STARTUP, INITIAL CHECKOUT, AND PRE-FUNCTIONAL CHECKLISTS

- A. The following procedures shall apply to all equipment and systems to be commissioned, according to Part 1, Systems to Be Commissioned.
 - 1. Pre-Functional Checklists are important to ensure that the equipment and systems are hooked up and operational. These ensure that Systems Functional Performance Testing may proceed without unnecessary delays. Each system to be commissioned shall have a full Pre-Functional Checklist completed by the Contractor prior to Systems Functional Performance Testing. No sampling strategies are used.
 - a. The Pre-Functional Checklist will identify the trades responsible for completing the checklist. The Contractor shall ensure the appropriate trades complete the checklists.

- b. The Commissioning Agent will review completed Pre-Functional Checklists and field-verify the accuracy of the completed checklist using sampling techniques.
- 2. Startup and Initial Checkout Plan: The Contractor shall develop detailed startup plans for all equipment. The primary role of the Contractor in this process is to ensure that there is written documentation that each of the manufacturer recommended procedures have been completed. Parties responsible for startup shall be identified in the Startup Plan and in the checklist forms.
 - a. The Contractor shall develop the full startup plan by combining (or adding to) the checklists with the manufacturer's detailed startup and checkout procedures from the O&M manual data and the field checkout sheets normally used by the Contractor. The plan shall include checklists and procedures with specific boxes or lines for recording and documenting the checking and inspections of each procedure and a summary statement with a signature block at the end of the plan.
 - b. The full startup plan shall at a minimum consist of the following items:
 - 1) The Pre-Functional Checklists.
 - 2) The manufacturer's standard written startup procedures copied from the installation manuals with check boxes by each procedure and a signature block added by hand at the end.
 - 3) The manufacturer's normally used field checkout sheets.
 - a) The Commissioning Agent will submit the full startup plan to the VA and Contractor for review. Final approval will be by the VA.
 - b) The Contractor shall review and evaluate the procedures and the format for documenting them, noting any procedures that need to be revised or added.
- 3. Sensor and Actuator Calibration
 - a. All field installed temperature, relative humidity, CO₂ and pressure sensors and gages, and all actuators (dampers and valves) on all equipment shall be calibrated using the methods described in Division 21, Division 22, Division 23, Division 26, Division 27, and Division 28 specifications.
 - b. All procedures used shall be fully documented on the Pre-Functional Checklists or other suitable forms, clearly

referencing the procedures followed and written documentation of initial, intermediate and final results.

4. Execution of Equipment Startup

- a. Four weeks prior to equipment startup, the Contractor shall schedule startup and checkout with the VA and Commissioning Agent. The performance of the startup and checkout shall be directed and executed by the Contractor.
- b. The Commissioning Agent will observe the startup procedures for selected pieces of primary equipment.
- c. The Contractor shall execute startup and provide the VA and Commissioning Agent with a signed and dated copy of the completed startup checklists, and contractor tests.
- d. Only individuals that have direct knowledge and witnessed that a line item task on the Startup Checklist was actually performed shall initial or check that item off. It is not acceptable for witnessing supervisors to fill out these forms.

3.2 DEFICIENCIES, NONCONFORMANCE, AND APPROVAL IN CHECKLISTS AND STARTUP

- A. The Contractor shall clearly list any outstanding items of the initial startup and Pre-Functional Checklist procedures that were not completed successfully, at the bottom of the procedures form or on an attached sheet. The procedures form and any outstanding deficiencies shall be provided to the VA and the Commissioning Agent within two days of completion.
- B. The Commissioning Agent will review the report and submit comments to the VA. The Commissioning Agent will work with the Contractor to correct and verify deficiencies or uncompleted items. The Commissioning Agent will involve the VA and others as necessary. The Contractor shall correct all areas that are noncompliant or incomplete in the checklists in a timely manner, and shall notify the VA and Commissioning Agent as soon as outstanding items have been corrected. The Contractor shall submit an updated startup report and a Statement of Correction on the original noncompliance report. When satisfactorily completed, the Commissioning Agent will recommend approval of the checklists and startup of each system to the VA.
- C. The Contractor shall be responsible for resolution of deficiencies as directed the VA.

3.3 PHASED COMMISSIONING

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

3.4 TRENDING AND ALARMS

- A. Trending is a method of testing as a standalone method or to augment manual testing. The Contractor shall trend any and all points of the system or systems at intervals specified below.
- B. Alarms are a means to notify the system operator that abnormal conditions are present in the system. Alarms shall be structured into three tiers - Critical, Priority, and Maintenance.
 - 1. Critical alarms are intended to be alarms that require the immediate attention of and action by the Operator. These alarms shall be displayed on the Operator Workstation in a popup style window that is graphically linked to the associated unit's graphical display. The popup style window shall be displayed on top of any active window within the screen, including non DDC system software.
 - 2. Priority level alarms are to be printed to a printer which is connected to the Operator's Work Station located within the engineer's office. Additionally Priority level alarms shall be able to be monitored and viewed through an active alarm application. Priority level alarms are alarms which shall require reaction from the operator or maintenance personnel within a normal work shift, and not immediate action.
 - 3. Maintenance alarms are intended to be minor issues which would require examination by maintenance personnel within the following shift. These alarms shall be generated in a scheduled report automatically by the DDC system at the start of each shift. The generated maintenance report will be printed to a printer located within the engineer's office.
- C. The Contractor shall provide a wireless internet network in the building for use during controls programming, checkout, and commissioning. This network will allow project team members to more effectively program, view, manipulate and test control devices while being in the same room as the controlled device.

D. The Contractor shall provide graphical trending through the DDC control system of systems being commissioned. Trending requirements are indicated below and included with the Systems Functional Performance Test Procedures. Trending shall occur before, during and after Systems Functional Performance Testing. The Contractor shall be responsible for producing graphical representations of the trended DDC points that show each system operating properly during steady state conditions as well as during the System Functional Testing. These graphical reports shall be submitted to the Resident Engineer and Commissioning Agent for review and analysis before, during dynamic operation, and after Systems Functional Performance Testing. The Contractor shall provide, but not limited to, the following trend requirements and trend submissions:

1. Pre-testing, Testing, and Post-testing - Trend reports of trend logs and graphical trend plots are required as defined by the Commissioning Agent. The trend log points, sampling rate, graphical plot configuration, and duration will be dictated by the Commissioning Agent. At any time during the Commissioning Process the Commissioning Agent may recommend changes to aspects of trending as deemed necessary for proper system analysis. The Contractor shall implement any changes as directed by the Resident Engineer. Any pre-test trend analysis comments generated by the Commissioning Team should be addressed and resolved by the Contractor, as directed by the Resident Engineer, prior to the execution of Systems Functional Performance Testing.
2. Dynamic plotting - The Contractor shall also provide dynamic plotting during Systems Functional Performance testing at frequent intervals for points determined by the Systems Functional Performance Test Procedure. The graphical plots will be formatted and plotted at durations listed in the Systems Functional Performance Test Procedure.
3. Graphical plotting - The graphical plots shall be provided with a dual y-axis allowing 15 or more trend points (series) plotted simultaneously on the graph with each series in distinct color. The plots will further require title, axis naming, legend etc. all described by the Systems Functional Performance Test Procedure. If this cannot be sufficiently accomplished directly in the Direct Digital Control System then it is the responsibility of the Contractor to plot these trend logs in Microsoft Excel.

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

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

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

Steam Boiler System Trending and Alarms							
Point	Type	Trend Interval	Operational Trend Duration	Testing Trend Duration	Alarm Type	Alarm Range	Alarm Delay
Boiler 2 Alarm	DI	COV	12 Hours	3 days	C	True	1 Min
Boiler 2 on Fuel Oil	DI	COV	12 Hours	3 days	N/A		
Boiler 2 Low Water Alarm	DI	COV	12 Hours	3 days	C	True	5 Min
Boiler 2 High Water Alarm	DI	COV	12 Hours	3 days	C	True	5 Min
Boiler 2 Feed Pump	DI	COV	12 Hours	3 days	N/A		
Boiler 3 Enable	DI	COV	12 Hours	3 days	N/A		
Boiler 3 Status	DI	COV	12 Hours	3 days	P	Status <> Command	10 min
Boiler 3 Alarm	DI	COV	12 Hours	3 days	C	True	1 Min
Boiler 3 on Fuel Oil	DI	COV	12 Hours	3 days	N/A		
Boiler 3 Low Water Alarm	DI	COV	12 Hours	3 days	C	True	5 Min
Boiler 3 High Water Alarm	DI	COV	12 Hours	3 days	C	True	5 Min
Boiler 3 Feed Pump	DI	COV	12 Hours	3 days	N/A		
Condensate Recovery Pump Status	DI	COV	12 Hours	3 days	P	Status <> Command	5 min
No. 1 Feed Pump Start / Stop	DO	COV	12 Hours	3 days	N/A		
No. 2 Feed Pump Start / Stop	DO	COV	12 Hours	3 days	N/A		
Condensate Recovery Pump Start / Stop	DO	COV	12 Hours	3 days	N/A		

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

1. Point-to-Point checkout documentation;

2. Sensor field calibration documentation including system name, sensor/point name, measured value, DDC value, and Correction Factor.
3. A sensor calibration table listing the referencing the location of procedures to following in the O&M manuals, and the frequency at which calibration should be performed for all sensors, separated by system, subsystem, and type. The calibration requirements shall be submitted both in the O&M manuals and separately in a standalone document containing all sensors for inclusion in the commissioning documentation. The following table is a sample that can be used as a template for submission.

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

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

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

3.5 SYSTEMS FUNCTIONAL PERFORMANCE TESTING

- A. This paragraph applies to Systems Functional Performance Testing of systems for all referenced specification Divisions.
- B. Objectives and Scope: The objective of Systems Functional Performance Testing is to demonstrate that each system is operating according to the Contract Documents. Systems Functional Performance Testing facilitates bringing the systems from a state of substantial completion to full dynamic operation. Additionally, during the testing process,

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

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

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

e.g., for the above case, by heating the outside air sensor with a hair blower rather than overwriting the value or by altering the appropriate setpoint to see the desired response. Before simulating conditions or overwriting values, sensors, transducers and devices shall have been calibrated.

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

continuing with Systems Functional Performance Testing of the remaining units.

- H. Cost of Retesting: The cost associated with expanded sample System Functional Performance Tests shall be solely the responsibility of the Contractor. Any required retesting by the Contractor shall not be considered a justified reason for a claim of delay or for a time extension by the Contractor.
- I. Coordination and Scheduling: The Contractor shall provide a minimum of 7 days notice to the Commissioning Agent and the VA regarding the completion schedule for the Pre-Functional Checklists and startup of all equipment and systems. The Commissioning Agent will schedule Systems Functional Performance Tests with the Contractor and VA. The Commissioning Agent will witness and document the Systems Functional Performance Testing of systems. The Contractor shall execute the tests in accordance with the Systems Functional Performance Test Procedure.
- J. Testing Prerequisites: In general, Systems Functional Performance Testing will be conducted only after Pre-Functional Checklists have been satisfactorily completed. The control system shall be sufficiently tested and approved by the Commissioning Agent and the VA before it is used to verify performance of other components or systems. The air balancing and water balancing shall be completed before Systems Functional Performance Testing of air-related or water-related equipment or systems are scheduled. Systems Functional Performance Testing will proceed from components to subsystems to systems. When the proper performance of all interacting individual systems has been achieved, the interface or coordinated responses between systems will be checked.
- K. Problem Solving: The Commissioning Agent will recommend solutions to problems found, however the burden of responsibility to solve, correct and retest problems is with the Contractor.

3.6 DOCUMENTATION, NONCONFORMANCE AND APPROVAL OF TESTS

- A. Documentation: The Commissioning Agent will witness, and document the results of all Systems Functional Performance Tests using the specific procedural forms developed by the Commissioning Agent for that purpose. Prior to testing, the Commissioning Agent will provide these forms to the VA and the Contractor for review and approval. The Contractor shall include the filled out forms with the O&M manual data.

B. Nonconformance: The Commissioning Agent will record the results of the Systems Functional Performance Tests on the procedure or test form. All items of nonconformance issues will be noted and reported to the VA on Commissioning Field Reports and/or the Commissioning Master Issues Log.

1. Corrections of minor items of noncompliance identified may be made during the tests. In such cases, the item of noncompliance and resolution shall be documented on the Systems Functional Test Procedure.
2. Every effort shall be made to expedite the systems functional Performance Testing process and minimize unnecessary delays, while not compromising the integrity of the procedures. However, the Commissioning Agent shall not be pressured into overlooking noncompliant work or loosening acceptance criteria to satisfy scheduling or cost issues, unless there is an overriding reason to do so by direction from the VA.
3. As the Systems Functional Performance Tests progresses and an item of noncompliance is identified, the Commissioning Agent shall discuss the issue with the Contractor and the VA.
4. When there is no dispute on an item of noncompliance, and the Contractor accepts responsibility to correct it:
 - a. The Commissioning Agent will document the item of noncompliance and the Contractor's response and/or intentions. The Systems Functional Performance Test then continues or proceeds to another test or sequence. After the day's work is complete, the Commissioning Agent will submit a Commissioning Field Report to the VA. The Commissioning Agent will also note items of noncompliance and the Contractor's response in the Master Commissioning Issues Log. The Contractor shall correct the item of noncompliance and report completion to the VA and the Commissioning Agent.
 - b. The need for retesting will be determined by the Commissioning Agent. If retesting is required, the Commissioning Agent and the Contractor shall reschedule the test and the test shall be repeated.
5. If there is a dispute about item of noncompliance, regarding whether it is an item of noncompliance, or who is responsible:
 - a. The item of noncompliance shall be documented on the test form with the Contractor's response. The item of noncompliance with

the Contractor's response shall also be reported on a Commissioning Field Report and on the Master Commissioning Issues Log.

- b. Resolutions shall be made at the lowest management level possible. Other parties are brought into the discussions as needed. Final interpretive and acceptance authority is with the Department of Veterans Affairs.
 - c. The Commissioning Agent will document the resolution process.
 - d. Once the interpretation and resolution have been decided, the Contractor shall correct the item of noncompliance, report it to the Commissioning Agent. The requirement for retesting will be determined by the Commissioning Agent. If retesting is required, the Commissioning Agent and the Contractor shall reschedule the test. Retesting shall be repeated until satisfactory performance is achieved.
- C. Cost of Retesting: The cost to retest a System Functional Performance Test shall be solely the responsibility of the Contractor. Any required retesting by the Contractor shall not be considered a justified reason for a claim of delay or for a time extension by the Contractor.
- D. Failure Due to Manufacturer Defect: If 10%, or three, whichever is greater, of identical pieces (size alone does not constitute a difference) of equipment fail to perform in compliance with the Contract Documents (mechanically or substantively) due to manufacturing defect, not allowing it to meet its submitted performance specifications, all identical units may be considered unacceptable by the VA. In such case, the Contractor shall provide the VA with the following:
- 1. Within one week of notification from the VA, the Contractor shall examine all other identical units making a record of the findings. The findings shall be provided to the VA within two weeks of the original notice.
 - 2. Within two weeks of the original notification, the Contractor shall provide a signed and dated, written explanation of the problem, cause of failures, etc. and all proposed solutions which shall include full equipment submittals. The proposed solutions shall not significantly exceed the specification requirements of the original installation.

3. The VA shall determine whether a replacement of all identical units or a repair is acceptable.
 4. Two examples of the proposed solution shall be installed by the Contractor and the VA shall be allowed to test the installations for up to one week, upon which the VA will decide whether to accept the solution.
 5. Upon acceptance, the Contractor shall replace or repair all identical items, at their expense and extend the warranty accordingly, if the original equipment warranty had begun. The replacement/repair work shall proceed with reasonable speed beginning within one week from when parts can be obtained.
- E. Approval: The Commissioning Agent will note each satisfactorily demonstrated function on the test form. Formal approval of the Systems Functional Performance Test shall be made later after review by the Commissioning Agent and by the VA. The Commissioning Agent will evaluate each test and report to the VA using a standard form. The VA will give final approval on each test using the same form, and provide signed copies to the Commissioning Agent and the Contractor.

3.7 DEFERRED TESTING

- A. Unforeseen Deferred Systems Functional Performance Tests: If any Systems Functional Performance Test cannot be completed due to the building structure, required occupancy condition or other conditions, execution of the Systems Functional Performance Testing may be delayed upon approval of the VA. These Systems Functional Performance Tests shall be conducted in the same manner as the seasonal tests as soon as possible. Services of the Contractor to conduct these unforeseen Deferred Systems Functional Performance Tests shall be negotiated between the VA and the Contractor.
- B. Deferred Seasonal Testing: Deferred Seasonal Systems Functional Performance Tests are those that must be deferred until weather conditions are closer to the systems design parameters. The Commissioning Agent will review systems parameters and recommend which Systems Functional Performance Tests should be deferred until weather conditions more closely match systems parameters. The Contractor shall review and comment on the proposed schedule for Deferred Seasonal Testing. The VA will review and approve the schedule for Deferred Seasonal Testing. Deferred Seasonal Systems Functional Performances Tests shall be witnessed and documented by the Commissioning Agent.

Deferred Seasonal Systems Functional Performance Tests shall be executed by the Contractor in accordance with these specifications.

3.8 OPERATION AND MAINTENANCE TRAINING REQUIREMENTS

- A. Training Preparation Conference: Before operation and maintenance training, the Commissioning Agent will convene a training preparation conference to include VA's Resident Engineer, VA's Operations and Maintenance personnel, and the Contractor. The purpose of this conference will be to discuss and plan for Training and Demonstration of VA Operations and Maintenance personnel.
- B. The Contractor shall provide training and demonstration as required by other Division 23, Division 26, and Division 27, sections. The Training and Demonstration will include, but is not limited to, the following:
1. Review the Contract Documents.
 2. Review installed systems, subsystems, and equipment.
 3. Review instructor qualifications.
 4. Review instructional methods and procedures.
 5. Review training module outlines and contents.
 6. Review course materials (including operation and maintenance manuals).
 7. Review and discuss locations and other facilities required for instruction.
 8. Review and finalize training schedule and verify availability of educational materials, instructors, audiovisual equipment, and facilities needed to avoid delays.
 9. For instruction that must occur outside, review weather and forecasted weather conditions and procedures to follow if conditions are unfavorable.
 10. A minimum of 24 hours of Training for each shift of boiler operation as boiler plant operates 24 hours a day, 7 days a week.
- C. Training Module Submittals: The Contractor shall submit the following information to the VA and the Commissioning Agent:
1. Instruction Program: Submit two copies of outline of instructional program for demonstration and training, including a schedule of proposed dates, times, length of instruction time, and instructors' names for each training module. Include learning objective and outline for each training module. At completion of training, submit two complete training manuals for VA's use.

2. Qualification Data: Submit qualifications for facilitator and/or instructor.
3. Attendance Record: For each training module, submit list of participants and length of instruction time.
4. Evaluations: For each participant and for each training module, submit results and documentation of performance-based test.
5. Demonstration and Training Videotapes: Submit two copies within seven days of end of each training module.
 - a. Identification: On each copy, provide an applied label with the following information:
 - 1) Name of Project.
 - 2) Name and address of photographer
 - 3) Name of Contractor.
 - 4) Date videotape was recorded.
 - 5) Description of vantage point, indicating location, direction (by compass point), and elevation or story of construction.
6. Transcript: Prepared on 8-1/2-by-11-inch paper, punched and bound in heavy-duty, 3-ring, vinyl-covered binders. Mark appropriate identification on front and spine of each binder. Include a cover sheet with same label information as the corresponding videotape. Include name of Project and date of videotape on each page.

D. QUALITY ASSURANCE

1. Facilitator Qualifications: A firm or individual experienced in training or educating maintenance personnel in a training program similar in content and extent to that indicated for this Project, and whose work has resulted in training or education with a record of successful learning performance.
2. Instructor Qualifications: A factory authorized service representative, complying with requirements in Division 01 Section "Quality Requirements," experienced in operation and maintenance procedures and training.
3. Photographer Qualifications: A professional photographer who is experienced photographing construction projects.

E. COORDINATION

1. Coordinate instruction schedule with VA's operations. Adjust schedule as required to minimize disrupting VA's operations.
2. Coordinate instructors, including providing notification of dates, times, length of instruction time, and course content.

3. Coordinate content of training modules with content of approved emergency, operation, and maintenance manuals. Do not submit instruction program until operation and maintenance data has been reviewed and approved by the VA.

F. INSTRUCTION PROGRAM

1. Program Structure: Develop an instruction program that includes individual training modules for each system and equipment not part of a system, as required by individual Specification Sections, and as follows:
 - a. Heat generation, including boilers, feedwater equipment, pumps, steam distribution piping, condensate return systems, heating hot water heat exchangers, and heating hot water distribution piping.

- G. Training Modules: Develop a learning objective and teaching outline for each module. Include a description of specific skills and knowledge that participants are expected to master. For each module, include instruction for the following:

1. Basis of System Design, Operational Requirements, and Criteria:
Include the following:
 - a. System, subsystem, and equipment descriptions.
 - b. Performance and design criteria if Contractor is delegated design responsibility.
 - c. Operating standards.
 - d. Regulatory requirements.
 - e. Equipment function.
 - f. Operating characteristics.
 - g. Limiting conditions.
 - h. Performance curves.
2. Documentation: Review the following items in detail:
 - a. Emergency manuals.
 - b. Operations manuals.
 - c. Maintenance manuals.
 - d. Project Record Documents.
 - e. Identification systems.
 - f. Warranties and bonds.
 - g. Maintenance service agreements and similar continuing commitments.
3. Emergencies: Include the following, as applicable:

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

- g. Instruction on use of special tools.
- 8. Repairs: Include the following:
 - a. Diagnosis instructions.
 - b. Repair instructions.
 - c. Disassembly; component removal, repair, and replacement; and reassembly instructions.
 - d. Instructions for identifying parts and components.
 - e. Review of spare parts needed for operation and maintenance.
- H. Training Execution:
 - 1. Preparation: Assemble educational materials necessary for instruction, including documentation and training module. Assemble training modules into a combined training manual. Set up instructional equipment at instruction location.
 - 2. Instruction:
 - a. Facilitator: Engage a qualified facilitator to prepare instruction program and training modules, to coordinate instructors, and to coordinate between Contractor and Department of Veterans Affairs for number of participants, instruction times, and location.
 - b. Instructor: Engage qualified instructors to instruct VA's personnel to adjust, operate, and maintain systems, subsystems, and equipment not part of a system.
 - 1) The Commissioning Agent will furnish an instructor to describe basis of system design, operational requirements, criteria, and regulatory requirements.
 - 2) The VA will furnish an instructor to describe VA's operational philosophy.
 - 3) The VA will furnish the Contractor with names and positions of participants.
 - 3. Scheduling: Provide instruction at mutually agreed times. For equipment that requires seasonal operation, provide similar instruction at start of each season. Schedule training with the VA and the Commissioning Agent with at least seven days' advance notice.
 - 4. Evaluation: At conclusion of each training module, assess and document each participant's mastery of module by use of **an oral, or a written**, performance-based test.

5. Cleanup: Collect used and leftover educational materials and remove from Project site. Remove instructional equipment. Restore systems and equipment to condition existing before initial training use.

I. Demonstration and Training Recording:

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

----- END -----

SECTION 02 41 00
DEMOLITION

PART 1 - GENERAL

1.1 DESCRIPTION:

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

1.2 RELATED WORK:

- A. Safety Requirements: GENERAL CONDITIONS Article, ACCIDENT PREVENTION.
- B. Disconnecting utility services prior to demolition: Section 01 00 00, GENERAL REQUIREMENTS.
- C. Reserved items that are to remain the property of the Government: Section 01 00 00, GENERAL REQUIREMENTS.
- D. Asbestos Removal: Section 02 82 11, TRADITIONAL ASBESTOS ABATEMENT.
- E. Lead Paint: Section 02 83 33.13, LEAD-BASED PAINT REMOVAL AND DISPOSAL.
- F. Environmental Protection: Section 01 57 19, TEMPORARY ENVIRONMENTAL CONTROLS.
- G. Construction Waste Management: Section 017419 CONSTRUCTION WASTE MANAGEMENT.
- H. Infectious Control: Section 01 00 00, GENERAL REQUIREMENTS, Article 1.7, 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. Comply with requirements of GENERAL CONDITIONS Article, ACCIDENT PREVENTION.
- B. Provide safeguards, including warning signs, barricades, temporary fences, warning lights, and other similar items that are required for protection of all personnel during demolition and removal operations. Comply with requirements of Section 01 00 00, GENERAL REQUIREMENTS, Article PROTECTION OF EXISTING VEGETATION, STRUCTURES, EQUIPMENT, UTILITIES AND IMPROVEMENTS.
- C. Maintain fences, barricades, lights, and other similar items around exposed excavations until such excavations have been completely filled.
- D. 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.

- E. 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.
 4. Keep hydrants clear and accessible at all times. Prohibit debris from accumulating within a radius of 4500 mm (15 feet) of fire hydrants.
- F. 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 Resident Engineer. 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 Resident Engineer's approval.
- G. The work shall comply with the requirements of Section 01 57 19, TEMPORARY ENVIRONMENTAL CONTROLS.
- H. The work shall comply with the requirements of Section 01 00 00, GENERAL REQUIREMENTS, Article 1.7 INFECTION PREVENTION MEASURES.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 DEMOLITION:

- A. Coordinate with Owner's Representative on any salvaging requirements related to demolition work.

- B. 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 to avoid accumulation at the demolition site. Materials that cannot be removed daily shall be stored in areas specified by the Resident Engineer. Break up concrete slabs below grade that do not require removal from present location into pieces not exceeding 600 mm (24 inches) square to permit drainage. Contractor shall dispose debris in compliance with applicable federal, state or local permits, rules and/or regulations.
- C. Remove and legally dispose of all materials, other than earth to remain as part of project work, from any trash dumps shown. Materials removed shall become property of contractor and shall be disposed of in compliance with applicable federal, state or local permits, rules and/or regulations. All materials in the indicated trash dump areas, including above surrounding grade and extending to a depth of 1500mm (5feet) below surrounding grade, shall be included as part of the lump sum compensation for the work of this section. Materials that are located beneath the surface of the surrounding ground more than 1500 mm (5 feet), or materials that are discovered to be hazardous, shall be handled as unforeseen. The removal of hazardous material shall be referred to Hazardous Materials specifications.
- D. Remove existing utilities as indicated or uncovered by work and terminate in a manner conforming to the nationally recognized code covering the specific utility and approved by the Resident Engineer. When Utility lines are encountered that are not indicated on the drawings, the Resident Engineer shall be notified prior to further work in that area.

3.2 CLEAN-UP:

On completion of work of this section and after removal of all debris, leave site in clean condition satisfactory to Resident Engineer. Clean-up shall include off the Medical Center 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.

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SECTION 06 61 16
SOLID POLYMER (SOLID SURFACING) FABRICATIONS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section specifies interior millwork.
- B. Items specified.
 - Solid Surface Counter Tops
- C. Work under this section includes counter tops utilizing solid polymer (solid surfacing) fabrication as shown on the drawings and as described in this specification.
- D. Installation of solid polymer counter tops will require strong, correctly located structural support. Selected manufacturer shall engineer structural wall supports, counter top structural supports, and other supporting components, to provide a stable, sound, secure installation, with close coordination with existing conditions.

1.2 SUBMITTALS

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Shop Drawings:
 - 1. Half full size scale for sections and details, 1/4-inch for elevations and plans.
 - 2. Submit detail drawings indicating locations, dimensions, component sizes, fabrication and joint details, attachment provisions, installation details, coordination requirements of adjacent work, and structural supports to meet load criteria as indicated on drawings.
 - 3. Submit product data indicating product description, fabrication information, and compliance with specified performance requirements for solid polymer and joint adhesive sealants.
- C. Samples:
 - 1. Submit a minimum 4 by 4 inch sample of color and pattern for approval. Samples shall indicate full range of color and pattern variation.
 - 2. Submit a minimum 1 foot wide by 6 inch deep, full size sample for counter top. Sample shall include edge profile, backsplash, and at least one seam. Sample shall be of pattern and color as selected by Owner.
 - 3. Approved samples shall be retained as a standard for work.

D. Certificates:

1. Solid polymer fabricators shall be certified to fabricate by the solid polymer material manufacturer being utilized. Mark all fabrications with the fabricator's certification label affixed in an inconspicuous location.
2. Fabricators shall have a minimum of 5 years of experience working with solid polymer materials.
3. Submit solid polymer manufacturer's certification attesting to fabricator qualification approval.

E. Manufacturer's literature

1.3 DELIVERY, STORAGE AND HANDLING

- A. Do not deliver materials to project site until areas are ready for installation. Deliver components and materials to the site undamaged, in containers clearly marked and labeled with manufacturer's name. Materials shall be stored indoors and adequate precautions taken to prevent damage to finished surfaces. Provide protective coverings to prevent physical damage or staining following installation, for duration of project.

1.4 WARRANTY

- A. Provide manufacturer's warranty of ten years against defects in materials, excluding damages caused by physical or chemical abuse or excessive heat. Warranty shall provide for material and labor for replacement or repair of defective material for a period of ten years after component 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 the basic designation only.
- B. American Society of Testing and Materials (ASTM):
- A53-07.....Pipe, Steel, Black and Hot-Dipped Zinc Coated,
Welded and Seamless
- D2583 (2007).....Indentation Hardness of Rigid Plastics by Means
of a Barcol Impressor
- D570 (1998, R2010e1)....Standard Test Method for Water Absorption of
Plastics

D638 (2010).....Standard Test Method for Tensile Properties of
Plastic

E84-09.....Surface Burning Characteristics of Building
Materials

C. Federal Specifications (Fed. Spec.):

A-A-1922A.....Shield Expansion

A-A-1936.....Contact Adhesive

FF-N-836D.....Nut, Square, Hexagon Cap, Slotted, Castle

FF-S-111D(1).....Screw, Wood

PART 2 - PRODUCTS

2.1 MATERIAL

- A. Provide solid polymer material that is a homogeneous filled solid polymer; not coated, laminated, or of a composite construction. Material shall have a minimum physical and performance properties specified. Superficial damage to a depth of 0.01 inch shall be repairable by sanding or polishing. Material thickness shall be as indicated on drawings. In no case shall material be less than 1/4 inch in thickness.
- B. Patterns and colors for all solid polymer components, fabrications, and exposed supports shall be selected by Owner. Pattern and color of solid polymer shall occur, and shall be consistent in appearance, throughout the entire depth (thickness) of the solid polymer material. Exposed finish surfaces and edges shall receive a uniform appearance.

2.2 ACCESSORY PRODUCTS

- A. Accessory products, as specified below, shall be manufactured by the solid polymer manufacturer or shall be products approved by the solid polymer manufacturer for use with the solid polymer materials being specified.
1. Seam Adhesive:
- a. Seam adhesive shall be a two-part adhesive kit to create permanent, inconspicuous, non-porous, hard seams and joints by chemical bond between solid polymer materials and components to create a monolithic appearance of the fabrication.
 - b. Adhesives shall be approved by the solid polymer manufacturer.
 - c. Adhesives shall be color-matched to the surfaces being bonded where solid-colored, solid polymer materials are being bonded together. The seam adhesive shall be clear or color matched where

particulate patterned, solid polymer materials are being bonded together.

2. Silicone Sealant:

- a. Sealants shall be a mildew-resistant silicone sealant or caulk in a clear formulation. The silicone sealant shall be approved for use by the solid polymer manufacturer.
- b. Use sealant to seal all expansion joints between solid polymer components and all joints between solid polymer components and existing walls.

3. Hardware:

- a. Provide grommets as indicated on the drawings.

2.3 FABRICATIONS

A. Components shall be factory or shop fabricated to sizes and shapes indicated, in accordance with approved Shop Drawings and manufacturer's requirements. Provide factory cutouts for grommets where indicated on drawings. Contours and radii shall be routed to template, with edges smooth. Defective and inaccurate work will be rejected.

B. Joints and Seams:

1. Form joints and seams between solid polymer components using manufacturer's approved seam adhesive. Joints shall be inconspicuous in appearance and without voids to create a monolithic appearance.

C. Edge Finishing

1. Rout and finish component edges to a smooth, uniform appearance and finish. Rout all cutouts, then sand all edges smooth.
2. Repair or reject defective or inaccurate work.

D. Counter Top

1. Fabricate all solid surfacing, solid polymer counter top components from 1/2 inch minimum thick material. Locations and dimensions shall be as indicated on drawings.
2. Counter tops shall be complete with 4 inch high integral backsplash with 90 degree transition.
3. Attach 2 inch wide reinforcing strip of polymer material under each horizontal counter top seam.
4. Color and pattern shall be selected by Owner from manufacturer's standards.

E. Structural support

1. Steel bracket supports, vertical steel tube and all associated framing and tie-ins shall be engineered by selected manufacturer to meet load criteria as indicated on drawings.

2. Color of exposed surfaces of structural supports shall be dark gray color from manufacturer's standards.

2.4 FIRE RETARDANT TREATMENT

- A. Any wood members or plywood substrate used are to be fire retardant treated. The treatment shall be in accordance with Mil. Spec. MIL-L19140.
- B. Treatment and performance inspection shall be by an independent and qualified testing agency that establishes performance ratings.
- C. Each piece of treated material shall bear identification of the testing agency and shall indicate performance in accordance with such rating of flame spread and smoke developed.
- D. Treat wood for maximum flame spread of 25 and smoke developed of 25.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install all components and units plumb, level, and rigid. Make field joints between solid polymer components using solid polymer manufacturer's approved seam adhesives, to provide a monolithic appearance with joints inconspicuous in the finished work.
- B. Use a clear, silicone sealant or caulk to seal all expansion joints between solid polymer components and all joints between solid polymer components and existing walls. Sealant bead shall be smooth and uniform in appearance and shall be the minimum size necessary to bridge any gaps between the solid surfacing material and the adjacent surface. Bead shall be continuous and run the entire length of the joint being sealed.

3.2 CLEAN-UP

- A. Components shall be cleaned after installation and covered to protect against damage during completion of the remaining project items. Components damaged after installation by other trades will be repaired or replaced at the General Contractor's cost. Component supplier will provide a repair/replace cost estimate to the General Contractor who shall approve estimate before repairs are made.
- B. Submit three copies of maintenance data indicating manufacturer's care, repair, and cleaning instructions. Maintenance video and kit shall be provided, if available.

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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 QUALITY CONTROL:

- A. Installer Qualifications: An experienced installer who has specialized in installing joint sealants similar in material, design, and extent to those indicated for this Project and whose work has resulted in joint-sealant installations with a record of successful in-service performance.
- B. Source Limitations: Obtain each type of joint sealant through one source from a single manufacturer.
- C. VOC: Acrylic latex and Silicone sealants shall have less than 50g/l VOC content.

1.3 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.

1.4 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.

1.5 DELIVERY, HANDLING, AND STORAGE:

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

1.6 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.

1.7 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.

1.8 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):

C612-10.....Mineral Fiber Block and Board Thermal
Insulation.

C717-10.....Standard Terminology of Building Seals and
Sealants.

C834-10.....Latex Sealants.

C919-08.....Use of Sealants in Acoustical Applications.

C920-10.....Elastomeric Joint Sealants.

C1193-09.....Standard Guide for Use of Joint Sealants.

C1330-02 (R2007).....Cylindrical Sealant Backing for Use with Cold
Liquid Applied Sealants.

D1056-07.....Specification for Flexible Cellular Materials—
Sponge or Expanded Rubber.

C. Sealant, Waterproofing and Restoration Institute (SWRI).

The Professionals' Guide

PART 2 - PRODUCTS

2.1 SEALANTS:

A. At Counter Top: Refer to specification 06 61 16 SOLID POLYMER (SOLID
SURFACING) FABRICATIONS.

B. 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.

2.2 CAULKING COMPOUND:

A. At Counter Top: Refer to specification 06 61 16 SOLID POLYMER (SOLID
SURFACING) FABRICATIONS.

B. C-1: ASTM C834, acrylic latex.

C. C-2: One component acoustical caulking, non drying, non hardening,
synthetic rubber.

2.3 COLOR:

A. Sealants used with exposed masonry shall match color of painted CMU.

B. Caulking shall be light gray or white, unless specified otherwise.

- C. At Counter Top: Refer to specification 06 61 16 SOLID POLYMER (SOLID SURFACING) FABRICATIONS.

2.4 JOINT SEALANT BACKING:

- A. General: Provide sealant backings of material and type that are nonstaining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.
- B. Cylindrical Sealant Backings: ASTM C1330, of type indicated below and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance:
 - 1. Type C: Closed-cell material with a surface skin.
- C. Elastomeric Tubing Sealant Backings: Neoprene, butyl, EPDM, or silicone tubing complying with ASTM D1056, nonabsorbent to water and gas, and capable of remaining resilient at temperatures down to minus 32° C (minus 26° F). Provide products with low compression set and of size and shape to provide a secondary seal, to control sealant depth, and otherwise contribute to optimum sealant performance.
- D. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint where such adhesion would result in sealant failure. Provide self-adhesive tape where applicable.

2.5 FILLER:

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

2.6 PRIMER:

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

2.7 CLEANERS-NON POUROUS SURFACES:

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 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.
 - 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.
- C. Do not cut or damage joint edges.
- D. Apply masking tape to face of surfaces adjacent to joints before applying primers, caulking, or sealing compounds.
 - 1. Do not leave gaps between ends of sealant backings.
 - 2. Do not stretch, twist, puncture, or tear sealant backings.
 - 3. Remove absorbent sealant backings that have become wet before sealant application and replace them with dry materials.
- E. Apply primer to sides of joints wherever required by compound manufacturer's printed instructions.
 - 1. Apply primer prior to installation of back-up rod or bond breaker tape.
 - 2. Use brush or other approved means that will reach all parts of joints.
- F. Take all necessary steps to prevent three sided adhesion of sealants.

3.3 BACKING INSTALLATION:

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

3.4 SEALANT DEPTHS AND GEOMETRY:

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

3.5 INSTALLATION:

- A. General:
 - 1. Apply sealants and caulking only when ambient temperature is between 5° C and 38° C (40° and 100° F).
 - 2. Do not use polysulfide base sealants where sealant may be exposed to fumes from bituminous materials, or where water vapor in continuous contact with cementitious materials may be present.
 - 3. Do not use sealant type listed by manufacture as not suitable for use in locations specified.
 - 4. Apply caulking and sealing compound in accordance with manufacturer's printed instructions.
 - 5. Avoid dropping or smearing compound on adjacent surfaces.
 - 6. Fill joints solidly with compound and finish compound smooth.
 - 7. Tool joints to concave surface unless shown or specified otherwise.
 - 8. Finish 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.

3.6 FIELD QUALITY CONTROL:

- A. Field-test joint-sealant adhesion to joint substrates as recommended by sealant manufacturer
- B. Inspect joints for complete fill, for absence of voids, and for joint configuration complying with specified requirements.
- C. Repair sealants pulled from test area by applying new sealants following same procedures used to originally seal joints. Ensure that original sealant surfaces are clean and new sealant contacts original sealant.

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. Joints:
 - 1. Counter Tops to Walls: Refer to specification 06 61 16 SOLID POLYMER (SOLID SURFACING) FABRICATIONS.
 - 2. Within Epoxy Floor Coating System: Per manufacturer's standards. Refer to specification 09 67 23 Epoxy Floor Coating.
 - 2. Pipe Penetrations: Type S-9
- B. Interior Caulking:
 - 1. Typical Narrow Joint 1/4 inch or less at Walls and Adjacent Components: Types C-1.
 - 2. Perimeter of Components which Adjoin Masonry Surfaces: Types C-1.
 - 3. Exposed Acoustical Joint at Sound Rated Door Frames: Type C-2.

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SECTION 08 11 13
HOLLOW METAL DOORS AND FRAMES

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section specifies steel doors, steel frames and related components.
- B. Terms relating to steel doors and frames as defined in ANSI A123.1 and as specified.

1.2 RELATED WORK

- A. Door Hardware: Section 08 71 00, DOOR HARDWARE.

1.3 TESTING

An independent testing laboratory shall perform testing.

1.4 SUBMITTALS

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Manufacturers Literature and Data:
 - 1. Sound rated doors, including test report from Testing Laboratory.

1.5 SHIPMENT

- A. Prior to shipment label each door and frame to show location, size, door swing and other pertinent information.
- B. Fasten temporary steel spreaders across the bottom of each door frame.

1.6 STORAGE AND HANDLING

- A. Store doors and frames at the site under cover.
- B. Protect from rust and damage during storage and erection until completion.

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. Door and Hardware Institute (DHI):
 - A115 Series.....Steel Door and Frame Preparation for Hardware,
Series A115.1 through A115.17 (Dates Vary)
- C. Steel Door Institute (SDI):
 - 114.....Recommended Specifications for Standard Steel
Doors and Frames
 - 128-1997.....Acoustical Performance for Steel Door and Frame
Assemblies
 - A250.8-03.....Standard Steel Doors and Frames
- D. American Society for Testing and Materials (ASTM):
 - A1008-08.....Steel, sheet, Cold-Rolled, Carbon, Structural,
High Strength Low Alloy and High Strength Low
Alloy with Improved Formability
- E. The National Association Architectural Metal Manufacturers (NAAMM):
 - Metal Finishes Manual (1988 Edition)
- F. Intertek Testing Services (ITS):
 - Certifications Listings...Latest Edition
- G. Factory Mutual System (FM):
 - Approval Guide

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Not Used
- B. Sheet Steel: ASTM A1008, cold-rolled for panels (face sheets) of doors.
- C. Anchors, Fastenings and Accessories: Fastenings anchors, clips
connecting members and sleeves from zinc coated steel.
- D. Prime Paint: Paint that meets or exceeds the requirements of A250.8.

2.2 FABRICATION GENERAL

- A. GENERAL:
 - 1. Follow SDI A250.8 for fabrication of standard steel doors, except as
specified otherwise. Doors to receive hardware specified in Section
08 71 00, DOOR HARDWARE. Tolerances as per SDI A250.8. Thickness, 44
mm (1-3/4 inches), unless otherwise shown.
 - 2. When vertical steel stiffeners are used for core construction, fill
spaces between stiffeners with mineral fiber insulation.

B. Heavy Duty Doors: SDI A250.8, Level 2, Model 2 of size and design shown. Core construction types a, d, or f, for interior doors.

C. Sound Rated Doors:

1. SDI 114.
2. Sound Transmission Class minimum of 45 when tested in accordance with ASTM E90.
3. Doors complete with integral spring type automatic door bottom seal and with integral continuous gaskets on the frames.
4. Fabricate vision panels to receive double glazing where shown.

2.3 METAL FRAMES

A. General:

1. SDI A250.8, 1.3 mm (0.053 inch) thick sheet steel, types and styles as shown or scheduled.

B. Reinforcement and Covers:

1. SDI A250.8 for, minimum thickness of steel reinforcement welded to back of frames.
2. Provide mortar guards securely fastened to back of hardware reinforcements.

C. Frame Anchors:

1. Floor anchors:

- a. Where floor fills occur, provide extension type floor anchors to compensate for depth of fill.
- b. At bottom of jamb use 1.3 mm (0.053 inch) thick steel clip angles welded to jamb and drilled to receive two 6 mm (1/4 inch) floor bolts.

2. Jamb anchors:

- a. Locate anchors on jambs near top and bottom of each frame, and at intermediate points not over 600 mm (24 inches) apart.
- b. Form jamb anchors of not less than 1 mm (0.042 inch) thick steel unless otherwise specified.
- c. Anchors for frames set in prepared openings:
 - 1) Drill jamb stop and strap spacers for 6 mm (1/4 inch) flat head bolts to pass thru frame and spacers.

2.4 SHOP PAINTING AND PREP

- A. SDI A250.8.
- B. Shop prep sound rated doors to be receive door hardware as specified in 08 71 00 DOOR HARDWARE.
- C. Color of door and door frames to match existing doors and frames in Boiler Area. Color selected by Owner from manufacturer's standard.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Plumb, align and brace frames securely until permanent anchors are set.
 - 1. Use triangular bracing near each corner on both sides of frames with temporary wood spreaders at midpoint.
 - 2. Use wood spreaders at bottom of frame if the shipping spreader is removed.
 - 3. Protect frame from accidental abuse.
 - 4. Where construction will permit concealment, leave the shipping spreaders in place after installation, otherwise remove the spreaders after the frames are set and anchored.
 - 5. Remove wood spreaders and braces only after the walls are built and jamb anchors are secured.
- B. Floor Anchors:
 - 1. Anchor the bottom of door frames to floor with two 6 mm (1/4 inch) diameter expansion bolts.
 - 2. Power actuated drive pins may be used to secure frame anchors to concrete floors.
- C. Jamb Anchors:
 - 1. Frames set in prepared openings of masonry or concrete: Expansion bolt to wall with 6 mm (1/4 inch) expansion bolts through spacers. Where subframes or rough bucks are used, 6 mm (1/4 inch) expansion bolts on 600 mm (24 inch) centers or power activated drive pins 600 mm (24 inches) on centers.
- D. Frames for Sound Rated Doors: Coordinate to line frames for sound rated doors with insulation.

3.2 INSTALLATION OF DOORS AND APPLICATION OF HARDWARE

- A. Install doors and hardware as specified in Section 08 71 00, DOOR HARDWARE.
- B. Refer to Section 08 71 00, DOOR HARDWARE, paragraph 1.3.C for hardware to be provided by Sound Rated Door manufacturer.

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SECTION 08 71 00
DOOR HARDWARE

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Door hardware and related items necessary for complete installation and operation of doors.

1.2 RELATED WORK

- A. Caulking: Section 07 92 00 JOINT SEALANTS.
- B. Application of Hardware: Section 08 11 13, HOLLOW METAL DOORS

1.3 GENERAL

- A. All hardware shall comply with ADA and ABA Accessibility Guidelines and Barrier Free Design Guide, PG-18-13, December 2011, unless specified otherwise.
- B. Hardware for application on metal doors and frames shall be made to standard templates. Furnish templates to the fabricator of these items in sufficient time so as not to delay the construction.
- C. The following items shall be provided by the Sound Rated Door manufacturer for sound rated doors. Refer to section 08 11 13 HOLLOW METAL DOORS AND FRAMES:
 - 1. Butt Hinges.
 - 2. Automatic Door Bottom Seal.
 - 3. Rubber Gaskets.

1.4 MAINTENANCE MANUALS

- A. In accordance with Section 01 00 00, GENERAL REQUIREMENTS Article titled "INSTRUCTIONS", furnish maintenance manuals and instructions on all door hardware. Provide installation instructions with the submittal documentation.

1.5 SUBMITTALS

- A. Submittals shall be in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA AND SAMPLES. Submit 6 copies of the schedule per Section 01 33 23. Submit 2 final copies of the final approved schedules to VAMC

Locksmith as record copies (VISN Locksmith if the VAMC does not have a locksmith).

B. Hardware Schedule: Prepare and submit hardware schedule in the following form:

Hardware Item	Quantity	Size	Reference Publication Type No.	Finish	Mfr. Name and Catalog No.	Key Control Symbols	UL Mark (if fire rated and listed)	ANSI/BHMA Finish Designation

C. Samples and Manufacturers' Literature:

1. Samples: All hardware items (proposed for the project) that have not been previously approved by Builders Hardware Manufacturers Association shall be submitted for approval. Tag and mark all items with manufacturer's name, catalog number and project number.
2. Samples are not required for hardware listed in the specifications by manufacturer's catalog number, if the contractor proposes to use the manufacturer's product specified.

D. Certificate of Compliance and Test Reports: Submit certificates that hardware conforms to the requirements specified herein. Certificates shall be accompanied by copies of reports as referenced. The testing shall have been conducted either in the manufacturer's plant and certified by an independent testing laboratory or conducted in an independent laboratory, within four years of submittal of reports for approval.

1.6 DELIVERY AND MARKING

A. Deliver items of hardware to job site in their original containers, complete with necessary appurtenances including screws, keys, and instructions. Tag one of each different item of hardware and deliver to Resident Engineer for reference purposes. Tag shall identify items by Project Specification number and manufacturer's catalog number. These items shall remain on file in Resident Engineer's office until all other similar items have been installed in project, at which time the

Resident Engineer will deliver items on file to Contractor for installation in predetermined locations on the project.

1.7 INSTRUCTIONS

- A. Hardware Sets are identified in Door Hardware Schedule on drawings. Symbols for hardware sets consist of letters (e.g., "HW") followed by a number
- B. Keying: All cylinders shall be keyed into existing system.

1.8 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. In text, hardware items are referred to by series, types, etc., listed in such specifications and standards, except as otherwise specified.
- B. American National Standards Institute/Builders Hardware Manufacturers Association (ANSI/BHMA):
 - A156.1-06.....Butts and Hinges
 - A156.2-03.....Bored and Pre-assembled Locks and Latches
 - A156.4-08.....Door Controls (Closers)
 - A156.6-05.....Architectural Door Trim
 - A156.16-08.....Auxiliary Hardware
 - A156.18-06.....Materials and Finishes
 - A156.21-09.....Thresholds
 - A156.22-05.....Door Gasketing and Edge Seal Systems
 - A250.8-03.....Standard Steel Doors and Frames
- C. National Fire Protection Association (NFPA):
 - 101-09.....Life Safety Code
- D. Underwriters Laboratories, Inc. (UL):
 - Building Materials Directory (2008)

PART 2 - PRODUCTS

2.1 BUTT HINGES

- A. Butt hinges shall be provided by Sound Rated Door manufacturer.
- B. ANSI A156.1. Provide only three-knuckle hinges, except five-knuckle where the required hinge type is not available in a three-knuckle version (e.g., some types of swing-clear hinges). The following types

of butt hinges shall be used for the types of doors listed, except where otherwise specified:

1. Interior Doors: Type A8112/A5112 for doors 900 mm (3 feet) wide or less and Type A8111/A5111 for doors over 900 mm (3 feet) wide.
- C. Provide quantity and size of hinges per door leaf as follows:
 1. Doors 1210 mm (4 feet) to 2260 mm (7 feet 5 inches) high: 3 hinges minimum.
 2. Doors up to 900 mm (3 feet) wide, standard weight: 114 mm x 114 mm (4-1/2 inches x 4-1/2 inches) hinges.

2.2 OVERHEAD CLOSERS

- A. Conform to ANSI A156.4, Grade 1.
- B. Closing devices shall be products of one manufacturer.
- C. Closers shall conform to the following:
 1. The closer shall have minimum 50 percent adjustable closing force over minimum value for that closer and have adjustable hydraulic back check effective between 60 degrees and 85 degrees of door opening.
 2. Material of closer body shall be forged or cast.
 3. Arm and brackets for closers shall be steel.
 4. Closers shall have full size metal cover; plastic covers will not be accepted.
 5. Closers shall have adjustable hydraulic back-check, separate valves for closing and latching speed, adjustable back-check positioning valve, and adjustable delayed action valve.
 6. Provide closers with any accessories required for the mounting application, including (but not limited to) drop plates, special soffit plates, spacers for heavy-duty parallel arm fifth screws, bull-nose or other regular arm brackets, longer or shorter arm assemblies, and special factory templating.
 7. Closer arms or backcheck valve shall not be used to stop the door from overswing, except in applications where a separate wall, floor, or overhead stop cannot be used.
 8. Provide all surface closers with the same body attachment screw pattern for ease of replacement and maintenance.
 9. All closers shall have a 1 1/2" (38mm) minimum piston diameter.

2.3 DOOR STOPS

- A. Conform to ANSI A156.16.
- B. Provide door stops wherever an opened door or any item of hardware thereon would strike a wall, column, equipment or other parts of building construction. For concrete, masonry or quarry tile construction, use lead expansion shields for mounting door stops.
- C. Provide floor stops; Type L02121 x 3 screws into floor. Floor stops, where used, must be installed within 4-inches of the wall face and impact the door within the leading half of its width.
- D. Where the specified floor stop cannot be used, provide surface mounted overhead stops.

2.4 LOCKS AND LATCHES

- A. Conform to ANSI A156.2. Locks and latches for doors 45 mm (1-3/4 inch) thick or over shall have beveled fronts. Lock cylinders shall accept BEST core - seven pin - SFIC. Contractor shall provide cores to Owner's locksmith to set pins for final installation. Cylinders for all locksets shall be removable core type. Disassembly of lever or lockset shall not be required to remove core from lockset.
- B. In addition to above requirements, locks and latches shall comply with following requirements:
 - 1. Cylindrical Lock and Latch Sets: levers shall meet ADA (Americans with Disabilities Act) requirements. Cylindrical locksets shall be series 4000 Grade I. All locks and latchsets shall be furnished with 122.55 mm (4-7/8-inch) curved lip strike and wrought box.

2.5 KEYS

- A. Supply ten (10) blank keys per set to Owner's locksmith per cylinder.

2.6 KICK PLATES

- A. Conform to ANSI Standard A156.6.
- B. Provide protective plates as specified below:
 - 1. Kick plates Type J100 series.
 - 2. Provide kick plates where specified. Kick plates shall be 12 inches high. Kick plates shall be minimum 0.050 inches thick. Provide kick plates beveled on all 4 edges (B4E). On push side of doors where jamb stop extends to floor, make kick plates 1-1/2 inches less than

width of door. Extend all other kick plates to within 1/4 inch of each edge of door.

2.7 THRESHOLDS

- A. Conform to ANSI A156.21, mill finish extruded aluminum, except as otherwise specified. In existing construction, thresholds shall be installed in a bed of sealant with ¼-20 stainless steel machine screws and expansion shields. Furnish thresholds for the full width of the openings.
- B. Provide threshold with non-slip abrasive finish.

2.8 AUTOMATIC DOOR BOTTOM SEAL AND RUBBER GASKET FOR SOUND CONTROL DOORS

- A. Automatic door bottom seal and rubber gaskets to be provided by Sound Rated Door manufacturer.
- B. Conform to ANSI A156.22. Provide mortise or under-door type, except where not practical. For mortise automatic door bottoms, provide type specific for metal door construction.

2.9 FINISHES

- A. Exposed surfaces of hardware shall have ANSI A156.18, finishes as specified below. Finishes on all hinges, closers, thresholds, etc., shall be as specified below under "Miscellaneous Finishes."
- B. 626 or 630: All surfaces on interior of buildings, except where other finishes are specified.
- C. Miscellaneous Finishes:
 - 1. Hinges --interior doors: 652 or 630.
 - 2. Thresholds: Mill finish aluminum.
 - 3. Other primed steel hardware: 600.
- D. Hardware Finishes for Existing Buildings: U.S. Standard finishes shall match finishes of hardware in (similar) existing spaces.

2.10 BASE METALS

- A. Apply specified U.S. Standard finishes on different base metals as following:

Finish	Base Metal
652	Steel
626	Brass or bronze
630	Stainless steel

PART 3 - EXECUTION

3.1 HARDWARE HEIGHTS

- A. For existing buildings locate hardware on doors at heights to match existing hardware. The Contractor shall visit the site, verify location of existing hardware and submit locations to VA Resident Engineer for approval.

3.2 INSTALLATION

- A. Closer devices shall be equipped and mounted to provide maximum door opening permitted by building construction or equipment. Closers shall be mounted on side of door inside rooms.

- B. Hinge Size Requirements:

Door Thickness	Door Width	Hinge Height
45 mm (1-3/4 inch)	900 mm (3 feet) and less	113 mm (4-1/2 inches)
45 mm (1-3/4 inch)	Over 900 mm (3 feet) but not more than 1200 mm (4 feet)	125 mm (5 inches)

- C. Hinge leaves shall be sufficiently wide to allow doors to swing clear of door frame trim and surrounding conditions.

- D. Existing hinges shall not be reused on door openings having new doors and new frames. Coordinate preparation for hinge cut-outs and screw-hole locations on doors and frames.

- E. Hinges Required Per Door:

Doors over 1500 mm (5 ft) high and not over 2280 mm (7 ft 6 in) high	3 butts
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- F. Fastenings: Suitable size and type and shall harmonize with hardware as to material and finish. Provide machine screws and lead expansion shields to secure hardware to concrete, ceramic or quarry floor tile, or solid masonry. Fiber or rawl plugs and adhesives are not permitted. All fastenings exposed to weather shall be of nonferrous metal.

- G. After locks have been installed; show in presence of Resident Engineer that keys operate their respective locks in accordance with keying requirements.

3.3 FINAL INSPECTION

- A. Installer to provide letter to VA Resident/Project Engineer that upon completion, installer has visited the Project and has accomplished the following:
1. Re-adjust hardware.
 2. Evaluate maintenance procedures and recommend changes or additions, and instruct VA personnel.
 3. Identify items that have deteriorated or failed.
 4. Submit written report identifying problems.

3.4 HARDWARE SETS

- A. Following sets of hardware correspond to hardware sets shown on the Door Hardware Schedule in the drawings.

INTERIOR SINGLE DOORS

HW-5G

Each Door to Have:

NON-RATED

		QUANTITY & TYPE AS REQUIRED
1 ½ PR	Hinges	
1	Storeroom Lock	F07
1	Kick Plate	J102
1	Floor Stop	L02121 x 3 FASTENERS
1	Threshold	J32300 x 57 MM WIDTH (2-1/4 INCHES)
1	Auto Door Bottom	R0Y346 - HEAVY DUTY
2	Sets Self-Adhesive Seals	R0Y154
1	Closer	C02011/C02021

Note: Hinges and Auto Door Bottom shall be provided by the sound rated door manufacturer.

- - - E N D - - -

SECTION 09 67 23
EPOXY FLOOR COATING

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section specifies a multi-component, thin application, slip resistant epoxy coating system with aggregate broadcast, including a sealer and vapor control primer. System shall be installed in existing Boiler Room and existing Boiler Control Room and shall be coordinated with existing equipment and existing door thresholds and door swings.

1.2 SUBMITTALS

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Manufacturer's Literature and Data:
1. Description of each product to be provided.
 2. Application and installation instructions.
 3. Maintenance Instructions: Submit manufacturer's written instructions for recommended maintenance practices.
- C. Qualification Data: For Installer.
- D. Samples:
1. Provide sample of color and texture for approval by Owner.
 2. Samples shall be 6 inches square, applied to a rigid backing by installer.
 3. Sample showing construction from substrate to finish surface in thickness specified and color and texture of finished surfaces. Finished flooring must match the approved samples in color and texture.
- E. Shop Drawings: Include plans, sections, component details, and coordination with existing equipment and existing door thresholds and door swings.
- F. Work Plan:
1. Submit a written plan and schedule describing in detail all phases of the coating operations and in its impact on the Boiler Room and Boiler Control Room operations.

2. Address work sequencing, surface preparation, flooring system application, and cure time projections, as well as how each step will be controlled, tested and evaluated.
3. Address safety measures.

G. Certifications and Approvals:

1. Manufacturer's certification of material and substrate compliance with specification.
2. Manufacturer's approval of installer.
3. Contractor's certificate of compliance with Quality Assurance requirements.

H. Warranty: As specified in this section.

1.3 QUALITY ASSURANCE

- A. Manufacture Certificate: Manufacture shall certify that a particular epoxy floor coating system has been manufactured and in use for a minimum of five (5) years.
- B. Installer Qualifications: Engage an experienced installer (applicator) who is experienced in applying epoxy floor coating systems similar in material, design, and extent to those indicated for this project for a minimum period of five (5) years, whose work has resulted in applications with a record of successful in-service performance, and who is acceptable to epoxy floor coating manufacturer.
1. Engage an installer who is certified in writing by epoxy floor coating manufacturer as qualified to apply epoxy floor coating systems indicated.
 2. Contractor shall have completed at least ten (10) projects of similar size and complexity. Include list of at least five (5) projects. List must include owner (purchaser); address of installation, contact information at installation project site; and date of installation.
 3. Installer's Personnel: Employ persons trained for application of specified product.
- C. Source Limitations:
1. Obtain primary epoxy floor coating materials including primers, resins, hardening agents, aggregates, and finish and sealing coats from a single manufacturer.
 2. Provide secondary materials, including patching and fill material, joint sealant, and repair material of type and from source recommended by manufacturer of primary materials.

- D. Mockups: Apply mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and establish quality standards for materials and execution.
1. Apply full-thickness mockups on 48 inch square floor area selected by Owner.
 2. Mock-ups shall demonstrate range of textures per manufacturer's recommendations to satisfy Owner's intent for slip resistance and maintenance/cleaning. Final texture shall be selected by Owner.
 3. Approved mockups not damaged during the testing may become part of the completed work if undisturbed at time of Substantial Completion.
 4. Sign off from Owner on texture for slip resistance and clean ability must be complete before installation of flooring system.
- E. Pre-Installation Conference:
1. Convene a meeting not less than thirty days prior to starting work.
 2. Attendance:
 - a. Contractor
 - b. Owner
 - c. Manufacturer and Installer's Representative
 3. Review the following:
 - a. Environmental requirements
 - 1) Air and surface temperature
 - 2) Relative humidity
 - 3) Ventilation
 - 4) Dust and contaminants
 - b. Protection of surfaces not scheduled to be coated
 - c. Inspect and discuss condition of substrate and other preparatory work performed
 - d. Review and verify availability of material; installer's personnel, equipment needed
 - e. Design and edge conditions.
 - f. Performance of the coating with chemicals anticipated in the area receiving the epoxy floor coating system
 - g. Application and repair
 - h. Field quality control
 - i. Cleaning
 - j. Protection of coating systems
 - k. One-year inspection and maintenance
 - l. Coordination with other work

- F. Manufacturer's Field Services: Manufacturer's representative shall provide technical assistance and guidance for surface preparation and application of epoxy floor coating systems.
- G. Contractor Job Site Log: Contractor shall document daily; the work accomplished environmental conditions and any other condition event significant to the long term performance of the epoxy flooring materials installation. The Contractor shall maintain these records for one year after Substantial Completion.

1.4 MATERIAL PACKAGING DELIVERY AND STORAGE

- A. Deliver materials to the site in original sealed packages or containers, clearly marked with the manufacturer's name or brand, type and color, production run number and date of manufacture.
- B. Protect materials from damage and contamination in storage or delivery, including moisture, heat, cold, direct sunlight, etc.
- C. Maintain temperature of storage area based on manufacturer's recommendations/requirements.
- D. Keep containers sealed until ready for use.
- E. Do not use materials beyond manufacturer's shelf life limits.

1.5 PROJECT CONDITIONS

- A. Environmental Limitations: Comply with epoxy floor coating manufacturer's written instructions for substrate temperature, ambient temperature, moisture, ventilation, and other conditions affecting epoxy floor coating applications.
- B. Close spaces to traffic during epoxy floor coating application and for not less than 24 hours after application, unless manufacturer recommends a longer period.
- C. Concrete substrate shall be properly prepped per manufacturer's standards including the shot blasting or power scarification of the existing concrete slab and the application of a vapor control primer over the existing concrete slab with no vapor barrier.
- D. Ensure all employees are trained in all aspects of safety measures, following the manufacturer's written safety precautions throughout mixing, application, and curing.

1.6 WARRANTY

- A. Work subject to the terms of the Article "Warranty of Construction" FAR clause 52.246-21.

- B. Warranty: Manufacture shall furnish a single, written warranty covering the full assembly for both material and workmanship for a extended period of three (3) full years from date of installation, or provide a joint and several warranty signed on a single document by manufacturer and applicator jointly and severally warranting the materials and workmanship for a period of three (3) full years from date of installation. A sample warranty letter must be included with bid package or bid may be disqualified.

1.7 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. American Society for Testing and Materials (ASTM):
- D412-06a.....Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers - Tension
 - D522 (2008).....Standard Test Methods for Mandrel Bend Test of Attached Organic Coatings
 - D624 (2012).....Standard Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers
 - D638-10.....Standard Test Method for Tensile Properties of Plastics
 - D695-10.....Standard Test Method for Compressive Properties of Rigid Plastics
 - D1308-02(2007).....Standard Test Method for Effect of Household Chemicals on Clear and Pigmented Organic Finishes
 - D1652-11.....Standard Test Method for Epoxy Content of Epoxy Resins
 - D2047.....Standard Test Method for Static Coefficient of Friction of Polish-Coated Flooring Surfaces as Measured by the James Machine
 - D2240-05.....Standard Test Method for Rubber Property - Durometer Hardness
 - D2794.....Standard Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact)
 - D3359-09.....Standard Test Method for Measuring Adhesion by Tape Test

- D4060-10.....Standard Test Method for Abrasion Resistance of
Organic Coatings by the Taber Abraser
- D4541-09.....Standard Test Method for Pull-Off Strength of
Coatings Using Portable Adhesion Testers
- E96-10.....Standard Test Methods for Water Vapor
Transmission of Materials
- E162-12a.....Standard Test Method for Surface Flammability of
Materials Using a Radiant Heat Energy Source
- F1869-11.....Standard Test Method for Measuring Moisture
Vapor Emission Rate of Concrete Subfloor Using
Anhydrous Calcium Chloride
- G21-09.....Standard Practice for Determining Resistance of
Synthetic Polymeric Materials to Fungi
- C. Military Specification (Mil Spec):
 - MIL-PRF-24667A.....Para. 4.6.12, Immersion Resistance
- D. National Fire Protection Association (NFPA):
 - 56A.....Inhalation Aesthetics replaced by NFPA 99
Standard for Health Care Facilities
- E. The Society For Protective Coatings (SSPC):
 - SP6.....Commercial Blast Cleaning

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION FOR EPOXY FLOOR COATING

- A. System Descriptions:
 - 1. Monolithic, multi-component, thin application, epoxy floor coating system including primer with vapor control for existing concrete slabs without a vapor barrier; high performance, durable, low-odor multi-component solvent free epoxy undercoat with quick dry-time and pre-engineered skid resistant aggregate broadcast media; and high performance epoxy and solvent free sealers.
- B. Products: Subject to compliance with applicable fire, health, environmental, and safety requirements for storage, handling, installation, and clean up.
- C. System Components: Verify specific requirements as systems vary by manufacturer. Verify build up layers of broadcast and installation method. Verify compatibility with substrate. Use manufacturer's standard components, compatible with each other and as follows:

1. Primer with Vapor Control, Negative Side Moisture Vapor Suppression System (primer coat):
 - a. Basis of Design: DEX-O-TEX VaporControl Primer 200 or approved equal which satisfies manufacturer's recommendations for vapor block/primer for existing concrete slabs without below slab vapor barrier.
 - b. Resin: Epoxy.
 - c. Application Method: Notched squeegee and nap roller.
 - d. Thickness of coat(s): 7 mils.
 - e. Number of Coats: One.
2. Undercoat: (body coat)
 - a. Basis of Design: DEX-O-TEX Posi-Tred O Epoxy Coating or approved equal.
 - b. Resin: Epoxy.
 - c. Formulation Description: Pigmented multi-component, high solids.
 - d. Application Method: Trowel, squeegee or roller.
 - e. Number of Coats: One.
 - f. Type / Finish: As selected by Owner from manufacturer's standards.
 - g. Thickness of coat(s): Ranges from 6 mil to 65 mils based on selected profile and aggregate density, as chosen by Owner through manufacturer's mock-up.
 - h. Number of Coats: One.
3. Aggregate: (broadcast)
 - a. Basis of Design: DEX-O-TEX pre-engineered aluminum oxide skid resistant.
 - b. Aggregate density and type: Selected by Owner from mock-up review which demonstrates manufacturer's texture recommendations.
 - c. Application Method: manufacturer's spray caster, broadcast into wet epoxy primer or undercoat per manufacturer's standards.
4. Sealer coat:
 - a. Basis of Design: DEX-O-TEX Quik-Glaze or approved equal.
 - b. Formulation Description: High solids, UV stable.
 - c. Type/Finish: As selected by Owner from manufacturer's standards.
 - d. Thickness of coat(s): 7 mils.
 - e. Number of Coats: One.
 - f. Application: Squeegees or rollers.

D. Physical Properties of Basis of Design:

1. Physical Properties of Primer Coat when tested at 75°F as follows:

Property	Test	Value
Adhesion	ASTM D4541	> 400 psi
Compressive Strength	ASTM D695	12,000 psi
Tensile Strength	ASTM D638	4,200 psi
Tensile Elongation	ASTM D638	2.7%
Alkali Resistance	ASTM D1308	Resistant
Moisture Vapor Emissivity	ASTM E96	0.158 Perms
Microbial Resistance	ASTM G21	Passes Rating 1

2. Physical Properties of Body Coat when tested at 75°F as follows:

Property	Test	Value
Tensile Strength	ASTM D638	1,200 psi
Adhesion	ASTM D4541	> 400 psi
Adhesion	ASTM D3359 (cross hatch)	No loosening
Immersion Resistance	MIL-PRF-24667A Para. 4.6.12	No softening, loss of adhesion, or other form of deterioration
Fire Resistance	ASTM E162	Flame Spread Index: 0 Smoke Deposited: 2 mg
Hardness	ASTM D2240 Shore D	75 to 80
Microbial Resistance	ASTM G21	Passes Rating 1

3. Physical Properties of Sealer Coat when tested at 75°F as follows:

Property	Test	Value
Tear Strength	ASTM D624, Die C	879 lb/in
Flexibility (180 degree bend, 1/8" Mandrel)	ASTM D522	Passes
Tensile Strength	ASTM D412	2,400 psi
Tensile Elongation	ASTM D412	100%
Taber Abrasion (CS17 Wheel, 1000g Load, 1000 Cycles)	ASTM D4060	8 mg loss
Impact Resistance	ASTM D2794	Direct: 160 in/lbs Reverse: 160 in/lbs
Hardness	ASTM D2240 Shore A	85 to 90
Solid Percent by Weight	-	95%
Dry Time 50% Relative Humidity	-	Surface Dry: 5 hours Hard Dry: 12 hours
Coefficient of Friction (Slip Resistance with leather footwear)	ASTM D2047	0.67 dry 0.82 wet
Microbial Resistance	ASTM G21	Passes Rating 1

E. System Characteristics:

1. Color and Pattern: As selected by Owner from manufacturer's standard colors.
2. Density of aggregate broadcast: As selected by Owner from mock-up review based on manufacturer's recommendations.
3. Overall System Thickness: See System Component thickness ranges under paragraph 2.1.C. Final thickness shall be coordinated with existing equipment and existing door thresholds and door swings.

2.2 SUPPLEMENTAL MATERIALS

- A. Joint Sealant: Type recommended or produced by epoxy floor coating manufacturer where required.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine the areas and conditions where epoxy flooring system is to be installed with the Owner.
- B. Moisture Vapor Emission Testing: Perform moisture vapor transmission testing in accordance with ASTM F1869 to determine the MVER of the substrate prior to commencement of the work. Refer to manufacturer's standards for requirements and procedures if moisture vapor transmission exceeds use of primer with vapor control.

3.2 PROJECT CONDITIONS

- A. Maintain temperature of rooms (air and surface) where work occurs, as required by manufacturer's standards.
- B. Maintain relative humidity as required by manufacturer's standards.
- C. Maintain proper ventilation of the area during application and curing time period.
 - 1. Comply with infection control measures of the VA Medical Center.

3.3 INSTALLATION REQUIREMENTS

- A. The manufacturer's instructions for application and installation shall be reviewed with the Owner.
- B. Substrate shall be approved by manufacturer's technical representative.

3.4 PREPARATION

- A. General: Prepare and clean substrates according to epoxy floor coating manufacturer's written instructions for substrate indicated. Provide clean and dry substrate for epoxy floor coating application.
- B. Concrete Substrates: Provide sound concrete surfaces free of laitance, glaze, efflorescence, curing compounds, form-release agents, dust, dirt, grease, oil, and other contaminants incompatible with epoxy floor primer and coating.
 - 1. Prepare concrete substrates as follows:
 - a. Shot-blast surfaces with an apparatus that abrades the concrete surface, contains the dispensed shot within the apparatus, and recirculates the shot by vacuum pickup.
 - b. Comply with manufacturer's written instructions and requirements for existing concrete slab preparation.
 - 2. Repair damaged and deteriorated concrete according to epoxy floor coating manufacturer's written recommendations.

3. Verify that concrete substrates are ready for primer application. Perform all testing as required by manufacturer's written instructions.
 4. Verify that existing equipment, door thresholds, and door swings have not been compromised by manufacturer's recommended overall epoxy floor coating system thickness.
 5. Verify that epoxy floor coating will adhere to concrete substrates. Perform tests recommended by manufacturer. Proceed with application only after substrates pass testing.
- C. Epoxy Floor Coating Materials: Mix components and prepare materials according to epoxy floor coating manufacturer's written instructions.
- D. Use patching and fill material to fill holes and depressions in substrates according to manufacturer's written instructions.
- E. Treat control joints and other nonmoving substrate cracks to prevent cracks from reflecting through epoxy floor coating according to manufacturer's written recommendations. Allowances should be included for flooring manufacturer recommended joint fill material, and concrete crack treatment.

3.5 APPLICATION

- A. General:** Apply components of epoxy floor coating system according to manufacturer's written instructions to produce a uniform, monolithic wearing surface of thickness indicated.
1. Coordinate application of components to provide optimum adhesion of epoxy floor coating system to substrate, and optimum intercoat adhesion.
 2. Cure epoxy floor coating components according to manufacturer's written instructions. Prevent contamination during application and curing processes.
 3. Determine existence of expansion or isolation joints. Where substrate expansion and isolation joints occur, provide joint in epoxy floor coating to comply with epoxy floor coating manufacturer's written recommendations.
 - a. Apply joint sealant to comply with manufacturer's written recommendations.
- B. Apply Primer: Over prepared substrate at manufacturer's recommended spreading rate. Apply primer with vapor control as required for existing concrete slabs without vapor barrier, per manufacturer's recommendations.
- C. Apply Body Coat: Mix material according to manufacturer's recommended procedures and spread rate.

- D. Broadcast Aggregate: Immediately broadcast aggregate using manufacturer's spray caster. Strict adherence to manufacturer's installation procedures and coverage rates is imperative.
- E. Apply Sealer: Remove excess un-bonded aggregate by lightly brushing and vacuuming the floor surface. Mix and apply sealer with strict adherence to manufacturer's installation procedures.

3.6 CURING, PROTECTION AND CLEANING

- A. Cure epoxy floor coating materials in compliance with manufacturer's directions, taking care to prevent contamination during stages of application and prior to completion of curing process.
- B. Close area of application for a minimum of 24 hours or longer if recommended by manufacturer. Coordinate with Owner.
- C. Protect epoxy floor coating materials from damage and wear during construction operation.
 - 1. Cover flooring with kraft type paper.
 - 2. Optional 1/4 inch thick hardboard, plywood, or particle board where area is in foot or vehicle traffic pattern, rolling or fixed scaffolding and overhead work occurs.
- D. Remove temporary covering and clean epoxy floor coating just prior to final inspection. Use cleaning materials and procedures recommended by epoxy floor coating manufacturer.

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SECTION 09 91 00
PAINTING

PART 1-GENERAL

1.1 DESCRIPTION

- A. Section specifies field painting.
- B. Section specifies prime coats which may be applied in shop under other sections.
- C. Painting includes mechanical identity markings.

1.2 RELATED WORK

- A. Shop prime painting of steel and ferrous metals: Division 08 - OPENINGS, Division 23 - HEATING, VENTILATION AND AIR-CONDITIONING, and Division 26 - ELECTRICAL sections.

1.3 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, or sample panels are prepared, 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. The Contractor may choose to use subsequent MPI "Approved Product List", however, only one list may be used for the entire contract and each coating system is to be from a single manufacturer. All coats on a particular substrate must be from a single manufacturer. No variation from the MPI "Approved Product List" where applicable is acceptable.
- C. Sample Panels:
 - 1. After painters' materials have been approved and before work is started submit sample panels showing each type of finish and color specified.
 - 2. Panels to show color: Composition board, 100 by 250 by 3 mm (4 inch by 10 inch by 1/8 inch).
 - 3. Attach labels to panel stating the following:
 - a. Federal Specification Number or manufacturers name and product number of paints used.
 - b. Product type and color.
 - c. Name of project.

4. Strips showing not less than 50 mm (2 inch) wide strips of undercoats and 100 mm (4 inch) wide strip of finish coat.
- D. Sample of identity markers.
- E. Manufacturers' Certificates indicating compliance with specified requirements:
 1. Manufacturer's paint substituted for Federal Specification paints meets or exceeds performance of paint specified.

1.4 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).

1.5 MOCK-UP PANEL

- A. Before starting apply paint as specified to an area, not to exceed 100 ft², selected by Owner.
- B. Finish and texture approved by Owner will be used as a standard of quality for remainder of work.

1.6 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-2008.....Threshold Limit Values (TLV) for Chemical
Substances and Physical Agents and Biological
Exposure Indices (BEIs)
- ACGIH TLV-DOC-2008.....Documentation of Threshold Limit Values and
Biological Exposure Indices, (Seventh Edition)
- C. American National Standards Institute (ANSI):
- A13.1-07.....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)
- F. Master Painters Institute (MPI):
- No. 4-07.....Interior/ Exterior Latex Block Filler
- No. 22-07.....Aluminum Paint, High Heat (up to 590° - 1100F)
(HR)
- No. 47-07.....Interior Alkyd, Semi-Gloss, MPI Gloss Level 5 (AK)
- No. 54-07.....Interior Latex, Semi-Gloss, MPI Gloss Level 5 (LE)
- No. 95-07.....Fast Drying Metal Primer
- G. Steel Structures Painting Council (SSPC):
- SSPC SP 1-04 (R2004)....Solvent Cleaning
- SSPC SP 2-04 (R2004)....Hand Tool Cleaning
- SSPC SP 3-04 (R2004)....Power Tool Cleaning

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Zero or low VOC interior paint, color as selected and approved by Owner.

2.2 PAINT PROPERTIES

- A. Use ready-mixed (including colors), except two component epoxies, polyurethanes, polyesters, 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/QUALITY ASSURANCE

- 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 10g/l for interior latex paints/primers.
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. Use high performance acrylic paints in place of alkyd paints, where possible.
7. VOC content for solvent-based paints shall not exceed 250g/l and shall not be formulated with more than one percent aromatic hydro carbons by weight.

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 day's 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. Do not paint in direct sunlight or on surfaces that the sun will soon warm.
4. Apply only on clean and dry surfaces.

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. 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. Masonry:
 1. Clean and remove dust, dirt, oil, grease efflorescence, form release agents, laitance, and other deterrents to paint adhesion.
 2. Use emulsion type cleaning agents to remove oil, grease, paint and similar products. Use of solvents, acid, or steam is not permitted.
 3. Remove loose mortar in masonry work.
 4. Replace mortar and fill open joints, holes, cracks and depressions with new mortar. Finish to match adjacent surfaces.

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 Owner.
- E. Finish surfaces to show solid even color, free from runs, lumps, brush marks, 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 Owner.
 - 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 motors, controls, telephone, and electrical equipment, and other recessed equipment and similar prefinished items.
- H. Do not paint in closed position operable items such as access doors and panels, 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.
- C. Additional field applied prime coats over shop or factory applied prime coats are not required.
- D. Metals:
 - Steel: MPI 95 (Fast Drying Metal Primer).
- E. Existing Concrete Masonry and Interior Surfaces of Existing Ceilings:
 - 1. MPI 4 (Block Filler) on all non-painted CMU interior surfaces.
 - 2. MPI 54 (Interior Latex, Semi-Gloss, MPI Gloss Level 5 (LE)).

3.6 INTERIOR FINISHES

- A. Apply following finish coats over prime coats in spaces or on surfaces.
- B. Metal Work:
 - 1. Apply to exposed surfaces.
 - 2. Apply two coats of MPI 47 (Interior Alkyd, Semi-Gloss (AK)).
 - 3. At Counter Top Supports: as indicated in section 06 61 16 SOLID POLYMER (SOLID SURFACING) FABRICATIONS.
 - 4. At Doors, Door Frames, and Existing Window Frames: Match existing doors and frames in Boiler Room. Color from manufacturer's standard colors.
 - 5. At Existing Ceiling Mounted A/C Units: Color to match ceiling.
- C. Existing Masonry Walls and Ceiling:
 - 1. Over MPI 4 (Interior Latex Block Filler) on all non-painted existing CMU surfaces.
 - 2. Two coats of MPI 54 (Interior Latex, Semi-Gloss, MPI Gloss Level 5 (LE)).
 - 3. Color from manufacturer's standards, as selected by Owner.

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 to match existing 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. Refinish areas as specified for new work to match adjoining work unless specified or scheduled otherwise.
- G. Sand or dull glossy surfaces prior to painting.
- H. 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. Paint color as selected by Owner.
- 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 Division 23 - HEATING, VENTILATION AND AIR-CONDITIONING, and Division 26 - ELECTRICAL.
- C. Paint after tests have been completed.
- D. Omit prime coat from factory prime-coated items.
- E. Color: Refer to
- F. Apply paint systems on properly prepared and primed surface as follows:
 1. Interior Locations:
 - a. Apply two coats of MPI 47 (Interior Alkyd, Semi-Gloss (AK)) to following items:
 - 1) Metal under 94 degrees C (200 degrees F) of items such as bare piping, fittings, hangers and supports.
 - 2) Equipment and systems such as hinged covers and frames for control cabinets and boxes, electric conduits and panel boards.
 - 3) Heating, ventilating, air conditioning, and machinery having shop prime coat and not factory finished.
 - b. Apply two coats of MPI 22 (High Heat Resistant Coating (HR)) to ferrous metal surface over 94 degrees K (200 degrees F) of following items:
 - 1) Exterior of boilers and ferrous metal in connection with boiler settings including supporting members, doors and door frames and fuel oil burning equipment.

3.10 IDENTITY PAINTING SCHEDULE

- A. Identify designated service in accordance with ANSI A13.1, unless specified otherwise, on exposed piping.
 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:

PIPING	COLOR OF EXPOSED PIPING	COLOR OF LETTERS	LEGEND ABBREVIATIONS
LPG	White	Black	LPG
Boiler Feedwater	Yellow	Black	Blr Feed
Boiler Compressed Air	Green	White	Blr Air
Fuel Oil	Orange	Black	Fuel Oil No. 2
Vent Line	Yellow	Black	Vent
Fuel Gas	Yellow	Black	Gas

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 23 05 10
COMMON WORK RESULTS FOR BOILER PLANT AND STEAM GENERATION

PART 1 - GENERAL

1.1 DESCRIPTION

- A. The requirements of this Section apply to all sections of Division 23 related to boiler plant and steam generation.
- 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

1.2 RELATED WORK

- A. Section 01 00 00, GENERAL REQUIREMENTS.
- B. Section 07 92 00, JOINT SEALANTS.
- C. Section 09 91 00, PAINTING.
- H. Section 23 05 12, GENERAL MOTOR REQUIREMENTS FOR HVAC and STEAM GENERATION.
- I. Section 23 05 51, NOISE AND VIBRATION CONTROL FOR BOILER PLANT.
- J. Section 23 08 11, DEMONSTRATIONS and TESTS FOR BOILER PLANT.
- K. Section 23 09 11, INSTRUMENTATION and CONTROL FOR BOILER PLANT.
- L. Section 23 21 11, BOILER PLANT PIPING SYSTEMS.
- M. Section 23 52 33, WATER-TUBE BOILERS.
- N. Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS: Requirements for commissioning, systems readiness checklists, and training.
- O. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS
- P. Section 26 29 11, LOW-VOLTAGE MOTOR STARTERS.

1.3 QUALITY ASSURANCE

- A. Mechanical, electrical and associated systems shall be safe, reliable, efficient, durable, easily and safely operable and maintainable, easily and safely accessible, and in compliance with applicable codes as specified. The systems shall be comprised of high quality institutional-class and industrial-class products of manufacturers that are experienced specialists in the required product lines. All construction firms and personnel shall be experienced and qualified specialists in industrial and institutional HVAC or steam boiler plant construction, as applicable.
- B. Products Criteria:
 - 1. Standard Products: Material and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of

the products for at least 3 years (or longer as specified elsewhere). The design, model and size of each item shall have been in satisfactory and efficient operation on at least three installations for approximately three years. However, digital electronics devices, software and systems such as controls, instruments, computer work station, shall be the current generation of technology and basic design that has a proven satisfactory service record of at least three years. See other specification sections for any exceptions and/or additional requirements.

2. 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).
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.

C. Equipment Service Organizations:

1. Boiler Plants: Service organizations, authorized and trained by the 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 personnel and 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.
- D. 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.
- E. Boiler Plant Welding: Refer to Section 23 21 11, BOILER PLANT PIPING SYSTEMS.
- F. 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 Resident Engineer for resolution. Provide written hard copies or computer files of manufacturer's installation instructions to the Resident Engineer 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 Resident Engineer 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.
- G. Upon request by Government, provide lists of previous installations for selected items of equipment. Include contact persons who will serve as references, with telephone numbers and e-mail addresses.

1.4 SUBMITTALS

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES, and with requirements in the individual specification sections.
- B. Contractor shall make all necessary field measurements and investigations to assure that the equipment and assemblies will meet contract requirements.
- C. If equipment is submitted which differs in arrangement from that shown, provide drawings that show the rearrangement of all associated systems. Approval will be given only if all features of the equipment and associated systems, including accessibility, are equivalent to that required by the contract.
- D. Prior to submitting shop drawings for approval, contractor shall certify in writing that manufacturers of all major items of equipment have each reviewed drawings and specifications, and have jointly coordinated and properly integrated their equipment and controls to provide a complete and efficient installation.
- E. Submittals and shop drawings for interdependent items, containing applicable descriptive information, shall be furnished together and complete in a group. Coordinate and properly integrate materials and equipment in each group to provide a completely compatible and efficient installation. Final review and approvals will be made only by groups.
- F. Submittal "Groups" for boiler plant work are defined in the following checklist:
 - 1. Group II (Burner Fuel Oil Systems):
 - a. Fuel oil pumping system.
 - b. Pressure control and relief valves.
 - 3. Group III: Burners including forced draft fan and motor controls, boiler accessories (trim), fuel valve trains, atomizing media valve trains.
 - 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, instruments and accessories, computer workstation and software, instrumentation, tools.
 - 5. Group VI (Feedwater System):
 - a. Boiler feed pumps, couplings, motors, motor controls and accessories.
 - 7. Group VII (Temporary Boiler Plant Equipment):
 - a. Boilers.

- b. Burners.
 - c. Controls.
 - d. Instruments.
 - e. Other Equipment.
- G. 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. Emergency shut off valve - gas.
 - 6. Sight flow indicators, oil and water.
 - 7. Thermometers and pressure gauges and accessories.
 - 8. Gas pressure regulators, relief valves, and filters.
 - 9. Flexible connectors, hose, braided.
 - 10. Dielectric fittings and unions.
 - 11. Supports and braces for pipe, stacks, breeching; load, size, movement calculations.
 - 12. Pressure gauge test kit.
 - 13. Earthquake valves - gas.
- H. 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.
- I. Manufacturer's Literature and Data: Submit under the pertinent section rather than under this section.
- 1. Submit electric motor data and variable speed drive data with the driven equipment.
 - 2. Equipment and materials identification.
 - 3. 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.

J. 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.

K. Boiler Plant Maintenance Data and Operating Instructions:

1. Provide four bound copies. Deliver to Resident Engineer 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.
 13. Step-by-Step written instructions that are specific for the system installed on testing all safety devices. The instructions should reference the most recent edition of the VHA BOILER PLANT SAFETY DEVICE TESTING MANUAL for each test. All safety devices listed in the manual shall be tested as a minimum.
- L. 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. American National Standard Institute (ANSI):
 - B31.1-2007.....Power Piping
- C. Rubber Manufacturers Association (ANSI/RMA):
 - IP-20-2007.....Specifications for Drives Using Classical
V-Belts and Sheaves
 - IP-21-2009.....Specifications for Drives Using Double-V
(Hexagonal) Belts
 - IP-22-2007.....Specifications for Drives Using Narrow V-Belts
and Sheaves
- D. Air Movement and Control Association (AMCA):
 - 410-96.....Recommended Safety Practices for Air Moving
Devices
- E. 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:
 - B31.1-2007.....Power Piping
- F. American Society for Testing and Materials (ASTM):
 - A36/A36M-08.....Standard Specification for Carbon Structural
Steel
 - A575-96(2007).....Standard Specification for Steel Bars, Carbon,
Merchant Quality, M-Grades
 - E84-10.....Standard Test Method for Surface Burning
Characteristics of Building Materials
 - E119-09c.....Standard Test Methods for Fire Tests of Building
Construction and Materials
- G. Manufacturers Standardization Society (MSS) of the Valve and Fittings
Industry, Inc:
 - SP-58-2009.....Pipe Hangers and Supports-Materials, Design and
Manufacture, Selection, Application, and
Installation
 - SP 69-2003.....Pipe Hangers and Supports-Selection and
Application
- I. National Electrical Manufacturers Association (NEMA):
 - MG-1-2009.....Motors and Generators
- J. National Fire Protection Association (NFPA):
 - 31-06.....Standard for Installation of Oil-Burning
Equipment
 - 54-09.....National Fuel Gas Code
 - 70-08.....National Electrical Code

85-07.....Boiler and Combustion Systems Hazards Code

90A-09.....Standard for the Installation of Air
Conditioning and Ventilating Systems

101-09.....Life Safety Code

1.6 DELIVERY, STORAGE AND HANDLING

A. Protection of Equipment:

1. Equipment and material placed on the job site shall remain in the custody of the Contractor until phased acceptance, whether or not the Government has reimbursed the Contractor for the equipment and material. The Contractor is solely responsible for the protection of such equipment and material against any damage.
2. Place damaged equipment in first class, new operating condition; or, replace same as determined and directed by the Resident Engineer. 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 Resident Engineer 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 Resident Engineer.
- 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.
- G. Temporary Facilities: Refer to Article, TEMPORARY PIPING AND EQUIPMENT in this section.

PART 2 - PRODUCTS

2.1 FACTORY-ASSEMBLED PRODUCTS

- A. Provide maximum standardization of components to reduce spare part requirements.
- B. Manufacturers of equipment assemblies that include components made by others shall assume complete responsibility for final assembled unit.
 - 1. All components of an assembled unit need not be products of same manufacturer.
 - 2. Constituent parts that are alike shall be products of a single manufacturer.

3. Components shall be compatible with each other and with the total assembly for intended service.
4. Contractor shall guarantee performance of assemblies of components, and shall repair or replace elements of the assemblies as required to deliver specified performance of the complete assembly.
- C. Components of equipment shall bear manufacturer's name and trademark, model number, serial number and performance data on a name plate securely affixed in a conspicuous place, or cast integral with, stamped or otherwise permanently marked upon the components of the equipment.
- D. Major items of equipment, which serve the same function, must be the same make and model. Exceptions will be permitted if performance requirements cannot be met.

2.2 COMPATIBILITY OF RELATED EQUIPMENT

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 ELECTRIC MOTORS

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

2.4 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 shall be rated for 100 percent output performance. Multiple units of the same class of equipment, i.e. pumps shall be product of a single manufacturer.
- C. Motors shall be premium efficiency type and be approved by the motor controller manufacturer. The controller-motor combination shall be guaranteed to provide full motor nameplate horsepower in variable frequency operation. Both driving and driven motor/fan sheaves shall be fixed pitch.
- D. Controller shall not add any current or voltage transients to the input AC power distribution system, DDC controls, sensitive medical equipment, etc., nor shall be affected from other devices on the AC power system.

E. Controller shall be provided with the following operating features and accessories:

1. Suitable for variable torque load.
2. Provide thermal magnetic circuit breaker or fused switch with external operator and incoming line fuses. Unit shall be rated for minimum 25,000 AIC. Provide AC input line reactors (3% impedance) and filters on incoming power line. Provide output line reactors on line between drive and motor where the distance between the breaker and motor exceeds 50 feet.

2.5 BOILER PLANT CONTROLS AND INSTRUMENTATION, COMPUTER WORKSTATION

- A. Provide, and place into proper operation, complete systems as specified in Section 23 09 11, INSTRUMENTATION AND CONTROL FOR BOILER PLANT. Furnish all hardware, software and programming to properly accomplish specified functions.
- B. 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.

2.7 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.
- 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. Boiler Plant: Provide for all valves.
 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.

2.8 PIPE AND EQUIPMENT SUPPORTS AND RESTRAINTS

- A. Pipe Hangers and Supports for Boiler Plant: Refer to Section 23 21 11, BOILER PLANT PIPING SYSTEMS.
- B. Pipe Supports: Comply with MSS SP-58. Type Numbers specified refer to this standard. For selection and application comply with MSS SP-69.
- C. 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.
- D. 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.
- E. Attachment to existing structure: Support from existing floor/roof frame.
- F. Attachment to Wood Construction: Wood screws or lag bolts.
- G. 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.
- H. 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.

I. Supports for Piping Systems:

1. 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.

2.9 SPECIAL TOOLS AND LUBRICANTS

- A. Furnish, and turn over to the Resident Engineer, 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.

2.10 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, and equipment. Locate piping, sleeves, inserts, hangers, 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. Equipment and Piping Support: Coordinate structural systems necessary for pipe and equipment support with pipe and equipment locations to permit proper installation.
- E. Location of pipe sleeves, trenches and chases shall be accurately coordinated with equipment and piping locations.
- F. 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 Resident Engineer 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 Resident Engineer. If the Contractor considers it necessary to drill through structural members, this matter shall be referred to Resident Engineer for approval.
 - 3. Do not penetrate membrane waterproofing.
- G. Interconnection of Instrumentation or Control Devices: Generally, electrical and pneumatic interconnections are not shown but must be provided.
- H. Minor Piping: Generally, small diameter pipe runs from drips and drains, water cooling, and other service are not shown but must be provided.
- I. 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.

J. 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.

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

L. Install steam piping expansion joints as per manufacturer's recommendations.

M. 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. 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.
4. 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.

5. Steam and Condensate Service Interruptions: Limited steam and condensate service interruptions, as required for interconnections of new and existing systems, will be permitted by the Resident Engineer during periods when the 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 Resident Engineer.
6. Phasing of Work: Comply with all requirements shown on drawings or specified.
7. 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.
8. 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.
9. Temporary Facilities: Refer to Article, TEMPORARY PIPING AND EQUIPMENT in this section.
10. 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.
- N. Switchgear/Electrical Equipment Drip Protection: Every effort shall be made to eliminate the installation of pipe above electrical and telephone switchgear. If this is not possible, encase pipe in a second

pipe with a minimum of joints. Installation of piping, ductwork, leak protection apparatus or other installations foreign to the electrical installation shall be located in the space equal to the width and depth of the equipment and extending from to a height of 1.8 m (6 ft.) above the equipment of to ceiling structure, whichever is lower (NFPA 70).

O. Inaccessible Equipment:

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

3.2 TEMPORARY PIPING AND EQUIPMENT

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

3.3 RIGGING

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

check structure adequacy and advise Contractor of recommended restrictions.

- E. Contractor shall check all clearances, weight limitations and shall offer a rigging plan designed by a Registered Professional Engineer. All modifications to structures, including reinforcement thereof, shall be at Contractor's cost, time and responsibility.
- F. Rigging plan and methods shall be referred to Resident Engineer 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 Resident Engineer.
- 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 Resident Engineer. Such access shall be provided without additional cost or time to the Government. Where work is in an operating plant, provide approved protection from dust and debris at all times for the safety of plant personnel and maintenance of plant operation and environment of the plant.
- B. In an operating facility, maintain the operation, cleanliness and safety. Government personnel will be carrying on their normal duties of operating, cleaning and maintaining equipment and plant operation. Confine the work to the immediate area concerned; maintain cleanliness and wet down demolished materials to eliminate dust. Do not permit debris to accumulate in the area to the detriment of plant operation. Perform all flame cutting to maintain the fire safety integrity of this plant. Adequate fire extinguishing facilities shall be available at all times. Perform all work in accordance with recognized fire protection standards. Inspection will be made by personnel of the VA Medical Center, and Contractor shall follow all directives of the RE or COTR with regard to rigging, safety, fire safety, and maintenance of operations.
- C. Completely remove all piping, wiring, conduit, and other devices associated with the equipment not to be re-used in the new work. This includes all pipe, valves, fittings, insulation, and all hangers including the top connection and any fastenings to building structural systems. Seal all openings, after removal of equipment, pipes, ducts,

and other penetrations in roof, walls, floors, in an approved manner and in accordance with plans and specifications where specifically covered. Structural integrity of the building system shall be maintained. Reference shall also be made to the drawings and specifications of the other disciplines in the project for additional facilities to be demolished or handled.

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

3.6 CLEANING AND PAINTING

- A. Prior to final inspection and acceptance of the plant and facilities for beneficial use by the Government, the plant facilities, equipment and systems shall be thoroughly cleaned and painted. Refer to Section 09 91 00, PAINTING.
- B. In addition, the following special conditions apply:
1. Cleaning shall be thorough. Use solvents, cleaning materials and methods recommended by the manufacturers for the specific tasks. Remove all rust prior to painting and from surfaces to remain unpainted. Repair scratches, scuffs, and abrasions prior to applying prime and finish coats.
 2. Material And Equipment Not To Be Painted Includes:
 - a. Motors, controllers, control switches, and safety switches.
 - b. Control and interlock devices.
 - c. Regulators.
 - d. Pressure reducing valves.
 - e. Control valves and thermostatic elements.
 - f. Lubrication devices and grease fittings.
 - g. Copper, brass, aluminum, stainless steel and bronze surfaces.
 - h. Valve stems and rotating shafts.
 - i. Pressure gauges and thermometers.
 - j. Glass.
 - k. Name plates.
 3. Control and instrument panels shall be cleaned, damaged surfaces repaired, and shall be touched-up with matching paint obtained from panel manufacturer.

4. Pumps, motors, steel and cast iron bases, and coupling guards shall be cleaned, and shall be touched-up with the same color as utilized by the pump manufacturer
5. 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. Feedwater -- 38 degrees C (100 degrees F) on insulation jacket surface and 120 degrees C (250 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 Resident Engineer in unopened containers that are properly identified as to application.

- C. Provide a separate grease gun with attachments for applicable fittings for each type of grease applied.
- D. All lubrication points shall be accessible without disassembling equipment, except to remove access plates.

3.10 COMMISSIONING

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

3.11 STARTUP AND TEMPORARY OPERATION

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

3.12 OPERATING AND PERFORMANCE TESTS

- A. Prior to the final inspection, perform required tests as specified in Section 01 00 00, GENERAL REQUIREMENTS, Article, TESTS, and Section 23 08 11, DEMONSTRATIONS AND TESTS FOR BOILER PLANT, 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.

3.13 DEMONSTRATIONS AND TESTS, TEMPORARY BOILER PLANT EQUIPMENT

- A. Test prior to placing in service.
- B. Demonstrate to Resident Engineer the proper operation of all equipment, instruments, operating and safety controls, and devices.
- C. Demonstrate to Resident Engineer 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.

3.14 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.

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

PART 1 - GENERAL

1.1 DESCRIPTION

- A. The requirements of this Section apply to all sections of Division 23.
- B. Definitions:
 - 1. Exposed: Piping, ductwork, and equipment exposed to view in finished rooms.
 - 2. Option or optional: Contractor's choice of an alternate material or method.
 - 3. 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 92 00, JOINT SEALANTS
- D. Section 09 91 00, PAINTING
- E. Section 23 05 12, GENERAL MOTOR REQUIREMENTS FOR HVAC and STEAM GENERATION
- F. Section 23 05 93, TESTING, ADJUSTING, and BALANCING FOR HVAC
- G. Section 23 07 11, HVAC and Boiler Plant Insulation
- H. Section 23 09 11, INSTRUMENTATION and CONTROL FOR BOILER PLANT
- I. Section 23 52 33, WATER-TUBE BOILERS
- J. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS
- K. Section 26 29 11, LOW-VOLTAGE MOTOR STARTERS

1.3 QUALITY ASSURANCE

- A. Mechanical, electrical and associated systems shall be safe, reliable, efficient, durable, easily and safely operable and maintainable, easily and safely accessible, and in compliance with applicable codes as specified. The systems shall be comprised of high quality institutional-class and industrial-class products of manufacturers that are experienced specialists in the required product lines. All construction firms and personnel shall be experienced and qualified specialists in industrial and institutional HVAC
- B. Products Criteria:
 - 1. Standard Products: Material and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of the products for at least 3 years (or longer as specified elsewhere). The design, model and size of each item shall have been in satisfactory and efficient operation on at least three installations

for approximately three years. 2. All items furnished shall be free from defects that would adversely affect the performance, maintainability and appearance of individual components and overall assembly.

3. Conform to codes and standards as required by the specifications. Conform to local codes, if required by local authorities such as the natural gas supplier, if the local codes are more stringent than those specified. Refer any conflicts to the Resident Engineer.
4. Multiple Units: When two or more units of materials or equipment of the same type or class are required, these units shall be products of one manufacturer.

C. 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 Resident Engineer for resolution. Provide written hard copies or computer files of manufacturer's installation instructions to the Resident Engineer 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.

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. Manufacturer's Literature and Data: Submit under the pertinent section rather than under this section.
 1. Equipment and materials identification.

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 Resident Engineer. Such repair or replacement shall be at no additional cost to the Government.

3. 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. Boilers shall be left clean following final internal inspection by Government insurance representative or inspector.
4. 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 BUILDING

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

beneficial use, the Contracting Officer will process necessary acceptance and the equipment will then be under the control and operation of Government personnel.

PART 2 - PRODUCTS

2.8 EQUIPMENT AND MATERIALS IDENTIFICATION

- A. Use symbols, nomenclature and equipment numbers specified, shown on the drawings and shown in the maintenance manuals. In addition, provide bar code identification nameplate for all equipment which will allow the equipment identification code to be scanned into the system for maintenance and inventory tracking. Identification for piping is specified in Section 09 91 00, PAINTING.
- 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.
- 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. Boiler Plant: Provide for all valves.
 - 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.

PART 3 - EXECUTION

3.7 IDENTIFICATION SIGNS

- A. Provide laminated plastic signs, with engraved lettering not less than 5 mm (3/16-inch) high, designating functions, for all equipment, switches, motor controllers, relays, meters, control devices, including automatic control valves. Nomenclature and identification symbols shall correspond to that used in maintenance manual, and in diagrams specified elsewhere. Attach by chain, adhesive, or screws.

- B. Factory Built Equipment: Metal plate, securely attached, with name and address of manufacturer, serial number, model number, size, performance.
- C. Pipe Identification: Refer to Section 09 91 00, PAINTING.

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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 common to more than one Section of Division 26.
- B. Section 26 29 11, LOW-VOLTAGE MOTOR STARTERS: Starters, control and protection for motors.
- C. Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS: Requirements for commissioning, systems readiness checklists, and training.

1.3 SUBMITTALS:

- A. In accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, submit the following:
- B. Shop Drawings:
 - 1. Provide documentation to demonstrate compliance with drawings and specifications.
 - 2. Include electrical ratings, efficiency, bearing data, power factor, frame size, dimensions, mounting details, materials, horsepower, voltage, phase, speed (RPM), enclosure, starting characteristics, torque characteristics, code letter, full load and locked rotor current, service factor, and lubrication method.
- C. Manuals:
 - 1. Submit simultaneously with the shop drawings, companion copies of complete installation, maintenance and operating manuals, including technical data sheets and application data.
- D. Certification: Two weeks prior to final inspection, unless otherwise noted, submit four copies of the following certification to the Resident Engineer:
 - 1. Certification that the motors have been applied, installed, adjusted, lubricated, and tested according to manufacturer published recommendations.
- E. Completed System Readiness Checklists provided by the Commissioning Agent and completed by the contractor, signed by a qualified technician and dated on the date of completion, in accordance with the requirements of Section 23 08 00 COMMISSIONING OF HVAC SYSTEMS.

1.4 APPLICABLE PUBLICATIONS:

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. National Electrical Manufacturers Association (NEMA):
 - MG 1-2006 Rev. 1 2009 ..Motors and Generators
 - MG 2-2001 Rev. 1 2007...Safety Standard for Construction and Guide for Selection, Installation and Use of Electric Motors and Generators
- C. National Fire Protection Association (NFPA):
 - 70-2008.....National Electrical Code (NEC)
- D. Institute of Electrical and Electronics Engineers (IEEE):
 - 112-04.....Standard Test Procedure for Polyphase Induction Motors and Generators
- E. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE):
 - 90.1-2007.....Energy Standard for Buildings Except Low-Rise Residential Buildings

PART 2 - PRODUCTS

2.1 MOTORS:

- A. For alternating current, fractional and integral horsepower motors, NEMA Publications MG 1 and MG 2 shall apply.
- B. All material and equipment furnished and installation methods shall conform to the requirements of Section 26 29 11, LOW-VOLTAGE MOTOR STARTERS; and Section 26 05 21, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW). Provide all electrical wiring, conduit, and devices necessary for the proper connection, protection and operation of the systems. Provide premium efficiency type motors as scheduled. Unless otherwise specified for a particular application, use electric motors with the following requirements.
- C. 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: 208-230/460 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 (Over 600V): Shall conform to NEMA Standards for connection to the nominal system voltage shown on the drawings.
- D. 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.
- E. Motors shall be designed for operating the connected loads continuously in a 40°C (104°F) environment, where the motors are installed, without exceeding the NEMA standard temperature rises for the motor insulation. If the motors exceed 40°C (104°F), the motors shall be rated for the actual ambient temperatures.
- F. Motor designs, as indicated by the NEMA code letters, shall be coordinated with the connected loads to assure adequate starting and running torque.
- G. Motor Enclosures:
 1. Shall be the NEMA types as specified and/or shown on the drawings.
 2. Where the types of motor enclosures are not shown on the drawings, they shall be the NEMA types, which are most suitable for the environmental conditions where the motors are being installed. Enclosure requirements for certain conditions are as follows:
 - a. Motors located outdoors, indoors in wet or high humidity locations, or in unfiltered airstreams shall be totally enclosed type.
 - b. Where motors are located in an NEC 511 classified area, provide TEFC explosion proof motor enclosures.

- c. Where motors are located in a corrosive environment, provide TEFC enclosures with corrosion resistant finish.
- 3. Enclosures shall be primed and finish coated at the factory with manufacturer's prime coat and standard finish.
- H. Special Requirements:
 - 1. Where motor power requirements of equipment furnished deviate from power shown on plans, provide electrical service designed under the requirements of NFPA 70 without additional time or cost to the Government.
 - 2. Assemblies of motors, starters, controls and interlocks on factory assembled and wired devices shall be in accordance with the requirements of this specification.
 - 3. Wire and cable materials specified in the electrical division of the specifications shall be modified as follows:
 - a. Wiring material located where temperatures can exceed 71 degrees C (160 degrees F) shall be stranded copper with Teflon FEP insulation with jacket. This includes wiring on the boilers.
 - b. Other wiring at boilers and to control panels shall be NFPA 70 designation THWN.
 - c. Provide shielded conductors or wiring in separate conduits for all instrumentation and control systems where recommended by manufacturer of equipment.
 - 4. Select motor sizes so that the motors do not operate into the service factor at maximum required loads on the driven equipment. Motors on pumps shall be sized for non-overloading at all points on the pump performance curves.
 - 5. Motors utilized with variable frequency drives shall be rated "inverter-duty" per NEMA Standard, MG1, Part 31.4.4.2. Provide motor shaft grounding apparatus that will protect bearings from damage from stray currents.
- I. Additional requirements for specific motors, as indicated in the other sections listed in Article 1.2, shall also apply.
- J. Energy-Efficient Motors (Motor Efficiencies): All permanently wired polyphase motors of 746 Watts (1 HP) or more shall meet the minimum full-load efficiencies as indicated in the following table. Motors of 746 Watts or more with open, drip-proof or totally enclosed fan-cooled enclosures shall be NEMA premium efficiency type, unless otherwise indicated. Motors provided as an integral part of motor driven

equipment are excluded from this requirement if a minimum seasonal or overall efficiency requirement is indicated for that equipment by the provisions of another section. Motors not specified as "premium efficiency" shall comply with the Energy Policy Act of 2005 (EPACT).

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

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

PART 3 - EXECUTION

3.1 INSTALLATION:

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

3.2 FIELD TESTS

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

3.3 STARTUP AND TESTING

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

3.4 COMMISSIONING

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

3.5 DEMONSTRATION AND TRAINING

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

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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, motors and steam turbines.

1.2 RELATED WORK

- A. Section 23 05 10, COMMON WORK RESULTS FOR BOILER PLANT and STEAM GENERATION
- B. Section 23 21 11, BOILER PLANT PIPING SYSTEMS: Vibration isolators
- C. Section 23 08 11, DEMONSTRATIONS and TESTS FOR BOILER PLANT
- D. Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS. Requirements for commissioning, systems readiness checklists, and training

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 (NOT USED)

PART 3 - EXECUTION

3.1 BALANCING AND ALIGNMENT OF ROTATING EQUIPMENT

Statically and dynamically balance all fans. Align shafts of fans 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).
- 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.

3.3 SOUND LEVELS

- A. Sound level limitations apply to Boiler No. 3 burners, fans, blowers, control valves, pressure reducing valves, motors.
- B. Sound levels shall not exceed 75 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.

3.4 COMMISSIONING

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

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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. Systems Readiness Report.
 - 5. Balancing water distribution systems; adjustment of total system to provide design performance; and testing performance of equipment and automatic controls.
 - 6. Recording and reporting results.
- B. Definitions:
 - 1. Basic TAB used in this Section: Chapter 37, "Testing, Adjusting and Balancing" of 2007 ASHRAE Handbook, "HVAC Applications".
 - 2. TAB: Testing, Adjusting and Balancing; the process of checking and adjusting HVAC systems to meet design objectives.
 - 3. AABC: Associated Air Balance Council.
 - 4. NEBB: National Environmental Balancing Bureau.
 - 5. Hydronic Systems: Includes boiler feedwater.

1.2 RELATED WORK

- A. Section 23 05 10, COMMON WORK RESULTS FOR BOILER PLANTS and STEAM GENERATION: General Mechanical Requirements.
- B. Section 23 52 33, WATER-TUBE BOILERS
- C. Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS. Requirements for commissioning, systems readiness checklists, and training
- D. Section 23 05 12 GENERAL MOTOR REQUIREMENTS FOR HVAC AND STEAM GENERATION EQUIPMENT

1.3 QUALITY ASSURANCE

- A. Refer to Articles, Quality Assurance and Submittals, in Section 23 05 10, COMMON WORK RESULTS FOR BOILER PLANTS and STEAM GENERATION, and Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.
- B. Qualifications:
 - 1. TAB Agency: The TAB agency shall be a subcontractor of the General Contractor and shall report to and be paid by the General Contractor.

2. The TAB agency shall be either a certified member of AABC or certified by the NEBB to perform TAB service for HVAC, water balancing and vibrations and sound testing of equipment. The certification shall be maintained for the entire duration of duties specified herein. If, for any reason, the agency loses subject certification during this period, the General Contractor shall immediately notify the Resident Engineer and submit another TAB firm for approval. Any agency that has been the subject of disciplinary action by either the AABC or the NEBB within the five years preceding Contract Award shall not be eligible to perform any work related to the TAB. All work performed in this Section and in other related Sections by the TAB agency shall be considered invalid if the TAB agency loses its certification prior to Contract completion, and the successor agency's review shows unsatisfactory work performed by the predecessor agency.
3. TAB Specialist: The TAB specialist shall be either a member of AABC or an experienced technician of the Agency certified by NEBB. The certification shall be maintained for the entire duration of duties specified herein. If, for any reason, the Specialist loses subject certification during this period, the General Contractor shall immediately notify the Resident Engineer and submit another TAB Specialist for approval. Any individual that has been the subject of disciplinary action by either the AABC or the NEBB within the five years preceding Contract Award shall not be eligible to perform any duties related to the HVAC systems, including TAB. All work specified in this Section and in other related Sections performed by the TAB specialist shall be considered invalid if the TAB Specialist loses its certification prior to Contract completion and must be performed by an approved successor.
4. TAB Specialist shall be identified by the General Contractor within 60 days after the notice to proceed. The TAB specialist will be coordinating, scheduling and reporting all TAB work and related activities and will provide necessary information as required by the Resident Engineer. The responsibilities would specifically include:
 - a. Shall directly supervise all TAB work.
 - b. Shall sign the TAB reports that bear the seal of the TAB standard. The reports shall be accompanied by report forms and schematic drawings required by the TAB standard, AABC or NEBB.

- c. Would follow all TAB work through its satisfactory completion.
 - d. Shall provide final markings of settings of all adjustment devices.
5. All TAB technicians performing actual TAB work shall be experienced and must have done satisfactory work on a minimum of 3 projects comparable in size and complexity to this project. Qualifications must be certified by the TAB agency in writing. The lead technician shall be certified by AABC or NEBB
- C. Test Equipment Criteria: The instrumentation shall meet the accuracy/calibration requirements established by AABC National Standards or by NEBB Procedural Standards for Testing, Adjusting and Balancing of Environmental Systems and instrument manufacturer. Provide calibration history of the instruments to be used for test and balance purpose.
- D. Tab Criteria:
- 1. One or more of the applicable AABC, NEBB or SMACNA publications, supplemented by ASHRAE Handbook "HVAC Applications" Chapter 36, and requirements stated herein shall be the basis for planning, procedures, and reports.
 - 2. Systems shall be adjusted for energy efficient operation as described in PART 3.

1.4 SUBMITTALS

- A. 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.
- B. 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.
- C. Submit Following for Review and Approval:
 - 1. Design Review Report within 90 days for conventional design projects after the system layout on water side is completed by the Contractor.
 - 2. Systems inspection report on equipment and installation for conformance with design.
 - 3. Systems Readiness Report. Report identifying current capacity of existing boiler feedwater pumps with two boilers under full operation prior to making any changes to the boiler feedwater system.

4. Final TAB reports covering flow balance and adjustments, and performance tests. This report will verify proper operation of the boiler feedwater pumps under full load of every two sets of boilers: 1 & 2, 1 & 3, 2 & 3.
 5. Include in final reports uncorrected installation deficiencies noted during TAB and applicable explanatory comments on test results that differ from design requirements.
- D. 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):
2007HVAC 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):
7th Edition 2005Procedural Standards for Testing, Adjusting,
Balancing of Environmental Systems
2nd Edition 2006Procedural Standards for the Measurement of
Sound and Vibration
3rd Edition 2009Procedural Standards for Whole Building Systems
Commissioning of New Construction

PART 2 - PRODUCTS (NOT USED)

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 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.

3.5 SYSTEM READINESS REPORT

- A. The TAB Contractor shall measure existing water flow rates associated with existing systems utilized to serve renovated areas as indicated on drawings. Submit report of findings to resident engineer.
- B. Inspect each System to ensure that it is complete including installation and operation of controls. Submit report to RE in standard format and forms prepared and or approved by the Commissioning Agent.
- C. Verify that all items such as piping, ports, terminals, connectors, etc., that is required for TAB are installed. Provide a report to the Resident Engineer.

3.6 TAB REPORTS

- A. 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.

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. 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 water systems for test and balance work.

- C. Coordinate TAB procedures with existing systems and any phased construction completion requirements for the project. Provide TAB reports for pre construction water flow rate Return existing areas outside the work area to pre constructed conditions.
- D. Allow 10 days time in construction schedule for TAB and submission of all reports for an organized and timely correction of deficiencies.
- F. Water Balance and Equipment Test: Include boiler feedwater pumps:
 - 1. Adjust flow rates for equipment. Set coils and evaporator to values on equipment submittals, if different from values on contract drawings.
 - 2. Record final measurements for hydronic equipment on performance data sheets.

3.10 MARKING OF SETTINGS

Following approval of Tab final Report, the setting of all HVAC adjustment devices including valves 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.

3.13 COMMISSIONING

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

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SECTION 23 07 11
HVAC AND BOILER PLANT INSULATION

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Field applied insulation for thermal efficiency and condensation control for HVAC piping.
- B. Definitions
 - 1. ASJ: All service jacket, white finish facing or jacket.
 - 2. Air conditioned space: Space having air temperature and/or humidity controlled by mechanical equipment.
 - 3. Cold: Equipment, ductwork or piping handling media at design temperature of 16 degrees C (60 degrees F) or below.
 - 4. Concealed: Ductwork and piping above ceilings and in chases, and pipe spaces.
 - 5. Exposed: Piping and equipment exposed to view in finished areas including mechanical, 6. FSK: Foil-scrim-kraft facing.
 - 7. Hot: Boiler Plant piping media and equipment 90 to 450 degrees F.
 - 8. Density: 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. Vapor Retarder (Vapor Barrier): A material which retards the transmission (migration) of water vapor. Performance of the vapor retarder is rated in terms of permeance (perms). For the purpose of this specification, vapor retarders shall have a maximum published permeance of 0.1 perms and vapor barriers shall have a maximum published permeance of 0.001 perms.
 - 13. FWPD: Feedwater pump discharge.

1.2 RELATED WORK

- A. Section 23 05 10, COMMON WORK RESULTS FOR BOILER PLANT and STEAM GENERATION: General requirements pertaining to mechanical Boiler Plant work.
- B. Section 23 21 11, BOILER PLANT PIPING SYSTEMS: Boiler plant piping.
- c. Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS. Requirements for commissioning, systems readiness checklists, and training.

1.3 QUALITY ASSURANCE

- A. Refer to article QUALITY ASSURANCE, in Section 23 05 10, COMMON WORK RESULTS FOR BOILER PLANT and STEAM GENERATION.

- B. Criteria:

- 1. Comply with NFPA 90A, particularly paragraphs 4.3.3.1 through 4.3.3.6, 4.3.10.2.6, and 5.4.6.4, parts of which are quoted as follows:

4.3.3.1 Pipe insulation and coverings, duct coverings, duct linings, vapor retarder facings, adhesives, fasteners, tapes, and supplementary materials added to air ducts, plenums, panels, and duct silencers used in duct systems, unless otherwise provided for in 4.3.3.1.1 or 4.3.3.1.2, shall have, in the form in which they are used, a maximum flame spread index of 25 without evidence of continued progressive combustion and a maximum smoke developed index of 50 when tested in accordance with NFPA 255, *Standard Method of Test of Surface Burning Characteristics of Building Materials*.

4.3.3.1.1 Where these products are to be applied with adhesives, they shall be tested with such adhesives applied, or the adhesives used shall have a maximum flame spread index of 25 and a maximum smoke developed index of 50 when in the final dry state. (See 4.2.4.2.)

4.3.3.1.2 The flame spread and smoke developed index requirements of 4.3.3.1.1 shall not apply to air duct weatherproof coverings where they are located entirely outside of a building, do not penetrate a wall or roof, and do not create an exposure hazard.

4.3.3.2 Closure systems for use with rigid and flexible air ducts tested in accordance with UL 181, Standard for Safety Factory-Made Air Ducts and Air Connectors, shall have been tested, listed, and used in accordance with the conditions of their listings, in accordance with one of the following:

- (1) UL 181A, Standard for Safety Closure Systems for Use with Rigid Air Ducts and Air Connectors
- (2) UL 181B, Standard for Safety Closure Systems for Use with Flexible Air Ducts and Air Connectors

4.3.3.3 Air duct, panel, and plenum coverings and linings, and pipe insulation and coverings shall not flame, glow, smolder, or smoke when tested in accordance with a similar test for pipe covering, ASTM C 411, Standard Test Method for Hot-Surface

Performance of High-Temperature Thermal Insulation, at the temperature to which they are exposed in service.

4.3.3.3.1 In no case shall the test temperature be below 121°C (250°F).

4.3.3.3.4 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.

4.3.3.3.5* Air duct linings shall be interrupted at fire dampers to prevent interference with the operation of devices.

4.3.3.3.6 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.

4.3.10.2.6.4 Optical-fiber and communication raceways shall be listed as having a maximum peak optical density of 0.5 or less, an average optical density of 0.15 or less, and a maximum flame spread distance of 1.5 m (5 ft) or less when tested in accordance with UL 2024, Standard for Safety Optical-Fiber Cable Raceway.

4.3.10.2.6.6 Supplementary materials for air distribution systems shall be permitted when complying with the provisions of 4.3.3.

5.4.6.4 Where air ducts pass through walls, floors, or partitions that are required to have a fire resistance rating and where fire dampers are not required, the opening in the construction around the air duct shall be as follows:

(1) Not exceeding a 25.4 mm (1 in.) average clearance on all sides

(2) Filled solid with an approved material capable of preventing the passage of flame and hot gases sufficient to ignite cotton waste when subjected to the time-temperature fire conditions required for fire barrier penetration as specified in NFPA 251, *Standard Methods of Tests of Fire Endurance of Building Construction and Materials*

2. Test methods: ASTM E84, UL 723, or NFPA 255.

3. Specified k factors are at 24 degrees C (75 degrees F) mean temperature unless stated otherwise. Where optional thermal insulation material is used, select thickness to provide thermal conductance no greater than that for the specified material. For pipe, use insulation manufacturer's published heat flow tables. For

- domestic hot water supply and return, run out insulation and condensation control insulation, no thickness adjustment need be made.
4. All materials shall be compatible and suitable for service temperature, and shall not contribute to corrosion or otherwise attack surface to which applied in either the wet or dry state.
- C. Every package or standard container of insulation or accessories delivered to the job site for use must have a manufacturer's stamp or label giving the name of the manufacturer and description of the material.

1.4 SUBMITTALS

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- B. Shop Drawings:
 1. All information, clearly presented, shall be included to determine compliance with drawings and specifications and ASTM, federal and military specifications.
 - a. Insulation materials: Specify each type used and state surface burning characteristics.
 - b. Insulation facings and jackets: Each type used. Make it clear that white finish will be furnished for exposed ductwork, casings and equipment.
 - c. Insulation accessory materials: Each type used.
 - d. Manufacturer's installation and fitting fabrication instructions for flexible unicellular insulation.
 - e. Make reference to applicable specification paragraph numbers for coordination.
- C. Samples:
 1. Each type of insulation: Minimum size 100 mm (4 inches) square for board/block/ blanket; 150 mm (6 inches) long, full diameter for round types.
 2. Each type of facing and jacket: Minimum size 100 mm (4 inches square).
 3. Each accessory material: Minimum 120 ML (4 ounce) liquid container or 120 gram (4 ounce) dry weight for adhesives / cement / mastic.

1.5 STORAGE AND HANDLING OF MATERIAL

Store materials in clean and dry environment, pipe covering jackets shall be clean and unmarred. Place adhesives in original containers.

Maintain ambient temperatures and conditions as required by printed instructions of manufacturers of adhesives, mastics and finishing cements.

1.6 APPLICABLE PUBLICATIONS

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by basic designation only.
- B. Federal Specifications (Fed. Spec.):
 L-P-535E (2)- 99.....Plastic Sheet (Sheeting): Plastic Strip; Poly (Vinyl Chloride) and Poly (Vinyl Chloride - Vinyl Acetate), Rigid.
- C. Military Specifications (Mil. Spec.):
 MIL-A-3316C (2)-90.....Adhesives, Fire-Resistant, Thermal Insulation
 MIL-A-24179A (1)-87.....Adhesive, Flexible Unicellular-Plastic Thermal Insulation
 MIL-C-19565C (1)-88.....Coating Compounds, Thermal Insulation, Fire-and Water-Resistant, Vapor-Barrier
 MIL-C-20079H-87.....Cloth, Glass; Tape, Textile Glass; and Thread, Glass and Wire-Reinforced Glass
- D. American Society for Testing and Materials (ASTM):
 A167-99(2004).....Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
 B209-07.....Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
 C411-05.....Standard test method for Hot-Surface Performance of High-Temperature Thermal Insulation
 C449-07.....Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement
 C533-09.....Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation
 C534-08.....Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form
 C547-07.....Standard Specification for Mineral Fiber pipe Insulation

- C552-07.....Standard Specification for Cellular Glass
Thermal Insulation
- C553-08.....Standard Specification for Mineral Fiber
Blanket Thermal Insulation for Commercial and
Industrial Applications
- C585-09.....Standard Practice for Inner and Outer Diameters
of Rigid Thermal Insulation for Nominal Sizes
of Pipe and Tubing (NPS System) R (1998)
- C612-10.....Standard Specification for Mineral Fiber Block
and Board Thermal Insulation
- C1126-04.....Standard Specification for Faced or Unfaced
Rigid Cellular Phenolic Thermal Insulation
- C1136-10.....Standard Specification for Flexible, Low
Permeance Vapor Retarders for Thermal
Insulation
- D1668-97a (2006).....Standard Specification for Glass Fabrics (Woven
and Treated) for Roofing and Waterproofing
- E84-10.....Standard Test Method for Surface Burning
Characteristics of Building
Materials
- E119-09c.....Standard Test Method for Fire Tests of Building
Construction and Materials
- E136-09b.....Standard Test Methods for Behavior of Materials
in a Vertical Tube Furnace at 750 degrees C
(1380 F)
- E. National Fire Protection Association (NFPA):
- 90A-09.....Standard for the Installation of Air
Conditioning and Ventilating Systems
- 96-08.....Standards for Ventilation Control and Fire
Protection of Commercial Cooking Operations
- 101-09.....Life Safety Code
- 251-06.....Standard methods of Tests of Fire Endurance of
Building Construction Materials
- 255-06.....Standard Method of tests of Surface Burning
Characteristics of Building Materials
- F. Underwriters Laboratories, Inc (UL):

723.....UL Standard for Safety Test for Surface Burning
 Characteristics of Building Materials with
 Revision of 09/08

G. Manufacturer's Standardization Society of the Valve and Fitting
 Industry (MSS):

SP58-2009.....Pipe Hangers and Supports Materials, Design,
 and Manufacture

PART 2 - PRODUCTS

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

2.1 MINERAL FIBER OR FIBER GLASS

- A. ASTM C612 (Board, Block), Class 1 or 2, density 48 kg/m³ (3 pcf), k = 0.037 (0.26) at 24 degrees C (75 degrees F), external insulation for temperatures up to 204 degrees C (400 degrees F) with foil scrim (FSK) facing.
- B. ASTM C553 (Blanket, Flexible) Type I, // Class B-3, Density 16 kg/m³ (1 pcf), k = 0.045 (0.31) // Class B-5, Density 32 kg/m³ (2 pcf), k = 0.04 (0.27) // at 24 degrees C (75 degrees F), for use at temperatures up to 204 degrees C (400 degrees F) with foil scrim (FSK) facing.
- C. ASTM C547 (Pipe Fitting Insulation and Preformed Pipe Insulation), Class 1, k = 0.037 (0.26) at 24 degrees C (75 degrees F), for use at temperatures up to 230 degrees C (450 degrees F) with an all service vapor retarder jacket with polyvinyl chloride pre-molded fitting covering.

2.8 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 ³ (lb/ ft ³)	232 (14.5)	288 (18)
Thermal conductivity: Min W/ m K (Btu in/h ft ² 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

2.9 INSULATION FACINGS AND JACKETS

- A. Vapor Retarder, higher strength with low water permeance ≤ 0.02 or less perm rating, Beach puncture 50 units for insulation facing on exposed ductwork, casings and equipment, and for pipe insulation jackets. Facings and jackets shall be all service type (ASJ) or PVDC Vapor Retarder jacketing.
- B. ASJ jacket shall be white kraft bonded to 0.025 mm (1 mil) thick aluminum foil, fiberglass reinforced, with pressure sensitive adhesive closure. Comply with ASTM C1136. Beach puncture 50 units, Suitable for painting without sizing. Jackets shall have minimum 40 mm (1-1/2 inch) lap on longitudinal joints and minimum 75 mm (3 inch) butt strip on end joints. Butt strip material shall be same as the jacket. Lap and butt strips shall be self-sealing type with factory-applied pressure sensitive adhesive.
- C. Vapor Retarder medium strength with low water vapor permeance of 0.02 or less perm rating), Beach puncture 25 units: Foil-Scrim-Kraft (FSK) or PVDC vapor retarder jacketing type for concealed ductwork and equipment.
- D. Field applied vapor barrier jackets shall be provided, in addition to the specified facings and jackets, on all exterior piping and ductwork as well as on interior piping and ductwork. The vapor barrier jacket shall consist of a multi-layer laminated cladding with a maximum water

vapor permeance of 0.001 perms. The minimum puncture resistance shall be 35 cm-kg (30 inch-pounds) for interior locations and 92 cm-kg (80 inch-pounds) for exterior or exposed locations or where the insulation is subject to damage.

- E. Glass Cloth Jackets: Pre-sized, minimum 0.18 kg per square meter (7.8 ounces per square yard), 2000 kPa (300 psig) bursting strength with integral vapor retarder where required or specified. Weather proof if utilized for outside service.
- F. Factory composite materials may be used provided that they have been tested and certified by the manufacturer.
- G. Pipe fitting insulation covering (jackets): Fitting covering shall be pre-molded to match shape of fitting and shall be polyvinyl chloride (PVC) conforming to Fed Spec L-P-335, composition A, Type II Grade GU, and Type III, minimum thickness 0.7 mm (0.03 inches). Provide color matching vapor retarder pressure sensitive tape.
- H. Aluminum Jacket-Piping systems: ASTM B209, 3003 alloy, H-14 temper, 0.6 mm (0.023 inch) minimum thickness with locking longitudinal joints. Jackets for elbows, tees and other fittings shall be factory-fabricated to match shape of fitting and of 0.6 mm (0.024) inch minimum thickness aluminum. Fittings shall be of same construction as straight run jackets but need not be of the same alloy. Factory-fabricated stainless steel bands shall be installed on all circumferential joints. Bands shall be 13 mm (0.5 inch) wide on 450 mm (18 inch) centers. System shall be weatherproof if utilized for outside service.

2.12 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.

2.13 MECHANICAL FASTENERS

- A. Pins, anchors: Welded pins, or metal or nylon anchors with galvanized steel-coated or fiber washer, or clips. Pin diameter shall be as recommended by the insulation manufacturer.
- B. Staples: Outward clinching monel or galvanized steel.
- C. Wire: 1.3 mm thick (18 gage) soft annealed galvanized or 1.9 mm (14 gage) copper clad steel or nickel copper alloy.
- D. Bands: 13 mm (0.5 inch) nominal width, brass, galvanized steel, aluminum or stainless steel.

2.14 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.

2.16 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 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). Insulate each pipe individually. Do not use scrap pieces of insulation where a full length section will fit.
- C. Insulation materials shall be installed in a first class manner with smooth and even surfaces, with jackets and facings drawn tight and smoothly cemented down at all laps. Insulation shall be continuous through all sleeves and openings, except at fire dampers and 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 retarder over ends and exposed edges of insulation. Anchors, supports and other metal projections through insulation on cold surfaces shall be insulated and vapor sealed for a minimum length of 150 mm (6 inches).
- D. Install vapor stops at all insulation terminations on either side of valves, pumps and equipment and particularly in straight lengths of pipe insulation.
- E. Construct insulation on parts of equipment such as chilled water pumps and heads of chillers, convertors and heat exchangers that must be opened periodically for maintenance or repair, so insulation can be removed and replaced without damage. Install insulation with bolted 1 mm thick (20 gage) galvanized steel or aluminum covers as complete units, or in sections, with all necessary supports, and split to coincide with flange/split of the equipment.
- F. Insulation on hot piping and equipment shall be terminated square at items not to be insulated, access openings and nameplates. Cover all exposed raw insulation with white sealer or jacket material.
- G. Protect all insulations outside of buildings with aluminum jacket using lock joint or other approved system for a continuous weather tight system. Access doors and other items requiring maintenance or access shall be removable and sealable.
- H. HVAC work not to be insulated:
 - 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 un-insulated items.

- I. Boiler plant work not to be insulated:
 - 1. Pipes, valves and fittings:
 - a. Gas fuel
 - b. Oil unheated
 - c. Compressed Air
- J. Apply insulation materials subject to the manufacturer's recommended temperature limits. Apply adhesives, mastic and coatings at the manufacturer's recommended minimum coverage.
- K. Elbows, flanges and other fittings shall be insulated with the same material as is used on the pipe straights. O. Provide vapor barrier jackets over insulation as follows:

3.2 INSULATION INSTALLATION

- A. 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 pre-molded, 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. d. Fitting tape shall extend over the adjacent pipe insulation and overlap on itself at least 50 mm (2 inches).

3. Nominal thickness in millimeters and inches specified in the schedule at the end of this section.

B. Calcium Silicate:

1. Minimum thickness in millimeter (inches) specified in the schedule at the end of this section for piping other than in boiler plant.
See paragraphs 3.3 through 3.7 for Boiler Plant Applications.

3.3 APPLICATION -BOILER PLANT, PIPE, VALVES, STRAINERS AND FITTINGS:

A. Temperature range 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 pre-molded 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)	125 (5)
25 to 38 (1-1/4 to 1-1/2)	125 (5)
38 (1-1/2) and above	150 (6)

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 pre-molded 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)	50 (2)
25 to 38 (1-1/4 to 1-1/2)	50 (2)
38 (1-1/2) and above	75 (3)

3.7 COMMISSIONING

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

3.8 PIPE INSULATION SCHEDULE

Provide insulation for piping systems as scheduled below:

Insulation Thickness Millimeters (Inches)					
		Nominal Pipe Size Millimeters (Inches)			
Operating Temperature Range/Service	Insulation Material	Less than 25 (1)	25 - 32 (1 - 1¼)	38 - 75 (1½ - 3)	100 (4) and Above
122-177 degrees C (251-350 degrees F) (FWPD)	Mineral Fiber (Above ground piping only)	75 (3)	100 (4)	113 (4.5)	113 (4.5)
93-260 degrees C (200-500 degrees F) (FWPD)	Calcium Silicate	100 (4)	125 (5)	150 (6)	150 (6)

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SECTION 23 08 00

COMMISSIONING OF HVAC SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. The requirements of this Section apply to all sections of Division 23.
- B. This project will have selected building systems commissioned. The complete list of equipment and systems to be commissioned are specified in Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS. The commissioning process, which the Contractor is responsible to execute, is defined in Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS. A Commissioning Agent (CxA) appointed by the Department of Veterans Affairs will manage the commissioning process.

1.2 RELATED WORK

- A. Section 01 00 00 GENERAL REQUIREMENTS.
- B. Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS.
- C. Section 01 33 23 SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

1.3 SUMMARY

- A. This Section includes requirements for commissioning the HVAC systems, subsystems and equipment. This Section supplements the general requirements specified in Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS.
- B. The commissioning activities have been developed to support the VA requirements to meet guidelines for Federal Leadership in Environmental, Energy, and Economic Performance.
- D. Refer to Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS for more specifics regarding processes and procedures as well as roles and responsibilities for all Commissioning Team members.

1.4 DEFINITIONS

- A. Refer to Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS for definitions.

1.5 COMMISSIONED SYSTEMS

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

1. Steam System (Boilers, controls, gages and instrumentation, safety relief valves, combustion burners/fans/motors, fuel delivery pumps and motors, flues, feed water pumps).
2. Direct Digital Control System (BACnet or similar Local Area Network (LAN), Operator Work Station hardware and software, building controller hardware and software, terminal unit controller hardware and software, all sequences of operation, system accuracy and response time).

1.6 SUBMITTALS

- A. The commissioning process requires review of selected Submittals. The Commissioning Agent will provide a list of submittals that will be reviewed by the Commissioning Agent. This list will be reviewed and approved by the VA prior to forwarding to the Contractor. Refer to Section 01 33 23 SHOP DRAWINGS, PRODUCT DATA, and SAMPLES for further details.
- B. The commissioning process requires Submittal review simultaneously with engineering review. Specific submittal requirements related to the commissioning process are specified in Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 PRE-FUNCTIONAL CHECKLISTS

- A. The Contractor shall complete Pre-Functional Checklists to verify systems, subsystems, and equipment installation is complete and systems are ready for Systems Functional Performance Testing. The Commissioning Agent will prepare Pre-Functional Checklists to be used to document equipment installation. The Contractor shall complete the checklists. Completed checklists shall be submitted to the VA and to the Commissioning Agent for review. The Commissioning Agent may spot check a sample of completed checklists. If the Commissioning Agent determines that the information provided on the checklist is not accurate, the Commissioning Agent will return the marked-up checklist to the Contractor for correction and resubmission. If the Commissioning Agent determines that a significant number of completed checklists for similar equipment are not accurate, the Commissioning Agent will select a broader sample of checklists for review. If the Commissioning Agent determines that a significant number of the broader sample of checklists is also inaccurate, all the checklists for the

type of equipment will be returned to the Contractor for correction and resubmission. Refer to SECTION 01 91 00 GENERAL COMMISSIONING REQUIREMENTS for submittal requirements for Pre-Functional Checklists, Equipment Startup Reports, and other commissioning documents.

3.2 CONTRACTORS TESTS

- A. Contractor tests as required by other sections of Division 23 shall be scheduled and documented in accordance with Section 01 00 00 GENERAL REQUIREMENTS. The Commissioning Agent will witness selected Contractor tests. Contractor tests shall be completed prior to scheduling Systems Functional Performance Testing.

3.3 SYSTEMS FUNCTIONAL PERFORMANCE TESTING:

- A. The Commissioning Process includes Systems Functional Performance Testing that is intended to test systems functional performance under steady state conditions, to test system reaction to changes in operating conditions, and system performance under emergency conditions. The Commissioning Agent will prepare detailed Systems Functional Performance Test procedures for review and approval by the Resident Engineer. The Contractor shall review and comment on the tests prior to approval. The Contractor shall provide the required labor, materials, and test equipment identified in the test procedure to perform the tests. The Commissioning Agent will witness and document the testing. The Contractor shall sign the test reports to verify tests were performed. See Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS, for additional details.

3.4 TRAINING OF VA PERSONNEL

- A. Training of the VA's operation and maintenance personnel is required in cooperation with the Resident Engineer and Commissioning Agent. Provide competent, factory authorized personnel to provide instruction to operation and maintenance personnel concerning the location, operation, and troubleshooting of the installed systems. The instruction shall be scheduled in coordination with the Resident Engineer after submission and approval of formal training plans. Refer to Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS and Division 23 Sections for additional Contractor training requirements.

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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) 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. Section 23 05 10, COMMON WORK RESULTS FOR BOILER PLANT and STEAM GENERATION: Operating and maintenance manuals
- B. Section 23 05 10, COMMON WORK RESULTS FOR BOILER PLANT and STEAM GENERATION: Demonstration, instructions and testing of temporary equipment
- C. Section 23 05 51, NOISE and VIBRATION CONTROL FOR BOILER PLANT: Sound levels; sound tests of rotating equipment
- D. Section 23 21 11, BOILER PLANT PIPING SYSTEMS: Leak testing of piping systems, pressure testing of non-boiler safety valves
- E. Section 23 52 33, WATER-TUBE BOILERS: Demonstration and testing of water tube boilers, burners, controls and accessories
- F. Section 23 09 11, INSTRUMENTATION and CONTROL FOR BOILER PLANT: Demonstration and testing of boiler plant instrumentation, controls and computer work station
- G. Section 23 08 00 COMMISSIONING OF HVAC SYSTEMS: Requirements for commissioning, systems readiness checklists, and training.

H. VHA Boiler Plant Safety Device Testing Manual, September 2008, Third Addition.

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. Compressed air systems
 - 3. 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, upon request, will provide a list of personnel to receive instructions and will coordinate their attendance at agreed-upon times.
- E. All safety devices shall comply with the VHA Boiler Plant Safety Devices Testing Manual.

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

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.
- C. Testing of all equipment shall be accordance with VHA Boiler Plant Safety Device Testing Manual. All items provided in this contract shall be labeled with half-inch high lettering with abbreviations identified in the VHA Boiler Plant Safety Device Testing Manual, Paragraph 1.4.

3.3 STARTUP AND TESTING

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

3.4 COMMISSIONING

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

3.5 DEMONSTRATIONS AND TRAINING

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

3.6 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 pumps, computer workstation and programs.
- C. Do not exceed three trainees per session, one-four hour session, per day, per trainee, per shift the boiler plant is operated. All boiler operators shall be included for complete training of equipment and controls.

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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. The new boiler control computer shall operate the boiler plant through the boiler plant operators. All items listed on sheet MP701 shall be on the new computer located in the boiler plant control room. Those items already on the existing Johnson Controls Metasys computer located in the boiler control room shall be transferred to the new computer. The existing Engineering Control Center (ECC) shall receive signals from the new computer allowing monitoring but not control of the boiler plant from the ECC. All control functions for the boiler plant shall reside in the new computer. All three boilers shall be controlled from the new boiler control computer. The existing ECC, located in Building No. 1 second floor mechanical room, shall be upgraded to display all control points with graphics.

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. Section 23 21 11, BOILER PLANT PIPING SYSTEMS: Piping for controls and instrumentation panel.
- C. Section 23 52 33, WATER-TUBE BOILERS: Instrumentation furnished with water tube boilers.
- D. Section 23 08 11, DEMONSTRATIONS and TESTS FOR BOILER PLANT.
- E. Section 26 29 11, LOW-VOLTAGE MOTOR STARTERS.
- F. Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS. Requirements for commissioning, systems readiness checklists, and training

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. Boiler controls for Boiler No. 3 shall be Hays-Cleveland to match the existing controls Boilers No. 1 and No. 2. The new head-end computer shall be Johnson Controls. All control points from the Hays-Cleveland boiler burner controls shall be sent to and fully interpreted by the new Johnson Controls head-end unit. Provide Maxon natural gas safety shutoff valves.

- 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. If new burners are part of the contract, 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 (Articles 1.3.A, B, D & F). In addition, submit past performance questionnaire (Form VA-NEBC) for five (5) past projects of the same class (scope & complexity) as this project.
- 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. Computer Workstation and Programming:
1. Catalog data with pictures, description, and performance data on all hardware.
 2. Hardware specifications.
 3. Software model number and supplier. Include complete documentation on all software with shipment.
 4. Confirmation that graphics to be provided complies with the specification.
 5. Description of computer furniture.
- H. As-built Logic and Wiring Diagrams: One set of reproducible prints and CAD disks delivered to Resident Engineer (RE) prior to turning systems over to VA for operation. Supply revised drawings if changes are made during the startup and commissioning process.
- I. 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).
- J. 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.
- K. Completed System Readiness Checklists provided by the Commissioning Agent and completed by the contractor, signed by a qualified technician and dated on the date of completion in accordance with the requirements of Section 23 08 00 COMMISSIONING OF HVAC SYSTEMS.

1.5 APPLICABLE PUBLICATIONS:

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. American National Standards Institute (ANSI):
- INCITS 154-1988(R1999)..Office Machines and Supplies - Alphanumeric
Machines - Keyboard Arrangements
- C. American Society of Mechanical Engineers (ASME):
- B16.36-2009.....Orifice Flanges
B31.1-2007.....Power Piping
B40.100-2005.....Pressure Gauges and Gauge Attachments
PTC 4-2008.....Fired Steam Generators
- D. National Fire Protection Association (NFPA):
- 70-2011.....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. Boiler water level, 3 element system.
 4. Control features:
 - a. Operator interface on controller faceplates and touch screens and computer workstation. 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 each boiler and for the master steam pressure control. Fuel/air control loops, including 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. All control items for one boiler may be shown on one touchscreen.
 - 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-differential (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. Membrane 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).
 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.
 18. The controller shall be Hays-Cleveland "AC Station" to match the controllers on Boilers No. 1 and No. 2.
- C. Power Supplies: Provide separate uninterrupted power supply for Boiler No. 3 boiler controller. 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. Touch Screen Operator Terminals:

1. Provide one touch screen control station and display for each boiler mounted on the boiler control panel. Touch screen shall be in complete communication with all controllers associated with the boiler and with the burner management system. Provide alternate control station to replace touch screen control functions if touch screen fails.

2. Control Station and Display Requirements:

- a. Local operation and programming of controllers, graphic display of information, alarm message display, historical and real time trending, remote controller tuning, x/y plots of fuel air curve data for intuitive commissioning of controllers, Ethernet connectivity and standard Internet browser remote communication. Network to boiler control and burner management systems.
- b. Selection of automatic or manual control of firing rate. Local manual control to increase and decrease the firing rate.
- c. Indicate burner management control status and diagnostics in English messages: control on, pre-purge, trial for ignition, igniter flame signal, main flame signal, post purge, burner off, all diagnostic information available from burner management system, continuous indication of flame signal.
- d. Real time display of all connected process parameters including control output, set point, process variable, all data gathering and processing from all controllers associated with the boiler.
- e. Display of all control system alarm messages and faults. History of alarms and faults and recommendations for troubleshooting.
- f. Complete display and facilities to allow programming all controllers associated with the boiler or the master control. Burner management is excluded from this requirement.
- g. Provide alternate means of automatic and manual operation of boiler firing rates and burner management status if touch-screen fails.
- h. Provide continuous display of critical operating parameters, including but not limited to the following:
 - 1) Steam Pressure

- 2) Water Level
 - 3) Draft Pressure
 - 4) Firing Rate
3. Touch Screen System Hardware and Software:
- a. 265 mm (10.4 inch) panel-mounted display, TFT with 256 colors, 640 x 480 pixel LCD resolution. Locate to allow easy viewing and access from operating floor.
 - b. Aluminum case allowing entire enclosure to be rated NEMA 4x.
 - c. Communication with SCADA program on computer work station.
 - d. Multiple RS-485 Modbus communication interfaces.
 - e. Field-replaceable backlight, real-time clock, battery-backed clock time stamps critical data, 8 MB on-board flash application memory, 512 MB memory card, application expanded memory card for historical, alarm and event storage, resistive analog touch screen with free formable to fit target shape.
 - f. Operation interaction shall be touch-based allowing easy selection of screens, manual/automatic status changes, start/stop functions, set point changes, output changes and PID tuning parameters without any special programming skills. Screen selection shall also be available through tactile feedback function keys.
 - g. Show facsimiles of each controller and clearly labeled English language and engineering unit display of the control parameters.
 - h. Graphic X/Y curve data plotting capability. When used in conjunction with fuel/air ratio control, provide automated fuel/air ratio curve and oxygen trim setpoint curve adjustment for rapid, error free burner tune-up. Only a single operator action shall be required to store commissioning data into multiple characterizer curves for a particular load point.
 - i. Configuration software Microsoft Windows based. Provide all necessary software to allow field modification or expansion of the system including graphics drawing programs and data base builders. Systems based on "run time only" programs are not acceptable.
- E. Drive Units and Actuators for Dampers, Fuel Flow Control Valves, Feedwater Flow Control Valves:
- 1. Electric drive units are required.

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, feedback signals are not permitted to perform this function within the VA. Belt-type drive units not permitted.
 - d. Drive unit shafts shall be keyed to fuel flow control valves and damper shafts to eliminate the possibility of slipping.
 - e. Drive units shall be industrial rated.
 - f. All gearing shall be brass or better, no plastic gears of any kind are permitted.
 4. Boiler outlet damper drive units may be different model than drive units for fuel valves and forced draft damper. Drive units shall be capable of 136 Nm (100 ft-lb.) torque minimum. Less powerful drive units may be utilized if certified as adequate by the burner manufacturer.
- F. Variable Frequency Drives (VFD) for Forced Draft Fans:
1. Refer to Section 26 29 11 LOW-VOLTAGE 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.
- G. Transmitters: See Paragraphs, PRESSURE SENSORS AND TRANSMITTERS, TEMPERATURE SENSORS AND TRANSMITTERS.
- H. Final Control Elements:
1. Fuel flow control valves, forced draft fan dampers, variable frequency forced draft fan drives (VFD), feedwater control valves: Refer to Section 23 52 33, WATER-TUBE BOILERS.
- I. 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.
- J. 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
- K. 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 105 psig. Individual set point adjustment range: +/- 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, and fuel flow control valves for ignition and running cycles. Refer to paragraph, BURNER MANAGEMENT SYSTEM WITH SAFETY INTERLOCKS AND ACCESSORIES.
 - g. The steam header pressure transmitter(s) shall be dedicated to header pressure control. Suppressed range transmitter(s), each with range +/- 20 percent of required set point. If two set points are required that are more than 138 kPa (20 psi) apart, provide two transmitters. Locate transmitters adjacent to main steam header. Refer to Paragraph, PRESSURE SENSORS AND TRANSMITTERS.
2. Parallel-Positioning Combustion Control (Air/Fuel Ratio, Excess Air):
- a. Boiler/burner sub-master 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 sub-master 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.
 - j. Consult Resident Engineer if flue gas carbon monoxide exceeds 200 parts per million (ppm) within the excess air limits specified above.
3. Automatic Flue Gas Oxygen Trim System:
- a. Boiler/burner sub-master 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 20 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 sub-master 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.
6. 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) Probe-Type Capacitance Systems: Optional control for 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 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.
- g. Set point position as recommended by boiler manufacturer.
- 7. 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, 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.
- E. Control Features:

1. Automatic recycling on high steam pressure only.
 2. Interrupted ignition.
 3. Electronically prevent UV scanner sensing ignition spark. Methods include early spark termination or by phasing the firing of the ignition spark off cycle from the scanner activation.
 4. Flame failure response time four seconds maximum.
 5. Ten seconds trial for ignition except 15 seconds permitted on heavy oil fuel.
 6. Pre-purge timing set for 4 air changes on fire tube boilers and 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 detailed boiler plant operating data and memory. Provide interface with SCADA (Supervisory Control and Data Acquisition) software on computer workstation to allow access to burner management memory and to current operating information. In addition, provide a BACnet (read only) interface to the central medical center \DDC control system.
- 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 for all three boilers:
 - 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 flue gas oxygen.
 - r. 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 Resident Engineer 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. 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.
- 6. 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.
7. 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.
8. 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.
9. 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. Burners with individual air compressors for air atomization shall be provided with one air pressure switch and compressor motor interlocks as specified above.
10. 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.
11. 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.
12. 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 33, WATER-TUBE BOILERS.
 13. Low Boiler Water Level Interlocks: Primary and auxiliary low water burner shut down interlocks. Refer to Paragraph, BOILER TRIM, in Section 23 52 33, WATER-TUBE BOILERS. Operation of auxiliary low water cutoff shall interrupt the power supply to the burner management control system.
 14. 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.
 15. 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.
 16. 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.
 17. Building Combustion Air Intake Interlock: Provide devices to prove outside air building wall louvers are open or 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.
 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. Release burner from low fire position to automatic or manual firing rate control.
 16. Provide 15 second post purge at end of burner firing cycle.
 17. 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.

2.4 BOILER/BURNER CONTROL PANELS:

- A. Type: Individual boiler/burner control panel with control station, control switches, instruments and indicators on panel fronts and controllers, relays and other components mounted on interior sub-bases. Panels shall be freestanding.
- B. Panel Construction:
 1. NEMA ICS-6, Type 4. Freestanding panels shall be minimum 3.5 mm (0.134 inch) thick steel sheet with steel angle or other reinforcement. Provide sufficient reinforcement to prevent any warping or displacement due to weight of equipment mounted within panel. All corners and edges shall be smooth. Mount all equipment on sub-bases. Mount switches, reset buttons, indicators and instruments on outside face of panel.
 2. Access doors shall be full height and width of panel, dust tight gaskets, key-type locks. On freestanding panels, doors shall have three-point latches and three hinges or piano hinges.
 3. Exterior finish: Undercoat of rust-resistant primer, finish coats of enamel. Color same as instrumentation panel or boiler manufacturer's standard color if panel is boiler-mounted.
 4. Interior finish: Undercoat of rust-resistant primer, finish coats of enamel, white.
 5. Identification: All elements on face of and on interior of panels shall be labeled. Nomenclature shall be keyed to wiring diagrams.
 6. Provide fan-type ventilation if necessary to protect equipment from overheating. Assume environment at 43 degrees C (110 degrees F).
- C. Burner Management System with Annunciator: See Paragraph, BURNER MANAGEMENT SYSTEM WITH SAFETY INTERLOCKS AND ACCESSORIES.
- D. Boiler Control Stations or Touch Screens, burner management displays and resets: See Paragraphs, AUTOMATIC BOILER CONTROL SYSTEMS, BURNER MANAGEMENT (FLAME SAFEGUARD CONTROL) SYSTEMS WITH SAFETY INTERLOCKS AND ACCESSORIES.
- E. Draft Gages: See Paragraph, DRAFT GAGES.
- F. Control switches on face of panel:
 1. Fuel selector.
 2. Burner start and stop selector (off-automatic-on).
 3. Circuit breaker for power to burner control system.

4. Alarm silence.
 5. Burner stop switch with mushroom head.
 6. Reset for burner management system.
- G. Boiler water level alarm on face of panel (non lock-out):
1. Provide separate visual indications and audible alarm (bell) for high water and low water. Low water alarm is separate from low water cutouts and set at higher level than low water cutouts.
 2. Indicating lights: Industrial, transformer type, removable amber lenses. Burner status and shut down annunciator specified above may be used. Standard water level alarm display of water level control manufacturer may be used.
 3. Alarm bell: 150 mm (six inch) diameter. Provide silencing control, which is automatically deactivated when another alarm condition occurs.
- H. Horn and bell: Mounted high on exterior of panel, audible throughout the boiler plant. The horn is for burner management system alarms and the bell is for high and low water level alarms (not burner cutoff) (See Paragraph G).
- I. 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 type terminal blocks, terminals numbered for identification, 20 percent extra terminals. Wiring shall be color-coded and numbered with numbering system that identifies the destination of each wire. There shall be no exposed wiring connections exceeding 120 volts inside the panels. All field wiring shall be brought to terminal strip in the panel. No wiring in series from one safety device to the next device is permitted.
 4. Piping: Stainless steel tubing, securely mounted, terminate in fittings at top of the cabinets.
- J. Panel Certification and Testing:
1. Manufacture and inspection of completed panels, including all wiring and components, shall comply with UL 508.
 2. Complete cabinets shall be factory tested and certified. The panel shall be labeled as complying with UL 508. A copy of the wiring diagram shall be placed in the cabinet prior to shipment.

2.5 COMPUTER WORK STATION AND PROGRAMMING:

- A. The new head-end computer shall be Johnson Controls. The individual boiler plant controllers and instrumentation system shall be networked with a central computer workstation to provide remote operation of the controllers, custom graphic display of information, alarm message display, report generation, historical trending and remote tuning of controllers. All control functions shall be accomplished within the individual controllers and shall be monitored by the central computer so that the integrity of the control system shall not be dependent on the status of the central computer or the interconnecting network. Burner management (flame safety control) systems shall not be controllable from the workstation but shall be monitored from the workstation for status and access to historical data. Modem and software shall provide remote communication with diagnostic and status indications.
- B. Hardware:
1. Microsoft Windows based desktop computer workstation with keyboard, mouse, two speakers, color graphic monitor, alarm printer, logging printer, uninterrupted power supply. Equip with latest version Microsoft Windows operating system compatible with SCADA software furnished. The system shall be designed so that additional workstations and peripheral equipment can be added in the future. Provide all devices necessary for complete access to all features of the programs applied.
 2. Desktop Computer: Comply with requirements published by SCADA software supplier for optimum performance of software furnished. System must include hardware as recommended by Microsoft for installation of Windows 7 Professional operating system. Minimum requirements are Intel Core i5 processor, 3.1 GHz, 4 GB DDR3 SDRAM memory; dual hard drives each one terabyte SATA, HD2500 graphics, DVD+/-RW optical drive, integrated Ethernet, sound card, audible alarm and a battery-backed clock which counts seconds, minutes, hours, days and years. Provide six USB ports, minimum.
 3. Digital Flat Panel Color Monitor: TFT, 500 mm (21 inch) diagonal (nominal) screen with capability of 1920 by 1080 pixels resolution, non-interlaced, dot pitch 0.31 maximum. Minimum of True 16bit colors supported. Energy-Star compliant. Provide a total of three 21-inch

screens; one for the new computer and one for each of the two existing computers in the boiler control room.

4. Keyboard: ASCII standard, QWERTY-style, enhanced 101-key consisting of at least 32 dedicated function keys and a 12-key numeric data entry section. Keys shall have tactile feedback and be permanently and clearly labeled. In addition, a set of arrow keys shall be provided for moving from the current screen of data to "next screen". Function keys shall have custom legends for each key to allow report generation, graphic display selection, alarm silencing, and data retrieval with single keystrokes. Provide removable continuous Mylar faceplate to exclude dust and spills.
5. Mouse: The operator interface shall minimize the use of the typewriter style keyboard through the use of a mouse and "point and click" approach to menu selection. Users shall be able to access features of the program from graphical displays through the use of the mouse.
6. Alarm Printer: Impact printer, 9-pin dot-matrix type. The printer shall have a minimum 96 character ASCII character set based on ANSI INCITS 154. The printer shall have tractor feed with adjustable sprockets for paper width up to 380 mm (15 inches), print at least 132 columns per line and have a draft quality speed of 680 characters per second. Character spacing shall be selectable at 10, 12 or 17 characters per 25 mm (one inch) at front panel. The printer shall utilize sprocket-fed fanfold paper. The printer shall have programmable control of top-of-form. The sound level of the unit shall not exceed 55 dBA at 1500 mm (5 feet). Provide one box of 2000 sheets of printer paper.
7. Logging Printer: Black/color inkjet type, 20 ppm black and white - 15 ppm color - draft quality, minimum 8 scalable fonts, 4800 x 1210 dpi color, 16 mb RAM, capability of letter and legal paper size.
8. Speakers: Provided by computer manufacturer.
9. Uninterrupted Power Supply: Provide complete protected power conditioner. Line interactive, UL 1449 rated, interactive digital display. Power supply shall protect computers, controls, instruments and accessories from damage due to ground leakage, spikes, surges, sags, transients and overloads in the incoming power supply. Smooth sine wave output. Hot swappable batteries. Audible and visual alarm

to signal failure of UPS. Battery shall provide at least 30 minutes of operating capacity.

10. Provide a desk unit for support of microcomputer, terminals and peripherals. The desk shall have a 600 x 760 mm (24 x 30 inch) workspace in addition to space for equipment. Desk shall have at least two drawers.

C. Supervisory Control and Data Acquisition (SCADA) Software:

1. Generally available non-custom system compliant with latest version of Microsoft Windows. Shall use Windows Open Systems Architecture (WOSA), such as in its use of dialog boxes and menus. Local system with capability for future networking. All features shall be supported on the in-plant hardware specified. The software shall be a complete package requiring no additional software to configure or run the features of the program. Program shall not require hardware "dongle" keys for licensing. The program shall be completely configured to perform all required functions at the required speed and with complete accuracy.
2. Configuration shall be accomplished from the keyboard or the mouse. All configuration changes shall be capable of being made while the system is on-line (operating) without interfering with the normal functions of the program. No programming, compiling or linking shall be required to configure the system.
3. Provide complete user documentation in electronic format, including examples of how to operate the various modules of the system. Provide keyword and specific text search features.
4. On-line "help" facility, based upon Windows standard Hypertext. This shall support full text word search, add custom comments, bookmark topics, copy and pasting into another application, printing, and use of system fonts and colors.
5. Provide pre-emptive multitasking to ensure that common Windows actions are permissible and do not interfere with I/O communications, processing of data, alarming, and the integrity of the real-time and historical data.
6. 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.
7. 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.
8. 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.
9. The system must support third-party objects and controls to be plugged in via OLE and Active X support.
10. 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.
11. 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.

12. 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.
13. Archiving and Reporting:
- a. Provide facility for automatically collecting, storing and recalling data. Recalled data shall be made available to a trend display program, a report generation program and to user-written programs.
 - b. Store data in Windows-compatible files in compressed format. Entries containing time, name, value and status will be made in the file whenever the real-time value exceeds the previously stored value by a user-supplied deadband limit. A deadband value of zero will cause an entry in the file each time the real-time value is examined. Files shall be organized according to time and will contain values for multiple, named variables. The files can be placed on the hard disk or floppy disk. Provide a mechanism for on-line maintenance and automatic purging of files.
 - c. The data to be collected by the archiving program will be identified through an interactive, menu-based configuration. The user will enter the tag name, collection rate, and data compression deadband value. Collection rates shall be selectable:

1 second, 2 seconds, 10 seconds, 20 seconds, 30 seconds, 1 minute, 2 minutes, 10 minutes.

- d. The operator shall be able to recall archived data from the disk to be displayed in graphic format along with real-time data. The display of archived data shall be user-configurable. It shall be possible to configure objects in graphic displays that, when selected, fetch pre-defined historical trend data from disk and display it to the operator. Attributes of pens shall be editable during run-time.
- e. The historical trend display shall be made up of the following components:
 - 1) Pen Group: Configuration shall be used to define the particular tag names to be displayed. Along with tag names, pen color, marker style and engineering units may be defined.
 - 2) Time Group: Configuration shall be used to define the time period over which the archived data is to be displayed.
 - 3) Legend Group: Configuration shall be used to define the legend parameters for a historical display. Both a primary and alternate legend may be displayed.
- f. The display shall support unlimited variables to be displayed on the same time/value axis simultaneously. For each entry in the display list, the operator will be able to assign a given tag name and marker to a particular line color selected from palettes of unlimited colors. The operator may also enter display engineering units ranges to cause scaling of the display. Support shall be provided for multiple, different y-axis engineering units to be displayed as appropriate.
- g. The display shall have two fields of view. The top portion of the screen shall be the graphic field and will display the values of the variables (y-axis) against time (x-axis). It will also contain labels for the axes and graphs. The bottom portion of the screen shall be user-configurable to display information, such as node-names, tag names, and descriptors, pertaining to the tags in the trend display.
- h. The trend object shall allow for bi-directional trending and scrolling. A movable, vertical line will act as a time cursor on the display. The date, time and values of the trends corresponding to that time will be displayed in the bottom

portion of the screen. The grid of the trend object shall be scrollable. The trend shall be shifted forward or backward in time by clicking on the right/left buttons. New data shall be fetched from the historical file as appropriate. The ability to display historical data with current data on the same chart must be supported. A transparent option for the trend must be selectable. The user shall be able to "zoom" on any section of the trend display by "cutting" that section with the mouse. The software will automatically re-scale both the y-axis and the time axis and will fetch the appropriate data for the time period selected. The trend object must have a refresh rate selectable in 0.1 second increments from a minimum of 0.10 seconds to a maximum of 1800 seconds.

- i. The trend display shall be printable to a color printer via the standard MS Windows NT print manager.

14. Event Scheduling:

- a. The system shall support a scheduler with time-based printing of reports.
- b. The system shall allow for scheduling of the following time-based printing of reports: Hourly, shift, daily, monthly, yearly.

15. Security Management:

- a. Provide a user-based security system which, when enabled, must allow for the creation of users with certain rights and/or privileges. These rights must include the ability to run any combination or all of the applications in the data acquisition system. The ability to allow or disallow users access to change values, such as set points and control setups, on an individual tag basis shall be supported.
- b. Groups of users, such as operators or supervisors, can be created and granted rights. All users assigned to a group obtain the rights of the group although they are tracked by the system by their individual ID. Individual members of a group may be also assigned additional rights.
- c. The system must support a tie to Windows NT security. When user-based security is enabled, an audit trail will be generated in the system, which will tag every operator action with a user ID.
- d. The system must support at least twenty separate security areas, assignable on a per-tag basis. Each tag can be assigned all of

the available security areas, none of the available security areas, or up to three individual security areas. Only users with clearance for those security areas shall have the ability to change parameters. Security area names may be up to twenty characters in length.

- e. The following functions must be supported: enable/disable user-based security; define users, passwords and login names; define groups to which users may belong; define security paths; define user and/or group rights/privileges; define security area names; define system auto-start user.
 - f. The ability to lock an operator or other user into the runtime graphics environment shall be provided. Disabling any combination of the following shall be supported, as configured by the user: starting other applications; switching to other applications that may be running; exiting from the system; restarting the computer using <Ctrl><Alt><Delete>; opening unauthorized screens; closing current screens; using the system menu; switching to the configuration environment; accessing the system tree.
 - g. The system shall allow for a login timeout setting for each user account. The system shall support manual login in and logout as well as automatic login. In addition, security information must be customizable through VBA scripting.
16. Services:

- a. Training: An interactive on-line 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.

17. 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.
18. 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 (if trim provided).
- 7) Boiler flue gas outlet draft (if outlet draft control system is provided), inches WC.
- 8) Economizer flue gas outlet temperature, °F.
- 9) Economizer feedwater inlet temperature, °F.
- 10) Boiler feedwater inlet (economizer outlet) temperature, °F.
- 11) Signal to feedwater control valve.
- 12) Water level in boiler plus or minus inches from normal level.
- 13) Boiler plus economizer "Heat Loss" combustion efficiency not including radiation and unaccounted losses.
- 14) Fuel flow rate and totalization if individual boiler fuel meters are provided gpm, gal. Totalization calculations shall be accomplished at the meters, not in the SCADA software.
- 15) 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.
- 16) Trends of all flow, pressure and temperature data as listed above. Provide adequate memory storage to maintain trend logging data every 15 minutes for a minimum of one year.

b. Boiler Plant:

- 1) Feedwater deaerator storage tank water level, inches of water.
- 2) Condensate storage tank water level, inches of water.
- 3) Pumps in operation.
- 4) Chemical feeders in operation.
- 5) Steam header pressure, psig.
- 6) Feedwater deaerator steam pressure, psig.
- 7) Emergency gas valve status (open or closed).
- 8) Natural gas header pressure, psig.
- 9) Fuel oil header pressure, psig.
- 10) Fuel oil header temperature (if heated oil), °F.

- 11) Boiler feed header pressure - each header, psig.
 - 12) LP igniter gas header pressure psig.
 - 13) Instrument air pressure psig.
 - 14) Fuel oil tank and piping leak detection in operation.
19. Specific Requirements - Historical Trending:
- a. Display No. 1 (one display per boiler): Individual boiler pressure-compensated steam flow rate, lb/hr ; flue gas oxygen, percent; boiler stack temperature, F; economizer flue gas outlet temperature, °F; fuel flow rate (if fuel meters are provided on the boilers), gpm, feedwater flow rate (if feedwater meters are provided on the boilers)gpm.
 - b. Display No. 2: Pressure-compensated steam flow rate for: total of all boilers; in-plant steam line; and each distribution steam line, lb/hr; total plant fuel flow, gpm.
 - c. Display No. 3: Outside air temperature, °F; feedwater temperature, °F; steam header pressure, psig.
20. 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 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) Condensate storage tank high and low water level.
 - 6) Feedwater deaerator high and low water level.
 - 7) Feedwater deaerator high and low steam pressure.
 - 8) High and low steam header pressure.
 - 9) Low feedwater pressure to each boiler.
 - 10) Emergency gas valve closed.
 - 11) High and low natural gas header pressure.
 - 12) High and low fuel oil header pressure.
 - 13) Propane igniter gas header pressurized (normal is zero pressure).
 - 14) Oil tank and piping system leak detected.
 - 15) Carbon monoxide (CO) or combustible gas in building.
 - 16) Control system faults.
 - 17) Medical gases.
 - 18) Medical vacuum.
 - 19) Emergency generator status.
- 21. Report Generation - Specific Requirements: The monitor shall display and the log sheet printer shall print out: instant, hourly, shift, daily and monthly plant operating reports. As a minimum, each report shall list:
 - a. Maximum simultaneous instantaneous steam flow rate, combination of all boilers, lb/hr.
 - b. Minimum simultaneous instantaneous steam flow rate, combination of all boilers, lb/hr.
 - c. Totalization of steam produced, each boiler and combination of all boilers, lb.
 - d. Totalization of steam used in boiler plant, lb.
 - e. Separate totalization of steam exported into each distribution system, lb .

- f. Totalization of oil consumed, //liters // gallons//.
- g. Totalization of natural gas consumed, mscf.
- h. Totalization of feedwater consumed, each boiler, gallons.
- i. Overall boiler efficiency, fuel vs. steam (combination of all boilers).
- j. Electricity used, kWh.
- k. Make-up water used, gallons.
- l. Make-up water as a percent of total steam production of all boilers combined.
- m. Number of heating degree-days.
- n. Hours of operation of each boiler.
- 22. 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.
- 23. 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 submaster controller for oxygen trim and computer work station. Single range, 0 to 10 percent oxygen.
- B. Performance:
 - 1. Minimum accuracy of plus or minus 2 percent of reading.
 - 2. Speed of response eight seconds or less to 90 percent accurate reading.
 - 3. Resolution 0.1 percent oxygen.
 - 4. These performance requirements are minimums and must be increased if necessary to suit the requirements of the oxygen trim system (if provided).
- C. Field-replaceable cell, heater, and cell temperature sensor. Resident Engineer 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.
1. Selectable manual/automatic calibration, which will operate at preprogrammed intervals and upon power-up.
 2. 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. Modbus communications and analog output compatible with boiler/burner submaster controller 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. Set point adjustable 0.5 to 3.0 percent oxygen. 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 4/1 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, 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 and in computer workstation. 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 psig). Pipe connections flanged 850 or 1025 kPa (125 or 150 psig) 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. Straightening Vanes: Provide as recommended by the meter manufacturer for the actual installation arrangement.
 - b. 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.

2.9 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) 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. For flex-tube water tube boilers provide gages for 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.

2.11 TEMPERATURE SENSORS AND TRANSMITTERS:

- A. Provide resistance temperature detectors (RTD).
- B. Provide transmitters or panel-mounted indicator transmitters, transducers, and receivers compatible with the system including the controllers 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.
- E. Provide stainless steel weather hood on existing outside air temperature sensor, which shields the sensor from direct sunlight.

2.13 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 (15 psig): 0 to 30 psig.
 2. Medium pressure steam to (59 psig): 0 to 100 psig.
 3. High pressure steam above (59 psig): 0 to 200 psig.
 4. Natural and LP gas: 0 to 30 psig.
 5. LP gas at tanks: 0 to 300 psig.
 6. Gas burner, 125 percent of full load pressure, inches WC.
 7. Oil pump suction: 30 inches Hg vacuum to 15 psig.
 8. Oil pump discharge: 0 to 200 psig.
 9. Oil burner, 125 percent of full load pressure, psig.
 10. Compressed air, 345 kPa & higher (50 psi & higher): 0 to 160 psig.
 11. Feedwater pump discharge: 0 to 300 psig.
 12. Feedwater pump suction: 30 inches Hg vacuum to 30 psig.
 13. Pumped condensate: 0 to 400 kPa/0 to 60 psig.
 14. Condensate transfer pump discharge: 0 to 60 psig.
 15. Condensate transfer pump suction: 30 inches Hg vacuum to 15 psig.
 16. Feedwater deaerator: 100 kPa vacuum to 200 kPa/30 inches Hg vacuum to 30 psig.
 17. Other services, 200 percent of maximum operating pressure.
- E. Boiler Steam Pressure Gages: Refer to Section 23 52 33, WATER-TUBE BOILERS.

F. Panel-mounted Gages: Refer to Article, MAIN INSTRUMENTATION AND CONTROL PANEL.

2.14 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 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.

2.15 BOILER PLANT BUILDING DANGEROUS GAS DETECTION SYSTEM; CARBON MONOXIDE AND COMBUSTIBLE GAS:

A. The existing dangerous gas detection system needs an additional carbon monoxide sensor to be located at the bottom of structure in the boiler plant.

B. System Description:

1. Carbon Monoxide (CO) Sensors: Transportable calibration, electrochemical plug-in type, range 0-100 ppm, detection limit less than plus or minus 5% of full scale, response time less than 10 seconds, zero drift less than 5% per year, span drift less than 10% per year, repeatability less than plus or minus 5% of full scale, active temperature compensation. Set point: 25 - 50 ppm. Sensor shall be fully compatible with the existing system.
2. Additional Features:
 - a. Capability to remotely mount sensor from transmitter to allow calibration at convenient point up to 100 feet away.
3. Calibration: Sensor/transmitters shall be calibrated with hand-held calibration devices furnished by system manufacturer. Provide complete calibration kit, including test gases, for commissioning and future calibrations. Provide permanently mounted tubing for remote-mounted sensors.

4. Approvals: NEC and CEC for explosion proof or non-incendive, when required.
5. Product Support: Supplier shall have organization, located within 150 miles of site, with capability of complete on-site product

2.16 GENERAL:

Ashcroft brand gauges and switches are not allowed. Honeywell pressure controls that use plunger switches are not allowed. Those with mercury switches are allowed.

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; and Section 26 05 21, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW). 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".
5. 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.
6. Except for short apparatus connections, run conduit and pneumatic tubing parallel to or at right angles to the building structure.
7. 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.
8. 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.
 9. 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. Locate outside air temperature sensor on north side of building away from heat sources. 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 (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). 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 tests shall be based on the most recent edition of the "VHA Boiler Plant Safety Device Testing Manual", also Refer to Section 23 52 33, WATER-TUBE BOILER.
- C. Steam Flow Measuring: Demonstrate proper calibration of each flow rate signal and indication and each totalizer signal and indication to Resident Engineer 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 Resident Engineer.
- 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 Resident Engineer 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.
- L. Computer Workstation Software Operation Test:
 - 1. Test ability to properly communicate with and operate the control systems.
 - 2. Demonstrate the ability to edit the programs off and on line.
 - 3. Demonstrate operation of all alarm points.
 - 4. Demonstrate the receipt, display, and saving of trend and status reports.
 - 5. Demonstrate display and operation of all graphics.
 - 6. Demonstrate all program calculating functions and report generation.
 - 7. Demonstrate proper operation of all printers.

3.7 STARTUP AND TESTING

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

3.8 COMMISSIONING

- A. Provide commissioning documentation in accordance with the requirements of Section 23 08 00 - COMMISSIONING OF HVAC SYSTEMS for all inspection,

start up, and contractor testing required above and required by the System Readiness Checklist provided by the Commissioning Agent.

- B. Components provided under this section of the specification will be tested as part of a larger system. Refer to Section 23 08 00 - COMMISSIONING OF HVAC SYSTEMS and related sections for contractor responsibilities for system commissioning.

3.9 DEMONSTRATION AND TRAINING

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

- - - E N D - - -

SECTION 23 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 10, COMMON WORK RESULTS FOR Boiler Plant and STEAM GENERATION
- B. Section 23 05 51, NOISE and VIBRATION CONTROL FOR BOILER PLANT.
- C. Control valves: Section 23 52 33, WATER-TUBE BOILERS.
- D. Flow Meters: Section 23 09 11, INSTRUMENTATION and CONTROL FOR BOILER PLANT.
- E. Section 23 08 11, DEMONSTRATIONS and TESTS FOR BOILER PLANT.
- F. Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS. Requirements for commissioning, systems readiness checklists, and training

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:
 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.

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.
4. Boiler and feedwater deaerator steam nozzle (pipe connection) allowable and actual forces and moments imposed by connecting piping.
5. Hanger load calculation methods and results for piping systems with pipe sizes 50 mm (2 inches) and below.
6. Piping layouts showing location and type of each hanger and support.
7. Catalog cuts showing design and construction of each hanger and support and conformance of hangers and supports to MSS standards.
8. Drawings showing arrangement and sizes of all components comprising each spring-type hanger and support assembly.
9. 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 _105_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 415 °F (if economizers are provided and economizer safety relief valve setting is 275 psig). Design pressure is the greater of: boiler feed pump shut off head; or (275 psig) 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 40 psig). Vacuum return systems shall operate between 0 and 8 inch Hg vacuum and equivalent steam saturation temperatures.
- E. Natural gas fuel systems are designed and materials and equipment are applied to prevent failure under gas pressure of _15_ psig entering Government property. LP gas systems for igniters (pilots) are designed for maximum LP tank pressure of 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 130 °F, and pressures of 150 psig.
- 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.
- I. Low pressure steam, condensate, vacuum and vents are designed for service pressures and temperatures equivalent to 15 psig saturated steam.
- J. Compressed air systems are designed to accommodate a maximum pressure of 125 psig.
- K. 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(2009).....Standard Specification for Ferritic Malleable Iron Castings

A48/A48M-03(2008).....Standard Specification for Gray Iron Castings
A53/A53M-10.....Standard Specification for Pipe, Steel, Black
and Hot-Dipped, Zinc-Coated, Welded and
Seamless
A105/A105M-10.....Standard Specification for Carbon Steel
Forgings for Piping Applications
A106/A106M-10.....Standard Specification for Seamless Carbon
Steel Pipe For High Temperature Service
A126-04(2009).....Standard Specification for Gray Iron Castings
for Valves, Flanges and Pipe Fittings
A193/A193M-10.....Standard Specification for Alloy-Steel and
Stainless Steel Bolting Materials for High
Temperature Service
A194/A194M-10.....Standard Specification for Carbon and Alloy
Steel Nuts for Bolts for High-Pressure or High-
Temperature Service, or Both
A197/A197M-00(2006).....Standard Specification for Cupola Malleable
Iron
A216/A216M-08.....Standard Specification for Steel Castings,
Carbon, Suitable for Fusion Welding, For High
Temperature Service
A234/A234M-10.....Standard Specification for Piping Fittings of
Wrought Carbon Steel and Alloy Steel for
Moderate and High Temperature Service
A269-10.....Standard Specification for Seamless and Welded
Austenitic Stainless Steel Tubing for General
Service
A395/A395M-99(2009).....Standard Specification for Ferritic Ductile
Iron Pressure-Retaining Castings for use at
Elevated Temperatures
A536-84(2009).....Standard Specification for Ductile Iron
Castings
B61-08.....Standard Specification for Steam or Valve
Bronze Castings
B62-09.....Standard Specification for Composition Bronze
or Ounce metal Castings
B88/B88M-09.....Standard Specification for Seamless Copper
Water Tube

C. American Society of Mechanical Engineers (ASME):

Boiler and Pressure Vessel Code: ~~2007~~2010 Edition with current Addenda

Section I.....Power Boilers

Section IX.....Welding and Brazing Qualifications

B16.3-2006.....Malleable Iron Threaded Fittings

B16.4-2006.....Gray Iron Threaded Fittings

B16.5-2009.....Pipe Flanges and Flanged Fittings: NPS ½
Through 24

B16.9-2007.....Factory Made Wrought Buttwelding Fittings

B16.11-2009.....Forged Fittings, Socket-Welding and Threaded

B16.22-2001.....Wrought Copper and Copper Alloy Solder Joint
Pressure Fittings

B31.1-2010.....Power Piping

D. Manufacturers Standardization Society of the Valve and Fittings

Industry (MSS):

SP-45-03(2008).....Bypass and Drain Connections

SP-58-2009.....Pipe Hangers and Supports-Materials, Design,
Manufacture, Selection, Application, and
Installation

SP-69-2003.....Pipe Hangers and Supports-Selection and
Application

SP-80-2008.....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 Code

31-2011.....Standard for the Installation of Oil Burning
Equipment

F. American Welding Society (AWS):

B2.1-2009.....Specification for Welding Procedure and
Performance Qualification

G. Pipe Fabrication Institute (PFI):

PFI ES-24-08.....Pipe Bending Methods, Tolerances, Process and
Material Requirements

PART 2 - PRODUCTS:

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

2.1 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 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.

2.6 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 steam condensate lines shall be rated at 510 kPa (75 psi), 120 °C (250 °F). Fittings on services shall be rated for the maximum pressure and temperature conditions of the service.

2.7 EARTHQUAKE AUTOMATIC GAS SHUT OFF VALVE:

A. Automatically stops gas flow to boiler plant when actuated by earth tremor.

- B. Type: Single seated, manual reset.
- C. Performance: Shall automatically shut bubble tight within five seconds when subjected to a horizontal sinusoidal oscillation having a peak acceleration of 2.94 m/sec^2 (0.3G) and a period of 0.4 seconds. The valve shall not shut-off when subjected for five seconds to horizontal, sinusoidal oscillations having: A peak acceleration of 3.92 m/sec^2 (0.4G) with a period of 0.1 second; a peak acceleration of 0.78 m/sec^2 (0.08G) with a period of 0.4 second or 1.0 second. Refer to drawings for pressure, flow and valve size requirements.
- D. Service: Natural gas or LP gas.
- E. Construction: 135 kPa (20 psi) minimum rating. Cast iron or aluminum body, rated for 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. Valves for LP gas service shall be rated at 1725 kPa (250 psi).
- F. Approvals: UL listed, State of California Standards for Earthquake Actuated Automatic Gas Shut-off Systems. Complies with ASCE 25
- G. Nitrile rubber, reset stem o-ring seal.
- H. Valve position indication, open or closed indicators.

2.8 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.

2.9 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.
- I. 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.
- J. 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 RE/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.

K. 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.
- 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.

2.11 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.

2.12 THREAD SEALANTS:

As recommended by the sealant manufacturer for the service.

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. Provide union adjacent to all threaded end valves.
- E. Do not install any piping within 600 mm (2 feet) of water tube 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), 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 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 may require up to ten percent of the welded piping joints to be examined using radiographic testing. If defective welds are discovered the RE 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.
- 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 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. They must comply with MSS-SP-97.

3.5 EXPANSION AND FLEXIBILITY

The design includes provision for piping expansion due to pressure, thermal, and weight. 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 and at no additional cost to the Government.

3.6 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.

3.7 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.

3.8 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.

3.9 DIELECTRIC CONNECTION

Where copper piping is connected to steel piping provide dielectric connections.

3.10 INSTALLATION - SIGHT FLOW INDICATORS

Locate to permit view from floor or platform.

3.11 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.

3.12 INSTALLATION - EMERGENCY GAS SAFETY SHUT-OFF VALVES AND EARTHQUAKE VALVES

- A. Locate so that valve position indicator is visible from nearest walkway.
- B. Provide control wiring and wiring to annunciator on instrumentation panel and to computer workstation (if provided).

3.13 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.

3.14 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.

3.15 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. New Reinforced Concrete Construction: Concrete inserts.
 - 2. 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.
 - 3. 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.
 - 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 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.
- F. Seismic Braces and Restraints: Do not insulate piping within one foot of device until device has been inspected by RE.

3.16 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.

3.17 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 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. When hydrostatic tests show leaks, the RE will require necessary welding repairs, in accordance with ASME B31.1, at the Contractor's cost.
- C. Perform operating test as follows:
 - 1. 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.

2. Test boiler feedwater, systems under service conditions and prove tight.
3. Test oil and compressed air systems under service conditions at pressure equal to highest setting of safety and relief valves in the individual systems.
4. 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.

3.18 COMMISSIONING

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

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SECTION 23 52 33
WATER-TUBE BOILERS

PART 1 - GENERAL

1.1 DESCRIPTION:

This section specifies packaged water tube boiler with trim (accessories), dual fuel (natural gas and fuel oil) burner and fuel trains.

1.2 RELATED WORK:

- A. Section 09 91 00, PAINTING.
- C. Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.
- D. Section 23 05 51, NOISE and VIBRATION CONTROL FOR BOILER PLANT.
- E. Section 23 21 11, BOILER PLANT PIPING SYSTEMS: Valves for boiler trim, non-return stop-check valve, piping for fuel and feedwater trains.
- G. Section 23 09 11, INSTRUMENTATION and CONTROL FOR BOILER PLANT: Burner controls, combustion control system, boiler water level control, pressure gages, thermometers.
- H. Section 23 08 11, DEMONSTRATIONS and TESTS FOR BOILER PLANT.
- I. Section 23 08 00 - COMMISSIONING OF HVAC SYSTEMS: Requirements for commissioning, systems readiness checklists, and training.

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, 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, BURNER and FUEL TRAINS. 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. 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. Complete data on oil atomization air compressor systems with sound attenuators.
 - 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.
- C. Burner Management (Flame Safeguard) Control System: Refer to Section 23 09 11, INSTRUMENTATION and CONTROL FOR BOILER PLANT.
- D. Boiler and Burner Predicted Performance Data, for Each Fuel, Site Altitude:

1. At Maximum Required Output With and Without Economizer (If Applicable) 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.
- E. ASME "P" Forms, Manufacturer's Data Report, on boiler and economizer construction.
- F. Pretest Data - Boiler, Burner, Controls: As required by Part 3.
- G. Final Test Report - Boiler, Burner, Controls: As required by Part 3.
- H. Completed System Readiness Checklists provided by the Commissioning Agent and completed by the contractor, signed by a qualified technician and dated on the date of completion, in accordance with the requirements of Section 23 08 00 COMMISSIONING OF HVAC SYSTEMS.

1.5 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. Pressure provided to the inlet of the boiler-mounted regulators will be _15_psig as maintained by the main gas regulator station.
- D. Fuel Oil: Will be furnished under Government contract. House pumping system provides pressure to the fuel train entrance on each burner fuel train. Verify Pressures. Pressure will vary in accordance with characteristics of backpressure regulator on house oil pump set. Refer to Section 23 50 11, BOILER PLANT MECHANICAL EQUIPMENT. Oil grade (No. 2) refers to ASTM D396.
- E. Air Atomizing Burners: Burner must include a dedicated air compressor system furnished by burner manufacturer.
- 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. ASTM International (ASTM):
A106/A106M-08.....Standard Specification for Seamless Carbon Steel Pipe for High Temperature Service.

- A178/178M-02(2007).....Standard Specification for Electric-Resistance-
Welded Carbon Steel and Carbon-Manganese Steel
Boiler and Superheater Tubes
- A269-10.....Standard Specification for Seamless and
Austenitic Welded Stainless Steel Tubing for
General Service
- C612-10.....Standard Specification for Mineral Fiber Block
and Board Thermal Insulation
- D396-09a.....Standard Specification for 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
Section VII.....Recommended Rules for Care of Power Boilers
Section IX.....Welding and Brazing Qualifications
Performance Test Code (PTC):
PTC 4-2008.....Fired Steam Generators
Code for Pressure Piping:
B31.1-2007.....Power Piping
- 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 (NBPVI):
NB-232007.....National Board Inspection Code
- F. Fluid Controls Institute (FCI):
70-2-2006.....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 BURNER AND FUEL TRAINS:

- A. Burner Type: Combination natural gas and fuel oil, packaged, forced draft, single burner, modulating firing, variable speed forced draft fan. Interrupted igniter (pilot), electrically ignited, natural gas and propane.

1. Gas Burner: Ring type with multiple ports and spuds, or spud type.
2. Oil Burner: Gun type, inside mix, air atomizing.
3. Igniter (Pilot): Interrupted, electrically ignited, natural and LP (propane) gas.

B. Service:

1. Continuous long term operation at all firing rates on each fuel listed under PROJECT CONDITIONS in Part 1. Design the entire burner and fuel train system for application to the specific boiler furnished and for service at the available fuel pressures and heating values.
2. Operate at all loads on any one fuel without any manual changes to burners, fuel trains or fuel pressures, atomizing media trains or pressures.
3. Igniter (Pilot) Fuels: Normal fuel will be natural gas. Propane will be used if there is an interruption in natural gas service.

C. Performance:

1. Igniter (pilot) flame on natural gas and propane shall form close to the point of ignition and shall be stable. Ignite both the gas and oil burner with single igniter.
2. Main flame on gas and oil fuels shall ignite at lowest firing rate.
3. Main flame characteristics at all firing rates:
 - a. Flame retained within 150 mm (6 inches) of diffuser.
 - b. Flame stable with no blowoff from the burner or flashback into the burner. No pulsations.
 - c. Throat refractory shall be sufficiently heated to provide stable flame on gas firing.
 - d. No deposits of unburned fuel or carbon at any location.
 - e. No carryover of flame beyond the end of the first pass (furnace).
 - f. Flame impingement on furnace tubes or refractory is not permitted if it results in hard carbonaceous deposits on furnace tubes or refractory or excessive emissions in the flue gas, or failure of furnace tubes, or deterioration of refractory.
4. Main Burner Operation:
 - a. Minimum turndown 10/1 on natural gas and 8/1 on fuel oil.
 - b. Utilize full travel of fuel control valve characterization cams (if cam type valve is utilized).
 - c. Operate at all loads on any one fuel without any manual changes to burners, fuel or atomizing media trains or pressures, air train.
 - d. Excess Air in Flue Gases with Oxygen Trim at Null Position:

Boiler Steam Output, Percent of Maximum Required Capacity	Percent Excess Air Allowable Range
Below 25	15 minimum
25 - 39	15 - 35
40 - 100	15 - 25

- e. Performance at any load point shall be repeatable after increasing or decreasing the firing rate. Repeatability plus or minus two percent excess air, at 20 percent and higher boiler loading except excess air must remain within ranges specified above.
5. Oxygen trim control set at maximum position shall not blow out the fire at any load point. At minimum position, the combustion shall not go below stoichiometric.
6. Oil Atomization: Light-off shall be with compressed air atomization media supplied by house compressor. Boiler shall operate with combustion controls on "manual" and continuously generate at least 13 percent of the maximum rated steam flow with input compressed air at 550 kPa (80 psi) and a maximum of 0.8 standard cubic meters per minute (30 SCFM).
7. Noise and Vibration: Refer to Section 23 05 51, NOISE and VIBRATION CONTROL FOR BOILER PLANT for requirements on forced draft fan and oil atomization system. Burners shall operate without pulsation.
- D. Flue Gas Emissions Limits:
1. Carbon Monoxide: Shall not exceed 200 PPM.
 2. Smoke: On natural gas and No. 2 oil shall not be visible and shall not exceed No. 1 on the Bacharach smoke scale.
- E. Burner Design, Construction and Arrangement:
1. Burner Access (Main Burner and Igniter): Arrange fuel trains, controls and other devices so that they do not interfere with the removal and replacement of burner parts.
 2. Arrangement of Fuel Trains: All devices shall be accessible for maintenance or replacement without removal of other devices. Do not mount any piping or devices within 600 mm (2 feet) of boiler side and top casings, and do not attach any piping or devices to boiler casings.
 3. Coatings: Provide surface preparation, heat resistant prime and finish coats using standard color of boiler manufacturer. Refer to Section 09 91 00, PAINTING.

4. Combustion Air System :
 - a. Air flow rates controlled by forced draft fan inlet or outlet dampers and variable speed drive.
 - b. Symmetrical, balanced distribution of combustion air into the burner.
 - c. Forced Draft Fan: Airfoil or backwardly inclined wheel, electric motor driven. Design for required excess air and for static pressure that is based on losses from fan inlet to stack or chimney outlet, including economizer, at jobsite altitude. Fan shall have no resonant frequencies at all operating speeds.
 - e. Motor: TEFC or open drip proof, non-overloading under all fan operating conditions, design for 40 °C ambient, premium efficiency type. Motors for variable speed service shall be rated inverter-ready. Refer to Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.
 - f. Damper: Design to provide accurate control of excess air with minimum hysteresis. On variable speed systems, the damper shall control only at lower firing rates.
 - g. Motor Starter Panel: Provide motor starter and variable speed drive mounted in NEMA 4 enclosure, readily accessible. Refer to Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION. Refer to Section 23 09 11, INSTRUMENTATION and CONTROL FOR BOILER PLANT, for burner management system motor power interlocks.
 - h. Sound Attenuator for burner on Boiler No. 3: Provide attenuator on forced draft air intake to reduce sound levels to allowable limits. Refer to Section 23 05 51, NOISE and VIBRATION CONTROL FOR BOILER PLANT.
5. Provide viewport, with one clear and one tinted replaceable interchangeable glass. Locate to permit view of main and igniter flames.
6. Burner Throat: Refractory tile, shaped to promote proper combustion, arranged with provisions for expansion and contraction and rated by the refractory manufacturer for the maximum service conditions.
7. Electrical Conduit: Provide liquid-tight flexible metal conduit with sealing fittings for all power and control services to fuel trains and burners. Refer to Section 26 05 33, RACEWAY and BOXES FOR ELECTRICAL SYSTEMS.
8. Factory Testing (Factory-Assembled Boilers): Mount burner and controls on boiler at factory and fire-test at all load points.

F. Natural Gas Main Fuel Valve and Piping Train:

1. Arrangement: Comply with typical arrangement in NFPA 85, Annex A, as modified by the following description: Starting at the entrance to the train, the devices are, in sequence: plug valve, filter, pressure gage, pressure regulator, valved connection to pilot burner fuel train, flow meter, pressure gage, low pressure switch, two automatic safety shut off valves, valved leak test, high pressure switch, fuel flow control valve, plug valve, pressure gage, burner. Provide tee connection for vent between the automatic safety shut off valves. Vent line shall include valved leak test connection, automatic vent valve, valved leak test connection, lockable plug valve, vent thru roof. High and low pressure switches shall be located to sense the constant pressure controlled by the burner pressure regulator and not the variable burner pressure.
2. Filter: Replaceable fiberglass or cellulose cartridge, 10 micron or smaller particle retention. Static pressure capability two times the maximum lock-up pressure of nearest upstream pressure regulator. Maximum pressure loss at high fire 1.3 kPa (5 inches water column). Provide vent with cock for relieving pressure in filter.
3. Pressure Regulator:
 - a. Type: Single seated, diaphragm-operated, designed for natural gas service. Controlled pressure shall be sensed downstream of main valve. Valve may be self-operated or pilot-operated as necessary to comply with performance requirements.
 - b. Service: Provide precisely controlled downstream pressure in fuel train, with upstream pressure as shown or specified. Inlet and outlet emergency pressure rating shall be at least twice the lock-up pressure of the nearest upstream pressure regulator. Purpose of high performance regulator is to provide more accurate flow control and thus greater burner efficiency and to allow set points of high and low gas pressure switches to be closer to the normal operating pressure.
 - c. Performance: Coordinate with burner requirements. Lock-up pressure shall not exceed 1.5 times regulated pressure. Coordinate speed of response with opening and closing time of automatic safety shut-off valves so that controlled pressure will be maintained during the opening and closing of the safety shut-off valves. The outlet pressure droop from low fire to high fire shall not exceed 5 percent of the set pressure.
 - d. Construction, Main Valve: Cast iron body, replaceable plug and seat.

4. Automatic Safety Shut-Off Valves:
 - a. Type: Motorized-opening, spring closing, controlled by burner control system. Two valves required.
 - b. Service: Provide open-shut control of fuel flow to burner. Valves shall shut bubble tight and be suitable for operation with upstream pressure of two times the highest pressure at entrance to boiler-mounted regulators.
 - c. Performance: Timed opening of six seconds or less to safely and smoothly ignite main flame, and close within one second.
 - d. Construction: Valves 65 mm (2-1/2 inches) and larger, flanged ends; valves 50 mm (2 inches) and below threaded ends; position indicator showing open and shut, visible from front or side of boiler. Aluminum seating surfaces not permitted. Proof of closure interlock switch on each valve. Proof of closure electrical circuit shall include non-latching push button interrupter for testing the circuit. Valved leak test fittings before and after each valve.
 - e. Approval: FM approved, UL listed for burner service. Valves shall be Maxon only.
 - f. Proof of Closure Test: Provide non-latching push button control in the proof of closure circuit to interrupt the circuit for testing.
5. Automatic Vent Valve:
 - a. Type: Motorized or solenoid closing, spring opening, full port, controlled by burner control system.
 - b. Service: Provide open-shut control of vent line that is connected between the two safety shut-off valves. Valves shall shut bubble-tight and be suitable for operation with upstream pressure of two times the highest pressure at entrance to boiler-mounted regulators. Valve shall be open whenever safety shut-off valves are closed.
 - c. Approval: UL listed for burner service.
6. Vent System Manual Plug Valve for Leak Tests: Located on vent line on outlet side of automatic vent valve. Provide locking device and lock wrench to lock valve to open position. Provide cylinder padlock keyed to VA Engineering key. Provide valved leak test connections between automatic vent valve and plug valve and ahead of the automatic vent valve.
7. Pressure Switches: Refer to the article on burner management system in Section 23 09 11, INSTRUMENTATION and CONTROL FOR BOILER PLANT.
8. Fuel Flow Control Valve:

- a. Type: Throttling, controlled by combustion control system (Refer to Section 23 09 11, INSTRUMENTATION and CONTROL FOR BOILER PLANT). Valve with adjustable characterization cam required on single point positioning control systems.
 - b. Performance and Service: Control fuel flow in exact proportion to combustion airflow over the entire firing range of the burner. Static pressure rating shall exceed the lockup pressure of the boiler-mounted regulator.
 - c. Construction: If provided, characterization cam shall be shaped by at least twelve adjustment screws.
9. Pressure Gages, Flow Meter: Refer to Section 23 09 11, INSTRUMENTATION and CONTROL FOR BOILER PLANT.
- G. Fuel Oil Valve and Piping Train:
 1. Arrangement: Comply with typical arrangement in NFPA 85, Annex A, as modified by the following description. Starting at the entrance to the train, the devices are, in order: manual shut off valve, filter, pressure gage, pressure regulator (if required by burner furnished), low pressure switch, high pressure switch, oil flow control valve, thermometer, valved drain, automatic safety shut off valve, valved leak test, automatic safety shut off valve, valved leak test, manual shut off valve, pressure gage, burner.
 2. Filter: Permanent edge-type elements, cleanable by rotation of a handle without interruption of flow. Filter element spacing 0.1 mm (0.0035 inch). Pressure rating shall exceed upstream safety relief valve set pressure plus accumulation. Maximum pressure loss 20 kPa (3 psi) at high fire. Provide plugged drain.
 3. Automatic Safety Shut-Off Valves:
 - a. Type: Motorized-opening, spring closing, controlled by burner control system. Two 2-way valves required on No. 2 oil service;
 - b. Service: Provide open-shut control of fuel flow to burner. Valves shall shut bubble-tight and be suitable for operation with upstream pressure exceeding upstream safety relief valve set pressure plus accumulation.
 - a. Performance: Timed opening of seven seconds or less to safely and smoothly ignite oil burner, one-second closure.
 - b. Construction: Threaded ends, valve position indicator visible from front or side of boiler. Proof of closure interlock switch on each valve. Provide non-latching push button switch in proof of closure circuit to interrupt circuit for testing.
 - c. Approval: FM approved, UL listed for burner service.

- d. Provide 9.5 mm (3/8 inch) relief valve on piping between safety shut-off valves, 1375 kPa (200 psi) rating, tight shut-off. Set pressure lower than pressure rating of safety shut-off valves. Provide valved leak-test connections between the two safety shut off valves and after the second safety shut off valve.
- 4. Pressure Switches: Refer to the article on burner management system in Section 23 09 11, INSTRUMENTATION and CONTROL FOR BOILER PLANT. Set points shall be as required by the burner manufacturer. If there are no requirements, the set points shall be within 50% of the controlled pressure.
- 5. Fuel Flow Control Valve:
 - a. Type: Throttling, controlled by combustion control system (Refer to Section 23 09 11, INSTRUMENTATION and CONTROL FOR BOILER PLANT). Valve with adjustable characterization cam required for single point positioning control systems.
 - b. Performance and Service: Control fuel flow in exact proportion to combustion airflow over the entire firing range of the burner. Pressure rating shall exceed oil pump safety relief valve pressure setting plus accumulation.
 - c. Construction: If provided, characterization cam shall be shaped by at least twelve adjustment screws.
- 6. Provide oil pump arranged and piped to provide automatic drainage of oil gun when burner is shut down manually. Not required when oil gun is less than 600 mm (2 feet) long.
- 7. Pressure Gages, Thermometers, Flow Meter: Refer to Section 23 09 11, INSTRUMENTATION and CONTROL FOR BOILER PLANT.
- H. Air Atomizing Valve and Piping Train:
 - 1. Differential Pressure Control Valve:
 - a. Type: Spring loaded, diaphragm-actuated, controlled by oil pressure at burner.
 - b. Service: Provide control of air pressure to the oil burner. Base valve size air pressure available at valve inlet. Valve body shall be rated for 1375 kPa (200 psi) steam pressure.
 - c. Performance: As required by burner.
 - d. Construction: Cast iron body, stainless steel trim, double stainless steel diaphragms with vented space between to separate oil and steam or air.
 - 2. Pressure Switches: Refer to paragraphs on the burner control system under Section 23 09 11, INSTRUMENTATION and CONTROL FOR BOILER PLANT.
 - 3. Shut-Off Valve:

- a. Type: Motorized or solenoid opening, spring closing, controlled by burner control system.
 - b. Service: Provide open-shut control of atomizing media flow to burner. If solenoid valve requires a minimum differential pressure for operation, coordinate pressure requirements with available pressures. Valve body shall be rated for 1025 kPa (150 psi) dead-end shut-off.
- I. Igniter (Pilot) Fuel Valve and Piping Train, Burner and Ignition System:
- 1. Arrangement: Comply with typical arrangement in NFPA 85, Annex A, as modified by the following description: Arrange the system to allow selection of either natural gas or propane for the ignition fuel. Provide separate piping with plug valve, pressure gage, filter and pressure regulator for natural gas and for propane. Connect to the main burner natural gas service downstream of the main burner pressure regulator. Join the natural gas and propane services by means of a three-way plug valve. Continue with one pipe line including a low pressure switch, pressure gage, automatic safety shut off valve, automatic vent, automatic safety shut off valve, igniter.
 - 2. Filters: Replaceable elements, five micron or smaller particle retention. Static pressure capability two times the maximum lockup pressure of nearest upstream pressure regulator. Maximum pressure loss, at full flow, 1.3 kPa (5 inches water column). Provide unions for filter removal.
 - 3. Pressure Regulators:
 - a. Type: Single-seated, diaphragm-operated. Provide separate regulators for natural gas service and for LP gas service. (Refer to the schematic diagrams shown on the drawings).
 - b. Service: Provide controlled pressure in igniter train as required by igniter, with upstream pressures as shown or specified. Inlet and outlet emergency pressure rating shall be at least twice the lockup pressure of the nearest upstream pressure regulator. As an alternate to the outlet emergency pressure rating, provide internal relief valve vented to outside set at pressure that will avoid overpressure on regulator outlet that could damage the regulator.
 - c. Performance: Lockup pressure shall not exceed 1.5 times the regulated pressure.
 - d. Construction: LP gas regulator must be designed for 1725 kPa (250 psi) maximum pressure.
 - 4. Automatic Safety Shut-Off and Vent Valves:

- a. Type: Solenoid-type, two normally closed shut-off valves and one normally-open vent valve, arranged as shown, controlled by the burner control system. Provide threaded leak-test ports with threaded plugs on each shut-off valve body.
 - b. Service: Provide open-shut control of fuel flow to igniter and vent between shut-off valves. Design for 140 kPa (20 psi) differential at shut-off.
 - c. Approval: Safety shut-off valves UL listed, FM approved for burner service. Vent valves UL listed for burner service.
5. Vent System Manual Plug Valve for Leak Tests: Located on vent line on outlet side of automatic vent valve. Provide locking device and lock wrench to lock valve to open position. Provide cylinder padlock keyed to VA Engineering key. Provide valved leak test connections between automatic vent valve and plug valve and ahead of the automatic vent valve.
 6. Igniter and Ignition System: Provide removable igniter, ignition electrodes, ignition transformer, high voltage cable. Provide shield at ignition area so that spark is not visible to ultraviolet (if provided) flame scanner from any position on its mounting.
 7. Igniter fuel train pipe and fittings: ASME B31.1 requirements do not apply. Refer to Section 23 21 11, BOILER PLANT PIPING SYSTEMS.
 8. Pressure Switch and Pressure Gages: Refer to Section 23 09 11, INSTRUMENTATION and CONTROL FOR BOILER PLANT.

2.2 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.

2.3 TOOLS:

- A. Oil Burner Vise and Wrenches: Deliver to the Contracting Officers Technical Representative (COTR)/Resident Engineer (RE) 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/RE for mounting by VA personnel. Furnish only if oil gun must be removed from burner when firing gas.
- C. Burner throat sweep to provide proper shape for reconstruction of castable refractory throats. Not required for throats made of preshaped tiles.

2.4 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. Complete set of filter elements and gaskets for each gas filter for each boiler.
4. Complete set of all gaskets for each edge-type oil filter for each boiler.

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 gallon oil for burner-mounted atomizing air compressors.
6. If cast refractory plug is utilized for furnace access, provide sufficient refractory material to rebuild one plug for each boiler.
7. One set of all gaskets for each type of oil gun.
8. One oil gun and nozzle of each type and size utilized.
9. 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. Soot Blower Element Position: Adjust so that nozzles do not blow directly on tubes.
- D. 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, 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 boiler is 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 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 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 RE.

B. Condition of Boiler and Economizer: Contractor and 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, Computer Workstation:

1. Perform tests on each 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 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 and computer workstation (if provided) 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 P, 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 temperature (heated oil only).
 - 6) Fuel flow rate.
 - 7) Boiler feed pressure, upstream of feedwater regulator (at minimum, 50 percent and maximum firing positions only).
 - 8) Boiler feed temperature (at minimum, 50 percent, maximum firing positions only).

- 9) Stack temperature: Boiler outlet, economizer outlet.
 - 10) Flue gas oxygen and carbon monoxide (utilize instrument which has been calibrated with certified test gases).
 - 11) Flue gas NO_x (if limit specified).
 - 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.
- 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.

3.4 STARTUP AND TESTING

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

3.5 COMMISSIONING

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

3.6 DEMONSTRATION AND TRAINING

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

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SECTION 26 05 11
REQUIREMENTS FOR ELECTRICAL INSTALLATIONS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section applies to all sections of Division 26.
- B. Furnish and install electrical 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, generators, automatic transfer switches, and other items and arrangements for the specified items are shown on drawings.
- C. Electrical service entrance equipment and arrangements for temporary and permanent connections to the utility's system shall conform to the utility's requirements. Coordinate fuses, circuit breakers and relays with the utility's system, and obtain utility 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 International Building Code (IBC), 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, materials, or services included in a list published by an organization that is acceptable to the authority having jurisdiction and concerned with evaluation of products or services, that maintains periodic inspection of production or listed equipment or materials or periodic evaluation of services, and whose listing states that the equipment, material, or services either meets appropriate designated standards or has been tested and found suitable for a specified purpose.
2. Labeled; Equipment or materials to which has been attached a label, symbol, or other identifying mark of an organization that is acceptable to the authority having jurisdiction and concerned with product evaluation, that maintains periodic inspection of production of labeled equipment or materials, and by whose labeling the manufacturer indicates compliance with appropriate standards or performance in a specified manner.
3. Certified; equipment or product 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 eight hours of receipt of

notification that service is needed. Submit name and address of service organizations.

1.5 APPLICABLE PUBLICATIONS

Applicable publications listed in all Sections of Division are the latest issue, unless otherwise noted.

1.6 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 or type 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 Resident Engineer 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 Resident Engineer 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.

1.7 EQUIPMENT REQUIREMENTS

Where variations from the contract requirements are requested in accordance with Section 00 72 00, GENERAL CONDITIONS and 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.

1.8 EQUIPMENT PROTECTION

- A. Equipment and materials shall be protected during shipment and storage against physical damage, vermin, dirt, corrosive substances, fumes, moisture, cold and rain.
1. Store equipment indoors in clean dry space with uniform temperature to prevent condensation. Equipment shall include but not be limited to switchgear, switchboards, panelboards, transformers, motor control centers, motor controllers, uninterruptible power systems, enclosures, controllers, circuit protective devices, cables, wire, light fixtures, electronic equipment, and accessories.
 2. During installation, equipment shall be protected against entry of foreign matter; and be vacuum-cleaned both inside and outside before testing and operating. Compressed air shall not be used to clean equipment. Remove loose packing and flammable materials from inside equipment.
 3. Damaged equipment shall be, as determined by the Resident Engineer, placed in first class operating condition or be returned to the source of supply for repair or replacement.
 4. Painted surfaces shall be protected with factory installed removable heavy kraft paper, sheet vinyl or equal.
 5. 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.

1.9 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 Resident Engineer 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 Resident Engineer.
- 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, safely and professionally. Disturbed or damaged work shall be replaced or repaired to its prior conditions, as required by Section 01 00 00, GENERAL REQUIREMENTS.
- F. Coordinate location of equipment and conduit with other trades to minimize interferences.

1.10 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 quickly for operation, maintenance, or inspections without the use of ladders, or without climbing or crawling under or over obstacles such as, but not limited to, motors, pumps, belt guards, transformers, piping, ductwork, conduit and raceways.

1.11 EQUIPMENT IDENTIFICATION

- A. In addition to the requirements of the NEC, install an identification sign which clearly indicates information required for use and maintenance of items such as switchboards and switchgear, panelboards, cabinets, motor controllers (starters), fused and unfused safety switches, automatic transfer switches, separately enclosed circuit breakers, individual breakers and controllers in switchboards,

switchgear and motor control assemblies, control devices and other significant equipment.

- B. Nameplates for Normal Power System equipment shall be laminated black phenolic resin with a white core with engraved lettering. Nameplates for Essential Electrical System (EES) equipment, as defined in the NEC, shall be laminated red phenolic resin with a white core with engraved lettering. Lettering shall be a minimum of 1/2 inch [12mm] high. Nameplates shall indicate equipment designation, rated bus amperage, voltage, number of phases, number of wires, and type of EES power branch as applicable. Secure nameplates with screws.
- C. Install adhesive arc flash warning labels on all equipment as required by NFPA 70E. Label shall indicate the arc hazard boundary (inches), working distance (inches), arc flash incident energy at the working distance (calories/cm²), required PPE category and description including the glove rating, voltage rating of the equipment, limited approach distance (inches), restricted approach distance (inches), prohibited approach distance (inches), equipment/bus name, date prepared, and manufacturer name and address.

1.12 SUBMITTALS

- A. Submit 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.
3. Elementary and interconnection wiring diagrams for communication and signal systems, control systems and equipment assemblies. All terminal points and wiring shall be identified on wiring diagrams.
 4. Parts list which shall include those replacement parts recommended by the equipment manufacturer.
- 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 instructions.
 - e. Safety precautions for operation and maintenance.
 - f. Diagrams and illustrations.
 - g. Periodic maintenance and testing procedures and frequencies, including replacement parts numbers and replacement frequencies.
 - h. Performance data.
 - i. Pictorial "exploded" parts list with part numbers. Emphasis shall be placed on the use of special tools and instruments. The list shall indicate sources of supply, recommended spare parts, and name of servicing organization.

- j. List of factory approved or qualified permanent servicing organizations for equipment repair and periodic testing and maintenance, including addresses and factory certification qualifications.
- G. Approvals will be based on complete submission of manuals together with shop drawings.
- H. After approval and prior to installation, furnish the Resident Engineer 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, occupancy sensor, outlet box, manual motor starter, device wall plate, engraved nameplate, wire and cable splicing and terminating material, and branch circuit single pole molded case circuit breaker.

1.13 SINGULAR NUMBER

Where any device or part of equipment is referred to in these specifications in the singular number (e.g., "the switch"), this reference shall be deemed to apply to as many such devices as are required to complete the installation as shown on the drawings.

1.14 ACCEPTANCE CHECKS AND TESTS

The contractor shall furnish the instruments, materials and labor for field tests.

1.15 TRAINING

- A. Training shall be provided in accordance with Article 1.25, 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 Resident Engineer 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. Section 07 84 00, FIRESTOPPING: Sealing around penetrations to maintain the integrity of fire-rated construction.
- B. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements that are common to more than one section.
- C. Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS: Requirements for personnel safety and to provide a low impedance path for possible ground fault currents.
- D. Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS: Conduits for cables and wiring.

1.3 QUALITY ASSURANCE

Refer to Paragraph, QUALIFICATIONS, in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1.4 FACTORY TESTS

Low voltage cables shall be thoroughly tested at the factory per NEMA WC-70 to ensure that there are no electrical defects. Factory tests shall be certified.

1.5 SUBMITTALS

In accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, submit the following:

- 1. Manufacturer's Literature and Data: Showing each cable type and rating.
- 2. Certifications: Two weeks prior to the final inspection, submit four copies of the following certifications to the Resident Engineer:
 - a. Certification by the manufacturer that the materials conform to the requirements of the drawings and specifications.
 - b. Certification by the contractor that the materials have been properly installed, connected, and tested.

1.6 APPLICABLE PUBLICATIONS

- A. Publications listed below (including amendments, addenda, revisions, supplements and errata) form a part of this specification to the extent referenced. Publications are reference in the text by designation only.

- B. American Society of Testing Material (ASTM):
D2301-04.....Standard Specification for Vinyl Chloride
Plastic Pressure-Sensitive Electrical Insulating
Tape
- C. National Fire Protection Association (NFPA):
70-11.....National Electrical Code (NEC)
- D. National Electrical Manufacturers Association (NEMA):
WC 70-09.....Power Cables Rated 2000 Volts or Less for the
Distribution of Electrical Energy
- E. Underwriters Laboratories, Inc. (UL):
44-05.....Thermoset-Insulated Wires and Cables
83-08.....Thermoplastic-Insulated Wires and Cables
467-071.....Electrical Grounding and Bonding Equipment
486A-486B-03.....Wire Connectors
486C-04.....Splicing Wire Connectors
486D-05.....Sealed Wire Connector Systems
486E-94.....Equipment Wiring Terminals for Use with Aluminum
and/or Copper Conductors
493-07.....Thermoplastic-Insulated Underground Feeder and
Branch Circuit Cable
514B-04.....Conduit, Tubing, and Cable Fittings
1479-03.....Fire Tests of Through-Penetration Fire Stops

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

- A. Conductors and cables shall be in accordance with NEMA WC-70 and as specified herein.
- 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. XHHW-2 or THHN-THWN shall be in accordance with NEMA WC-70, UL 44, and UL 83.
- 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
Blue	C	Yellow
White	Neutral	Gray *
* or white with colored (other than green) tracer.		

- a. Lighting circuit "switch legs" and 3-way switch "traveling wires" shall have color coding that is unique and distinct (e.g., pink and purple) from the color coding indicated above. The unique color codes shall be solid and in accordance with the NEC.
2. Use solid color insulation or solid color coating for No. 12 AWG and No. 10 AWG branch circuit phase, neutral, and ground conductors.
3. Conductors No. 8 AWG and larger shall be color-coded using one of the following methods:
 - a. Solid color insulation or solid color coating.
 - b. Stripes, bands, or hash marks of color specified above.
 - c. Color as specified using 0.75 in [19 mm] wide tape. Apply tape in half-overlapping turns for a minimum of 3 in [75 mm] for terminal points, and in junction boxes, pull-boxes, troughs, and manholes. Apply the last two laps of tape with no tension to prevent possible unwinding. Where cable markings are covered by tape, apply tags to cable, stating size and insulation type.
4. For modifications and additions to existing wiring systems, color coding shall conform to the existing wiring system.

2.2 SPLICES AND JOINTS

- A. In accordance with UL 486A, C, D, E, and NEC.
- B. Aboveground Circuits (No. 10 AWG and smaller):
 1. Connectors: Solderless, screw-on, reusable pressure cable type, rated 600 V, 220° F [105° 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 manufacturer's packaging, shall be strictly followed.
- C. Aboveground Circuits (No. 8 AWG and larger):
 1. Connectors shall be indent, hex screw, or bolt clamp-type of high conductivity and corrosion-resistant material, listed for use with copper and aluminum conductors.

2. Field-installed compression connectors for cable sizes 250 kcmil and larger shall have not fewer 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. Splice and joint insulation level shall be not less than the insulation level of the conductors being joined.
4. Plastic electrical insulating tape: Per ASTM D2304, flame-retardant, cold and weather resistant.

2.3 CONTROL WIRING

- A. Unless otherwise specified elsewhere in these specifications, control wiring shall be as specified for power and lighting wiring, except that the minimum size shall be not less than No. 14 AWG.
- B. Control wiring shall be large enough such that the voltage drop under in-rush conditions does not adversely affect operation of the controls.

2.4 WIRE LUBRICATING COMPOUND

- A. Lubricating compound shall be suitable for the wire insulation and conduit, and shall not harden or become adhesive.

PART 3 - EXECUTION

3.1 GENERAL

- A. Install in accordance with the NEC, and as specified.
- B. Install all wiring in raceway systems.
- C. Splice cables and wires only in outlet boxes, junction boxes, pull-boxes, manholes, or handholes.
- D. Wires of different systems (e.g., 120 V, 277 V) 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 panel boards, 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. Use lubricants approved for the cable.
 2. Use nonmetallic ropes 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. All cables in a single conduit shall be pulled simultaneously.
 5. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- I. No more than three single-phase branch circuits shall be installed in any one conduit.

3.2 NOT USED 3.3 SPLICE INSTALLATION

- A. Splices and terminations shall be mechanically and electrically secure.
- B. Tighten electrical connectors and terminals according to manufacturer's published torque values.
- C. 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 FEEDER IDENTIFICATION

- A. In each interior pull-box and junction box, install metal tags on all circuit cables and wires to clearly designate their circuit identification and voltage. The tags shall be the embossed brass type, 1.5 in [40 mm] in diameter and 40 mils thick. Attach tags with plastic ties.

3.5 EXISTING WIRING

Unless specifically indicated on the plans, existing wiring shall not be reused for a new installation.

3.6 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 panel boards of suitable voltages, which are intended to supply such systems and have suitable spare circuit breakers or space for installation.

3.7 CONTROL AND SIGNAL SYSTEM WIRING IDENTIFICATION

- A. Install a permanent wire marker on each wire at each termination.
- B. Identifying numbers and letters on the wire markers shall correspond to those on the wiring diagrams used for installing the systems.
- C. Wire markers shall retain their markings after cleaning.

3.8 ACCEPTANCE CHECKS AND TESTS

- A. Feeders and branch circuits shall have their insulation tested after installation and before connection to utilization devices, such as fixtures, motors, or appliances. Test each conductor with respect to adjacent conductors and to ground. Existing conductors to be reused shall also be tested.
- B. Applied voltage shall be 500VDC for 300-volt rated cable, and 1000VDC for 600-volt rated cable. Apply test for one minute or until reading is constant for 15 seconds, whichever is longer. Minimum insulation resistance values shall not be less than 25 megohms for 300-volt rated cable and 100 megohms for 600-volt rated cable.
- C. Perform phase rotation test on all three-phase circuits.
- D. The contractor shall furnish the instruments, materials, and labor for all 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 the general grounding and bonding requirements for electrical equipment and operations 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 made, supplementary, and 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 QUALITY ASSURANCE

Refer to Paragraph, QUALIFICATIONS, in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1.4 SUBMITTALS

- A. Submit in accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.
- B. Shop Drawings:
 - 1. Clearly present enough information 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 are in accordance with the drawings and specifications.
 - 2. Certification by the contractor that the complete installation has been properly installed and tested.

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 designation only.

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

B1-07.....Standard Specification for Hard-Drawn Copper
Wire

B3-07.....Standard Specification for Soft or Annealed
Copper Wire

B8-04.....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

C2-07.....National Electrical Safety Code

C. National Fire Protection Association (NFPA):

70-11.....National Electrical Code (NEC)

99-2005.....Health Care Facilities

D. Underwriters Laboratories, Inc. (UL):

44-05Thermoset-Insulated Wires and Cables

83-08Thermoplastic-Insulated Wires and Cables

467-07Grounding and Bonding Equipment

486A-486B-03Wire Connectors

PART 2 - PRODUCTS

2.1 GROUNDING AND BONDING CONDUCTORS

A. Equipment grounding conductors shall be UL 44 or UL 83 insulated stranded copper, except that sizes No. 10 AWG [6 mm²] and smaller shall be solid copper. Insulation color shall be continuous green for all equipment grounding conductors, except that wire sizes No. 4 AWG [25 mm²] and larger shall be identified per NEC.

B. Bonding conductors shall be ASTM B8 bare stranded copper, except that sizes No. 10 AWG [6 mm²] and smaller shall be ASTM B1 solid bare copper wire.

C. Conductor sizes shall not be less than shown on the drawings, or not less than required by the NEC, whichever is greater.

2.2 GROUND CONNECTIONS

A. Above Grade:

1. Bonding Jumpers: Compression-type connectors, using zinc-plated fasteners and external tooth lockwashers.
2. Connection to Building Steel: Exothermic-welded type connectors.
3. Ground Busbars: Two-hole compression type lugs, using tin-plated copper or copper alloy bolts and nuts.
4. Rack and Cabinet Ground Bars: One-hole compression-type lugs, using zinc-plated or copper alloy fasteners.

PART 3 - EXECUTION

3.1 GENERAL

- A. Ground in accordance with the NEC, as shown on drawings, and as specified herein.
- B. 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.

3.2 INACCESSIBLE GROUNDING CONNECTIONS

Make grounding connections, which are normally buried or otherwise inaccessible (except connections for which access for periodic testing is required), by exothermic weld.

3.3 RACEWAY

A. Conduit Systems:

1. Ground all metallic conduit systems. All metallic conduit systems shall contain an equipment grounding conductor.
2. Non-metallic conduit systems, except non-metallic feeder conduits that carry a grounded conductor from exterior transformers to interior or building-mounted service entrance equipment, shall contain an equipment grounding conductor.
3. Conduit that only contains a grounding conductor, and is provided for its mechanical protection, shall be bonded to that conductor at the entrance and exit from the conduit.
4. Metallic conduits which terminate without mechanical connection to an electrical equipment housing by means of locknut and bushings or adapters, shall be provided with grounding bushings. Connect bushings with a bare grounding conductor to the equipment ground bus.

- B. Feeders and Branch Circuits: Install equipment grounding conductors with all feeders and power and lighting branch circuits.
- C. Boxes, Cabinets, Enclosures, and Panelboards:
 - 1. Bond the equipment grounding conductor to each pullbox, junction box, outlet box, device box, cabinets, and other enclosures through which the conductor passes
 - 2. Provide lugs in each box and enclosure for equipment grounding conductor termination.
- D. Wireway Systems:
 - 1. Bond the metallic structures of wireway to provide 100% electrical continuity throughout the wireway system, by connecting a No. 6 AWG [16 mm²] bonding jumper at all intermediate metallic enclosures and across all section junctions.
 - 2. Install insulated No. 6 AWG [16 mm²] bonding jumpers between the wireway system, bonded as required above, and the closest building ground at each end and approximately every 50 ft [16 M].
 - 3. Use insulated No. 6 AWG [16 mm²] bonding jumpers to ground or bond metallic wireway at each end for all intermediate metallic enclosures and across all section junctions.
- E. Receptacles shall not be grounded through their mounting screws. Ground receptacles with a jumper from the receptacle green ground terminal to the device box ground screw and a jumper to the branch circuit equipment grounding conductor.
- F. Ground lighting fixtures to the equipment grounding conductor of the wiring system 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.
- G. Fixed electrical appliances and equipment shall be provided with a ground lug for termination of the equipment grounding conductor.

3.4 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.

3.5 CONDUCTIVE PIPING

- A. Bond all conductive piping systems, interior and exterior, to the grounding electrode system. Bonding connections shall be made as close as practical to the equipment ground bus.

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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. Section 06 10 00, ROUGH CARPENTRY: Mounting board for telephone closets.
- B. Section 07 60 00, FLASHING AND SHEET METAL: Fabrications for the deflection of water away from the building envelope at penetrations.
- C. Section 07 84 00, FIRESTOPPING: Sealing around penetrations to maintain the integrity of fire rated construction.
- D. Section 07 92 00, JOINT SEALANTS: Sealing around conduit penetrations through the building envelope to prevent moisture migration into the building.
- E. Section 09 91 00, PAINTING: Identification and painting of conduit and other devices.
- F. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements and items that are common to more than one section of Division 26.
- G. 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 QUALITY ASSURANCE

Refer to Paragraph, QUALIFICATIONS, in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1.4 SUBMITTALS

In accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, submit the following:

- A. Manufacturer's Literature and Data: Showing each cable type and rating. The specific item proposed and its area of application shall be identified on the catalog cuts.
- B. 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.

C. Certifications:

1. Two weeks prior to the final inspection, submit four copies of the following certifications to the COTR:
 - a. Certification by the manufacturer that the material conforms to the requirements of the drawings and specifications.
 - b. Certification by the contractor that the material has been properly installed.

1.5 APPLICABLE PUBLICATIONS

- A. Publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by designation only.
- B. American National Standards Institute (ANSI):
 - C80.1-05.....Electrical Rigid Steel Conduit
 - C80.3-05.....Steel Electrical Metal Tubing
 - C80.6-05.....Electrical Intermediate Metal Conduit
- C. National Fire Protection Association (NFPA):
 - 70-11.....National Electrical Code (NEC)
- D. Underwriters Laboratories, Inc. (UL):
 - 1-05.....Flexible Metal Conduit
 - 5-04.....Surface Metal Raceway and Fittings
 - 6-07.....Electrical Rigid Metal Conduit - Steel
 - 50-95.....Enclosures for Electrical Equipment
 - 360-093.....Liquid-Tight Flexible Steel Conduit
 - 467-07.....Grounding and Bonding Equipment
 - 514A-04.....Metallic Outlet Boxes
 - 514B-04.....Conduit, Tubing, and Cable Fittings
 - 514C-96.....Nonmetallic Outlet Boxes, Flush-Device Boxes and Covers
 - 651-05.....Schedule 40 and 80 Rigid PVC Conduit and Fittings
 - 651A-00.....Type EB and A Rigid PVC Conduit and HDPE Conduit
 - 797-07.....Electrical Metallic Tubing
 - 1242-06.....Electrical Intermediate Metal Conduit - Steel
- E. National Electrical Manufacturers Association (NEMA):
 - TC-2-03.....Electrical Polyvinyl Chloride (PVC) Tubing and Conduit
 - TC-3-04.....PVC Fittings for Use with Rigid PVC Conduit and Tubing
 - FB1-07.....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 0.5 in [13 mm] unless otherwise shown. Where permitted by the NEC, 0.5 in [13 mm] flexible conduit may be used for tap connections to recessed lighting fixtures.
- B. Conduit:
 - 1. Rigid steel: Shall conform to UL 6 and ANSI C80.1.
 - 2. Rigid intermediate steel conduit (IMC): Shall conform to UL 1242 and ANSI C80.6.
 - 3. Electrical metallic tubing (EMT): Shall conform to UL 797 and ANSI C80.3. Maximum size not to exceed 4 in [105 mm] and shall be permitted only with cable rated 600 V or less.
 - 4. Flexible galvanized steel conduit: Shall conform to UL 1.
 - 5. Liquid-tight flexible metal conduit: Shall conform to UL 360.
 - 6. 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 NEMA FB1.
 - b. Standard threaded couplings, locknuts, bushings, conduit bodies, and elbows: Only steel or malleable iron materials are acceptable. Integral retractable type IMC couplings are also acceptable.
 - c. Locknuts: Bonding type with sharp edges for digging into the metal wall of an enclosure.
 - d. Bushings: Metallic insulating type, consisting of an insulating insert, molded or locked into the metallic body of the fitting. Bushings made entirely of metal or nonmetallic material are not permitted.
 - e. Erickson (union-type) and set screw type couplings: Approved for use in concrete are permitted for use to complete a conduit run where conduit is installed in concrete. Use set screws of case-hardened steel with hex head and cup point to firmly seat in conduit wall for positive ground. Tightening of set screws with pliers is prohibited.
 - f. Sealing fittings: Threaded cast iron type. Use continuous drain-type sealing fittings to prevent passage of water vapor. In concealed work, install fittings in flush steel boxes with blank cover plates having the same finishes as that of other electrical plates in the room.
 - 2. Electrical metallic tubing fittings:

- a. Fittings and conduit bodies shall meet the requirements of UL 514B, ANSI C80.3, and NEMA FB1.
 - b. Only steel or malleable iron materials are acceptable.
 - c. Compression couplings and connectors: Concrete-tight and rain-tight, with connectors having insulated throats.
 - 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.
3. Flexible steel conduit fittings:
- a. Conform to UL 514B. Only steel or malleable iron materials are acceptable.
 - b. Clamp-type, with insulated throat.
4. Liquid-tight flexible metal conduit fittings:
- a. Fittings shall meet the requirements of UL 514B and NEMA FB1.
 - b. Only steel or malleable iron materials are acceptable.
 - c. Fittings must incorporate a threaded grounding cone, a steel or plastic compression ring, and a gland for tightening. Connectors shall have insulated throats.
5. Surface metal raceway fittings: As recommended by the raceway manufacturer. Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, conduit entry fittings, accessories, and other fittings as required for complete system.
6. Expansion and deflection couplings:
- a. Conform to UL 467 and UL 514B.
 - b. Accommodate a 0.75 in [19 mm] deflection, expansion, or contraction in any direction, and allow 30 degree angular deflections.
 - c. Include internal flexible metal braid, sized to guarantee conduit ground continuity and a low-impedance path for fault currents, in accordance with UL 467 and the NEC tables for equipment grounding conductors.
 - d. Jacket: Flexible, corrosion-resistant, watertight, moisture and heat-resistant molded rubber material with stainless steel jacket clamps.
- D. Conduit Supports:
- 1. Parts and hardware: Zinc-coat or provide equivalent corrosion protection.
 - 2. Individual Conduit Hangers: Designed for the purpose, having a pre-assembled closure bolt and nut, and provisions for receiving a hanger rod.

3. Multiple conduit (trapeze) hangers: Not less than 1.5 x 1.5 in [38 mm x 38 mm], 12-gauge steel, cold-formed, lipped channels; with not less than 0.375 in [9 mm] 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 the front face of raised cover is flush with the wall. Surface-mounted wall or ceiling boxes shall be installed with surface-style flat or raised covers.

F. Wireways: Equip with hinged covers, except where removable covers are shown. Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for a complete system.

PART 3 - EXECUTION

3.1 PENETRATIONS

A. Cutting or Holes:

1. Cut holes in advance where they should be placed in the structural elements, such as ribs or beams. Obtain the approval of the COTR prior to drilling through structural elements.
2. Cut holes through concrete and masonry in new and existing structures with a diamond core drill or concrete saw. Pneumatic hammers, impact electric, hand, or manual hammer-type drills are not allowed, except where permitted by the COTR as required by limited working space.

B. Firestop: Where conduits, wireways, and other electrical raceways pass through fire partitions, fire walls, smoke partitions, or floors, install a fire stop that provides an effective barrier against the spread of fire, smoke and gases as specified in Section 07 84 00, FIRESTOPPING.

C. Waterproofing: At floor, exterior wall, and roof conduit penetrations, completely seal 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 specified herein.
- B. Essential (Emergency) raceway systems shall be entirely independent of other raceway systems, except where shown on drawings.
- C. Install conduit as follows:

1. In complete mechanically and electrically continuous runs before pulling in cables or wires.
2. Unless otherwise indicated on the drawings or specified herein, installation of all conduits shall be concealed within finished walls, floors, and ceilings.
3. Flattened, dented, or deformed conduit is not permitted. Remove and replace the damaged conduits with new undamaged material.
4. Assure conduit installation does not encroach into the ceiling height head room, walkways, or doorways.
5. Cut square, ream, remove burrs, and draw up tight.
6. Independently support conduit at 8 ft [2.4 M] on centers. Do not use other supports, i.e., suspended ceilings, suspended ceiling supporting members, lighting fixtures, conduits, mechanical piping, or mechanical ducts.
7. Support within 12 in [300 mm] of changes of direction, and within 12 in [300 mm] of each enclosure to which connected.
8. Close ends of empty conduit with plugs or caps at the rough-in stage until wires are pulled in, to prevent entry of debris.
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. Conduit bodies shall only be used for changes in direction, and shall not contain splices.

D. Conduit Bends:

1. Make bends with standard conduit bending machines.
2. Conduit hickey may be used for slight offsets and for straightening stubbed out conduits.
3. Bending of conduits with a pipe tee or vise is prohibited.

E. Layout and Homeruns:

1. Install conduit with wiring, including homeruns, as shown on drawings.
2. Deviations: Make only where necessary to avoid interferences and only after drawings showing the proposed deviations have been submitted 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:
 - 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 3 in [75 mm] thick is prohibited.
 - a. Conduit outside diameter larger than one-third of the slab thickness is prohibited.
 - b. Space between conduits in slabs: Approximately six conduit diameters apart, and one conduit diameter at conduit crossings.
 - c. Install conduits approximately in the center of the slab so that there will be a minimum of 0.75 in [19 mm] of concrete around the conduits.
 5. Make couplings and connections watertight. Use thread compounds that are UL approved conductive type to ensure low resistance ground continuity through the conduits. Tightening setscrews with pliers is prohibited.
- B. Above Furred or Suspended Ceilings and in Walls:
1. Conduit for conductors above 600 V: Rigid steel. Mixing different types of conduits indiscriminately in the same system is prohibited.
 2. Conduit for conductors 600 V and below: Rigid steel, IMC, or EMT. Mixing different types of conduits 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 6 ft [1.8 M] of flexible metal conduit extending from a junction box to the fixture.
 5. Tightening setscrews 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 V: Rigid steel. Mixing different types of conduits indiscriminately in the system is prohibited.

- C. Conduit for Conductors 600 V and Below: Rigid steel, IMC, or EMT. Mixing different types of conduits 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 8 ft [2.4 M] 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 V safety orange. Refer to Section 09 91 00, PAINTING for preparation, paint type, and exact color. In addition, paint legends, using 2 in [50 mm] high black numerals and letters, showing the cable voltage rating. Provide legends where conduits pass through walls and floors and at maximum 20 ft [6 M] intervals in between.

3.5 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 explosion-proof lighting fixtures, switches, and receptacles, as required by the NEC.

3.6 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 5 ft [1.5 M] of the exterior and below concrete building slabs in contact with soil, gravel, or vapor barriers. Conduit shall be half-lapped with 10 mil PVC tape before installation. After installation, completely recoat or retape any damaged areas of coating.

3.7 MOTORS AND VIBRATING EQUIPMENT

- A. Use flexible metal conduit for connections to motors and other electrical equipment subject to movement, vibration, misalignment, cramped quarters, or noise transmission.
- B. Use liquid-tight flexible metal conduit for installation in exterior locations, moisture or humidity laden atmosphere, corrosive atmosphere, water or spray wash-down operations, inside airstream of HVAC units, and locations subject to seepage or dripping of oil, grease, or water.

Provide a green equipment grounding conductor with flexible metal conduit.

3.8 EXPANSION JOINTS

- A. Conduits 3 in [75 mm] 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 3 in [75 mm] with junction boxes on both sides of the expansion joint. Connect conduits to junction boxes with sufficient slack of flexible conduit to produce 5 in [125 mm] vertical drop midway between the ends. Flexible conduit shall have a bonding jumper installed. In lieu of this flexible conduit, expansion and deflection couplings as specified above for conduits 15 in [375 mm] and larger are acceptable.
- C. Install expansion and deflection couplings where shown.

3.9 CONDUIT SUPPORTS, INSTALLATION

- A. Safe working load shall not exceed one-quarter of proof test load of fastening devices.
- B. Use pipe straps or individual conduit hangers for supporting individual conduits.
- C. Support multiple conduit runs with trapeze hangers. Use trapeze hangers that are designed to support a load equal to or greater than the sum of the weights of the conduits, wires, hanger itself, and 200 lbs [90 kg]. 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 0.25 in [6 mm] bolt size and not less than 1.125 in [28 mm] embedment.
 - b. Power set fasteners not less than 0.25 in [6 mm] diameter with depth of penetration not less than 3 in [75 mm].
 - c. Use vibration and shock-resistant anchors and fasteners for attaching to concrete ceilings.
- E. Hollow Masonry: Toggle bolts.
- F. Bolts supported only by plaster or gypsum wallboard are not acceptable.
- G. Metal Structures: Use machine screw fasteners or other devices specifically designed and approved for the application.

- H. Attachment by wood plugs, rawl plug, plastic, lead or soft metal anchors, or wood blocking and bolts supported only by plaster is prohibited.
- I. Chain, wire, or perforated strap shall not be used to support or fasten conduit.
- J. Spring steel type supports or fasteners are prohibited for all uses except horizontal and vertical supports/fasteners within walls.
- K. Vertical Supports: Vertical conduit runs shall have riser clamps and supports in accordance with the NEC and as shown. Provide supports for cable and wire with fittings that include internal wedges and retaining collars.

3.10 BOX INSTALLATION

- A. Boxes for Concealed Conduits:
 - 1. Flush-mounted.
 - 2. Provide raised covers for boxes to suit the wall or ceiling, construction, and finish.
- B. In addition to boxes shown, install additional boxes where needed to prevent damage to cables and wires during pulling-in operations.
- 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 mounted back-to-back in the same wall are prohibited. A minimum 24 in [600 mm] center-to-center lateral spacing shall be maintained between boxes.
- E. Minimum size of outlet boxes for ground fault interrupter (GFI) receptacles is 4 in [100 mm] square x 2.125 in [55 mm] 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 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 QUALITY ASSURANCE

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, construction materials, grade and termination information.
- C. Manuals: Two weeks prior to final inspection, deliver four copies of the following to the Resident Engineer: 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 Resident Engineer: Certification by the Contractor that the devices comply with the drawings and specifications, and have been properly installed, aligned, and tested.

1.5 APPLICABLE PUBLICATIONS

- A. Publications listed below (including amendments, addenda, revisions, supplements and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by basic designation only.

- B. National Fire Protection Association (NFPA):
 - 70.....National Electrical Code (NEC)
- C. National Electrical Manufacturers Association (NEMA):
 - WD 1.....General Color Requirements for Wiring Devices
 - WD 6Wiring Devices - Dimensional Requirements
- D. Underwriter's Laboratories, Inc. (UL):
 - 5.....Surface Metal Raceways and Fittings
 - 20.....General-Use Snap Switches
 - 231.....Power Outlets
 - 467.....Grounding and Bonding Equipment
 - 498.....Attachment Plugs and Receptacles
 - 943.....Ground-Fault Circuit-Interrupters

PART 2 - PRODUCTS

SPEC WRITER NOTE: Refer to the Electrical Design Manual for locations in which to install hospital-grade receptacles, and standard receptacles. Clearly indicate the requirements on the drawings.

2.1 TOGGLE SWITCHES

- 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. Ratings:
 - a. 120 volt circuits: 20 amperes at 120-277 volts AC.
 - b. 277 volt circuits: 20 amperes at 120-277 volts AC.

2.2 WALL PLATES

- A. Wall plates for switches and receptacles shall be steel .
- B. Standard NEMA design, so that products of different manufacturers will be interchangeable. Dimensions for openings in wall plates shall be accordance with NEMA WD 6.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Installation shall be in accordance with the NEC and as shown as on the drawings.
- B. Provide barriers in multigang outlet boxes to separate systems of different voltages, Normal Power and Emergency Power systems, and in compliance with the NEC.
- C. Coordinate with other work, including painting, electrical boxes and wiring installations, as necessary to interface installation of wiring devices with other work.
- D. Install wall switches with OFF position down.
- E. Label device plates with a permanent adhesive label listing panel and circuit feeding the wiring device.
- F. Test wiring devices for damaged conductors, high circuit resistance, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new, and retest as specified above.

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SECTION 26 29 11
MOTOR STARTERS

PART 1 - GENERAL

1.1 DESCRIPTION

All motor starters and variable speed motor controllers, 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.
- D. 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 QUALITY ASSURANCE

Refer to Paragraph, QUALIFICATIONS, in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1.4 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, weights, mounting details, materials, running over current protection, size of enclosure, over current protection, wiring diagrams, starting characteristics, interlocking and accessories.
- C. 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 Resident Engineer.
- D. Certification: Two weeks prior to final inspection, unless otherwise noted, submit four copies of the following certifications to the Resident Engineer:
 - 1. Certification that the equipment has been properly installed, adjusted, and tested.
 - 2. Certification by the manufacturer that medium voltage motor controller(s) conforms to the requirements of the drawings and specifications. This certification must be furnished to the Resident Engineer prior to shipping the controller(s) to the job site.

1.5 APPLICABLE PUBLICATIONS

- A. Publications listed below (including amendments, addenda, revisions, supplements and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by basic designation only.
- B. Institute of Electrical and Electronic Engineers (IEEE):
 - 519.....Recommended Practices and Requirements for
Harmonic Control in Electrical Power Systems
 - C37.90.1.....Standard Surge Withstand Capability (SWC) Tests
for Protective Relays and Relay Systems
- C. National Electrical Manufacturers Association (NEMA):
 - ICS 1.....Industrial Control and Systems General
Requirements
 - ICS 1.1.....Safety Guidelines for the Application,
Installation and Maintenance of Solid State
Control
 - ICS 2.....Industrial Control and Systems, Controllers,
Contactors and Overload Relays Rated 600 Volts
DC
 - ICS 6.....Industrial Control and Systems Enclosures
 - ICS 7.....Industrial Control and Systems Adjustable-Speed
Drives
 - ICS 7.1.....Safety Standards for Construction and Guide for
Selection, Installation and Operation of
Adjustable-Speed Drive Systems
- D. National Fire Protection Association (NFPA):
 - 70.....National Electrical Code (NEC)

E. Underwriters Laboratories Inc. (UL):

508.....Industrial Control Equipment

PART 2 - PRODUCTS

2.1 MOTOR STARTERS, GENERAL

- A. 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 (solid state 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 e.
Check every motor controller after installation and verify that correct sizes of protective devices have been installed.
 - e. Deliver four copies of a summarized list to the Resident Engineer, 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. Unless noted otherwise, equip with not less than two normally open and two normally closed auxiliary contacts. Provide green run pilot lights and H-O-A control devices as indicated, operable at front of enclosure without opening enclosure. Push buttons, selector switches, pilot lights, etc., shall be interchangeable.
8. Enclosures:
- a. Shall be the NEMA types shown on the drawings for the motor controllers and shall be the NEMA types which are the most suitable for the environmental conditions where the motor controllers are being installed.
 - b. Doors mechanically interlocked to prevent opening unless the breaker or switch within the enclosure is open. Provision for padlock must be provided.
 - c. 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 installation.

2.2 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. 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. Operating and Design Conditions:

Elevation: 1000 feet AMSL

Temperatures: Maximum 120°F Minimum -10°F

Relative Humidity: 95%

Drive Location: Boiler Plant

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. The drive shall be able to restart into a rotating motor operating in either the forward or reverse direction and matching that frequency.
 - a. Incorrect phase sequence.
 - b. Single phasing.
 - c. 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.)
9. Automatic Reset/Restart: Attempt three restarts after drive fault or on return of power after an interruption and before shutting down for

- manual reset or fault correction; adjustable delay time between restart attempts.
10. Power-Interruption Protection: To prevent motor from re-energizing after a power interruption until motor has stopped, unless "Bidirectional Autospeed Search" feature is available and engaged.
 11. Bidirectional Autospeed Search: Capable of starting VFC into rotating loads spinning in either direction and returning motor to set speed in proper direction, without causing damage to drive, motor, or load.
- F. Minimum efficiency shall be 95 percent at 100 percent speed and 85percent 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. Controller shall include a 3% line reactor, and RFI/EMI filter.
- 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.
- K. Hardware and software to enable the BAS to monitor, control, and display controller status and alarms.
- L. Network Communications Ports: Ethernet and RS-422.
- M. Embedded BAS Protocols for Network Communications: As specified in Division 22.
- N. Bypass Operation: Manually transfers motor between power converter output and bypass circuit, manually, automatically, or both. Unit is capable of stable operation (starting, stopping, and running) with motor completely disconnected from power converter. Transfer between power converter and bypass contactor and retransfer shall only be allowed with the motor at zero speed.
- O. Bypass Controller: Provide contactor-style bypass, arranged to isolate the power converter input and output and permit safe testing of the power converter, both energized and de-energized, while motor is operating in bypass mode. Motor overload protection shall be provided.
1. Bypass Contactor: Load-break NEMA-rated contactor.
 2. Input and Output Isolating Contactors: Non-load-break, NEMA-rated contactors.
 3. Isolating Switch: Non-load-break switch arranged to isolate power converter and permit safe troubleshooting and testing of the power converter, both energized and de-energized, while motor is operating in bypass mode; pad-lockable, door-mounted handle mechanism.
- P. Provide connections between variable speed motor controllers and motors as required.

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. Furnish and install heater elements in motor starters and to match the installed motor characteristics. Submit a list of all motors listing motor nameplate rating and heater element installed.
- C. Motor Data: Provide neatly-typed label inside each motor starter enclosure door identifying motor served, nameplate horsepower, full load amperes, code letter, service factor, voltage/phase rating and heater element installed.
- D. Connect hand-off auto selector switches so that automatic control only is by-passed in "manual" position and any safety controls are not by-passed.

- E. Install manual motor starters in flush enclosures in finished areas.
- F. Examine control diagrams indicated before ordering motor controllers.
Should conflicting data exist in specifications, drawings and diagrams,
request corrected data prior to placing orders.

3.2 ADJUSTING

- A. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.
- B. Adjust overload-relay heaters or settings if power factor correction capacitors are connected to the load side of the overload relays.
- C. Adjust trip settings of MCPs and thermal-magnetic circuit breakers with adjustable instantaneous trip elements. Initially adjust at six times the motor nameplate full-load ampere ratings and attempt to start motors several times, allowing for motor cooldown between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed eight times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify Resident Engineer before increasing settings.

3.3 ACCEPTANCE CHECKS AND TESTS

- A. Perform in accordance with the manufacturer's recommendations. Include the following visual and mechanical inspections and electrical tests:
 - 1. Visual and Mechanical Inspection
 - a. Compare equipment nameplate data with specifications and approved shop drawings.
 - b. Inspect physical, electrical, and mechanical condition.
 - c. Inspect contactors.
 - d. Clean motor starters and variable speed motor controllers.
 - e. Verify overload element ratings are correct for their applications.
 - f. If motor-running protection is provided by fuses, verify correct fuse rating.
 - g. Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data.
 - 2. Variable speed motor controllers:
 - a. Final programming and connections to variable speed motor controllers shall be by a factory-trained technician. Set all programmable functions of the variable speed motor controllers to meet the requirements and conditions of use.
 - b. Test all control and safety features of the variable frequency drive.

3.4 FOLLOW-UP VERIFICATION

Upon completion of acceptance checks, settings, and tests, the Contractor shall show by demonstration in service that the motor starters and variable speed motor controllers are in good operating condition and properly performing the intended functions.

3.5 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. 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: Cables and wiring.
- 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 faults.
- D. Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS: Conduits for cables and wiring.
- E. Section 26 29 11, LOW-VOLTAGE MOTOR STARTERS: Motor rated toggle switches.

1.3 QUALITY ASSURANCE

Refer to Paragraph, QUALIFICATIONS, in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1.4 SUBMITTALS

- A. Submit in accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.
- B. Shop Drawings:
 - 1. Clearly present sufficient information to determine compliance with drawings and specifications.
 - 2. Include electrical ratings, dimensions, mounting details, materials, enclosure types, and fuse types and classes.
 - 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. Terminals on wiring diagrams shall be identified to facilitate maintenance and operation.
 - 3. Wiring diagrams shall indicate internal wiring and any interlocking.

- D. Certifications: Two weeks prior to the final inspection, submit four copies of the following certifications to the COTR:
1. Certification by the manufacturer that the materials conform to the requirements of the drawings and specifications.
 2. Certification by the contractor that the materials have been properly installed, connected, and tested.

1.5 APPLICABLE PUBLICATIONS

- A. Publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by designation only.
- B. National Electrical Manufacturers Association (NEMA):
- FU 1-07.....Low Voltage Cartridge Fuses
- KS 1-06.....Enclosed and Miscellaneous Distribution
Equipment Switches (600 Volts Maximum)
- C. National Fire Protection Association (NFPA):
- 70-11.....National Electrical Code (NEC)
- D. Underwriters Laboratories, Inc. (UL):
- 98-04.....Enclosed and Dead-Front Switches
- 248-00.....Low Voltage Fuses
- 977-94.....Fused Power-Circuit Devices

PART 2 - PRODUCTS

2.1 LOW VOLTAGE FUSIBLE SWITCHES RATED 600 AMPERES AND LESS

- A. In accordance with UL 98, NEMA KS1, and NEC.
- B. Shall have NEMA classification General Duty (GD) for 240 V switches and NEMA classification Heavy Duty (HD) for 480 V switches.
- C. Shall be HP rated.
- D. Shall have the following features:
1. Switch mechanism shall be the quick-make, quick-break type.
 2. Copper blades, visible in the OFF position.
 3. An arc chute for each pole.
 4. External operating handle shall indicate ON and OFF position and have lock-open padlocking provisions.
 5. Mechanical interlock shall permit opening of the door only when the switch is in the OFF position, defeatable to permit inspection.
 6. Fuse holders for the sizes and types of fuses specified.
 7. Solid neutral for each switch being installed in a circuit which includes a neutral conductor.
 8. Ground lugs for each ground conductor.
 9. Enclosures:
 - a. Shall be the NEMA types shown on the drawings for the switches.

b. Where the types of switch enclosures are not shown, they shall be the NEMA types most suitable for the ambient environmental conditions. 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 without provisions for 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 HP rated.

2.4 MOTOR RATED TOGGLE SWITCHES

Refer to Section 26 29 11, LOW-VOLTAGE MOTOR STARTERS.

2.5 LOW VOLTAGE CARTRIDGE FUSES

- A. In accordance with NEMA FU1.
- B. Motor Branch Circuits: Class RK1, time delay.
- C. Other Branch Circuits: Class RK1, time delay.
- D. Control Circuits: Class CC, ast acting.

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. Arrange fuses such that rating information is readable without removing the fuse.

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.

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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 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.
- D. Section 26 27 26, WIRING DEVICES: Wiring devices used for control of the lighting systems.

1.3 QUALITY ASSURANCE

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. Product Data: For each type of lighting fixture (luminaire) designated on the LIGHTING FIXTURE SCHEDULE, arranged in order of fixture designation, submit the following information.
 - 1. Material and construction details include information on housing, optics system and lens/diffuser.
 - 2. Physical dimensions and description.
 - 3. Wiring schematic and connection diagram.
 - 4. Installation details.
 - 5. Energy efficiency data.
 - 6. Photometric data based on laboratory tests complying with IESNA Lighting Measurements, testing and calculation guides.
 - 7. Lamp data including lumen output (initial and mean), color rendition index (CRI), rated life (hours) and color temperature (degrees Kelvin).
 - 8. Ballast data including ballast type, starting method, ambient temperature, ballast factor, sound rating, system watts and total harmonic distortion (THD).
- C. 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 Resident Engineer.

D. Certifications:

1. Two weeks prior to final inspection, submit four copies of the following certifications to the Resident Engineer:
 - a. Certification by the Contractor that the equipment has been properly installed, adjusted, and tested.

1.5 APPLICABLE PUBLICATIONS

- A. Publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by designation only.
- B. Institute of Electrical and Electronic Engineers (IEEE):
C62.41-91.....Guide on the Surge Environment in Low Voltage
(1000V and less) AC Power Circuits
- C. National Fire Protection Association (NFPA):
70.....National Electrical Code (NEC)
101.....Life Safety Code
- D. 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
- E. 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
1029A-06.....Ignitors and Related Auxiliaries for HID Lamp
Ballasts
1598-00.....Luminaires
1574-04.....Standard for Track Lighting Systems

2108-04.....Standard for Low-Voltage Lighting Systems

8750-08.....Light Emitting Diode (LED) Light Sources for Use
in Lighting Products

F. 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 and UL 1598, 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. 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.

4. Hinged door closure frames shall operate smoothly without binding when the fixture is in the installed position, 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. Lamp holders for bi-pin 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.

E. 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.

F. Metal Finishes:

1. The manufacturer shall apply 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, and shall be applied after fabrication.
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.
- G. Lighting fixtures shall have a specific means for grounding metallic wireways and housings to an equipment grounding conductor.
- H. Light Transmitting Components for Fluorescent Fixtures:
1. Shall be 100 percent virgin acrylic.
 2. Flat lens panels shall have not less than 1/8 inch [3.2mm] 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.
- I. Lighting fixtures in hazardous areas shall be suitable for installation in Class and Group areas as defined in NFPA 70, and shall comply with UL 844.

2.2 BALLASTS

- A. Linear Fluorescent Lamp Ballasts: Multi-voltage (120 - 277V) electronic programmed-start type, complying with UL 935 and with ANSI C 82.11, designed for type and quantity of lamps indicated. Ballast shall be designed for full light output unless dimmer or bi-level control is indicated; including the following features:
1. Lamp end-of-life detection and shutdown circuit (T5 lamps only).
 2. Automatic lamp starting after lamp replacement.
 3. Sound Rating: Class A.
 4. Total Harmonic Distortion Rating: 10 percent or less.
 5. Transient Voltage Protection: IEEE C62.41.1 and IEEE C62.41.2, Category A or better.
 6. Operating Frequency: 20 kHz or higher.
 7. Lamp Current Crest Factor: 1.7 or less.
 8. Ballast Factor: 0.87 or higher unless otherwise indicated.
 9. Power Factor: 0.98 or higher.

10. Interference: Comply with 47 CFT 18, Ch.1, Subpart C, for limitations on electromagnetic and radio-frequency interference for non-consumer equipment.
11. 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.
12. 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 LAMPS

A. Linear and U-shaped T5 and T8 Fluorescent Lamps:

1. Rapid start fluorescent lamps shall comply with ANSI C78.1; and instant-start lamps shall comply with ANSI C78.3.
2. Chromacity of fluorescent lamps shall comply with ANSI C78.376.
3. Except as indicated below, lamps shall be low-mercury energy saving type, have a color temperature between 3500° and 4100°K, a Color Rendering Index (CRI) of greater than 70, average rated life of 20,000 hours, and be suitable for use with dimming ballasts, unless otherwise indicated. Low mercury lamps shall have passed the EPA Toxicity Characteristic Leachate Procedure (TCLP) for mercury by using the lamp sample preparation procedure described in NEMA LL

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. 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. Surface mounted lighting fixtures:
 - a. Fixtures shall be bolted against the ceiling independent of the outlet box at four points spaced near the corners of each unit. The bolts (or stud-clips) shall be minimum 1/4-20 [6mm] bolt, secured to main ceiling runners and/or secured to cross runners. Non-turning studs may be attached to the main ceiling runners and cross runners with special non-friction clip devices designed for the purpose, provided they bolt through the runner, or are also secured to the building structure by 12 gauge safety hangers. Studs or bolts securing fixtures weighing in excess of 56 pounds [25kg] shall be supported directly from the building structure.
 - b. Where ceiling cross runners are installed for support of lighting fixtures they must have a carrying capacity equal to that of the main ceiling runners and be rigidly secured to the main runners.
 - c. Fixtures less than 15 pounds [6.8kg] in weight and occupying less than two square feet [600mm x 600mm] of ceiling area may, (when designed for the purpose) be supported directly from the outlet box when all the following conditions are met.
 - 1) Screws attaching the fixture to the outlet box pass through round holes (not key-hole slots) in the fixture body.
 - 2) The outlet box is attached to a main ceiling runner (or cross runner) with approved hardware.
 - 3) The outlet box is supported vertically from the building structure.
 - d. Fixtures mounted in open construction shall be secured directly to the building structure with approved bolting and clamping devices.
- D. Furnish and install the specified lamps for all lighting fixtures installed and all existing lighting fixtures reinstalled under this project.
- E. Bond lighting fixtures and metal accessories to the grounding system as specified in Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS.
- F. Burn-in all lamps that require specific aging period to operate properly, prior to occupancy by Government. Burn-in period to be 40 hours minimum, unless a lesser period is specifically recommended by lamp manufacturer. Burn-in fluorescent and compact fluorescent lamps intended to be dimmed, for at least 100 hours at full voltage. Replace any lamps and ballasts which fail during burn-in.

- G. At completion of project, relamp/reballast fixtures which have failed lamps/ballasts. Clean fixtures, lenses, diffusers and louvers that have accumulated dust/dirt/fingerprints during construction. Replace damaged lenses, diffusers and louvers with new.
- H. Dispose of lamps per requirements of Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.

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