



*Design Replace Boilers,
Bldg. 100 Energy Center
C.W. Bill Young VA Medical Center*

*Contract VA248-16-C-0145
Project 516-15-107*

**SPECIFICATIONS
100% Design DOCUMENTS**

Prepared for

Department of Veterans Affairs
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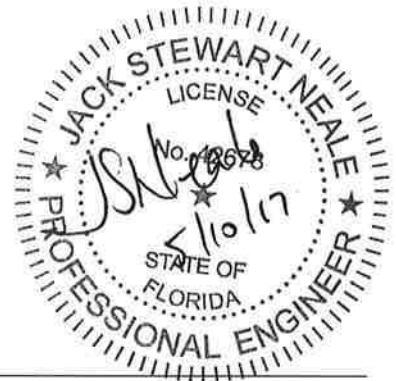


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**DEPARTMENT OF VETERANS AFFAIRS
 VHA MASTER SPECIFICATIONS**

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GENERAL REQUIREMENTS
11-01-15

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*Replace Boilers - Bldg. 100 Energy Center
CW Bill Young VA Medical Center - Bay Pines, FL*

*100% Design Submittal
May 15, 2017*

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SECTION 01 00 00
GENERAL REQUIREMENTS
11-01-15

1.1 SAFETY REQUIREMENTS

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

1.2 GENERAL INTENTION

- A. Contractor shall completely prepare site for building operations, including demolition and removal of existing structures, and furnish labor and materials and perform work for
Design to Replace Boilers, Bldg. 100 at C. W. Bill Young VAMC, Bay Pines VAHC, VA Project Number 516-15-107 as required by drawings and specifications.
- B. Not Used.
- C. Offices of AKEA Design, Inc, as Architect-Engineers, will render certain technical services during construction. Such services shall be considered as advisory to the Government and shall not be construed as expressing or implying a contractual act of the Government without affirmations by Contracting Officer or his duly authorized representative.
- D. Before placement and installation of work subject to tests by testing laboratory retained by Department of Veterans Affairs, the Contractor shall notify the COR in sufficient time to enable testing laboratory personnel to be present at the site in time for proper taking and testing of specimens and field inspection. Such prior notice shall be not less than three work days unless otherwise designated by the COR.
- 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. The Complete Steam Trap Monitoring Systems including all associated electrical and communications systems has been award under a different contract and is no longer required under the execution of the boiler replacement contract as specified in the listed drawings and specifications.

1.3 STATEMENT OF BID ITEM(S)

- A. BASE BID: Work includes all General, Mechanical, Structural, Electrical, and Communication for new Boilers, Controls, and Steam Trap Monitoring as shown on contract documents dated May 15, 2017 with all removal of existing systems and installation of new systems as base bid. Work includes all labor, material, equipment and supervision to perform the required construction work on this project. Completion time: 780 Days.
- B. DEDUCT ALTERNATE NO. 1: Includes all work in BASE BID, except DEDUCT New Boiler Stacks and reuse existing boiler stack. Completion time: 720 Days.
- C. DEDUCT ALTERNATE NO. 2: Includes all work in BASE BID and DEDUCT ALTERNATE NO. 1, and DEDUCT ALTERNATE NO. 2, except DEDUCT Boiler Room Ventilation Systems including all ductwork, air devices, fans, electrical, supports, and framing required. Completion time: 720 Days.
- D. DEDUCT ALTERNATE NO. 3: Includes all work in BASE BID and DEDUCT ALTERNATE NO. 1, and DEDUCT ALTERNATE NO. 2, and DEDUCT ALTERNATE NO. 3, except DEDUCT Water Softener and Chemical Feed System including all piping, electrical, controls, and communications systems required. Completion time: 660 Days.
- E. DEDUCT ALTERNATE NO. 4: Includes all work in BASE BID and DEDUCT ALTERNATE NO. 1, and DEDUCT ALTERNATE NO. 2, and DEDUCT ALTERNATE NO. 3, except DEDUCT new Boiler No. B-1 reuse exiting Boiler B-1 and remove temporary mobile boiler for the phase 3 sequence. Completion time: 600 Days.

1.4 SPECIFICATIONS AND DRAWINGS FOR CONTRACTOR

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

1.5 CONSTRUCTION SECURITY REQUIREMENTS

A. Security Plan:

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

B. Security Procedures:

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

C. Guards:

1. The General Contractor shall provide unarmed guards at the project site after construction hours.
2. The Contractor shall provide the guards and VA police with communication devices as directed.
3. The general Contractor shall install equipment for recording guard rounds to ensure systematic checking of the premises.

D. Key Control:

1. The General Contractor shall provide duplicate keys and lock combinations to the Contracting officers representative (COR) for the purpose of security inspections of every area of project including tool boxes and parked machines and take any emergency action.
2. The General Contractor shall turn over all permanent lock cylinders to the VA locksmith for permanent installation.

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.
3. Certain documents, sketches, videos or photographs and drawings may be marked "Law Enforcement Sensitive" or "Sensitive Unclassified". Secure such information in separate containers and limit the access to only those who will need it for the project. Return the information to the Contracting Officer upon request.
4. These security documents shall not be removed or transmitted from the project site without the written approval of Contracting Officer.
5. All paper waste or electronic media such as CD's and diskettes shall be shredded and destroyed in a manner acceptable to the VA.
6. Notify Contracting Officer and Site Security Officer immediately when there is a loss or compromise of "sensitive information".

7. All electronic information shall be stored in specified location following VA standards and procedures using an Engineering Document Management Software (EDMS).
 - a. Security, access and maintenance of all project drawings, both scanned and electronic shall be performed and tracked through the EDMS system.
 - b. "Sensitive information" including drawings and other documents may be attached to e-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 24 hours before the date and time of access. Access shall be restricted to picking up and dropping off materials and supplies.
2. A limited number of (2 to 5) permits shall be issued for General Contractor and its employees for parking in designated areas only.

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 COR.
- 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.
 - 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 will 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 COR. All such actions shall be coordinated with the COR or 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:

The Medical Center must maintain its operation 24 hours a day 7 days a week. Therefore, any interruption in service must be scheduled and coordinated with the COR to ensure that no lapses in operation occur. It is the CONTRACTOR'S responsibility to develop a work plan and schedule detailing, at a minimum, the procedures to be employed, the equipment and materials to be used, the interim life safety measure to be used during the work, and a schedule defining the duration of the work with milestone subtasks. The work to be outlined shall include, but not be limited to:

To insure such executions, Contractor shall furnish the COR 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 COR 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 COR and Contractor, as follows:

1. Phase 1 Demolition:
 - a. Coordinate with VA to remove all portable items from the west part of the plant.
 - b. Demolish incinerator stack.

2. Phase 1 Construction:
 - a. New condensate tank - located on a structural mezzanine built over the existing pit.
 - b. New water softeners - located on west end of plant near the pit.
 - c. New mechanical plant ventilation system - located on the roof and in the clerestory areas.
 - d. New boiler B-3 - located in the empty spot where the old summer boiler used to be.
 - e. New boiler exhaust stacks. Two (2) stacks in location of old incinerator stack.
 - f. New continuous blowdown heat exchanger - located in plant as shown.
 - g. New blowdown separator - located in the existing pit.
 - h. New trench from pit to boiler B-3, with new fuel oil and blowdown piping.
 - i. Startup all new equipment.
3. Phase 2 Demolition
 - a. Demo existing boilers B-3 and B-2 after new boiler plant equipment is active.
4. Phase 2 Construction
 - a. Extend new trench and piping.
 - b. Provide new Boiler B-2. Connect to new exhaust stack installed in phase 1.
5. Phase 3 Demolition
 - a. Demo existing Boiler B-1
 - b. Demo existing boiler breeching and exhaust stack.
 - c. Demo existing water softener and chemical feed systems.
 - d. Demo existing fuel oil, natural gas, and blowdown piping in trench.
 - e. Demo existing condensate tank.
6. Phase 3 Construction
 - a. Provide new boiler exhaust stack riser in location of old stack.
 - b. Extend new trench and piping.
 - c. Provide new Boiler B-1 and new master control panel.

J. Building(s) No. (s) 100 will be occupied during performance of work.

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

K. When a building and/or construction site is turned over to Contractor, Contractor shall accept entire responsibility including upkeep and maintenance therefore:

1. Contractor shall maintain in operating condition existing fire protection and alarm equipment. In connection with fire alarm equipment, Contractor shall make arrangements for pre-inspection of site with Fire Department or Company (Department of Veterans Affairs or municipal) whichever will be required to respond to an alarm from Contractor's employee or watchman.

L. Utilities Services: Maintain existing utility services for Medical Center at all times. Provide temporary facilities, labor, materials, equipment, connections, and utilities to assure uninterrupted services. Where necessary to cut existing water, steam, gases, sewer or air pipes, or conduits, wires, cables, etc. of utility services or of fire protection systems and communications systems (including telephone), they shall be cut and capped at suitable places where shown; or, in absence of such indication, where directed by COR.

1. No utility service such as water, gas, steam, sewers or electricity, or fire protection systems and communications systems may be interrupted without prior approval of COR. Electrical work shall be accomplished with all affected circuits or equipment de-energized.

- When an electrical outage cannot be accomplished, work on any energized circuits or equipment shall not commence without a detailed work plan, the Medical Center Director's prior knowledge and written approval. Refer to specification Sections 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, 27 05 11 REQUIREMENTS FOR COMMUNICATIONS INSTALLATIONS and 28 05 00, COMMON WORK RESULTS FOR ELECTRONIC SAFETY AND SECURITY for additional requirements.
2. Contractor shall submit a request to interrupt any such services to COR, in writing, 7 days in advance of proposed interruption. Request shall state reason, date, exact time of, and approximate duration of such interruption.
 3. Contractor will be advised (in writing) of approval of request, or of which other date and/or time such interruption will cause least inconvenience to operations of Medical Center. Interruption time approved by Medical Center may occur at other than Contractor's normal working hours.
 4. Major interruptions of any system must be requested, in writing, at least 15 calendar days prior to the desired time and shall be performed as directed by the COR.
 5. In case of a contract construction emergency, service will be interrupted on approval of COR. Such approval will be confirmed in writing as soon as practical.
- 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 but are not required to be entirely removed, shall be sealed, capped or plugged at the main, branch or panel they originate from. The lines shall not be capped in finished areas, but shall be removed and sealed, capped or plugged in ceilings, within furred spaces, in unfinished areas, or within walls or partitions; so that they are completely behind the finished surfaces.
- 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. N. Coordinate the work for this contract with other construction operations as directed by COR. This includes the scheduling of traffic and the use of roadways, as specified in Article, USE OF ROADWAYS.

1.7 ALTERATIONS

A. Protection: Provide the following protective measures:

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

1.8 DISPOSAL AND RETENTION

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

1. Reserved items which are to remain property of the Government are identified by attached tags as items to be stored. Items that remain property of the Government shall be removed or dislodged from present locations in such a manner as to prevent damage which would be detrimental to re-installation and reuse. Store such items where directed by COR.
2. Items not reserved shall become property of the Contractor and be removed by Contractor from Medical Center.

(FAR 52.236-9)

B. 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.

C. Refer to FAR clause 52.236-7, "Permits and Responsibilities," which is included in General Conditions. A National Pollutant Discharge Elimination System (NPDES) permit is required for this project. The Contractor is considered an "operator" under the permit and has extensive responsibility for compliance with permit requirements. VA will make the permit application available at the (appropriate medical center) office. The apparent low bidder, contractor and affected subcontractors shall furnish all information and certifications that are required to comply with the permit process and permit requirements. Many of the permit requirements will be satisfied by completing construction as shown and specified. Some requirements involve the Contractor's method of operations and operations planning and the Contractor is responsible for employing best management practices. The affected activities often include, but are not limited to the following:

- Designating areas for equipment maintenance and repair;
- Providing waste receptacles at convenient locations and provide regular collection of wastes;
- Locating equipment wash down areas on site, and provide appropriate control of wash-waters;
- Providing protected storage areas for chemicals, paints, solvents, fertilizers, and other potentially toxic materials; and
- Providing adequately maintained sanitary facilities.

1.9 RESTORATION

A. Remove, cut, alter, replace, patch and repair existing work as necessary to install new work. Except as otherwise shown or specified, do not cut, alter or remove any structural work, and do not disturb any ducts, plumbing, steam, gas, or electric work without approval of the COR. Existing work to be altered or extended and that is found to be defective in any way, shall be reported to the COR before it is disturbed. Materials and workmanship used in restoring work, shall

conform in type and quality to that of original existing construction, except as otherwise shown or specified.

- B. Upon completion of contract, deliver work complete and undamaged. Existing work (walls, ceilings, partitions, floors, mechanical and electrical work, lawns, paving, roads, walks, etc.) disturbed or removed as a result of performing required new work, shall be patched, repaired, reinstalled, or replaced with new work, and refinished and left in as good condition as existed before commencing work.
- C. At Contractor's own expense, Contractor shall immediately restore to service and repair any damage caused by Contractor's workmen to existing piping and conduits, wires, cables, etc., of utility services or of fire protection systems and communications systems (including telephone) which are not scheduled for discontinuance or abandonment.
- D. Expense of repairs to such utilities and systems not shown on drawings or locations of which are unknown will be covered by adjustment to contract time and price in accordance with clause entitled "CHANGES" (FAR 52.243-4 and VAAR 852.236-88) and "DIFFERING SITE CONDITIONS" (FAR 52.236-2).

1.10 PHYSICAL DATA

- A. Data and information furnished or referred to below is for the Contractor's information. The Government shall not be responsible for any interpretation of or conclusion drawn from the data or information by the Contractor.
 - 1. The indications of physical conditions on the drawings and in the specifications are the result of site investigations by AKEA Design, Inc.
- B. Subsurface conditions have been developed by core borings and test pits. Logs of subsurface exploration are shown diagrammatically on drawings.
- D. Government does not guarantee that other materials will not be encountered nor that proportions, conditions or character of several materials will not vary from those indicated by explorations. Bidders are expected to examine site of work and logs of borings; and, after investigation, decide for themselves character of materials and make

their bids accordingly. Upon proper application to Department of Veterans Affairs, bidders will be permitted to make subsurface explorations of their own at site.

1.11 LAYOUT OF WORK

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

1.12 AS-BUILT DRAWINGS

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

1.13 USE OF ROADWAYS

- A. For hauling, use only established public roads and roads on Medical Center property and, when authorized by the COR, such temporary roads which are necessary in the performance of contract work. Temporary

roads shall be constructed and restoration performed by the Contractor at Contractor's expense. When necessary to cross curbing, sidewalks, or similar construction, they must be protected by well-constructed bridges.

- B. When new permanent roads are to be a part of this contract, Contractor may construct them immediately for use to facilitate building operations. These roads may be used by all who have business thereon within zone of building operations.

1.14 TEMPORARY USE OF MECHANICAL AND ELECTRICAL EQUIPMENT

- A. Use of new installed mechanical and electrical equipment to provide heat, ventilation, plumbing, light and power will be permitted subject to written approval and compliance with the following provisions:
1. Permission to use each unit or system must be given by COR in writing. If the equipment is not installed and maintained in accordance with the written agreement and following provisions, the COR will withdraw permission for use of the equipment.
 2. Electrical installations used by the equipment shall be completed in accordance with the drawings and specifications to prevent damage to the equipment and the electrical systems, i.e. transformers, relays, circuit breakers, fuses, conductors, motor controllers and their overload elements shall be properly sized, coordinated and adjusted. Installation of temporary electrical equipment or devices shall be in accordance with NFPA 70, National Electrical Code, (2014 Edition), Article 590, *Temporary Installations*. Voltage supplied to each item of equipment shall be verified to be correct and it shall be determined that motors are not overloaded. The electrical equipment shall be thoroughly cleaned before using it and again immediately before final inspection including vacuum cleaning and wiping clean interior and exterior surfaces.
 3. Units shall be properly lubricated, balanced, and aligned. Vibrations must be eliminated.
 4. 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.

5. 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.
- D. Any damage to the equipment or excessive wear due to prolonged use will be repaired replaced by the contractor at the contractor's expense.

1.15 TEMPORARY TOILETS

- A. Provide where directed, (for use of all Contractor's workmen) ample temporary sanitary toilet accommodations as approved by COR, provide suitable dry closets where directed. Keep such places clean and free from flies, and all connections and appliances connected therewith are to be removed prior to completion of contract, and premises left perfectly clean.

1.16 AVAILABILITY AND USE OF UTILITY SERVICES

- A. The Government shall make all reasonably required amounts of utilities available to the Contractor from existing outlets and supplies, as specified in the contract. The amount to be paid by the Contractor for chargeable electrical services shall be the prevailing rates charged to the Government. The Contractor shall carefully conserve any utilities furnished without charge.
- B. The Contractor, at Contractor's expense and in a workmanlike manner, in compliance with code and as satisfactory to the Contracting Officer, shall install and maintain all necessary temporary connections and distribution lines, and all meters required to measure the amount of electricity used for the purpose of determining charges. Before final acceptance of the work by the Government, the Contractor shall remove all the temporary connections, distribution lines, meters, and associated paraphernalia and repair restore the infrastructure as required.
- C. Contractor shall install meters at Contractor's expense and furnish the Medical Center a monthly record of the Contractor's usage of electricity as hereinafter specified.
- D. 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, and electrical welding devices. Electricity for all other uses is available at no cost to the Contractor.
- E. Water (for Construction and Testing): Furnish temporary water service.
 - 1. Obtain water by connecting to the Medical Center water distribution system. Provide reduced pressure backflow preventer at each connection as per code. Water is available at no cost to the Contractor.

2. Maintain connections, pipe, fittings and fixtures and conserve water-use so none is wasted. Failure to stop leakage or other wastes will be cause for revocation (at COR discretion) of use of water from Medical Center's system.

F. 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 and paid by the Contractor at Contractor's expense.

1.17 TESTS

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

for a building. Other related components are return air, exhaust air, steam, controls and electricity, etc. Another example of a system which involves several components of different disciplines is a boiler installation. Efficient and acceptable boiler operation depends upon the coordination and proper operation of fuel, combustion air, controls, steam, feedwater, condensate and other related components.

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

1.18 INSTRUCTIONS

- A. Contractor shall furnish Maintenance and Operating manuals (hard copies and electronic) and verbal instructions when required by the various sections of the specifications and as hereinafter specified.
- B. Manuals: Maintenance and operating manuals and one compact disc (four hard copies and one electronic copy each) for each separate piece of equipment shall be delivered to the COR coincidental with the delivery of the equipment to the job site. Manuals shall be complete, detailed guides for the maintenance and operation of equipment. They shall include complete information necessary for starting, adjusting, maintaining in continuous operation for long periods of time and dismantling and reassembling of the complete units and sub-assembly components. Manuals shall include an index covering all component parts clearly cross-referenced to diagrams and illustrations. Illustrations shall include "exploded" views showing and identifying each separate item. Emphasis shall be placed on the use of special tools and instruments. The function of each piece of equipment, component, accessory and control shall be clearly and thoroughly explained. All necessary precautions for the operation of the equipment and the reason for each precaution shall be clearly set forth. Manuals must reference the exact model, style and size of the piece of equipment and system

being furnished. Manuals referencing equipment similar to but of a different model, style, and size than that furnished will not be accepted.

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

1.19 CONSTRUCTION SIGN

- A. Provide a Construction Sign where directed by the COR. 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 COR.

1.20 SAFETY SIGN

A. Provide a Safety Sign where directed by COR. 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 COR.

D. Standard Detail Drawing Number SD10000-02(Found on VA TIL) of safety sign showing required legend and other characteristics of sign is required.

E. Post the number of accident free days on a daily basis.

Estimated Cost		No. of Photographs
Up to	\$250,000	50 to 100
" "	\$500,000	100 to 150
" "	\$1,000,000	150 to 200
" "	\$2,000,000	200 to 250
" "	\$5,000,000	250 to 300
" "	\$10,000,000	300 to 400
More than	\$10,000,000	400 to 500

1.21 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. 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. 7. As-built conditions of mechanical, electrical, plumbing and all other systems shall be documented. Overlapping

- photographic techniques shall be used to insure maximum coverage.
Indexing and navigation accomplished through interactive drawings.
5. 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.
 6. Customizable project-specific digital photographic documentation of other details or milestones. Indexing and navigation accomplished through interactive plans.
 7. Detailed Exact-Built of all Slabs for all project slab pours just prior to placing concrete or as directed by the COR.
 8. Detailed Interior exact built overlapping photos of the entire building to include documentation of all mechanical, electrical and plumbing systems as directed by COR.
 9. In event a greater or lesser number of images than specified above are required by the COR, 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 COR. 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-Builts 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.

1.22 FINAL ELEVATION DIGITAL IMAGES

- A. A minimum of four (4) images of each elevation shall be taken with a minimum 6 MP camera, by a professional photographer with different settings to allow the COR to select the image to be printed. All images are provided to the RE on a CD.
- B. Photographs shall be taken upon completion, including landscaping. They shall be taken on a clear sunny day to obtain sufficient detail to show depth and to provide clear, sharp pictures. Pictures shall be 400 mm x 500 mm (16 by 20 inches), printed on regular weight paper, matte finish archival grade photographic paper and produced by a RA4 process from the digital image with a minimum 300 PPI. Identifying data shall be carried on label affixed to back of photograph without damage to photograph and shall be similar to that provided for final construction photographs.
- C. Furnish six (6) 400 mm x 500 mm (16 by 20 inch) color prints of the following buildings constructed under this project (elevations as selected by the RE from the images taken above). Photographs shall be artistically composed showing full front elevations. All images shall become property of the Government. Each of the selected six prints shall be place in a frame with a minimum of 2 inches of appropriate matting as a border. Provide a selection of a minimum of 3 different frames from which the SRE will select one style to frame all six prints. Photographs with frames shall be delivered to the COR in boxes suitable for shipping.

1. Boiler Plant Building No. 100 CEP.

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SECTION 01 32 16.15
PROJECT SCHEDULES
(SMALL PROJECTS - DESIGN/BID/BUILD)
02-01-15

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 _____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 an application and certificate for payment using VA Form 10-6001a or 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
07-01-15

- 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 in single units unless otherwise specified. Submit shop drawings, schedules, manufacturers' literature and data, and certificates in quadruplicate, except where a greater number is specified.
 - B. Submittals will receive consideration only when covered by a transmittal letter signed by Contractor. Letter shall be sent via first class mail 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 Contracting Officer's Representative (COR) and to Architect-Engineer simultaneously with submission of material to a commercial testing laboratory.
 5. Laboratory test reports shall be sent directly to COR and the Architect-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 (except laboratory samples), shop drawings, test reports, certificates and manufacturers' literature and data, shall be submitted for approval to:

AKEA Design, Inc.
(Architect-Engineer)
3603 NW 98th Street, Suite B
(A/E P.O. Address)
Gainesville, Florida 32606
(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 COR.

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

C.W. Bill Young VAMC
10,000 Bay Pines Blvd.
(P.O. Address)
Bay Pines, FL 33744
(City, State and Zip Code)

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SECTION 01 35 26
SAFETY REQUIREMENTS
09-01-16

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SECTION 01 35 26
SAFETY REQUIREMENTS

1.1 APPLICABLE PUBLICATIONS:

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

B. American Society of Safety Engineers (ASSE):

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

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

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

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

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

D. The Facilities Guidelines Institute (FGI):

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

E. National Fire Protection Association (NFPA):

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

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

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

70-2014.....National Electrical Code

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

70E-2015Standard for Electrical Safety in the Workplace

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

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

F. The Joint Commission (TJC)

TJC ManualComprehensive Accreditation and Certification
Manual

G. U.S. Nuclear Regulatory Commission

10 CFR 20Standards for Protection Against Radiation

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

29 CFR 1904Reporting and Recording Injuries & Illnesses

29 CFR 1910Safety and Health Regulations for General
Industry

29 CFR 1926Safety and Health Regulations for Construction
Industry

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

I. VHA Directive 2005-007

1.2 DEFINITIONS:

A. Critical Lift. A lift with the hoisted load exceeding 75% of the crane's maximum capacity; lifts made out of the view of the operator (blind picks); lifts involving two or more cranes; personnel being hoisted; and special hazards such as lifts over occupied facilities, loads lifted close to power-lines, and lifts in high winds or where other adverse environmental conditions exist; and any lift which the crane operator believes is critical.

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

C. "Qualified Person" means one who, by possession of a recognized degree, certificate, or professional standing, or who by extensive knowledge,

training and experience, has successfully demonstrated his ability to solve or resolve problems relating to the subject matter, the work, or the project.

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

E. Accident/Incident Criticality Categories:

No impact - near miss incidents that should be investigated but are not required to be reported to the VA;

Minor incident/impact - incidents that require first aid or result in minor equipment damage (less than \$5000). These incidents must be investigated but are not required to be reported to the VA;

Moderate incident/impact - Any work-related injury or illness that results in:

1. Days away from work (any time lost after day of injury/illness onset);
2. Restricted work;
3. Transfer to another job;
4. Medical treatment beyond first aid;
5. Loss of consciousness;
6. A significant injury or illness diagnosed by a physician or other licensed health care professional, even if it did not result in (1) through (5) above or,
7. any incident that leads to major equipment damage (greater than \$5000).

These incidents must be investigated and are required to be reported to the VA;

Major incident/impact - Any mishap that leads to fatalities, hospitalizations, amputations, and losses of an eye as a result of contractors' activities. Or any incident which leads to major property damage (greater than \$20,000) and/or may generate publicity or high visibility. These incidents must be investigated and are required to be

reported to the VA as soon as practical, but not later than 2 hours after the incident.

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

1.3 REGULATORY REQUIREMENTS:

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

1.4 ACCIDENT PREVENTION PLAN (APP):

- A. The APP (aka Construction Safety & Health Plan) shall interface with the Contractor's overall safety and health program. Include any portions of the Contractor's overall safety and health program referenced in the APP in the applicable APP element and ensure it is site-specific. The Government considers the Prime Contractor to be the "controlling authority" for all worksite safety and health of each subcontractor(s). Contractors are responsible for informing their subcontractors of the safety provisions under the terms of the contract and the penalties for noncompliance, coordinating the work to prevent one craft from interfering with or creating hazardous working conditions for other crafts, and inspecting subcontractor operations to ensure that accident prevention responsibilities are being carried out.
- B. The APP shall be prepared as follows:
1. Written in English by a qualified person who is employed by the Prime Contractor articulating the specific work and hazards pertaining to the contract (model language can be found in ASSE

- A10.33). Specifically articulating the safety requirements found within these VA contract safety specifications.
2. Address both the Prime Contractors and the subcontractors work operations.
 3. State measures to be taken to control hazards associated with materials, services, or equipment provided by suppliers.
 4. Address all the elements/sub-elements and in order as follows:
 - a. **SIGNATURE SHEET.** Title, signature, and phone number of the following:
 - 1) Plan preparer (Qualified Person such as corporate safety staff person or contracted Certified Safety Professional with construction safety experience);
 - 2) Plan approver (company/corporate officers authorized to obligate the company);
 - 3) Plan concurrence (e.g., Chief of Operations, Corporate Chief of Safety, Corporate Industrial Hygienist, project manager or superintendent, project safety professional). Provide concurrence of other applicable corporate and project personnel (Contractor).
 - b. **BACKGROUND INFORMATION.** List the following:
 - 1) Contractor;
 - 2) Contract number;
 - 3) Project name;
 - 4) Brief project description, description of work to be performed, and location; phases of work anticipated (these will require an AHA).
 - c. **STATEMENT OF SAFETY AND HEALTH POLICY.** Provide a copy of current corporate/company Safety and Health Policy Statement, detailing commitment to providing a safe and healthful workplace for all employees. The Contractor's written safety program goals, objectives, and accident experience goals for this contract should be provided.

d. RESPONSIBILITIES AND LINES OF AUTHORITIES. Provide the following:

- 1) A statement of the employer's ultimate responsibility for the implementation of his SOH program;
- 2) Identification and accountability of personnel responsible for safety at both corporate and project level. Contracts specifically requiring safety or industrial hygiene personnel shall include a copy of their resumes.
- 3) The names of Competent and/or Qualified Person(s) and proof of competency/qualification to meet specific OSHA Competent/Qualified Person(s) requirements must be attached.
- 4) Requirements that no work shall be performed unless a designated competent person is present on the job site;
- 5) Requirements for pre-task Activity Hazard Analysis (AHAs);
- 6) Lines of authority;
- 7) Policies and procedures regarding noncompliance with safety requirements (to include disciplinary actions for violation of safety requirements) should be identified;

e. SUBCONTRACTORS AND SUPPLIERS. If applicable, provide procedures for coordinating SOH activities with other employers on the job site:

- 1) Identification of subcontractors and suppliers (if known);
- 2) Safety responsibilities of subcontractors and suppliers.

f. TRAINING.

- 1) Site-specific SOH orientation training at the time of initial hire or assignment to the project for every employee before working on the project site is required.
- 2) Mandatory training and certifications that are applicable to this project (e.g., explosive actuated tools, crane operator, rigger, crane signal person, fall protection, electrical lockout/NFPA 70E, machine/equipment lockout, confined space, etc....) and any requirements for periodic retraining/recertification are required.

- 3) Procedures for ongoing safety and health training for supervisors and employees shall be established to address changes in site hazards/conditions.
- 4) OSHA 10-hour training is required for all workers on site and the OSHA 30-hour training is required for Trade Competent Persons (CPs)

g. SAFETY AND HEALTH INSPECTIONS.

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

h. ACCIDENT/INCIDENT INVESTIGATION & REPORTING. The Contractor shall conduct mishap investigations of all Moderate and Major as well as all High Visibility Incidents. The APP shall include accident/incident investigation procedure and identify person(s) responsible to provide the following to the Project Manager and Facility Safety Manager and Contracting Officer Representative or Government Designated Authority:

- 1) Exposure data (man-hours worked);
- 2) Accident investigation reports;
- 3) Project site injury and illness logs.

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

- 1) Emergency response;

- 2) Contingency for severe weather;
- 3) Fire Prevention;
- 4) Medical Support;
- 5) Posting of emergency telephone numbers;
- 6) Prevention of alcohol and drug abuse;
- 7) Site sanitation (housekeeping, drinking water, toilets);
- 8) Night operations and lighting;
- 9) Hazard communication program;
- 10) Welding/Cutting "Hot" work;
- 11) Electrical Safe Work Practices (Electrical LOTO/NFPA 70E);
- 12) General Electrical Safety;
- 13) Hazardous energy control (Machine LOTO);
- 14) Site-Specific Fall Protection & Prevention;
- 15) Excavation/trenching;
- 16) Asbestos abatement;
- 17) Lead abatement;
- 18) Respiratory protection;
- 19) Health hazard control program;
- 20) Abrasive blasting;
- 21) Heat/Cold Stress Monitoring;
- 22) Crystalline Silica Monitoring (Assessment);
- 23) Demolition plan (to include engineering survey);
- 24) Formwork and shoring erection and removal;
- 25) PreCast Concrete;
- 26) Public (Mandatory compliance with ANSI/ASSE A10.34-2012).

- C. Submit the APP to the Project Manager and Facility Safety Manager and Contracting Officer Representative or Government Designated Authority for review for compliance with contract requirements in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA AND SAMPLES 15 calendar days prior to the date of the preconstruction conference for acceptance. Work cannot proceed without an accepted APP.
- D. Once accepted by the Project Manager and Facility Safety Manager and Contracting Officer Representative or Government Designated Authority, the APP and attachments will be enforced as part of the contract. Disregarding the provisions of this contract or the accepted APP will be cause for stopping of work, at the discretion of the Contracting Officer in accordance with FAR Clause 52.236-13, *Accident Prevention*, until the matter has been rectified.
- E. Once work begins, changes to the accepted APP shall be made with the knowledge and concurrence of the Project Manager project superintendent, project overall designated OSHA Competent Person, and facility Safety Manager, and Contracting Officer Representative or Government Designated Authority. Should any severe hazard exposure, i.e. imminent danger, become evident, stop work in the area, secure the area, and develop a plan to remove the exposure and control the hazard. Notify the Contracting Officer within 24 hours of discovery. Eliminate/remove the hazard. In the interim, take all necessary action to restore and maintain safe working conditions in order to safeguard onsite personnel, visitors, the public and the environment.

1.5 ACTIVITY HAZARD ANALYSES (AHAS):

- A. AHAs are also known as Job Hazard Analyses, Job Safety Analyses, and Activity Safety Analyses. Before beginning each work activity involving a type of work presenting hazards not experienced in previous project operations or where a new work crew or sub-contractor is to perform the work, the Contractor(s) performing that work activity shall prepare an AHA (Example electronic AHA forms can be found on the US Army Corps of Engineers web site)
- B. AHAs shall define the activities being performed and identify the work sequences, the specific anticipated hazards, site conditions, equipment, materials, and the control measures to be implemented to eliminate or reduce each hazard to an acceptable level of risk.

- C. Work shall not begin until the AHA for the work activity has been accepted by the Project Manager and Facility Safety Manager or Contracting Officer Representative or Government Designated Authority and discussed with all engaged in the activity, including the Contractor, subcontractor(s), and Government on-site representatives at preparatory and initial control phase meetings.
1. The names of the Competent/Qualified Person(s) required for a particular activity (for example, excavations, scaffolding, fall protection, other activities as specified by OSHA and/or other State and Local agencies) shall be identified and included in the AHA. Certification of their competency/qualification shall be submitted to the Government Designated Authority (GDA) for acceptance prior to the start of that work activity.
 2. The AHA shall be reviewed and modified as necessary to address changing site conditions, operations, or change of competent/qualified person(s).
 - a. If more than one Competent/Qualified Person is used on the AHA activity, a list of names shall be submitted as an attachment to the AHA. Those listed must be Competent/Qualified for the type of work involved in the AHA and familiar with current site safety issues.
 - b. If a new Competent/Qualified Person (not on the original list) is added, the list shall be updated (an administrative action not requiring an updated AHA). The new person shall acknowledge in writing that he or she has reviewed the AHA and is familiar with current site safety issues.
 3. Submit AHAs to the Project Manager and Facility Safety Manager or Contracting Officer Representative or Government Designated Authority for review for compliance with contract requirements in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA AND SAMPLES for review at least 15 calendar days prior to the start of each phase. Subsequent AHAs as shall be formatted as amendments to the APP. The analysis should be used during daily inspections to ensure the implementation and effectiveness of the activity's safety and health controls.

4. The AHA list will be reviewed periodically (at least monthly) at the Contractor supervisory safety meeting and updated as necessary when procedures, scheduling, or hazards change.
5. Develop the activity hazard analyses using the project schedule as the basis for the activities performed. All activities listed on the project schedule will require an AHA. The AHAs will be developed by the contractor, supplier, or subcontractor and provided to the prime contractor for review and approval and then submitted to the Project Manager and Facility Safety Manager or Contracting Officer Representative or Government Designated Authority.

1.6 PRECONSTRUCTION CONFERENCE:

- A. Contractor representatives who have a responsibility or significant role in implementation of the accident prevention program, as required by 29 CFR 1926.20(b) (1), on the project shall attend the preconstruction conference to gain a mutual understanding of its implementation. This includes the project superintendent, subcontractor superintendents, and any other assigned safety and health professionals.
 - B. Discuss the details of the submitted APP to include incorporated plans, programs, procedures and a listing of anticipated AHAs that will be developed and implemented during the performance of the contract. This list of proposed AHAs will be reviewed at the conference and an agreement will be reached between the Contractor and the Contracting Officer's representative as to which phases will require an analysis. In addition, establish a schedule for the preparation, submittal, review, and acceptance of AHAs to preclude project delays.
 - C. Deficiencies in the submitted APP will be brought to the attention of the Contractor within 14 days of submittal, and the Contractor shall revise the plan to correct deficiencies and re-submit it for acceptance. Do not begin work until there is an accepted APP.
- WRITER NOTE: If the contract will involve (a) work of a long duration or hazardous nature, or (b) performance within a Government facility that on the advice of VA construction safety representatives involves hazardous operations that might endanger the safety of the public, patients and/or Government personnel or property, the SSHA and

Superintendent and/or Quality Control Manager must be separate persons
(See Section 1.7(C) for choice).

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

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

1.8 TRAINING:

- A. The designated Prime Contractor SSHO must meet the requirements of all applicable OSHA standards and be capable (through training, experience, and qualifications) of ensuring that the requirements of 29 CFR 1926.16 and other appropriate Federal, State and local requirements are met for the project. As a minimum the SSHO must have completed the OSHA 30-hour Construction Safety class and have five (5) years of construction industry safety experience or three (3) years if he/she possesses a Certified Safety Professional (CSP) or certified Construction Safety and Health Technician (CSHT) certification or have a safety and health degree from an accredited university or college.
- B. All designated CPs shall have completed the OSHA 30-hour Construction Safety course within the past 5 years.
- C. In addition to the OSHA 30 Hour Construction Safety Course, all CPs with high hazard work operations such as operations involving asbestos, electrical, cranes, demolition, work at heights/fall protection, fire safety/life safety, ladder, rigging, scaffolds, and trenches/excavations shall have a specialized formal course in the hazard recognition & control associated with those high hazard work operations. Documented "repeat" deficiencies in the execution of safety requirements will require retaking the requisite formal course.
- D. All other construction workers shall have the OSHA 10-hour Construction Safety Outreach course and any necessary safety training to be able to identify hazards within their work environment.
- E. Submit training records associated with the above training requirements to the Project Manager and Facility Safety Manager or Contracting Officer Representative or Government Designated Authority for review for compliance with contract requirements in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA AND SAMPLES 15 [__] calendar days prior to the date of the preconstruction conference for acceptance.
- F. Prior to any worker for the contractor or subcontractors beginning work, they shall undergo a safety briefing provided by the SSHO or his/her designated representative. As a minimum, this briefing shall include information on the site-specific hazards, construction limits, VAMC safety guidelines, means of egress, break areas, work hours, locations of restrooms, use of VAMC equipment, emergency procedures,

accident reporting etc... Documentation shall be provided to the Resident Engineer that individuals have undergone contractor's safety briefing.

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

1.9 INSPECTIONS:

- A. The SSHO shall conduct frequent and regular safety inspections (daily) of the site and each of the subcontractors CPs shall conduct frequent and regular safety inspections (daily) of their work operations as required by 29 CFR 1926.20(b)(2). Each week, the SSHO shall conduct a formal documented inspection of the entire construction areas with the subcontractors' "Trade Safety and Health CPs" present in their work areas. Coordinate with, and report findings and corrective actions weekly to Project Manager and Facility Safety and Contracting Officer Representative or Government Designated Authority.
- B. A Certified Safety Professional (CSP) with specialized knowledge in construction safety or a certified Construction Safety and Health Technician (CSHT) shall randomly conduct a monthly site safety inspection. The CSP or CSHT can be a corporate safety professional or independently contracted. The CSP or CSHT will provide their certificate number on the required report for verification as necessary.
1. Results of the inspection will be documented with tracking of the identified hazards to abatement.
 2. The Project Manager and Facility Safety Manager and Contracting Officer Representative or Government Designated Authority will be notified immediately prior to start of the inspection and invited to accompany the inspection.
 3. Identified hazard and controls will be discussed to come to a mutual understanding to ensure abatement and prevent future reoccurrence.
 4. A report of the inspection findings with status of abatement will be provided to the Project Manager and Facility Safety Manager and Contracting Officer Representative or Government Designated Authority // within one week of the onsite inspection.

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

- A. The prime contractor shall establish and maintain an accident reporting, recordkeeping, and analysis system to track and analyze all injuries and illnesses, high visibility incidents, and accidental property damage (both government and contractor) that occur on site. Notify the Project Manager and Facility Safety Manager and Contracting Officer Representative or Government Designated Authority as soon as practical, but no more than four hours after any accident meeting the definition of a Moderate or Major incidents, High Visibility Incidents, , or any weight handling and hoisting equipment accident. Within notification include contractor name; contract title; type of contract; name of activity, installation or location where accident occurred; date and time of accident; names of personnel injured; extent of property damage, if any; extent of injury, if known, and brief description of accident (to include type of construction equipment used, PPE used, etc.). Preserve the conditions and evidence on the accident site until the Project Manager and Facility Safety Manager and Contracting Officer Representative or Government Designated Authority determine whether a government investigation will be conducted.
- B. Conduct an accident investigation for all Minor, Moderate and Major incidents as defined in paragraph DEFINITIONS, and property damage accidents resulting in at least \$20,000 in damages, to establish the root cause(s) of the accident. Complete the VA Form 2162 (or equivalent), and provide the report to the Project Manager and Facility Safety Manager and Contracting Officer Representative or Government Designated Authority within 5 calendar days of the accident. The Project Manager and Facility Safety Manager and Contracting Officer Representative or Government Designated Authority will provide copies of any required or special forms.
- C. A summation of all man-hours worked by the contractor and associated sub-contractors for each month will be reported to the Project Manager and Facility Safety Manager and Contracting Officer Representative or Government Designated Authority monthly.

- D. A summation of all Minor, Moderate, and Major incidents experienced on site by the contractor and associated sub-contractors for each month will be provided to the Project Manager and Facility Safety Manager and Contracting Officer Representative or Government Designated Authority monthly. The contractor and associated sub-contractors' OSHA 300 logs will be made available to the Project Manager and Facility Safety Manager and Contracting Officer Representative or Government Designated Authority // as requested.

1.11 PERSONAL PROTECTIVE EQUIPMENT (PPE):

- A. PPE is governed in all areas by the nature of the work the employee is performing. For example, specific PPE required for performing work on electrical equipment is identified in NFPA 70E, Standard for Electrical Safety in the Workplace.
- B. Mandatory PPE includes:
1. Hard Hats - unless written authorization is given by the Project Manager and Facility Safety Manager and Contracting Officer Representative or Government Designated Authority in circumstances of work operations that have limited potential for falling object hazards such as during finishing work or minor remodeling. With authorization to relax the requirement of hard hats, if a worker becomes exposed to an overhead falling object hazard, then hard hats would be required in accordance with the OSHA regulations.
 2. Safety glasses - unless written authorization is given by the Project Manager and Facility Safety Manager and Contracting Officer Representative or Government Designated Authority in circumstances of no eye hazards, appropriate safety glasses meeting the ANSI Z.87.1 standard must be worn by each person on site.
 3. Appropriate Safety Shoes - based on the hazards present, safety shoes meeting the requirements of ASTM F2413-11 shall be worn by each person on site unless written authorization is given by the Project Manager and Facility Safety Manager and Contracting Officer Representative or Government Designated Authority in circumstances of no foot hazards.

4. Hearing protection - Use personal hearing protection at all times in designated noise hazardous areas or when performing noise hazardous tasks.

1.12 TUBERCULOSIS SCREENING

A. Contractor shall provide written certification that all contract employees assigned to the work site have had a pre-placement tuberculin screening within 90 days prior to assignment to the worksite and been found have negative TB screening reactions. Contractors shall be required to show documentation of negative TB screening reactions for any additional workers who are added after the 90-day requirement before they will be allowed to work on the work site. NOTE: This can be the Center for Disease Control (CDC) and Prevention and two-step skin testing or a Food and Drug Administration (FDA)-approved blood test.

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

1.13 FIRE SAFETY

A. Fire Safety Plan: Establish and maintain a site-specific fire protection program in accordance with 29 CFR 1926. Prior to start of work, prepare a plan detailing project-specific fire safety measures, including periodic status reports, and submit to Project Manager and Facility Safety Manager and Contracting Officer Representative or Government Designated Authority for review for compliance with contract requirements in accordance with Section 01 33 23, SHOP

DRAWINGS, PRODUCT DATA AND SAMPLES. This plan may be an element of the Accident Prevention Plan.

- B. 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 Project Manager and Facility Safety Manager and Contracting Officer Representative or Government Designated Authority. All existing or temporary fire protection systems (fire alarms, sprinklers) located in construction areas shall be tested as coordinated with the medical center. Parameters for the testing and results of any tests performed shall be recorded by the medical center and copies provided to the Resident Engineer.
- C. Smoke Detectors: Prevent accidental operation. Remove temporary covers at end of work operations each day. Coordinate with Project Manager and Facility Safety Manager and Contracting Officer Representative or Government Designated Authority.
- D. Hot Work: Perform and safeguard hot work operations in accordance with NFPA 241 and NFPA 51B. Coordinate with Facility Safety Office. Obtain permits from facility Safety Manager at least 4 hours in advance.
- E. Fire Hazard Prevention and Safety Inspections: Inspect entire construction areas weekly. Coordinate with, and report findings and corrective actions weekly to Project Manager and Facility Safety Manager and Contracting Officer Representative or Government Designated Authority.
- F. 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.
- F. Dispose of waste and debris in accordance with NFPA 241. Remove from buildings daily.
- G. If required, submit documentation to the Facility Safety Office and COR or other Government Designated Authority that personnel have been

trained in the fire safety aspects of working in areas with impaired structural or compartmentalization features.

1.14 ELECTRICAL

- A. All electrical work shall comply with NFPA 70 (NEC), NFPA 70B, NFPA 70E, 29 CFR Part 1910 Subpart J - General Environmental Controls, 29 CFR Part 1910 Subpart S - Electrical, and 29 CFR 1926 Subpart K in addition to other references required by contract.
- B. All qualified persons performing electrical work under this contract shall be licensed journeyman or master electricians. All apprentice electricians performing under this contract shall be deemed unqualified persons unless they are working under the immediate supervision of a licensed electrician or master electrician.
- C. All electrical work will be accomplished de-energized and in the Electrically Safe Work Condition (refer to NFPA 70E for Work Involving Electrical Hazards, including Exemptions to Work Permit). Any Contractor, subcontractor or temporary worker who fails to fully comply with this requirement is subject to immediate termination in accordance with FAR clause 52.236-5(c). Only in rare circumstance where achieving an electrically safe work condition prior to beginning work would increase or cause additional hazards, or is infeasible due to equipment design or operational limitations is energized work permitted. The Project Manager and Facility Safety Manager and Contracting Officer Representative or Government Designated Authority with approval of the Medical Center Director will make the determination if the circumstances would meet the exception outlined above. An AHA and permit specific to energized work activities will be developed, reviewed, and accepted by the VA prior to the start of that activity.
 - 1. Development of a Hazardous Electrical Energy Control Procedure is required prior to de-energization. A single Simple Lockout/Tagout Procedure for multiple work operations can only be used for work involving qualified person(s) de-energizing one set of conductors or circuit part source. Task specific Complex Lockout/Tagout Procedures are required at all other times.
 - 2. Verification of the absence of voltage after de-energization and lockout/tagout is considered "energized electrical work" (live work) under NFPA 70E, and shall only be performed by qualified persons

wearing appropriate shock protective (voltage rated) gloves and arc rate personal protective clothing and equipment, using Underwriters Laboratories (UL) tested and appropriately rated contact electrical testing instruments or equipment appropriate for the environment in which they will be used.

3. Personal Protective Equipment (PPE) and electrical testing instruments will be readily available for inspection by the Project Manager and Facility Safety Manager and Contracting Officer Representative or Government Designated Authority.

D. Before beginning any electrical work, an Activity Hazard Analysis (AHA) will be conducted to include Shock Hazard and Arc Flash Hazard analyses (NFPA Tables can be used only as a last alternative and it is strongly suggested a full Arc Flash Hazard Analyses be conducted). Work shall not begin until the AHA for the work activity and permit for energized work has been reviewed and accepted by the Project Manager and Facility Safety Manager and Contracting Officer Representative or Government Designated Authority and discussed with all engaged in the activity, including the Contractor, subcontractor(s), and Government on-site representatives at preparatory and initial control phase meetings.

E. Ground-fault circuit interrupters. GFCI protection shall be provided where an employee is operating or using cord- and plug-connected tools related to construction activity supplied by 125-volt, 15-, 20-, or 30-ampere circuits. Where employees operate or use equipment supplied by greater than 125-volt, 15-, 20-, or 30- ampere circuits, GFCI protection or an assured equipment grounding conductor program shall be implemented in accordance with NFPA 70E - 2015, Chapter 1, Article 110.4(C)(2)..

1.15 FALL PROTECTION

A. The fall protection (FP) threshold height requirement is 6 ft (1.8 m) for ALL WORK, unless specified differently or the OSHA 29 CFR 1926 requirements are more stringent, to include steel erection activities, systems-engineered activities (prefabricated) metal buildings, residential (wood) construction and scaffolding work.

1. The use of a Safety Monitoring System (SMS) as a fall protection method is prohibited.

2. The use of Controlled Access Zone (CAZ) as a fall protection method is prohibited.
3. A Warning Line System (WLS) may ONLY be used on floors or flat or low-sloped roofs (between 0 - 18.4 degrees or 4:12 slope) and shall be erected around all sides of the work area (See 29 CFR 1926.502(f) for construction of WLS requirements). Working within the WLS does not require FP. No worker shall be allowed in the area between the roof or floor edge and the WLS without FP. FP is required when working outside the WLS.
4. Fall protection while using a ladder will be governed by the OSHA requirements.

1.16 SCAFFOLDS AND OTHER WORK PLATFORMS

- A. All scaffolds and other work platforms construction activities shall comply with 29 CFR 1926 Subpart L.
- B. The fall protection (FP) threshold height requirement is 6 ft (1.8 m) as stated in Section 1.16.
- C. The following hierarchy and prohibitions shall be followed in selecting appropriate work platforms.
 1. Scaffolds, platforms, or temporary floors shall be provided for all work except that can be performed safely from the ground or similar footing.
 2. Ladders less than 20 feet may be used as work platforms only when use of small hand tools or handling of light material is involved.
 3. Ladder jacks, lean-to, and prop-scaffolds are prohibited.
 4. Emergency descent devices shall not be used as working platforms.
- D. Contractors shall use a scaffold tagging system in which all scaffolds are tagged by the Competent Person. Tags shall be color-coded: green indicates the scaffold has been inspected and is safe to use; red indicates the scaffold is unsafe to use. Tags shall be readily visible, made of materials that will withstand the environment in which they are used, be legible and shall include:
 1. The Competent Person's name and signature;

2. Dates of initial and last inspections.

- E. Mast Climbing work platforms: When access ladders, including masts designed as ladders, exceed 20 ft (6 m) in height, positive fall protection shall be used.

1.17 CRANES

- A. All crane work shall comply with 29 CFR 1926 Subpart CC.
- B. Prior to operating a crane, the operator must be licensed, qualified or certified to operate the crane. Thus, all the provisions contained with Subpart CC are effective and there is no "Phase In" date.
- C. A detailed lift plan for all lifts shall be submitted to the Project Manager and/or Facility Safety Manager and/or other Government Designated Authority 14 days prior to the scheduled lift complete with route for truck carrying load, crane load analysis, siting of crane and path of swing and all other elements of a critical lift plan where the lift meets the definition of a critical lift. Critical lifts require a more comprehensive lift plan to minimize the potential of crane failure and/or catastrophic loss. The plan must be reviewed and accepted by the General Contractor before being submitted to the VA for review. The lift will not be allowed to proceed without prior acceptance of this document.
- D. Crane operators shall not carry loads
1. over the general public or VAMC personnel
 2. over any occupied building unless
 - a. the top two floors are vacated
 - b. or overhead protection with a design live load of 300 psf is provided

1.18 CONTROL OF HAZARDOUS ENERGY (LOCKOUT/TAGOUT)

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

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

1.19 CONFINED SPACE ENTRY

- A. All confined space entry shall comply with 29 CFR 1926, Subpart AA except for specifically referenced operations in 29 CFR 1926 such as excavations/trenches [1926.651(g)].
- B. A site-specific Confined Space Entry Plan (including permitting process) shall be developed and submitted to the Project Manager and/or Facility Safety Manager and/or other Government Designated Authority.

1.20 WELDING AND CUTTING

As specified in section 1.14, Hot Work: Perform and safeguard hot work operations in accordance with NFPA 241 and NFPA 51B. Coordinate with Project Manager and/or Facility Safety Manager and/or other Government Designated Authority. Obtain permits from Project Manager and/or Facility Safety Manager and/or other Government Designated Authority at least 4 hours in advance.

1.21 LADDERS

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

- G. Ladders shall be inspected for visible defects on a daily basis and after any occurrence that could affect their safe use. Broken or damaged ladders shall be immediately tagged "DO NOT USE," or with similar wording, and withdrawn from service until restored to a condition meeting their original design.

1.22 FLOOR & WALL OPENINGS

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

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SECTION 01 42 19
REFERENCE STANDARDS
05-01-16

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.aabchg.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
AIA	American Institute of Architects http://www.aia.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>

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

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

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

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

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
SOI	Secretary of the Interior http://www.cr.nps.gov/local-law/arch_stnds_8_2.htm
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
06-01-16

PART 1 - GENERAL

1.1 DESCRIPTION:

This section specifies materials testing activities and inspection services required during project construction to be provided by a Testing Laboratory retained by the General Contractor and the Department of Veterans Affairs.

1.2 APPLICABLE PUBLICATIONS:

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.
- B. American Association of State Highway and Transportation Officials (AASHTO):
 - T27-11.....Standard Method of Test for Sieve Analysis of Fine and Coarse Aggregates
 - T96-02 (R2006).....Standard Method of Test for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
 - T99-10.....Standard Method of Test for Moisture-Density Relations of Soils Using a 2.5 Kg (5.5 lb.) Rammer and a 305 mm (12 in.) Drop
 - T104-99 (R2007).....Standard Method of Test for Soundness of Aggregate by Use of Sodium Sulfate or Magnesium Sulfate
 - T180-10.....Standard Method of Test for Moisture-Density Relations of Soils using a 4.54 kg (10 lb.) Rammer and a 457 mm (18 in.) Drop
 - T191-02(R2006).....Standard Method of Test for Density of Soil In-Place by the Sand-Cone Method
- C. American Concrete Institute (ACI):
 - 506.4R-94 (R2004).....Guide for the Evaluation of Shotcrete
- D. American Society for Testing and Materials (ASTM):
 - A325-10.....Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength

A370-12.....	Standard Test Methods and Definitions for Mechanical Testing of Steel Products
A416/A416M-10.....	Standard Specification for Steel Strand, Uncoated Seven-Wire for Prestressed Concrete
A490-12.....	Standard Specification for Heat Treated Steel Structural Bolts, 150 ksi Minimum Tensile Strength
C31/C31M-10.....	Standard Practice for Making and Curing Concrete Test Specimens in the Field
C33/C33M-11a.....	Standard Specification for Concrete Aggregates
C39/C39M-12.....	Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
C109/C109M-11b.....	Standard Test Method for Compressive Strength of Hydraulic Cement Mortars
C136-06.....	Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
C138/C138M-10b.....	Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete
C140-12.....	Standard Test Methods for Sampling and Testing Concrete Masonry Units and Related Units
C143/C143M-10a.....	Standard Test Method for Slump of Hydraulic Cement Concrete
C172/C172M-10.....	Standard Practice for Sampling Freshly Mixed Concrete
C173/C173M-10b.....	Standard Test Method for Air Content of freshly Mixed Concrete by the Volumetric Method
C330/C330M-09.....	Standard Specification for Lightweight Aggregates for Structural Concrete
C567/C567M-11.....	Standard Test Method for Density Structural Lightweight Concrete
C780-11.....	Standard Test Method for Pre-construction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry
C1019-11.....	Standard Test Method for Sampling and Testing Grout
C1064/C1064M-11.....	Standard Test Method for Temperature of Freshly Mixed Portland Cement Concrete

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

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

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

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

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

D1143/D1143M-07e1.....Standard Test Methods for Deep Foundations
Under Static Axial Compressive Load

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

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

D1557-09.....Standard Test Methods for Laboratory Compaction
Characteristics of Soil Using Modified Effort
(56,000ft lbf/ft³ (2,700 KNm/m³))

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

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

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

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

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

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

- D6938-10.....Standard Test Method for In-Place Density and
Water Content of Soil and Soil-Aggregate by
Nuclear Methods (Shallow Depth)
- E94-04(2010).....Standard Guide for Radiographic Examination
- E164-08.....Standard Practice for Contact Ultrasonic
Testing of Weldments
- E329-11c.....Standard Specification for Agencies Engaged in
Construction Inspection, Testing, or Special
Inspection
- E543-09.....Standard Specification for Agencies Performing
Non-Destructive Testing
- E605-93(R2011).....Standard Test Methods for Thickness and Density
of Sprayed Fire Resistive Material (SFRM)
Applied to Structural Members
- E709-08.....Standard Guide for Magnetic Particle
Examination
- E1155-96(R2008).....Determining FF Floor Flatness and FL Floor
Levelness Numbers
- E. American Welding Society (AWS):
- D1.D1.1M-10.....Structural Welding Code-Steel

1.3 REQUIREMENTS:

- A. Accreditation Requirements: 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.; E329, C1077, D3666, D3740, A880, E543) 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 EARTHWORK:

- A. General: The Testing Laboratory shall provide qualified personnel, materials, equipment, and transportation as required to perform the services identified/required herein, within the agreed to schedule and/or time frame. The work to be performed shall be as identified herein and shall include but not be limited to the following:
1. Observe fill and subgrades during proof-rolling to evaluate suitability of surface material to receive fill or base course. Provide recommendations to the Resident Engineer regarding suitability or unsuitability of areas where proof-rolling was observed. Where unsuitable results are observed, witness excavation of unsuitable material and recommend to Resident Engineer extent of removal and replacement of unsuitable materials and observe proof-rolling of replaced areas until satisfactory results are obtained.
 2. Provide // full time // part time // observation of fill placement and compaction and field density testing in building areas and provide // full time // part time // observation of fill placement and compaction and field density testing in pavement areas to verify that earthwork compaction obtained is in accordance with contract documents.
 3. Provide supervised geotechnical technician to inspect excavation, subsurface preparation, and backfill for structural fill.
- B. Testing Compaction:
1. Determine maximum density and optimum moisture content for each type of fill, backfill and subgrade material used, in compliance with // AASHTO // T99/T180 // Method A // // ASTM // D698 // D1557 // Method A // ASTM D698 and/or ASTM D1557.
 2. Make field density tests in accordance with the primary testing method following ASTM D6938 // AASHTO T238 // wherever possible. Field density tests utilizing ASTM D1556 // AASHTO T191 //, or //

ASTM D2167 // shall be utilized on a case by case basis only if there are problems with the validity of the results from the primary method due to specific site field conditions. Should the testing laboratory propose these alternative methods, they should provide satisfactory explanation to the Resident Engineer before the tests are conducted.

- a. Building Slab Subgrade: At least one test of subgrade for every 185 m² (2000 square feet) of building slab, but in no case fewer than three tests. In each compacted fill layer, perform one test for every 185 m² (2000 square feet) of overlaying building slab, but in no case fewer than three tests.
- b. Foundation Wall Backfill: One test per 30 m (100 feet) of each layer of compacted fill but in no case fewer than two tests.
- c. Pavement Subgrade: One test for each 335 m² (400 square yards), but in no case fewer than two tests.
- d. Curb, Gutter, and Sidewalk: One test for each 90 m (300 feet), but in no case fewer than two tests.
- e. Trenches: One test at maximum 30 m (100 foot) intervals per 1200 mm (4 foot) of vertical lift and at changes in required density, but in no case fewer than two tests.
- f. Footing Subgrade: At least one test for each layer of soil on which footings will be placed. Subsequent verification and approval of each footing subgrade may be based on a visual comparison of each subgrade with related tested subgrade when acceptable to Resident Engineer. In each compacted fill layer below wall footings, perform one field density test for every 30 m (100 feet) of wall. Verify subgrade is level, all loose or disturbed soils have been removed, and correlate actual soil conditions observed with those indicated by test borings.

3.2 FOUNDATION PILES:

- A. Witness load test procedure for conformance with ASTM D1143 and interpret test data to verify geotechnical recommendations for pile capacity. Submit load test report in accordance with ASTM D1143.
- B. Review Contractor's equipment, methods, and procedures prior to starting any work on site. Provide continuous inspection of pile installation. Maintain a record of all pertinent phases of operation for submittal to Resident Engineer.

3.3 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/m³ (pounds per cubic feet).
 - f. Weather conditions during placing.
 - g. Temperature of concrete in each test cylinder when test cylinder was molded.
 - h. Maximum and minimum ambient temperature during placing.
 - i. Ambient temperature when concrete sample in test cylinder was taken.
 - j. Date delivered to laboratory and date tested.

3.4 STRUCTURAL STEEL:

- A. General: Provide shop and field inspection and testing services to certify structural steel work is done in accordance with contract documents. Welding shall conform to AWS D1.1 Structural Welding Code.
- B. Prefabrication Inspection:
 1. Review design and shop detail drawings for size, length, type and location of all welds to be made.
 2. Approve welding procedure qualifications either by pre-qualification or by witnessing qualifications tests.
 3. Approve welder qualifications by certification or retesting.
 4. Approve procedure for control of distortion and shrinkage stresses.

5. Approve procedures for welding in accordance with applicable sections of AWS D1.1.

C. Fabrication and Erection:

1. Weld Inspection:

- a. Inspect welding equipment for capacity, maintenance and working condition.
- b. Verify specified electrodes and handling and storage of electrodes in accordance with AWS D1.1.
- c. Inspect preparation and assembly of materials to be welded for conformance with AWS D1.1.
- d. Inspect preheating and interpass temperatures for conformance with AWS D1.1.
- e. Measure 25 percent of fillet welds.
- f. Welding Magnetic Particle Testing: Test in accordance with ASTM E709 for a minimum of:
 - 1) 20 percent of all shear plate fillet welds at random, final pass only.
 - 2) 20 percent of all continuity plate and bracing gusset plate fillet welds, at random, final pass only.
 - 3) 100 percent of tension member fillet welds (i.e., hanger connection plates and other similar connections) for root and final passes.
 - 4) 20 percent of length of built-up column member partial penetration and fillet welds at random for root and final passes.
 - 5) 100 percent of length of built-up girder member partial penetration and fillet welds for root and final passes.
- g. Welding Ultrasonic Testing: Test in accordance with ASTM E164 and AWS D1.1 for 100 percent of all full penetration welds, braced and moment frame column splices, and a minimum of 20 percent of all other partial penetration column splices, at random.
- h. Welding Radiographic Testing: Test in accordance with ASTM E94, and AWS D1.1 for 5 percent of all full penetration welds at random.
- i. Verify that correction of rejected welds are made in accordance with AWS D1.1.

- j. Testing and inspection do not relieve the Contractor of the responsibility for providing materials and fabrication procedures in compliance with the specified requirements.
- 2. Bolt Inspection:
 - a. Inspect high-strength bolted connections in accordance AISC Specifications for Structural Joints Using ASTM A325 or A490 Bolts.
 - b. Slip-Critical Connections: Inspect 10 percent of bolts, but not less than 2 bolts, selected at random in each connection in accordance with AISC Specifications for Structural Joints Using ASTM A325 or A490 Bolts. Inspect all bolts in connection when one or more are rejected.
 - c. Fully Pre-tensioned Connections: Inspect 10 percent of bolts, but not less than 2 bolts, selected at random in 25 percent of connections in accordance with AISC Specification for Structural Joints Using ASTM A325 or A490 Bolts. Inspect all bolts in connection when one or more are rejected.
 - d. Bolts installed by turn-of-nut tightening may be inspected with calibrated wrench when visual inspection was not performed during tightening.
 - e. Snug Tight Connections: Inspect 10 percent of connections verifying that plies of connected elements have been brought into snug contact.
 - f. Inspect field erected assemblies; verify locations of structural steel for plumbness, level, and alignment.
- D. Submit inspection reports, record of welders and their certification, and identification, and instances of noncompliance to Resident Engineer.

3.5 TYPE OF TEST:

Approximate Number of Tests Required

A. Concrete:

Making and Curing Concrete Test Cylinders (ASTM C31)	_____
Compressive Strength, Test Cylinders (ASTM C39)	_____
Concrete Slump Test (ASTM C143)	_____
Concrete Air Content Test (ASTM C173)	_____
Unit Weight, Lightweight Concrete (ASTM C567)	_____
Aggregate, Normal Weight: Gradation (ASTM C33)	_____
Deleterious Substances (ASTM C33)	_____
Soundness (ASTM C33)	_____
Abrasion (ASTM C33)	_____
Aggregate, Lightweight Gradation (ASTM C330)	_____
Deleterious Substances (ASTM C330)	_____
Unit Weight (ASTM C330)	_____
Flatness and Levelness Readings (ASTM E1155) (number of days)	_____

B. Structural Steel:

Ultrasonic Testing of Welds (ASTM E164)	_____
Magnetic Particle Testing of Welds (ASTM E709)	_____
Radiographic Testing of Welds (ASTM E94)	_____

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SECTION 01 57 19
TEMPORARY ENVIRONMENTAL CONTROLS
01-11

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 Resident Engineer and the Contracting Officer 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 material storage areas, and stockpiles of excess materials.
 - j. Work Area Plan showing the proposed activity in each portion of the area and identifying the areas of limited use or nonuse. Plan should include measures for marking the limits of use areas. This plan may be incorporated within the Erosion Control Plan.
- B. Approval of the Contractor's Environmental Protection Plan will not relieve the Contractor of responsibility for adequate and continued control of pollutants and other environmental protection measures.
- C. 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.
- D. 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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MODIFICATION

06-01-12 CONTENT REVISED IN REFERENCE TO REQUIREMENT FOR RECYCLING OF
CONSTRUCTION AND DEMOLITION WASTE.
09-01-13

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 recycle construction and demolition waste to a minimum of 50 percent.
- D. Contractor shall be responsible for implementation of any special programs involving rebates or similar incentives related to recycling. Any revenues or savings obtained from salvage or recycling shall accrue to the contractor.
- E. Contractor shall provide all demolition, removal and legal disposal of materials. Contractor shall ensure that facilities used for recycling, reuse and disposal shall be permitted for the intended use to the extent required by local, state, federal regulations. The Whole Building Design Guide website <http://www.wbdg.org/tools/cwm.php> 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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SECTION 01 81 13
SUSTAINABLE CONSTRUCTION REQUIREMENTS
09-01-15

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This Section describes general requirements and procedures to comply with federal mandates and U.S. Department of Veterans Affairs (VA) policies for sustainable construction as summarized in the VA Sustainable Design Manual.
- B. The Design Professional has selected materials and utilized integrated design processes that achieve the Government's objectives. Contractor is responsible to maintain and support these objectives in developing means and methods for performing work and in proposing product substitutions or changes to specified processes. By submitting a change or substitution of materials or processes, contractor must demonstrate its diligence in performing the level of investigation and comparison required under federal mandates and VA policies.

1.2 RELATED WORK

- A. Section 01 57 19 TEMPORARY ENVIRONMENTAL CONTROLS.
- B. Section 01 74 19 CONSTRUCTION WASTE MANAGEMENT.
- C. Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS.

1.3 DEFINITIONS

- A. Total Materials Cost: A tally of actual material cost from specification divisions 03 through 10, 31 (applicable to foundations) and 32 (applicable to paving, site improvements, and planting). Alternatively, 45 percent of total construction hard costs in those specification divisions.
- B. Recycled Content: Recycled content of materials is defined according to Federal Trade Commission Guides for the Use of Environmental Marketing Claims (16 CFR Part 260). Recycled content value of a material assembly is determined by weight. Recycled fraction of assembly is multiplied by cost of assembly to determine recycled content value.
 - 1. "Post-Consumer" material is defined as waste material generated by households or by commercial, industrial, and institutional facilities in their role as end users of the product, which can no longer be used for its intended purpose.
 - 2. "Pre-Consumer" material is defined as material diverted from waste stream during the manufacturing process. Excluded is reutilization

of materials such as rework, regrind, or scrap generated in a process and capable of being reclaimed within the same process that generated it.

- C. Biobased Products: Biobased products are derived from plants and other renewable agricultural, marine, and forestry materials and provide an alternative to conventional petroleum derived products. Biobased products include diverse categories such as lubricants, cleaning products, inks, fertilizers, and bioplastics.
- D. Low Pollutant-Emitting Materials: Materials and products which are minimally odorous, irritating, or harmful to comfort and well-being of installers and occupants.
- E. Volatile Organic Compounds (VOC): Chemicals that are emitted as gases from certain solids or liquids. VOCs include a variety of chemicals, some of which may have short- and long-term adverse health effects.

1.4 REFERENCE STANDARDS

- A. Carpet and Rug Institute Green Label Plus program.
- B. U.S. Department of Agriculture BioPreferred program (USDA BioPreferred).
- C. U.S. Environmental Protection Agency Comprehensive Procurement Guidelines (CPG).
- D. U.S. Environmental Protection Agency WaterSense Program (WaterSense).
- E. U.S. Environmental Protection Agency ENERGY STAR Program (ENERGY STAR).
- F. U. S. Department of Energy Federal Energy Management Program (FEMP).
- G. Green Electronic Council EPEAT Program (EPEAT).

1.5 SUBMITTALS

- A. All submittals to be provided by contractor to COR/Resident Engineer and Architect.
- B. Sustainability Action Plan:
 - 1. Submit documentation as required by this section; provide additional copies of typical submittals required under technical sections when sustainable construction requires copies of record submittals.
 - 2. Within 30 days after Preconstruction Meeting provide a narrative plan for complying with requirements stipulated within this section.
 - 3. Sustainability Action Plan must:
 - a. Make reference to sustainable construction submittals defined by this section.
 - b. Address all items listed under PERFORMANCE CRITERIA.
 - c. Indicate individual(s) responsible for implementing the plan.

- C. Project Materials Cost Data Spreadsheet: Within 30 days after the Preconstruction Meeting provide a preliminary Project Materials Cost Data Spreadsheet. The Project Materials Cost Data Spreadsheet must be an electronic file and indicate all materials in Divisions 3 through 10, 31, and 32 used for Project (excluding labor costs and excluding all mechanical, electrical, and plumbing system components), and be organized by specification section. The spreadsheet must include the following:
1. Identify each reused or salvaged material, its cost, and its replacement value.
 2. Identify each recycled-content material, its post-consumer and pre-consumer recycled content as a percentage the product's weight, its cost, its combined recycled content value, defined as the sum of post-consumer recycled content value plus one-half of pre-consumer recycled content value, and total combined recycled content value for all materials as a percentage of total materials costs.
 3. Identify each biobased material, its source, its cost, and total value of biobased materials as a percentage of total materials costs.
 4. Total cost for Project and total cost of building materials used for Project.
- D. Product Submittals:
1. Recycled Content: Submit product data from manufacturer indicating percentages by weight of post-consumer and pre-consumer recycled content for products having recycled content (excluding MEP systems equipment and components).
 2. Biobased Content: Submittals for products to be installed or used included on the USDA BioPreferred program's product category lists. Data to include biobased content and source of biobased material; indicating name of manufacturer, cost of each material.
- E. Sustainable Construction Progress Reports: Concurrent with each Application for Payment, submit a Sustainable Construction Progress Report to confirm adherence with Sustainability Action Plan.
1. Include narratives of revised strategies for bringing work progress into compliance with plan and product submittal data and calculations to demonstrate compliance with thresholds based on materials costs.
 2. Include updated and current Project Materials Cost Data Spreadsheet.

3. Include updated and current Low Pollutant-Emitting Materials Tracking Spreadsheet.
 4. Include construction waste tracking, in tons or cubic yards, including waste description, whether diverted or landfilled, hauler, and percent diverted for comingled quantities; and excluding land-clearing debris and soil. Provide haul receipts and documentation of diverted percentages for comingled wastes.
- F. Closeout Submittals: Within 14 days after Substantial Completion provide the following:
1. Final version of Project Material Cost Data Spreadsheet.
 2. Final version of Low Pollutant-Emitting Materials Tracking Spreadsheet.
 3. Manufacturer's cut sheets and product data highlighting the Minimum Efficiency Reporting Value (MERV) for filtration media installed at return air grilles during construction if permanently installed air handling units are used during construction.
 4. Manufacturer's cut sheets and product data highlighting the Minimum Efficiency Reporting Value (MERV) for final filtration media in air handling units.
 5. Minimum 18 construction photographs including six photographs taken on three different occasions during construction of ANSI/SMACNA 008-2008, Chapter 3 approaches employed, along with a brief description of each approach, documenting implementation of IAQ management measures, such as protection of ducts and on-site stored or installed absorptive materials.
 6. Flush-out Documentation:
 - a. Product data for filtration media used during flush-out.
 - b. Product data for filtration media installed immediately prior to occupancy.
 - c. Signed statement describing building air flush-out procedures including dates when flush-out was begun and completed and statement that filtration media was replaced after flush-out.

1.6 QUALITY ASSURANCE

- A. Preconstruction Meeting: After award of Contract and prior to commencement of Work, schedule and conduct meeting with COR/Resident Engineer and Architect to discuss the Project Sustainable Action Plan content as it applies to submittals, project delivery, required Construction Indoor Air Quality (IAQ) Management Plan, and other

Sustainable Construction Requirements. The purpose of this meeting is to develop a mutual understanding of the Sustainable Construction Requirements and coordination of contractor's management of these requirements with the Contracting Officer and the Construction Quality Manager.

- B. Construction Job Conferences: Status of compliance with Sustainable Construction Requirements of these specifications will be an agenda item at regular job meetings conducted during the course of work at the site.

1.7 APPLICABLE PUBLICATIONS

- A. Publications listed below form a part of this specification to extent referenced. Publications are referenced in text by basic designation only. Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
- B. Green Seal Standard GS-11, Paints, 1st Edition, May 20, 1993.
- C. Green Seal Standard GC-03, Anti-Corrosive Paints, 2nd Edition, January 7, 1997.
- D. Green Seal Standard GC-36, Commercial Adhesives, October 19, 2000.
- E. South Coast Air Quality Management District (SCAQMD) Rule 1113, Architectural Coatings, rules in effect on January 1, 2004.
- F. South Coast Air Quality Management District (SCAQMD) Rule 1168, July 1, 2005 and rule amendment date of January 7, 2005.
- G. Sheet Metal and Air Conditioning National Contractors' Association (SMACNA) IAQ Guidelines for Occupied Buildings under Construction, 2nd Edition (ANSI/SMACNA 008-2008), Chapter 3.
- H. California Department of Public Health Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers, Version 1.1, Emission Testing method for California Specification 01350 (CDPH Standard Method V1.1-2010).
- I. Federal Trade Commission Guides for the Use of Environmental Marketing Claims (16 CFR Part 260).
- J. ASHRAE Standard 52.2-2007.

PART 2 - PRODUCTS

2.1 PERFORMANCE CRITERIA

- A. Construction waste diversion from landfill disposal must comprise at least 50 percent of total construction waste, excluding land clearing debris and soil. Alternative daily cover (ADC) does not qualify as material diverted from disposal.
- 1. Paints and coatings applied on site must comply with the following criteria:
 - a. VOC content limits for paints and coatings established in Green Seal Standard GS-11.
 - b. VOC content limit for anti-corrosive and anti-rust paints applied to interior ferrous metal substrates of 250 g/L established in Green Seal GC-03.
 - c. Clear wood finishes, floor coatings, stains, primers, sealers, and shellacs applied to interior elements must not exceed VOC content limits established in SCAQMD Rule 1113.
 - d. Comply with the following VOC content limits:
 - 1) Anti-Corrosive/Antirust Paints: 250 g/L.
 - 2) Concrete Curing Compounds: 350 g/L.
- B. Recycled Content:
 - 1. Any product being installed or used that are listed on EPA Comprehensive Procurement Guidelines designated product list must meet or exceed the EPA's recycled content recommendations. The EPA Comprehensive Procurement Guidelines categories include:
 - a. Cement and concrete.
 - b. Consolidated and reprocessed latex paint.
 - c. Nonpressure pipe.
 - d. Patio blocks.
 - 2. Provide building materials with recycled content such that post-consumer recycled content value plus half the pre-consumer recycled content value constitutes a minimum of [10] [20] percent of cost of materials used for Project, exclusive of mechanical, electrical and plumbing components, specialty items such as elevators, and labor and delivery costs.

C. Biobased Content:

1. Materials and equipment being installed or used that are listed on the USDA BioPreferred program product category list must meet or exceed USDA's minimum biobased content threshold. Refer to individual specification sections for detailed requirements applicable to that section.

a. USDA BioPreferred program categories include:

- 1) Industrial Cleaners.
- 2) Interior Paints and Coatings.
- 3) Multipurpose Cleaners.
- 4) Multipurpose Lubricants.
- 5) Paint Removers.
- 6) Plastic Insulating Foam.
- 7) Water Tank Coatings.
- 8) Wood and Concrete Sealers.
- 9) Wood and Concrete Stains.

D. Materials, products, and equipment being installed which fall into a category covered by the WaterSense program must be WaterSense-labeled or meet or exceed WaterSense program performance requirements, unless disallowed for infection control reasons.

PART 3 - EXECUTION

3.1 FIELD QUALITY CONTROL

1. Protect stored on-site and installed absorptive materials from moisture damage.

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SECTION 01 91 00
GENERAL COMMISSIONING REQUIREMENTS
10-01-15

PART 1 - GENERAL

1.1 COMMISSIONING DESCRIPTION

- A. This Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS shall form the basis of the construction phase commissioning process and procedures. The Commissioning Agent shall add, modify, and refine the commissioning procedures, as approved by the Department of Veterans Affairs (VA), to suit field conditions and actual manufacturer's equipment, incorporate test data and procedure results, and provide detailed scheduling for all commissioning tasks.
- B. Various sections of the project specifications require equipment startup, testing, and adjusting services. Requirements for startup, testing, and adjusting services specified in the Division 7, Division 21, Division 22, Division 23, Division 26, Division 27, Division 28, and Division 31 series sections of these specifications are intended to be provided in coordination with the commissioning services and are not intended to duplicate services. The Contractor shall coordinate the work required by individual specification sections with the commissioning services requirements specified herein.
- C. Where individual testing, adjusting, or related services are required in the project specifications and not specifically required by this commissioning requirements specification, the specified services shall be provided and copies of documentation, as required by those specifications shall be submitted to the VA and the Commissioning Agent to be indexed for future reference.
- D. Where training or educational services for VA are required and specified in other sections of the specifications, including but not limited to Division 7, Division 8, Division 21, Division 22, Division 23, Division 26, Division 27, Division 28, and Division 31 series sections of the specification, these services are intended to be provided in addition to the training and educational services specified herein.
- E. Commissioning is a systematic process of verifying that the building systems perform interactively according to the construction documents and the VA's operational needs. The commissioning process shall encompass and coordinate the system documentation, equipment startup,

control system calibration, testing and balancing, performance testing and training. Commissioning during the construction and post-occupancy phases is intended to achieve the following specific objectives according to the contract documents:

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

1.2 CONTRACTUAL RELATIONSHIPS

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

the construction process. By its nature, a high level of communication and cooperation between the Commissioning Agent and all other parties (Architects, Engineers, Subcontractors, Vendors, third party testing agencies, etc.) is essential to the success of the Commissioning effort.

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

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

1.3 RELATED WORK

- A. Section 01 00 00 GENERAL REQUIREMENTS.
- B. Section 01 32 16.01 ARCHITECTURAL AND ENGINEERING CPM SCHEDULES
- C. Section 01 32.16.15 PROJECT SCHEDULES (SMALL PROJECTS - DESIGN/BID/BUILD)
- D. Section 01 33 23 SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES
- E. Section 23 08 00 COMMISSIONING OF HVAC SYSTEMS.
- F. Section 26 08 00 COMMISSIONING OF ELECTRICAL SYSTEMS.
- G. Section 27 08 00 COMMISSIONING OF COMMUNICATIONS 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 United States Green Building Council's (USGBC) LEED™ rating program and to support delivery of project performance in accordance with the VA requirements developed for the project to support the following credits:
 - 1. Commissioning activities and documentation for the LEED™ section on "Energy and Atmosphere" and the prerequisite of "Fundamental Building Systems Commissioning."
 - 2. Commissioning activities and documentation for the LEED™ section on "Energy and Atmosphere" requirements for the "Enhanced Building System Commissioning" credit.
 - 3. Activities and documentation for the LEED™ section on "Measurement and Verification" requirements for the Measurement and Verification credit.
- D. The commissioning activities have been developed to support the Green Buildings Initiative's Green Globes rating program and to support delivery of project performance in accordance with the VA requirements developed for the project.

1.5 ACRONYMS

List of Acronyms	
Acronym	Meaning
A/E	Architect / Engineer Design Team
AHJ	Authority Having Jurisdiction
ASHRAE	Association Society for Heating Air Condition and Refrigeration Engineers
BOD	Basis of Design
BSC	Building Systems Commissioning
CCTV	Closed Circuit Television
CD	Construction Documents
CMMS	Computerized Maintenance Management System
CO	Contracting Officer (VA)
COR	Contracting Officer's Representative (see also VA-RE)
COBie	Construction Operations Building Information Exchange
CPC	Construction Phase Commissioning
Cx	Commissioning
CxA	Commissioning Agent
CxM	Commissioning Manager
CxR	Commissioning Representative
DPC	Design Phase Commissioning
FPT	Functional Performance Test
GBI-GG	Green Building Initiative - Green Globes
HVAC	Heating, Ventilation, and Air Conditioning
LEED	Leadership in Energy and Environmental Design
NC	Department of Veterans Affairs National Cemetery
NCA	Department of Veterans Affairs National Cemetery Administration
NEBB	National Environmental Balancing Bureau
O&M	Operations & Maintenance
OPR	Owner's Project Requirements
PFC	Pre-Functional Checklist
PFT	Pre-Functional Test
SD	Schematic Design
SO	Site Observation
TAB	Test Adjust and Balance

List of Acronyms	
Acronym	Meaning
VA	Department of Veterans Affairs
VAMC	VA Medical Center
VA CFM	VA Office of Construction and Facilities Management
VACO	VA Central Office
VA PM	VA Project Manager
VA-RE	VA Resident Engineer
USGBC	United States Green Building Council

1.6 DEFINITIONS

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

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

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

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

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

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

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

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

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

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

Commissioning Agent (CxA): The qualified Commissioning Professional who administers the Cx process by managing the Cx team and overseeing the Commissioning Process. Where CxA is used in this specification it means the Commissioning Agent, members of his staff or appointed members of the commissioning team. Note that LEED uses the term Commissioning Authority in lieu of Commissioning Agent.

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

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

Commissioning Issue: A condition identified by the Commissioning Agent or other member of the Commissioning Team that adversely affects the commissionability, operability, maintainability, or functionality of a system, equipment, or component. A condition that is in conflict with

the Contract Documents and/or performance requirements of the installed systems and components. (See also - Commissioning Observation).

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Deficiency: See "Commissioning Issue".

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

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

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

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

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

Executive Summary: A section of the Commissioning report that reviews the general outcome of the project. It also includes any unresolved

issues, recommendations for the resolution of unresolved issues and all deferred testing requirements.

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

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

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

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

Integrated System Testing: Integrated Systems Testing procedures entail testing of multiple integrated systems performance to verify proper functional interface between systems. Typical Integrated Systems Testing includes verifying that building systems respond properly to loss of utility, transfer to emergency power sources, re-transfer from emergency power source to normal utility source; interface between HVAC controls and Fire Alarm systems for equipment shutdown, interface between Fire Alarm system and elevator control systems for elevator recall and shutdown; interface between Fire Alarm System and Security Access Control Systems to control access to spaces during fire alarm conditions; and other similar tests as determined for each specific project.

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

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

Maintainability: A design component or construction process that will allow a system or component to be effectively maintained. This includes adequate room for access to adjust and repair the equipment.

Maintainability also includes components that have readily obtainable repair parts or service.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Testing, Adjusting, and Balancing (TAB): A systematic process or service applied to heating, ventilating and air-conditioning (HVAC) systems and other environmental systems to achieve and document air and hydronic flow rates. The standards and procedures for providing these services are referred to as "Testing, Adjusting, and Balancing" and are described in the Procedural Standards for the Testing, Adjusting and Balancing of Environmental Systems, published by NEBB or AABC.

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

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

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

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

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

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

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

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

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

1.7 SYSTEMS TO BE COMMISSIONED

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

Systems To Be Commissioned	
System	Description
Foundations (excluding structural)	Standard, special, slab-on-grade, vapor barriers, air barriers
Specialties	
HVAC	
Noise and Vibration Control	Noise and vibration levels for critical equipment such as Air Handlers, Chillers, Cooling Towers, Boilers, Generators, etc. will be commissioned as part of the system commissioning
Direct Digital Control System**	Operator Interface Computer, Operator Work Station (including graphics, point mapping, trends, alarms), Network Communications Modules and Wiring, Integration Panels. [DDC Control panels will be commissioned with the systems controlled by the panel]
Steam/Heating Hot Water System**	Boilers, boiler feed water system, economizers/heat recovery equipment, condensate recovery, water treatment, boiler fuel system, controls, interface with facility DDC system.
Facility Fuel Gas Systems	Witness Natural gas piping pressure testing, natural gas compressors and storage, propane storage

Electrical	
Medium-Voltage Electrical Distribution Systems	Medium-Voltage Switchgear, Medium-Voltage Switches, Underground ductbank and distribution, Pad-Mount Transformers, Medium-Voltage Load Interrupter Switches,
Grounding & Bonding Systems	Witness 3rd party testing, review reports
Electric Power Monitoring Systems	Metering, sub-metering, power monitoring systems, PLC control systems
Electrical System Protective Device Study	Review reports, verify field settings consistent with Study
Secondary Unit Substations	Medium-voltage components, transformers, low-voltage distribution, verify breaker testing results (injection current, etc)
Low-Voltage Distribution System	Normal power distribution system, Life-safety power distribution system, critical power distribution system, equipment power distribution system, switchboards, distribution panels, panelboards, verify breaker testing results (injection current, etc)
Emergency Power Generation Systems	Generators, Generator paralleling switchgear, automatic transfer switches, PLC and other control systems
Lighting & Lighting Control** Systems	Emergency lighting, occupancy sensors, lighting control systems, architectural dimming systems, theatrical dimming systems, exterior lighting and controls

Communications	
Grounding & Bonding System	Witness 3rd party testing, review reports

1.8 COMMISSIONING TEAM

- A. The commissioning team shall consist of, but not be limited to, representatives of Contractor, including Project Superintendent and subcontractors, installers, schedulers, suppliers, and specialists deemed appropriate by the Department of Veterans Affairs (VA) and Commissioning Agent.
- B. Members Appointed by Contractor:
 - 1. Contractor' Commissioning Manager: The designated person, company, or entity that plans, schedules and coordinates the commissioning activities for the construction team.
 - 2. Contractor's Commissioning Representative(s): Individual(s), each having authority to act on behalf of the entity he or she represents, explicitly organized to implement the commissioning process through coordinated actions.
- C. Members Appointed by VA:
 - 1. Commissioning Agent: The designated person, company, or entity that plans, schedules, and coordinates the commissioning team to implement the commissioning process. The VA will review and approve the contractor's CxA submittal by contractor under the contractor's contract.
 - 2. User: Representatives of the facility user and operation and maintenance personnel.
 - 3. A/E: Representative of the Architect and engineering design professionals.

1.9 VA'S COMMISSIONING RESPONSIBILITIES

- A. Approve an individual, company or firm submitted by the contractor to act as the Commissioning Agent.
- B. Assign operation and maintenance personnel and schedule them to participate in commissioning team activities including, but not limited to, the following:
 - 1. Coordination meetings.
 - 2. Training in operation and maintenance of systems, subsystems, and equipment.
 - 3. Testing meetings.
 - 4. Witness and assist in Systems Functional Performance Testing.
 - 5. Demonstration of operation of systems, subsystems, and equipment.

- C. Provide the Construction Documents, prepared by Architect and approved by VA, to the Commissioning Agent and for use in managing the commissioning process, developing the commissioning plan, systems manuals, and reviewing the operation and maintenance training plan.

1.10 CONTRACTOR'S COMMISSIONING RESPONSIBILITIES

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

10. Provide technicians who are familiar with the construction and operation of installed systems and who shall develop specific test procedures to conduct Systems Functional Performance Testing of installed systems.

1.11 COMMISSIONING AGENT'S RESPONSIBILITIES

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

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

1.12 COMMISSIONING DOCUMENTATION

- A. Commissioning Plan: A document, prepared by Commissioning Agent, that outlines the schedule, allocation of resources, and documentation requirements of the commissioning process, and shall include, but is not limited, to the following:
 - 1. Plan for delivery and review of submittals, systems manuals, and other documents and reports. Identification of the relationship of these documents to other functions and a detailed description of submittals that are required to support the commissioning processes. Submittal dates shall include the latest date approved submittals must be received without adversely affecting commissioning plan.

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

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

1. Creating an Commissioning Issues Log Entry:
 - a. Identify the issue with unique numeric or alphanumeric identifier by which the issue may be tracked.
 - b. Assign a descriptive title for the issue.
 - c. Identify date and time of the issue.
 - d. Identify test number of test being performed at the time of the observation, if applicable, for cross reference.
 - e. Identify system, subsystem, and equipment to which the issue applies.
 - f. Identify location of system, subsystem, and equipment.
 - g. Include information that may be helpful in diagnosing or evaluating the issue.
 - h. Note recommended corrective action.
 - i. Identify commissioning team member responsible for corrective action.
 - j. Identify expected date of correction.
 - k. Identify person that identified the issue.
2. Documenting Issue Resolution:
 - a. Log date correction is completed or the issue is resolved.
 - b. Describe corrective action or resolution taken. Include description of diagnostic steps taken to determine root cause of the issue, if any.
 - c. Identify changes to the Contract Documents that may require action.
 - d. State that correction was completed and system, subsystem, and equipment are ready for retest, if applicable.
 - e. Identify person(s) who corrected or resolved the issue.
 - f. Identify person(s) verifying the issue resolution.
- G. Final Commissioning Report: The Commissioning Agent will document results of the commissioning process, including unresolved issues, and performance of systems, subsystems, and equipment. The Commissioning Report will indicate whether systems, subsystems, and equipment have been properly installed and are performing according to the Contract Documents. This report will be used by the Department of Veterans Affairs when determining that systems will be accepted. This report will be used to evaluate systems, subsystems, and equipment and will serve as a future reference document during VA occupancy and operation.

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

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

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

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

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

1. Design Narrative, including system narratives, schematics, single-line diagrams, flow diagrams, equipment schedules, and changes made throughout the Project.

2. Reference to Final Commissioning Plan.
3. Reference to Final Commissioning Report.
4. Approved Operation and Maintenance Data as submitted by the Contractor.

1.13 SUBMITTALS

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

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

equipment or system to fulfill requirements of the Commissioning Plan.

2. The Commissioning Agent may request further documentation as is necessary for the commissioning process or to support other VA data collection requirements, including Construction Operations Building Information Exchange (COBIE), Building Information Modeling (BIM), etc.

1.14 COMMISSIONING PROCESS

- A. The Commissioning Agent will be responsible for the overall management of the commissioning process as well as coordinating scheduling of commissioning tasks with the VA and the Contractor. As directed by the VA, the Contractor shall incorporate Commissioning tasks, including, but not limited to, Systems Functional Performance Testing (including predecessors) with the Master Construction Schedule.
- B. Within 14 days of contract award, the Contractor shall designate a specific individual as the Commissioning Manager (CxM) to manage and lead the commissioning effort on behalf of the Contractor. The Commissioning Manager shall be the single point of contact and communications for all commissioning related services by the Contractor.
- C. Within 14 days of contract award, the Contractor shall ensure that each subcontractor designates specific individuals as Commissioning Representatives (CXR) to be responsible for commissioning related tasks. The Contractor shall ensure the designated Commissioning Representatives participate in the commissioning process as team members providing commissioning testing services, equipment operation, adjustments, and corrections if necessary. The Contractor shall ensure that all Commissioning Representatives shall have sufficient authority to direct their respective staff to provide the services required, and to speak on behalf of their organizations in all commissioning related contractual matters.

1.15 QUALITY ASSURANCE

- A. Instructor Qualifications: Factory authorized service representatives shall be experienced in training, operation, and maintenance procedures for installed systems, subsystems, and equipment.
- B. Test Equipment Calibration: The Contractor shall comply with test equipment manufacturer's calibration procedures and intervals. Recalibrate test instruments immediately whenever instruments have been

repaired following damage or dropping. Affix calibration tags to test instruments. Instruments shall have been calibrated within six months prior to use.

1.16 COORDINATION

- A. Management: The Commissioning Agent will coordinate the commissioning activities with the VA and Contractor. The Commissioning Agent will submit commissioning documents and information to the VA. All commissioning team members shall work together to fulfill their contracted responsibilities and meet the objectives of the contract documents.
- B. Scheduling: The Contractor shall work with the Commissioning Agent and the VA to incorporate the commissioning activities into the construction schedule. The Commissioning Agent will provide sufficient information (including, but not limited to, tasks, durations and predecessors) on commissioning activities to allow the Contractor and the VA to schedule commissioning activities. All parties shall address scheduling issues and make necessary notifications in a timely manner in order to expedite the project and the commissioning process. The Contractor shall update the Master Construction as directed by the VA.
- C. Initial Schedule of Commissioning Events: The Commissioning Agent will provide the initial schedule of primary commissioning events in the Commissioning Plan and at the commissioning coordination meetings. The Commissioning Plan will provide a format for this schedule. As construction progresses, more detailed schedules will be developed by the Contractor with information from the Commissioning Agent.
- D. Commissioning Coordinating Meetings: The Commissioning Agent will conduct periodic Commissioning Coordination Meetings of the commissioning team to review status of commissioning activities, to discuss scheduling conflicts, and to discuss upcoming commissioning process activities.
- E. Pretesting Meetings: The Commissioning Agent will conduct pretest meetings of the commissioning team to review startup reports, Pre-Functional Checklist results, Systems Functional Performance Testing procedures, testing personnel and instrumentation requirements.
- F. Systems Functional Performance Testing Coordination: The Contractor shall coordinate testing activities to accommodate required quality assurance and control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing

and inspecting. The Contractor shall coordinate the schedule times for tests, inspections, obtaining samples, and similar activities.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

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

PART 3 - EXECUTION

3.1 COMMISSIONING PROCESS ROLES AND RESPONSIBILITIES

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

Construction Phase		Cx/A = Commissioning Agent						L = Lead	
Category	Task Description	Cx/A	RE	A/E	PC	O&M		P = Participate	
Meetings	Construction Commissioning Kick Off meeting	L	A	P	P	O		A = Approve	
	Commissioning Meetings	L	A	P	P	O		R = Review	
	Project Progress Meetings	P	A	P	L	O		O = Optional	
	Controls Meeting	L	A	P	P	O			
Coordination	Coordinate with [OGC's, AHJ, Vendors, etc.] to ensure that Cx interacts properly with other systems as needed to support the OPR and BOD.	L	A	P	P	N/A			
Cx Plan & Spec	Final Commissioning Plan	L	A	R	R	O			
Schedules	Duration Schedule for Commissioning Activities	L	A	R	R	N/A			
OPR and BOD	Maintain OPR on behalf of Owner	L	A	R	R	O			
	Maintain BOD/DID on behalf of Owner	L	A	R	R	O			
Document Reviews	TAB Plan Review	L	A	R	R	O			
	Submittal and Shop Drawing Review	R	A	R	L	O			
	Review Contractor Equipment Startup Checklists	L	A	R	R	N/A			
	Review Change Orders, ASI, and RFI	L	A	R	R	N/A			

Construction Phase		CxA = Commissioning Agent						L = Lead
Commissioning Roles & Responsibilities		RE = Resident Engineer						P = Participate
		A/E = Design Arch/Engineer						A = Approve
		PC = Prime Contractor						R = Review
		O&M = Gov't Facility O&M						O = Optional
		CxA	RE	A/E	PC	O&M	Notes	
Category	Task Description							
	Witness Factory Testing	P	A	P	L	O		
Site Observations	Construction Observation Site Visits	L	A	R	R	O		
	Final Pre-Functional Checklists	L	A	R	R	O		
	Final Functional Performance Test Protocols	L	A	R	R	O		
Functional Test Protocols	Issues Resolution Meetings	P	A	P	L	O		
	Status Reports	L	A	R	R	O		
Technical Activities	Maintain Commissioning Issues Log	L	A	R	R	O		
Reports and Logs								

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

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

Acceptance Phase		CxA = Commissioning Agent						L = Lead
Commissioning Roles & Responsibilities		RE = Resident Engineer						P = Participate
		A/E = Design Arch/Engineer						A = Approve
		PC = Prime Contractor						R = Review
		O&M = Gov't Facility O&M						O = Optional
		CxA	RE	A/E	PC	O&M	Notes	
Category	Task Description	CxA	RE	A/E	PC	O&M	Notes	
	Lessons Learned and Commissioning Report Review Meeting	L	A	P	P	O		
Coordination	Coordinate with [OGC's, AHJ, Vendors, etc.] to ensure that Cx interacts properly with other systems as needed to support OPR and BOD	L	P	P	P	O		
Cx Plan & Spec	Maintain/Update Commissioning Plan	L	A	R	R	O		
Schedules	Prepare Functional Test Schedule	L	A	R	R	O		
OPR and BOD	Maintain OPR on behalf of Owner	L	A	R	R	O		
	Maintain BOD/DID on behalf of Owner	L	A	R	R	O		
	Review Completed Pre-Functional Checklists	L	A	R	R	O		
Document Reviews	Pre-Functional Checklist Verification	L	A	R	R	O		
	Review Operations & Maintenance Manuals	L	A	R	R	R		
	Training Plan Review	L	A	R	R	R		
	Warranty Review	L	A	R	R	O		
	Review TAB Report	L	A	R	R	O		
Site Observations	Construction Observation Site Visits	L	A	R	R	O		
	Witness Selected Equipment Startup	L	A	R	R	O		
Functional Test Protocols	TAB Verification	L	A	R	R	O		
	Systems Functional Performance Testing	L	A	P	P	P		
	Retesting	L	A	P	P	P		
Technical								
	Issues Resolution Meetings	P	A	P	L	O		

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

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

Warranty Phase		CxA = Commissioning Agent						L = Lead
Commissioning Roles & Responsibilities		RE = Resident Engineer						P = Participate
		A/E = Design Arch/Engineer						A = Approve
		PC = Prime Contractor						R = Review
		O&M = Gov't Facility O&M						O = Optional
		CxA	RE	A/E	PC	O&M	Notes	
Category	Task Description							
Meetings	Post-Occupancy User Review Meeting	L	A	O	P	P		
Site Observations	Periodic Site Visits	L	A	O	O	P		
Functional Test Protocols	Deferred and/or seasonal Testing	L	A	O	P	P		

Warranty Phase		Cx/A = Commissioning Agent					L = Lead
Commissioning Roles & Responsibilities		RE = Resident Engineer					P = Participate
		A/E = Design Arch/Engineer					A = Approve
		PC = Prime Contractor					R = Review
		O&M = Gov't Facility O&M					O = Optional
Category	Task Description	Cx/A	RE	A/E	PC	O&M	Notes
Technical Activities	Issues Resolution Meetings	L	S	O	O	P	
	Post-Occupancy Warranty Checkup and review of Significant Outstanding Issues	L	A		R	P	
Reports and Logs	Final Commissioning Report Amendment	L	A		R	R	
	Status Reports	L	A		R	R	

3.2 STARTUP, INITIAL CHECKOUT, AND PRE-FUNCTIONAL CHECKLISTS

A. The following procedures shall apply to all equipment and systems to be commissioned, according to Part 1, Systems to Be Commissioned.

1. Pre-Functional Checklists are important to ensure that the equipment and systems are hooked up and operational. These ensure that Systems Functional Performance Testing may proceed without unnecessary delays. Each system to be commissioned shall have a full Pre-Functional Checklist completed by the Contractor prior to Systems Functional Performance Testing. No sampling strategies are used.

a. The Pre-Functional Checklist will identify the trades responsible for completing the checklist. The Contractor shall ensure the appropriate trades complete the checklists.

b. The Commissioning Agent will review completed Pre-Functional Checklists and field-verify the accuracy of the completed checklist using sampling techniques.

2. Startup and Initial Checkout Plan: The Contractor shall develop detailed startup plans for all equipment. The primary role of the Contractor in this process is to ensure that there is written documentation that each of the manufacturer recommended procedures have been completed. Parties responsible for startup shall be identified in the Startup Plan and in the checklist forms.

a. The Contractor shall develop the full startup plan by combining (or adding to) the checklists with the manufacturer's detailed startup and checkout procedures from the O&M manual data and the field checkout sheets normally used by the Contractor. The plan shall include checklists and procedures with specific boxes or lines for recording and documenting the checking and inspections of each procedure and a summary statement with a signature block at the end of the plan.

b. The full startup plan shall at a minimum consist of the following items:

1) The Pre-Functional Checklists.

2) The manufacturer's standard written startup procedures copied from the installation manuals with check boxes by each procedure and a signature block added by hand at the end.

3) The manufacturer's normally used field checkout sheets.

c. The Commissioning Agent will submit the full startup plan to the VA and Contractor for review. Final approval will be by the VA.

- d. The Contractor shall review and evaluate the procedures and the format for documenting them, noting any procedures that need to be revised or added.
- 3. Sensor and Actuator Calibration
 - a. All field installed temperature, relative humidity, CO2 and pressure sensors and gages, and all actuators (dampers and valves) on all equipment shall be calibrated using the methods described in Division 21, Division 22, Division 23, Division 26, Division 27, and Division 28 specifications.
 - b. All procedures used shall be fully documented on the Pre-Functional Checklists or other suitable forms, clearly referencing the procedures followed and written documentation of initial, intermediate and final results.
- 4. Execution of Equipment Startup
 - a. Four weeks prior to equipment startup, the Contractor shall schedule startup and checkout with the VA and Commissioning Agent. The performance of the startup and checkout shall be directed and executed by the Contractor.
 - b. The Commissioning Agent will observe the startup procedures for selected pieces of primary equipment.
 - c. The Contractor shall execute startup and provide the VA and Commissioning Agent with a signed and dated copy of the completed startup checklists, and contractor tests.
 - d. Only individuals that have direct knowledge and witnessed that a line item task on the Startup Checklist was actually performed shall initial or check that item off. It is not acceptable for witnessing supervisors to fill out these forms.

3.3 DEFICIENCIES, NONCONFORMANCE, AND APPROVAL IN CHECKLISTS AND STARTUP

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

correct all areas that are noncompliant or incomplete in the checklists in a timely manner, and shall notify the VA and Commissioning Agent as soon as outstanding items have been corrected. The Contractor shall submit an updated startup report and a Statement of Correction on the original noncompliance report. When satisfactorily completed, the Commissioning Agent will recommend approval of the checklists and startup of each system to the VA.

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

3.4 PHASED COMMISSIONING

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

3.5 DDC SYSTEM TRENDING FOR COMMISSIONING

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

automatically by the DDC system at the start of each shift. The generated maintenance report will be printed to a printer located within the engineer's office.

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

3. Graphical plotting - The graphical plots shall be provided with a dual y-axis allowing 15 or more trend points (series) plotted simultaneously on the graph with each series in distinct color. The plots will further require title, axis naming, legend etc. all described by the Systems Functional Performance Test Procedure. If this cannot be sufficiently accomplished directly in the Direct Digital Control System then it is the responsibility of the Contractor to plot these trend logs in Microsoft Excel.
4. The following tables indicate the points to be trended and alarmed by system. The Operational Trend Duration column indicates the trend duration for normal operations. The Testing Trend Duration column indicates the trend duration prior to Systems Functional Performance Testing and again after Systems Functional Performance Testing. The Type column indicates point type: AI = Analog Input, AO = Analog Output, DI = Digital Input, DO = Digital Output, Calc = Calculated Point. In the Trend Interval Column, COV = Change of Value. The Alarm Type indicates the alarm priority; C = Critical, P = Priority, and M = Maintenance. The Alarm Range column indicates when the point is considered in the alarm state. The Alarm Delay column indicates the length of time the point must remain in an alarm state before the alarm is recorded in the DDC. The intent is to allow minor, short-duration events to be corrected by the DDC system prior to recording an alarm.

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		

Steam and Condensate Pumps Trending and Alarms							
Point	Type	Trend Interval	Operationa l Trend Duration	Testing Trend Duration	Alarm Type	Alarm Range	Alarm Delay
High Water Level Alarm	DI	COV	12 hours	3 days	C	True	5 Min
Condensate Pump Start/Stop	DO	COV	12 hours	3 days	P	Status <> Command	10 min

Domestic Hot Water Trending and Alarms							
Point	Type	Trend Interval	Operationa l Trend Duration	Testing Trend Duration	Alarm Type	Alarm Range	Alarm Delay

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

Steam Boiler System Trending and Alarms							
Point	Type	Trend Interval	Operationa l Trend Duration	Testing Trend Duration	Alarm Type	Alarm Range	Alarm Delay
Boiler 1&3 on Fuel Oil	DI	COV	12 Hours	3 days	N/A		
Boiler 1&3 Low Water Alarm	DI	COV	12 Hours	3 days	C	True	5 Min
Boiler 1&3 High Water Alarm	DI	COV	12 Hours	3 days	C	True	5 Min
Boiler 1&3 Feed Pump	DI	COV	12 Hours	3 days	N/A		
Boiler 2 Enable	DI	COV	12 Hours	3 days	N/A		
Boiler 2 Status	DI	COV	12 Hours	3 days	P	Status <> Command	10 min
Boiler 2 Alarm	DI	COV	12 Hours	3 days	C	True	1 Min
Boiler 2 on Fuel Oil	DI	COV	12 Hours	3 days	N/A		
Boiler 2 Low Water Alarm	DI	COV	12 Hours	3 days	C	True	5 Min
Boiler 2 High Water Alarm	DI	COV	12 Hours	3 days	C	True	5 Min
Boiler 2 Feed Pump	DI	COV	12 Hours	3 days	N/A		
Combustion Damper Status	DI	COV	12 Hours	3 days	P	Status <> Command	5 min
Condensate Recovery Pump Status	DI	COV	12 Hours	3 days	P	Status <> Command	5 min
Boiler 1&3 Feed Pump Start / Stop	DO	COV	12 Hours	3 days	N/A		
Boiler 2 Start / Stop	DO	COV	12 Hours	3 days	N/A		
Combustion Damper Command	DO	COV	12 Hours	3 days	N/A		
Condensate Recovery Pump Start / Stop	DO	COV	12 Hours	3 days	N/A		

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.
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.

3.6 SYSTEMS FUNCTIONAL PERFORMANCE TESTING

- A. This paragraph applies to Systems Functional Performance Testing of systems for all referenced specification Divisions.
- B. Objectives and Scope: The objective of Systems Functional Performance Testing is to demonstrate that each system is operating according to the Contract Documents. Systems Functional Performance Testing facilitates bringing the systems from a state of substantial completion to full dynamic operation. Additionally, during the testing process, areas of noncompliant performance are identified and corrected, thereby improving the operation and functioning of the systems. In general, each system shall be operated through all modes of operation (seasonal, occupied, unoccupied, warm-up, cool-down, part- and full-load, fire alarm and emergency power) where there is a specified system response. The Contractor shall verify each sequence in the sequences of operation. Proper responses to such modes and conditions as power failure, freeze condition, low oil pressure, no flow, equipment failure, etc. shall also be tested.

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

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

4. Altering Setpoints: Rather than overwriting sensor values, and when simulating conditions is difficult, altering setpoints to test a sequence is acceptable. For example, to see the Air Conditioning compressor lockout initiate at an outside air temperature below 12 C (54 F), when the outside air temperature is above 12 C (54 F), temporarily change the lockout setpoint to be 2 C (4 F) above the current outside air temperature.
5. Indirect Indicators: Relying on indirect indicators for responses or performance shall be allowed only after visually and directly verifying and documenting, over the range of the tested parameters, that the indirect readings through the control system represent actual conditions and responses. Much of this verification shall be completed during systems startup and initial checkout.
- F. Setup: Each function and test shall be performed under conditions that simulate actual conditions as closely as is practically possible. The Contractor shall provide all necessary materials, system modifications, etc. to produce the necessary flows, pressures, temperatures, etc. necessary to execute the test according to the specified conditions. At completion of the test, the Contractor shall return all affected building equipment and systems, due to these temporary modifications, to their pretest condition.
- G. Sampling: No sampling is allowed in completing Pre-Functional Checklists. Sampling is allowed for Systems Functional Performance Test Procedures execution. The Commissioning Agent will determine the sampling rate. If at any point, frequent failures are occurring and testing is becoming more troubleshooting than verification, the Commissioning Agent may stop the testing and require the Contractor to perform and document a checkout of the remaining units, prior to continuing with Systems Functional Performance Testing of the remaining units.
- H. Cost of Retesting: The cost associated with expanded sample System Functional Performance Tests shall be solely the responsibility of the Contractor. Any required retesting by the Contractor shall not be considered a justified reason for a claim of delay or for a time extension by the Contractor.
- I. Coordination and Scheduling: The Contractor shall provide a minimum of 7 days' notice to the Commissioning Agent and the VA regarding the completion schedule for the Pre-Functional Checklists and startup of

all equipment and systems. The Commissioning Agent will schedule Systems Functional Performance Tests with the Contractor and VA. The Commissioning Agent will witness and document the Systems Functional Performance Testing of systems. The Contractor shall execute the tests in accordance with the Systems Functional Performance Test Procedure.

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

3.7 DOCUMENTATION, NONCONFORMANCE AND APPROVAL OF TESTS

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

- Commissioning Agent shall not be pressured into overlooking noncompliant work or loosening acceptance criteria to satisfy scheduling or cost issues, unless there is an overriding reason to do so by direction from the VA.
3. As the Systems Functional Performance Tests progresses and an item of noncompliance is identified, the Commissioning Agent shall discuss the issue with the Contractor and the VA.
 4. When there is no dispute on an item of noncompliance, and the Contractor accepts responsibility to correct it:
 - a. The Commissioning Agent will document the item of noncompliance and the Contractor's response and/or intentions. The Systems Functional Performance Test then continues or proceeds to another test or sequence. After the day's work is complete, the Commissioning Agent will submit a Commissioning Field Report to the VA. The Commissioning Agent will also note items of noncompliance and the Contractor's response in the Master Commissioning Issues Log. The Contractor shall correct the item of noncompliance and report completion to the VA and the Commissioning Agent.
 - b. The need for retesting will be determined by the Commissioning Agent. If retesting is required, the Commissioning Agent and the Contractor shall reschedule the test and the test shall be repeated.
 5. If there is a dispute about item of noncompliance, regarding whether it is an item of noncompliance, or who is responsible:
 - a. The item of noncompliance shall be documented on the test form with the Contractor's response. The item of noncompliance with the Contractor's response shall also be reported on a Commissioning Field Report and on the Master Commissioning Issues Log.
 - b. Resolutions shall be made at the lowest management level possible. Other parties are brought into the discussions as needed. Final interpretive and acceptance authority is with the Department of Veterans Affairs.
 - c. The Commissioning Agent will document the resolution process.
 - d. Once the interpretation and resolution have been decided, the Contractor shall correct the item of noncompliance, report it to the Commissioning Agent. The requirement for retesting will be

determined by the Commissioning Agent. If retesting is required, the Commissioning Agent and the Contractor shall reschedule the test. Retesting shall be repeated until satisfactory performance is achieved.

- C. Cost of Retesting: The cost to retest a System Functional Performance Test shall be solely the responsibility of the Contractor. Any required retesting by the Contractor shall not be considered a justified reason for a claim of delay or for a time extension by the Contractor.
- D. Failure Due to Manufacturer Defect: If 10%, or three, whichever is greater, of identical pieces (size alone does not constitute a difference) of equipment fail to perform in compliance with the Contract Documents (mechanically or substantively) due to manufacturing defect, not allowing it to meet its submitted performance specifications, all identical units may be considered unacceptable by the VA. In such case, the Contractor shall provide the VA with the following:
1. Within one week of notification from the VA, the Contractor shall examine all other identical units making a record of the findings. The findings shall be provided to the VA within two weeks of the original notice.
 2. Within two weeks of the original notification, the Contractor shall provide a signed and dated, written explanation of the problem, cause of failures, etc. and all proposed solutions which shall include full equipment submittals. The proposed solutions shall not significantly exceed the specification requirements of the original installation.
 3. The VA shall determine whether a replacement of all identical units or a repair is acceptable.
 4. Two examples of the proposed solution shall be installed by the Contractor and the VA shall be allowed to test the installations for up to one week, upon which the VA will decide whether to accept the solution.
 5. Upon acceptance, the Contractor shall replace or repair all identical items, at their expense and extend the warranty accordingly, if the original equipment warranty had begun. The replacement/repair work shall proceed with reasonable speed beginning within one week from when parts can be obtained.

- E. Approval: The Commissioning Agent will note each satisfactorily demonstrated function on the test form. Formal approval of the Systems Functional Performance Test shall be made later after review by the Commissioning Agent and by the VA. The Commissioning Agent will evaluate each test and report to the VA using a standard form. The VA will give final approval on each test using the same form, and provide signed copies to the Commissioning Agent and the Contractor.

3.8 DEFERRED TESTING

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

3.9 OPERATION AND MAINTENANCE TRAINING REQUIREMENTS

- A. Training Preparation Conference: Before operation and maintenance training, the Commissioning Agent will convene a training preparation conference to include VA's Resident Engineer, VA's Operations and Maintenance personnel, and the Contractor. The purpose of this conference will be to discuss and plan for Training and Demonstration of VA Operations and Maintenance personnel.

- B. The Contractor shall provide training and demonstration as required by other Division 21, Division 22, Division 23, Division 26, Division 27, Division 28, and Division 31 sections. The Training and Demonstration shall include, but is not limited to, the following:
1. Review the Contract Documents.
 2. Review installed systems, subsystems, and equipment.
 3. Review instructor qualifications.
 4. Review instructional methods and procedures.
 5. Review training module outlines and contents.
 6. Review course materials (including operation and maintenance manuals).
 7. Review and discuss locations and other facilities required for instruction.
 8. Review and finalize training schedule and verify availability of educational materials, instructors, audiovisual equipment, and facilities needed to avoid delays.
 9. For instruction that must occur outside, review weather and forecasted weather conditions and procedures to follow if conditions are unfavorable.
- C. Training Module Submittals: The Contractor shall submit the following information to the VA and the Commissioning Agent:
1. Instruction Program: Submit two copies of outline of instructional program for demonstration and training, including a schedule of proposed dates, times, length of instruction time, and instructors' names for each training module. Include learning objective and outline for each training module. At completion of training, submit two complete training manuals for VA's use.
 2. Qualification Data: Submit qualifications for facilitator and/or instructor.
 3. Attendance Record: For each training module, submit list of participants and length of instruction time.
 4. Evaluations: For each participant and for each training module, submit results and documentation of performance-based test.
 5. Demonstration and Training Recording:
 - a. General: Engage a qualified commercial photographer to record demonstration and training. Record each training module separately. Include classroom instructions and demonstrations, board diagrams, and other visual aids, but not student practice.

At beginning of each training module, record each chart containing learning objective and lesson outline.

- b. Video Format: Provide high quality color DVD color on standard size DVD disks.
 - c. Recording: Mount camera on tripod before starting recording, unless otherwise necessary to show area of demonstration and training. Display continuous running time.
 - d. Narration: Describe scenes on video recording by audio narration by microphone while demonstration and training is recorded. Include description of items being viewed. Describe vantage point, indicating location, direction (by compass point), and elevation or story of construction.
 - e. Submit two copies within seven days of end of each training module.
6. Transcript: Prepared on 8-1/2-by-11-inch paper, punched and bound in heavy-duty, 3-ring, vinyl-covered binders. Mark appropriate identification on front and spine of each binder. Include a cover sheet with same label information as the corresponding videotape. Include name of Project and date of videotape on each page.

D. Quality Assurance:

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

E. Training Coordination:

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

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

F. Instruction Program:

1. Program Structure: Develop an instruction program that includes individual training modules for each system and equipment not part of a system, as required by individual Specification Sections, and as follows:
 - a. Heat generation, including boilers, feedwater equipment, pumps, steam distribution piping, condensate return systems, heating hot water heat exchangers, and heating hot water distribution piping.
 - b. Communication systems, including intercommunication, surveillance, nurse call systems, public address, mass evacuation, voice and data, and entertainment television equipment.

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

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

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

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

4. Evaluation: At conclusion of each training module, assess and document each participant's mastery of module by use of an oral, or a written, performance-based test.
5. Cleanup: Collect used and leftover educational materials and remove from Project site. Remove instructional equipment. Restore systems and equipment to condition existing before initial training use.

I. Demonstration and Training Recording:

1. General: 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 -----

DEMOLITION
SECTION 02 41 00
02-01-15

PART 1 - GENERAL

1.1 DESCRIPTION:

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

1.2 RELATED WORK:

- A. Lead Paint: See attached Lead Based Paint Abatement.pdf
- B. Lead Based Paint Report

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. Provide enclosed dust chutes with control gates from each floor to carry debris to truck beds and govern flow of material into truck. Provide overhead bridges of tight board or prefabricated metal construction at dust chutes to protect persons and property from falling debris.
- E. Prevent spread of flying particles and dust. Sprinkle rubbish and debris with water to keep dust to a minimum. Do not use water if it results in hazardous or objectionable condition such as, but not limited to; ice, flooding, or pollution. Vacuum and dust the work area daily.

- F. In addition to previously listed fire and safety rules to be observed in performance of work, include following:
1. 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.
 2. Keep hydrants clear and accessible at all times. Prohibit debris from accumulating within a radius of 4500 mm (15 feet) of fire hydrants.
- G. Before beginning any demolition work, the Contractor shall survey the site and examine the drawings and specifications to determine the extent of the work. The contractor shall take necessary precautions to avoid damages to existing items to remain in place, to be reused, or to remain the property of the 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.
- H. The work shall comply with the requirements of Section 01 57 19, TEMPORARY ENVIRONMENTAL CONTROLS.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 DEMOLITION:

- A. Completely demolish and remove buildings and structures, including all appurtenances related or connected thereto, as noted below:
1. As required for installation of new 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.

- C. Remove and legally dispose of all materials 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.

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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ACM ENGINEERING & ENVIRONMENTAL SERVICES

SOUTH BEND, INDIANA • FORT WAYNE, INDIANA • ELMHURST, ILLINOIS
TAMPA, FLORIDA • FORT LAUDERDALE, FLORIDA • HOUSTON, TEXAS

LEAD-BASED PAINT ABATEMENT PLAN

FOR:

**Apollo Environmental, Inc.
11553 US Highway 41 S.
Gibsonton, Florida 33534**

LOCATION:

**C.W. Bill Young VA Medical Center
Boilers & Appurtenances
10000 Bay Pines Blvd. - Building 100
St. Petersburg, Florida 33708**

PERFORMED BY:

**ACM Engineering & Environmental Services
5404 Hoover Blvd
Suite 9
Tampa, Florida 33634**

DATE:

March 14th, 2017

Apollo Environmental, Inc.
ACM Engineering & Environmental Services, Inc.
EPA Certification# FL-115267-2
11553 US Highway 41 S.
Gibson, Florida 33534

LEAD-BASED PAINT ABATEMENT PLAN

C.W. Bill Young VA Medical Center
Boilers & Appurtenances
10000 Bay Pines Blvd. - Building 100
St. Petersburg, Florida 33708

PART 1 - GENERAL

1.1 EXECUTIVE SUMMARY

- A. Section Includes:
 - 1. Report dated February 24th, 2017 identifying positive lead-based paint (LBP) within Boiler Room (Building 100) at the C.W. Bill Young VA Medical Center in St. Petersburg, Florida.
 - 2. Lead-based Paint Abatement plan for removing and disposing of lead-based paint identified within the Boiler Room (Building 100) at the C.W. Bill Young VA Medical Center in St. Petersburg, Florida.

1.2 RELATED REQUIREMENTS

- A. Demolition Disturbing Lead-Based Paint: Section 02 41 00, DEMOLITION
- B. Surface Preparation Disturbing Lead-Based Paint: Section 09 91 00, PAINTING

1.3 DEFINITIONS

- A. Action Level: Employee exposure, without regard to use of respirator, to lead airborne concentration of 30 micrograms per cubic meter (0.03 parts per million) of air averaged over 8-hour period. As used in this section, 30 micrograms per cubic meter of air (0.03 parts per million)" refers to action level.
- B. Area Monitoring: Sampling of lead concentrations within lead control area and inside physical boundaries which are representative of airborne lead concentrations which may reach breathing zone of personnel potentially exposed to lead.
- C. Breathing Zone: Area within hemisphere, forward of shoulders, with 150 mm to 225 mm (6 to 9 inches) radius and center at nose or mouth of employee.
- D. Certified Industrial Hygienist (CIH): As used in this section, refers to an Industrial Hygienist employed by Contractor.
- E. Change Rooms and Shower Facilities: Rooms within designated physical boundary around lead control area equipped with separate storage facilities for clean protective work clothing and equipment and for street clothes which prevent cross- contamination.

- F. Competent Person: Person capable of identifying lead hazards in work area and authorized by contractor to take corrective action.
- G. Decontamination Room: Room for removal of contaminated personal protective equipment (PPE)
- H. Eight-Hour Time Weighted Average (TWA): Airborne concentration of lead averaged over 8-hour workday to which an employee is exposed
- I. High Efficiency Particulate Air (HEPA) Filter Equipment: HEPA filtered vacuuming equipment with UL 586 filter system capable of collecting and retaining lead-contaminated paint dust. HEPA filter means 99.97 percent efficient against 0.3 micron (0.012 mil) size particles
- J. Lead: Metallic lead, inorganic lead compounds, and organic lead soaps. Excluded from this definition are other organic lead compounds
- K. Lead Control Area: Enclosed area or structure with full containment to prevent spreading lead dust, paint chips, and debris from lead-based paint removal operations. Lead control area is isolated by physical boundaries to prevent unauthorized entry of personnel.
- L. Lead Permissible Exposure Limit (PEL): Fifty micrograms per cubic meter (0.05 parts per million) of air as 8-hour time weighted average as determined by 29 CFR Part 1910.1025. When employee is exposed for more than 8 hours per work day, determine PEL by following formula.
$$\text{PEL micrograms/cubic meter (parts per million) of air} = 400/\text{No. of hrs. worked per day.}$$
- M. Personnel Monitoring: Sampling of lead concentrations within employee breathing zone to determine 8-hour time weighted average concentration according to 29 CFR Part 1910.1025. Take samples representative of employee's work tasks.
- N. Physical Boundary: Area physically roped or partitioned off around enclosed lead control area to limit unauthorized entry of personnel. As used in this section, "inside boundary" shall mean same as "outside lead control area."

1.4 APPLICABLE PUBLICATIONS

- A. Comply with references to extent specified in this section
- B. American National Standards Institute (ANSI):
 - 1. Z9.2-12 - Fundamentals Governing the Design & Operation of Local Exhaust Ventilation Systems
- C. Code of Federal Regulations (CFR):
 - 1. 29 CFR Part 1910 - Occupational Safety and Health Standards
 - 2. 29 CFR Part 1926 - Safety and Health Regulations for Construction
 - 3. 40 CFR Part 260 - Hazardous Waste Management System: General
 - 4. 40 CFR Part 261 - Identification and Listing of Hazardous Waste
 - 5. 40 CFR Part 262 - Standards Applicable to Generators of Hazardous Waste
 - 6. 40 CFR Part 263 - Standards Applicable to Transporters of Hazardous Waste

7. 40 CFR Part 264 - Standards for Owners and Operations of Hazardous Waste Treatment, Storage, and Disposal Facilities
8. 40 CFR Part 265 - Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities
9. 40 CFR Part 268 - Land Disposal Restrictions
10. 49 CFR Part 172 - Hazardous Material Table, Special Provisions, Hazardous Material Communications, Emergency Response Information, and Training Requirements, and Security Plans
11. 49 CFR Part 178 - Specifications for Packaging

1.5 PRE-REMOVAL MEETINGS

- A. Conduct pre-removal meeting a minimum of 30 days before beginning Work of this section
 1. Required Participants:
 - a. Contracting Officer's Representative
 - b. Certified Industrial Hygienist
 - c. Architect/Engineer
 - d. Inspection and Testing Agency
 - e. Contractor
 - f. Paint removal contractor
 - g. Other installers responsible for finishing resulting surfaces
 2. Meeting Agenda: Distribute agenda to participants minimum 3 days before meeting
 - a. Respiratory protection program
 - b. Hazard communication program
 - c. Hazardous waste management plan
 - d. Safety and health regulation compliance
 - e. Employee training
 - f. Removal schedule
 - g. Removal sequence
 - h. Preparatory work
 - i. Protection before, during, and after removal
 - j. Removal
 - k. Inspecting and testing
 - l. Other items affecting successful completion
 3. Document and distribute meeting minutes to participants to record decisions affecting installation

1.6 SUBMITTALS

- A. Submittal Procedures: Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES
- B. Manufacturer's Literature and Data:
 - 1. Description of each product
 - a. Paint removal products
 - b. Surface cleaning products
 - c. Equipment e.g. air filtration device, vacuums, etc.
 - d. Respiratory protection
 - e. Personal protective equipment (PPE)
 - 2. Safety data sheet for all products and paint removal chemicals
 - 3. Installation instructions
 - a. Paint removal products
- C. Test Reports: Submit testing laboratory reports
 - 1. Submit air monitoring results within three working days, signed by testing laboratory employee performing air monitoring, employee analyzing sample, and CIH.
- D. Certificates: Certify completed training
 - 1. Submit certificate for each employee signed and dated by CIH and employee stating employee was trained.
- E. Qualifications: Substantiate qualifications comply with specifications
 - 1. Paint removal contractor
 - 2. Testing laboratory
 - a. Name, address, and telephone number
 - b. Current evidence of participation in NIOSH PAT Program
 - c. Copy of current AIHA accreditation certificate
 - 3. Industrial hygienist
 - a. Name, address, and telephone number
 - b. Resume showing previous experience
 - c. Copy of current ABIH CIH certification
 - 4. Paint disposal facility
 - a. Name, address, and telephone number
 - b. Current license or authorization to receive and dispose lead contaminated waste
- F. Record Documents:
 - 1. Completed and signed hazardous waste manifest from waste transporter
 - 2. Paint disposal facility receipts and disposition reports
 - 3. Certification of medical examinations
 - 4. Employee training certification

1.7 QUALITY ASSURANCE

- A. Safety and Health Regulation Compliance:
 - 1. Comply with laws, ordinances, rules, and regulations of federal, state, and local authorities having jurisdiction regarding removing, handling, storing, transporting, and disposing lead waste materials
 - a. Comply with applicable requirements of 29 CFR Part 1910.1025
 - b. Notify Contracting Officer's Representative and request resolution of conflicts between regulations and specified requirements before starting work
 - 2. Comply with the following local laws, ordinances, criteria, rules and regulations regarding removing, handling, storing, transporting, and disposing lead-contaminated materials.
- B. Paint Removal Contractor: Experienced contractor, registered or licensed by applicable state agency regulating lead-based paint removal
- C. Testing Laboratory: Certified independent testing laboratory experienced in analyzing lead in air samples, lead in bulk samples, lead in water samples, and reporting
- D. Certified Industrial Hygienist: Certified as CIH by American Board of Industrial Hygiene in comprehensive practice and responsible for:
 - 1. Certify Training
 - 2. Review and approve lead-based paint removal plan for conformance to applicable referenced standards
 - 3. Inspect lead-based paint removal work for conformance with approved plan
 - 4. Direct monitoring
 - 5. Ensure work is performed according to specifications
 - 6. Ensure personnel and environment hazardous exposures are adequately controlled
- E. Paint Disposal Facility: Certified and licensed disposal facility permitted to receive and dispose lead-based paint waste
- F. Lead-based Paint Removal Plan:
 - 1. Submit detailed, site-specific plan describing lead-based paint removal procedures
 - 2. Include sketch showing location, size, and details of lead control areas, decontamination rooms, change rooms, shower facilities, and mechanical ventilation system.
 - 3. Include unpermitted eating, drinking, and smoking within lead control area notices. Allowable restroom procedures and locations, interface of trades, work sequencing, collected wastewater and paint debris disposal plan, air sampling plan, respirators, protective equipment, and detailed description of containment methods ensuring airborne lead concentrations do not exceed action level outside lead control area.
 - 4. Include air sampling, training and strategy, sampling methodology, frequency, duration, and qualifications of air monitoring personnel.

- G. Respiratory Protection Program: Establish and implement program required by 29 CFR Part 1910.134, 29 CFR Part 1910.1025, and 29 CFR Part 1926.62
 - 1. Provide each employee negative pressure or other appropriate respirator
 - a. Test fit each employee's respirator as required by 29 CFR Part 1926.62
- H. Hazard Communication Program: Establish and implement program required by 29 CFR Part 1910.1200
- I. Hazardous Waste Management Plan: Establish and implement plan according to applicable requirements of Federal, State, and local hazardous waste regulations including the following:
 - 1. Identification of hazardous wastes associated with work
 - 2. Estimated quantities of generated and disposed waste
 - 3. Names and qualifications of each contractor transporting, storing, treating, and disposing wastes. Include facility location and 24-hour point of contact. Provide two copies of EPA Region 4 hazardous waste permit applications, permits and EPA Waste Generator Identification Number.
 - 4. Names and qualifications (experience and training) of personnel working on-site with hazardous wastes
 - 5. List of required waste handling equipment including cleaning, volume reduction, and transport equipment
 - 6. Spill prevention, containment, and cleanup contingency implementation measures
 - 7. Work plan and schedule for waste containment, removal, and disposal with daily waste cleaned up and containerization

1.8 WARRANTY

- A. Construction Warranty: FAR clause 52.246-21, "Warranty of Construction"

PART 2 - PRODUCTS

2.1 PAINT REMOVAL PRODUCTS

- A. Chemical Stripper: Capable of removing existing paint layers and acceptable to CIH
 - 1. Chemical remover shall not contain methylene chloride and shall be tested to ensure that they are compatible with the substrate and with neutralizers.
 - 2. Chemical removers shall be applied in accordance with all manufacturers' instructions.

2.2 ACCESSORIES

- A. Waste Collection Drums: Compatible with 49 CFR Part 178; Type 1A2, steel, removable head, 200 L (55 gal.) maximum capacity, capable of containing waste without loss
- B. Vacuum Cleaner: HEPA equipped

- C. Scrapers:
 - 1. Metal type for use on metal, concrete, and masonry surfaces
 - 2. Non-metallic type for use on wood, plaster, gypsum board, and other surfaces
- D. Rinse Water: Potable
- E. Cleaning Cloths: Cotton or organic fiber

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Before exposure to lead-contaminated dust, provide workers with comprehensive medical examination required by 29 CFR Part 1926.62 (l) (1) (i) and (ii).
 - 1. Exemption: Examination is not required when employee medical records show last examination required by 29 CFR Part 1926.62(l) was completed within previous 12 months.
- B. Maintain complete and accurate employee medical records according to 29 CFR Part 1910.20
- C. Train each employee performing paint removal, disposal, and air sampling operations according to 29 CFR Part 1926.62
 - 1. Certify training is completed before employee is permitted to work on project and enter lead control area

3.2 PREPARATION

- A. Protect existing work indicated to remain
 - 1. Perform paint removal work without damaging and contaminating adjacent work
 - 2. Restore damage and contamination to original condition
- B. Notify Contracting Officer 20 days before starting paint removal work
- C. Lead Control Area Requirements:
 - 1. Establish lead control area by enclosing lead-based paint removal work area with containment screens
 - 2. Manage removal operations using local ventilation to exterior utilizing HEPA equipped air filtration devices, drop cloths, and available decontamination room with minimum one (1) change room
- D. Boundary Requirements: Provide physical boundaries around lead control area by roping off area and/or providing curtains, portable partitions or other enclosures to ensure that unauthorized individuals do not enter the lead control area.
- E. Heating, Ventilating and Air Conditioning (HVAC) Systems: Shut down, lock out, and isolate HVAC systems supplying exhausting, and passing through lead control areas. Seal HVAC inlets and outlet within lead control area with 6-mil plastic sheet and tape.

- F. Change Room and Shower Facilities: Provide remote clean change rooms and decontamination facilities adjacent to the physical boundary around lead control area according to 29 CFR Part 1926.62.
- G. Mechanical Ventilation System:
 - 1. Provide ventilation system to control personnel exposure to lead according to 29 CFR Part 1926.57
 - 2. Design, construct, install, and maintain HEPA filtered fixed local exhaust ventilation system according to ANSI Z9.2 and approved by CIH
 - 3. Exhaust ventilation air to exterior
- H. Personnel Protection: Provide and use required protective clothing and equipment within lead control area
- I. Warning Signs: Provide warning signs complying with 29 CFR Part 1926.62 at lead control area approaches. Locate signs so personnel read signs and take necessary precautions before entering lead control area.

3.3 WORK PROCEDURES

- A. Remove lead-based paint according to approved lead-based paint removal plan
 - 1. Perform work only in presence of CIH or Industrial Hygienist (IH) Technician under direction of CIH ensuring continuous inspection of work in progress and direction of air monitoring activities.
 - 2. Handle, store, transport, and dispose lead and/or lead contaminated waste according to 40 CFR Part 260, 40 CFR Part 261, 40 CFR Part 262, 40 CFR Part 263, 40 CFR Part 264, and 40 CFR Part 265. Comply with land disposal restriction notification requirements as required by 40 CFR Part 268.
- B. Use procedures and equipment required to limit occupational and environmental lead exposure when lead-based paint is removed according to 29 CFR Part 1926.62.
- C. Dispose removed paint and waste according to Environmental Protection Agency (EPA), federal, state, and local requirements.
- D. Personnel Exiting Procedures:
 - 1. When personnel exit lead control area, comply with the following procedures:
 - a. Vacuum exposed clothing surfaces
 - b. Remove protective clothing and equipment in decontamination room. Place clothing in approved impermeable disposal bag
 - c. Shower
 - d. Dress in clean clothes before leaving lead control area

E. Monitoring - General:

1. Monitor airborne lead concentrations according to 29 CFR Part 1910.1025 by testing laboratory as directed by CIH.
2. Take personal air monitoring samples on employees anticipated to have greatest exposure risk as determined by CIH. Additionally, take air monitoring samples on minimum 25 percent of work crew or minimum of two employees, whichever is greater, during each work shift.
3. Submit results of air monitoring samples, signed by CIH, within 24 hours after taking air samples. Notify Contracting Officer's Representative immediately of lead exposure at or exceeding action level outside of lead control area.

F. Monitoring During Paint Removal:

1. Perform personal and area monitoring during entire paint removal operation
2. Conduct area monitoring at physical boundary daily for each work shift to ensure unprotected personnel are not exposed above action level anytime.
3. For outdoor operations, take at least one sample on each shift leeward of lead control area. When adjacent areas are contaminated, clean area of contamination and have CIH visually inspect and certify lead contamination is cleaned.
4. Stop work when outside boundary lead levels meet or exceed action level. Notify Contracting Officer's Representative, immediately.
5. Correct conditions causing increased lead concentration as directed by CIH.
6. Review sampling data collected during work stoppage to determine if conditions require additional work method modifications as determined by CIH.
7. Resume paint removal when approved by CIH.

3.4 LEAD-BASED PAINT REMOVAL

- A. Remove paint within areas indicated on drawings completely exposing substrate. Minimize damage to substrate.
- B. Comply with paint removal processes described lead paint removal plan.
- C. Lead-Based Paint Removal: Select processes for each application to minimize work area lead contamination and waste.

3.5 SUBSTRATE SURFACE PREPARATION

- A. Protect substrates from deterioration and contamination until refinished
 1. Protect metal substrates from flash rusting
- B. Prepare and paint substrates according to Section 09 91 00, PAINTING
- C. Lead-based paint must be removed a minimum of 100 mm (4 in.) on each side of the centerline of cut, bolt row, rivet row, or weld as applicable from structural steel prior to any heating, welding, or flame cutting, unless it can be clearly demonstrated through exposure monitoring that other work

practices and engineering controls under the oversight of a CIH can effectively maintain actual worker exposure below the PEL.

- D. No grinding, sanding, cutting, or pulverizing of lead-based paint shall be permitted.

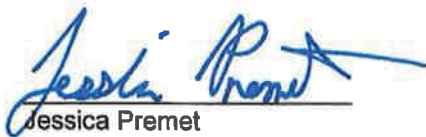
3.6 FIELD QUALITY CONTROL

- A. Field Tests: Performed by testing laboratory specified in Section 01 45 29, TESTING LABORATORY SERVICES
 - 1. Note: Section 01 45 29, TESTING LABORATORY SERVICES includes VA provided testing for large projects and contractor provided testing for small projects. Coordinate testing responsibility.
 - 2. Size determination for this project has not been defined
- B. Perform sampling and testing for:
 - 1. Air monitoring
 - 2. Lead based paint

3.7 CLEANING AND DISPOSAL

- A. Cleaning:
 - 1. Maintain lead control area surfaces free of accumulating paint chips and dust. Confine dust, debris, and waste to work area.
 - 2. Vacuum clean work area daily, at end of each shift, and when paint removal operation is complete.
- B. CIH Certification: Certify in writing that inside and outside lead control area air monitoring samples are less than action level, employee respiratory protection was adequate, the work was performed according to 29 CFR Part 1926.62, and no visible accumulations of lead-based paint and dust remain on worksite.
 - 1. Do not remove lead control area or roped-off boundary and warning signs before Contracting Officer's Representative's receipt of CIH's certification
 - 2. Re-clean areas showing dust or residual paint chips
- C. Testing: Where indicated and when directed by Contracting Officer's Representative, test lead-based paint residue and used abrasive according to 40 CFR Part 261 for hazardous waste.
- D. Waste Collection:
 - 1. Collect lead-contaminated materials including waste, scrap, debris, bags, containers, equipment, and clothing, which may produce airborne lead contamination.
 - 2. Place lead contaminated materials in waste disposal drums. Label each drum identifying waste type according to 49 CFR Part 172 and date waste materials were first put into drum. Obtain and complete the Uniform Hazardous Waste Manifest forms. Comply with land disposal restriction notification requirements required by 40 CFR Part 268.

3. Coordinate temporary storage location on project site with Contracting Officer's Representative
- E. Waste Disposal (Government Responsible for Disposal):
1. Minimum 14 days before delivery, notify Contracting Officer's Representative who will arrange for job site inspection of drums and manifests by authorized facility personnel.
 2. Contracting Officer's Representative will arrange hazardous wastes removal, transport and delivery to authorized waste disposal facility to ensure drums do not remain on project site longer than 90 calendar days from drum label date.
- F. Waste Disposal (Contractor Responsible for Disposal):
1. Do not store hazardous waste drums in temporary storage location longer than 90 calendar days from drum label date.
 2. Remove, transport, and deliver drums to paint disposal facility.
 - a. Obtain signed receipt including date, time, quantity, and description of materials received according to 40 CFR Part 262.
 - b. Obtain final report of materials disposition after disposal completion.



Jessica Premet

EPA Approved Lead-Based Paint Risk Assessor (Certification# LBP-R-I155991-1)

EPA Approved Lead-Based Paint Inspector (Certification# FL-I-I155991-1)

March 14th, 2017

United States Environmental Protection Agency

This is to certify that

Jessica Marie Premet



has fulfilled the requirements of the Toxic Substances Control Act (TSCA) Section 402, and has received certification to conduct lead-based paint activities pursuant to 40 CFR Part 745.226 as:

Risk Assessor

In the Jurisdiction of:

All EPA Administered Lead-based Paint Activities Program States, Tribes and Territories

This certification is valid from the date of issuance and expires

July 28, 2019

LBP-R-1155991-1

Certification #

July 14, 2016

Issued On

Adrienne Priselac, Manager, Toxics Office

Land Division



United States Environmental Protection Agency

This is to certify that

Jessica Marie Premet



has fulfilled the requirements of the Toxic Substances Control Act (TSCA) Section 402, and has received certification to conduct lead-based paint activities pursuant to 40 CFR Part 745.226 as:

Inspector

In the Jurisdiction of:

Florida

This certification is valid from the date of issuance and expires August 27, 2018

FL-I-1155991-1

Certification #

August 13, 2015

Issued On



Adrienne Priselac, Manager, Toxics Office
Land Division

United States Environmental Protection Agency

This is to certify that

ACM Engineering & Environmental Service, Inc.

has fulfilled the requirements of the Toxic Substances Control Act (TSCA) Section 402, and has received certification to conduct lead-based paint activities pursuant to 40 CFR Part 745.226

In the Jurisdiction of:

Florida

This certification is valid from the date of issuance and expires September 30, 2017

FL-115267-2

Certification #

September 16, 2014

Issued On

Michelle Price

Michelle Price, Chief

Lead, Heavy Metals, and Inorganics Branch

United States Environmental Protection Agency

This is to certify that



ACM Engineering & Environmental Service, Inc.

has fulfilled the requirements of the Toxic Substances Control Act (TSCA) Section 402, and has received certification to conduct lead-based paint renovation, repair, and painting activities pursuant to 40 CFR Part 745.89

In the Jurisdiction of:

All EPA Administered States, Tribes, and Territories

This certification is valid from the date of issuance and expires September 30, 2019

NAT-115267-1

Certification #

September 16, 2014

Issued On

A handwritten signature in black ink, appearing to read "Michelle Price".

Michelle Price, Chief

Lead, Heavy Metals, and Inorganics Branch

State of Florida

Department of State

I certify from the records of this office that ACM ENGINEERING & ENVIRONMENTAL SERVICES INC. is a corporation organized under the laws of the State of Florida, filed on September 22, 2005.

The document number of this corporation is P05000130542.

I further certify that said corporation has paid all fees due this office through December 31, 2017, that its most recent annual report/uniform business report was filed on January 18, 2017, and that its status is active.

I further certify that said corporation has not filed Articles of Dissolution.

*Given under my hand and the
Great Seal of the State of Florida
at Tallahassee, the Capital, this
the Eighteenth day of January,
2017*



Ken DeFuria
Secretary of State

Tracking Number: CC8722601995

To authenticate this certificate, visit the following site, enter this number, and then follow the instructions displayed.

<https://services.sunbiz.org/Filings/CertificateOfStatus/CertificateAuthentication>

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ACM ENGINEERING & ENVIRONMENTAL SERVICES

SOUTH BEND, INDIANA • FORT WAYNE, INDIANA • ELMHURST, ILLINOIS
TAMPA, FLORIDA • FORT LAUDERDALE, FLORIDA • HOUSTON, TEXAS

LEAD-BASED PAINT INSPECTION REPORT

FOR:

***Apollo Environmental, Inc.
P.O. Box 239
Gibsonton, Florida 33534***

LOCATION:

***C.W. Bill Young VA Medical Center
Boilers & Appurtenances
10000 Bay Pines Blvd. - Building 100
St. Petersburg, Florida 33708***

PERFORMED BY:

***ACM Engineering & Environmental Services
5404 Hoover Blvd
Suite 9
Tampa, Florida 33634***

DATE:

February 24th, 2017

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IV	Disclosure Responsibility and Disclaimer
V	Calibration and Results

I: Cover Letter

February 24th, 2017

Apollo Environmental, Inc.
P.O. Box 239
Gibsonton, Florida 33534

Subject: Lead-Based Paint Inspection Report for the C.W. Bill Young VA Medical Center- Boilers & Appurtenances located at:
10000 Bay Pines Blvd. – Building 100
St. Petersburg, Florida 33708

Enclosed is the report for the lead inspection that was conducted among the Boilers, Steam Control Lines, Water Treatment/Chemical Lines, and Condensate Lines of the C. W. Bill Young VA Medical Center located at 10000 Bay Pines Blvd. – Building 100 in St. Petersburg, Florida. The scope of the lead-based paint inspection is considered a screening for due diligence purposes to identify the presence of lead-based paint on the structure.

ACM Engineering and Environmental Services, Inc. (ACM) (Certification # FL-115267-2) conducted a lead-based paint inspection at the above-referenced site. The XRF analysis was performed within current acceptable United States Environmental Protection Agency (USEPA) guidelines and Housing and Urban Development (HUD) industry guidelines as well as State of Florida Regulations.

An Olympus Innov-X Systems Delta Classic DC-4000 X-ray fluorescence (XRF) lead paint analyzer was used to analyze paint for lead. XRF Instrument serial # 561046 was utilized for this assessment.

USEPA Certified Lead Risk Assessor Jessica Premet (Certification # LBP-R-I15599-1, Expiration Date July 28th, 2019) tested this site on February 14th, 2017.

Working under the direction of Apollo Environmental, Inc., it has been determined that there are lead-based paints and/or coatings on the Boilers and Steam Control Lines of the C.W. Bill Young VA Medical Center located at 10000 Bay Pines Blvd. – Building 100 in St. Petersburg, Florida 33708.

If you have any questions and/or comments, please contact us directly at (813)-282-1232.

Regards,



Jessica Premet

EPA Approved Lead-Based Paint Risk Assessor
EPA Approved Lead-Based Paint Inspector

II: Executive Summary

On behalf of Apollo Environmental Inc., a lead-based paint analysis was performed on the Boilers, Steam Control Lines, Water Treatment/Chemical Lines, and Condensate Lines of the C.W. Bill Young VA Medical Center at 10000 Bay Pines Blvd. – Building 100 in St. Petersburg, Florida. The scope of the lead-based paint inspection is considered a screening for due diligence purposes to identify the presence of lead-based paint in the structure. All painted components were analyzed according to the specifications described in the protocols for lead-based paint testing in the *Housing and Urban Development (HUD) Guidelines (Revised 1997) for the inspection of lead-based paint-Chapter 7*. Additionally all Federal, State and City regulations governing the inspection of lead-based paint for Florida were followed.

The analysis of the painted components at the C.W. Bill Young VA Medical Center-Boilers & Appurtenances was performed using an Olympus Innov-X Systems Delta Classic DC-4000 X-ray fluorescence (XRF) lead paint analyzer serial # 561046. The data collected is in Appendix V titled XRF Results.

Working under the direction of Apollo Environmental, Inc., it has been determined that there are lead-based paints and/or coatings on the Boilers and Steam Control Lines of the C.W. Bill Young VA Medical Center located at 10000 Bay Pines Blvd. – Building 100 in St. Petersburg, Florida 33708.

III: Scope of Inspection

A. Structure Background

The C.W. Bill Young VA Medical Center located at 10000 Bay Pines Blvd. – Building 100 in St. Petersburg, Florida is a multi-story structure. No written permission was required to access the property.

B. Training

The inspector has a USEPA Certification and has also been trained in the use, calibration and maintenance of the X-Ray Fluorescence (XRF) equipment they currently use, along with necessary principles of Radiation Safety.

C. Equipment

An Olympus Innov-X Systems Delta Classic DC-4000XRF Instrument serial # 561046 was utilized for the assessment. The instrument was calibrated on February 14th, 2017 at 9:37am. See the attached XRF Performance Characteristic Sheets (PCS).

D. Inspection Company

The field work was performed under the direction of Apollo Environmental, Inc. by an inspector employed with ACM Engineering and Environmental Services, Inc. The Company's telephone number is (813)-282-1232. See attached USEPA Lead-based Paint Activities Certification (FL-115267-2).

E. Methods

The calibration of the Delta Classic DC-4000XRF is done in accordance with the Performance Characteristic Sheet (PCS) for this instrument. As a standard operating procedure for all lead-based paint assessments, ACM performs a set of calibration checks to verify that the XRF instrument being utilized for the inspection is operating properly and within acceptable limits. ACM's calibration checks and quality control protocol include the following procedures:

- Performing the manufacture's recommended quality control procedures utilizing a 316 calibration check reference coin.
- Performing calibration checks by collecting a series of measurements from standard reference materials (SRM) developed by the National Institute of Standards and Technology (NIST).
- ACM utilizes the Red and White SRM NIST paint films during its standard operating procedures for calibration checks. The lead levels and associated confidence levels of the NIST SRM paint films that ACM utilizes are as follows:
 - Red – $1.02 \text{ mg/cm}^2 \pm 0.04 \text{ mg/cm}^2$
 - White – $<0.0001 \text{ mg/cm}^2$
- Three XRF measurements are collected from each individual SRM. The three readings are then individually averaged and compared to the calibration check limits for the Red and White films present within the performance characteristics sheet (PCS) associated with the XRF instrument.
- If the averaged SRM readings fall within the check limits for the Red and White films, then the instrument is ready for use. If the average readings fall outside of the check limits, then a second round of calibration checks are performed. If the average readings again fall outside of the check limits during the second round of calibrations then the instrument is taken off the site and sent to the manufacturer for repair and/or re-calibration.
- Verification that the XRF instrument is performing within its calibration tolerances is performed at the beginning of the inspection, at least every four hours during the inspection and at the end of the inspection.

The results of calibration checks associated with this assessment may be found in Appendix V (Calibration and Results) of this report.

F. Findings

10000 Bay Pines Blvd. – Building 100 St. Petersburg, Florida 33708

Positive Lead-Based Paint XRF Results

Seventeen (17) of the sixty-eight (68) locations analyzed during the assessment were determined to contain materials encapsulated in a paint or coating that has a lead concentration level greater than or equal to 1.0 mg/cm². Paints and coatings that are determined to contain levels of lead at or above the USEPA/HUD level of 1.0 mg/cm² through the utilization of XRF analysis techniques meet the necessary criteria to be categorized as a lead-based paint.

Working under the direction of Apollo Environmental Inc., it has been determined that the following components contain lead in amounts greater than or equal to 1.0 mg/cm² in a paint or coating:

XRF SAMPLE NO:	DESCRIPTION OR NAME	REF. NUMBER	COMPONENT	ITEM SUBSTRATE - WOOD(W), METAL(M), DRYWALL (DW), CONCRETE (C)	PAINT COLOR	PAINT STATUS INTACT (I), FAIR (F), POOR (P)	XRF LEAD CONCENTRATION READING (mg/cm2)	LEAD BASED PAINT HAZARD IDENTIFIER A - Negative Pb B - Positive Pb C - Inconclusive
4	Boiler #1	1	Gas Pipe	M	Yellow	I	4.11	B
5	Boiler #1	1	Gas Vent Pipe	M	Yellow	I	2.61	B
6	Boiler #1	1	Shut Off Valve	M	Orange/Yellow	I	2.42	B
7	Boiler #1	1	Valve	M	Red	I	1.00	B
19	Boiler #2	2	Gas Pipe	M	Yellow	I	5.28	B
20	Boiler #2	2	Gas Vent Pipe	M	Yellow	I	5.36	B
22	Boiler #2	2	Shut Off Valve	M	Orange/Yellow	I	2.10	B
23	Boiler #2	2	Valve	M	Red	I	1.00	B
29	Boiler #2	2	Pipe Insulation	Insulation	Yellow	I	1.32	B
32	Boiler #3	3	Gas Pipe	M	Yellow	I	6.12	B
33	Boiler #3	3	Gas Vent Pipe	M	Yellow	I	2.26	B
36	Boiler #3	3	Shut Off Valve	M	Orange/Yellow	I	2.96	B
37	Boiler #3	3	Valve	M	Red	I	1.00	B
38	Boiler #3	3	Valve	M	Light Yellow	I	1.00	B
40	Boiler #3	3	Insulation	Insulation	Yellow	I	3.61	B
54	Steam Line Control	5	Valve Bracket	M	Yellow	I	5.10	B
56	Steam Line Control	5	Valve Bracket	M	Yellow	I	1.22	B

Summary and Distribution Table:

Positive readings: 17
All readings: 68
Percent positive: 25%

Negative Lead-Based Paint XRF Results

The remaining fifty-one (51) of the sixty-eight (68) locations analyzed during the assessment were determined to contain building materials encapsulated in a paint and/or coating that contained a lead concentration level that was less than 1.00 mg/cm^2 and therefore do not meet the criteria to be considered a lead-based paint. Note: Under OSHA standards, any building material determined to contain levels of lead above 0.0 mg/cm^2 through the utilization of XRF analysis techniques meet the necessary criteria to be categorized as a lead-based paint.

Summary and Distribution Table:

Negative readings: 51

All readings: 68

Percent negative: 75%

G. Conclusions

The above listed components were determined to be positive for a lead-based paint and/or coating as defined by the USEPA/HUD for containing lead in concentrations greater than or equal to 1.0 mg/cm^2 . The sample results are presented in Appendix V of this report. When evaluating this report, it is assumed that according to EPA guidelines, that if one testing combination (i.e. window, door) is positive for lead in an interior or exterior room equivalent, that all other similar testing combinations in those areas are assumed to be positive. The same is true for negative readings. All inaccessible areas are assumed to be positive, even though they were not able to be tested.

IV: Disclosure Responsibility

A copy of this summary must be provided to new lessees (tenants) and purchasers of this property under Federal Law (24 CFR part 35 and 40 CFR part 745) before they become obligated under a lease or sales contract. The complete report must also be provided to new purchasers and it must be made available to new tenants. Landlords and sellers are also required to distribute an educational pamphlet and include standard warning language in their leases or sales contracts to ensure that parents have the information they need to protect their children from lead-based paint hazards.

DISCLAIMER

This is our report of a survey, X-Ray Fluorescence (XRF) analysis, of the readily accessible areas of this structure. The presence or absence of lead-based paint or lead-based paint hazards applies only to the tested or assessed surfaces on the date of the field visit and it should be understood that conditions may change due to deterioration or maintenance. The results and material conditions noted within this report were accurate at the time of the inspection and in no way reflect the conditions at the property after the date of the inspection. Ongoing monitoring by the owner is usually necessary. No other environmental concerns were addressed during this inspection.

V: Calibration & Results

Calibration Check Test Results

Address/Unit No. : C.W. Bill Young VA Medical Center- Boilers
10000 Bay Pines Blvd. Bldg 100 St. Petersburg, FL 33708

Device: Innov-X Systems Delta Classic DC-4000

XRF Serial No: 561046

Date: 2/14/2017

Contractor: ACM Engineering & Environmental Services

Inspector: Jessica Premet

Inspector Signature: *Jessica Premet*

* If the average falls outside of the XRF Calibration Check Tolerance Limits listed on the instrument's Performance Characteristics Sheets (PCS), consult the manufacturer's recommendations to bring the instrument back into control. Retest all testing combinations tested since the last successful Calibration Check test.

First Calibration White Film Strip

NIST SRM Used: White <0.0001 mg/cm ²			Time: 9:37am		
Calibration Check Tolerance Used: 0.0 mg/cm ²			Reading Average	Within Limits	Outside Limits
First Reading	Second Reading	Third Reading			
0.00	0.00	0.00	0.00	✓	

First Calibration Red Film Strip

NIST SRM Used: Red 1.02 mg/cm ² +/- 0.04 mg/cm ²			Time: 9:39am		
Calibration Check Tolerance Used: 1.0 - 1.1 mg/cm ²			Reading Average	Within Limits	Outside Limits
First Reading	Second Reading	Third Reading			
1.06	1.02	0.95	1.01	✓	

Second Calibration White Film Strip

NIST SRM Used: White <0.0001 mg/cm ²			Time: 11:32am		
Calibration Check Tolerance Used: 0.0 mg/cm ²			Reading Average	Within Limits	Outside Limits
First Reading	Second Reading	Third Reading			
0.00	0.00	0.00	0.00	✓	

Second Calibration Red Film Strip

NIST SRM Used: Red 1.02 mg/cm ² +/- 0.04 mg/cm ²			Time: 11:34am		
Calibration Check Tolerance Used: 1.0 - 1.1 mg/cm ²			Reading Average	Within Limits	Outside Limits
First Reading	Second Reading	Third Reading			
1.08	1.15	0.93	1.05	✓	

LEAD-BASED PAINT IDENTIFICATION INSPECTION ANALYSIS RESULTS

Project # FT17-076

CLIENT: Apollo Environmental
 ADDRESS: 10000 Bay Pines Blvd. Bldg 100
 CITY, STATE, ZIP: St. Petersburg, FL 33708
 CONTACT: Ed Butler
 AD-33745

DATE ANALYZED: 2/14/17
 LOCATION: C. W. Bill Young VA Medical Center-Boilers
 INSPECTOR: Jessica Premet
 XRF: Model: Innov-X Delta Classic DC-4000
 XRF Ser No: 561046

XRF SAMPLE NO	DESCRIPTION OR NAME	REF. NUMBER	COMPONENT	ITEM SUBSTRATE - WOOD(W), METAL(M), DRYWALL(DW), CONCRETE (C)	PAINT COLOR	PAINT STATUS INTACT (I), FAIR (F), POOR (P)	XRF LEAD CONCENTRATION READING (mg/cm2)	LEAD BASED PAINT HAZARD IDENTIFIER A - Negative Pb B - Positive Pb C - Inconclusive
1	Standardization Check	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2	Boiler #1	1	Main Tank	M	Dark Blue	I	0.00	A
3	Boiler #1	1	Tank Cap	M	Dark Blue	I	0.00	A
4	Boiler #1	1	Gas Pipe	M	Yellow	I	4.11	B
5	Boiler #1	1	Gas Vent Pipe	M	Yellow	I	2.61	B
6	Boiler #1	1	Shut Off Valve	M	Orange/Yellow	I	2.42	B
7	Boiler #1	1	Valve	M	Red	I	1.00	B
8	Boiler #1	1	Valve	M	Dark Blue	I	0.01	A
9	Boiler #1	1	Valve	M	Black	I	0.00	A
10	Boiler #1	1	Pipe	M	Dark Blue	I	0.08	A
11	Boiler #1	1	Gas Vent Pipe	M	White	I	0.00	A
12	Boiler #1	1	Electrical Box	M	Dark Blue	I	0.00	A
13	Boiler #1	1	Drain Pipe	M	Dark Blue	I	0.01	A
14	Boiler #1	1	Fuel Oil Supply	M	Black	I	0.00	A
15	Boiler #2	2	Main Tank	M	Dark Blue	I	0.01	A
16	Boiler #2	2	Tank Cap	M	Dark Blue	I	0.01	A
17	Boiler #2	2	Electrical Box	M	Dark Blue	I	0.00	A
18	Boiler #2	2	Electrical Box	M	Gray	I	0.00	A
19	Boiler #2	2	Gas Pipe	M	Yellow	I	5.28	B
20	Boiler #2	2	Gas Vent Pipe	M	Yellow	I	5.36	B
21	Boiler #2	2	Gas Vent Pipe	M	White	I	0.00	A

LEAD-BASED PAINT IDENTIFICATION INSPECTION ANALYSIS RESULTS

Project # FT17-076

CLIENT: Apollo Environmental
 ADDRESS: 10000 Bay Pines Blvd. Bldg 100
 CITY, STATE, ZIP: St. Petersburg, FL 33708
 CONTACT: Ed Butler
 AD-33745

DATE ANALYZED: 2/14/17
 LOCATION: C. W. Bill Young VA Medical Center-Boilers
 INSPECTOR: Jessica Premet
 XRF: Model: Innov-X Delta Classic DC-4000
 XRF Ser No: 561046

XRF SAMPLE NO.	DESCRIPTION OR NAME	REF. NUMBER	COMPONENT	ITEM SUBSTRATE - WOOD(W), METAL(M), DRYWALL(DW), CONCRETE (C)	PAINT COLOR	PAINT STATUS INTACT (I), FAIR (F), POOR (P)	XRF LEAD CONCENTRATION READING (mg/cm2)	LEAD BASED PAINT HAZARD IDENTIFIER A - Negative Pb B - Positive Pb C - Inconclusive
22	Boiler #2	2	Shut Off Valve	M	Orange/Yellow	I	2.10	B
23	Boiler #2	2	Valve	M	Red	I	1.00	B
24	Boiler #2	2	Natural Gas Tank	M	Dark Blue	I	0.00	A
25	Boiler #2	2	Tank Cap	M	Aqua	I	0.00	A
26	Boiler #2	2	Compressed Air Pipe	M	Dark Blue	I	0.04	A
27	Boiler #2	2	Drain Pipe	M	Black	I	0.06	A
28	Boiler #2	2	Shut Inlet	M	Dark Blue	I	0.00	A
29	Boiler #2	2	Pipe Insulation	Insulation	Yellow	I	1.32	B
30	Boiler #3	3	Main Tank	M	Dark Blue	I	0.00	A
31	Boiler #3	3	Tank Cap	M	Dark Blue	I	0.01	A
32	Boiler #3	3	Gas Pipe	M	Yellow	I	6.12	B
33	Boiler #3	3	Gas Vent Pipe	M	Yellow	I	2.26	B
34	Boiler #3	3	Gas Vent Pipe	M	White	I	0.00	A
35	Boiler #3	3	Electrical Box	M	Gray	I	0.00	A
36	Boiler #3	3	Shut Off Valve	M	Orange/Yellow	I	2.96	B
37	Boiler #3	3	Valve	M	Red	I	1.00	B
38	Boiler #3	3	Valve	M	Light Yellow	I	1.00	B
39	Boiler #3	3	Valve	M	Black	I	0.00	A
40	Boiler #3	3	Insulation	Insulation	Yellow	I	3.61	B
41	Boiler #3	3	Compressed Air Pipe	M	Dark Blue	I	0.02	A
42	Boiler #3	3	Shut Inlet	M	Dark Blue	I	0.00	A

LEAD-BASED PAINT IDENTIFICATION INSPECTION ANALYSIS RESULTS

Project # FT17-076

CLIENT: Apollo Environmental
ADDRESS: 10000 Bay Pines Blvd. Bldg 100
CITY, STATE, ZIP: St. Petersburg, FL 33708
CONTACT: Ed Butler
AD-33745

DATE ANALYZED: 2/14/17
LOCATION: C. W. Bill Young VA Medical Center-Boilers
INSPECTOR: Jessica Premet
XRF: Model: Innov-X Delta Classic DC-4000
XRF Ser No: 561046

XRF SAMPLE NO	DESCRIPTION OR NAME	REF NUMBER	COMPONENT	ITEM SUBSTRATE - WOOD(W), METAL(M), DRYWALL(DW), CONCRETE (C)	PAINT COLOR	PAINT STATUS INTACT (I), FAIR (F), POOR (P)	XRF LEAD CONCENTRATION READING (mg/cm2)	LEAD BASED PAINT HAZARD IDENTIFIER A - Negative Pb B - Positive Pb C - Inconclusive
43	Boiler #3	3	Fuel Oil Pipe	M	Dark Blue	I	0.03	A
44	Boiler #3	3	Electrical Box	M	Dark Blue	I	0.00	A
45	Boiler #3	3	Support Beams	M	Black	I	0.44	A
46	Water Treatment/Chemical Area	4	Water Supply Pipe	M	Light Blue	P	0.15	A
47	Water Treatment/Chemical Area	4	Water Return Pipe	M	Light Blue	P	0.03	A
48	Water Treatment/Chemical Area	4	Valve	M	White	P	0.01	A
49	Water Treatment/Chemical Area	4	Support Beam	M	Gray	I	0.00	A
50	Water Treatment/Chemical Area	4	Water Return Pipe	M	White	I	0.09	A
51	Steam Line Control	5	Valve	M	Dark Blue	I	0.00	A
52	Steam Line Control	5	Valve	M	Red	I	0.02	A
53	Steam Line Control	5	Valve	M	Silver	I	0.01	A
54	Steam Line Control	5	Valve Bracket	M	Yellow	I	5.10	B
55	Steam Line Control	5	Valve Bracket	M	Silver	I	0.02	A
56	Steam Line Control	5	Valve Bracket	M	Yellow	I	1.22	B
57	Steam Line Control	5	Main Condensate Pipe	M	White	P	0.00	A
58	Condensate Pump	6	Main Tank	M	White	I	0.00	A
59	Condensate Pump	6	Tank Cap	Insulation	White	P	0.00	A
60	Condensate Pump	6	Natural Gas Pipe	M	White	I	0.00	A
61	Condensate Pump	6	Supply Pipe	M	Black	I	0.00	A
62	Condensate Pump	6	Valve	M	Black	I	0.00	A
63	Condensate Pump	6	Pipe	M	Blue	I	0.01	A

LEAD-BASED PAINT IDENTIFICATION INSPECTION ANALYSIS RESULTS

Project # FT17-076

CLIENT: Apollo Environmental, Inc.
 ADDRESS: 10000 Bay Pines Blvd. Bldg 100
 CITY, STATE, ZIP: St. Petersburg, FL 33708
 CONTACT: Ed Butler
 AD-33745

DATE ANALYZED: 2/14/17
 LOCATION: C. W. Bill Young VA Medical Center-Boilers
 INSPECTOR: Jessica Premet
 XRF: Model: Innov-X Delta Classic DC-4000
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XRF SAMPLE NO:	DESCRIPTION OR NAME	REF. NUMBER	COMPONENT	ITEM SUBSTRATE - WOOD(W), METAL(M), DRYWALL(DW), CONCRETE (C)	PAINT COLOR	PAINT STATUS INTACT (I), FAIR (F), POOR (P)	XRF LEAD CONCENTRATION READING (mg/cm2)	LEAD BASED PAINT HAZARD IDENTIFIER A - Negative Pb B - Positive Pb C - Inconclusive
64	Condensate Pump	6	Support Beam	M	White	I	0.13	A
65	Condensate Pump	6	South Wall Pipe	M	White	P	0.00	A
66	Condensate Pump	6	West Wall Pipe	M	White	P	0.09	A
67	Condensate Pump	6	Support Beam	M	White	P	0.00	A
68	Condensate Pump	6	Support Beam	M	Blue	P	0.01	A
69	Condensate Pump	6	Upper Pipe	M	White	P	0.00	A

Performance Characteristic Sheet

EFFECTIVE DATE: October 12, 2006

EDITION NO.: 1

MANUFACTURER AND MODEL:

Make: *Innov-X Systems, Inc.*
Models: *LBP4000 with software version 1.4 and higher*
Source: *X-ray tube (no radioactive isotopes)*

FIELD OPERATION GUIDANCE

OPERATING PARAMETERS:

Inspection mode, variable reading time.

XRF CALIBRATION CHECK LIMITS:

1.0 to 1.1 mg/cm ² (inclusive)

SUBSTRATE CORRECTION:

Not applicable

INCONCLUSIVE RANGE OR THRESHOLD:

INSPECTION MODE READING DESCRIPTION	SUBSTRATE	INCONCLUSIVE RANGE (mg/cm ²)
Results not corrected for substrate bias on any substrate	Brick	0.6 to 1.1
	Concrete	0.6 to 1.1
	Drywall	0.6 to 1.1
	Metal	0.6 to 1.1
	Plaster	0.6 to 1.1
	Wood	0.6 to 1.1

BACKGROUND INFORMATION

EVALUATION DATA SOURCE AND DATE:

This sheet is supplemental information to be used in conjunction with Chapter 7 of the HUD *Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing* ("HUD Guidelines"). Performance parameters shown on this sheet are calculated from the EPA/HUD evaluation using archived building components. Testing was conducted on 146 test locations, with two separate instruments, in December 2005.

OPERATING PARAMETERS:

Performance parameters shown in this sheet are applicable only when properly operating the instrument using the manufacturer's instructions and procedures described in Chapter 7 of the HUD Guidelines.

XRF CALIBRATION CHECK:

The calibration of the XRF instrument should be checked using the paint film nearest 1.0 mg/cm² in the NIST Standard Reference Material (SRM) used (e.g., for NIST SRM 2579, use the 1.02 mg/cm² film).

If the average (rounded to 1 decimal place) of three readings is outside the acceptable calibration check range, follow the manufacturer's instructions to bring the instrument into control before XRF testing proceeds.

SUBSTRATE CORRECTION VALUE COMPUTATION:

Chapter 7 of the HUD Guidelines provides guidance on correcting XRF results for substrate bias. Supplemental guidance for using the paint film nearest 1.0 mg/cm² for substrate correction is provided:

XRF results are corrected for substrate bias by subtracting from each XRF result a correction value determined separately in each house for single-family housing or in each development for multifamily housing, for each substrate. The correction value is an average of XRF readings taken over the NIST SRM paint film nearest to 1.0 mg/cm² at test locations that have been scraped bare of their paint covering. Compute the correction values as follows:

Using the same XRF instrument, take three readings on a bare substrate area covered with the NIST SRM paint film nearest 1 mg/cm². Repeat this procedure by taking three more readings on a second bare substrate area of the same substrate covered with the NIST SRM.

Compute the correction value for each substrate type where XRF readings indicate substrate correction is needed by computing the average of all six readings as shown below.

For each substrate type (the 1.02 mg/cm² NIST SRM is shown in this example; use the actual lead loading of the NIST SRM used for substrate correction):

$$\text{Correction value} = (1\text{st} + 2\text{nd} + 3\text{rd} + 4\text{th} + 5\text{th} + 6\text{th Reading}) / 6 - 1.02 \text{ mg/cm}^2$$

Repeat this procedure for each substrate requiring substrate correction in the house or housing development.

EVALUATING THE QUALITY OF XRF TESTING:

Randomly select ten testing combinations for retesting from each house or from two randomly selected units in multifamily housing.

Take one XRF reading on each of the ten testing combinations selected for retesting.

Determine if the XRF testing in the units or house passed or failed the test by applying the steps below.

Compute the Retest Tolerance Limit by the following steps:

Calculate the average of the original XRF reading and the retest XRF reading for each testing combination.

Square the average for each testing combination.

Add the ten squared averages together. Call this quantity C.

Multiply the number C by 0.0072. Call this quantity D.

Add the number 0.032 to D. Call this quantity E.

Take the square root of E. Call this quantity F.

Multiply F by 1.645. The result is the Retest Tolerance Limit.

Compute the average of all ten original XRF readings.

Compute the average of all ten re-test XRF readings.

Find the absolute difference of the two averages.

If the difference is less than the Retest Tolerance Limit, the inspection has passed the retest. If the difference of the overall averages equals or exceeds the Retest Tolerance Limit, this procedure should be repeated with ten new testing combinations. If the difference of the overall averages is equal to or greater than the Retest Tolerance Limit a second time, then the inspection should be considered deficient.

Use of this procedure is estimated to produce a spurious result approximately 1% of the time. That is, results of this procedure will call for further examination when no examination is warranted in approximately 1 out of 100 dwelling units tested.

TESTING TIMES:

For the variable-time inspection paint test mode, the instrument continues to read until it has determined whether the result is positive or negative (with respect to the 1.0 mg/cm² Federal standard), with 95% confidence. The following table provides testing time information for this testing mode.

Testing Times Using Variable Reading Time Inspection Mode (Seconds)						
Substrate	All Data			Median for laboratory-measured lead levels (mg/cm ²)		
	25 th Percentile	Median	75 th Percentile	Pb < 0.25	0.25 ≤ Pb < 1.0	1.0 ≤ Pb
Wood, Drywall	2.1	2.3	5.4	2.2	5.4	2.2
Metal	2.6	3.2	5.3	2.7	5.1	5.1
Brick, Concrete, Plaster	3.1	4.0	5.7	3.2	4.0	5.9

CLASSIFICATION OF RESULTS:

When an inconclusive range is specified on the *Performance Characteristic Sheet*, XRF results are classified as positive if they are greater than the upper boundary of the inconclusive range, negative if they are less than the lower boundary of the inconclusive range, or inconclusive if in between. The inconclusive range includes both its upper and lower bounds. If the instrument reads "> x mg/cm²", the value "x" should be used for classification purposes, ignoring the ">". For example, a reading reported as ">1.0 mg/cm²" is classified as 1.0 mg/cm², or inconclusive. When the inconclusive range reported in this PCS is used to classify the readings obtained in the EPA/HUD evaluation, the following False Positive, False Negative and Inconclusive rates are obtained:

FALSE POSITIVE RATE: 2.5% (2/80)
 FALSE NEGATIVE RATE: 1.9% (4/212)
 INCONCLUSIVE RATE: 16.4% (48/212)

DOCUMENTATION:

A document titled *Methodology for XRF Performance Characteristic Sheets* provides an explanation of the statistical methodology used to construct the data in the sheets, and provides empirical results from using the recommended inconclusive ranges or thresholds for specific XRF instruments. For a copy of this document call the National Lead Information Center Clearinghouse at 1-800-424-LEAD.

This XRF Performance Characteristic Sheet was developed by the Midwest Research Institute (MRI) and QuanTech, Inc., under a contract between MRI and the XRF manufacturer. XRF Performance Characteristic Sheets were originally developed by the MRI under a grant from the U. S. Environmental Protection Agency and the U.S. Department of Housing and Urban Development. HUD has determined that the information provided here is acceptable when used as guidance in conjunction with Chapter 7, Lead-Based Paint Inspection, of HUD's *Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing*.



National Institute of Standards & Technology

Certificate of Analysis

Standard Reference Material[®] 2573

Lead Paint Film

For Portable X-Ray Fluorescence Analyzers – Nominal 1.0 mg/cm²
(Color Code: Red)

This Standard Reference Material (SRM) is intended for checking the calibration of portable, hand-held, x-ray fluorescence analyzers when testing for lead in paint coatings on interior and exterior building surfaces. A unit of SRM 2573 consists of a white polyester sheet, approximately 7.6 cm wide, 10.2 cm long, and 0.2 mm thick, coated with a single, red-colored paint layer, approximately 0.04 mm thick. A blank, SRM 2570, is also provided. The blank is coated with a lead-free, lacquer layer on a white polyester sheet of the same thickness as the lead paint samples. All sheets are over-coated with a clear, thin, plastic laminate to protect the surface from abrasion. SRM 2573 and SRM 2570 are two of a set of six paint films (SRM 2570 to SRM 2575) available as SRM 2579a.

The certified values for lead for this SRM and the blank, SRM 2570, are reported in Table 1 in units of mg/cm². These values are based on measurements by isotope dilution inductively-coupled plasma mass spectrometry.

Table 1. Certified Lead Values

Level	Color Code	Lead Concentration, in mg/cm ²
SRM 2570	White (Blank)	<0.001
SRM 2573	Red	1.040 ± 0.064

The uncertainty of each certified value is expressed as an expanded uncertainty, U , at the 95 % level of confidence and is calculated according to the method described in the ISO Guide [1,2]. Because of variability in the paint film between different sheets of each SRM, the uncertainties are 95 % prediction intervals. The expanded uncertainty is calculated as $U = k u_c$, where u_c is intended to represent, at the level of one standard deviation, the combined uncertainty due to material variability and measurement uncertainty. The coverage factor, k , is determined from the Student's t -distribution corresponding to the calculated effective degrees of freedom and 95 % level of confidence.

Expiration of Certification: The certification of SRM 2573 is valid, within the measurement uncertainties specified, until 01 July 2020, provided the SRM is handled and stored in accordance with the instructions given in this certificate (see "Instructions for Use"). The certification is nullified if the SRM is damaged, contaminated, or otherwise modified.

Maintenance of SRM Certification: NIST will monitor this SRM over the period of its certification. If substantive technical changes occur that affect the certification before the expiration of this certificate, NIST will notify the purchaser. Registration (see attached sheet) will facilitate notification.

The overall direction and coordination of the analytical measurements leading to certification were performed by G.C. Turk and J.D. Fassett of the NIST Analytical Chemistry Division. Analytical measurements were performed by K.E. Murphy, J.R. Sieber, A.F. Marlow, L.J. Wood, P.R. Seo, and M. Lankosz of the NIST Analytical Chemistry Division. The SRM was fabricated under the direction of J.R. Sieber of the NIST Analytical Chemistry Division.

Stephen A. Wise, Chief
Analytical Chemistry Division

Robert L. Watters, Jr., Chief
Measurement Services Division

Gaithersburg, MD 20899
Certificate Issue Date: 24 March 2009
See Certificate Revision History on Last Page

SRM 2573

Page 1 of 2



Your Vision, Our Future

Olympus Innov-X

100 Sylvan Rd; 100 Trade Center; Suite 500

Woburn, MA 01801 USA

Tel: 781-938-5005 Fax: 781-938-0128

www.innovx.com info@innovx.com

Certificate of Calibration

Certification No: 01561046-1

Date Calibrated: December 8, 2011

Instrument No: 561046

Type: DC-4000

This instrument was calibrated according to Innov-X Systems in-house calibration procedure. The calibration was verified using Soil Certified Reference Materials produced by National Institute of Standards and Technology (NIST).

This instrument conforms to Innov-X Systems Quality Assurance standards.

Test Technician

The Netherlands

(P) +31 (0) 7362 72590

(F) +31 (0) 7362 72599

Hong Kong

(P) +852 2 515 0999

(F) +852 2 505 6129

Australia

(P) +61 2 9577 9500

(F) +61 2 9519 1850



United States Environmental Protection Agency

This is to certify that

Jessica Marie Premet



has fulfilled the requirements of the Toxic Substances Control Act (TSCA) Section 402, and has received certification to conduct lead-based paint activities pursuant to 40 CFR Part 745.226 as:

Risk Assessor

In the Jurisdiction of:

All EPA Administered Lead-based Paint Activities Program States, Tribes and Territories

This certification is valid from the date of issuance and expires July 28, 2019

LBP-R-1155991-1

Certification #

July 14, 2016

Issued On



Adrienne Priselac, Manager, Toxics Office
Land Division

United States Environmental Protection Agency

This is to certify that

Jessica Marie Premet



has fulfilled the requirements of the Toxic Substances Control Act (TSCA) Section 402, and has received certification to conduct lead-based paint activities pursuant to 40 CFR Part 745.226 as:

Inspector

In the Jurisdiction of:

Florida

This certification is valid from the date of issuance and expires August 27, 2018

FL-I-1155991-1

Certification #

August 13, 2015

Issued On



Adrienne Priselac, Manager, Toxics Office

Land Division

Certificate of Completion

This Certifies that
Jessica Premet
of ACM Engineering & Environmental Services, Inc.
has successfully completed the Olympus OSSA
Radiation Safety & Operator Training for field portable
X-Ray Fluorescence Spectrum Analyzers

Richard Gunsenfouner
Authorized Trainer
Olympus OSSA

Completion Date
June 19, 2015

Michael L. Tremblay
Corporate RSO
Olympus NDT

United States Environmental Protection Agency

This is to certify that

ACM Engineering & Environmental Service, Inc.

has fulfilled the requirements of the Toxic Substances Control Act (TSCA) Section 402, and has received certification to conduct lead-based paint activities pursuant to 40 CFR Part 745.226

In the Jurisdiction of:

Florida

This certification is valid from the date of issuance and expires September 30, 2017

FL-115267-2

Certification #

September 16, 2014

Issued On

Michelle Price

Michelle Price, Chief

Lead, Heavy Metals, and Inorganics Branch

United States Environmental Protection Agency

This is to certify that



ACM Engineering & Environmental Service, Inc.

has fulfilled the requirements of the Toxic Substances Control Act (TSCA) Section 402, and has received certification to conduct lead-based paint renovation, repair, and painting activities pursuant to 40 CFR Part 745.89

In the Jurisdiction of:

All EPA Administered States, Tribes, and Territories

This certification is valid from the date of issuance and expires September 30, 2019

NAT-115267-1

Certification #

September 16, 2014

Issued On

A handwritten signature in black ink, appearing to read "Michelle Price".

Michelle Price, Chief

Lead, Heavy Metals, and Inorganics Branch

State of Florida

Department of State

I certify from the records of this office that ACM ENGINEERING & ENVIRONMENTAL SERVICES INC. is a corporation organized under the laws of the State of Florida, filed on September 22, 2005.

The document number of this corporation is P05000130542.

I further certify that said corporation has paid all fees due this office through December 31, 2017, that its most recent annual report/uniform business report was filed on January 18, 2017, and that its status is active.

I further certify that said corporation has not filed Articles of Dissolution.

*Given under my hand and the
Great Seal of the State of Florida
at Tallahassee, the Capital, this
the Eighteenth day of January,
2017*



Ken Detjen
Secretary of State

Tracking Number: CC8722601995

To authenticate this certificate, visit the following site, enter this number, and then follow the instructions displayed.

<https://services.sunbiz.org/Filings/CertificateOfStatus/CertificateAuthentication>

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SECTION 03 30 53
(SHORT-FORM) CAST-IN-PLACE CONCRETE
02-01-16

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Cast-in-place structural concrete.
2. Slab on grade infill.
3. Foundation wall infill.
4. Footings.
5. Equipment pads.
6. Preparation of existing surfaces to receive concrete.
7. Preparation of existing surface to received concrete topping.

1.2 RELATED REQUIREMENTS

- A. Materials Testing and Inspection During Construction: Section 01 45 29, TESTING LABORATORY SERVICES.

1.3 APPLICABLE PUBLICATIONS

- A. Comply with references to extent specified in this Section.
- B. American Concrete Institute (ACI):
1. 117-15 - Tolerances for Concrete Construction, Materials and Commentary.
 2. 117M-10(R2015) - Tolerances for Concrete Construction, Materials and Commentary.
 3. 211.1-91(R2009) - Proportions for Normal, Heavyweight, and Mass Concrete.
 4. 211.2-98(R2004) - Selecting Proportions for Structural Lightweight Concrete.
 5. 301/310M-10 - Structural Concrete.
 6. 305.1-14 - Hot Weather Concreting.
 7. 306.1-90(R2002) - Cold Weather Concreting.
 8. 318/318M-14 - Building Code Requirements for Structural Concrete and SP-66-04-ACI Detailing Manual.
 9. 347-04 - Guide to Formwork for Concrete.

C. ASTM International (ASTM):

1. A615/A615M-15a¹ - Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
2. A996/A996M-15 - Rail-Steel and Axle-Steel Deformed Bars for Concrete Reinforcement.
3. A1064/A1064M-15 - Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.
4. C33/C33M-13 - Concrete Aggregates.
5. C39/C39M-15a - Compressive Strength of Cylindrical Concrete Specimens.
6. C94/C94M-15a - Ready-Mixed Concrete.
7. C143/C143M-15 - Slump of Hydraulic Cement Concrete.
8. C150/C150M-15 - Portland Cement.
9. C171-07 - Sheet Material for Curing Concrete.
10. C192/C192M-15 - Making and Curing Concrete Test Specimens in the Laboratory.
11. C219-14a - Terminology Relating to Hydraulic Cement.
12. C260/C260M-10a - Air-Entraining Admixtures for Concrete.
13. C330/C330M-14 - Lightweight Aggregates for Structural Concrete.
14. C494/C494M-15 - Chemical Admixtures for Concrete.
15. C618-15 - Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
16. C881/C881M-14 - Epoxy-Resin-Base Bonding Systems for Concrete.
17. C989/C989M-14 - Slag Cement for Use in Concrete and Mortars.
18. C1240-15 - Silica Fume Used in Cementitious Mixtures.
19. D1751-04(2013¹) - Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction (Non-extruding and Resilient Bituminous Types).
20. E1155-14 - Determining FF Floor Flatness and FL Floor Levelness Numbers.
21. E1745-11 - Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs.

D. International Concrete Repair Institute:

1. 310.2R-2013 - Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, Polymer Overlays, and Concrete Repair.

1.4 SUBMITTALS

- A. Submittal Procedures: Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Material Submittals:
 - 1. Cast-in-place Concrete
 - 2. Reinforcing Steel
 - 3. Concrete Inserts
 - 4. Premolded Expansion Joint Material
- C. Submittal Drawings:
 - 1. Large scale drawings of reinforcing steel.
- D. Manufacturer's Literature and Data:
 - 1. Concrete Mix Design.
 - 2. Air-entraining admixture, chemical admixtures, and curing compounds.
 - 3. Indicate manufacturer's recommendation for each application.

1.5 DELIVERY

- A. Deliver each ready-mixed concrete batch with mix certification in duplicate according to ASTM C94/C94M.

1.6 WARRANTY

- A. Construction Warranty: FAR clause 52.246-21, "Warranty of Construction."

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Portland Cement: ASTM C150/C150M, Type I or II.
- B. Pozzolans:
 - 1. Fly Ash: ASTM C618, Class C or F including supplementary optional physical requirements.
- C. Coarse Aggregate: ASTM C33/C33M.
 - 1. Size 467 for footings and walls over 300 mm (12 inches) thick.
 - 2. Size 7 for coarse aggregate for applied topping Size 67 for other applications.
- D. Fine Aggregate: ASTM C33/C33M.
- E. Mixing Water: Fresh, clean, and potable.
- F. Air-Entraining Admixture: ASTM C260/C260M.
- G. Chemical Admixtures: ASTM C494/C494M.
- H. Vapor Barrier: ASTM E1745, Class A with a minimum puncture resistance of 2200 g (3000 lbs.); minimum 0.38 mm (15 mil) thick.

- I. Reinforcing Steel: ASTM A615/A615M or ASTM A996/A996M, deformed. See Structural Drawings for grade.
- J. Forms: Wood, plywood, metal, or other materials, approved by Contracting Officer, of grade or type suitable to obtain type of finish specified.
 - 1. Plywood: Exterior grade, free of defects and patches on contact surface.
 - 2. Lumber: Sound, grade-marked, S4S stress graded softwood.
 - 3. Form coating: As recommended by Contractor.
- K. Welded Wire Fabric: ASTM A1064/A1064M, plain; Grade 65; sized as indicated.
- L. Expansion Joint Filler: ASTM D1751.
- M. Sheet Materials for Curing Concrete: ASTM C171.
- N. Liquid Densifier/Sealer: 100 percent active colorless aqueous siliconate solution.
- O. Grout, Non-Shrinking: Premixed non-ferrous. Grout to show no settlement or vertical drying shrinkage at 3 days. Compressive strength for grout, at least 18 MPa (2500 psi) at 3 days and 35 MPa (5000 psi) at 28 days.

2.2 ACCESSORIES

- A. Bonding Agent: ASTM C 1059/C 1059M, Type II.
- B. Structural Adhesive: ASTM C881, 2-component material suitable for use on dry or damp surfaces. Provide material Type, Grade, and Class to suit Project requirements.
- C. Water Stops: Rubber base with self-healing properties. Expanding clay based products not acceptable.

2.3 CONCRETE MIXES

- A. Design concrete mixes according to ASTM C94/C94M, Option C.
- B. Compressive strength at 28 days: minimum 30 MPa (4,000 psi).
- C. Submit mix design and results of compression tests to the Contracting Officer for his evaluation. Identify all materials, including admixtures, making-up the concrete.
- D. Maximum Slump for Vibrated Concrete: 100 mm (4 inches) tested according to ASTM C143.
- E. Cement and Water Factor (See Table I):

TABLE I - CEMENT AND WATER FACTORS FOR CONCRETE				
Concrete: Strength 1	Non-Air-Entrained		Air-Entrained 2	
Min. 28 Day Comp. Str.: 30 MPa (4000 psi)	Min. Cement 325 kg/cu. m (550 lbs./cu. yd.)	Max. Water Cement Ratio 0.55	Min. Cement 340kg/cu.m (570 bs./cu yd.)	Max. Water Cement Ratio 0.50
Footnotes: 1. If trial mixes are used, achieve a compressive strength 8.3 MPa (1200 psi) in excess of f'c. 2. For Concrete Exposed to High Sulfate Content Soils: Maximum water cement ratio is 0.44. * Laboratory Determined according to ACI 211.1 for normal weight concrete.				

F. Air-entrainment as specified, and conform with the following for air content table:

TABLE II - TOTAL AIR CONTENT FOR VARIOUS SIZES OF COARSE AGGREGATES	
Nominal Maximum Size of Coarse Aggregate	Total Air Content, percent
10 mm (3/8 inches)	6 Moderate exposure; 7.5 severe exposure
13 mm (1/2 inches)	5.5 Moderate exposure; 7 severe exposure
19 mm (3/4 inches)	5 Moderate exposure; 6 severe exposure
25 mm (1 inches)	4.5 Moderate exposure; 6 severe exposure
40 mm (1 1/2 inches)	4.5 Moderate exposure; 5.5 severe exposure

2.4 BATCHING AND MIXING

- A. Store, batch, and mix materials according to ASTM C94/C94M.
 1. Job-Mixed: Batch mix concrete in stationary mixers as specified in ASTM C94/C94M.
 2. Ready-Mixed Concrete: Comply with ASTM C94/C94M, except use of non-agitating equipment for transporting concrete to Site is not acceptable.

3. When aggregate producer's instructions deviate from specifications, submit proposed resolution for Contracting Officer's Representative consideration.

PART 3 - EXECUTION

3.1 FORMWORK

- A. Installation: Conform to ACI 347. Construct forms to obtain concrete of the shapes, dimensions and profiles indicated, with tight joints.
- B. Design and construct forms to prevent bowing-out of forms between supports and to be removable without prying against or otherwise damaging fresh concrete.
- C. When patching formed concrete, seal form edges against existing surface to prevent leakage; set forms so that patch is flush with adjacent surfaces.
- D. Treating and Wetting: Treat or wet concrete contact surfaces:
 1. Coat plywood and lumber forms with non-staining form sealer.
 2. Wet wood forms thoroughly when they are not treated with form release agent.
 3. Clean and coat removable metal forms with light form oil before reinforcement is placed.
 4. In hot weather, cool metal forms by thoroughly wetting with water just before placing concrete.
 5. Prevent water from accumulating and remaining within forms.
- E. Inserts, Sleeves, and Similar Items: Install flashing reglets, masonry ties, anchors, inserts, wires, hangers, sleeves, boxes for floor hinges, and other cast-in items specified in other Sections. Place where indicated, square, flush and secured to formwork.
- F. Construction Tolerances - General: Install and maintain concrete formwork to assure completion of work within specified tolerances.
- G. Adjust or replace completed work exceeding specified tolerances before placing concrete.

3.2 REINFORCEMENT

- A. Install concrete reinforcement according to ACI 318 and ACI SP-66.
- B. Support and securely tie reinforcing steel to prevent displacement during placing of concrete.
- C. Drilling for Dowels in Existing Concrete: Use sharp bits, drill hole slightly oversize, fill with epoxy grout, inset the dowel, and remove excess epoxy.

3.3 VAPOR BARRIER

- A. Place interior concrete slabs on a continuous vapor barrier.
- B. Lap joints 150 mm (6 inches) and seal with a compatible pressure-sensitive tape.
- C. Patch punctures and tears.

3.4 PLACING CONCRETE

- A. Remove water from excavations before concrete is placed. Remove hardened concrete, debris and other foreign materials from interior of forms, and from inside of mixing and conveying equipment. Obtain approval from Contracting Officer's Representative before placing concrete.
- B. Install screeds at required elevations for concrete slabs.
- C. Roughen and clean free from laitance, foreign matter, and loose particles before placing new concrete on existing concrete.
 - 1. Blow-out areas with compressed air and immediately coat contact areas with adhesive in compliance with manufacturer's instructions.
- D. Place structural concrete according to ACI 301 and ACI 318.
- E. Convey concrete from mixer to final place of deposit by method that will prevent segregation or loss of ingredients. Do not deposit, in Work, concrete that has attained its initial set or has contained its water or cement more than 1 1/2 hours. Do not allow concrete to drop freely more than 1500 mm (5 feet) in unexposed work nor more than 900 mm (3 feet) in exposed work.
- F. Place and consolidate concrete in horizontal layers not exceeding 300 mm (12 inches) in thickness. Consolidate concrete by spading, rodding, and mechanical vibrator. Do not secure vibrator to forms or reinforcement. Continuously vibrate during placement of concrete.
- G. Hot Weather Concrete Placement: As recommended by ACI 305.1 to prevent adversely affecting properties and serviceability of hardened concrete.
- H. Cold Weather Concrete Placement: As recommended by ACI 306.1, to prevent freezing of thin sections less than 300 mm (12 inches) and to permit concrete to gain strength properly.
 - 1. Do not use calcium chloride without written approval from Contracting Officer's Representative.

3.5 TOLERANCES

- A. Slab on Grade Finish Tolerance: Comply with ACI 117, FF-number and FL-number method.

1. Paragraph 4.8.3, Class A 3 mm (1/8 inches) for offset in form-work.
2. Table R4.8.4, "Flat" 6 mm (1/4 inch) in 3 m (10 feet) for slabs.

3.6 PROTECTION AND CURING

- A. Protect exposed surfaces of concrete from premature drying, wash by rain or running water, wind, mechanical damage, and excessive hot or cold temperatures.
- B. Curing Methods: Cure concrete with curing compound using wet method with sheets.
- C. Formed Concrete Curing: Wet the tops and exposed portions of formed concrete and keep moist until forms are removed.
 1. If forms are removed before 14 days after concrete is cast, install sheet curing materials as specified above.
- D. Concrete Flatwork Curing:
 1. Install sheet materials according to the manufacturer's instructions.
 - a. When manufacturer's instructions deviate from specifications, submit proposed resolution for Contracting Officer's Representative consideration.

3.7 FORM REMOVAL

- A. Maintain forms in place until concrete is self-supporting, with construction operation loads.
- B. Remove fins, laitance and loose material from concrete surfaces when forms are removed. Repair honeycombs, rock pockets, sand runs, spalls, or otherwise damaged surfaces by patching with the same mix as concrete minus the coarse aggregates.
- C. Finish to match adjacent surfaces.

3.8 FINISHES

- A. Vertical and Overhead Surface Finishes:
 1. Surfaces Concealed in Completed Construction: As-cast; no additional finishing required.
 2. Surfaces Exposed in Unfinished Areas: As-cast; no additional finishing required.
 - a. Mechanical rooms.
 - b. Electrical rooms.
 3. Surfaces Exposed to View Scheduled for Paint Finish: Remove fins, burrs and similar projections by mechanical means approved by Contracting Officer's Representative flush with adjacent surface.

Lightly rub with fine abrasive stone or hone. Use ample amount of water during rubbing without working up a lather of mortar or changing texture of concrete.

4. Surfaces Exposed to View in Finished Areas: Grout finish, unless otherwise shown, for uniform color and smooth finish treated.
 - a. Remove laitance, fins and burrs.
 - b. Scrub concrete with wire brushes. Clean stained concrete surfaces with hone or stone.
 - c. Apply grout composed of 1 part Portland cement and 1 part clean, fine sand (smaller than 600 micro-m (No. 30) sieve). Work grout into surface of concrete with cork floats or fiber brushes until pits and honeycomb are filled.
 - d. After grout has hardened, but is still plastic, remove surplus grout with sponge rubber float and by rubbing with clean burlap.
 - e. In hot, dry weather fog spray surfaces with water to keep grout wet during setting period. Complete finished areas in same day. Confine limits of finished areas to natural breaks in wall surface. Do not leave grout on concrete surface overnight.

B. Slab Finishes:

1. Allow bleed water to evaporate before surface is finished. Do not sprinkle dry cement on surface to absorb water.
2. Scratch Finish: Rake or wire broom after partial setting slab surfaces to received bonded applied cementitious application, within 2 hours after placing, to roughen surface and provide permanent bond between base slab and applied cementitious materials.
3. Steel Trowel Finish: Applied toppings, concrete surfaces to receive resilient floor covering or carpet, future floor roof and other monolithic concrete floor slabs and concrete surfaces exposed to view without other finish indicated or specified.
 - a. Delay final steel troweling to secure smooth, dense surface, usually when surface can no longer be dented by fingers. During final troweling, tilt steel trowel at slight angle and exert heavy pressure on trowel to compact cement paste and form dense, smooth surface.
 - b. Finished surface: Free from trowel marks. Uniform in texture and appearance.
4. Finished Slab Flatness (FF) and Levelness (FL):

- a. Slab on Grade: Specified overall value FF 25/FL 20. Minimum local value FF 17/FL 15.
- b. Test flatness and levelness according to ASTM E1155.

3.9 SURFACE TREATMENTS

- A. Mix and apply the following surface treatments according to manufacturer's instructions.
 - 1. When manufacturer's instructions deviate from specifications, submit proposed resolution for Contracting Officer's Representative consideration.

3.10 APPLIED TOPPING

- A. Install concrete topping with thickness and strength shown with only enough water to ensure stiff, workable, plastic mix.
- B. Continuously place applied topping until entire area is complete, struck off with straightedge, compact by rolling or tamping, float and steel trowel to hard smooth finish.

3.11 RESURFACING FLOORS

- A. Remove existing flooring by abrasive blasting or grinding, in areas to receive resurfacing, to expose existing structural slab. Achieve a surface profile of 2 to 4 according to ICRI 310.2R for the condition found at Site.
- B. Prepare exposed structural slab surface by cleaning, wetting, and applying adhesive according to manufacturer's instructions as specified in the flooring section.

3.12 FOUNDATION WALL INFILL

- A. Install air-entrained concrete at foundation wall infill, as indicated.
- B. Install expansion and contraction joints, waterstops, weep holes, reinforcement and railing sleeves, as indicated.
- C. Finish exposed surfaces to match adjacent concrete surfaces, new or existing.
- D. Place porous backfill, as indicated on Drawings.

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SECTION 05 12 00
STRUCTURAL STEEL FRAMING
02-01-16

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Structural steel shapes, plates, and bars.
2. Structural pipe.
3. Bolts, nuts, and washers.

1.2 RELATED REQUIREMENTS

- A. Materials Testing And Inspection During Construction: Section 01 45 29, TESTING LABORATORY SERVICES.
- B. Steel Gratings, Trench Covers, and Railings: Section 05 50 00, METAL FABRICATIONS.
- C. Painting: Section 09 91 00, PAINTING.

1.3 APPLICABLE PUBLICATIONS

- A. Comply with references to extent specified in this section.
- B. American Institute of Steel Construction (AISC):
 1. AISC Manual - Steel Construction Manual, 14th Ed.
 2. 303-10 - Code of Structural Steel Buildings and Bridges.
 3. 360-10: Specification for Structural Steel Buildings.
- C. The American Society of Mechanical Engineers (ASME):
 1. B18.22.1-09 - Washers: Helical Spring-Lock, Tooth Lock, and Plain Washers.
- D. American Welding Society (AWS):
 1. D1.1/D1.1M-15 - Structural Welding Code - Steel.
- E. ASTM International (ASTM):
 1. A6/A6M-14 - General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling.
 2. A36/A36M-14 - Carbon Structural Steel.
 3. A53/A53M-12 - Pipe, Steel, Black and Hot-Dip, Zinc-Coated, Welded and Seamless.
 4. A123/A123M-15 - Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 5. A242/A242M-13 - High-Strength Low-Alloy Structural Steel.
 6. A283/A283M-13 - Low and Intermediate Tensile Strength Carbon Steel Plates.

7. A307-14 - Carbon Steel Bolts, Studs, and Threaded Rod 60,000 PSI Tensile Strength.
 8. A325-14 - Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.
 9. A490-14a - Structural Bolts, Alloy Steel, Heat Treated, 150 ksi Minimum Tensile Strength.
 10. A500/A500M-13 - Cold-Formed Welded and Seamless Carbon Steel Structural Tubing and Rounds and Shapes.
 11. A501/A501M-14 - Hot-Formed Welded and Seamless Carbon Steel Structural Tubing and Rounds and Shapes.
 12. A572/A572M-15 - High-Strength Low-Alloy Columbium-Vanadium Structural Steel.
 13. A992/A992M-15 - Structural Shapes.
 14. F2329/F2329M-15 - Zinc Coating, Hot-Dip, Requirements for Application to Carbon and Alloy steel Bolts, Screws, washers, Nuts, and Special Threaded Fasteners.
- F. Master Painters Institute (MPI):
1. No. 18 - Primer, Zinc Rich, Organic.
- G. Military Specifications (Mil. Spec.):
1. MIL-P-21035 - Paint, High Zinc Dust Content, Galvanizing, Repair.
- H. Occupational Safety and Health Administration (OSHA):
1. 29 CFR 1926.752(e) - Guidelines For Establishing The Components Of A Site-Specific Erection Plan.
 2. 29 CFR 1926-2001 - Safety Standards for Steel Erection.
- I. Research Council on Structural Connections (RCSC) of The Engineering Foundation:
1. Specification for Structural Joints Using ASTM A325 or A490 Bolts.

1.4 SUBMITTALS

- A. Submittal Procedures: Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Material Submittals:
1. Structural Steel W-shapes
 2. Steel Angles, Channels, plates, and bars
 3. Hollow Structural Sections (HSS Shapes)
 4. Structural Steel Pipe
 5. Primer Paint

- C. Submittal Drawings:
 - 1. Show size, configuration, and fabrication and installation details.
 - 2. Provide complete shop fabrication drawings for all steel structures.
- D. Test Reports: Certify products comply with specifications.
 - 1. Welders' qualifying tests.
- E. Certificates: Certify each product complies with specifications.
 - 1. Structural steel.
 - 2. Steel connections.
 - 3. Welding materials.
 - 4. Shop coat primer paint.
- F. Qualifications: Substantiate qualifications comply with specifications.
 - 1. Fabricator with project experience list.
 - 2. Installer with project experience list
 - 3. Welders and welding procedures

1.5 QUALITY ASSURANCE

- A. Fabricator Qualifications: AISC Quality Certification participant designated as AISC Certified Plant, Category STD.
 - 1. Regularly fabricates specified products.
 - 2. Fabricated specified products with satisfactory service on five similar installations for minimum five years.
 - a. Project Experience List: Provide contact names and addresses for completed projects.
- B. Installer Qualifications: AISC Quality Certification Program participant designated as AISC-Certified Erector, Category ACSE.
 - 1. Regularly installs specified products.
 - 2. Installed specified products with satisfactory service on five similar installations for minimum five years.
 - a. Project Experience List: Provide contact names and addresses for completed projects.
- C. Before commencement of Work, ensure steel erector provides written notification required by OSHA 29 CFR 1926.752(e). Submit a copy of the notification to Contracting Officer's Representative.
- D. Welders and Welding Procedures Qualifications: AWS D1.1/D1.1M.

1.6 WARRANTY

- A. Construction Warranty: FAR clause 52.246-21, "Warranty of Construction."

PART 2 - PRODUCTS

2.1 MATERIALS

- A. W-Shapes: ASTM A992/A992M, 50 ksi minimum yield stress.
- B. Channel and Angles: ASTM A36/A36M, 36 ksi minimum yield stress.
- C. Plates and Bars: ASTM A36/A36M, 36 ksi minimum yield stress.
- D. Hollow Structural Sections HSS Shapes: ASTM A500/A500M, 46 ksi minimum yield stress.
- E. Structural Pipe: ASTM A53/A53M, Grade B.
- F. Bolts, Nuts and Washers: Galvanized for galvanized framing and plain finish for other framing.
 - 1. High-strength bolts, including nuts and washers: ASTM A325 Bolts and nuts, other than high-strength: ASTM A307, Grade A.
 - 2. Plain washers, other than those in contact with high-strength bolt heads and nuts: ASME B18.22.1.
- G. Welding Materials: AWS D1.1, type to suit application.

2.2 FABRICATION

- A. Fabricate structural steel according to Chapter M, AISC 360.
- B. Shop and Field Connections:
 - 1. Weld connections according to AWS D1.1/D1.1M. Welds shall be made only by welders and welding operators who have been previously qualified by tests as prescribed in AWS D1.1 to perform type of work required.
 - 2. High-Strength Bolts: High-strength bolts tightened to a bolt tension minimum 70 percent of their minimum tensile strength. Tightening done with properly calibrated wrenches, by turn-of-nut method or by use of direct tension indicators (bolts or washers). Tighten bolts in connections identified as slip-critical using Direct Tension Indicators. Twist-off torque bolts are not an acceptable alternate fastener for slip critical connections.

2.3 FINISHES

- A. Shop Priming: Prime paint structural steel according to AISC 303, Section 6.
- B. Shop Finish Painting: Apply primer and finish paint as specified in Section 09 91 00, PAINTING.

- C. Do not paint:
 - 1. Surfaces within 50 mm (2 inches) of field welded joints.
 - 2. Surfaces indicated to be encased in concrete.
 - 3. Surfaces receiving sprayed on fireproofing.
 - 4. Beam top flanges receiving shear connector studs applied.
- D. Structural Steel Galvanizing: ASTM A123/A123M, hot dipped, after fabrication. Touch-up after erection: Clean and wire brush any abraded and other spots worn through zinc coating, including threaded portions of bolts and welds and touch-up with galvanizing repair paint.
 - 1. Galvanize structural steel framing installed at exterior locations.
- E. Bolts, Nuts, and Washers Galvanizing: ASTM F2329, hot-dipped.

2.4 ACCESSORIES

- A. General: Shop paint steel according to AISC 303, Section 6.
- B. Finish Paint System: Primer and finish as specified in Section 09 91 00, PAINTING.
- C. Galvanizing Repair Paint: MPI No. 18.

PART 3 - EXECUTION

3.1 ERECTION

- A. Erect structural steel according to AISC 303 and AISC 360.
- B. Set structural steel accurately at locations and elevations indicated on drawings.
- C. Maintain erection tolerances of structural steel within AISC 303 requirements.
- D. Weld and bolt connections as specified for shop connections.

3.2 FIELD PAINTING

- A. After welding, clean and prime weld areas to match adjacent finish.
- B. Touch-up primer damaged by construction operations.
- C. Apply galvanizing repair paint to galvanized coatings damaged by construction operations.
- D. Finish Painting: As specified in Section 09 91 00, PAINTING.

3.3 FIELD QUALITY CONTROL

- A. Record Survey:
 - 1. Measure and record structural steel framing plumbness, level, and alignment after completing bolting and welding and before installation of work supported by structural steel.

2. Identify deviations from allowable tolerances specified in
AISC Manual.

- - E N D - -

SECTION 05 50 00
METAL FABRICATIONS
07-01-14

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section specifies items and assemblies fabricated from structural steel shapes and other materials as shown and specified.
- B. Items specified.
 - 1. Frames:
 - 2. Gratings
 - 3. Railings:
 - 4. Covers and frames for pits and trenches

1.2 RELATED WORK

- A. Prime and finish painting: Section 09 91 00, PAINTING.
- B. Section 05 12 00, STRUCTURAL STEEL FRAMING

1.3 SUBMITTALS

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Shop Drawings:
 - 1. Each item specified, showing complete detail, location in the project, material and size of components, method of joining various components and assemblies, finish, and location, size and type of anchors.
 - 2. Mark items requiring field assembly for erection identification and furnish erection drawings and instructions.
 - 3. Provide templates and rough-in measurements as required.
- C. Manufacturer's Certificates: finish as specified.
- D. Furnish setting drawings and instructions for installation of anchors to be preset into concrete and masonry work, and for the positioning of items having anchors to be built into concrete or masonry construction.

1.4 QUALITY ASSURANCE

- A. Each manufactured product shall meet, as a minimum, the requirements specified, and shall be a standard commercial product of a manufacturer regularly presently manufacturing items of type specified.
- B. Each product type shall be the same and be made by the same manufacturer.
- C. Assembled product to the greatest extent possible before delivery to the site.

- D. Include additional features, which are not specifically prohibited by this specification, but which are a part of the manufacturer's standard commercial product.

1.5 APPLICABLE PUBLICATIONS

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. American Society of Mechanical Engineers (ASME):
- B18.6.1-97.....Wood Screws
 - B18.2.2-87(R2005).....Square and Hex Nuts
- C. American Society for Testing and Materials (ASTM):
- A36/A36M-12.....Structural Steel
 - A47-99(R2009).....Malleable Iron Castings
 - A48-03(R2012).....Gray Iron Castings
 - A53-12.....Pipe, Steel, Black and Hot-Dipped, Zinc-Coated
Welded and Seamless
 - A123-12.....Zinc (Hot-Dip Galvanized) Coatings on Iron and
Steel Products
 - A240/A240M-14.....Standard Specification for Chromium and
Chromium-Nickel Stainless Steel Plate, Sheet
and Strip for Pressure Vessels and for General
Applications.
 - A269-10.....Seamless and Welded Austenitic Stainless Steel
Tubing for General Service
 - A307-12.....Carbon Steel Bolts and Studs, 60,000 PSI
Tensile Strength
 - A391/A391M-07(R2012)....Grade 80 Alloy Steel Chain
 - A786/A786M-09.....Rolled Steel Floor Plate
 - B221-13.....Aluminum and Aluminum-Alloy Extruded Bars,
Rods, Wire, Shapes, and Tubes
 - B456-11.....Electrodeposited Coatings of Copper Plus Nickel
Plus Chromium and Nickel Plus Chromium
 - B632-08.....Aluminum-Alloy Rolled Tread Plate
 - C1107-13.....Packaged Dry, Hydraulic-Cement Grout
(Nonshrink)
 - D3656-13.....Insect Screening and Louver Cloth Woven from
Vinyl-Coated Glass Yarns
 - F436-11.....Hardened Steel Washers

- F468-06(R2012).....Nonferrous Bolts, Hex Cap Screws, Socket Head
Cap Screws and Studs for General Use
- F593-13.....Stainless Steel Bolts, Hex Cap Screws, and
Studs
- F1667-11.....Driven Fasteners: Nails, Spikes and Staples
- D. American Welding Society (AWS):
 - D1.1-10.....Structural Welding Code Steel
 - D1.2-08.....Structural Welding Code Aluminum
 - D1.3-08.....Structural Welding Code Sheet Steel
- E. National Association of Architectural Metal Manufacturers (NAAMM)
 - AMP 521-01.....Pipe Railing Manual
 - AMP 500-06.....Metal Finishes Manual
 - MBG 531-09.....Metal Bar Grating Manual
 - MBG 532-09.....Heavy Duty Metal Bar Grating Manual
- F. Structural Steel Painting Council (SSPC)/Society of Protective
Coatings:
 - SP 1-04.....No. 1, Solvent Cleaning
 - SP 2-04.....No. 2, Hand Tool Cleaning
 - SP 3-04.....No. 3, Power Tool Cleaning
- G. Federal Specifications (Fed. Spec):
 - RR-T-650E.....Treads, Metallic and Nonmetallic, Nonskid

PART 2 - PRODUCTS

2.1 DESIGN CRITERIA

- A. In addition to the dead loads, design fabrications to support the
following live loads unless otherwise specified.
- B. Ladders and Rungs: 120 kg (250 pounds) at any point.
- C. Railings and Handrails: 900 N (200 pounds) in any direction at any
point.
- D. Floor Plates, Gratings, Catwalks, and Platforms: 500 kg/m² (100 pounds
per square foot). Use 1000 pounds for concentrated loads.

2.2 MATERIALS

- A. Steel channels, angles, plates and bars: ASTM A36.
- B. Stainless Steel: ASTM A240, Type 302 or 304.
- C. Steel Floor Plate: ASTM A786
- D. Floor Bar Grating: GW Series
- E. Steel Pipe: ASTM A53, Grade B.
- F. Primer Paint: As specified in Section 09 91 00, PAINTING.

2.3 HARDWARE

A. Rough Hardware:

1. Furnish rough hardware with a standard plating, applied after punching, forming and assembly of parts; galvanized, cadmium plated, or zinc-coated by electro-galvanizing process. Galvanized G-90 where specified.
2. Use G90 galvanized coating on ferrous metal for exterior work unless non-ferrous metal or stainless is used.

B. Fasteners:

1. Bolts with Nuts:
 - a. ASME B18.2.2.
 - b. ASTM A307 for 415 MPa (60,000 psi) tensile strength bolts.
 - c. ASTM F468 for nonferrous bolts.
 - d. ASTM F593 for stainless steel.
2. Screws: ASME B18.6.1.
3. Washers: ASTM F436, type to suit material and anchorage.
4. Nails: ASTM F1667, Type I, style 6 or 14 for finish work.

2.4 FABRICATION GENERAL

A. Material

1. Use material as specified. Use material of commercial quality and suitable for intended purpose for material that is not named or its standard of quality not specified.
2. Use material free of defects which could affect the appearance or service ability of the finished product.

B. Size:

1. Size and thickness of members as shown.
2. When size and thickness is not specified or shown for an individual part, use size and thickness not less than that used for the same component on similar standard commercial items or in accordance with established shop methods.

C. Connections

1. Except as otherwise specified, connections may be made by welding, riveting or bolting.
2. Field riveting will not be approved.
3. Holes, for rivets and bolts: Accurately punched or drilled and burrs removed.

4. Size and shape welds to develop the full design strength of the parts connected by welds and to transmit imposed stresses without permanent deformation or failure when subject to service loadings.
5. Use Rivets and bolts of material selected to prevent corrosion (electrolysis) at bimetallic contacts. Plated or coated material will not be approved.
6. Use stainless steel connectors for removable members machine screws or bolts.

D. Fasteners and Anchors

1. Use methods for fastening or anchoring metal fabrications to building construction as shown or specified.
2. Where fasteners and anchors are not shown, design the type, size, location and spacing to resist the loads imposed without deformation of the members or causing failure of the anchor or fastener, and suit the sequence of installation.
3. Use material and finish of the fasteners compatible with the kinds of materials which are fastened together and their location in the finished work.
4. Fasteners for securing metal fabrications to new construction only, may be by use of threaded or wedge type inserts or by anchors for welding to the metal fabrication for installation before the concrete is placed or as masonry is laid.
5. Fasteners for securing metal fabrication to existing construction or new construction may be expansion bolts, toggle bolts, power actuated drive pins, welding, self-drilling and tapping screws or bolts.

E. Workmanship

1. General:
 - a. Fabricate items to design shown.
 - b. Furnish members in longest lengths commercially available within the limits shown and specified.
 - c. Fabricate straight, true, free from warp and twist, and where applicable square and in same plane.
 - d. Provide holes, sinkages and reinforcement shown and required for fasteners and anchorage items.
 - e. Provide openings, cut-outs, and tapped holes for attachment and clearances required for work of other trades.
 - f. Prepare members for the installation and fitting of hardware.

- g. Cut openings in gratings and floor plates for the passage of ducts, sumps, pipes, conduits and similar items. Provide reinforcement to support cut edges.
 - h. Fabricate surfaces and edges free from sharp edges, burrs and projections which may cause injury.
2. Welding:
- a. Weld in accordance with AWS.
 - b. Welds shall show good fusion, be free from cracks and porosity and accomplish secure and rigid joints in proper alignment.
 - c. Where exposed in the finished work, continuous weld for the full length of the members joined and have depressed areas filled and protruding welds finished smooth and flush with adjacent surfaces.
 - d. Finish welded joints to match finish of adjacent surface.
3. Joining:
- a. Miter or butt members at corners.
 - b. Where frames members are butted at corners, cut leg of frame member perpendicular to surface, as required for clearance.
4. Anchors:
- a. Where metal fabrications are shown to be preset in concrete, weld 32 x 3 mm (1-1/4 by 1/8 inch) steel strap anchors, 150 mm (6 inches) long with 25 mm (one inch) hooked end, to back of member at 600 mm (2 feet) on center, unless otherwise shown.
 - b. Where metal fabrications are shown to be built into masonry use 32 x 3 mm (1-1/4 by 1/8 inch) steel strap anchors, 250 mm (10 inches) long with 50 mm (2 inch) hooked end, welded to back of member at 600 mm (2 feet) on center, unless otherwise shown.
5. Cutting and Fitting:
- a. Accurately cut, machine and fit joints, corners, copes, and miters.
 - b. Fit removable members to be easily removed.
 - c. Design and construct field connections in the most practical place for appearance and ease of installation.
 - d. Fit pieces together as required.
 - e. Fabricate connections for ease of assembly and disassembly without use of special tools.
 - f. Joints firm when assembled.

- g. Conceal joining, fitting and welding on exposed work as far as practical.
 - h. Do not show rivets and screws prominently on the exposed face.
 - i. The fit of components and the alignment of holes shall eliminate the need to modify component or to use exceptional force in the assembly of item and eliminate the need to use other than common tools.
- F. Finish:
- 1. Finish exposed surfaces in accordance with NAAMM AMP 500 Metal Finishes Manual.
 - 2. Steel and Iron: NAAMM AMP 504.
 - a. Zinc coated (Galvanized): ASTM A123, G90 unless noted otherwise.
 - b. Surfaces exposed in the finished work:
 - 1) Finish smooth rough surfaces and remove projections.
 - 2) Fill holes, dents and similar voids and depressions with epoxy type patching compound.
 - c. Shop Prime Painting:
 - 1) Surfaces of Ferrous metal:
 - a) Items not specified to have other coatings.
 - b) Galvanized surfaces specified to have prime paint.
 - c) Remove all loose mill scale, rust, and paint, by hand or power tool cleaning as defined in SSPC-SP2 and SP3.
 - d) Clean of oil, grease, soil and other detrimental matter by use of solvents or cleaning compounds as defined in SSPC-SP1.
 - e) After cleaning and finishing apply one coat of primer as specified in Section 09 91 00, PAINTING.
 - 2) Non-ferrous metals: Comply with MAAMM-500 series.
- G. Protection:
- 1. Spot prime all abraded and damaged areas of zinc coating which expose the bare metal, using zinc rich paint on hot-dip zinc coat items and zinc dust primer on all other zinc coated items.

2.5 SUPPORTS

- A. General:
- 1. Fabricate structural steel shapes as shown.
 - 2. Use clip angles or make provisions for welding hangers and braces to overhead construction.
 - 3. Field connections may be welded or bolted.

2.6 COVERS AND FRAMES FOR PITS AND TRENCHES

- A. Fabricate covers to support live loads specified.
- B. Galvanized steel members after fabrication in accordance with ASTM A123, G-90 coating.
- C. Steel Covers:
 - 1. Use 6 mm (1/4 inch) thick floor plate for covers unless otherwise shown. Use gratings where shown as specified in paragraph GRATINGS. Use smooth floor plate unless noted otherwise.
 - 2. Provide clearance at all sides to permit easy removal of covers.
 - 3. Make cutouts within 6 mm (1/4 inch) of penetration for passage of pipes and ducts.
 - 4. Drill covers for flat head countersunk screws.
 - 5. Make cover sections not to exceed 2.3 m² (25 square feet) in area and 90 kg (200 pounds) in weight.
 - 6. Fabricate trench cover sections not be over 900 mm (3 feet) long and if width of trench is more than 900 mm (3 feet) or over, equip one end of each section with an angle or "T" bar stiffener to support adjoining plate.
 - 7. Use two, 13 mm (1/2 inch) diameter steel bar flush drop handles for each cover section.
- D. Steel Frames:
 - 1. Form frame from structural steel angles as shown. Where not shown use 63 x 63 x 6 mm (2-1/2 x 2-1/2 x 1/4 inch) angles for frame openings over 1200 mm (4 feet) long and 50 x 50 x 6 mm (2 ix 2 x 1/4 inch) for frame openings less than 1200 mm (4 feet).
 - 2. Fabricate intermediate supporting members from steel "T's" or angles; located to support cover section edges.
 - 3. Where covers are required use steel border bars at frames so that top of cover will be flush with frame and finish floor.

2.7 GRATINGS

- A. Fabricate gratings to support live loads specified and a concentrated load as specified.
- B. Provide clearance at all sides to permit easy removal of grating.
- C. Make cutouts in gratings with 6 mm (1/4 inch) minimum to 25 mm (one inch) maximum clearance for penetrations or passage of pipes and ducts. Edge band cutouts.
- D. Fabricate in sections not to exceed 2.3 m² (25 square feet) in area and 90 kg (200 pounds) in weight.

- E. Fabricate sections of grating with end-banding bars.
- F. Fabricate angle frames and supports, including anchorage as shown.
 - 1. Fabricate intermediate supporting members from "T's" or angles.
 - 2. Locate intermediate supports to support grating section edges.
 - 3. Butt or miter, and weld angle frame at corners.
- G. Steel Bar Gratings:
 - 1. Fabricate grating using steel bars, frames, supports and other members shown in accordance with Metal Bar Grating Manual.
 - 2. Galvanize steel members after fabrication in accordance with ASTM A123, G-90 for exterior gratings, gratings in concrete floors, and interior grating where specified.
 - 3. Interior gratings: Prime paint unless specified galvanized.

2.8 SHELF ANGLES

- A. Fabricate from steel angles of size shown.
- B. Fabricate angles with horizontal slotted holes for 19 mm (3/4 inch) bolts spaced at not over 900 mm (3 feet) on centers and within 300 mm (12 inches) of ends unless otherwise specified.

2.9 RAILINGS

- A. In addition to the dead load design railing assembly to support live load specified.
- B. Fabrication General:
 - 1. Provide continuous welded joints, dressed smooth and flush.
 - 2. Standard flush fittings, designed to be welded, may be used.
 - 3. Exposed threads will not be approved.
 - 4. Form handrail brackets to size and design shown.
- C. Handrails:
 - 1. Close free ends of rail with flush metal caps welded in place except where flanges for securing to walls with bolts are shown.
 - 2. Make provisions for attaching handrail brackets to wall, posts, and handrail as shown.
- D. Steel Pipe Railings:
 - 1. Fabricate of steel pipe with welded joints.
 - 2. Number and space of rails as shown.
 - 3. Space posts for railings not over 1800 mm (6 feet) on centers between end posts.
 - 4. Opening Guard Rails:
 - a. Fabricate rails with flanged fitting at each end to fit between wall opening jambs.

- b. Design flange fittings for fastening with machine screws to steel plate anchored to jambs.
- c. Fabricate rails for floor openings for anchorage in sleeves.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Set work accurately, in alignment and where shown, plumb, level, free of rack and twist, and set parallel or perpendicular as required to line and plane of surface.
- B. Items set into concrete or masonry.
 - 1. Provide temporary bracing for such items until concrete or masonry is set.
 - 2. Place in accordance with setting drawings and instructions.
 - 3. Build strap anchors, into masonry as work progresses.
- C. Set frames of gratings, covers, and similar items flush with finish floor or wall surface and, where applicable, flush with side of opening.
- D. Field weld in accordance with AWS.
 - 1. Design and finish as specified for shop welding.
 - 2. Use continuous weld unless specified otherwise.
- E. Install anchoring devices and fasteners as shown and as necessary for securing metal fabrications to building construction as specified. Power actuated drive pins may be used except for removable items and where members would be deformed or substrate damaged by their use.
- F. Spot prime all abraded and damaged areas of zinc coating as specified and all abraded and damaged areas of shop prime coat with same kind of paint used for shop priming.

3.2 INSTALLATION OF SUPPORTS

- A. Anchorage to structure.
 - 1. Secure angles or channels and clips to overhead structural steel by continuous welding unless bolting is shown.
 - 2. Secure supports to concrete inserts by bolting or continuous welding as shown.
 - 3. Secure supports to mid height of concrete beams when inserts do not exist with expansion bolts and to slabs, with expansion bolts unless shown otherwise.
 - 4. Secure steel plate or hat channels to studs as detailed.

3.3 COVERS AND FRAMES FOR PITS AND TRENCHES

- A. Set frame and cover flush with finish floor.
- B. Secure plates to frame with flat head countersunk screws.

3.4 OTHER FRAMES

- A. Set frame flush with surface unless shown otherwise.
- B. Anchor frames at ends and not over 450 mm (18 inches) on centers unless shown otherwise.
- C. Set in formwork before concrete is placed.

3.5 GRATINGS

- A. Set grating flush with finish floor; top of curb, or areaway wall. Set frame so that horizontal leg of angle frame is flush with face of wall except when frame is installed on face of wall.
- B. Where grating terminates at a wall bolt frame to concrete or masonry with expansion bolts unless shown otherwise.
- C. Secure removable supporting members in place with stainless steel bolts.
- D. Bolt gratings to supports.

3.6 RAILINGS

- A. Steel Posts:
 - 1. Secure fixed posts to concrete with expansion bolts through flanged fittings except where sleeves are shown with pourable grout.
 - 2. Secure posts to steel with welds.
- B. Anchor to Walls:
 - 1. Anchor rails to concrete or solid masonry with machine screws through flanged fitting to steel plate.
 - a. Anchor steel plate to concrete or solid masonry with expansion bolts.
 - b. Anchor steel plate to hollow masonry with toggle bolts.
 - 2. Anchor flanged fitting with toggle bolt to steel support in frame walls.
- C. Handrails:
 - 1. Install brackets within 300 mm (12 inches) of return of walls, and at evenly spaced intermediate points not exceeding 1200 mm (4 feet) on centers unless shown otherwise.

3.7 STEEL COMPONENTS FOR MILLWORK ITEMS

Coordinate and deliver to Millwork fabricator for assembly where millwork items are secured to metal fabrications.

3.8 CLEAN AND ADJUSTING

- A. Adjust movable parts including hardware to operate as designed without binding or deformation of the members centered in the opening or frame and, where applicable, contact surfaces fit tight and even without forcing or warping the components.
- B. Clean after installation exposed prefinished and plated items and items fabricated from stainless steel, aluminum and copper alloys, as recommended by the metal manufacture and protected from damage until completion of the project.

- - - E N D - - -

SECTION 09 91 00
PAINTING
01-01-16

PART 1 - GENERAL

1.1 DESCRIPTION:

- A. Work of this Section includes all labor, materials, equipment, and services necessary to complete the painting and finishing as shown on the construction documents and/or specified herein, including, but not limited to, the following:
1. Prime coats which may be applied in shop under other sections.
 2. Prime painting unprimed surfaces to be painted under this Section.
 3. Painting items furnished with a prime coat of paint, including touching up of or repairing of abraded, damaged or rusted prime coats applied by others.
 4. Painting ferrous metal (except stainless steel) exposed to view.
 5. Painting galvanized ferrous metals exposed to view.
 6. Painting pipes, pipe coverings, conduit, ducts, insulation, hangers, supports and other mechanical and electrical items and equipment exposed to view.
 7. Painting surfaces above, behind or below grilles, gratings, diffusers, louvers lighting fixtures, and the like, which are exposed to view through these items.
 8. Painting includes shellacs, stains, varnishes, coatings specified, and striping or markers and identity markings.
 9. Incidental painting and touching up as required to produce proper finish for painted surfaces, including touching up of factory finished items.
 10. Painting of any surface not specifically mentioned to be painted herein or on construction documents, but for which painting is obviously necessary to complete the job, or work which comes within the intent of these specifications, is to be included as though specified.

1.2 RELATED WORK:

- A. Activity Hazard Analysis: Section 01 35 26, SAFETY REQUIREMENTS.
- B. Lead Paint Removal: Section 02 83 33.13, LEAD-BASED PAINT REMOVAL AND DISPOSAL.

C. Shop prime painting of steel and ferrous metals: Division 05 - METALS, Division 08 - OPENINGS; Division 10 - SPECIALTIES; Division 11 - EQUIPMENT; Division 12 - FURNISHINGS; Division 13 - SPECIAL CONSTRUCTION; Division 14 - CONVEYING EQUIPMENT; Division 21 - FIRE SUPPRESSION; Division 22 - PLUMBING; Division 23 - HEATING; VENTILATION AND AIR-CONDITIONING; Division 26 - ELECTRICAL; Division 27 - COMMUNICATIONS; and Division 28 - ELECTRONIC SAFETY AND SECURITY sections.

1.3 SUBMITTALS:

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Painter qualifications.
- C. Manufacturer's Literature and Data:
 - 1. Before work is started, or sample panels are prepared, submit manufacturer's literature and technical data, 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 (1) 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.
- D. Manufacturers' Certificates indicating compliance with specified requirements:
 - 1. Manufacturer's paint substituted for Federal Specification paints meets or exceeds performance of paint specified.
 - 2. High temperature aluminum paint.
 - 3. Epoxy coating.
 - 4. Intumescent clear coating or fire retardant paint.
 - 5. Plastic floor coating.

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. Specify Coat Types: Prime; body; finish; etc.

C. Maintain space for storage, and handling of painting materials and equipment in a ventilated, 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 7 and 30 degrees C (45 and 85 degrees F).

1.5 QUALITY ASSURANCE:

A. Qualification of Painters: Use only qualified journeyman painters for the mixing and application of paint on exposed surfaces. Submit evidence that key personnel have successfully performed surface preparation and application of coating on a minimum of three (3) similar projects within the past three (3) years.

B. Paint Coordination: Provide finish coats which are compatible with the prime paints used. Review other Sections of these specifications in which prime paints are to be provided to ensure compatibility of the total coatings system for the various substrates. Upon request from other subcontractors, furnish information on the characteristics of the finish materials proposed to be used, to ensure that compatible prime coats are used. Provide barrier coats over incompatible primers or remove and re-prime as required. Notify the Contracting Officer Representative (COR) in writing of any anticipated problems using the coating systems as specified with substrates primed by others.

1.6 REGULATORY REQUIREMENTS:

A. Paint materials are to conform to the restrictions of the local Environmental and Toxic Control jurisdiction.

1. Volatile Organic Compounds (VOC) Emissions Requirements: Field-applied paints and coatings that are inside the waterproofing system to not exceed limits of authorities having jurisdiction.

2. Lead-Based 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, and Department of Housing and Urban Development.
 - c. Do not use coatings having a lead content over 0.06 percent by weight of non-volatile content.
 - d. For lead-paint removal, see Section 02 83 33.13, LEAD-BASED PAINT REMOVAL AND DISPOSAL.
- 3. Asbestos: Provide materials that do not contain asbestos.
 - 4. Chromate, Cadmium, Mercury, and Silica: Provide materials that do not contain zinc-chromate, strontium-chromate, Cadmium, mercury or mercury compounds or free crystalline silica.
 - 5. Human Carcinogens: Provide materials that do 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.

1.7 SAFETY AND HEALTH

- A. Apply paint materials using safety methods and equipment in accordance with the following:
 - 1. Comply with applicable Federal, State, and local laws and regulations, and with the ACCIDENT PREVENTION PLAN, including the Activity Hazard Analysis (AHA) as specified in Section 01 35 26, SAFETY REQUIREMENTS. The AHA is to include analyses of the potential impact of painting operations on painting personnel and on others involved in and adjacent to the work zone.
- B. Safety Methods Used During Paint Application: Comply with the requirements of SSPC PA Guide 10.
- C. Toxic Materials: To protect personnel from overexposure to toxic materials, conform to the most stringent guidance of:
 - 1. The applicable manufacturer's Material Safety Data Sheets (MSDS) or local regulation.
 - 2. 29 CFR 1910.1000.
 - 3. ACHIH-BKLT and ACGHI-DOC, threshold limit values.

1.8 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-2012.....Threshold Limit Values (TLV) for Chemical
Substances and Physical Agents and Biological
Exposure Indices (BEIs)

ACGIH TLV-DOC-2012.....Documentation of Threshold Limit Values and
Biological Exposure Indices, (Seventh Edition)

C. ASME International (ASME):

A13.1-07(R2013).....Scheme for the Identification of Piping Systems

D. Code of Federal Regulation (CFR):

40 CFR 59.....Determination of Volatile Matter Content, Water
Content, Density Volume Solids, and Weight Solids
of Surface Coating

E. Commercial Item Description (CID):

A-A-1272A.....Plaster Gypsum (Spackling Compound)

F. Federal Specifications (Fed Spec):

TT-P-1411A.....Paint, Copolymer-Resin, Cementitious (For
Waterproofing Concrete and Masonry Walls) (CEP)

G. Master Painters Institute (MPI):

1.....Aluminum Paint
4.....Interior/ Exterior Latex Block Filler
5.....Exterior Alkyd Wood Primer
7.....Exterior Oil Wood Primer
8.....Exterior Alkyd, Flat MPI Gloss Level 1
9.....Exterior Alkyd Enamel MPI Gloss Level 6
10.....Exterior Latex, Flat
11.....Exterior Latex, Semi-Gloss
18.....Organic Zinc Rich Primer
22.....Aluminum Paint, High Heat (up to 590° - 1100F)
27.....Exterior / Interior Alkyd Floor Enamel, Gloss
31.....Polyurethane, Moisture Cured, Clear Gloss
36.....Knot Sealer
43.....Interior Satin Latex, MPI Gloss Level 4
44.....Interior Low Sheen Latex, MPI Gloss Level 2
45.....Interior Primer Sealer
46.....Interior Enamel Undercoat
47.....Interior Alkyd, Semi-Gloss, MPI Gloss Level 5
48.....Interior Alkyd, Gloss, MPI Gloss Level 6

- 50.....Interior Latex Primer Sealer
- 51.....Interior Alkyd, Eggshell, MPI Gloss Level 3
- 52.....Interior Latex, MPI Gloss Level 3
- 53.....Interior Latex, Flat, MPI Gloss Level 1
- 54.....Interior Latex, Semi-Gloss, MPI Gloss Level 5
- 59.....Interior/Exterior Alkyd Porch & Floor Enamel, Low
Gloss
- 60.....Interior/Exterior Latex Porch & Floor Paint, Low
Gloss
- 66.....Interior Alkyd Fire Retardant, Clear Top-Coat (ULC
Approved)
- 67.....Interior Latex Fire Retardant, Top-Coat (ULC
Approved)
- 68.....Interior/ Exterior Latex Porch & Floor Paint,
Gloss
- 71.....Polyurethane, Moisture Cured, Clear, Flat
- 77.....Epoxy Cold Cured, Gloss
- 79.....Marine Alkyd Metal Primer
- 90.....Interior Wood Stain, Semi-Transparent
- 91.....Wood Filler Paste
- 94.....Exterior Alkyd, Semi-Gloss
- 95.....Fast Drying Metal Primer
- 98.....High Build Epoxy Coating
- 101.....Epoxy Anti-Corrosive Metal Primer
- 108.....High Build Epoxy Coating, Low Gloss
- 114.....Interior Latex, Gloss
- 119.....Exterior Latex, High Gloss (acrylic)
- 134.....Galvanized Water Based Primer
- 135.....Non-Cementitious Galvanized Primer
- 138.....Interior High Performance Latex, MPI Gloss Level 2
- 139.....Interior High Performance Latex, MPI Gloss Level 3
- 140.....Interior High Performance Latex, MPI Gloss Level 4
- 141.....Interior High Performance Latex (SG) MPI Gloss
Level 5
- 163.....Exterior Water Based Semi-Gloss Light Industrial
Coating, MPI Gloss Level 5

H. Society for Protective Coatings (SSPC):

SSPC SP 1-82(R2004).....Solvent Cleaning

SSPC SP 2-82(R2004).....Hand Tool Cleaning

SSPC SP 3-28(R2004).....Power Tool Cleaning

SSPC SP 10/NACE No.2.....Near-White Blast Cleaning

SSPC PA Guide 10.....Guide to Safety and Health Requirements

I. Maple Flooring Manufacturer's Association (MFMA):

J. U.S. National Archives and Records Administration (NARA):

29 CFR 1910.1000.....Air Contaminants

K. Underwriter's Laboratory (UL)

PART 2 - PRODUCTS

2.1 MATERIALS:

- A. Conform to the coating specifications and standards referenced in PART 3. Submit manufacturer's technical data sheets for specified coatings and solvents.

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.
- C. Provide undercoat paint produced by the same manufacturer as the finish coats. Use only thinners approved by the paint manufacturer, and use only to recommended limits.
- D. VOC Content: For field applications that are inside the weatherproofing system, paints and coating to comply with VOC content limits of authorities having jurisdiction and the following VOC content limits:
1. Flat Paints and Coatings: 50 g/L.
 2. Non-flat Paints and Coatings: 150 g/L.
 3. Anticorrosive and Antirust Paints applied to Ferrous Metals: 250 g/L.
 4. Zinc-Rich Industrial Maintenance Primers: 340 g/L.
- E. VOC test method for paints and coatings is to be in accordance with 40 CFR 59 (EPA Method 24). Part 60, Appendix A with the exempt compounds' content determined by Method 303 (Determination of Exempt Compounds) in the South Coast Air Quality Management District's (SCAQMD) "Laboratory Methods of Analysis for Enforcement Samples" manual.

2.3 PLASTIC TAPE:

- A. Pigmented vinyl plastic film in colors as specified.
- B. Pressure sensitive adhesive back.
- C. Widths as shown on construction documents.

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 COR and the product manufacturer. Under no circumstances are application conditions to exceed manufacturer recommendations.
 - c. When the relative humidity exceeds 85 percent; or to damp or wet surfaces; unless otherwise permitted by the paint manufacturer's printed instructions.
 - 2. Maintain interior temperatures until paint dries hard.
 - 3. Do no exterior painting when it is windy and dusty.
 - 4. Do not paint in direct sunlight or on surfaces that the sun will warm.
 - 5. Apply only on clean, dry and frost free surfaces except as follows:
 - a. Apply water thinned acrylic and cementitious paints to damp (not wet) surfaces only when allowed by manufacturer's printed instructions.
 - b. Concrete and masonry when permitted by manufacturer's recommendations, dampen surfaces to which water thinned acrylic and cementitious paints are applied with a fine mist of water on hot dry days to prevent excessive suction and to cool surface.

6. Varnishing:

- a. Apply in clean areas and in still air.
- b. Before varnishing vacuum and dust area.
- c. Immediately before varnishing wipe down surfaces with a tack rag.

3.2 INSPECTION:

- A. Examine the areas and conditions where painting and finishing are to be applied and correct any conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions are corrected to permit proper installation of the work.

3.3 GENERAL WORKMANSHIP REQUIREMENTS:

- A. Application may be by brush or roller. Spray application only upon acceptance from the COR in writing.
- B. Furnish to the COR a painting schedule indicating when the respective coats of paint for the various areas and surfaces will be completed. This schedule is to be kept current as the job progresses.
- C. Protect work at all times. Protect all adjacent work and materials by suitable covering or other method during progress of work. Upon completion of the work, remove all paint and varnish spots from floors, glass and other surfaces. Remove from the premises all rubbish and accumulated materials of whatever nature not caused by others and leave work in a clean condition.
- D. Remove and protect hardware, accessories, device plates, lighting fixtures, and factory finished work, and similar items, or provide in place protection. Upon completion of each space, carefully replace all removed items by workmen skilled in the trades involved.
- E. When indicated to be painted, remove electrical panel box covers and doors before painting walls. Paint separately and re-install after all paint is dry.
- F. Materials are to be applied under adequate illumination, evenly spread and flowed on smoothly to avoid runs, sags, holidays, brush marks, air bubbles and excessive roller stipple.
- G. Apply materials with a coverage to hide substrate completely. When color, stain, dirt or undercoats show through final coat of paint, the surface is to be covered by additional coats until the paint film is of uniform finish, color, appearance and coverage, at no additional cost to the Government.

- H. All coats are to be dry to manufacturer's recommendations before applying succeeding coats.

3.4 SURFACE PREPARATION:

A. General:

1. The Contractor shall be held wholly responsible for the finished appearance and satisfactory completion of painting work. Properly prepare all surfaces to receive paint, which includes cleaning, sanding, and touching-up of all prime coats applied under other Sections of the work. Broom clean all spaces before painting is started. All surfaces to be painted or finished are to be completely dry, clean and smooth.
2. See other sections of specifications for specified surface conditions and prime coat.
3. Perform preparation and cleaning procedures in strict accordance with the paint manufacturer's instructions and as herein specified, for each particular substrate condition.
4. Clean surfaces before applying paint or surface treatments 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. Schedule the cleaning and painting so that dust and other contaminants from the cleaning process will not fall in wet, newly painted surfaces.
5. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:
 - a. Concrete: 12 percent.
 - b. Fiber-Cement Board: 12 percent.
 - c. Masonry (Clay and CMU's): 12 percent.

B. Ferrous Metals:

1. Remove oil, grease, soil, drawing and cutting compounds, flux and other detrimental foreign matter in accordance with SSPC-SP 1 (Solvent Cleaning).
2. Remove loose mill scale, rust, and paint, by hand or power tool cleaning, as defined in SSPC-SP 2 (Hand Tool Cleaning) and SSPC-SP 3 (Power Tool Cleaning).
3. Fill dents, holes and similar voids and depressions in flat exposed surfaces of hollow steel doors and frames, access panels, roll-up steel doors and similar items specified to have semi-gloss or gloss finish with TT-F-322D (Filler, Two-Component Type,

For Dents, Small Holes and Blow-Holes). Finish flush with adjacent surfaces.

- a. Fill flat head countersunk screws used for permanent anchors.
- b. Do not fill screws of item intended for removal such as glazing beads.

3. Spot prime abraded and damaged areas in shop prime coat which expose bare metal with same type of paint used for prime coat. Feather edge of spot prime to produce smooth finish coat.
4. Spot prime abraded and damaged areas which expose bare metal of factory finished items with paint as recommended by manufacturer of item.

C. Zinc-Coated (Galvanized) Metal Copper and Copper Alloys Surfaces Specified Painted:

1. Clean surfaces to remove grease, oil and other deterrents to paint adhesion in accordance with SSPC-SP 1 (Solvent Cleaning).
2. Spot coat abraded and damaged areas of zinc-coating which expose base metal on hot-dip zinc-coated items with MPI 18 (Organic Zinc Rich Coating). Prime or spot prime with MPI 134 (Waterborne Galvanized Primer) or MPI 135 (Non-Cementitious Galvanized Primer) depending on finish coat compatibility.

D. Masonry, Concrete, Cement Board, Cement Plaster and Stucco:

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. Neutralize Concrete floors to be painted by washing with a solution of 1.4 Kg (3 pounds) of zinc sulfate crystals to 3.8 L (1 gallon) of water, allow to dry three (3) days and brush thoroughly free of crystals.
5. Repair broken and spalled concrete edges with concrete patching compound to match adjacent surfaces as specified in Division 03, CONCRETE Sections. Remove projections to level of adjacent surface by grinding or similar methods.

3.5 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 (2) component and two (2) 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.

3.6 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 (3) coats; prime, body, and finish. When two (2) 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 COR.
- E. Apply by brush or roller. Spray application for new or existing occupied spaces only upon approval by acceptance from COR in writing.
 - 1. Apply painting materials specifically required by manufacturer to be applied by spraying.
 - 2. In new construction and in existing occupied spaces, where paint is applied by spray, mask or enclose with polyethylene, or similar air tight material with edges and seams continuously sealed including items specified in "Building and Structural Work Field Painting"; "Work not Painted"; motors, controls, telephone, and electrical equipment, fronts of sterilizes and other recessed equipment and similar prefinished items.
- F. Do not paint in closed position operable items such as access doors and panels, window sashes, overhead doors, and similar items except overhead roll-up doors and shutters.

3.7 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 except for exterior exposed steel apply an additional prime coat.
- D. Prime rabbets for stop and face glazing of wood, and for face glazing of steel.
 - 1. Apply two (2) coats of primer MPI 7 (Exterior Oil Wood Primer) or MPI 5 (Exterior Alkyd Wood Primer) or sealer MPI 45 (Interior Primer Sealer) or MPI 46 (Interior Enamel Undercoat) to surfaces of wood doors, including top and bottom edges, which are cut for fitting or for other reason.
 - 2. Apply one (1) coat of primer MPI 7 (Exterior Oil Wood Primer) or MPI 5 (Exterior Alkyd Wood Primer) or sealer MPI 45 (Interior Primer Sealer) or MPI 46 (Interior Enamel Undercoat) as soon as delivered to site to surfaces of unfinished woodwork, except concealed surfaces of shop fabricated or assembled millwork and surfaces specified to have varnish, stain or natural finish.
 - 3. Back prime and seal ends of exterior woodwork, and edges of exterior plywood specified to be finished.
 - 4. Apply MPI 67 (Interior Latex Fire Retardant, Top-Coat (UL Approved) to wood for fire retardant finish.
- E. Metals except boilers, incinerator stacks, and engine exhaust pipes:
 - 1. Steel and iron: MPI 79 (Marine Alkyd Metal Primer) or MPI 95 (Fast Drying Metal Primer). Use MPI 101 (Cold Curing Epoxy Primer) where finish is specified.
 - 2. Zinc-coated steel and iron: MPI 134 (Waterborne Galvanized Primer) or MPI 135 (Non-Cementitious Galvanized Primer) .
 - 3. Aluminum scheduled to be painted: MPI 95 (Fast Drying Metal Primer).
 - 4. Terne Metal: MPI 79 (Marine Alkyd Metal Primer) or MPI 95 (Fast Drying Metal Primer) .
 - 5. Copper and copper alloys scheduled to be painted: MPI 95 (Fast Drying Metal Primer).
 - 6. Machinery not factory finished: MPI 9 (Exterior Alkyd Enamel).

7. Metal over 94 degrees C (201 degrees F), Boilers, Incinerator Stacks, and Engine Exhaust Pipes: MPI 22 (High Heat Resistant Coating).

F. Gypsum Board :

1. MPI 10 (Exterior Latex, Flat finish: Use MPI 10 (Exterior Latex, Flat.

G. Concrete Masonry Units except glazed or integrally colored and decorative units:

1. MPI 4 (Block Filler) on interior surfaces.
2. Prime exterior surface as specified for exterior finishes.

H. Cement Plaster or stucco Concrete Masonry, Brick Masonry Interior Surfaces of Ceilings and Walls:

1. MPI 54 (Interior Latex, Semi-Gloss, MPI Gloss Level 5).
2. MPI 141 (Interior High Performance Latex, MPI Gloss Level 5).

I. Concrete Floors: MPI 99 (Water-based Acrylic Curing and Sealing Compound).

3.8 EXTERIOR FINISHES:

A. Wood:

1. Do not apply finish coats on surfaces concealed after installation, top and bottom edges of wood doors and sash, or on edges of wood framed insect screens.
2. Two (2) coats of MPI 10 Exterior Latex, Flat).

B. Steel and Ferrous Metal:

1. Two (2) coats of MPI 8 (Exterior Alkyd, Flat) on exposed surfaces, except on surfaces over 94 degrees C (201 degrees F).
2. One (1) coat of MPI 22 (High Heat Resistant Coating) on surfaces over 94 degrees K (290 degrees F) and on surfaces of boiler, incinerator, stacks engine exhaust pipes.

C. Machinery without factory finish except for primer: One (1) coat MPI 8 (Exterior Alkyd, Flat) MPI 9 (Exterior Alkyd Enamel) MPI 94 (Exterior Alkyd, Semi-Gloss).

D. Concrete Masonry Units Brick Cement Plaster Concrete:

1. General:

- a. Mix as specified in manufacturer's printed directions.
- b. Do not mix more paint than can be used within four (4) hours after mixing. Discard paint that has started to set.
- c. Dampen warm surfaces above 24 degrees C (75 degrees F) with fine mist of water before application of paint. Do not leave free water on surface.

- d. Cure paint with a fine mist of water as specified in manufacturer's printed instructions.
2. Use two (2) coats of TT-P-1411 (Paint, Co-polymer-Resin, Cementitious), unless specified otherwise.

3.9 INTERIOR FINISHES:

A. Metal Work:

1. Apply to exposed surfaces.
2. Omit body and finish coats on surfaces concealed after installation except electrical conduit containing conductors over 600 volts.
3. Ferrous Metal, Galvanized Metal, and Other Metals:
 - a. Apply two (2) coats of MPI 47 (Interior Alkyd, Semi-Gloss) unless specified otherwise.
 - b. Machinery: One (1) coat MPI 9 (Exterior Alkyd Enamel).
 - c. Ferrous Metal over 94 degrees K (290 degrees F): Boilers, Incinerator Stacks, and Engine Exhaust Pipes: One (1) coat MPI 22 (High Heat Resistant Coating).

B. Gypsum Board or Plaster:

1. One (1) coat of MPI 45 (Interior Primer Sealer) MPI 46 (Interior Enamel Undercoat) plus one (1) coat of MPI 139 (Interior High Performance Latex, MPI Gloss level 3).

C. Masonry and Concrete Walls:

1. Over MPI 4 (Interior/Exterior Latex Block Filler) on CMU surfaces.

D. Wood:

1. Sanding:
 - a. Use 220-grit sandpaper.
 - b. Sand sealers and varnish between coats.
 - c. Sand enough to scarify surface to assure good adhesion of subsequent coats, to level roughly applied sealer and varnish, and to knock off "whiskers" of any raised grain as well as dust particles.
2. Sealers:
 - a. MPI 31 (gloss) or MPI 71 (flat) thinned as recommended by manufacturer at rate of one (1) part of thinner to four (4) parts of varnish.
 - b. Apply sealers specified except sealer may be omitted where pigmented, penetrating, or wiping stains containing resins are used.
 - c. Allow manufacturer's recommended drying time before sanding, but not less than 24 hours or 36 hours in damp or muggy weather.
 - d. Sand as specified.

3. Paint Finish:

- a. One (1) coat of MPI 45 (Interior Primer Sealer) MPI 46 (Interior Enamel Undercoat) plus one (1) coat of MPI 47 (Interior Alkyd, Semi-Gloss).
- E. Cement Board: One (1) coat of MPI 141 (Interior High Performance Latex, MPI Gloss Level).
- F. Concrete Floors: One (1) coat of MPI 68 (Interior/ Exterior Latex Porch & Floor Paint, Gloss).
- G. Miscellaneous:
 - 1. MPI 1 (Aluminum Paint): Two (2) coats of aluminum paint.
 - 2. Existing acoustical units scheduled to be repainted except acoustical units with a vinyl finish:
 - a. Clean units free of dust, dirt, grease, and other deterrents to paint adhesion.

3.10 REFINISHING EXISTING PAINTED SURFACES:

- A. Clean, patch and repair existing surfaces as specified under "Surface Preparation". No "telegraphing" of lines, ridges, flakes, etc., through new surfacing is permitted. Where this occurs, sand smooth and re-finish until surface meets with COR's approval.
- B. Remove and reinstall items as specified under "General Workmanship Requirements".
- C. Remove existing finishes or apply separation coats to prevent non compatible coatings from having contact.
- D. Patched or Replaced Areas in Surfaces and Components: Apply spot prime and body coats as specified for new work to repaired areas or replaced components.
- E. Except where scheduled for complete painting apply finish coat over plane surface to nearest break in plane, such as corner, reveal, or frame.
- F. In existing rooms and areas where alterations occur, clean existing stained and natural finished wood retouch abraded surfaces and then give entire surface one (1) coat of MPI 31 (Polyurethane, Moisture Cured, Clear Gloss) MPI 71 (Polyurethane, Moisture Cured, Clear Flat)
- G. Refinish areas as specified for new work to match adjoining work unless specified or scheduled otherwise.
- H. Coat knots and pitch streaks showing through old finish with MPI 36 (Knot Sealer) before refinishing.
- I. Sand or dull glossy surfaces prior to painting.

- J. Sand existing coatings to a feather edge so that transition between new and existing finish will not show in finished work.

3.11 PAINT COLOR:

- A. For additional requirements regarding color see Articles, "REFINISHING EXISTING PAINTED SURFACE" and "MECHANICAL AND ELECTRICAL FIELD PAINTING SCHEDULE".
- 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.
 - 4. All new steel shall be painted black to match existing.
- C. Painting, Caulking, Closures, and Fillers Adjacent to Casework:
 - 1. Paint to match color of casework where casework has a paint finish.
 - 2. Paint to match color of wall where casework is stainless steel, plastic laminate, or varnished wood.

3.12 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 02 - EXISTING CONDITIONS, Division 21 - FIRE SUPPRESSION, Division 22 - PLUMBING, Division 23 - HEATING, VENTILATION AND AIR-CONDITIONING, Division 26 - ELECTRICAL, Division 27 - COMMUNICATIONS, and Division 28 - ELECTRONIC SAFETY AND SECURITY.
- C. Paint after tests have been completed.
- D. Omit prime coat from factory prime-coated items.
- E. Finish painting of mechanical and electrical equipment is not required when located in interstitial spaces, above suspended ceilings, in concealed areas such as pipe and electric closets, pipe basements, pipe tunnels, trenches, attics, roof spaces, shafts and furred spaces except on electrical conduit containing feeders 600 volts or more.
- F. Omit field painting of items specified in "BUILDING AND STRUCTURAL WORK FIELD PAINTING"; "Building and Structural Work not Painted".
- G. Color:
 - a. White: Exterior unfinished surfaces of enameled plumbing fixtures. Insulation coverings on breeching and uptake inside boiler house,

drums and drum-heads, oil heaters, condensate tanks and condensate piping.

- b. Gray: Heating, ventilating, air conditioning and refrigeration equipment (except as required to match surrounding surfaces), and water and sewage treatment equipment and sewage ejection equipment.
 - c. Aluminum Color: Ferrous metal on outside of boilers and in connection with boiler settings including supporting doors and door frames and fuel oil burning equipment, and steam generation system (bare piping, fittings, hangers, supports, valves, traps and miscellaneous iron work in contact with pipe).
 - d. Federal Safety Red: Exposed fire protection piping hydrants, post indicators, electrical conducts containing fire alarm control wiring, and fire alarm equipment.
 - e. Federal Safety Orange: Entire lengths of electrical conduits containing feeders 600 volts or more.
 - f. Color to match brickwork sheet metal covering on breeching outside of exterior wall of boiler house.
- I. Apply paint systems on properly prepared and primed surface as follows:
- 1. Exterior Locations:
 - a. Apply two (2) coats of MPI 8 (Exterior Alkyd, Flat) MPI 94 (Exterior Alkyd, Semi-gloss) MPI 9 (Exterior Alkyd Enamel) to the following ferrous metal items:

Vent and exhaust pipes with temperatures under 94 degrees C (201 degrees F), roof drains, fire hydrants, post indicators, yard hydrants, exposed piping and similar items.
 - b. Apply two (2) coats of MPI 10 (Exterior Latex, Flat) MPI 11 (Exterior Latex, Semi-Gloss) MPI 119 (Exterior Latex, High Gloss (acrylic)) to galvanized and zinc-copper alloy metal.
 - c. Apply one (1) coat of MPI 22 (High Heat Resistant Coating), 650 degrees C (1200 degrees F) to incinerator stacks, boiler stacks, and engine generator exhaust.
 - 2. Interior Locations:
 - a. Apply two (2) coats of MPI 47 (Interior Alkyd, Semi-Gloss) to following items:
 - 1) Metal under 94 degrees C (201 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, cast-iron radiators, electric conduits and panel boards.
 - 3) Heating, ventilating, air conditioning, plumbing equipment, and machinery having shop prime coat and not factory finished.
 - c. Apply one (1) coat of MPI 50 (Interior Latex Primer Sealer) and one (1) coat of MPI 53 (Interior Latex, Flat, MPI Gloss Level 1) MPI 44 (Interior Low Sheen Latex) MPI 52 (Interior Latex, MPI Gloss Level 3) MPI 43 (Interior Satin Latex) MPI 54 (Interior Latex, Semi-Gloss, MPI Gloss Level 5) MPI 114 (Interior Latex, Gloss) on finish of insulation on boiler breeching and uptakes inside boiler house, drums, drumheads, oil heaters, feed water heaters, tanks and piping.
 - d. Apply two (2) coats of MPI 22 (High Heat Resistant Coating) to ferrous metal surface over 94 degrees K (290 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.
 - 2) Steam line flanges, bare pipe, fittings, valves, hangers and supports over 94 degrees K (290 degrees F).
 - 3) Engine generator exhaust piping and muffler.
 - e. Paint electrical conduits containing cables rated 600 volts or more using two (2) coats of MPI 9 (Exterior Alkyd Enamel) MPI 8 (Exterior Alkyd, Flat) MPI 94 (Exterior Alkyd, Semi-gloss) in the Federal Safety Orange color in exposed and concealed spaces full length of conduit.
3. Other exposed locations:
- a. Cloth jackets of insulation of ducts and pipes in connection with plumbing, air conditioning, ventilating refrigeration and heating systems: One (1) coat of MPI 50 (Interior Latex Primer Sealer) and one (1) coat of MPI 10 (Exterior Latex, Flat) MPI 11 (Exterior Latex Semi-Gloss MPI 119 (Exterior Latex, High Gloss (acrylic))).

3.13 BUILDING AND STRUCTURAL WORK FIELD PAINTING:

- A. Painting and finishing of interior and exterior work except as specified here-in-after.
 - 1. Painting of disturbed, damaged and repaired or patched surfaces when entire space is not scheduled for complete repainting or refinishing.
 - 2. Painting of ferrous metal and galvanized metal.
 - 3. Painting of wood with fire retardant paint exposed in attics, when used as mechanical equipment space (except shingles).
 - 4. Identity painting and safety painting.
- B. Building and Structural Work not Painted:
 - 1. Prefinished items:
 - a. Casework, doors, elevator entrances and cabs, metal panels, wall covering, and similar items specified factory finished under other sections.
 - b. Factory finished equipment and pre-engineered metal building components such as metal roof and wall panels.
 - 2. Finished surfaces:
 - a. Hardware except ferrous metal.
 - b. Anodized aluminum, stainless steel, chromium plating, copper, and brass, except as otherwise specified.
 - c. Signs, fixtures, and other similar items integrally finished.
 - 3. Concealed surfaces:
 - a. Inside dumbwaiter, elevator and duct shafts, interstitial spaces, pipe basements, crawl spaces, pipe tunnels, above ceilings, attics, except as otherwise specified.
 - b. Inside walls or other spaces behind access doors or panels.
 - c. Surfaces concealed behind permanently installed casework and equipment.
 - 4. Moving and operating parts:
 - a. Shafts, chains, gears, mechanical and electrical operators, linkages, and sprinkler heads, and sensing devices.
 - b. Tracks for overhead or coiling doors, shutters, and grilles.
 - 5. Labels:
 - a. Code required label, such as Underwriters Laboratories Inc., Intertek Testing Service or Factory Mutual Research Corporation.
 - b. Identification plates, instruction plates, performance rating, and nomenclature.

6. Galvanized metal:

- a. Exterior chain link fence and gates, corrugated metal areaways, and gratings.
- b. Gas Storage Racks.
- c. Except where specifically specified to be painted.

7. Metal safety treads and nosings.

8. Gaskets.

9. Concrete curbs, gutters, pavements, retaining walls, exterior exposed foundations walls and interior walls in pipe basements.

10. Face brick.

11. Structural steel encased in concrete, masonry, or other enclosure.

12. Structural steel to receive sprayed-on fire proofing.

13. Ceilings, walls, columns in interstitial spaces.

14. Ceilings, walls, and columns in pipe basements.

3.14 IDENTITY PAINTING SCHEDULE:

- A. Identify designated service in new buildings or projects with extensive remodeling in accordance with ASME A13.1, unless specified otherwise, on exposed piping, piping above removable ceilings, piping in accessible pipe spaces, interstitial spaces, and piping behind access panels. For existing spaces where work is minor match existing.

- 1. Legend may be identified using snap-on coil plastic markers or by paint 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 12.2 M (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 using black stencil paint.
- 5. Identify pipe contents with sufficient additional details such as temperature, pressure, and contents to identify possible hazard. Insert working pressure shown on construction documents 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 BACKGROUND	COLOR OF LETTERS	LEGEND ABBREVIATIONS
Blow-off		Green	White	Blow-off
Boiler Feedwater		Green	White	Blr Feed
High Pressure Steam		Green	White	H.P. 100
High Pressure Condensate				
Return		Green	White	H.P. Ret 100
Medium Pressure Steam		Green	White	M. P. Stm 60
Medium Pressure Condensate				
Return		Green	White	M.P. Ret 60
Low Pressure Steam		Green	White	L.P. Stm 5
Low Pressure Condensate				
Return		Green	White	L.P. Ret 5
Gravity Condensate Return		Green	White	Gravity Cond Ret
Pumped Condensate Return		Green	White	Pumped Cond Ret
Fuel Oil - Grade No 2 (Diesel Fuel included under Fuel Oil)		Brown	White	Fuel Oil-Grade No 2
Boiler Water Sampling		Green	White	Sample
Chemical Feed		Green	White	Chem Feed
Continuous Blow-Down		Green	White	Cont. B D
Pumped Condensate		Green	White	Pump Cond
Pump Recirculating		Green	White	Pump-Recirc.
Vent Line		Green	White	Vent
Fuel Gas		Yellow	Black	Gas

7. Electrical Conduits containing feeders over 600 volts, paint legends using 50 mm (2 inch) high black numbers and letters, showing the voltage class rating. Provide legends where conduits pass through walls and floors and at maximum 6096 mm (20 foot) intervals in between. Use labels with yellow background with black border and words Danger High Voltage Class, 15KV.

8. See Sections for methods of identification, legends, and abbreviations of the following:

- a. Regular compressed air lines: Section 22 15 00, GENERAL SERVICE COMPRESSED-AIR SYSTEMS.
- b. Conduits containing high voltage feeders over 600 volts:
 Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS.

B. Fire and Smoke Partitions:

1. Identify partitions above ceilings on both sides of partitions except within shafts in letters not less than 64 mm (2 1/2 inches) high.
2. Stenciled message: "SMOKE BARRIER" or, "FIRE BARRIER" as applicable.
3. Locate not more than 6096 mm (20 feet) on center on corridor sides of partitions, and with a least one (1) message per room on room side of partition.
4. Use semi-gloss paint of color that contrasts with color of substrate.

C. Identify columns in pipe basements and interstitial space:

1. Apply stenciled number and letters to correspond with grid numbering and lettering indicated on construction documents.
2. Paint numbers and letters 101 mm (4 inches) high, locate 45 mm (18 inches) below overhead structural slab.
3. Apply on four (4) sides of interior columns and on inside face only of exterior wall columns.
4. Color:
 - a. Use black on concrete columns.
 - b. Use white or contrasting color on steel columns.

3.15 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 22 05 11
COMMON WORK RESULTS FOR PLUMBING

PART 1 - GENERAL

1.1 DESCRIPTION

- A. The requirements of this Section shall apply to all sections of Division 22.
- B. Definitions:
 - 1. Exposed: Piping and equipment exposed to view in finished rooms.
- C. Abbreviations/Acronyms:
 - 1. ABS: Acrylonitrile Butadiene Styrene
 - 2. AC: Alternating Current
 - 3. ACR: Air Conditioning and Refrigeration
 - 4. AI: Analog Input
 - 5. AISI: American Iron and Steel Institute
 - 6. AO: Analog Output
 - 7. AWG: American Wire Gauge
 - 8. BACnet: Building Automation and Control Network
 - 9. BAg: Silver-Copper-Zinc Brazing Alloy
 - 10. BAS: Building Automation System
 - 11. BCuP: Silver-Copper-Phosphorus Brazing Alloy
 - 12. BSG: Borosilicate Glass Pipe
 - 13. CDA: Copper Development Association
 - 14. C: Celsius
 - 15. CLR: Color
 - 16. CO: Carbon Monoxide
 - 17. COR: Contracting Officer's Representative
 - 18. CPVC: Chlorinated Polyvinyl Chloride
 - 19. CR: Chloroprene
 - 20. CRS: Corrosion Resistant Steel
 - 21. CWP: Cold Working Pressure
 - 22. CxA: Commissioning Agent
 - 23. db(A): Decibels (A weighted)
 - 24. DDC: Direct Digital Control
 - 25. DI: Digital Input
 - 26. DISS: Diameter Index Safety System
 - 27. DO: Digital Output
 - 28. DVD: Digital Video Disc

- 29. DN: Diameter Nominal
- 30. DWV: Drainage, Waste and Vent
- 31. ECC: Engineering Control Center
- 32. EPDM: Ethylene Propylene Diene Monomer
- 33. EPT: Ethylene Propylene Terpolymer
- 34. ETO: Ethylene Oxide
- 35. F: Fahrenheit
- 36. FAR: Federal Acquisition Regulations
- 37. FD: Floor Drain
- 38. FED: Federal
- 39. FG: Fiberglass
- 40. FNPT: Female National Pipe Thread
- 41. FPM: Fluoroelastomer Polymer
- 42. GPM: Gallons Per Minute
- 43. HDPE: High Density Polyethylene
- 44. Hg: Mercury
- 45. HOA: Hands-Off-Automatic
- 46. HP: Horsepower
- 47. HVE: High Volume Evacuation
- 48. ID: Inside Diameter
- 49. IPS: Iron Pipe Size
- 50. Kg: Kilogram
- 51. kPa: Kilopascal
- 52. lb: Pound
- 53. L/s: Liters Per Second
- 54. L/min: Liters Per Minute
- 55. MAWP: Maximum Allowable Working Pressure
- 56. MAX: Maximum
- 57. MED: Medical
- 58. m: Meter
- 59. MFG: Manufacturer
- 60. mg: Milligram
- 61. mg/L: Milligrams per Liter
- 62. ml: Milliliter
- 63. mm: Millimeter
- 64. MIN: Minimum
- 65. NF: Oil Free Dry (Nitrogen)
- 66. NPTF: National Pipe Thread Female

- 67. NPS: Nominal Pipe Size
- 68. NPT: Nominal Pipe Thread
- 69. OD: Outside Diameter
- 70. OSD: Open Sight Drain
- 71. OS&Y: Outside Stem and Yoke
- 72. OXY: Oxygen
- 73. PBPU: Prefabricated Bedside Patient Units
- 74. PH: Power of Hydrogen
- 75. PLC: Programmable Logic Controllers
- 76. PP: Polypropylene
- 77. PPM: Parts per Million
- 78. PSIG: Pounds per Square Inch
- 79. PTFE: Polytetrafluoroethylene
- 80. PVC: Polyvinyl Chloride
- 81. PVDF: Polyvinylidene Fluoride
- 82. RAD: Radians
- 83. RO: Reverse Osmosis
- 84. RPM: Revolutions Per Minute
- 85. RTRP: Reinforced Thermosetting Resin Pipe
- 86. SCFM: Standard Cubic Feet Per Minute
- 87. SDI: Silt Density Index
- 88. SPEC: Specification
- 89. SPS: Sterile Processing Services
- 90. STD: Standard
- 91. SUS: Saybolt Universal Second
- 92. SWP: Steam Working Pressure
- 93. TEFC: Totally Enclosed Fan-Cooled
- 94. TFE: Tetrafluoroethylene
- 95. THHN: Thermoplastic High-Heat Resistant Nylon Coated Wire
- 96. THWN: Thermoplastic Heat & Water Resistant Nylon Coated Wire
- 97. T/P: Temperature and Pressure
- 98. USDA: U.S. Department of Agriculture
- 99. V: Volt
- 100. VAC: Vacuum
- 101. VA: Veterans Administration
- 102. VAMC: Veterans Administration Medical Center
- 103. VAC: Voltage in Alternating Current
- 104. WAGD: Waste Anesthesia Gas Disposal

105. WOG: Water, Oil, Gas

1.2 RELATED WORK

- A. Section 01 00 00, GENERAL REQUIREMENTS.
- B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- C. Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- D. Section 01 81 13, SUSTAINABLE CONSTRUCTION REQUIREMENTS.
- E. Section 01 91 00, GENERAL COMMISSIONING REQUIREMENTS.
- F. Section 05 50 00, METAL FABRICATIONS.
- G. Section 09 91 00, PAINTING.
- H. Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.
- I. Section 23 09 11, INSTRUMENTATION AND CONTROL FOR BOILER PLANT
- J. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.
- K. Section 26 05 19, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES.
- L. Section 26 29 11, MOTOR CONTROLLERS.

1.3 APPLICABLE PUBLICATIONS

- A. The publications listed below shall form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. American Society for Testing and Materials (ASTM):
 - A36/A36M-2012.....Standard Specification for Carbon Structural Steel
 - A575-96(R2013)e1.....Standard Specification for Steel Bars, Carbon, Merchant Quality, M-Grades
- C. International Code Council, (ICC):
 - IBC-2012.....International Building Code
 - IPC-2012.....International Plumbing Code
- D. Manufacturers Standardization Society (MSS) of the Valve and Fittings Industry, Inc:
 - SP-58-2009.....Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application and Installation
 - SP-69-2003.....Pipe Hangers and Supports - Selection and Application
- E. National Electrical Manufacturers Association (NEMA):
 - MG 1-2011.....Motors and Generators
- F. National Fire Protection Association (NFPA):
 - 51B-2014.....Standard for Fire Prevention During Welding, Cutting and Other Hot Work

70-2014.....National Electrical Code (NEC)

G. NSF International (NSF):

14-2012.....Plastic Piping System Components and Related
Materials

61-2012.....Drinking Water System Components - Health
Effects

372-2011.....Drinking Water System Components - Lead Content

1.4 SUBMITTALS

- A. Submittals, including number of required copies, shall be submitted in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- B. Information and material submitted under this section shall be marked "SUBMITTED UNDER SECTION 22 05 11, COMMON WORK RESULTS FOR PLUMBING", with applicable paragraph identification.
- C. Contractor shall make all necessary field measurements and investigations to assure that the equipment and assemblies will meet contract requirements and will fit the space available.
- D. If equipment is submitted which differs in arrangement from that shown, provide drawings that show the rearrangement of all associated systems. Approval will be given only if all features of the equipment and associated systems, including accessibility, are equivalent to that required by the contract.
- E. Prior to submitting shop drawings for approval, contractor shall certify in writing that manufacturers of all major items of equipment have each reviewed drawings and specifications, and have jointly coordinated and properly integrated their equipment and controls to provide a complete and efficient installation.
- F. Installing Contractor shall provide lists of previous installations for selected items of equipment. Contact persons who will serve as references, with telephone numbers and e-mail addresses shall be submitted with the references.
- G. Manufacturer's Literature and Data: Manufacturer's literature shall be submitted under the pertinent section rather than under this section.
 - 1. Electric motor data and variable speed drive data shall be submitted with the driven equipment.
 - 2. Equipment and materials identification.
 - 3. Firestopping materials.

4. Hangers, inserts, supports and bracing. Provide load calculations for variable spring and constant support hangers.
5. Wall, floor, and ceiling plates.
- H. 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.
- I. Coordination Drawings: Complete consolidated and coordinated layout drawings shall be submitted for all new systems, and for existing systems that are in the same areas. The drawings shall include plan views, elevations and sections of all systems and shall be on a scale of not less than 1:32 (3/8 inch equal to one foot). Clearly identify and dimension the proposed locations of the principal items of equipment. The drawings shall clearly show the proposed location and adequate clearance for all equipment, controls, piping, pumps, valves and other items. Equipment foundations shall not be installed until equipment or piping layout drawings have been approved. Detailed layout drawings shall be provided for all piping systems. In addition, details of the following shall be provided.
 1. Mechanical equipment rooms.
 2. Hangers, inserts, supports, and bracing.
 3. Pipe sleeves.
 4. Equipment penetrations of floors, walls, ceilings, or roofs.
- 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. Include complete list indicating all components of the systems with diagrams of the internal wiring for each item of equipment.
 2. Include listing of recommended replacement parts for keeping in stock supply, including sources of supply, for equipment shall be provided. The listing shall include belts for equipment: Belt manufacturer, model number, size and style, and distinguished whether of multiple belt sets.
- K. Completed System Readiness Checklist 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 22 08 00 COMMISSIONING OF PLUMBING SYSTEMS.

- L. Submit training plans, trainer qualifications and instructor qualifications in accordance with the requirements of Section 22 08 00 COMMISSIONING OF PLUMBING SYSTEMS.

1.5 QUALITY ASSURANCE

A. Products Criteria:

1. Standard Products: Material and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture, supply and servicing of the specified products for at least 5 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 5 years.
2. Equipment Service: There shall be permanent service organizations, authorized and trained by manufacturers of the equipment supplied, located within 160 km (100 miles) of the project. These organizations shall come to the site and provide acceptable service to restore operations within four hours of receipt of notification by phone, e-mail or fax in event of an emergency, such as the shut-down of equipment; or within 24 hours in a non-emergency. Names, mail and e-mail addresses and phone numbers of service organizations providing service under these conditions for (as applicable to the project): pumps, compressors, water heaters, critical instrumentation, computer workstation and programming shall be submitted for project record and inserted into the operations and maintenance manual.
3. All items furnished shall be free from defects that would adversely affect the performance, maintainability and appearance of individual components and overall assembly.
4. The products and execution of work specified in Division 22 shall conform to the referenced codes and standards as required by the specifications. Local codes and amendments enforced by the local code official shall be enforced, if required by local authorities such as the natural gas supplier. If the local codes are more stringent, then the local code shall apply. Any conflicts shall be brought to the attention of the Contracting Officers Representative (COR).

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.
 9. Bio-Based Materials: For products designated by the USDA's Bio-Preferred Program, provide products that meet or exceed USDA recommendations for bio-based content, so long as products meet all performance requirements in this specifications section. For more information regarding the product categories covered by the Bio-Preferred Program, visit <http://www.biopreferred.gov>.
- B. Manufacturer's Recommendations: Where installation procedures or any part thereof are required to be in accordance with the recommendations of the manufacturer of the material being installed, printed copies of these recommendations shall be furnished to the COR prior to installation. Installation of the item will not be allowed to proceed until the recommendations are received. Failure to furnish these recommendations can be cause for rejection of the material.
- C. Execution (Installation, Construction) Quality:
1. All items shall be applied and installed in accordance with manufacturer's written instructions. Conflicts between the manufacturer's instructions and the contract documents shall be referred to the COR for resolution. Printed copies or electronic files of manufacturer's installation instructions shall be provided to the COR at least 10 working days prior to commencing installation of any item.
 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, and control devices. Prior to commencing installation work, refer conflicts between this requirement and contract documents to COR for resolution.
3. Complete layout drawings shall be required by Paragraph, SUBMITTALS. Construction work shall not start on any system until the layout drawings have been approved by VA.
 4. Installer Qualifications: Installer shall be licensed and shall provide evidence of the successful completion of at least five projects of equal or greater size and complexity. Provide tradesmen skilled in the appropriate trade.
 5. If an installation is unsatisfactory to the COR, the Contractor shall correct the installation at no additional cost or additional time to the Government.
- D. Guaranty: Warranty of Construction, FAR clause 52.246-21.
- E. Plumbing Systems: IPC, International Plumbing Code. Unless otherwise required herein, perform plumbing work in accordance with the latest version of the IPC. For IPC codes referenced in the contract documents, advisory provisions shall be considered mandatory, the word "should" shall be interpreted as "shall". Reference to the "code official" or "owner" shall be interpreted to mean the COR.
- F. Cleanliness of Piping and Equipment Systems:
1. Care shall be exercised in the storage and handling of equipment and piping material to be incorporated in the work. Debris arising from cutting, threading and welding of piping shall be removed.
 2. Piping systems shall be flushed, blown or pigged as necessary to deliver clean systems.
 3. The interior of all tanks shall be cleaned prior to delivery and beneficial use by the Government. All piping shall be tested in accordance with the specifications and the International Plumbing Code (IPC). All filters, strainers, fixture faucets shall be flushed of debris prior to final acceptance.
 4. Contractor shall be fully responsible for all costs, damage, and delay arising from failure to provide clean systems.

1.6 DELIVERY, STORAGE AND HANDLING

A. Protection of Equipment:

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

1.7 AS-BUILT DOCUMENTATION

- A. Submit manufacturer's literature and data updated to include submittal review comments and any equipment substitutions.
- B. Submit operation and maintenance data updated to include submittal review comments, substitutions and construction revisions shall be inserted into a three ring binder. All aspects of system operation and maintenance procedures, including piping isometrics, wiring diagrams of all circuits, a written description of system design, control logic, and sequence of operation shall be included in the operation and maintenance manual. The operations and maintenance manual shall include troubleshooting techniques and procedures for emergency situations. Notes on all special systems or devices such as damper and door closure interlocks shall be included. A List of recommended spare parts (manufacturer, model number, and quantity) shall be furnished. Information explaining any special knowledge or tools the owner will be required to employ shall be inserted into the As-Built documentation.
- C. The installing contractor shall maintain as-built drawings of each completed phase for verification; and, shall provide the complete set at the time of final systems certification testing. As-built drawings are to be provided, and a copy of them in latest Auto-Cad version provided on compact disk or DVD. Should the installing contractor engage the testing company to provide as-built or any portion thereof,

it shall not be deemed a conflict of interest or breach of the 'third party testing company' requirement.

- D. Certification documentation shall be provided prior to submitting the request for final inspection. The documentation shall include all test results, the names of individuals performing work for the testing agency on this project, detailed procedures followed for all tests, and a certification that all results of tests were within limits specified.

PART 2 - PRODUCTS

2.1 MATERIALS FOR VARIOUS SERVICES

- A. Non-pressure PVC pipe shall contain a minimum of 25 percent recycled content. Steel pipe shall contain a minimum of 25 percent recycled content.
- B. Plastic pipe, fittings and solvent cement shall meet NSF 14 and shall bear the NSF seal "NSF-PW". Solder or flux containing lead shall not be used with copper pipe.
- C. Material or equipment containing a weighted average of greater than 0.25 percent lead shall not be used in any potable water system intended for human consumption, and shall be certified in accordance with NSF 61 or NSF 372.
- D. In-line devices such as water meters, building valves, check valves, stops, valves, fittings, tanks and backflow preventers shall comply with NSF 61 and NSF 372.

2.2 FACTORY-ASSEMBLED PRODUCTS

- A. Standardization of components shall be maximized to reduce spare part requirements.
- B. Manufacturers of equipment assemblies that include components made by others shall assume complete responsibility for final assembled unit.
1. All components of an assembled unit need not be products of same manufacturer.
 2. Constituent parts that are alike shall be products of a single manufacturer.
 3. Components shall be compatible with each other and with the total assembly for intended service.
 4. Contractor shall guarantee performance of assemblies of components, and shall repair or replace elements of the assemblies as required to deliver specified performance of the complete assembly at no additional cost or time to the Government.

- C. Components of equipment shall bear manufacturer's name and trademark, model number, serial number and performance data on a name plate securely affixed in a conspicuous place, or cast integral with, stamped or otherwise permanently marked upon the components of the equipment.
- D. Major items of equipment, which serve the same function, shall be the same make and model.

2.3 COMPATIBILITY OF RELATED EQUIPMENT

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

2.4 SAFETY GUARDS

- A. Pump shafts and couplings shall be fully guarded by a sheet steel guard, covering coupling and shaft but not bearings. Material shall be minimum 16-gage sheet steel; ends shall be braked and drilled and attached to pump base with minimum of four 8 mm (1/4 inch) bolts. Reinforce guard as necessary to prevent side play forcing guard onto couplings.
- B. All Equipment shall have moving parts protected from personal injury.

2.5 LIFTING ATTACHMENTS

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

2.6 ELECTRIC MOTORS, MOTOR CONTROL, CONTROL WIRING

- A. All material and equipment furnished and installation methods used shall conform to the requirements of Section 22 05 12, GENERAL MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT; Section 26 29 11, MOTOR CONTROLLERS; and, Section 26 05 19, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES. All electrical wiring, conduit, and devices necessary for the proper connection, protection and operation of the systems shall be provided. Premium efficient motors shall be provided. Unless otherwise specified for a particular application, electric motors shall have the following requirements.

B. Special Requirements:

1. 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 cost or time to the Government.
2. Assemblies of motors, starters, and 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. Shielded conductors or wiring in separate conduits for all instrumentation and control systems shall be provided where recommended by manufacturer of equipment.
4. Motor sizes shall be selected 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.

C. Motor Efficiency and Power Factor: All motors, when specified as "high efficiency or Premium Efficiency" by the project specifications on driven equipment, shall conform to efficiency and power factor requirements in Section 22 05 12, GENERAL MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT, with no consideration of annual service hours. Motor manufacturers generally define these efficiency requirements as "NEMA premium efficient" and the requirements generally exceed those of the Energy Policy Act (EPACT), revised 2005. Motors not specified as "high efficiency or premium efficient" shall comply with EPACT.

- D. Single-phase Motors: Capacitor-start type for hard starting applications. Motors for centrifugal pumps may be split phase or permanent split capacitor (PSC).
- E. Poly-phase Motors: NEMA Design B, Squirrel cage, induction type. Each two-speed motor shall have two separate windings. A time delay (20 seconds minimum) relay shall be provided for switching from high to low speed.
- F. Rating: Rating shall be continuous duty at 100 percent capacity in an ambient temperature of 40° C (104° F); minimum horsepower as shown on drawings; maximum horsepower in normal operation shall not exceed nameplate rating without service factor.

- G. Insulation Resistance: Not less than one-half meg-ohm between stator conductors and frame shall be measured at the time of final inspection.

2.7 EQUIPMENT AND MATERIALS IDENTIFICATION

- A. Use symbols, nomenclature and equipment numbers specified, shown on the drawings, or shown in the maintenance manuals. Coordinate equipment and valve identification with local VAMC shops. 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 7 mm (3/16 inch) high of brass with black-filled letters, or rigid black plastic with white letters specified in Section 09 91 00, PAINTING shall be permanently fastened to the equipment. Unit components such as water heaters, tanks, coils, filters, etc. shall be identified.
- C. Control Items: All temperature, pressure, and controllers shall be labeled and the component's function identified. Identify and label each item as they appear on the control diagrams.
- D. Valve Tags and Lists:
1. Plumbing: All valves shall be provided with valve tags and listed on a valve list (Fixture stops not included).
 2. Valve tags: Engraved black filled numbers and letters not less than 15 mm (1/2 inch) high for number designation, and not less than 8 mm (1/4 inch) for service designation on 19 gage, 40 mm (1-1/2 inches) round brass disc, attached with brass "S" hook or brass chain.
 3. Valve lists: Valve lists shall be created using a word processing program and printed on plastic coated cards. The plastic coated valve list card(s), sized 215 mm (8-1/2 inches) by 275 mm (11 inches) shall show valve tag number, valve function and area of control for each service or system. The valve list shall be in a punched 3-ring binder notebook. An additional copy of the valve list shall be mounted in picture frames for mounting to a wall. COR shall instruct contractor where frames shall be mounted.

2.8 PIPE AND EQUIPMENT SUPPORTS AND RESTRAINTS

- A. In lieu of the paragraph which follows, suspended equipment support and restraints may be designed and installed in accordance with the International Building Code (IBC), Submittals based on the International Building Code (IBC) requirements, or the following paragraphs of this Section shall be stamped and signed by a professional engineer registered in the state where the project is located. The Support system of suspended equipment over 227 kg (500 pounds) shall be submitted for approval of the COR in all cases. See the above specifications for lateral force design requirements.
- B. Type Numbers Specified: For materials, design, manufacture, selection, application, and installation refer to MSS SP-58. For selection and application refer to MSS SP-69. Refer to Section 05 50 00, METAL FABRICATIONS, for miscellaneous metal support materials and prime coat painting.
- C. For Attachment to Concrete Construction:
1. Concrete insert: Type 18, MSS SP-58.
 2. Self-drilling expansion shields and machine bolt expansion anchors: Permitted in concrete not less than 100 mm (4 inches) thick when approved by the COR for each job condition.
 3. Power-driven fasteners: Permitted in existing concrete or masonry not less than 100 mm (4 inches) thick when approved by the COR for each job condition.
- D. For Attachment to Steel Construction: MSS SP-58.
1. Welded attachment: Type 22.
 2. Beam clamps: Types 20, 21, 28 or 29. Type 23 C-clamp may be used for individual copper tubing up to 23 mm (7/8 inch) outside diameter.
- E. Hanger Rods: Hot-rolled steel, ASTM A36/A36M or ASTM 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 40 mm (1-1/2 inches) minimum of adjustment and incorporate locknuts. All-thread rods are acceptable.
- F. Multiple (Trapeze) Hangers: Galvanized, cold formed, lipped steel channel horizontal member, not less than 43 mm by 43 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.
1. Allowable hanger load: Manufacturers rating less 91kg (200 pounds).

2. Guide individual pipes on the horizontal member of every other trapeze hanger with 8 mm (1/4 inch) U-bolt fabricated from steel rod. Provide Type 40 insulation shield, secured by two 15 mm (1/2 inch) galvanized steel bands, or insulated calcium silicate shield for insulated piping at each hanger.

G. Pipe Hangers and Supports: (MSS SP-58), use hangers sized to encircle insulation on insulated piping. Refer to Section 22 07 11, PLUMBING INSULATION for insulation thickness. To protect insulation, provide Type 39 saddles for roller type supports or insulated calcium silicate shields. Provide Type 40 insulation shield or insulated calcium silicate shield at all other types of supports and hangers including those for insulated piping.

1. General Types (MSS SP-58):

- a. Standard clevis hanger: Type 1; provide locknut.
- b. Riser clamps: Type 8.
- c. Wall brackets: Types 31, 32 or 33.
- d. Roller supports: Type 41, 43, 44 and 46.
- e. Saddle support: Type 36, 37 or 38.
- f. Turnbuckle: Types 13 or 15.
- g. U-bolt clamp: Type 24.
- h. Copper Tube:
 - 1) Hangers, clamps and other support material in contact with tubing shall be painted with copper colored epoxy paint, copper-coated, plastic coated or taped with isolation tape to prevent electrolysis.
 - 2) For vertical runs use epoxy painted, copper-coated 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.
- j. Spring hangers are required on all plumbing system pumps one horsepower and greater.

2. Plumbing Piping (Other Than General Types):

- a. Horizontal piping: Type 1, 5, 7, 9, and 10.
- b. Blocking, stays and bracing: Angle iron or preformed metal channel shapes, 1.3 mm (18 gage) minimum.

2.9 TOOLS AND LUBRICANTS

- A. Furnish, and turn over to the COR, special tools not readily available commercially, that are required for disassembly or adjustment of equipment and machinery furnished.
- B. Grease Guns with Attachments for Applicable Fittings: One for each type of grease required for each motor or other equipment.
- C. Tool Containers: metal, permanently identified for intended service and mounted, or located, where directed by the COR.
- D. Lubricants: A minimum of 0.95 L (1 quart) of oil, and 0.45 kg (1 pound) of grease, of equipment manufacturer's recommended grade and type, in unopened containers and properly identified as to use for each different application. Bio-based materials shall be utilized when possible.

2.10 ASBESTOS

- A. Materials containing asbestos are not permitted.

PART 3 - EXECUTION

3.1 ARRANGEMENT AND INSTALLATION OF EQUIPMENT AND PIPING

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

- E. Location of pipe sleeves, trenches and chases shall be accurately coordinated with equipment and piping locations.
- F. Minor Piping: Generally, small diameter pipe runs from drips and drains, water cooling, and other services are not shown but must be provided.
- G. 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 COR. Damaged or defective items in the opinion of the COR, shall be replaced at no additional cost or time to the Government.
 - 2. Protect all finished parts of equipment, such as shafts and bearings where accessible, from rust prior to operation by means of protective grease coating and wrapping. Close pipe openings with caps or plugs during installation. Pipe openings, equipment, and plumbing fixtures shall be tightly covered against dirt or mechanical injury. At completion of all work thoroughly clean fixtures, exposed materials and equipment.
- H. Concrete and Grout: Concrete and shrink compensating grout 25 MPa (3000 psig) minimum, specified in Section 03 30 00, CAST-IN-PLACE CONCRETE, shall be used for all pad or floor mounted equipment.
- I. Gages, thermometers, valves and other devices shall be installed with due regard for ease in reading or operating and maintaining said devices. Thermometers and gages shall be located and positioned to be easily read by operator or staff standing on floor or walkway provided. Servicing shall not require dismantling adjacent equipment or pipe work.
- J. Interconnection of Controls and Instruments: Electrical interconnection is generally not shown but shall be provided. This includes interconnections of sensors, transmitters, transducers, control devices, control and instrumentation panels, alarms, instruments and computer workstations. Comply with NFPA 70.
- K. Many plumbing systems interface with the HVAC control system. See the HVAC control points list and Section 23 09 11, Instrumentation and Control for Boiler Plant.

L. Work in Existing Building:

1. Perform as specified in Article, OPERATIONS AND STORAGE AREAS, Article, ALTERATIONS, and Article, RESTORATION of the Section 01 00 00, GENERAL REQUIREMENTS for relocation of existing equipment, alterations and restoration of existing building(s).
2. As specified in Section 01 00 00, GENERAL REQUIREMENTS, Article, OPERATIONS AND STORAGE AREAS, make alterations to existing service piping at times that will cause the least interfere with normal operation of the facility.

M. 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 or additional time to the Government.
2. The term "conveniently accessible" is defined as capable of being reached without the use of ladders, or without climbing or crawling under or over obstacles such as electrical conduit, motors, fans, pumps, belt guards, transformers, high voltage lines, piping, and ductwork.

3.2 TEMPORARY PIPING AND EQUIPMENT

- A. Continuity of operation of existing facilities may require temporary installation or relocation of equipment and piping. Temporary equipment or pipe installation or relocation shall be provided to maintain continuity of operation of existing facilities.
- B. The Contractor shall provide all required facilities in accordance with the requirements of phased construction and maintenance of service. All piping and equipment shall be properly supported, sloped to drain, operate without excessive stress, and shall be insulated where injury can occur to personnel by contact with operating facilities. The requirements of paragraph 3.1 shall apply.
- C. Temporary facilities and piping shall be completely removed back to the nearest active distribution branch or main pipe line and any openings in structures sealed. Dead legs are not allowed in potable water systems. Necessary blind flanges and caps shall be provided to seal open piping remaining in service.

3.3 RIGGING

- A. Openings in building structures shall be planned to accommodate design scheme.
- B. Alternative methods of equipment delivery may be offered and will be considered by Government under specified restrictions of phasing and service requirements as well as structural integrity of the building.
- C. All openings in the building shall be closed when not required for rigging operations to maintain proper environment in the facility for Government operation and maintenance of service.
- D. Contractor shall provide all facilities required to deliver specified equipment and place on foundations. Attachments to structures for rigging purposes and support of equipment on structures shall be Contractor's full responsibility.
- E. Contractor shall check all clearances, weight limitations and shall provide a rigging plan designed by a Registered Professional Engineer. All modifications to structures, including reinforcement thereof, shall be at Contractor's cost, time and responsibility.
- F. Rigging plan and methods shall be referred to COR for evaluation prior to actual work.

3.4 PIPE AND EQUIPMENT SUPPORTS

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

2. Provide steel structural members, in addition to those shown, of adequate capability to support the imposed loads, located in accordance with the final approved layout of equipment and piping.
3. Tubing and capillary systems shall be supported in channel troughs.

F. Floor Supports:

1. Provide concrete bases, concrete anchor blocks and pedestals, and structural steel systems for support of equipment and piping. Concrete bases and structural systems shall be anchored and doweled to resist forces under operating and seismic conditions (if applicable) without excessive displacement or structural failure.
2. Bases and supports shall not be located and installed until equipment mounted thereon has been approved. Bases shall be sized to match equipment mounted thereon plus 50 mm (2 inch) excess on all edges. Structural drawings shall be reviewed for additional requirements. Bases shall be neatly finished and smoothed, shall have chamfered edges at the top, and shall be suitable for painting.
3. All equipment shall be shimmed, leveled, firmly anchored, and grouted with epoxy grout. Anchor bolts shall be placed in sleeves, anchored to the bases. Fill the annular space between sleeves and bolts with a grout material to permit alignment and realignment.

3.5 LUBRICATION

- A. All equipment and devices requiring lubrication shall be lubricated prior to initial operation. All devices and equipment shall be field checked for proper lubrication.
- B. All devices and equipment shall be equipped with required lubrication fittings. A minimum of one liter (one quart) of oil and 0.45 kg (1 pound) of grease of manufacturer's recommended grade and type for each different application shall be provided. All materials shall be delivered to COR in unopened containers that are properly identified as to application.
- C. A separate grease gun with attachments for applicable fittings shall be provided for each type of grease applied.
- D. All lubrication points shall be accessible without disassembling equipment, except to remove access plates.
- E. All lubrication points shall be extended to one side of the equipment.

3.6 PLUMBING SYSTEMS DEMOLITION

- A. Rigging access, other than indicated on the drawings, shall be provided after approval for structural integrity by the COR. Such access shall be provided without additional cost or time to the Government. Where work is in an operating plant, approved protection from dust and debris shall be provided at all times for the safety of plant personnel and maintenance of plant operation and environment of the plant.
- B. In an operating plant, cleanliness and safety shall be maintained. The plant shall be kept in an operating condition. Government personnel will be carrying on their normal duties of operating, cleaning and maintaining equipment and plant operation. Work shall be confined to the immediate area concerned; maintain cleanliness and wet down demolished materials to eliminate dust. Dust and debris shall not be permitted to accumulate in the area to the detriment of plant operation. All flame cutting shall be performed to maintain the fire safety integrity of this plant. Adequate fire extinguishing facilities shall be available at all times. All work shall be performed in accordance with recognized fire protection standards including NFPA 51B. Inspections will be made by personnel of the VA Medical Center, and the Contractor shall follow all directives of the COR with regard to rigging, safety, fire safety, and maintenance of operations.
- C. Unless specified otherwise, all piping, wiring, conduit, and other devices associated with the equipment not re-used in the new work shall be completely removed from Government property per Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT. This includes all concrete equipment pads, pipe, valves, fittings, insulation, and all hangers including the top connection and any fastenings to building structural systems. All openings shall be sealed after removal of equipment, pipes, ducts, and other penetrations in roof, walls, floors, in an approved manner and in accordance with plans and specifications where specifically covered. Structural integrity of the building system shall be maintained. Reference shall also be made to the drawings and specifications of the other disciplines in the project for additional facilities to be demolished or handled.
- D. All valves including gate, globe, ball, butterfly and check, all pressure gages and thermometers with wells shall remain Government property and shall be removed and delivered to COR 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. Coordinate with the COR and Infection Control.

3.7 CLEANING AND PAINTING

- A. Prior to final inspection and acceptance of the plant and facilities for beneficial use by the Government, the plant facilities, equipment and systems shall be thoroughly cleaned and painted. Refer to Section 09 91 00, PAINTING.
- B. In addition, the following special conditions apply:
 - 1. Cleaning shall be thorough. Solvents, cleaning materials and methods recommended by the manufacturers shall be used for the specific tasks. All rust shall be removed prior to painting and from surfaces to remain unpainted. Scratches, scuffs, and abrasions shall be repaired prior to applying prime and finish coats.
 - 2. The following Material and Equipment shall NOT be painted:
 - a. Motors, controllers, control switches, and safety switches.
 - b. Control and interlock devices.
 - c. Regulators.
 - d. Pressure reducing valves.
 - e. Control valves and thermostatic elements.
 - f. Lubrication devices and grease fittings.
 - g. Copper, brass, aluminum, stainless steel and bronze surfaces.
 - h. Valve stems and rotating shafts.
 - i. Pressure gages and thermometers.
 - j. Glass.
 - k. Name plates.
 - 3. Control and instrument panels shall be cleaned and damaged surfaces repaired. Touch-up painting shall be made with matching paint type and color obtained from manufacturer or computer matched.
 - 4. Pumps, motors, steel and cast iron bases, and coupling guards shall be cleaned, and shall be touched-up with the same paint type and color as utilized by the pump manufacturer.
 - 5. Temporary Facilities: Apply paint to surfaces that do not have existing finish coats per Section 09 91 00, Painting.

6. The final result shall be a smooth, even-colored, even-textured factory finish on all items. The entire piece of equipment shall be repainted, if necessary, to achieve this. Lead based paints shall not be used.

3.8 IDENTIFICATION SIGNS

- A. Laminated plastic signs, with engraved lettering not less than 7 mm (3/16 inch) high, shall be provided that designates equipment function, for all equipment, switches, motor controllers, relays, meters, control devices, including automatic control valves. Nomenclature and identification symbols shall correspond to that used in maintenance manual, and in diagrams specified elsewhere. Attach by chain, adhesive, or screws.
- B. Factory Built Equipment: Metal plate, securely attached, with name and address of manufacturer, serial number, model number, size, and performance data shall be placed on factory built equipment.
- C. Pipe Identification: Refer to Section 09 91 00, PAINTING.

3.9 STARTUP AND TEMPORARY OPERATION

- A. Startup of equipment shall be performed as described in the equipment specifications. Vibration within specified tolerance shall be verified prior to extended operation. Temporary use of equipment is specified in Section 01 00 00, GENERAL REQUIREMENTS, Article, TEMPORARY USE OF MECHANICAL AND ELECTRICAL EQUIPMENT.
- B. The commissioning Agent will observe startup and contractor testing of selected equipment. Coordinate the startup and contractor testing schedules with the Contracting Officer's Representative and Commissioning Agent. Provide a minimum of 2 weeks prior notice.

3.10 OPERATING AND PERFORMANCE TESTS

- A. Prior to the final inspection, all required tests shall be performed as specified in Section 01 00 00, GENERAL REQUIREMENTS, Article, TESTS and submit the test reports and records to the COR.
- 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 systems occurs at a time when final control settings and adjustments cannot be properly made to make performance tests, then conduct such performance tests and finalize control settings during the first actual seasonal use of the respective

systems following completion of work. Rescheduling of these tests shall be requested in writing to COR for approval.

- D. Perform tests as required for commissioning provisions in accordance with Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS and Section 01 91 00, GENERAL COMMISSIONING REQUIREMENTS.

3.11 OPERATION AND MAINTENANCE MANUALS

- A. All new and temporary equipment and all elements of each assembly shall be included.
- B. Data sheet on each device listing model, size, capacity, pressure, speed, horsepower, impeller size, and other information shall be included.
- C. Manufacturer's installation, maintenance, repair, and operation instructions for each device shall be included. Assembly drawings and parts lists shall also be included. A summary of operating precautions and reasons for precautions shall be included in the Operations and Maintenance Manual.
- D. Lubrication instructions, type and quantity of lubricant shall be included.
- E. Schematic diagrams and wiring diagrams of all control systems corrected to include all field modifications shall be included.
- F. Set points of all interlock devices shall be listed.
- G. Trouble-shooting guide for the control system troubleshooting shall be inserted into the Operations and Maintenance Manual.
- H. The control system sequence of operation corrected with submittal review comments shall be inserted into the Operations and Maintenance Manual.
- I. Emergency procedures for shutdown and startup of equipment and systems.

3.12 COMMISSIONING

- A. Provide commissioning documentation in accordance with the requirements of Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.
- B. Components provided under this section of the specification will be tested as part of a larger system.

3.13 DEMONSTRATION AND TRAINING

- A. Provide services of manufacturer's technical representative for four 4 hour sessions to instruct VA Personnel in operation and maintenance of the system.

- B. Submit training plans and instructor qualifications in accordance with the requirements of Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.

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SECTION 22 05 12
GENERAL MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section describes the general motor requirements for plumbing equipment and applies to all sections of Division 22.
- B. A complete listing of all acronyms and abbreviations are included in Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING.

1.2 RELATED WORK

- A. Section 01 00 00, GENERAL REQUIREMENTS.
- B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- C. Section 01 81 13, SUSTAINABLE CONSTRUCTION REQUIREMENTS.
- D. Section 01 91 00, GENERAL COMMISSIONING REQUIREMENTS.
- E. Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.
- F. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.
- G. Section 26 29 11, MOTOR CONTROLLERS: STARTERS, CONTROL AND PROTECTION OF MOTORS.

1.3 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 Bearing Manufacturers Association (ABMA):
ABMA 9-1990 (R2008).....Load Ratings and Fatigue Life for Ball Bearings
- C. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
841-2009.....IEEE Standard for Petroleum and Chemical
Industry-Premium-Efficiency, Severe-Duty,
Totally Enclosed Fan-Cooled (TEFC) Squirrel
Cage Induction Motors--Up to and Including 370
kW (500 HP)
- D. National Electrical Manufacturers Association (NEMA):
MG 1-2011.....Motors and Generators
MG 2-2001 (R2007).....Safety Standard for Construction and Guide for
Selection, Installation and Use of Electric
Motors and Generators
250-2008.....Enclosures for Electrical Equipment (1000 Volts
Maximum)
- E. National Fire Protection Association (NFPA):
70-2011.....National Electrical Code (NEC)

1.4 SUBMITTALS

- A. Submittals, including number of required copies, shall be submitted in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Information and material submitted under this section shall be marked "SUBMITTED UNDER SECTION 22 05 12, GENERAL MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT", with applicable paragraph identification.
- C. Shop Drawings:
 - 1. Sufficient information, clearly presented, shall be included to determine compliance with drawings and specifications.
 - 2. Motor nameplate information shall be submitted including electrical ratings, dimensions, mounting details, materials, horsepower, power factor, current as a function of speed, current efficiency, speed as a function of load, RPM, enclosure, starting characteristics, torque characteristics, code letter, full load and locked rotor current, service factor, and lubrication method.
 - 3. Motor parameters required for the determination of the Reed Critical Frequency of vertical hollow shaft motors shall be submitted.
- D. Operating and Maintenance Manuals: Companion copies of complete maintenance and operating manuals, including technical data sheets and application data shall be submitted simultaneously with the shop drawings. Complete operating and maintenance manuals including wiring diagrams, technical data sheets and information for ordering replaceable parts:
 - 1. Include complete list indicating all components of the systems.
 - 2. Include complete diagrams of the internal wiring for each item of equipment.
 - 3. Diagrams shall have their terminals identified to facilitate installation, operation and maintenance.
- E. Certification: Two weeks prior to final inspection, unless otherwise noted, the following certification shall be submitted to the Contracting Officer's Representative (COR).
 - 1. Certification shall be submitted stating that the motors have been properly applied, installed, adjusted, lubricated, and tested.

1.5 QUALITY ASSURANCE

- A. Bio-Based Materials: For products designated by the USDA's Bio-Preferred Program, provide products that meet or exceed USDA recommendations for bio-based content, so long as products meet all

performance requirements in this specifications section. For more information regarding the product categories covered by the Bio-Preferred Program, visit <http://www.biopreferred.gov>.

PART 2 - PRODUCTS

2.1 MOTORS

- A. For alternating current, fractional and integral horsepower motors, NEMA MG 1 and NEMA MG 2 shall apply.
- B. For severe duty totally enclosed motors, IEEE 841 shall apply.
- C. Voltage ratings shall be as follows:
 - 1. Three phase less than 74.6 kW (100 HP), connected to 240-volt or 480-volt systems: 230/460 volts, dual connection.
- D. Number of phases shall be as follows:
 - 1. Motors, 373 W (1/2 HP) and larger: 3 phase.
- E. Horsepower ratings shall be adequate for operating the connected loads continuously in the prevailing ambient temperatures in areas where the motors are installed, without exceeding the NEMA standard temperature rises for the motor insulation.
- F. Motor designs, as indicated by the NEMA code letters, shall be coordinated with the connected loads to assure adequate starting, acceleration and running torque without exceeding nameplate ratings or considering service factor.
- G. Motor Enclosures:
 - 1. Shall be the NEMA types shown on the drawings for the motors.
 - 2. Where the types of motor enclosures are not shown on the drawings, they shall be the NEMA types per NEMA 250, which are most suitable for the environmental conditions where the motors are being installed.
 - 3. Enclosures shall be primed and finish coated at the factory with manufacturer's prime coat and standard finish.
 - 4. All motors in hazardous locations shall be approved for the application and meet the Class and Group as required by the area classification.
- H. Electrical Design Requirements:
 - 1. Motors shall be continuous duty.
 - 2. The insulation system shall be rated minimum of Class B, 130 degrees C (266 degrees F).
 - 3. The maximum temperature rise by resistance at rated power shall not exceed Class B limits, 80 degrees C (144 degrees F).

4. The speed/torque and speed/current characteristics shall comply with NEMA Design A or B, as specified.
5. Motors shall be suitable for full voltage starting, unless otherwise noted. Coordinate motor features with applicable motor controllers.

I. Mechanical Design Requirements:

1. Bearings shall be rated for a minimum fatigue life of 26,280 hours for belt-driven loads and 100,000 hours for direct-drive loads based on L10 (Basic Rating Life) at full load direct coupled, except vertical high thrust motors which require a 40,000 hour rating. A minimum fatigue life of 40,000 hours is required for VFD drives.
2. Grease lubricated bearings shall be designed for electric motor use. Grease shall be capable of the temperatures associated with electric motors and shall be compatible with Polyurea based greases.
3. Grease fittings, if provided, shall be Alemite type or equivalent.
4. Oil lubricated bearings, when specified, shall have an externally visible sight glass to view oil level.
5. Vibration shall not exceed 3.8 mm (0.15 inch) per second, unfiltered peak.
6. Noise level shall meet the requirements of the application.
7. All external fasteners shall be corrosion resistant.
8. Grounding provisions shall be in the main terminal box.

J. Additional requirements for specific motors, as indicated in other sections, shall also apply.

K. NEMA Premium Efficiency Electric Motors, Motor Efficiencies: All permanently wired polyphase motors of 746 W (1 HP) or more shall meet the minimum full-load efficiencies as indicated in the following table, and as specified in this specification. Motors of 746 W (1 HP) or more with open, drip-proof or totally enclosed fan-cooled enclosures shall be NEMA premium efficiency type, unless otherwise indicated.

Minimum Efficiencies Open Drip-Proof				Minimum Efficiencies Totally Enclosed Fan-Cooled			
Rating kW (HP)	1200 RPM	1800 RPM	3600 RPM	Rating kW (HP)	1200 RPM	1800 RPM	3600 RPM
1.49 (2)	87.5%	86.5%	85.5%	1.49 (2)	88.5%	86.5%	85.5%

- L. Minimum Power Factor at Full Load and Rated Voltage: 90 percent at 1200 RPM, 1800 RPM and 3600 RPM. Power factor correction capacitors shall be installed unless the motor is controlled by a variable frequency drive. The power factor correction capacitors shall be able to withstand high voltage transients and power line variations without breakdown.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. 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.
- B. If an installation is unsatisfactory to the COR, the Contractor shall correct the installation at no cost to the Government.

3.2 FIELD TESTS

- A. Megger all motors after installation, before start-up. All motors shall test free from grounds.

3.3 COMMISSIONING

- A. Provide commissioning documentation in accordance with the requirements of Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.
- B. Components provided under this section of the specification will be tested as part of a larger system.

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SECTION 22 05 23
GENERAL-DUTY VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section describes the requirements for general-duty valves for domestic water and sewer systems.
- B. A complete listing of all acronyms and abbreviations are included in Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING.

1.2 RELATED WORK

- A. Section 01 00 00, GENERAL REQUIREMENTS.
- B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA AND SAMPLES.
- C. Section 01 81 13, SUSTAINABLE CONSTRUCTION REQUIREMENTS.
- D. Section 01 91 00, GENERAL COMMISSIONING REQUIREMENTS.
- E. Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING.
- F. Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.

1.3 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 Sanitary Engineering (ASSE):
 - 1013-2011.....Performance Requirements for Reduced Pressure Principle Backflow Preventers and Reduced Pressure Principle Fire Protection Backflow Preventers
- C. American Society for Testing and Materials (ASTM):
 - A126-2004(R2009).....Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
 - A276-2013a.....Standard Specification for Stainless Steel Bars and Shapes
 - A536-1984(R2009).....Standard Specification for Ductile Iron Castings
 - B62-2009.....Standard Specification for Composition Bronze or Ounce Metal Castings
 - B584-2013.....Standard Specification for Copper Alloy Sand Castings for General Applications
- D. International Code Council (ICC):
 - IPC-2012.....International Plumbing Code

- E. Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS):
 - SP-67-2011.....Butterfly Valves
 - SP-70-2011.....Gray Iron Gate Valves, Flanged and Threaded Ends
 - SP-80-2013.....Bronze Gate, Globe, Angle, and Check Valves
 - SP-110-2010.....Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends
- F. National Environmental Balancing Bureau (NEBB):
 - 7th Edition 2005 Procedural Standards for Testing, Adjusting, Balancing of Environmental Systems
- G. NSF International (NSF):
 - 61-2012.....Drinking Water System Components - Health Effects
 - 372-2011.....Drinking Water System Components - Lead Content
- H. University of Southern California Foundation for Cross Connection Control and Hydraulic Research (USC FCCCHR):
 - 9th Edition.....Manual of Cross-Connection Control

1.4 SUBMITTALS

- A. Submittals, including number of required copies, shall be submitted in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- B. Information and material submitted under this section shall be marked "SUBMITTED UNDER SECTION 22 05 23, GENERAL-DUTY VALVES FOR PLUMBING PIPING", with applicable paragraph identification.
- C. Manufacturer's Literature and Data Including: Full item description and optional features and accessories. Include dimensions, weights, materials, applications, standard compliance, model numbers, size, and capacity.
 - 1. Ball Valves.
 - 2. Gate Valves.
 - 3. Butterfly Valves.
 - 4. Check Valves.
 - 5. Backflow Preventers.
 - 6. Chainwheels.
- D. Test and Balance reports for balancing valves.
- E. Complete operating and maintenance manuals including wiring diagrams, technical data sheets and information for ordering replaceable parts:

1. Include complete list indicating all components of the systems.
 2. Include complete diagrams of the internal wiring for each item of equipment.
 3. Diagrams shall have their terminals identified to facilitate installation, operation and maintenance.
 4. Piping diagrams of thermostatic mixing valves to be installed.
- F. Completed System Readiness Checklist 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 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.
- G. Submit training plans and instructor qualifications in accordance with the requirements of Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Valves shall be prepared for shipping as follows:
1. Protect internal parts against rust and corrosion.
 2. Protect threads, flange faces, grooves, and weld ends.
 3. Set angle, gate, and globe valves closed to prevent rattling.
 4. Set ball and plug valves open to minimize exposure of functional surfaces.
 5. Set butterfly valves closed or slightly open.
 6. Block check valves in either closed or open position.
- B. Valves shall be prepared for storage as follows:
1. Maintain valve end protection.
 2. Store valves indoors and maintain at higher than ambient dew point temperature.
- C. A sling shall be used for large valves. The sling shall be rigged to avoid damage to exposed parts. Hand wheels or stems shall not be used as lifting or rigging points.

PART 2 - PRODUCTS

2.1 VALVES, GENERAL

- A. Asbestos packing and gaskets are prohibited.
- B. Bronze valves shall be made with dezincification resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc shall not be permitted.
- C. Valves in insulated piping shall have 50 mm or DN50 (2 inch) stem extensions and extended handles of non-thermal conductive material that allows operating the valve without breaking the vapor seal or

disturbing the insulation. Memory stops shall be fully adjustable after insulation is applied.

- D. Exposed Valves over 65 mm or DN65 (2-1/2 inches) installed at an elevation over 3.6 m (12 feet) shall have a chain-wheel attachment to valve hand-wheel, stem, or other actuator.
- E. All valves used to supply potable water shall meet the requirements of NSF 61 and NSF 372.
- F. Bio-Based Materials: For products designated by the USDA's Bio-Preferred Program, provide products that meet or exceed USDA recommendations for bio-based content, so long as products meet all performance requirements in this specifications section. For more information regarding the product categories covered by the Bio-Preferred Program, visit <http://www.biopreferred.gov>.

2.2 SHUT-OFF VALVES

A. Cold Water:

- 1. 50 mm or DN50 (2 inches) and smaller: Ball, MSS SP-110, Ball valve shall be full port three piece or two piece with a union design with adjustable stem package. Threaded stem designs are not allowed. The ball valve shall have a SWP rating of 1035 kPa (150 psig) and a CWP rating of 4138 kPa (600 psig). The body material shall be Bronze ASTM B584, Alloy C844. The ends shall be non-lead solder.
- 2. Less than 100 mm DN100 (4 inches): Butterfly shall have an iron body with EPDM seal and aluminum bronze disc. The butterfly valve shall meet MSS SP-67, type I standard. The butterfly valve shall have a SWP rating of 1380 kPa (200 psig). The valve design shall be lug type suitable for bidirectional dead-end service at rated pressure. The body material shall meet ASTM A536, ductile iron.
- 3. 100 mm DN100 (4 inches) and larger:
 - a. Class 125, OS&Y, Cast Iron Gate Valve. The gate valve shall meet MSS SP-70 type I standard. The gate valve shall have a CWP rating of 1380 kPa (200 psig). The valve materials shall meet ASTM A126, grey iron with bolted bonnet, flanged ends, bronze trim, and positive-seal resilient solid wedge disc. The gate valve shall be gear operated for sizes under 200 mm or DN200 (8 inches) and crank operated for sizes 200 mm or DN200 (8 inches) and above.
 - b. Single flange, ductile iron butterfly valves: The single flanged butterfly valve shall meet the MSS SP-67 standard. The butterfly valve shall have a CWP rating of 1380 kPa (200 psig). The

butterfly valve shall be lug type, suitable for bidirectional dead-end service at rated pressure without use of downstream flange. The body material shall comply with ASTM A536 ductile iron. The seat shall be EPDM with stainless steel disc and stem.

- c. Grooved end, ductile iron butterfly valves. The grooved butterfly valve shall meet the MSS SP-67 standard. The grooved butterfly valve shall have a CWP rating of 1380 kPa (200 psig). The valve materials shall be epoxy coated ductile iron conforming to ASTM A536 with two-piece stainless steel stem, Buna-N or EPDM encapsulated ductile iron disc, and EPDM seal. The butterfly valve shall be gear operated.

2.4 CHECK VALVES

- A. 75 mm or DN75 (3 inches) and smaller shall be Class 125, bronze swing check valves with non-metallic disc suitable for type of service. The check valve shall meet MSS SP-80 Type 4 standard. The check valve shall have a CWP rating of 1380 kPa (200 psig). The check valve shall have a Y pattern horizontal body design with bronze body material conforming to ASTM B62, solder joints, and PTFE or TFE disc.

2.5 BACKFLOW PREVENTERS

- A. A backflow prevention assembly shall be installed at any point in the plumbing system where the potable water supply comes in contact with a potential source of contamination. The backflow prevention assembly shall be approved by the University of Southern California Foundation for Cross Connection Control and Hydraulic Research (USCFCCC).
- B. The reduced pressure principle backflow prevention assembly shall be ASSE listed 1013 with full port OS&Y positive-seal resilient gate valves and an integral relief monitor switch. The main body and access cover shall be epoxy coated ductile iron conforming to ASTM A536 grade 4. The seat ring and check valve shall be the thermoplastic type suited for water service. The stem shall be stainless steel conforming to ASTM A276. The seat disc shall be the elastomer type suited for water service. The checks and the relief valve shall be accessible for maintenance without removing the device from the line. An epoxy coated wye type strainer with flanged connections shall be installed on the inlet. Reduced pressure backflow preventers shall be installed in the following applications.
 - 1. Water make up to heating systems, cooling tower, chilled water system, generators, and similar equipment consuming water.

2.6 CHAINWHEELS

- A. Valve chain wheel assembly with sprocket rim brackets and chain shall be constructed according to the following:
 - 1. Brackets: Type, number, size, and fasteners required to mount actuator on valve.
 - 2. Attachment: For connection to ball and butterfly valve stem.
 - 3. Sprocket rim with chain guides: Ductile or cast iron of type and size required for valve with zinc coating.
 - 4. Chain: Stainless steel of size required to fit sprocket rim.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Valve interior shall be examined for cleanliness, freedom from foreign matter, and corrosion. Special packing materials shall be removed, such as blocks, used to prevent disc movement during shipping and handling.
- B. Valves shall be operated in positions from fully open to fully closed. Guides and seats shall be examined and made accessible by such operations.
- C. Threads on valve and mating pipe shall be examined for form and cleanliness.
- D. Mating flange faces shall be examined for conditions that might cause leakage. Bolting shall be checked for proper size, length, and material. Gaskets shall be verified for proper size and that its material composition is suitable for service and free from defects and damage.
- E. Do not attempt to repair defective valves; replace with new valves.

3.2 INSTALLATION

- A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- B. Valves shall be located for easy access and shall be provide with separate support. Valves shall be accessible with access doors when installed inside partitions or above hard ceilings.
- C. Valves shall be installed in horizontal piping with stem at or above center of pipe.
- D. Valves shall be installed in a position to allow full stem movement.
- E. Install chain wheels on operators for all valves 4 inches and larger and more than 3.6 m (12 feet) above floor. Chains shall be extended to 1524 mm (60 inches) above finished floor.

- F. Check valves shall be installed for proper direction of flow and as follows:
 - 1. Swing Check Valves: In horizontal position with hinge pin level and on top of valve.
- G. Install backflow preventers in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction. Locate backflow preventers in same room as connected equipment or system.
 - 1. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe to floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are not acceptable for this application.
- H. Install pressure gages on outlet of backflow preventers.
- I. Do not install bypass piping around backflow preventers.
- J. If an installation is unsatisfactory to the COR, the Contractor shall correct the installation at no cost to the Government.

3.3 ADJUSTING

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

3.4 COMMISSIONING

- A. Provide commissioning documentation in accordance with the requirements of Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.
- B. Components provided under this section of the specification will be tested as part of a larger system.

3.5 DEMONSTRATION AND TRAINING

- A. Provide services of manufacturer's technical representative for four, 4-hour sessions to instruct VA Personnel in operation and maintenance of the system.
- B. Submit training plans and instructor qualifications in accordance with the requirements of Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.

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SECTION 22 08 00

COMMISSIONING OF PLUMBING SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. The requirements of this Section apply to all sections of Division 22.
- B. This project will have selected building systems commissioned. The complete list of equipment and systems to be commissioned are specified in Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS. The commissioning process, which the Contractor is responsible to execute, is defined in Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS. A Commissioning Agent (CxA) appointed by the Department of Veterans Affairs will manage the commissioning process.

1.2 RELATED WORK

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

1.3 SUMMARY

- A. This Section includes requirements for commissioning plumbing systems, subsystems and equipment. This Section supplements the general requirements specified in Section 01 91 00 General Commissioning Requirements.
- B. 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 Division 22 is part of the construction process. Documentation and testing of these systems, as well as training of the VA's Operation and Maintenance personnel in accordance with the requirements of Section 01 91 00 and of Division 22, is required in cooperation with the VA and the Commissioning Agent.
- B. The Plumbing systems commissioning will include the systems listed in Section 01 91 00 General Commissioning Requirements.

1.6 SUBMITTALS

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

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 CONSTRUCTION INSPECTIONS

- A. Commissioning of the Building Plumbing Systems will require inspection of individual elements of the Plumbing construction throughout the construction period. The Contractor shall coordinate with the Commissioning Agent in accordance with Section 01 91 00 and the Commissioning Plan to schedule inspections as required to support the commissioning process.

3.2 PRE-FUNCTIONAL CHECKLISTS

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

resubmission. Refer to SECTION 01 91 00 GENERAL COMMISSIONING REQUIREMENTS for submittal requirements for Pre-Functional Checklists, Equipment Startup Reports, and other commissioning documents.

3.3 CONTRACTORS TESTS

- A. Contractor tests as required by other sections of Division 22 shall be scheduled and documented in accordance with Section 01 00 00 GENERAL REQUIREMENTS. All testing shall be incorporated into the project schedule. Contractor shall provide no less than 7 calendar days' notice of testing. The Commissioning Agent will witness selected Contractor tests at the sole discretion of the Commissioning Agent. Contractor tests shall be completed prior to scheduling Systems Functional Performance Testing.

3.4 SYSTEMS FUNCTIONAL PERFORMANCE TESTING:

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

3.5 TRAINING OF VA PERSONNEL

- A. Training of the VA operation and maintenance personnel is required in cooperation with the Resident Engineer and Commissioning Agent. Provide competent, factory authorized personnel to provide instruction to operation and maintenance personnel concerning the location, operation, and troubleshooting of the installed systems. Contractor shall submit training agendas and trainer resumes in accordance with the requirements of Section 01 91 00. The instruction shall be scheduled in coordination with the Resident Engineer after submission and approval of formal training plans. Refer to Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS and Division 22 Sections for additional Contractor training requirements.

*Replace Boilers - Bldg. 100 Energy Center
CW Bill Young VA Medical Center - Bay Pines, FL*

*100% Design Documents
May 15, 2017*

----- END -----

SECTION 22 11 00
FACILITY WATER DISTRIBUTION

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Domestic water systems, including piping, equipment and all necessary accessories as designated in this section.
- B. A complete listing of all acronyms and abbreviations are included in Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING.

1.2 RELATED WORK

- A. Section 01 00 00, GENERAL REQUIREMENTS.
- B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- C. Section 01 81 13, SUSTAINABLE CONSTRUCTION REQUIREMENTS.
- D. Section 01 91 00, GENERAL COMMISSIONING REQUIREMENTS.
- E. Section 09 91 00, PAINTING.
- F. Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING.
- G. Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.

1.3 APPLICABLE PUBLICATIONS

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. American Society of Mechanical Engineers (ASME):
 - B16.9-2012.....Factory-Made Wrought Buttwelding Fittings
 - B16.18-2012.....Cast Copper Alloy Solder Joint Pressure Fittings
 - B16.22-2013.....Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings
 - B16.24-2011.....Cast Copper Alloy Pipe Flanges and Flanged Fittings: Classes 150, 300, 600, 900, 1500, and 2500
 - B16.51-2013.....Copper and Copper Alloy Press-Connect Fittings
 - ASME Boiler and Pressure Vessel Code -
- C. American Society of Sanitary Engineers (ASSE):
 - 1010-2004.....Performance Requirements for Water Hammer Arresters
- D. American Society for Testing and Materials (ASTM):
 - A47/A47M-1999 (R2014)...Standard Specification for Ferritic Malleable Iron Castings

- A53/A53M-2012.....Standard Specification for Pipe, Steel, Black
and Hot-Dipped, Zinc-Coated, Welded and
Seamless
- A183-2014.....Standard Specification for Carbon Steel Track
Bolts and Nuts
- A403/A403M-2014.....Standard Specification for Wrought Austenitic
Stainless Steel Piping Fittings
- A536-1984 (R2014).....Standard Specification for Ductile Iron
Castings
- B32-2008 (R2014).....Standard Specification for Solder Metal
- B75/B75M-2011.....Standard Specification for Seamless Copper Tube
- B88-2014.....Standard Specification for Seamless Copper
Water Tube
- E1120-2008.....Standard Specification for Liquid Chlorine
- E1229-2008.....Standard Specification for Calcium Hypochlorite
- E. American Welding Society (AWS):
- A5.8M/A5.8-2011-AMD1....Specification for Filler Metals for Brazing and
Braze Welding
- F. International Code Council (ICC):
- IPC-2012.....International Plumbing Code
- G. Manufacturers Specification Society (MSS):
- SP-58-2009.....Pipe Hangers and Supports - Materials, Design,
Manufacture, Selection, Application, and
Installation
- SP-72-2010a.....Ball Valves with Flanged or Butt-Welding Ends
for General Service
- SP-110-2010.....Ball Valves Threaded, Socket-Welding, Solder
Joint, Grooved and Flared Ends
- H. NSF International (NSF):
- 14-2015.....Plastics Piping System Components and Related
Materials
- 61-2014a.....Drinking Water System Components - Health
Effects
- 372-2011.....Drinking Water System Components - Lead Content

1.4 SUBMITTALS

- A. Submittals, including number of required copies, shall be submitted in
accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND
SAMPLES.

- B. Information and material submitted under this section shall be marked "SUBMITTED UNDER SECTION 22 11 00, FACILITY WATER DISTRIBUTIONS", with applicable paragraph identification.
- C. Manufacturer's Literature and Data including: Full item description and optional features and accessories. Include dimensions, weights, materials, applications, standard compliance, model numbers, size, and capacity.
 - 1. All items listed in Part 2 - Products.
- D. Complete operating and maintenance manuals including wiring diagrams, technical data sheets and information for ordering replacement parts:
 - 1. Include complete list indicating all components of the systems.
 - 2. Include complete diagrams of the internal wiring for each item of equipment.
 - 3. Diagrams shall have their terminals identified to facilitate installation, operation and maintenance.
- E. Completed System Readiness Checklist provided by the CxA and completed by the Contractor, signed by a qualified technician and dated on the date of completion, in accordance with the requirements of Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.
- F. Submit training plans and instructor qualifications in accordance with the requirements of Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.

1.5 QUALITY ASSURANCE

- A. All grooved joint couplings, fittings, valves, and specialties shall be the products of a single manufacturer. Grooving tools shall be by the same manufacturer as the groove components.
- B. All pipe, couplings, fittings, and specialties shall bear the identification of the manufacturer and any markings required by the applicable referenced standards.
- C. Bio-Based Materials: For products designated by the USDA's Bio-Preferred Program, provide products that meet or exceed USDA recommendations for bio-based content, so long as products meet all performance requirements in this specifications section. For more information regarding the product categories covered by the Bio-Preferred Program, visit <http://www.biopreferred.gov>.

1.6 SPARE PARTS

- A. For mechanical press-connect fittings, provide tools required for each pipe size used at the facility.

1.7 AS-BUILT DOCUMENTATION

- A. Submit manufacturer's literature and data updated to include submittal review comments and any equipment substitutions.
- B. Submit operation and maintenance data updated to include submittal review comments, substitutions and construction revisions shall be in electronic version on compact disc or DVD. All aspects of system operation and maintenance procedures, including piping isometrics, wiring diagrams of all circuits, a written description of system design, control logic, and sequence of operation shall be included in the operation and maintenance manual. The operations and maintenance manual shall include troubleshooting techniques and procedures for emergency situations. Notes on all special systems or devices shall be included. A list of recommended spare parts (manufacturer, model number, and quantity) shall be furnished. Information explaining any special knowledge or tools the owner will be required to employ shall be inserted into the As-Built documentation.
- C. The installing contractor shall maintain as-built drawings of each completed phase for verification; and, shall provide the complete set at the time of final systems certification testing. As-built drawings are to be provided, and a copy of them in latest Auto-CAD version provided on compact disk or DVD. Should the installing contractor engage the testing company to provide as-built or any portion thereof, it shall not be deemed a conflict of interest or breach of the 'third party testing company' requirement.
- D. Certification documentation shall be provided to COR 10 working days prior to submitting the request for final inspection. The documentation shall include all test results, the names of individuals performing work for the testing agency on this project, detailed procedures followed for all tests, and certificate if applicable that all results of tests were within limits specified. If a certificate is not available, all documentation shall be on the Certifier's letterhead.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Material or equipment containing a weighted average of greater than 0.25 percent lead are prohibited in any potable water system intended for human consumption, and shall be certified in accordance with NSF 61 or NSF 372. Endpoint devices used to dispense water for drinking shall meet the requirements of NSF 61, Section 9.

- B. Plastic pipe, fittings, and solvent cement shall meet NSF 14 and shall be NSF listed for the service intended.

2.2 ABOVE GROUND (INTERIOR) WATER PIPING

- A. Pipe: Copper tube, ASTM B88, Type K or L, drawn.

- B. Fittings for Copper Tube:

1. Wrought copper or bronze castings conforming to ASME B16.18 and B16.22. Unions shall be bronze, MSS SP-72, MSS SP-110, solder or braze joints. Use 95/5 tin and antimony for all soldered joints.
2. Grooved fittings, 50 to 150 mm (2 to 6 inch) wrought copper ASTM B75/B75M C12200. Mechanical grooved couplings, 2070 kpa (300 psig) minimum ductile iron, ASTM A536 Grade 448-310-12 (Grade 65-45-12), or malleable iron, ASTM A47/A47M Grade 22410 (Grade 32510) housing, with EPDM gasket, steel track head bolts, ASTM A183, coated with copper colored alkyd enamel.
3. Mechanical press-connect fittings for copper pipe and tube shall conform to the material and sizing requirements of ASME B16.51, NSF 61 approved, 50 mm (2 inch) size and smaller mechanical press-connect fittings, double pressed type, with EPDM (ethylene propylene diene monomer) non-toxic synthetic rubber sealing elements and un-pressed fitting identification feature.
4. Mechanically formed tee connection: Form mechanically extracted collars in a continuous operation by drilling pilot hole and drawing out tube surface to form collar, having a height of not less than three times the thickness of tube wall. Adjustable collaring device shall ensure proper tolerance and complete uniformity of the joint. Notch and dimple joining branch tube in a single process to provide free flow where the branch tube penetrates the fitting. Braze joints.
5. Flanged fittings, bronze, class 150, solder-joint ends conforming to ASME B16.24.

- C. Fittings for Stainless Steel:

1. Stainless steel butt-welded fittings, Type 316, Schedule 10, conforming to ASME B16.9.
2. Grooved fittings, stainless steel, Type 316, Schedule 40, conforming to ASTM A403/A403M. Segmentally fabricated fittings are not allowed. Mechanical grooved couplings, ductile iron, 4138 kPa (600 psig), ASTM A536 Grade 448-310-12 (Grade 65-45-12), or malleable iron, ASTM A47/A47M Grade 22410 (Grade 32510) housing, with EPDM gasket, steel

track head bolts, ASTM A183, coated with copper colored alkyd enamel.

- D. Adapters: Provide adapters for joining pipe or tubing with dissimilar end connections.
- E. Solder: ASTM B32 alloy type Sb5, HA or HB. Provide non-corrosive flux.
- F. Brazing alloy: AWS A5.8M/A5.8, brazing filler metals shall be BCuP series for copper to copper joints and BAg series for copper to steel joints.

2.3 EXPOSED WATER PIPING

- A. Unfinished Rooms, Mechanical Rooms and Kitchens: Chrome-plated brass piping is not required. Paint piping systems as specified in Section 09 91 00, PAINTING.

2.4 STRAINERS

- A. Provide on high pressure side of pressure reducing valves, on suction side of pumps, on inlet side of indicating and control instruments and equipment subject to sediment damage and where shown on drawings. Strainer element shall be removable without disconnection of piping.
- B. Water: Basket or "Y" type with easily removable cover and brass strainer basket.
- C. Body: Less than 75 mm (3 inches), brass or bronze; 75 mm (3 inches) and greater, cast iron or semi-steel.

2.5 DIELECTRIC FITTINGS

- A. Provide dielectric couplings or unions between pipe of dissimilar metals.

2.6 STERILIZATION CHEMICALS

- A. Hypochlorite: ASTM E1120.
- B. Liquid Chlorine: ASTM E1229.

2.7 WATER HAMMER ARRESTER

- A. Closed copper tube chamber with permanently sealed 413 kPa (60 psig) air charge above a Double O-ring piston. Two high heat Buna-N O-rings pressure packed and lubricated with FDA approved silicone compound. All units shall be designed in accordance with ASSE 1010. Access shall be provided where devices are concealed within partitions or above ceilings. Size and install in accordance with PDI-WH 201 requirements. Provide water hammer arrestors at:
 - 1. All solenoid valves.
 - 2. All quick opening or closing valves.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Comply with the International Plumbing Code and the following:

1. Install branch piping for water from the piping system and connect to all fixtures, valves, cocks, outlets, casework, cabinets and equipment, including those furnished by the Government or specified in other sections.
2. Pipe shall be round and straight. Cutting shall be done with proper tools. Pipe, except for plastic and glass, shall be reamed to remove burrs and a clean smooth finish restored to full pipe inside diameter.
3. All pipe runs shall be laid out to avoid interference with other work/trades.
4. Install union and shut-off valve on pressure piping at connections to equipment.
5. Pipe Hangers, Supports and Accessories:
 - a. All piping shall be supported per the IPC, MSS SP-58, and SMACNA as required.
 - b. Shop Painting and Plating: Hangers, supports, rods, inserts and accessories used for pipe supports shall be shop coated with zinc chromate primer paint. Electroplated copper hanger rods, hangers and accessories may be used with copper tubing.
 - c. Floor, Wall and Ceiling Plates, Supports, Hangers:
 - 1) Solid or split un-plated cast iron.
 - 2) All plates shall be provided with set screws.
 - 3) Pipe Hangers: Height adjustable clevis type.
 - 4) Adjustable Floor Rests and Base Flanges: Steel.
 - 5) Hanger Rods: Mild, low carbon steel, fully threaded or Threaded at each end with two removable nuts at each end for positioning rod and hanger and locking each in place.
 - 6) Pipe Hangers and Riser Clamps: Malleable iron or carbon steel. Pipe Hangers and riser clamps shall have a copper finish when supporting bare copper pipe or tubing.
 - 7) Rollers: Cast iron.
 - 8) Self-drilling type expansion shields shall be "Phillips" type, with case hardened steel expander plugs.
 - 9) Miscellaneous Materials: As specified, required, directed or as noted on the drawings for proper installation of hangers,

supports and accessories. If the vertical distance exceeds 6.1 m (20 feet) for cast iron pipe additional support shall be provided in the center of that span. Provide all necessary auxiliary steel to provide that support.

6. Install chrome plated cast brass escutcheon with set screw at each wall, floor and ceiling penetration in exposed finished locations and within cabinets and millwork.
7. Mechanical press-connect fitting connections shall be made in accordance with the manufacturer's installation instructions. The tubing shall be fully inserted into the fitting and the tubing marked at the shoulder of the fitting. The fitting alignment shall be checked against the mark on the tubing to assure the tubing is fully engaged (inserted) in the fitting. Ensure the tube is completely inserted to the fitting stop (appropriate depth) and squared with the fitting prior to applying the pressing jaws onto the fitting. The joints shall be pressed using the tool(s) approved by the manufacturer. Minimum distance between fittings shall be in accordance with the manufacturer's requirements. When the pressing cycle is complete, visually inspect the joint to ensure the tube has remained fully inserted, as evidenced by the visible insertion mark.

B. Domestic Water piping shall conform to the following:

1. Grade all lines to facilitate drainage. Provide drain valves at bottom of risers and all low points in system.

3.2 TESTS

- A. General: Test system either in its entirety or in sections. Submit testing plan to COR 10 working days prior to test date.
- B. Potable Water System: Test after installation of piping. Fill systems with water and maintain hydrostatic pressure of 1035 kPa (150 psig) gage for two hours. No decrease in pressure is allowed. Provide a pressure gage with a shutoff and bleeder valve at the highest point of the piping being tested. Pressure gauge shall have 1 psig increments.
- C. The test pressure shall hold for the minimum time duration required by the applicable plumbing code or authority having jurisdiction.

3.3 COMMISSIONING

- A. Provide commissioning documentation in accordance with the requirements of Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.
- B. Components provided under this section of the specification will be tested as part of a larger system.

3.4 DEMONSTRATION AND TRAINING

- A. Provide services of manufacturer's technical representative for four, 4-hour sessions to instruct VA Personnel in operation and maintenance of the system.
- B. Submit training plans and instructor qualifications in accordance with the requirements of Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.

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SECTION 22 31 11
WATER SOFTENERS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Provide sodium cycle, cation exchange, pressure type, water softening equipment complete with piping services, electrical services, controls, accessories and auxiliary equipment.
- B. Provide duplex brine pump complete with piping services, electrical services, controls, accessories and auxiliary equipment.

1.2 RELATED WORK

- A. Section 01 00 00, GENERAL REQUIREMENTS.
- B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- C. Section 01 81 13, SUSTAINABLE CONSTRUCTION REQUIREMENTS.
- D. Section 01 91 00, GENERAL COMMISSIONING REQUIREMENTS.
- F. Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING.
- G. SECTION 22 08 00, COMMISSIONING OF Plumbing SYSTEMS: Requirements for commissioning, systems readiness checklist, and training.

1.3 APPLICABLE PUBLICATIONS

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. American Society of Mechanical Engineers (ASME):
 - B40.100-2013.....Pressure Gauges and Gauge Attachments
 - BPVC Section X-2015.....Fiber-Reinforced Plastic Pressure Vessels
- C. American Society of Sanitary Engineering (ASSE):
 - 1013-2011.....Performance Requirements for Reduced Pressure Principle Backflow Preventers and Reduced Pressure Principle Fire Protection Backflow Preventers
- D. American Water Works Association (AWWA):
 - B300-2010.....Hypochlorites
 - B301-2010.....Liquid Chlorine
 - C651-2014.....Disinfecting Water Mains
- E. Department of Health and Human Services, Food and Drug Administration (FDA):
 - CFR 21, Chapter 1, Part 173.25, Ion-Exchange Resins

F. National Electrical Manufacturers Association (NEMA):

ICS 6-1993 (R2001, R2006) Industrial Control and Systems: Enclosures

G. NSF International (NSF):

61-2014a.....Drinking Water System Components - Health
Effects

372-2011.....Drinking Water System Components - Lead Content

H. Underwriters' Laboratories, Inc. (UL):

979-2005 (R2014).....Standard for Water Treatment Appliances

1.4 SUBMITTALS

- A. Submittals, including number of required copies, shall be submitted in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Information and material submitted under this section shall be marked "SUBMITTED UNDER SECTION 22 31 11, WATER SOFTENERS", with applicable paragraph identification.
- C. Manufacturer's Literature and Data including: Full item description and optional features and accessories. Include dimensions, weights, materials, applications, standard compliance, model numbers, size, and capacity.
 - 1. Softener tank construction, coatings and linings. Bio-based materials shall be utilized when possible.
 - 2. Tank distribution system design.
 - 3. Main operating valve.
 - 4. Control system and flow meter.
 - 5. Wiring diagram for controls.
 - 6. Exchange resin.
 - 7. Brine system.
 - 8. Accessories including pressure gages and test kit.
 - 9. Performance data including normal and maximum flow and pressure drop. Certification that required performance shall be achieved.
 - 10. Piping.
- D. Complete detailed layout, setting, arrangement, and installation drawings including electrical/pneumatic controls. Drawings shall also show all parts of the apparatus including relative positions, dimensions, and sizes and general arrangement of connecting piping.
- E. Completed System Readiness Checklist provided by the CxA and completed by the contractor, signed by a qualified technician and dated on the

date of completion, in accordance with the requirements of Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.

- F. Submit training plans and instructor qualifications in accordance with the requirements of Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.

1.5 QUALITY ASSURANCE

- A. Bio-Based Materials: For products designated by the USDA's Bio-Preferred Program, provide products that meet or exceed USDA recommendations for bio-based content, so long as products meet all performance requirements in this specifications section. For more information regarding the product categories covered by the Bio-Preferred Program, visit <http://www.biopreferred.gov>.

1.6 PROJECT CONDITIONS

- A. Water sample shall be tested by USEPA certified testing laboratory. Sample shall be taken by water softener equipment contractor and submitted for testing.

- B. Influent Water Analysis:

Total Hardness as Calcium Carbonate	15 gpg
Total Iron	0 ppm
Turbidity in Nephelometric Turbidity units	0 NTU
pH	7

Confirm influent water analysis prior to submitting equipment.

- C. Effluent Water Quality; Zero gpg hardness (ASTM Soap test method).

- D. Design Parameters:

Design System Flow and Pressure Drop: 130gpm @ 6.5 psig

Continuous System Flow and Pressure Drop: 235gpm @ 15 psig

Peak System Flow and Pressure Drop: 325gpm @ 25 psig)

Backwash/Rinse Flow: 110 gpm

Daily Water Usage: 134,000 gallons per day

Daily Hours of Water Demand: 24

Operating Temperature Range: 35 to 110 degrees F

Operating Pressure Range (System): 30-100 psig

Electrical Requirements: Dedicated 120 v, 60 Hz, 1 phase.

1.7 AS-BUILT DOCUMENTATION

- A. Submit manufacturer's literature and data updated to include submittal review comments and any equipment substitutions.

- B. Submit operation and maintenance data updated to include submittal review comments, substitutions and construction revisions shall be in

electronic version on compact disc or DVD. All aspects of system operation and maintenance procedures, including piping isometrics, wiring diagrams of all circuits, a written description of system design, control logic, and sequence of operation shall be included in the operation and maintenance manual. The operations and maintenance manual shall include troubleshooting techniques and procedures for emergency situations. Notes on all special systems or devices such as damper and door closure interlocks shall be included. A List of recommended spare parts (manufacturer, model number, and quantity) shall be furnished. Information explaining any special knowledge or tools the owner will be required to employ shall be inserted into the As-Built documentation.

- C. The installing contractor shall maintain as-built drawings of each completed phase for verification; and, shall provide the complete set at the time of final systems certification testing. As-built drawings are to be provided, and a copy of them in Auto-CAD provided on compact disk or DVD. Should the installing contractor engage the testing company to provide as-built or any portion thereof, it shall not be deemed a conflict of interest or breach of the 'third party testing company' requirement.
- D. Certification documentation shall be provided to COR 10 working days prior to submitting the request for final inspection. The documentation shall include all test results, the names of individuals performing work for the testing agency on this project, detailed procedures followed for all tests, and certification that all results of tests were within limits specified.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Material or equipment containing a weighted average of greater than 0.25 percent lead is prohibited in any potable water system intended for human consumption, and shall be certified in accordance with NSF 61 or NSF 372.

2.2 SOFTENING SYSTEM

- A. Vertical, down flow, pressure type with manifold piping, valves, and automatic controls to operate on sodium cycle. Automatic-alternating duplex (twin) units. Designed for 690 kPa (100 psig) working pressure. All materials exposed to water shall be considered as generally safe by

the Food and Drug Administration (FDA). System shall comply with UL 979.

B. Performance Requirements:

1. Continuous flow of zero hardness soft water (use hardness test strips) with influent water conditions and flows listed in Part 1, with only one of the duplex units in service.
2. Exchanger material shall not wash out of apparatus during any softening run regardless of rate of flow.
3. Turbidity and color of treated water shall not increase above that of raw water.
4. Dirty or turbid water shall not occur during any softening run, regardless of changes in demand rate.
5. Strainer system, gravel bed, and exchange material shall not become fouled, either by turbidity in the raw water, or by dirt, rust or scale from pipe to the extent to render backwash ineffective.
6. Regeneration shall be accomplished within a period of 75 minutes and occur not more than once per day. Regeneration period shall be that part of cycle of operation from the time unit has delivered its softening capacity until it is ready to be delivering soft water again, including all backwashing, brining and brine washout, complete. Amount of salt necessary to completely recondition unit after a capacity run shall not exceed 240 kg per cubic meter (15 pounds per cubic foot) of existing material.

- C. Softener resin tank(s) shall be constructed of composite fiberglass reinforced plastic (FRP) construction. The inner shell shall be constructed of high density polyethylene with an outer shell of continuous fiberglass roving. The maximum operating pressure shall be 150 psig and despised with a safety factor of 4:1 for minimum burst pressure. Maximum design temperature shall be rated for 120° F. All tank service connections shall be integrally molded flanged openings. The pressure vessel support base shall be a tri-pod design and constructed of polyethylene. A minimum freeboard of 50% shall be provided for backwash expansion above the normal ion exchange resin bed level. Provide pressure vessel stamped and certified in accordance with ASME Section X. Maximum working pressure to be 150 psig and designed with a safety factor of 6:1 for minimum burst pressure.
- D. Distribution System: The upper distribution system shall be a single point baffle constructed of Schedule-80 PVC pipe and fittings. The

lower distributor system shall be of the hub and radial type design, constructed of PVC with slotted full flow non-clogging replaceable ABS strainers and covered with a subfill of 1/8" x 1/16" washed gravel.

- E. Main Operating Valves: The main operating valves shall be a nest of individual diaphragm valves. The valves shall have Noryl thermoplastic bodies, Buna-N diaphragm and stainless steel and brass internal parts. The valves shall be slow opening and closing, and free of water hammer. There shall be no contact of dissimilar metals within the valves and no special tools shall be required to services the valves. Valves can be operated either hydraulically or pneumatically.
- F. Brine System shall be platform type with a dry salt storage compartment and a saturated brine compartment sufficient for at least four regenerations at full salting. The tank shall be of polyethylene construction. It shall be equipped with a float operated plastic brine valve and allow for simple adjustment of salt dosage without removal of salt or salt shelf system. Provide an external automatic self-adjusting brine injector to draw brine and rinse at a constant rate regardless of water pressure in the range 30 to 100 PSI. Brine injector shall be made of PVC and be sized to provide adequate brine draw for the specified softener system.
- G. Softening Resin shall be of a premium grade high capacity, cation type, to be furnished in the sodium form. It shall be stable over the entire pH range, have good resistance to bead fracture, and be insoluble in all common solvents. The resin shall be capable of 30,000 grains per cubic foot capacity when regenerated with 15 lbs. NaCl. Resin shall be FDA compliant under CFR 21, Chapter 1, Part 173.25.
- H. Flow Control: An automatic backwash control shall be provided to maintain a proper backwash and fast flush flows over wide variations of operating pressure. Controller shall contain no moving parts, and require no field adjustment
- I. Piping and Fittings: The main operating valves and manifold piping shall be factory assembled and shipped attached to the resin tank for ease of installation and start-up. Piping and fittings shall be Schedule 80 PVC.
- J. Control System: A NEMA 4-X rated, factory mounted and wired electrical enclosure with all timing and sequencing controls for the softener shall be manufactured and provided by the same vendor providing the water treatment hardware. The controls shall include an automatic

regeneration timer having the capability of providing site adjustable regeneration steps of backwash, brine injection, brine displacement, flush and return to service. Indicator lights on the controller shall display the current status of the system. A multi-ported pilot control stager shall be factory wired and pre-tubed to automatically pressure activate the main operating valves through the steps of regeneration. An indicator on the stager indicates the cycle of operation at all times. Complete function and control of all regeneration steps can be performed manually in the event of a power failure.

- K. Skid Mount/Pre-piped/Pre-wired: The softener resin tanks shall be skid mounted on a 4" channel iron skid (7.25 lbs. per foot, ASTM grade A-36). The skid shall be cross-braced with 4" channel or angle iron. All steel surfaces shall be finish coated with Safety Blue epoxy paint system. All interconnecting piping shall be Sch 80 PVC. Include inlet and outlet PVC isolation ball valves for each tank and a PVC system bypass valve. Inlet, outlet and drain headers shall be provided and terminated at the skid edge. All piping shall be suitably supported by channel supports anchored to the skid. Provide sampling cocks for hard water inlet and soft water outlet. Electric wiring, where applicable, shall be complete between all inter unit controls and require only a single power source connection. The inter unit wiring shall be contained in waterproof conduit. All inter-tank hydraulic or pneumatic tubing shall be installed as part of the skid package. The resin tanks are to be bolted to the skid. Permanent attachment, or welding, will not be acceptable. The entire skid mounted system shall be leak and electrically tested as a unit by the manufacturer before shipment. The entire skidded system shall be factory hydrotested at 100 psig for a minimum of 2 hours. A complete hydrotest report shall be provided in the service manual.

2.3 REGENERATION INITIATION

- A. Twin Alternating Metered System
- B. The twin water softener shall be equipped with one (1) turbine or paddle-type water meter in the common outlet header. When the user specified volume is reached, the meter register will send a 120-volt signal to an alternator stager that will direct the softener presently on-line to begin regeneration immediately while placing the stand-by softener into service mode. System shall produce a continuous supply of soft water.

2.4 BRINE PUMP

- A. Brine pump skid to be fabricated of electric weld low carbon steel. The skid to be provided with hold down holes and mouse holes to minimize water pooling under the skid. Prime coat and finish coat with high solids epoxy 3-5 mils thick.
- B. Provide two (2) pumps, flooded suction type, 25gpm at 70 feet head, 2 Hp each, 460v, 3 phase.
- C. The brine pump skid is to be supplied with a Hayward PVC basket strainer fitted with a 40 mesh stainless steel screen to prevent undissolved salt from entering the brine system.
- D. Each brine pump to be provided with a discharge pressure gauge.
- E. The brine pump skid will be provided with the proper suction and discharge manual isolating valves along with pump discharge check valves.
- F. All brine pump skid piping to be sch 80 PVC except where noted. All fittings to be sch 80 PVC with socket weld or threaded fittings.
- G. The brine pump skid to be provided with a NEMA 4 master control panel. The master control panel to be supplied with all motor starters, overloads, hand-off-auto switched, pilot lights and safety disconnect.
- H. The complete brine pump skid will have a full hydro-test at 80 psig (pump case limitation) for 2 hours to insure the skid to be leak free before shipping.

2.4 PRESSURE GAGES

- A. ASME B40.100, Grade A, 1 percent accuracy, 115 mm (4-1/2 inches) diameter, all metal case, bottom connected. White dials, black hands, graduated from 0 to 690 kPa (0 to 100 psig) and identity labeled. Provide gages with gage cocks at softener hard water inlet and soft water outlet to show pressure drop thru softener.

2.5 WATER TESTING EQUIPMENT

- A. Furnish water testing hardness test strips which measure 0-25 grains of hardness with minimum bottle of 50 strips with color code chart for reading test strips.

PART 3 - EXECUTION

3.1 REQUIRED TECHNICAL SERVICES

- A. Provide services of a qualified manufacturer's representative to check complete installation for conformance to manufacturer's recommendation, put system into service, make all adjustments required for full

conformance to design and specified requirements, and perform all demonstrations and tests.

3.2 FLUSHING AND DISINFECTING

- A. Flush and disinfect new water lines and softener interiors in accordance with AWWA C651.
- B. Material:
 - 1. Liquid chlorine: AWWA B301.
 - 2. Hypochlorite: AWWA B300.

3.3 STARTUP AND TESTING

- A. Operating: Tests shall be conducted in presence of COR. It is prohibited, for testing purposes, to add to or subtract from exchange material used in apparatus, neither will any regenerating agent, other than the solution specified, be permitted.
- B. Procedure:
 - 1. Regenerate system to demonstrate operation of multiport valve.
 - 2. Operate each softener at constant maximum required capacity for ten minutes after soft water is produced. When necessary, waste softened water to sewer to maintain above flow rate. Contractor shall submit samples to a USEPA certified testing laboratory. A certified test report shall be prepared indicating hardness levels are within the specified range. Hardness shall be less than 50 mg/L or as specified.
 - 3. Demonstrate all features of the control system including diagnostics and flow and cycle indications.
- C. The CxA will observe startup and contractor testing of selected equipment. Coordinate the startup and contractor testing schedules with the COR and CxA. Contractor shall provide a minimum of 10 working days prior to startup and testing.

3.4 COMMISSIONING

- A. Provide commissioning documentation in accordance with the requirements of Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.
- B. Components provided under this section of the specification will be tested as part of a larger system.

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 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.

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SECTION 22 67 21
WATER DEALKALIZING SYSTEM

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Provide a chloride anion, pressure type, water dealkalizing system, complete, ready for operation, including electrical connections, services, controls, and all required accessories and equipment.

1.2 RELATED WORK

- A. Section 01 00 00, GENERAL REQUIREMENTS.
- B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- C. Section 01 81 13, SUSTAINABLE CONSTRUCTION REQUIREMENTS.
- D. Section 01 91 00, GENERAL COMMISSIONING REQUIREMENTS.
- E. Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING.
- F. SECTION 22 08 00, COMMISSIONING OF Plumbing SYSTEMS: Requirements for commissioning, systems readiness checklist, and training.

1.3 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 their basic designation only.
- B. American Society of Mechanical Engineers (ASME):
B40.100-2013.....Pressure Gauges and Gauge Attachments
- C. ASTM International Standards (ASTM):
E1229-2008.....Standard Specification for Calcium Hypochlorite
E1120-2008.....Standard Specification for Liquid Chlorine
- D. American Water Works Association (AWWA):
C651-2005Disinfecting Water Mains

1.4 SUBMITTALS

- A. Submittals, including number of required copies, shall be submitted in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Information and material submitted under this section shall be marked "SUBMITTED UNDER SECTION 22 67 21, WATER DEALKALIZING SYSTEM", with applicable paragraph identification.
- C. Manufacturer's Literature and Data including: Full item description and optional features and accessories. Include dimensions, weights, materials, applications, standard compliance, model numbers, size, and capacity.
 - 1. Piping

2. Valves
3. Dealkalizing System
4. Controls
5. Pressure Gages
6. Water meter
7. Caustic pump
8. Water Testing Equipment
- D. Completely detailed layout, setting, arrangement, and installation drawings including electrical/hydraulic controls. Drawings shall also show all parts of the apparatus including relative positions, dimensions, sizes, required clearances for unobstructed operation and general arrangement of connecting piping.
- E. Certification of performance requirements.
- F. ASME U-form tank construction form.
- G. Field performance test results.
- H. Completed System Readiness Checklist provided by the CxA and completed by the contractor, signed by a qualified technician and dated on the date of completion, in accordance with the requirements of Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.
- I. Submit training plans and instructor qualifications in accordance with the requirements of Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.

1.5 QUALITY ASSURANCE

- A. Influent Water Analysis:
 - Total Hardness 10 gpg (soft water feed required)
 - Total Alkalinity 72 ppm
 - Total Anions 100 ppm
 - Total Dissolved Solids (TDS) 250 ppm
 - Turbidity 0 NTU
 - pH 7Obtain and verify the analysis.
- B. Performance Requirements: Provide written certification that the following performance requirements shall be met by equipment under actual operating conditions:
 1. Exchanger material shall not wash out of the apparatus during any dealkalizing run regardless of rate of flow.

2. Turbidity and color of treated water shall not be increased above same of sodium cycle treated water by reason of passing through the exchanger equipment.
3. Strainer system, gravel bed, and exchange material shall not become fouled by dirt, rust, or scale from pipe lines to the extent to render backwash ineffective.
4. Effluent Water Quality: 90% alkalinity reduction.

C. System Requirements:

1. DESIGN PARAMETERS

Design System Flow & Pressure Drop	170 gpm @ 23.6 psi
Continuous System Flow & Pressure Drop	87.5 gpm @ 15 psi
Peak System Flow & Pressure Drop	175 gpm @ 25 psi
Daily Water Usage	15,000 gpd
Daily Hours of Water Demand	24 Hours/Day
Operating Temperature Range	35-100 °F
Operating Pressure Range (System)	30-100 psi
Electrical Requirements	120V/1Ph/60Hz

2. Regeneration shall be accomplished within a period of 75 minutes. Regeneration period shall be that part of cycle of operation from the time unit has delivered its dealkalizing capacity until it is ready to deliver dealkalized water again, including all backwashing, brining and brine washout, etc., complete. Quantity of caustic soda shall be approximately one tenth of salt employed.

- D. Required Technical Services: Provide services of a qualified manufacturer's representative to check complete installation for conformance to manufacturer's recommendation, put system into service, make adjustments required for full conformance to design and specified requirements, and test per Part 3 of this specification.

- E. Bio-Based Materials: For products designated by the USDA's Bio-Preferred Program, provide products that meet or exceed USDA recommendations for bio-based content, so long as products meet all performance requirements in this specifications section. For more information regarding the product categories covered by the Bio-Preferred Program, visit <http://www.biopreferred.gov>.

1.6 AS-BUILT DOCUMENTATION

- A. Submit manufacturer's literature and data updated to include submittal review comments and any equipment substitutions.
- B. Submit operation and maintenance data updated to include submittal review comments, substitutions and construction revisions shall be in electronic version on compact disc or DVD. All aspects of system operation and maintenance procedures, including piping isometrics, wiring diagrams of all circuits, a written description of system design, control logic, and sequence of operation shall be included in the operation and maintenance manual. The operations and maintenance manual shall include troubleshooting techniques and procedures for emergency situations. Notes on all special systems or devices such as damper and door closure interlocks shall be included. A List of recommended spare parts (manufacturer, model number, and quantity) shall be furnished. Information explaining any special knowledge or tools the owner will be required to employ shall be inserted into the As-Built documentation.
- C. The installing contractor shall maintain as-built drawings of each completed phase for verification; and, shall provide the complete set at the time of final systems certification testing. As-built drawings are to be provided, and a copy of them in the latest AutoCAD version. provided on compact disc or DVD. Should the installing contractor engage the testing company to provide as-built or any portion thereof, it shall not be deemed a conflict of interest or breach of the 'third party testing company' requirement.
- D. Certification documentation shall be provided to COR 10 working days prior to submitting the request for final inspection. The documentation shall include all test results, the names of individuals performing work for the testing agency on this project, detailed procedures followed for all tests, and certification that all results of tests were within limits specified.

PART 2 - PRODUCTS

2.1 TANKS

- A. Tanks shall be manufactured of fiberglass reinforced polyester (FRP). The exterior side shall be reinforced by a continuous roving glass filament overwrap of the same color as the vessel(s) shell. The tanks(s) shall be supported by a molded polypropylene structural base. The tanks(s) shall be designed for a working pressure of 150 psi and a temperature of 120°F. A minimum freeboard volume of 50% shall be provided to assure adequate bed expansion during backwash.

2.2 DISTRIBUTION

- A. Upper distribution system shall be a single plastic disperser.
- B. Lower Distributor: The backwash distributor and treated water collector shall be of the hub-radial design and shall require only assembly of the riser pipe upon installation. The radials shall be designed with a higher density of slots at the outer ends to provide adequate distribution and collection of water away from the center of the tank. Internal piping material shall be constructed of PVC and/or ABS plastic. A washed gravel underbedding shall be provided as a support bed for the exchange media and an aid in backwashing

2.3 MAIN OPERATING VALVES

- A. The control valve shall have 3-inch inlet and outlet connections and be constructed of lead-free brass. It shall be of the mechanically actuated, four position type to accomplish the regeneration steps of backwash, brine draw / slow rinse, fast rinse and brine tank refill. The valve shall contain a fixed orifice eductor nozzle and self-adjusting backwash flow control.

2.4 CONTROL SYSTEM

- A. The control system shall have an integral timer for adjustable duration of the various steps in the regeneration cycle and shall allow for the manual initiation of the regeneration cycle.
- B. The system shall have an electronic microprocessor based controller with a 2 line/16-character LCD backlit display. The display shall indicate: time of day, batch volume remaining, valve state, valve address and system number. In addition, a LED status light shall be provided to indicate controller status: in service, regenerating, standby, or error. Programming and time of day to be stored in non-volatile memory.

- C. The controller shall also be capable of providing the hours between last two regenerations, hours since last regeneration and valve position.
- D. The controller shall operate on 24 VAC and multi-unit communications shall be accomplished with low voltage network cables.
- E. Metered units shall also provide: current flow rate, peak flow rate, water usage totalization and batch volume remaining. A calendar clock override of the water meter is provided to initiate regeneration (programmable to 1-30 days).
- F. Mode of Operation: The system shall operate as twin alternating. The system controller shall keep one tank online at all times with the second tank either in standby or regenerating. One volumetric meter shall be included and installed in the common outlet header. After a preset volume of water has passed through the online tank, the controller will initiate a regeneration. The second tank is brought online providing for a continuous supply of treated water. Upon completion of regeneration, the offline tank status will change to standby

2.5 BRINE SYSTEM

- A. The combination salt storage and brine measuring tank with cover shall be constructed of rotationally molded rigid polyethylene. The brine tank shall be equipped with an elevated salt plate for the collection of brine and shall have a chamber to house a brine valve assembly. The brine valve assembly shall include an automatic air eliminator and safety float shut-off valve. It shall open automatically, to educt brine, close to prevent the entrance of air after the brine has been drawn, and permit refill of the tank with the correct amount of water. Brine dosage shall be controlled by the dealkalizer control valve through an adjustment on the clock timer. The system shall be designed to allow proper refilling regardless of the salt level in the tank.

2.6 CAUSTIC FEED SYSTEM

- A. Provide an automatic chemical feed system to inject a small amount of caustic into the diluted brine solution during the brine draw period. Caustic assisted regeneration will remove carbon dioxide from the water and maximize capacity. The system shall consist of a caustic pump, portable pump stand, foot valve, suction and discharge tubing and controls.

- B. The caustic pump shall be a positive displacement diaphragm metering pump that is infinitely adjustable from 0 to 100% of the capacity range. Ball check valves on the suction and discharge will insure metering accuracy. The pump motor shall operate on 120 volt, 60 Hz, single phase electrical power.

2.7 DEALKALIZER RESIN

- A. The ion exchange resin shall be virgin high capacity strongly basic, anion type stable over the entire pH range with high regeneration efficiency and low susceptibility to organic fouling. Each cubic foot of resin shall be capable of removing 9,059 grains of total exchangeable anions as calcium carbonate when regenerated with 5 lbs. of salt and 0.33 lbs. of caustic.

2.8 SKID MOUNT, PREPIPED, AND PREWIRED

- A. The dealkalizer resin tanks shall be factory mounted on an epoxy-coated carbon steel skid. The control valves shall be pre-installed on the dealkalizer tanks. All interconnecting piping and isolation valves between dealkalizer tanks shall be furnished. Piping and fittings shall be constructed of Schedule 80 PVC. Controls and water meters shall be factory wired.

2.9 PRESSURE GAGES

- A. ASME B40.100, Grade A, 1 percent accuracy, 115 mm (4-1/2 inches) diameter, all metal case, bottom connected. White dials, black hands, graduated from 0 to 690 kPa (0 to 100 psig) and identity labeled. Provide gages with gage cocks at soft water inlet and dealkalizer outlet to show pressure drop thru dealkalizer.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. If an installation is unsatisfactory to the COR, the Contractor shall correct the installation at no cost or additional time to the Government.

3.2 FLUSHING AND DISINFECTING

- A. Flush and disinfect new water lines and dealkalizer interior in accordance with AWWA C651.
- B. Material:
 - 1. Liquid Chlorine: ASTM E1120.
 - 2. Hypochlorite: ASTM E1229.

3.3 STARTUP AND TESTING

- A. Operating: Tests shall be performed in the presence of COR. Contractor shall provide a minimum of 10 working days prior to startup and testing. It is prohibited, for testing purposes, to add to or subtract from exchange material used in apparatus, neither shall any regenerating agent, other than the solution specified, be permitted.
- B. Procedure:
 - 1. Operate dealkalizer at a constant maximum required capacity for ten minutes after dealkalized water is produced. If necessary, waste treated water to sewer to maintain above flow rate. Dealkalized water production shall begin when a sample of 40 cc does not indicate more than 20 mg/L (20 ppm) of alkalinity.
 - 2. Regenerate system to demonstrate operation of multiport valve and control system.
- C. The CxA will observe startup and contractor testing of selected equipment. Coordinate the startup and contractor testing schedules with the COR and CxA. Contractor shall provide a minimum of 10 working days prior to startup and testing.

3.4 COMMISSIONING

- A. Provide commissioning documentation in accordance with the requirements of Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.
- B. Components provided under this section of the specification will be tested as part of a larger system.

3.5 DEMONSTRATION AND TRAINING

- A. Provide services of manufacturer's technical representative for (2) 4 hour sessions to instruct VA Personnel in operation and maintenance of units.
- B. Submit training plans and instructor qualifications in accordance with the requirements of Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.

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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, Engineer at the construction site.

1.2 RELATED WORK

- A. Section 00 01 15, Index of Drawings.
- B. Section 01 00 00, GENERAL REQUIREMENTS.
- C. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- D. Section 03 30 53, (SHORT FORM) CAST-IN-PLACE CONCRETE.
- E. Section 05 50 00, METAL FABRICATIONS.
- F. Section 09 91 00, PAINTING.
- G. Section 22 31 11, WATER SOFTENERS.
- H. SECTION 22 67 21, WATER DEALKALIZING SYSTEM
- I. Section 23 05 12, GENERAL MOTOR REQUIREMENTS FOR HVAC and STEAM GENERATION EQUIPMENT.
- J. Section 23 05 51, NOISE AND VIBRATION CONTROL FOR BOILER PLANT.
- K. Section 23 05 93, TESTING, ADJUSTING, and BALANCING FOR HVAC.
- L. Section 23 07 11, HVAC and BOILER PLANT INSULATION.
- M. Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.
- N. Section 23 08 11, DEMONSTRATIONS and TESTS FOR BOILER PLANT.
- O. Section 23 09 11, INSTRUMENTATION and CONTROL FOR BOILER PLANT.
- P. Section 23 21 11, BOILER PLANT PIPING SYSTEMS
- Q. Section 23 31 00, HVAC DUCTS AND CASINGS.
- R. Section 23 34 00, HVAC FANS
- S. Section 23 37 00, AIR OUTLETS AND INLETS
- T. Section 23 50 11, BOILER PLANT MECHANICAL EQUIPMENT.
- U. Section 23 51 00, BREECHINGS, CHIMNEYS, and STACKS.
- V. Section 23 52 39, FIRE-TUBE BOILERS
- W. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS
- X. Section 26 29 11, MOTOR CONTROLLERS

- Y. VHA Boiler Plant Safety Device Testing Manual, copied in its entirety at the end of this specification section.

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. All VA safety device requirements shall be complied with regardless of the size, type, or operating pressure of boiler to include condensing boilers, hot water boilers for heating systems, as defined in the latest edition of the VHA Boiler Plant Safety Device Testing Manual. The systems shall be comprised of high quality institutional-class and industrial-class products of manufacturers that are experienced specialists in the required product lines. All construction firms and personnel shall be experienced and qualified specialists in industrial and institutional HVAC or steam boiler plant construction, as applicable.
- B. Flow Rate Tolerance for HVAC Equipment: Section 23 05 93, TESTING, ADJUSTING, AND BALANCING FOR HVAC.
- C. Equipment Vibration Tolerance:
1. Refer to Section 23 05 51, NOISE AND VIBRATION CONTROL FOR BOILER PLANT. Equipment shall be factory-balanced to this tolerance and re-balanced on site, as necessary.
- D. Products Criteria:
1. Standard Products: Material and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of the products for at least 3 years (or longer as specified elsewhere). The design, model and size of each item shall have been in satisfactory and efficient operation on at least three installations for approximately three years. However, digital electronics devices, software and systems such as controls, instruments, computer work station, shall be the current generation of technology and basic design that has a proven satisfactory service record of at least three years. See other specification sections for any exceptions and/or additional requirements.
 2. 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.

E. 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.

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

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

2. Comply with provisions of ASME B31 series "Code for Pressure Piping".
 3. Certify that each welder has passed American Welding Society (AWS) qualification tests for the welding processes involved, and that certification is current.
- G. Boiler Plant Welding: Refer to Sections 23 21 11, BOILER PLANT PIPING SYSTEMS.
- H. Execution (Installation, Construction) Quality:
1. Apply and install all items in accordance with manufacturer's written instructions. Refer conflicts between the manufacturer's instructions and the contract drawings and specifications to the 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. Failure of the contractor to resolve, or point out any issues will result in the contractor correcting at no additional cost to the government.
 3. Provide complete layout drawings required by Paragraph, SUBMITTALS. Do not commence construction work on any system until the layout drawings have been approved.
 4. Workmanship/craftsman's ship will be of the highest quality and standards. The VA reserves the right to reject any work based on poor quality of workmanship this work shall be removed and done again at no additional cost to the government.

- I. 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. It is the contractor's responsibility to ensure all submittals meet the VA specifications and requirements and it is assumed by the VA that all submittals do meet the VA specs unless the contractor as requested a variance in writing and approved by VA/VHA Central Office prior to the submittal. If at any time during the project it is found that any item does not meet the VA specs and there was no variance approval the contractor to correct at no additional cost to the government even if a submittal was approved.
- 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 III: Boilers, burners including forced draft fan and motor controls, boiler accessories (trim), fuel valve trains, atomizing media valve trains, stacks and breeching.

2. Group IV (Boiler/Burner Controls and Boiler Plant Controls and Instrumentation): Boiler control system, burner management (flame safeguard) systems (may be included with Group III), flow measuring systems, control and instrument panels and accessories, feedwater deaerator and condensate storage tank water level control systems, instruments and accessories, computer workstation and software, instrumentation, tools.
3. Group V (Condensate Storage):
 - a. Condensate storage tank and accessories.
 - b. Concrete foundation and anchorage.
4. Group VI (Condensate Transfer):
 - a. Condensate transfer pumps, motors, accessories.
 - e. Water level control valve at boilers as approved in Group III.
- 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. Continuous blow-off heat recovery system.
 4. Emergency shut off valve - gas.
 5. Safety valves and drip pan ells.
 6. Temperature control valves, sensors.
 7. Steam pressure reducing valves and pilots.
 8. Continuous blow off control system, valves - boilers.
 9. Sight flow indicators, oil and water.
 10. Steam traps with orifice sizes and pressure ratings.
 11. Thermometers and pressure gauges and accessories.
 12. Chemical feeders.
 13. Sample coolers.
 14. Blowdown tank and accessories.
 15. Gas pressure regulators, relief valves, and filters.
 16. Flexible connectors, hose, braided.
 17. Dielectric fittings and unions.
 18. Quick-couple hose fittings and steam hose.
 19. Heating and ventilating equipment.
 20. Condensate pump sets.
 21. Compressed air system.
 22. Vibration isolators - air, water, oil.

23. Supports and braces for pipe, stacks, breeching; load, size, movement calculations.
24. Pressure gauge test kit.
25. Insulation, field-applied.
26. Boiler plant building dangerous gas detection system.

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. Refer to Section 00 72 00, GENERAL CONDITIONS, Article, SUBCONTRACTS AND WORK COORDINATION.
2. The drawings shall include plan views, elevations and sections of all systems and shall be on a scale of not less than 1:32 (3/8-inch equal to one foot). Clearly identify and dimension the proposed locations of the principal items of equipment. The drawings shall clearly show locations and adequate clearance for all equipment, piping, valves, control panels and other items. Show the access means for all items requiring access for operations and maintenance. Provide detailed layout drawings of all piping and duct systems.
3. Do not install equipment foundations, equipment or piping until layout drawings have been approved.
4. In addition, for HVAC systems, provide details of the following:
 - a. Mechanical equipment rooms.
 - c. Hangers, inserts, supports, and bracing.
 - d. Pipe sleeves.
 - e. Duct or equipment penetrations of floors, walls, ceilings, or roofs.

I. Manufacturer's Literature and Data: Submit under the pertinent section rather than under this section.

1. Submit belt drive with the driven equipment. Submit selection data for specific drives when requested by the Resident Engineer.
2. Submit electric motor data and variable speed drive data with the driven equipment.
3. Equipment and materials identification.
4. Fire-stopping materials.
5. Hangers, inserts, supports and bracing. Provide load calculations for variable spring and constant support hangers. For boiler plants, refer to Section 23 21 11, BOILER PLANT PIPING SYSTEMS, for additional requirements.

6. Wall, floor, and ceiling plates.

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. Air Conditioning, Heating and Refrigeration Institute (AHRI):
430-2009.....Central Station Air-Handling Units
- C. American National Standard Institute (ANSI):
B31.1-2007.....Power Piping
- D. 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
- E. Air Movement and Control Association (AMCA):
410-96.....Recommended Safety Practices for Air Moving
Devices
- F. American Society of Mechanical Engineers (ASME):
Boiler and Pressure Vessel Code (BPVC):
Section I-2007.....Power Boilers
Section IX-2007.....Welding and Brazing Qualifications
Code for Pressure Piping:
B31.1-2007.....Power Piping
- G. 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
- H. 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

SP 127-2001.....Bracing for Piping Systems, Seismic - Wind -
Dynamic, Design, Selection, 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. NO BOILER or piece of equipment such as the DA Tank will be accepted for beneficial use until ALL Safety Devices have been tested and passed in accordance with the latest edition of the VHA Boiler Plant Safety Device Testing Manual, and all control systems are proven to be fully operational without faults or shutdowns for a period not less than 21 days of continuous operation without interaction from any person other than that of normal operational duties.

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

PART 2 - PRODUCTS

2.1 FACTORY-ASSEMBLED PRODUCTS

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

2.2 COMPATIBILITY OF RELATED EQUIPMENT

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

2.3 BELT DRIVES

- A. Type: ANSI/RMA standard V-belts with proper motor pulley and driven sheave. Belts shall be constructed of reinforced cord and rubber.
- B. Dimensions, rating and selection standards: ANSI/RMA IP-20 and IP-21.
- C. Minimum Horsepower Rating: Motor horsepower plus recommended ANSI/RMA service factor (not less than 20 percent) in addition to the ANSI/RMA allowances for pitch diameter, center distance, and arc of contact.
- D. Maximum Speed: 25 m/s (5000 feet per minute).
- E. Adjustment Provisions: For alignment and ANSI/RMA standard allowances for installation and take-up.
- F. Drives may utilize a single V-Belt (any cross section) when it is the manufacturer's standard.
- G. Multiple Belts: Matched to ANSI/RMA specified limits by measurement on a belt measuring fixture. Seal matched sets together to prevent mixing or partial loss of sets. Replacement, when necessary, shall be an entire set of new matched belts.
- H. Sheaves and Pulleys:
 - 1. Material: Pressed steel, or close grained cast iron.
 - 2. Bore: Fixed or bushing type for securing to shaft with keys.
 - 3. Balanced: Statically and dynamically.
 - 4. Groove spacing for driving and driven pulleys shall be the same.
 - 5. Minimum Diameter of V-Belt Sheaves (ANSI/RMA recommendations) in millimeters and inches:
- I. Drive Types, Based on ARI 435:
 - 1. Provide adjustable-pitch or fixed-pitch drive as follows:
 - a. Fan speeds up to 1800 RPM: 7.5 kW (10 horsepower) and smaller.
 - b. Fan speeds over 1800 RPM: 2.2 kW (3 horsepower) and smaller.
 - 2. Provide fixed-pitch drives for drives larger than those listed above.
 - 3. The final fan speeds required to just meet the system CFM and pressure requirements, without throttling, shall be determined by adjustment of a temporary adjustable-pitch motor sheave or by fan law calculation if a fixed-pitch drive is used initially.

2.4 DRIVE GUARDS

- A. For machinery and equipment, provide guards as shown in AMCA 410 for belts, chains, couplings, pulleys, sheaves, shafts, gears and other moving parts regardless of height above the floor to prevent damage to equipment and injury to personnel. Drive guards may be excluded where motors and drives are inside factory fabricated air handling unit casings.
- B. Pump shafts and couplings shall be fully guarded by a sheet steel guard, covering coupling and shaft but not bearings. Material shall be minimum 16-gage sheet steel; ends shall be braked and drilled and attached to pump base with minimum of four 6 mm (1/4-inch) bolts. Reinforce guard as necessary to prevent side play forcing guard onto couplings.
- C. V-belt and sheave assemblies shall be totally enclosed, firmly mounted, non-resonant. Guard shall be an assembly of minimum 22-gage sheet steel and expanded or perforated metal to permit observation of belts. 25 mm (one-inch) diameter hole shall be provided at each shaft centerline to permit speed measurement.
- D. Materials: Sheet steel, cast iron, expanded metal or wire mesh rigidly secured so as to be removable without disassembling pipe, duct, or electrical connections to equipment.
- E. Access for Speed Measurement: 25 mm (One inch) diameter hole at each shaft center.

2.5 LIFTING ATTACHMENTS

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

2.6 ELECTRIC MOTORS

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

2.7 VARIABLE SPEED MOTOR CONTROLLERS

- A. Refer to Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS and Section 26 29 11, LOW-VOLTAGE MOTOR STARTERS for specifications.
- B. The combination of controller and motor shall be provided by the manufacturer of the driven equipment, such as pumps and fans, and shall be rated for 100 percent output performance. Multiple units of the same class of equipment, i.e. 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 30,000 AIC. Provide AC input line reactors (3% impedance) on incoming power line. Provide output line reactors on line between drive and motor for motors over 50 HP or where the distance between the breaker and motor exceeds 50 feet.

2.8 BOILER PLANT CONTROLS AND INSTRUMENTATION, COMPUTER WORKSTATION

- A. Provide, and place into proper operation, complete systems as specified in Section 23 50 11, BOILER PLANT MECHANICAL EQUIPMENT; and Section 23 09 11, INSTRUMENTATION AND CONTROL FOR BOILER PLANT. Furnish all hardware, software and programming to properly accomplish specified functions.
- B. Electronic Systems: Provide complete, protected power supplies as specified. Power supplies shall protect computers, controls, instruments and accessories from damage due to spikes, surges, transients, and overloads in the incoming power supply. Provide all interconnections between elements of the system. Entire installation shall conform to NFPA 70.

2.9 EQUIPMENT AND MATERIALS IDENTIFICATION

- A. Use symbols, nomenclature and equipment numbers specified, shown on the drawings and shown in the maintenance manuals. Identification for piping is specified in Section 09 91 00, PAINTING.
- B. Interior (Indoor) Equipment: Engraved nameplates, with letters not less than 48 mm (3/16-inch) high of brass with black-filled letters, or rigid black plastic with white letters specified in Section 09 91 00, PAINTING permanently fastened to the equipment. Identify unit components such as coils, filters, fans, etc.
- C. Exterior (Outdoor) Equipment: Brass nameplates, with engraved black filled letters, not less than 48 mm (3/16-inch) high riveted or bolted to the equipment.
- D. Control Items: Label all temperature and humidity sensors, controllers and control dampers. Identify and label each item as they appear on the control diagrams.
- E. Valve Tags and Lists:
 - 1. 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.

2.10 FIRESTOPPING

- A. Section 07 84 00, FIRESTOPPING specifies an effective barrier against the spread of fire, smoke and gases where penetrations occur for piping and ductwork. Refer to Section 23 07 11, HVAC, PLUMBING, AND BOILER PLANT INSULATION, for firestop pipe and duct insulation.

2.11 GALVANIZED REPAIR COMPOUND

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

2.12 HVAC PIPE AND EQUIPMENT SUPPORTS AND RESTRAINTS

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

- I. 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.
- J. 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.
- K. Supports for Piping Systems:
 - 1. Select hangers sized to encircle insulation on insulated piping. Refer to Section 23 07 11, HVAC, PLUMBING, AND BOILER PLANT INSULATION for insulation thickness. To protect insulation, provide Type 39 saddles for roller type supports or preinsulated calcium silicate shields. Provide Type 40 insulation shield or preinsulated calcium silicate shield at all other types of supports and hangers including those for preinsulated piping.
 - 2. Piping Systems except High and Medium Pressure Steam (MSS SP-58):
 - a. Standard clevis hanger: Type 1; provide locknut.
 - b. Riser clamps: Type 8.
 - c. Wall brackets: Types 31, 32 or 33.
 - d. Roller supports: Type 41, 43, 44 and 46.
 - e. Saddle support: Type 36, 37 or 38.
 - f. Turnbuckle: Types 13 or 15. Preinsulated.
 - g. U-bolt clamp: Type 24.
 - h. Copper Tube:
 - 1) Hangers, clamps and other support material in contact with tubing shall be painted with copper colored epoxy paint, plastic coated or taped with non-adhesive isolation tape to prevent electrolysis.

- 2) For vertical runs use epoxy painted or plastic coated riser clamps.
- 3) For supporting tube to strut: Provide epoxy painted pipe straps for copper tube or plastic inserted vibration isolation clamps.
- 4) Insulated Lines: Provide pre-insulated calcium silicate shields sized for copper tube.
 - i. Supports for plastic or glass piping: As recommended by the pipe manufacturer with black rubber tape extending one inch beyond steel support or clamp.
3. High and Medium Pressure Steam (MSS SP-58):
 - a. Provide eye rod or Type 17 eye nut near the upper attachment.
 - b. Piping 50 mm (2 inches) and larger: Type 43 roller hanger. For roller hangers requiring seismic bracing provide a Type 1 clevis hanger with Type 41 roller attached by flat side bars.
- L. Pre-insulated Calcium Silicate Shields:
 1. Provide 360 degree water resistant high density 965 kPa (140 psi) compressive strength calcium silicate shields encased in galvanized metal.
 2. Pre-insulated calcium silicate shields to be installed at the point of support during erection.
 3. Shield thickness shall match the pipe insulation.
 4. The type of shield is selected by the temperature of the pipe, the load it must carry, and the type of support it will be used with.
 - a. Shields for supporting chilled or cold water shall have insulation that extends a minimum of 1 inch past the sheet metal. Provide for an adequate vapor barrier in chilled lines.
 - b. The pre-insulated calcium silicate shield shall support the maximum allowable water filled span as indicated in MSS-SP 69. To support the load, the shields may have one or more of the following features: structural inserts 4138 kPa (600 psi) compressive strength, an extra bottom metal shield, or formed structural steel (ASTM A36) wear plates welded to the bottom sheet metal jacket.
 5. Shields may be used on steel clevis hanger type supports, roller supports or flat surfaces.

2.13 PIPE PENETRATIONS

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

J. Sealant and Adhesives: Shall be as specified in Section 07 92 00, JOINT SEALANTS.

2.14 PENETRATIONS

- A. Provide curbs for roof mounted piping, ductwork and equipment. Curbs shall be 18 inches high with continuously welded seams, built-in cant strip, interior baffle with acoustic insulation, curb bottom, hinged curb adapter.
- B. Provide firestopping for openings through fire and smoke barriers, maintaining minimum required rating of floor, ceiling or wall assembly. See section 07 84 00, FIRESTOPPING.

2.15 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. Refrigerant Tools: Provide system charging/Evacuation equipment, gauges, fittings, and tools required for maintenance of furnished equipment.
- D. Tool Containers: Hardwood or metal, permanently identified for intended service and mounted, or located, where directed by the Resident Engineer.
- E. Lubricants: A minimum of 0.95 L (one quart) of oil, and 0.45 kg (one pound) of grease, of equipment manufacturer's recommended grade and type, in unopened containers and properly identified as to use for each different application.

2.16 WALL, FLOOR AND CEILING PLATES

- A. Material and Type: Chrome plated brass or chrome plated steel, one piece or split type with concealed hinge, with set screw for fastening to pipe, or sleeve. Use plates that fit tight around pipes, cover openings around pipes and cover the entire pipe sleeve projection.
- B. Thickness: Not less than 2.4 mm (3/32-inch) for floor plates. For wall and ceiling plates, not less than 0.64 mm (0.025-inch) for up to 80 mm (3-inch pipe), 0.89 mm (0.035-inch) for larger pipe.

- C. Locations: Use where pipe penetrates floors, walls and ceilings in exposed locations, in finished areas only. Use also where insulation ends on exposed water supply pipe drop from overhead. Provide a watertight joint in spaces where brass or steel pipe sleeves are specified.

2.17 ASBESTOS

- A. Materials containing asbestos are not permitted.

PART 3 - EXECUTION

3.1 ARRANGEMENT AND INSTALLATION OF EQUIPMENT AND PIPING

- A. Coordinate location of piping, sleeves, inserts, hangers, ductwork and equipment. Locate piping, sleeves, inserts, hangers, ductwork and equipment clear of windows, doors, openings, light outlets, and other services and utilities. Prepare equipment layout drawings to coordinate proper location and personnel access of all facilities. Submit the drawings for review as required by Part 1. Follow manufacturer's published recommendations for installation methods not otherwise specified.
- B. Operating Personnel Access and Observation Provisions: Select and arrange all equipment and systems to provide clear view and easy access, without use of portable ladders, for maintenance and operation of all devices including, but not limited to: all equipment items, valves, filters, strainers, transmitters, sensors, control devices. All gages and indicators shall be clearly visible by personnel standing on the floor or on permanent platforms. Do not reduce or change maintenance and operating space and access provisions that are shown on the drawings.
- C. 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. Panels mounted on the sides near the front of fire tube boilers are acceptable.
- D. Boiler Access Platforms: Arrange piping and equipment to allow access by a person standing on the platforms to all valves located above the boilers, to boiler manways located on top of the boilers.
- E. Equipment and Piping Support: Coordinate structural systems necessary for pipe and equipment support with pipe and equipment locations to permit proper installation.
- F. Location of pipe sleeves, trenches and chases shall be accurately coordinated with equipment and piping locations.

G. Cutting Holes:

1. Cut holes through concrete and masonry by rotary core drill.
Pneumatic hammer, impact electric, and hand or manual hammer type drill will not be allowed, except as permitted by 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.

H. Interconnection of Instrumentation or Control Devices: Generally, electrical and pneumatic interconnections are not shown but must be provided.

I. Minor Piping: Generally, small diameter pipe runs from drips and drains, water cooling, and other service are not shown but must be provided.

J. Electrical Interconnection of Controls and Instruments: This generally not shown but must be provided. This includes interconnections of sensors, transmitters, transducers, control devices, control and instrumentation panels, instruments and computer workstations. Comply with NFPA-70.

K. Protection and Cleaning:

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

- L. Concrete and Grout: Use concrete and shrink compensating grout 25 MPa (3000 psi) minimum, specified in Section 03 30 00, CAST-IN-PLACE CONCRETE.
- M. Install gages, thermometers, valves and other devices with due regard for ease in reading or operating and maintaining said devices. Locate and position thermometers and gages to be easily read by operator or staff standing on floor or walkway provided. Servicing shall not require dismantling adjacent equipment or pipe work.
- N. Install steam piping expansion joints as per manufacturer's recommendations.
- O. Work in Existing Building:
 - 1. Perform as specified in Article, OPERATIONS AND STORAGE AREAS, Article, ALTERATIONS, and Article, RESTORATION of the Section 01 00 00, GENERAL REQUIREMENTS for relocation of existing equipment, alterations and restoration of existing building(s).
 - 2. As specified in Section 01 00 00, GENERAL REQUIREMENTS, Article, OPERATIONS AND STORAGE AREAS, make alterations to existing service piping at times that will least interfere with normal operation of the facility.
 - 3. 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. NO BOILER or piece of equipment such as the DA Tank will be accepted for beneficial use until ALL Safety Devices have been tested and passed in accordance with the latest edition of the VHA Boiler Plant Safety Device Testing Manual, and all control systems are proven to be fully operational without faults or shutdowns for a period not less than 21 days of continues operation without interaction from any person other than that of normal operational duties. 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.

P. 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 to ceiling structure, whichever is lower (NFPA 70).

Q. 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. All electrical test points shall be accessible without working upside down or need of inspection mirrors, and done at terminal strips within sight of the equipment.

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. Overhead Supports:
 - 1. The basic structural system of the building is designed to sustain the loads imposed by equipment and piping to be supported overhead.

2. Provide steel structural members, in addition to those shown, of adequate capability to support the imposed loads, located in accordance with the final approved layout of equipment and piping.
3. Tubing and capillary systems shall be supported in channel troughs.

F. Floor Supports:

1. Provide concrete bases, concrete anchor blocks and pedestals, and structural steel systems for support of equipment and piping. Anchor and dowel concrete bases and structural systems to resist forces under operating 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. Boiler stack and breeching -- 65 degrees C (150 degrees F) on insulation jacket surface and 315 degrees C (600 degrees F) on metal surface of stacks and breeching.
 - b. Condensate and feedwater -- 38 degrees C (100 degrees F) on insulation jacket surface and 120 degrees C (250 degrees F) on metal pipe surface.
 - c. Steam -- 52 degrees C (125 degrees F) on insulation jacket surface and 190 degrees C (375 degrees F) on metal pipe surface.
 - 8. Final result shall be smooth, even-colored, even-textured factory finish on all items. Completely repaint the entire piece of equipment if necessary to achieve this.

3.7 IDENTIFICATION SIGNS

- A. Provide laminated plastic signs, with engraved lettering not less than 5 mm (3/16-inch) high, designating functions, for all equipment, switches, motor controllers, relays, meters, control devices, including automatic control valves. Nomenclature and identification symbols shall correspond to that used in maintenance manual, and in diagrams specified elsewhere. Attach by chain, adhesive, or screws.
- B. Factory Built Equipment: Metal plate, securely attached, with name and address of manufacturer, serial number, model number, size, performance.
- C. Boiler Plant Instrumentation Panel: Refer to Section 23 09 11.
- D. Boiler Control Panels: Refer to Section 23 09 11, INSTRUMENTATION AND CONTROL FOR BOILER PLANT
- E. Pipe Identification: Refer to Section 09 91 00, PAINTING.

3.8 MOTOR AND DRIVE ALIGNMENT

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

3.9 LUBRICATION

- A. Lubricate all devices requiring lubrication prior to initial operation. Field-check all devices for proper lubrication.
- B. Equip all devices with required lubrication fittings or devices. Provide a minimum of one liter (one quart) of oil and 0.5 kg (one pound) of grease of manufacturer's recommended grade and type for each different application; also provide 12 grease sticks for lubricated plug valves. Deliver all materials to 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

- A. Startup 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.
- D. No adjustments maybe made during the acceptance inspection. All adjustments should have been made by this point.

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.
- E. New Boilers Installed in Temporary Location:
 - 1. Perform all tests required by boiler specification.
 - 2. Perform complete retest after boiler is placed in its permanent location.

3.14 INSTRUCTIONS TO VA PERSONNEL

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

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**VHA Boiler Plant Safety Device Testing Manual
Third Edition**

**By
Thomas Burch
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Third Edition

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1 INTRODUCTION

1.1 OBJECTIVE

The purpose of this manual used with manufacturers' manuals and design set points is to support the development of an individual boiler plant safety program for your specific boiler plant. The text presents a concise and thorough treatment of boiler safety as applied to automatically-fired gas and oil, heating and process boilers and boiler support equipment servicing healthcare facilities. The text includes a description of each boiler safety device, how it works, what its purpose is, and how to test the device. The safety devices are organized by categories in four chapters: Water Level Control, Pressure Containment, Fuel Train Safety Devices, and Burner and Air Train Safety Devices. A fifth chapter provides detailed step by step procedures for testing every device covered. This chapter can be used as a checklist and guide for safety testing. Some boilers will not include all of these devices.

The text does not replace existing standards. It succinctly states the main import of the standards. The final guide to safety should include all applicable standards. However, the testing envisioned in this text is far more rigorous than current industrial practice, even though the basic concept of this manual is that all boiler safety devices should consistently function properly. Proper function requires 1) proper installation, 2) proper calibration, and 3) proper activation. In situations that may arise where adherence to this manual would adversely affect the operation of the boiler, special authority may be requested to deviate from the manual through the Director, Health Care Engineering (10NB).

1.2 BACKGROUND INFORMATION

One must understand that the use of the term "boiler" may refer to the system that includes the generation, distribution, and use of steam. There are many safety devices such as level alarms, safety valves, relief valves, etc that are found on the components involved in the distribution and use of steam. The safety checks are necessary and must be conducted on **all devices in the system** in order to insure that the system is safe.

It is important that one has the manufacturer's manuals on all equipment to be tested before beginning the tests described herein. This is essential to know the manufacturer's recommended operating conditions, the wiring diagram, etc.

1.3 GENERAL OBSERVATIONS ON SAFETY TESTING

1.3.1 Items to be Checked on Any Interlock Device

Many safety devices utilize switches that actuate based on some set point to automatically alarm or shut the boiler off by shutting the two automatic fuel shut off valves. It is extremely important that one recognize that there are four attributes to such systems required for proper operation. These are:

- The switch must be in the right place.
- The switch must have the proper setpoint.
- The switch must activate at the proper setpoint.
- The switch must produce the desired effect.

All safety testing described in this text involving such switches centers around making sure that all these requirements are met. The most common failure in this regard is a failure to insure that the switch has the proper set point which requires measuring operating parameters in order to determine the proper set point.

1.3.2 Confirming That All Devices Actually Function for Intended Purpose

In testing any interlock device that operates through the automatic control system, it is paramount that the testing procedure verifies compliance with the four requirements listed above.

1.3.3 Lockable Valve Requirements

In order to facilitate testing of some types of interlock devices, it is sometimes convenient to temporarily isolate the interlock device and provide test ports by means of manual valves. However, these modifications cannot be allowed to increase risk by locking out a safety device during normal operation and should clearly indicate test and normal position. Any such manual valve that could isolate a safety device from its normal operating circuit should be lockable and the lock should be lockable **only** in the correct operating position.

1.3.4 Confirming That Jumpers Are Removed and Valves Properly Locked

In many cases in order to test a device, it will be necessary to either electrically jumper (bypass) a device or to valve out the device. The safety testing personnel should only carry a fixed number of jumpers and should make sure that at the end of a test that all jumpers being used are accounted for and that all lockable valves are locked in their correct position.

1.4 NOMENCLATURE

AFOSV	Automatic Fuel Oil Shutoff Valves
ALWCO	Auxiliary Low Water Cutoff
APFGSOV	Automatic Pilot Fuel Gas Shutoff Valves
APFGSVV	Automatic Pilot Fuel Gas Solenoid Vent Valve
CAPI	Control Air Pressure Interlock
CAPS	Combustion Air Pressure Switch
DA	Deaerator
DAODS	Deaerator Overflow Drain System
DASV	Deaerator Safety Valve
FDDWOPS	Forced Draft Damper Wide-Open Pre-Purge Proving Switch
FDMIS	Forced Draft Motor Interlock Switches
FGRDI	Flue Gas Recirculation Damper Interlock
AFGSOV	Automatic Fuel Gas Shutoff Valves and Solenoid Vent Valve
AFGSVV	Automatic Fuel Gas Shutoff Solenoid Vent Valve
FPI	Furnace Pressure Interlock
FSMFO	Flame Scanner-for main flame out
FSNSIS	Flame Scanner Not Sensing Igniter Spark
HFGPCS	High Fuel Gas Pressure Cutoff Switch
HFOPCS	High Fuel Oil Pressure Cutoff Switch
HWAB	High Water Alarm on Boiler
HWACT	High Water Alarm on Condensate Tank
HWADT	High Water Alarm on Deaerator Tank

IT	Igniter Timing
LAMDPS	Low Atomizing Media Differential Pressure Switch
LAMPS	Low Atomizing Media Pressure Switch
LFGOLI	Low Flue Gas Oxygen Level Interlock
LFGPCS	Low Fuel Gas Pressure Cutoff Switch
LFOPCS	Low Fuel Oil Pressure Cutoff Switch
LFPS	Low-Fire Proving Switch
LPFGPCS	Low Pilot Fuel Gas Pressure Cutoff Switch
LRVE	Liquid Relief Valve on Economizer
LRVOPS	Liquid Relief Valve on Oil Pump Set
LWA	Low Water Alarm
LWACT	Low Water Alarm on Condensate Tank
LWADT	Low Water Alarm on Deaerator Tank
LWCO	Low Water Cutoff
MFIT	Main Flame Ignition Timing
MV	Manual Valve
NRBSPLS	Non-Recycle Boiler Steam Pressure Limit Switch
OADI	Outside Air Damper Interlock
OBPS	Oil Burner Position Switch
OSDI	Outlet Stack Damper Interlock Switch
PAPS	Purge Airflow Proving Switch
POC_AFOSV	Proof of Closure on Automatic Fuel Oil Shutoff Valves
POC-AFGSOV	Proof of Closure on Automatic Fuel Shutoff Valves
PPT	Pre-Purge and Post-Purge Timing
PRV	Pressure Reducing Valve
RBSPLS	Recycle Boiler Steam Pressure Limit Switch
SVB	Steam Safety Valves on Boiler
SVFPRV	Safety Valve Following PRV
TP	Test Port

1.5 PREPARATION OF SYSTEM FOR SAFETY TESTING

The normal boiler installation does not generally allow easy access and control for testing. Safety testing is an ongoing activity for safe boiler plant operation. Modifications should be made to allow safe convenient testing. In this section a discussion is given of system modifications that will allow easy testing. The discussion is organized around classes of different safety devices. For detailed drawings illustrating a convenient test setup for each device, refer to the safety testing procedures given in the appendix.

1.5.1 Setup for testing a Steam Safety Valve Following a PRV

In order to test a safety valve following a PRV, a manual isolation valve should be installed downstream of the safety valve so that the valve can be tested without raising the pressure on the system downstream of the valve. (See Figure 1.1)

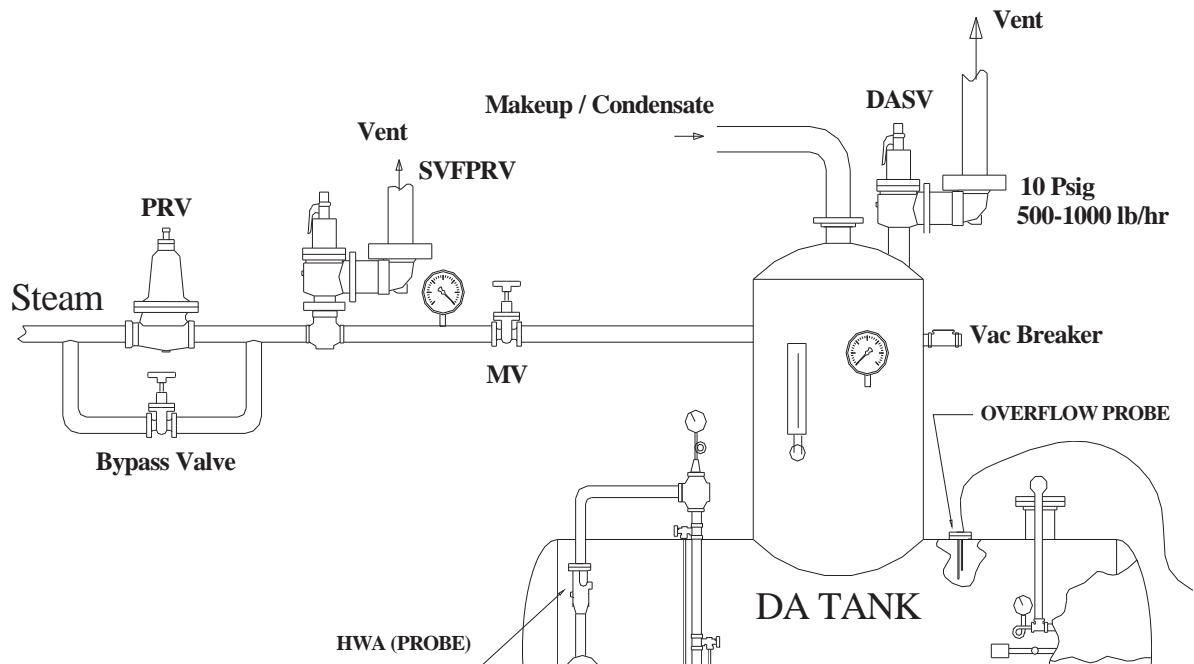


Figure 1.1 Safety Valve Following a PRV

1.5.2 Setup for testing a combustion air switch, purge air switch, furnace pressure switch, control air pressure switch, and high pressure switches for main gas and pilot.

In order to test these switches it is convenient to be able to temporarily isolate these switches from the normal pressure source and to apply test pressures that can be accurately measured. At the same time the piping should be such that the actual pressure that the switch senses can also be measured. The arrangement that is pictorially shown in Figure 1.2 for testing the combustion air pressure switch allows this objective to be met for all switches covered in this section.

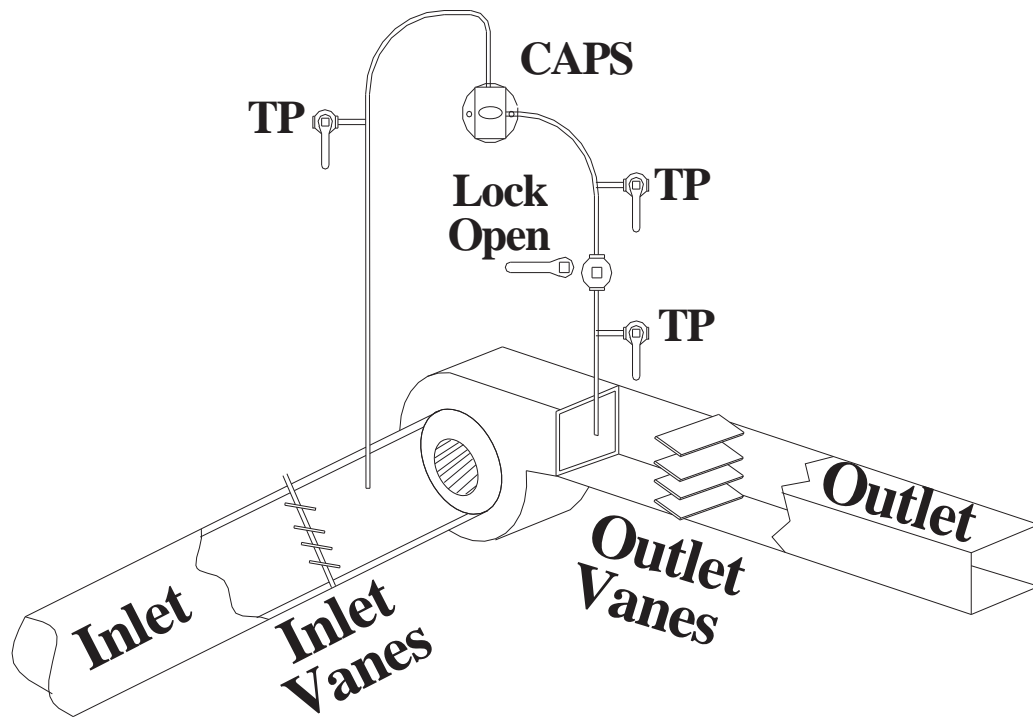


Figure 1.2 Air Pressure Switch

1.5.3 Setup for Leak Checking Oil and Gas Block Valves and Gas Bleed Vent Valve

In order to easily test for leaks in the block valves a test port (TP) and pressure gage must be available both in the line between the valves and downstream of the second valve. Also in the case of gas, a lockable manual valve downstream of the solenoid bleed vent valve is required. A port and pressure gage in the line between the solenoid valve and lockable manual valve is also needed. Note, there are two test ports (TP) for determining normal operating pressures and one test port (TP) for testing the isolated interlock. This arrangement is schematically shown for natural gas in Figure 1.3 and Figure 4.4 for oil fuel.

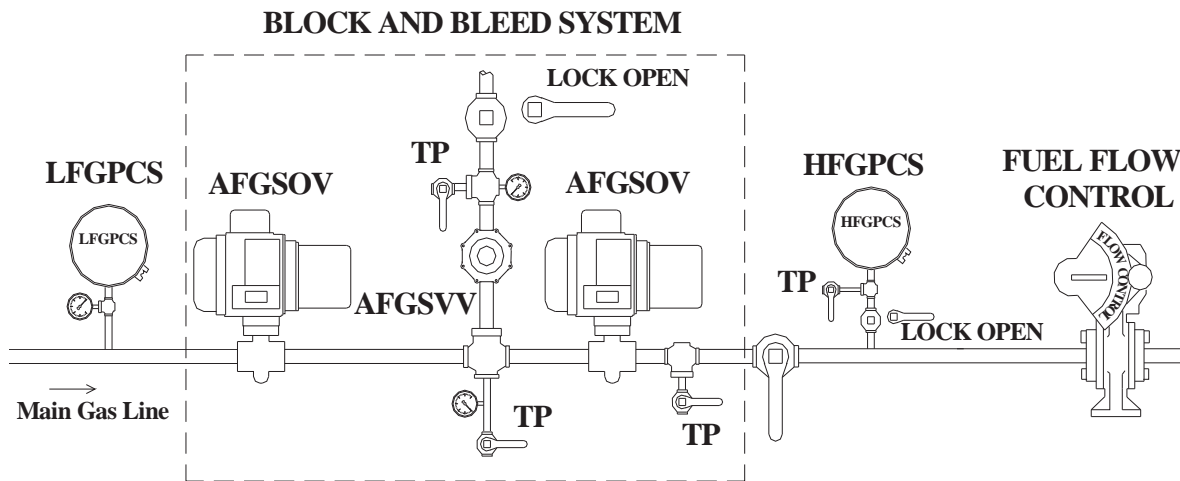


Figure 1.3 Leak Checking Automatic Shutoff Valves

1.5.4 Setup for Checking Dangerous Gas Detection System For the Building

Sample gas with a level of CO and combustibles slightly exceeding the sensor set points should be available with a means to supply the gas to the sensor per the manufacturers test procedures.

1.5.5 Setup for Checking the Deaerator Overflow System and Oil Liquid Relief Valve

A sight glass with turbine wheel should be installed downstream of the valve in order to visually confirm that flow exists. The oil liquid relief valve also requires a pressure gage at the pump discharge.

1.5.6 Setup for Checking Proof of Closure Switches, Low Fire Proving Switch, Force Draft Damper Vane Interlock, Outlet Stack Damper Interlock, Recycle Steam Pressure Switch, Non-recycle Pressure Switch, Primary Low Water Cutoff, and Recirculation Damper Interlock

It is necessary to electrically isolate these switches for testing. The two electrical leads from each of these switches should be wired into an electrical control panel and the terminals to which they run should be clearly identified. Only one wire should be under a given terminal.

1.5.7 Setup for Hydrostatic Testing

In order to hydrostatically test any device it is necessary that valves are available to isolate the device, a test port is available to apply the test pressure, and a pressure gage is available to monitor the pressure in the device (See Figure 1.4). All devices that could be damaged by the test pressure must be removed prior to conducting the hydrostatic testing.

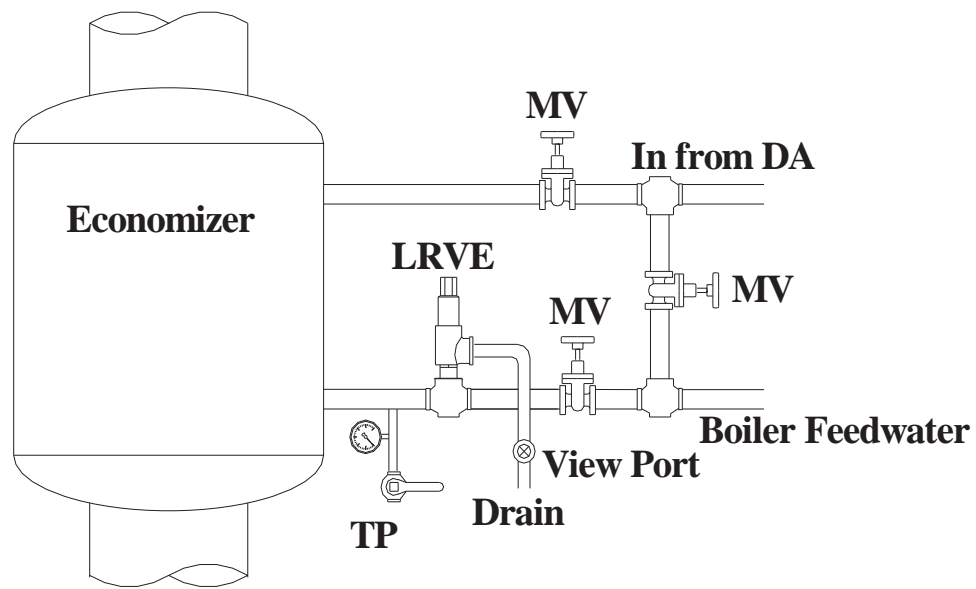


Figure 1.4 Hydro Testing

2 WATER LEVEL CONTROL

2.1 LOW WATER CUTOFFS

2.1.1 Description

A low water cutoff is a device that causes causing the automatic fuel safety shutoff valves to close if the water level in the boiler drops below a pre-set safe level. Low water causes about 50 percent of all boiler incidents. Low water can cause the boiler to overheat which could lead to the failure of the pressure vessel with enormous potential damage (explosion). Two low-water cutoffs are required. Low-water cutoffs operate either on a "float" system or electrode system. In the float system there is a cross arm connection to the boiler (high and low connection points). Between these connection points there is a vertical section containing a volume sufficient to house the float. If the water level falls below a prescribed level, the falling float will cause a switch to actuate causing the automatic fuel valves to close. (See Figure 2.1)

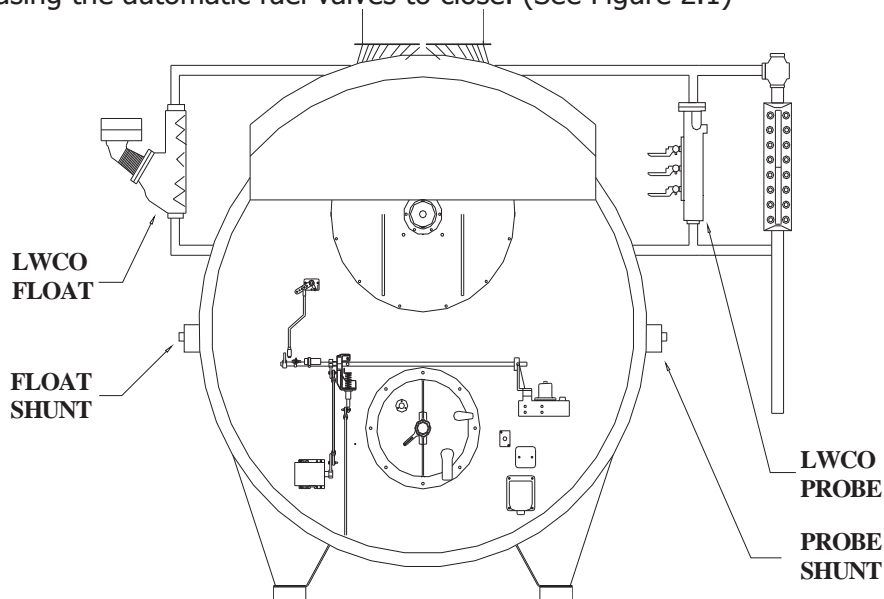


Figure 2.1 Low Water Cutoff

In the electrode system, there is a similar cross arm arrangement as in the float system. Probes extend vertically downward into the vertical pipe connecting the cross arms. The electrodes are located at the bottom of the probe and are used to measure the conductivity of the media in which the electrodes are immersed. The conductivity of water is much higher than steam. Hence, if the water level drops below the probe, a drastic change in conductivity occurs. This change is used in an electrical circuit to cause the automatic fuel shut-off valves to close. Most safety codes require at least one float system be included to protect against low water. This is shown in Figure 2.1. The VA requires one float and one probe. True redundancy requires two separate cross arm arrangements. Use of a single cross arm could lead to a situation in which blockage in the cross arm renders both level control safety devices useless.

Some low-water cutoffs are provided with non-latching "shunt" switches by which the cutoff switch is bypassed. Arrangements for shunt switches include individual shunt

switches on one or both cutoffs or a switch which shunts both cutoffs. Operators can use the shunt switch in "testing" of the low-water cutoff to prevent the boiler from shutting off. Operators electrically check the low-water cutoff using this method. When no shunt is available or the shunt is across both low water cutoffs, it is necessary to use an electrical jumper to temporarily by-pass one cutoff in order to test the other cutoff.

A boiler control system should never allow the boiler to automatically restart after a low-water cutoff has actuated to stop boiler operation.

A detailed step by step test procedure is given in Appendix A.

2.1.2 Consequences of Low Water Cutoff Failure

If the low water cutoffs both fail, the boiler would then be fired with no water in the boiler. This will cause the metal temperatures to rise rapidly and the metal strength to be significantly decreased. In fire tube boilers the main Morrison tube typically collapses which could allow steam onto the boiler fireside. The steam pressure has been known to blow the ends out of the boiler through concrete block walls a distance of hundreds of feet. Similar catastrophes could occur in water tube boilers.

2.1.3 Testing a Low Water Cutoff

Low-water cutoffs must be tested in a mode in which they fail. Testing is basically done by allowing the water level to lower in a "slow drain". In order to be in a realistic mode, one must not follow a procedure that actuates the cutoff by rapidly blowing off a volume of water from the cross arms. This is very important in testing a float type cutoff. It is recommended that the rate of decrease in water level be a maximum of 1 inch/minute.

A detailed step by step test procedure is given in Appendix A.

2.2 LOW WATER ALARM

2.2.1 Description

The low water alarm provides audible and visual warnings that the water level is approaching a dangerously low level. These alarms are based either on a conductivity probe or float as described in the previous section. These alarms are used on the boiler, deaerator and condensate receiver tanks. On the boiler, the low water alarm must be set to activate before either of the low water level cutoff switches shuts off the boiler. On the deaerator and condensate receiver tanks, the alarm is the only indication of a low water problem. On these devices the setting should be above the point of pump cavitation and with visible water in the sight glass. The alarm should not be set so high that it causes excessive alarm activation. Of course lack of water in the deaerator or condensate receiver will quickly result in loss of water to the boiler with the problems described in the section of low water level control.

The alarm testing should include a careful consideration as to whether the alarm setpoint is at the correct level for its intended purpose.

2.2.2 Consequence of Water Level Alarm Failure

Low water in a condensate or deaerator tank is a precursor to low water failure in a boiler with the problems described above. There is also the hazard of damage to a

condensate transfer or boiler feed pump from running dry. A low water alarm on a boiler is a warning to operators of an impending potential problem of a "boil out" of water.

2.2.3 Testing Low Water Alarms

This alarm is tested by causing a drop in water level in the vessel being tested. The alarm should activate at the desired setpoint (the setpoint must be above the level at which dangerous operations will occur, at a level allowing operators to restore the proper level, and visible in the appropriate sight glass).

A step by step procedure is given in Appendix A for three situations: boilers, deaerators, and condensate tanks.

2.3 HIGH WATER ALARM

2.3.1 Description

A high water alarm is used on a boiler, deaerator, and condensate tanks to aid in preventing overfilling. Due to the failure rate of float type devices used for this purpose, high water alarms should always be a conductivity probe type device.

2.3.2 Consequence of High Water Alarm Failure

High water in a condensate tank could lead to backup of condensate in condensate lines. High water in a deaerator will result in poor deaeration but also leads to violent shaking of the vessel. High water in a boiler could result in pushing liquid into the steam line. Slugs of water in the steam system can move at high velocity due to the motive force of steam causing water hammer. Water hammer can cause valves and other fittings to explode and steam piping to rupture. Death and injury from these events is a regular occurrence. This same effect could produce high water levels in the steam supply to a steam powered appliance connected to the system with detrimental effects on the process.

2.3.3 Testing the High Water Alarm

The high water alarm can be tested off-line. Slowly fill the vessel with water, observe the water level in the sight glass, and note the point at which the alarm sounds. Be careful not to overfill the system, above the level at which the alarm should actuate.

A step by step procedure is given in Appendix A for three situations: boilers, deaerators, and condensate tanks.

2.4 OVERFLOW DRAIN SYSTEM

2.4.1 Description

Deaerator tanks and condensate storage tanks have overflow systems to prevent overfilling. The deaerator overflow is shown in Figure 2.2. The overflow system on the condensate tank also helps guarantee that the condensate tank remains at atmospheric pressure and consists of a drain line connected to the vessel. The drain line from a deaerator includes a normally closed device that opens if the water level is too high and allows water to drain either to sewer or into the condensate tank. Three different types of overflow control valve systems have been utilized on deaerator tanks:

- A float valve which opens when liquid water comes into a standpipe that has an opening near the top of the deaerator.
- An electronic valve which is operated by a conductivity probe indicating that water level is too high. In this case the water should be drained from the bottom region of the tank to avoid the possibility of exhausting steam in case the valve opens before the water level reaches proper height.
- An electronic valve which is operated by a differential pressure cell indicating that water level is too high. In this case the water should be drained from the bottom region of the tank to avoid the possibility of exhausting steam in case the valve opens before the water level reaches proper height.

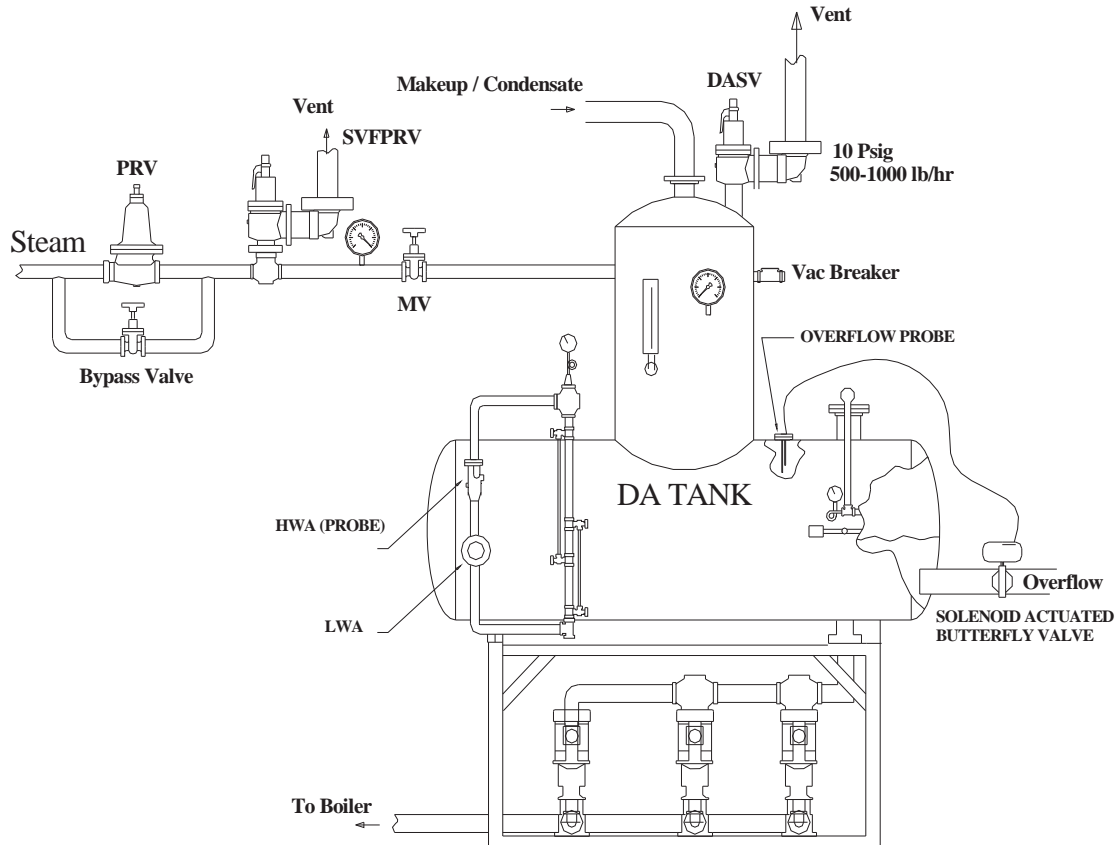


Figure 2.2 Overflow Drain System

2.4.2 Consequence of Overflow Drain Failure

The consequence of an overflow drain failure is the same as that discussed in section 2.3.2.

2.4.3 Testing the Overflow Drain System

The purpose of the test is to determine if the system is capable of draining water from the deaerator at a rate equal to or greater than the maximum potential supply of water to the deaerator. The system can be tested with the deaerator out of service (steam valved out and feedwater pumps off). To test the drain system, fill the deaerator with water at a rate equivalent to the maximum rate that could possibly be supplied to the

deaerator. Observe the water level in the sight glass. Use the sight glass to confirm that the drain system is capable of maintaining the water level at the drain level.

A step by step procedure is given in Appendix A.

3 PRESSURE CONTAINMENT

3.1 SAFETY VALVES

3.1.1 Description

The safety valves are connected to a boiler, steam line, or other device that must be protected from over-pressure. Each safety valve discharges into a drip pan ell which discharges through a slip joint into an oversized vent pipe that extends to outside the building. By utilizing drip pan ells, there is no direct connection between the vent pipe and the safety valve so that there is no stress imposed on the safety valve from the thermal expansion of the vent pipe. Liquid relief valves on unheated services, such as fuel oil, can be directly connected to a vent. Safety valves must be present on the boiler, deaerator, any pressurized condensate receiver, and at all points in steam lines just downstream of any pressure-reducing valves. Each safety valve must have a dedicated separate vent line (See Figure 3.1). Properly designed redundant safety systems for this extremely important safety device allow the system to prevent a boiler explosion even if one of the safety valves and / or vent system fails.

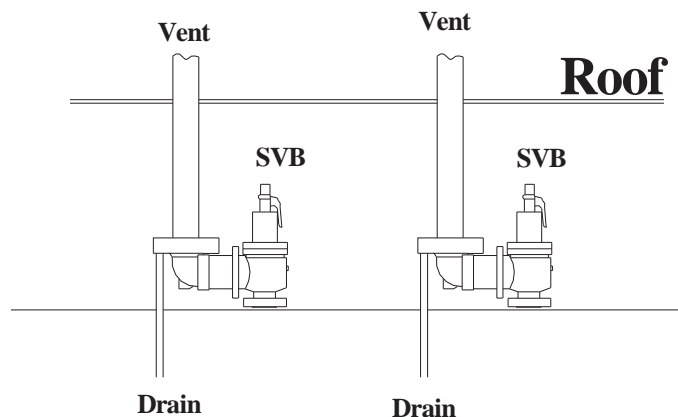


Figure 3.1 Boiler Safety Valves

3.1.2 Consequences of a Safety Valve Failure

Safety valves are the last line of defense against the over-pressurization of the boiler or steam system components. If these valves fail along with all the other measures designed to prevent over-pressurization, a violent explosion could occur. Of course, such an explosion could wipe out buildings and people within several hundred feet of the boiler or system component.

3.1.3 Checking a Safety Valve

The aspects of the safety valve that must be checked include:

- Is the safety valve vented to the outside with proper piping?
- Is the lift pressure set correctly?
- Does the valve open at the correct pressure?
- Are the safety valves present capable of handling the maximum boiler/steam capacity?
- Is the blowdown (set-point minus reseal pressure) correct?

- Is the safety valve properly drained?
- Can the safety valve be safely checked?

Some authorities recommend doing all safety valve testing on a test stand. However, there is a chance that the valves could be mixed up or damaged in installation so that this test method is not as reliable as testing the valves in situ. Also some authorities check a safety valve by lifting the handle. This test does not confirm that the valve opens at its setting. It does confirm that the valve can vent steam (is not blocked). This test should never be performed at a working pressure less than 75 percent of the safety valve setting.

A detailed test procedure which allows the 7 points enumerated above to be checked is given in Appendix A for three situations: boilers, deaerators, and piping following a PRV station.

3.2 RELIEF VALVES

3.2.1 Description

Relief valves are spring-loaded valves that open if the liquid pressure in the system that they protect increases above a pre-set limit. They are similar to safety valves with the exception that they do not exhibit "popping" action or blowdown. (Relief valves do not incorporate the "huddling" chamber found on safety valves). These valves are connected to an exhaust pipe that conveys the fluid to the building exterior or storage tank. Two important pieces of equipment requiring relief valves in boiler applications are economizers and oil pump sets

3.2.2 Consequences of a Relief Valve Failure

Failure of a relief valve could lead to a pressure vessel explosion with serious consequences. For example, there are several cases yearly in which the relief valve on domestic water heaters fail with the result that an entire house is "leveled". A even more devastating event could result from the explosion of an economizer. Failure could also lead to equipment damage due to overheating-e.g. in operation of an oil pump.

3.2.3 Checking a relief valve

There are several aspects of a safety or relief valve that must be checked. These include:

- Is the valve vented with proper piping?
- Is the lift pressure correct?
- Does the valve open at correct pressure?
- Will the valve handle the maximum capacity of the device that it protects?

Testing procedure for the relief valve on an oil pump set and economizers are given in Appendix A.

3.3 HIGH STEAM PRESSURE LIMIT SWITCHES

3.3.1 Description

A boiler should be fitted with two, high-steam-pressure-limit switches (HSPLS). Both switches have the function of causing the two automatic fuel shut off valves to close if a

preset pressure limit is exceeded. One switch may be a recycle switch meaning that once the pressure falls below the set point pressure the boiler will automatically restart. The other switch must be a non-recycle switch meaning that it must be manually reset after a pressure excursion above its limit. The pressure setting on the non recycle switch should be slightly higher than the setting on the recycle switch but lower than the maximum working pressure for the boiler. The non-recycle limit should also be lower than the lowest lift pressure for the safety valves. The required differences in the settings described above should be sufficient to allow the boiler to operate without excessive nuisance trips or blowing of safety valves.

3.3.2 Consequences of High Steam Pressure Limit Switch Failure

If both HSPLS switches were to fail, the safety valve becomes the last line of defense against a pressure vessel explosion. A tendency of boiler operators is to not worry about the performance of the HSPLS (especially the non-recycle one) because the safety valve is still available to save the operation. This thinking represents the "slippery slope" in safety because true safety relies on redundant measures. In looking at accidents in industry one can almost always find several unsafe factors that led to the particular accident. Ignoring the first warning escalates the risk.

3.3.3 Checking High Steam Pressure Limit Switches

Items to be checked about the HSPLS include:

- Are the limits on the switches set correctly, and
- Do the switches work?

These tests are described in Appendix A.

3.4 BOILER HYDROSTATIC TESTING

3.4.1 Description

A hydrostatic test is performed on a boiler, deaerator, and economizer to determine if it is capable of withstanding the potential operating pressure. It is very important to understand that any leak is a sign of weakness in the vessel and should be thoroughly inspected by a professional and properly repaired before the vessel is put back into operation. (These leaks could represent small cracks or metal thinning/corrosion/etc that is not discernable to the eye).

3.4.2 Consequences of Failure to Hydrostatic Test

If weak spots are present and the vessel is operated, a significant chance exists that a pressure vessel explosion could occur with tremendous loss of property and life. Failure to perform a proper hydrostatic test would allow a weakened vessel to be operated with the attendant dangers of such operation.

3.4.3 Performing a Hydrostatic Test

To perform a hydrostatic test, fill the vessel completely full of water below 200 F. Remove and plug all safety and relief valves. Close all supply and discharge lines. The boiler should be completely locked and tagged out from all energy sources following OSHA requirements and the fireside opened for inspection. The hydrostatic pressure for the test at about 1.5 times working pressure should be applied for several hours. The dry side should be checked for any sign of leaks. Any leaks should be professionally evaluated in terms of whether the vessel can be operated safely without repair.

In applying the hydrostatic pressure, care must be exercised not to overpressure the vessel. If the vessel were pressurized above its elastic limit, the vessel would not be fit for further use and should be scrapped!

4 FUEL TRAIN SAFETY DEVICES

4.1 LOW PRESSURE FUEL CUTOFF SWITCH

4.1.1 Description

The low-pressure fuel cutoff switch causes the automatic fuel shutoff valves to close if the fuel pressure is below the lower limit for safe operation. LPFCS safety devices are found on the main gas line, main oil line, and pilot gas line. The switch in all three of these applications senses the supply fuel pressure after the pressure regulating valve and upstream of any fuel control valve (See Figure 4.1). For the main oil and gas supply lines, the switch is in continuous operation once the boiler is in the run mode. For the pilot gas supply, the switch operates continuously while the pilot flame is on.

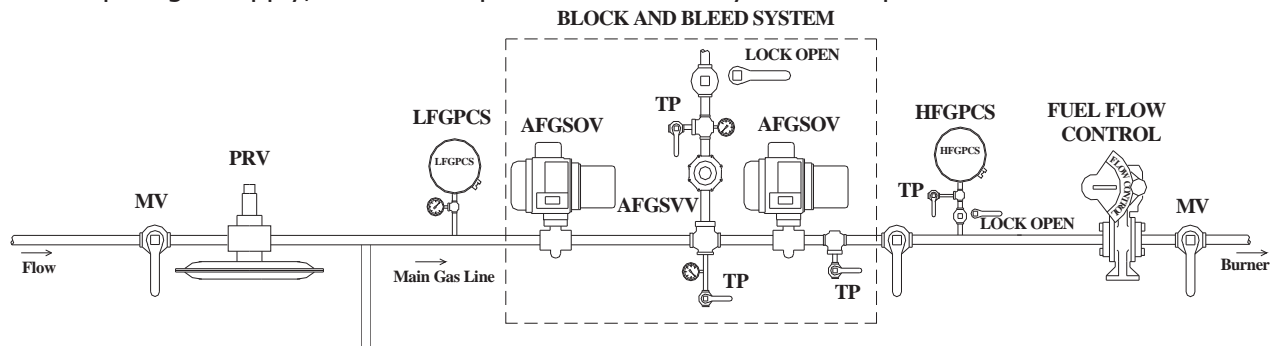


Figure 4.1 Low Pressure Fuel Cutoff

4.1.2 Consequences of Low Pressure Fuel Cutoff Switch Failure

Low fuel pressure can result in unstable burning or flameout conditions. When fuel pressure returns to normal, the combustion chamber can overfill with fuel before igniting. This can easily result in combustion explosions that are violent enough to blow the “ends” of the boiler and even through surrounding structures. Extensive property damage, injury, and even death can result.

4.1.3 Checking the Low Pressure Fuel Cutoff Switch

The checking procedure for this switch is designed to answer three questions:

- (1) Is the switch in correct place?
- (2) Are its limits correctly set?
- (3) Does the switch work to produce the desired result?

The switch should never be located upstream of the pressure regulating valve and should never be located downstream of the fuel flow control valve. The low pressure limit should be 80% of the normal regulated supply pressure. (On gas operation, some pressure regulation devices require improvement because they allow a substantial “dip” in supply pressure on initial light-off). A step by step test procedure for the low pressure fuel cut out switch for the main gas and main oil supply systems as well as the pilot gas system is given in Appendix A.

4.2 HIGH PRESSURE FUEL CUTOFF SWITCH

4.2.1 Description

The high fuel pressure cutoff switch is used to cause the automatic fuel shutoff valves to close if fuel pressure is above a given the higher limit for safe operation. These switches are used for both the main gas and main oil fuel supply systems (See Figure 4.2). In both of these applications the switch senses the supply fuel pressure after the pressure regulating valve and upstream of the fuel control valve. The switch is in continuous operation once the boiler is in the run mode.

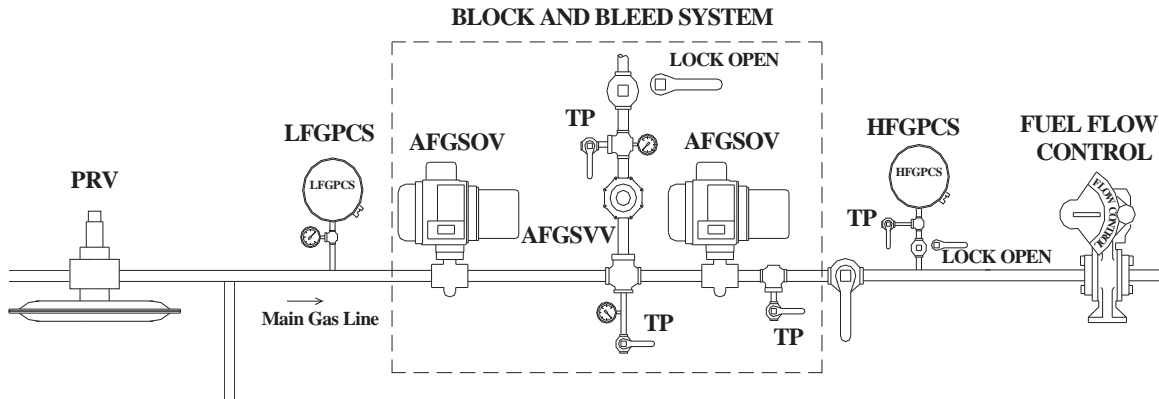


Figure 4.2 High Pressure Fuel Cutoff

4.2.2 Consequences of High Pressure Fuel Cutoff Switch Failure

High fuel pressure can cause unstable flame conditions but more importantly it can result in over-firing the boiler. Over-firing can damage burner/boiler materials to the point of meltdown and explosion. The generation of steam can be so intense that a pressure vessel explosion can occur. High fuel pressure can easily occur if a pressure regulator and high-pressure cutoff switch were to fail.

4.2.3 Checking the High Pressure Fuel Cutoff Switch

The checking procedure for this switch is designed to answer three questions:

- Is the switch in correct place?
- Are its limits correctly set?
- Does the switch work?

The switch should never be located upstream of the pressure regulating valve and should never be located downstream of the fuel flow control valve. The high pressure limit should be 120% of the normal regulated supply pressure for natural gas and 110% for light oil.

A step by step test procedure for the high pressure fuel cut out switch for the main gas and main oil supply systems is given in Appendix A.

4.3 VENTING BETWEEN AUTOMATIC GAS SHUTOFF VALVES

4.3.1 Description

The volume between the automatic fuel shutoff valves for gas should be vented to the atmosphere with a system as shown in Figure 4.3 for both the main gas and pilot line automatic shut off valves. While the boiler is running the solenoid valve is shut and gas

flows through the two automatic shutoff valves to the burner. When the fuel shut-off valves close, the solenoid valve opens and vents any residual gas in the space between the valve and any leakage of gas through the first automatic shutoff valve.

The purpose of the vent system is to insure that even if the first automatic shutoff valve leaks, the gas is vented rather than allowed to move through the second automatic fuel-shutoff valve and then into boiler. The vent line should be vented to the atmosphere.

BLOCK AND BLEED SYSTEM

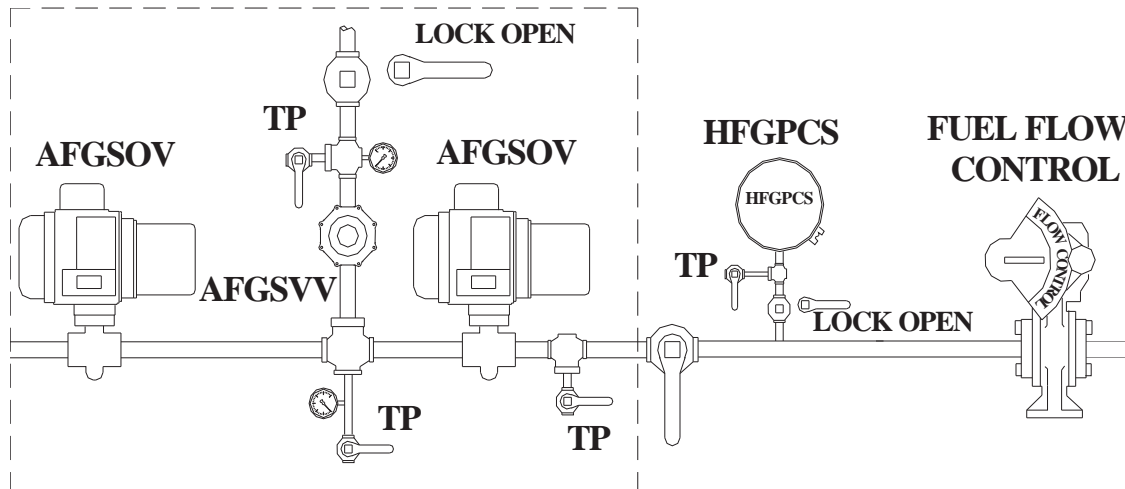


Figure 4.3 Gas Train Vent Valve

4.3.2 Consequences of a Failed Vent Valve

Fuel leaks into the boiler are obviously dangerous because if both automatic shut off valves leak, gas would fill the boiler furnace while the boiler is off. Fuel mixed with air is an explosive. Any source of ignition could result in disaster. On ignition if purging did not adequately vent this gas, a tremendous explosion would result when igniting the fuel. This combustion explosion could easily wipe out all property and personnel within several hundred feet of the boiler.

4.3.3 Testing the Gas Train Vent Valve (solenoid valve)

Testing of the vent system should include verifying that the correct physical system is in place, that the vent valve is closed (does not leak) when the boiler is firing, and that the vent valve is open when the boiler is not firing. Vent piping should be checked for insect nests that can block the flow of gas.

A detailed step by step procedure to check all these aspects of the vent valve are given in Appendix A.

4.4 LEAK TEST OF AUTOMATIC FUEL SHUT OFF VALVES

4.4.1 Description

A block and bleed system is provided as discussed in section 4.3 to prevent fuel from entering and potentially collecting in the boiler while the boiler is off. This system is used on the main oil and gas supply lines to the burner as well as the pilot gas supply. (On the main oil supply line a vent is not required.) The two automatic shut off valves

used in either case are the means by which the boiler is automatically shut down in case any operating limit is not satisfied. It is absolutely essential that these valves do not leak when closed. For both oil and gas, applicable codes require two automatic shut off valves. It is that important.

4.4.2 Consequences of Leaking Automatic Shut off Valves

There is a slight probability that one or more of the automatic fuel shut off valves would leak. If both valves leaked and the vent system did not function in the case of gas, fuel would be introduced into the burner and into the boiler furnace while the boiler is off. This fuel would produce a combustible mixture in the boiler. Fuel leaks into the boiler are obviously dangerous because it allows the presence of a combustible air-fuel mixture that could explode when the fuel is ignited on startup. This combustion explosion could easily wipe out all property and personnel within several hundred feet of the boiler.

4.4.3 Testing the Automatic Fuel Shut off Valves for Leaks

The testing for leaks can be done when the boiler is off. The best test procedure for gas is a situation in which the leak could be measured with a "bubble test". This method involves connecting a tube to a confined space downstream of the valve being tested with positive pressure on the upstream side of the valve. The tube is placed approximately 1/16th of an inch below a water surface. Any leak will show up as a bubble generated in the water at the tube exit. Any testing by watching pressure fall is difficult to evaluate because generally there are many potential sources for leaks in the system which will obscure the results. For oil a test port can be provided to visually observe whether oil drains from the test port.

A step by step procedure is given in Appendix A.

4.5 OIL LOW ATOMIZING MEDIA PRESSURE SWITCH

4.5.1 Description

An atomizing fluid (compressed air or steam) is usually used to aid in the combustion of the oil fuel (See Figure 4.4). A safety switch is required that shuts the boiler off in case of low atomizing pressure. This switch measures pressure in the atomizing fluid line immediately after the pressure regulating system and causes the automatic fuel control valves to close if the atomizing pressure falls below its setpoint. If there is a differential pressure regulator, the sensor should be located upstream of that regulator.

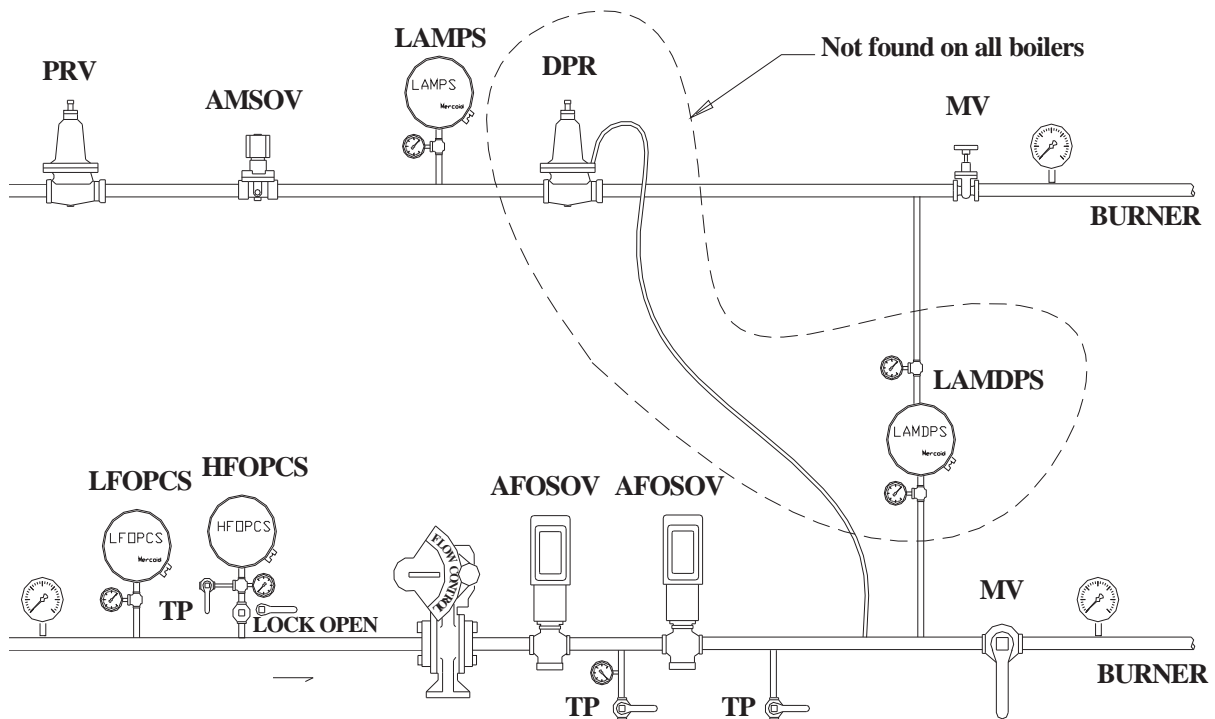


Figure 4.4 Low Atomizing Media Pressure Switch

4.5.2 Consequences of Low Atomizing Media Pressure

Low atomizing pressure could cause poor combustion leading to the production of carbon monoxide, flame instability, and possible combustion explosions leading to serious loss of property and injury/death.

4.5.3 Testing the Oil Low Atomizing Media Pressure Switch

There are basically three items that need checking;

- Is the switch correctly set?
- Is the switch located correctly?
- Does the switch work to produce the desired effect?

The setpoint on the oil low atomizing pressure switch should not allow the atomizing media pressure fall below level recommended by the burner manufacturer. Testing is accomplished on-line by slowly lowering the oil atomizing media pressure and observing that the switch operates at the correct set point. In order to test the low oil atomizing media switch a calibrated pressure gage or other method to measure pressure is required. Make certain that the burner is producing negligible combustibles at the set point pressure condition.

A step by step procedure is given in Appendix A.

4.6 AUTOMATIC FUEL SHUTOFF VALVE PROOF OF CLOSURE SWITCH

4.6.1 Description

The function of an automatic fuel shutoff valve is absolutely essential. All safety devices that require fuel shutdown rely on the two automatic fuel shutoff valves to perform this task. Proof of Closure switches must be present in both automatic shut off valves. Both oil and gas automatic shut off valves require proof of closure switches. The switches in the two valves should be wired in series so that an indicated failure in either valve will prevent the boiler from starting. The proof of closure switch is an integral part of the automatic fuel shutoff valve. It has a simple function to guarantee that the automatic fuel shutoff valve is closed before allowing the boiler to go through the burner startup sequence. If the automatic fuel shutoff valve is not closed, the proof of closure switch will be open, breaking the circuit and not allowing the burner to start. The proof of closure switch is active only during the startup sequence.

4.6.2 Consequences of a Failed Proof of Closure Switch

If the proof of closure switches fail, they could "stick" closed even with the valve open. This malfunction would present a false signal to the burner management system indicating that the valve is closed when it might not be closed. This malfunction could allow the fuel to be ignited with a large quantity of fuel in the furnace. Under this scenario, a horrible combustion explosion would occur. The result could be a tremendous loss of property and death as well as physical harm to personnel within several hundred feet of the boiler.

4.6.3 Testing the Automatic Fuel Shutoff Valve (Proof of Closure) Switch

In order to test a proof of closure switch one must demonstrate the following:

- That the switch is closed when the valve is closed.
- That the switch opens immediately once the valve starts to open.
- The boiler will not start with the switch open.

A detailed step by step procedure to determine whether the proof of closure switches meet the above requirements is given in Appendix A.

5 BURNER AND AIR TRAIN SAFETY DEVICES

5.1 THE FLAME SCANNER

5.1.1 Description

A flame scanner is a device that continually monitors the flame to determine whether a flame is present in the combustion chamber. If the flame is extinguished for any reason, the scanner causes the two automatic fuel shutoff valves to close.

Modern flame scanners work by converting either the ultraviolet (UV) or infrared (IR) portion of the thermal radiation produced by the flame to an electrical signal. The UV scanner has some disadvantage in that it can sometimes see the igniter spark as a flame. The IR scanner has a disadvantage in that it can mistake glowing refractory for a flame. Properly adjusted, the UV scanner is superior and is required by the VA. The strength of the electrical scanner signal is then the indication as to whether an adequate flame is present.

UV scanners can fail unsafe, showing a flame detected when none is present. Some organizations do not consider this a problem on boilers that cycle on/off frequently as the burner management system will not allow a burner to start if a flame is "detected" while the burner is off. On V.A. boilers, which operate continuously for long periods, it is necessary to utilize "self-checking" UV scanners. The "self-checking" feature detects a scanner failure and immediately shuts down the burner."

5.1.2 Consequences of a Failed Flame Scanner

If the flame scanner allows fuel to be supplied to the combustion zone when no flame exists, horrific combustion explosions can occur. The combination of a spark due to some type of "glowing" material and a "pocket" of fuel/air mixture at an explosive ratio can result in an explosion. Another scenario is relighting the boiler with an explosive mixture of fuel and air present. There have been numerous accidents in which the front or back of the boiler have blown off and through masonry walls with loss of life and property damage.

5.1.3 Checking a Flame Scanner

There are many potential tests for a flame scanner depending on the situation. The guiding principle is to try to check the scanner operating in the same mode that a potential failure might occur. The best test is then to cause the flame to extinguish and to determine whether the flame scanner then causes the two automatic fuel shut-off valves to close. It is very important that the flame scanner be checked on both oil and gas firing.

There are really three attributes of the flame scanner that one should check:

1. Is the flame scanner a UV self-checking scanner?
2. Does the flame scanner sense the igniter spark?
3. Will the flame scanner cause the automatic fuel shut-off valves to close within the allowable time (4 sec) when the fire is extinguished?

A detailed step by step procedure is given for testing the flame scanner in Appendix A.

5.2 LOW FIRE PROVING SWITCH

5.2.1 Description

In the startup procedure for the boiler, the safest way to light the main burner is with a minimum of fuel input. There are electrical position switches located on the control systems for the fuel flow control valves and the combustion air damper that activate when the damper is at low-fire position. These low-fire proving switches have the function of not allowing the main flame to be ignited if the firing position is not a minimum. In some electronic control systems a potentiometer is used to determine the position of the inlet damper by the output of a voltage level to the controller. The required V.A. system is position switches actuated by the fuel control valves and the damper themselves rather than at some point nearer the drive motors that operate the valves and damper. Parallel position systems require separate proof of the low fire position for air and fuel.

5.2.2 Consequences of a Failed Low Fire Proving Switch

Failure of the low-fire proving switch could allow the boiler to start in a high fire position. This result could easily lead to a violent combustion explosion with property loss as well as injury and death to individuals within a few hundred feet of the boiler.

5.2.3 Testing the Low-Fire Proving Switch

The low-fire proving switch should be tested during the boiler startup sequence. There are basically three things that should be tested:

- Is the switch the right type and located correctly?
- Is the switch “activated” at any position other than “low fire”?
- Does the switch in the non-activated position prevent the boiler from firing?

A detailed step by step procedure for testing the low fire proving switch is given in Appendix A.

5.3 COMBUSTION AIR FLOW SWITCH

5.3.1 Description

A combustion airflow switch is used for the purpose of causing the two automatic fuel shutoff valves to close if the forced draft fan is not producing airflow (See Figure 5.1). Typically, this switch uses a pressure measurement across the fan. The switch is in the safety control circuit anytime the boiler is in the run position. A set point for the switch is established by measuring the minimum pressure rise seen by the switch over the firing range and setting its value at approximately 80% of the minimum pressure rise. For the combustion air flow switch one desires that the pressure rise being measured is as large as possible and is “flat” i.e. independent of firing rate.

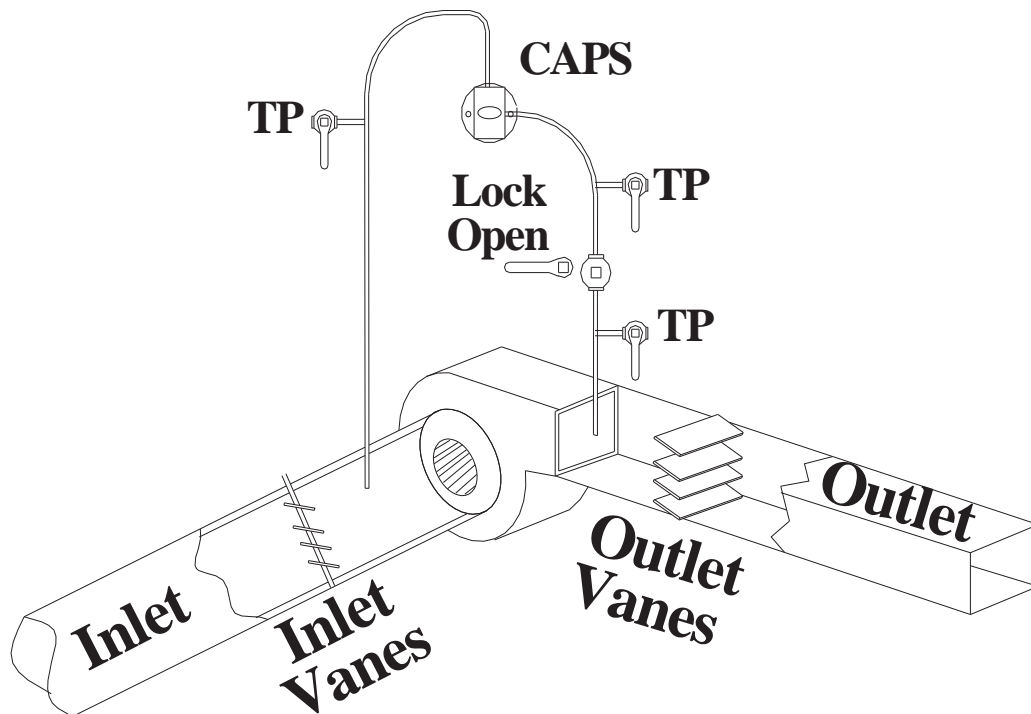


Figure 5.1 Combustion Air Pressure Switch

5.3.2 Consequences of a Failed Combustion Air Switch

If the fan fails to produce adequate combustion air, seriously incomplete combustion will occur. The flame will be highly unstable and the risk of a combustion explosion which could send boiler parts flying for several hundred feet is high. In addition, the production of carbon monoxide with its attendant toxicity can easily cause death for operators.

5.3.3 Testing Combustion Air Flow Switch

The combustion air flow switch should be tested while the boiler is running. There are basically three things that should be tested:

- Is the switch located correctly?
- Is the switch setpoint correct?
- Does the switch stop the boiler from firing with insufficient combustion air?

A detailed step by step procedure for testing the combustion air flow switch is given in Appendix A.

5.4 PURGE AIR FLOW PROVING SWITCH

5.4.1 Description

The purpose of the purge airflow-proving switch (PAPS) is to insure that during purging sufficient air volume is moved through the boiler. Four air changes are required for fire tube boilers and 8 air changes are required for water tube boilers. A boiler cannot be overpurged. Hence, the PAPS serves the role of proving airflow rate during purging. The PAPS works by measuring pressure change across a boiler element. One desires that the switch sees a small pressure change at low fire with a much larger change in

the purge (high fire) position. Typically this pressure should be measured across the boiler bank without variable restrictions. The proper set point for the switch is approximately 80% of the maximum pressure change sensed by the switch.

5.4.2 Consequences of a Failed Purge Airflow Proving Switch

If this switch were to malfunction, it would be possible to ignite the pilot and or main flame with combustible gas mixtures present in the boiler. This could lead to a terrible combustion explosion with serious loss of property and life.

5.4.3 Testing the Purge Airflow Proving Switch

The purge air flow proving switch should be tested during the boiler startup sequence. There are basically three things that should be tested:

- Is the switch located correctly (i.e. pressure taps across right element)?
- Is the switch setpoint correct?
- Does the switch in the non-activated position stop the boiler from leaving purge?

A detailed step by step procedure for testing the purge air flow proving switch is given in Appendix A.

5.5 BURNER POSITION SWITCH

5.5.1 Description

Some manufacturers of oil burners require a position switch to indicate that the burner is in the correct position before firing. The switch is generally a simple proximity switch that is electrically closed by depression of the switch by the burner as it is fully inserted into the boiler. For those boilers utilizing this switch it must be tested.

5.5.2 Consequences of Burner Position Switch Failure

If the boiler could fire on oil with the burner partly retracted, fire, production of carbon monoxide, flame instability, and combustion explosions could result. This could lead to serious loss of property and injury/death.

5.5.3 Testing the Burner Position Switch

The switch must be periodically tested to determine if the boiler would fire on oil with the burner partially retracted. If the switch is properly set up, the boiler control will not allow the boiler to leave purge with the burner out of position. A detailed step by step testing procedure is given in Appendix A.

5.6 FORCED DRAFT MOTOR INTERLOCK

5.6.1 Description

The forced draft motor interlock provides an extra level of safety relative to proving "purge air flow" and "combustion air flow" and protects the fan motor from running with an inadequate power supply. There are three types of interlocks currently being used. The simplest interlock is an auxiliary contact which is a single pole switch that "makes" when the main switch supplying 3-phase power to the fan is closed. One could cut any or all of the power leads going to the motor and this switch would indicate acceptable operation. Clearly, this interlock is not acceptable. A second design utilizes phase monitors on all three legs which looks at the incoming power characteristics which will work if one loses incoming power to the panel. However, the fan motor could be

disconnected electrically and the phase monitor would indicate acceptable operation. Again this interlock is not acceptable. The proper interlock is based on current relays in which current in all three legs supplying power to the motor is measured (See Figure 5.2). This interlock involves encircling each power lead with a current pickup. The lack of current through any of these current pickups will stop boiler operation. For testing it is best if one uses a type of current pickup around each lead that could be opened and removed without disconnecting the power lead from its terminal strip.

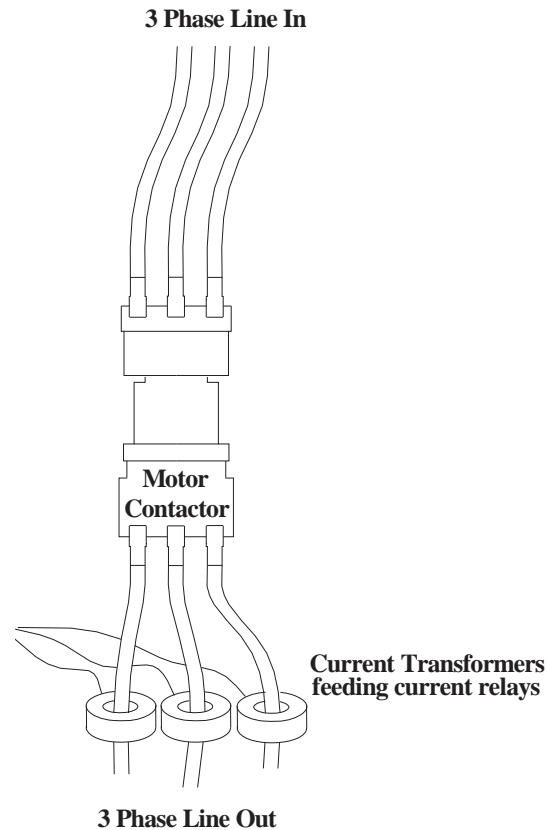


Figure 5.2 Forced Draft Motor Interlock

5.6.2 Consequences of a Failed Forced Draft Fan Motor Interlock

If the fan fails to run or runs at a lower speed, the boiler would produce combustibles leading to the same problems discussed in section 5.5.2.

5.6.3 Testing the Forced Draft Fan Motor Interlock

The test for this interlock consists of determining whether the right type of switch is in place and then removing the current pickups, one at a time, and determining if the boiler shuts down. A detailed step by step procedure is given in Appendix A.

5.7 FURNACE PRESSURE INTERLOCK

5.7.1 Description

The purpose of the high furnace pressure interlock (FPI) is to insure that the furnace pressure does not exceed an acceptable limit due to some type of blockage. The FPI works by measuring pressure in the boiler furnace while the boiler is running. A pressure that exceeds the FPI setpoint "breaks" the interlock to an open position and

causes the boiler to shut down. The proper set point for the switch is approximately 120% of the actual furnace pressure at high fire condition.

5.7.2 Consequences of Low Furnace Pressure Interlock Failure

A blockage in the exit portion of the boiler combustion gas circuit, leads to high furnace pressure and incomplete combustion. Under this condition carbon monoxide is generated and the combustion gases are potentially highly explosive. If the FPI were to malfunction two highly undesirable consequences might occur. First, high furnace pressure would cause incompletely combusted gasses internal to the boiler furnace to be expelled into the boiler room. Carbon monoxide levels in the boiler room could reach a point where occupants would be killed. Secondly, these incomplete combustion gases could explode if a supply of oxygen became available (For example the flame might be temporary extinguished, and the explosively re-ignited by a "hot spot" in the boiler.) Therefore, the consequences of a failed FPI could be the loss of life of many people from carbon monoxide poison and flying debris from a boiler explosion.

5.7.3 Testing the Furnace Pressure Interlock

The FPI can be tested by first determining the furnace pressure at high fire in order to establish a proper setpoint for the interlock. It can then be tested offline by pressurizing the interlock with air. There are basically four items that need checking;

- Is the switch located correctly (i.e. pressure taps between the internal volume of the boiler furnace and atmosphere)?
- Is the interlock set point correct?
- Does the interlock break at the correct set point?
- Does the interlock in the open position stop the boiler from operating?

A detailed step by step procedure for testing the FPI is given in Appendix A.

5.8 OUTLET DAMPER POSITION INTERLOCK

5.8.1 Description

The purpose to the outlet damper position interlock (ODPI) is to insure that the outlet damper is open during purge. This interlock is a part of the safety system to insure that adequate purging has occurred prior to the ignition sequence. Therefore, it is a pre-ignition interlock. The ODPI is a displacement electrical switch that should be activated by movement of the outlet damper into the correct position for purging. (In many cases this interlock is on the jackshaft drive motor that is linked to the damper, but this arrangement does not meet VA specifications.) If the interlock is not "made", the safety controller for the boiler does not allow the boiler to leave purge.

5.8.2 Consequences of Outlet Damper Position Interlock

A blockage in the exit portion of the boiler combustion gas circuit due to a closed or partially closed outlet damper, leads to inadequate flow of combustion air. Under this condition there is the potential for highly combustible gases to be present in the boiler furnace after purging is complete because the air flow restriction reduces the volume of purge gases to the point that combustible gases remain in the boiler or exhaust system. If the ODPI were to fail, these incomplete combustion gases could explode when the igniter attempts to light the pilot. This explosion would cause boiler parts to fly hundreds of feet leaving anyone in its path badly injured or dead.

5.8.3 Testing the Outlet Damper Position Interlock

The ODPI can be tested by determining the point at which the interlock “makes”. This point should be with the outlet damper within one or two degrees of wide open. A wire can then be disconnected from the interlock which would simulate a failed interlock. The boiler should not prove purge under this condition. There are basically three things that should be tested;

- Is the interlock located correctly (i.e. actuated by damper movement itself)?
- Does the interlock “make” at the proper point?
- Does the interlock prevent boiler from leaving purge if it is not “made”?

A detailed step by step procedure for testing the ODPI is given in Appendix A.

5.9 FORCED DRAFT DAMPER WIDE OPEN PRE-PURGE PROVING SWITCH

5.9.1 Description

The FDDWOPS is necessary to show that the inlet vanes are wide open for purge. This switch is of the proximity type. It can be located such that the movement of the linkages moving the inlet vanes activates the switch when the vanes are in the wide-open position. The VA required system would be a switch actuated by the damper itself rather than at some point nearer the drive motor operating the damper.

5.9.2 Consequences of a Failed FDDWOPS

If this switch failed, the boiler and stack could contain a highly explosive mixture of combustible gases due to inadequate purge. This gas mixture could explode when either the pilot or main flame are operated. This massive explosion would likely cause severe property damage and personal injury and death in an area several hundred feet from the boiler.

5.9.3 Testing the FDDWOPS

The FDDWOPS should be tested during the boiler startup sequence. There are basically three things that should be tested:

- Is the switch the right type and located correctly?
- Is the switch “activated” at any position other than “high fire”?
- Does the switch in the non-activated position prevent the boiler from firing?

A detailed step by step procedure for testing the FDDWOPS is given in Appendix A.

5.10 PRE-PURGE AND POST-PURGE TIMERS

5.10.1 Description

There is a purge cycle at light off and also when the boiler shuts down. The purpose of purging is to make sure that no combustible gas is present in an unfired boiler nor prior to pilot ignition. It is necessary to prove that the purge cycle extends for the correct duration to achieve the required air changes, as determined by the applicable codes. A timer in the burner management system accomplishes this function. Older timers, no longer acceptable, can be adjusted at any time. Timers that are acceptable are adjusted when the burner is commissioned and then “burn in” the timing so that subsequent changes cannot be made without replacing the timer. Codes require that fire tube boilers have a minimum pre-purge of 4 air changes and water tube boilers a minimum of 8 air changes. Before testing, one must verify the correct duration of the purge cycle. Generally, post purge timing is 15 seconds, minimum.

5.10.2 Consequences of Improper Purge Timing

If the timer does not function correctly, the boiler and stack could contain a highly explosive mixture of combustible gases due to inadequate purge. This gas mixture could explode when either the pilot or main flame are operated. The massive explosion that results would likely cause severe property damage and personal injury and death in an area several hundred feet from the boiler.

5.10.3 Testing the Pre and Post Purge Timer

The test is simple in that the duration of purge can be measured simply with a stop watch. The amount of purge air actually moved is more difficult to determine. An approximate calculation for the cubic feet of air moved is given by the following formula:

$$\text{Standard Cubic Feet of Air} = [(\text{boiler steam capacity in lb/hr})/3600] \times [\text{purge duration in seconds}]/.075$$

This amount of cubic feet of air should exceed four times the fireside volume of a firetube boiler and eight times the fireside volume of a water tube boiler. A detailed step by step test procedure is given in Appendix A.

5.11 IGNITER TIMER AND MAIN FLAME IGNITION TIMER

5.11.1 Description

The igniter serves as a spark to light the pilot flame. Moving quickly from an ignition source to pilot light to main flame does not allow a large amount of combustible gas in the boiler without the presence of an ignition source at anytime during light off. The igniter and main flame ignition time is controlled by the burner management system and should not be adjustable by operators. NFPA currently sets the maximum igniter spark duration of 10 seconds. For natural gas or light oil, the time allowed from the time that the two automatic shut off valves open until they close is 14 seconds (this is 10 sec for main flame ignition and 4 seconds for valves to close).

5.11.2 Consequences of Excessive Igniter or Main Flame Ignition Timing

If the igniter stays on too long and the pilot flame fails to ignite, an excessive amount of pilot gas could enter the boiler leading to a boiler explosion. Similarly if the trial time for main flame ignition is excessive, large amounts of fuel could enter the boiler and subsequently explode. Such explosions would likely cause severe property damage and personal injury and death in an area several hundred feet from the boiler.

There is an electronic timing mechanism that regulates the duration of time that the igniter produces a spark. If the trial for ignition (igniter or main flame) is too long, it allows time for a large amount of combustible fuel to enter the boiler. Then if ignition does finally occur the massive explosion described above will take place

5.11.3 Testing the igniter timer

The test of igniter time requires that one close both the main and pilot fuel supplies and measure the time the igniter is on during start up of the boiler. To test the time for trial for main flame, pilot gas is supplied to the boiler with the main fuel line manual valve closed. With this set up a stop watch can be used to measure the time that the main fuel valves remain open during an attempt to start the boiler. A detailed step by step procedure for these tests is given in Appendix A.

5.12 AUTOMATIC FUEL SHUTOFF VALVE CLOSURE TIME AFTER MAIN FLAME FAILURE

5.12.1 Description

When the main flame is extinguished for any reason, the flame scanner should sense a lack of flame and, through the burner management control system, cause the automatic fuel shutoff valves to close. It is essential that these valves close quickly to prevent large amounts of combustible fuel from entering the furnace without a flame present. It should take less than 4 seconds for the automatic fuel valves to close and in most case about 3 seconds.

5.12.2 Consequences of Excessive Time to Close Main Fuel Valves

If large amounts of combustible fuel were present without a flame due to the automatic shut off valves remaining open too long after a flame failure, and subsequently ignition sources were applied, a massive boiler explosion would result likely causing severe property damage and personal injury and death in an area several hundred feet from the boiler.

5.12.3 Testing the Automatic Fuel Shutoff Valves Closure Time After a Main Flame Failure

The automatic fuel shutoff valve closure time can be tested at the same time the flame scanner is tested. The test is conducted with the boiler running. The fuel supply to the boiler is cut off by the manual valve located just before the burner and the time for the automatic fuel shut off valves to close is measured. A detailed step by step test procedure is given in Appendix A.

5.13 AUTOMATIC FUEL SHUTOFF VALVE CLOSURE TIME AFTER IGNITION FLAME FAILURE

5.13.1 Description

If the pilot flame fails during the ignition period, the flame scanner should sense a lack of flame and, through the burner management control system, cause the automatic fuel shutoff valves to close. It is essential that these valves close quickly to prevent large amounts of combustible fuel from entering the furnace without a flame present. If large amounts of combustible fuel were present without a flame and subsequently ignition sources were applied, a massive boiler explosion would result likely causing severe property damage and personal injury and death in an area several hundred feet from the boiler.

5.14 MINIMUM PILOT FLAME TEST

5.14.1 Description

The startup sequence begins with an electronic spark that is used to ignite the gas pilot. The gas pilot in turn is used to start the main flame. The pilot flame is crucial to smooth ignition of the main flame. The length of the pilot flame is crucial to reliable ignition. The pilot flame needs to be of a length such that it will ignite the main flame very quickly to prevent the buildup of combustible fuel in the furnace. The pilot flame length increases with gas pressure supplied to it. The minimum possible gas pressure supplied to the pilot is guaranteed by the set point on the low gas pressure cutoff switch in the

pilot fuel train. This set point should be about 80% of the regulated pilot gas pressure. The shortest pilot flame that will reliably ignite the main flame occurs at this minimum pilot gas pressure. Hence, a test to determine if the pilot length is adequate should be done at this minimum pilot gas pressure.

A complication exists in many situations for the backup fuel source for the pilot. Many systems normally use natural gas for the pilot fuel with propane or propane-air mixtures as the back up fuel. Natural gas and propane-air mixes should exhibit about the same burning characteristics. Propane has more energy per unit volume than natural gas and hence will have a different flame shape. If the situation being tested may involve both natural gas and propane as the pilot fuels, testing should be done to prove that the pilot flame is acceptable with either fuel. This test will also verify that the pilot can be successfully operated on either fuel.

5.14.2 Consequences of Inadequate Pilot Flame

Accidents commonly occur when boiler operators make multiple unsuccessful tries to ignite the fuel. Typically, these accidents involve introducing significant amounts of fuel into the boiler in several attempts to fire the main burner. If purging is not adequate, a point can easily be reached in which an explosive mixture of fuel is ignited. The massive explosion that often results usually causes severe property damage and personal injury and death in an area several hundred feet from the boiler. Even in the case of one try for main flame ignition, it must be remembered that if the igniter duration is too long, failure to quickly ignite the flame because of inadequate pilot flame length can cause a devastating explosion.

5.14.3 Testing for minimum pilot flame

The test involves setting the pilot gas pressure to a level just above the set point pressure on the low pilot gas cutoff switch. Then trials are made to see if the pilot can smoothly light both gas and oil. A detailed step by step procedure is given in Appendix A.

5.15 CONTROL AIR PRESSURE INTERLOCK

5.15.1 Description

Some older control systems use compressed air to operate various boiler controls. If air pressure is lost, the ability to regulate air and fuel flow into the boiler, feedwater flow, etc is lost. A control air pressure interlock switch that continuously measures air pressure in the air supply lines to the boiler controls is required. If the air pressure drops below a level necessary to operate the controls, the switch will trip and not allow the boiler to start, or if the boiler is running, will shut the boiler down. The person testing this switch should know the required air pressure specified by the control manufacturer and should adjust the setpoint pressure on the interlock to 120% of the minimum allowed pressure. An alarm to indicate problems at a pressure higher than the interlock setpoint is desirable.

5.15.2 Consequences of Failed Control Air Pressure Interlock Switch

Low control air pressure could easily result in a situation in which the air/fuel ratio moves into a situation where a furnace explosion could occur or dangerous levels of carbon monoxide is generated.

The explosion and toxic fumes that can be generated in this way could easily damage property and injure/kill people within hundreds of feet from the boiler. Also if the feedwater control valve is pneumatically operated, low control air pressure could result in the boiler running out of water with the problems described in section 2.1.2

5.15.3 Testing the Control Air Pressure Interlock

The test can be done with the boiler off. The control air pressure supplied to the switch can be reduced to just below the set point. At this condition the boiler should not start. A detailed step by step procedure is given in Appendix A.

5.16 FLUE GAS RE-CIRCULATION DAMPER SET FOR PRE-PURGE

5.16.1 Description

Some newer boilers are fitted with flue gas re-circulation in order to decrease NO_x levels produced in the combustion process. This system consists of a duct connected to the stack that re-circulates some flue gas into the incoming combustion air stream. There is a damper in this duct to control the amount of flue gas that is re-circulated. On the pre-purge cycle, it is necessary to insure that all combustible gases are purged from the re-circulation duct. Hence it is necessary to insure that the damper be in the wide-open position during purge. The flue gas re-circulation damper switch is used to show that the re-circulation damper is wide open for purge. This switch is of the proximity type. It is located such that the movement of the linkages moving the damper close the switch when the damper is in the wide-open position. The safest system would be a position switch actuated by the damper itself rather than at some point nearer the drive motor operating the damper.

5.16.2 Consequences of a Closed Flue Gas Recirculation Damper During Purge

If the pre-purge cycle does not eliminate all combustible gases from the system before the ignition sequence, a massive explosion could occur causing serious property damage, injury, and death within several hundred feet of the boiler.

5.16.3 Testing the Re-circulation Damper Interlock Switch

The re-circulation damper interlock switch should be tested during the boiler startup sequence. There are basically three things that should be tested:

- Is the switch the right type and located correctly?
- Is the switch “activated” at any position other than “wide open”?
- Does the switch with the damper in a non-activated position prevent the boiler from beginning the purge count

A detailed step by step procedure for testing the recirculation damper interlock switch is given in Appendix A.

5.17 LOW FLUE GAS OXYGEN LEVEL INTERLOCK

5.17.1 Description

The V.A. requires that all boilers have a low flue gas oxygen level alarm and interlock, which protects against firing with a “rich” fuel/air mixture. This system consists of using a zirconium oxide sensor in the stack to continuously measure oxygen. This signal is used to provide an alarm and interlock if the oxygen level falls below a setpoint. The setpoint should be as low as possible without the possibility of excessive CO and

combustibles being present in the exhaust gas from the boiler. This interlock is electronically integrated into the burner management system for the boiler.

5.17.2 Consequences of a Failed Low Oxygen Alarm and Interlock

Insufficient combustion air results in flue gas with low oxygen and high combustibles which represent two very significant safety hazards. First, carbon monoxide will be a significant portion of the combustibles and can be fatal if breathed by humans at a sufficient level. Second, these combustible gases can produce a violent explosion if air is introduced. The explosion and toxic fumes that can be generated in this way could easily damage property and injure/kill people within hundreds of feet from the boiler.

5.17.3 Testing a Low Oxygen Alarm and Interlock

To properly test the alarm or cutoff it is necessary to know three things:

- Does the zirconium oxide sensor read the correct value?
- Has the trip point of the low oxygen interlock been set at the oxygen level at which the combustion is safe?
- Does the alarm interlock work? (i.e. provides an alarm and shuts the boiler down if levels below setpoint exist).

A detailed step by step procedure for the required test is given in Appendix A.

5.18 INTERLOCK OF OUTSIDE AIR DAMPER WITH BURNER MANAGEMENT SYSTEM

5.18.1 Description

Air for combustion must be available from the outside atmosphere (outside air) in the amount necessary to burn the fuel. Natural gas and oil require about 15 lb of air to burn 1 lb of fuel. The safety issue in this situation involves a scenario in which the outside air openings are closed to the point that insufficient air is supplied to the boiler. Boiler rooms can be placed into two distinct categories in terms of outside air supply. One type boiler room has so many leaks, open windows/vents/doors that there is no chance of starving the boiler for outside air. A second type boiler room is one in which normally there are a lot of openings to the outside but the possibility exists that these openings could be closed to a point where the boiler would be starved for air.

In the first type boiler room there is no need for an interlock because it is not possible to starve the boiler for air. In the second type boiler room there is generally no control to prevent the boiler from operating even though a potential danger exists. In this case, consideration of some method to prevent operation of the boiler with insufficient outside air should be given. Since generally there are several openings that must be closed to produce insufficient combustion air, no one position switch mounted at one of these openings will suffice to prevent the problem for all boilers. In some cases each boiler is provided combustion air through adjustable louvers with an interlock switch that prevents that boiler from being operated with the air intake louver closed. A cheaper solution is to permanently install sufficient area to provide the necessary outside air for all boilers by either welding or locking windows open or replacing windows with fixed air intake louvers.

5.18.2 Consequences of Inadequate Outside Air

This situation will cause high levels of combustibles in the boiler. High combustibles represent two very significant safety hazards. First, carbon monoxide will be a significant portion of the combustibles and can be fatal if breathed by humans at a sufficient level. Second, these combustible gases can produce a violent explosion if air is introduced. The explosion and toxic fumes that can be generated in this way could easily damage property and injure/kill people within hundreds of feet from the boiler.

5.18.3 Testing the Outside Air Damper Switch

Basically, the test involves determining whether sufficient outside air openings are guaranteed and sufficiently sized. If an outside air damper switch is used to make that guarantee, it can be simply tested by trying to start the boiler with the outside air damper closed. A detailed step by step procedure is given in Appendix A.

Appendix A STEP BY STEP TEST PROCEDURES

Appendix A.1 INTRODUCTION

This appendix presents step by step test procedures for each safety device. The appendix provides forms for obtaining and recording all necessary data for each safety device being tested. It begins with tables that allow a thorough definition of the testing agency/personnel, responsible parties at the site, and boiler/burner data. This base data is followed by overarching requirements for safety testing. This information is then followed by one sheet for each device being tested to be used by the testing agency personnel as a check list and data form.

Appendix A.2 BASIC INFORMATION

VISN: _____
VA Medical Center: _____
Contact Name: _____
Phone: _____
Email: _____
Evaluators: _____
Date: _____

Individuals in Attendance:

Boiler and Burner Description

Boiler #	
Manufacturer:	
Model and Capacity:	
Serial #: National Board No.:	
Typical Operating Pressure:	
Design Pressure:	
Date of Manufacture:	
Boiler Controls:	
Burner	
Manufacturer:	
Type of burner:	
Fuels:	
Date of Manufacture:	

Appendix A.3 GENERAL REQUIREMENTS FOR TESTING

The following test procedures make certain assumptions that are listed below.

- After each test, equipment should be returned to normal operating condition and the boiler should be fired to confirm its operability.
- "Jumping" means disabling the switch electrically
- Any electric "jumper" application requires that all power to the device being "jumped" be shut off.
- All pressure gages used in a test must be recently calibrated.
- Any valve that disables a safety device should be lockable only in the operating position.
- The setpoint is the value at which the switch indicator is set. The trip point is the actual value at which the switch activates. Some language used in the test procedures assumes that the setpoint equals the trip point.
- Potentiometers used as safeties should be evaluated to determine if they are also used as the control. This is not acceptable.

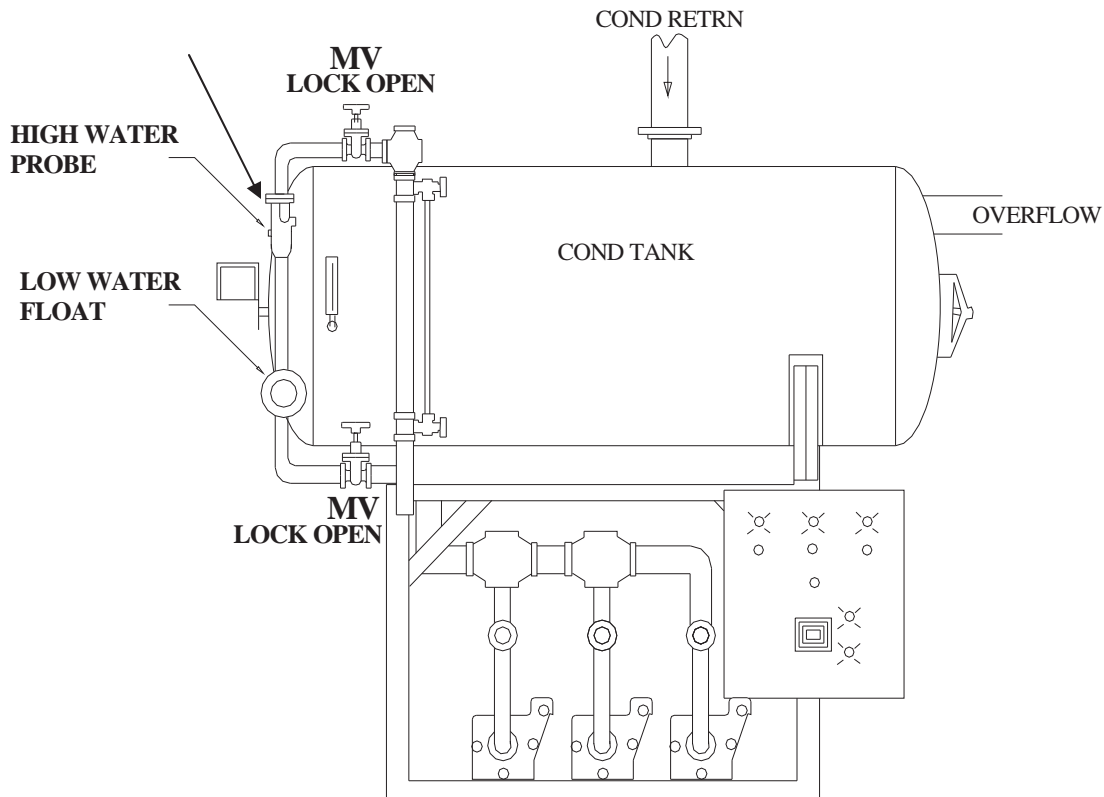
Appendix A.4 Detailed Test Procedures - Checklists

Checklist for High Water Alarm on Condensate Tank (HWACT)

Item	Make	Float / Probe	Alarm Setpoint	Correct Device Type Y / N	Correct Location Y / N
HWACT					

*Alarm setpoint should be below 2/3rds of tank height & at least 4" below the overflow.

*Alarm type should be a probe sensor.



- Drain sight glass without draining alarm column and quickly close drain valve. Water level should quickly rise in sight glass indicating good communication with tank.
- Use bypass valve to add water to the condensate tank at a rate not to exceed 1 inch per minute. Use water level sight glass to observe point that alarm sounds. **DO NOT ALLOW WATER LEVEL TO LEAVE SIGHT GLASS.**
- Put maximum water supply to condensate tank and verify overflow is adequate.

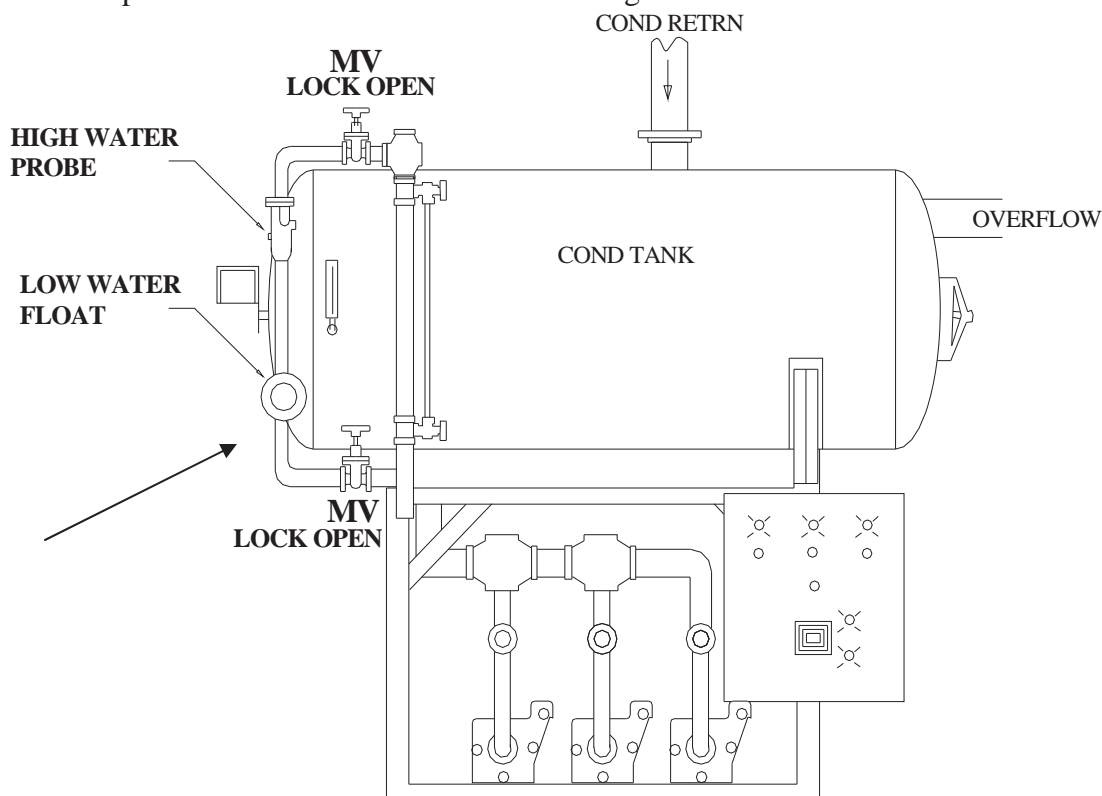
Result	Y/N	Water Level
Did the alarm work correctly?		
What was the water level in sight glass at alarm point?		
Is overflow adequate?		
Can the switch be isolated with manual valves		

Comment:

Checklist for Low Water Alarm on Condensate Tank (LWACT)

Item	Make	Float / Probe	Alarm Setpoint	Correct Device Type Y / N	Correct Location Y / N
LWACT					

*Alarm set point should be above 1/3rd of tank height?



- Drain sight glass without draining alarm column and quickly close drain valve. Water level should quickly rise in sight glass indicating good communication with tank.
- Drain the water from the condensate tank at a rate not to exceed 1 inch per minute. Use water level sight glass to observe alarm point. **DO NOT ALLOW WATER LEVEL TO LEAVE SIGHT GLASS**

Result	Y/N	Water Level
Did the alarm work correctly?		
What was the water level in sight glass at alarm point?		
Can the switch be isolated with manual valves		

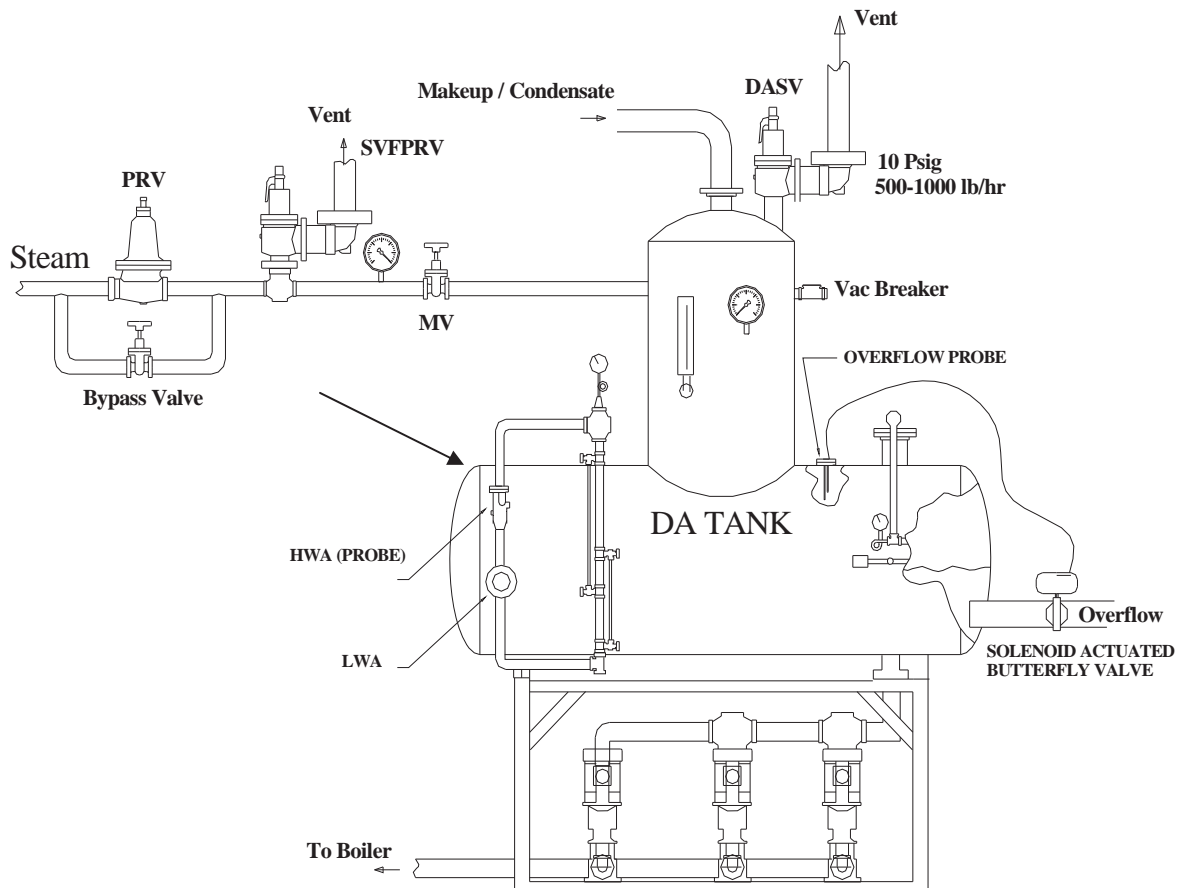
Comment:

Checklist for High Water Alarm on Deaerator Tank (HWADT)

Item	Make	Float / Probe	Alarm Setpoint	Correct Device Type Y / N	Correct Location Y / N
HWADT					

*Alarm setpoint should be below 2/3rds of tank height & at least 4" below the overflow.

*Alarm type should be a probe sensor.



- Drain sight glass without draining alarm column and quickly close drain valve. Water level should quickly rise in sight glass indicating good communication with tank.
- Use bypass valve to add water to the deaerator at a rate not to exceed 1 inch per minute. Use water level sight glass to observe point that alarm sounds. **DO NOT ALLOW WATER LEVEL TO LEAVE SIGHT GLASS.**

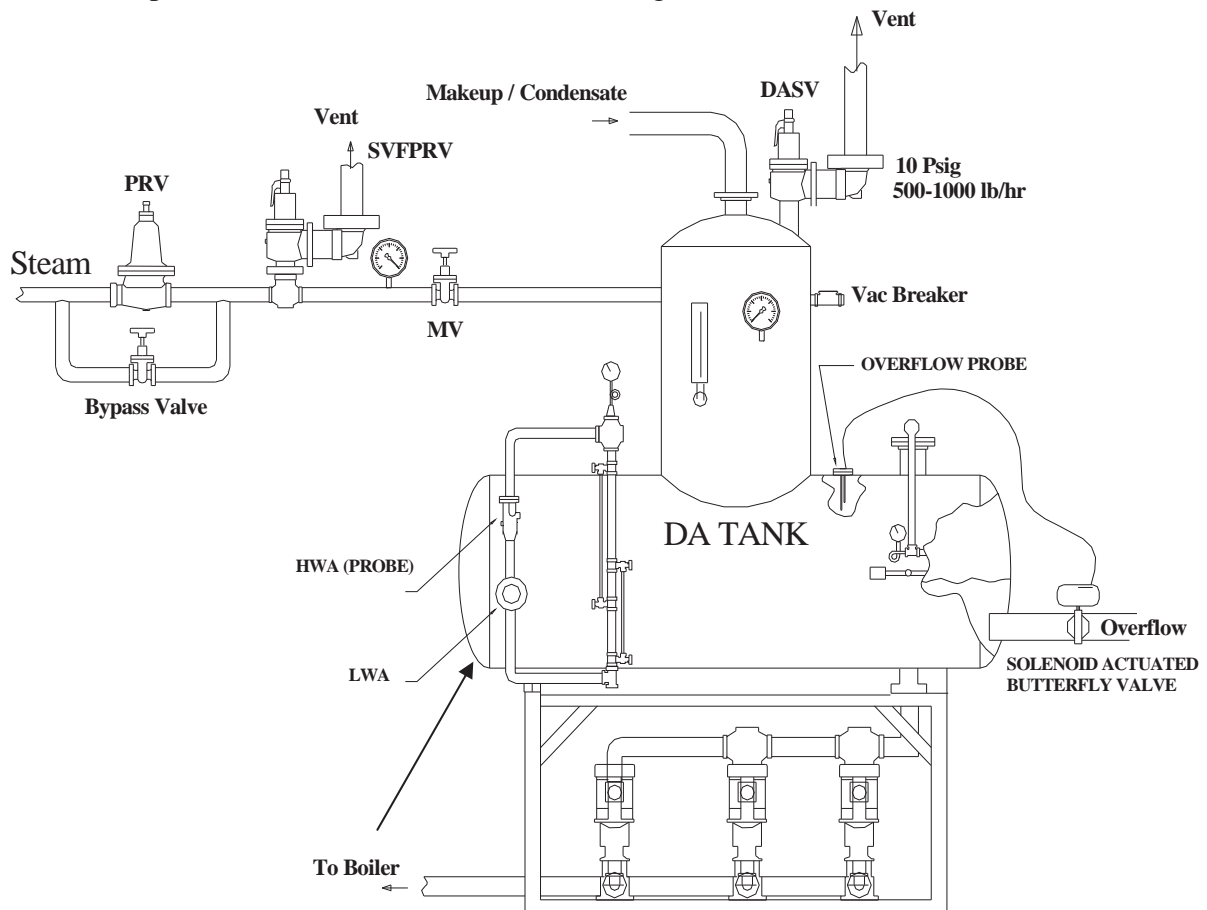
Result	Y/N	Water Level
Did the alarm work correctly?		
What was the water level in sight glass at alarm point?		
Can the switch be isolated with manual valves		

Comment:

Checklist for Low Water Alarm on Deaerator Tank (LWADT)

Item	Make	Float / Probe	Alarm Setpoint	Correct Device Type Y / N	Correct Location Y / N
LWADT					

*Alarm set point should be above 1/3rd of tank height.



- Drain the sight glass and quickly close drain valve. Water level should quickly rise in sight glass indicating good communication with tank.
- Drain the water from the deaerator at a rate not to exceed 1 inch per minute. Use water level sight glass to observe alarm point **DO NOT ALLOW WATER LEVEL TO LEAVE SIGHT GLASS.**

Result	Y/N	Water Level
Did the alarm work correctly?		
What was the water level in sight glass at alarm point?		
Can the switch be isolated with manual valves		

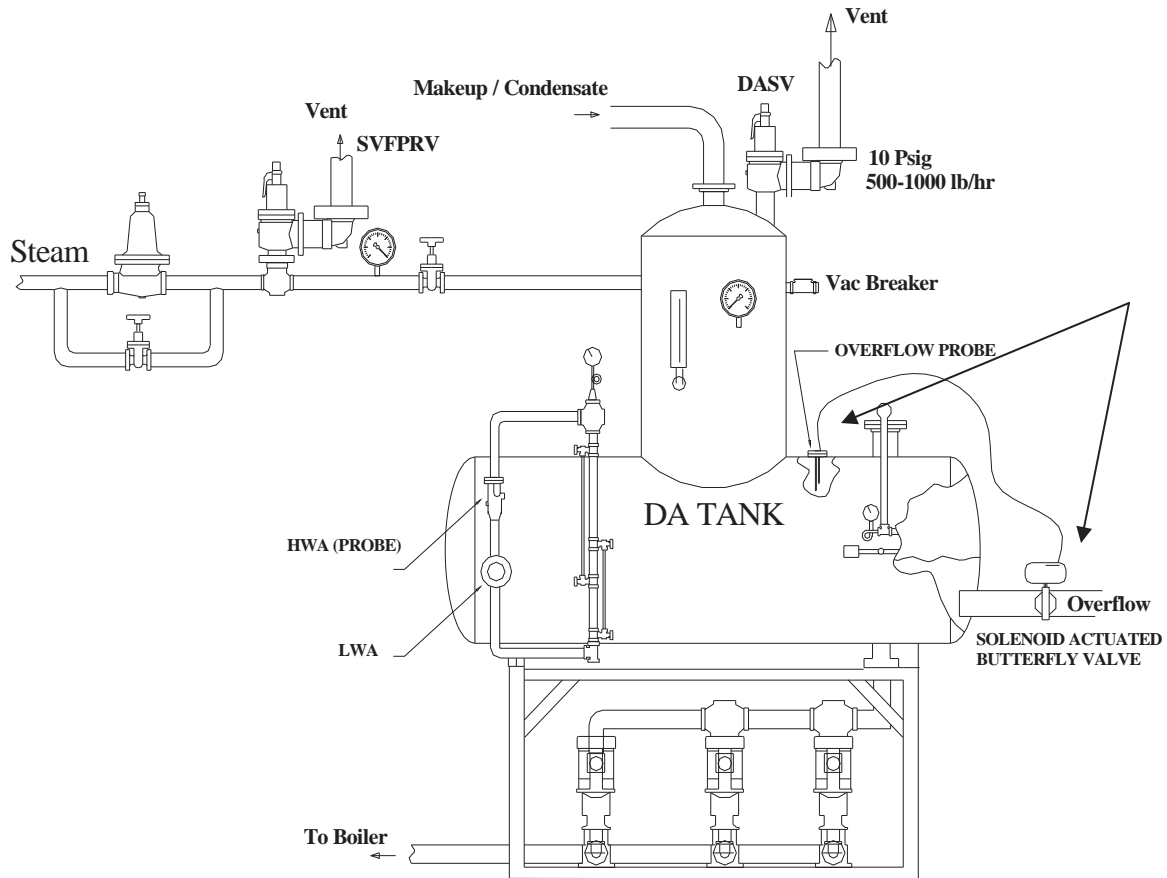
Comment:

Checklist for Deaerator Overflow Drain System (DAODS)

Item	Make	Float / Probe	Overflow Setpoint	Correct Device Type Y / N	Correct Location Y / N
DAODS					

*Overflow type should be a conductivity probe connected to electronic valve.

*Setpoint should be at least 4" below top of tank.



- Drain the sight glass and quickly close drain valve. Water level should quickly rise in sight glass indicating good communication with tank.
- Open manual bypass valve to supply feedwater at maximum rate.
- Use sight glass in drain system to determine that dump valve has opened. Use water level sight glass to observe whether dump valve maintains water level visible in sight glass. DO NOT ALLOW WATER LEVEL TO LEAVE SIGHT GLASS.

Result	Y/N	Water Level
Did the overflow valve work correctly?		
Was the water level maintained in sight glass.		
View port in place to view overflow?		

Comment:

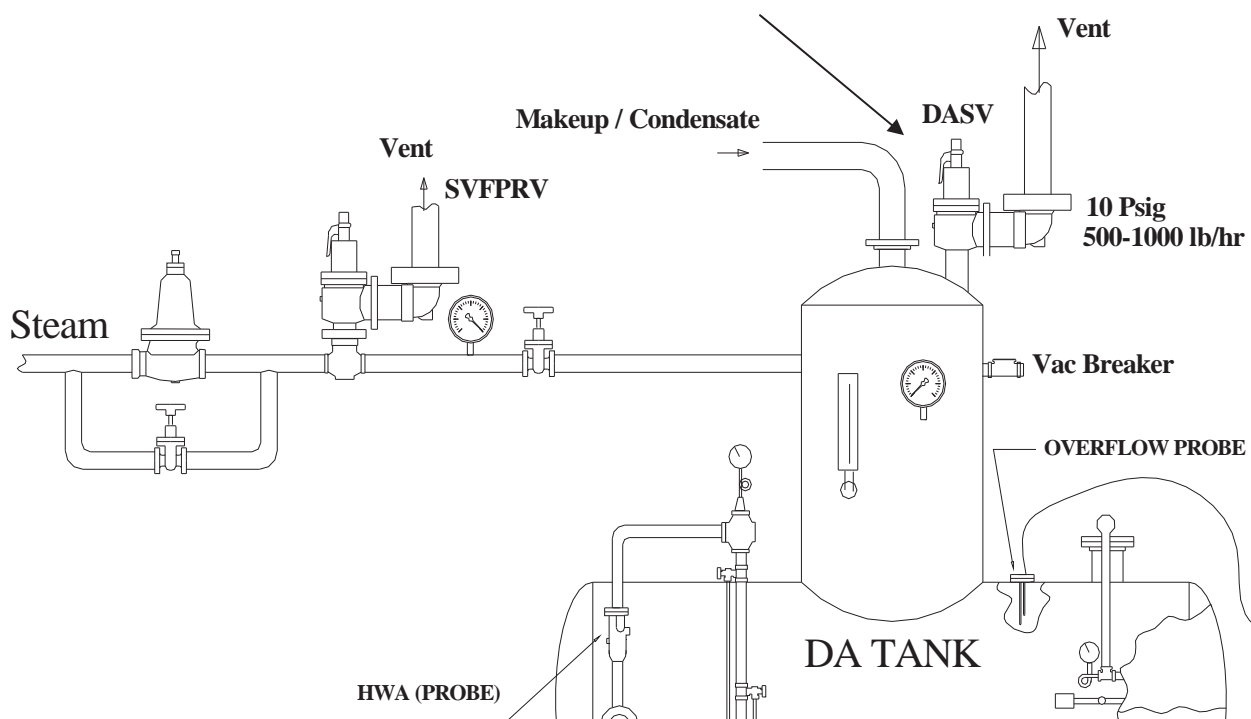
Checklist for Deaerator Safety Valve (DASV)

Item	Make	Capacity (lb/hr)	Range	DASV Setpoint	DA PRES (psig)	Correct Installation
DASV						
Pressure Gage						

*Setpoint should be about 5 PSIG higher than DA pressure

*Capacity should be approximately (1000 lb/hr)

Item	Make	Type	MAWP	NDT (date)
Deaerator				



- Abort testing if NDT is not current within six years.
- Pour water into drip pan ell drain and confirm that it is open.
- Slowly open bypass valve to raise pressure until safety lifts. **DO NOT RAISE PRESSURE MORE THAN 2 PSIG ABOVE SET POINT PRESSURE.**
- Re-seat pressure should be about 6% less than lift pressure.
- After lifting valve, close bypass valve and allow safety to reseat.

Result	Y/N	Pressure
Did the safety valve work correctly?		
What was the safety valve relief pressure?		
What is the re-seat pressure?		
Is vacuum breaker present (VA requirement)?		

Comment:

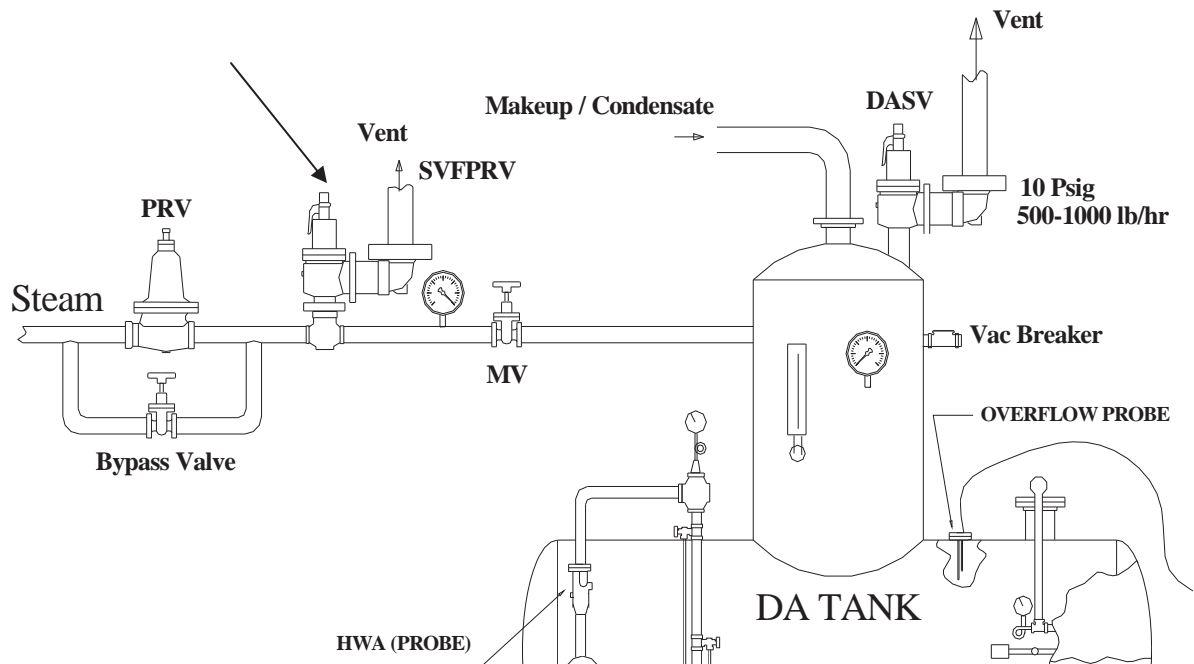
Checklist for Safety Valve Following PRV (SVFPRV) - Steam

Item	Make	Capacity (lb/hr)	Range	SVFPRV Setpoint	DA PRES (psig)	Correct Installation
SVFPRV						
Pressure Gage						

*Setpoint should be about 5 PSIG higher than DA safety lift point.

Item	Make/Type	Size (in)	Pressure upstream	Pressure downstream	Wide Open Flow Capacity lb/hr
PRV					
Bypass					

*SVFPRV must relieve largest wide open flow capacity, PRV or bypass valve.



- Pour water into drip pan ell drain and confirm that it is open.
- Close the manual valve in steam line following the safety valve.
- Slowly open bypass valve to raise pressure until safety lifts. **DO NOT RAISE PRESSURE MORE THAN 2 PSIG ABOVE SETPOINT PRESSURE.**
- Re-seat pressure should be about 6% less than lift pressure.
- Open larger of the bypass valve or PRV completely and perform accumulation test. The pressure should rise no more than 6% above the setpoint pressure.
- After lifting valve, close bypass valve, open manual valve in steam line after PRV and allow safety to reseat.

Result	Y/N	Pressure
Did the safety valve work correctly?		
What was the safety valve relief pressure?		
What is the re-seat pressure?		

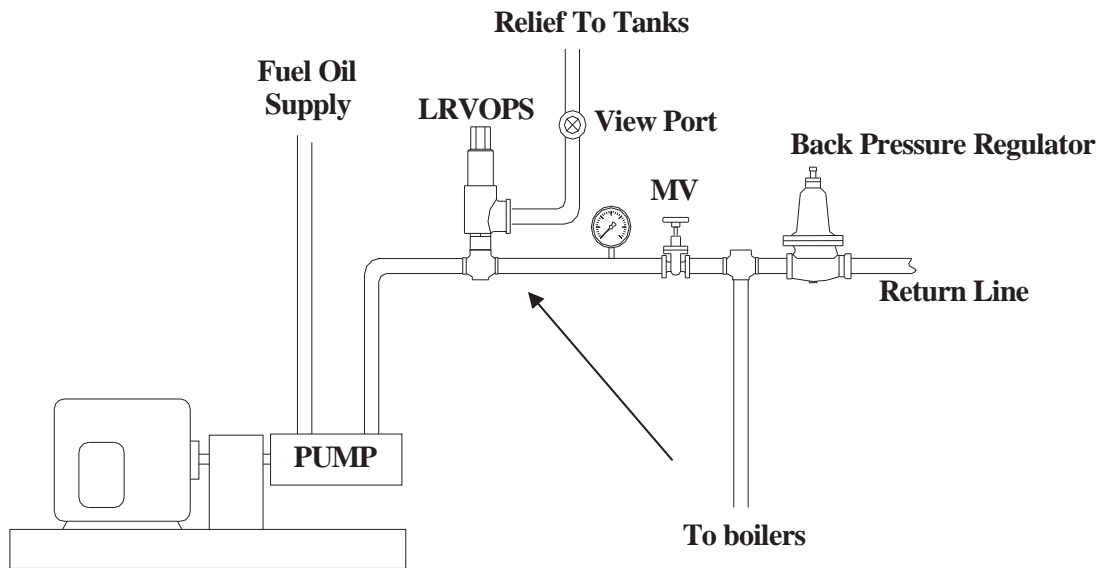
Comment:

Checklist for Liquid Relief Valve on Oil Pump Set (LRVOPS)

Item	Make	Capacity (gal/hr)	Range	LRVOPS Setpoint	Oil Supply Pressure	Correct Installation
LRVOPS						
Pressure Gage						

*Setpoint should be less than the max allowable pump pressure and less than 10 psig above normal regulated oil supply pressure.

* Liquid relief should not be used as a backpressure regulator.



- Slowly close manual valve in oil line after relief valve or raise pressure regulator set pressure until relief valve lifts (use view port to determine if valve is open).
- The pressure should rise no more than 10 psig above normal regulated oil supply pressure.

Result	Y/N	Pressure
Did the relief valve work correctly?		
What was the safety valve relief pressure?		
Did valve re-seat?		
View port in place to view oil flow thru relief valve?		
Is a back pressure regulator present?		

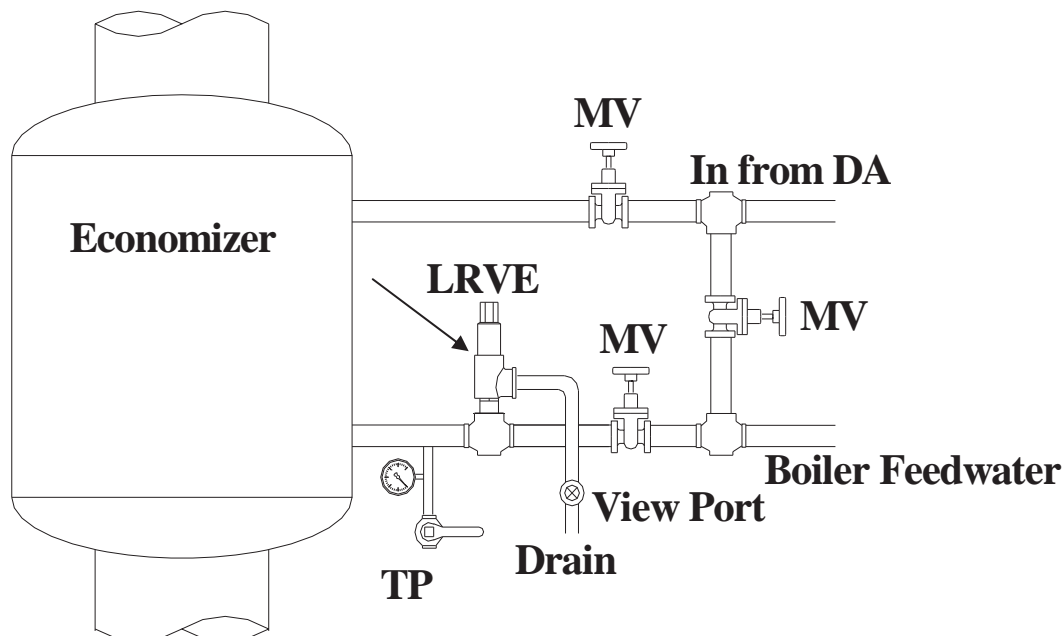
Comment:

Checklist for Liquid Relief Valve on Economizer (LRVE)

Item	Make	Capacity (gal/hr)	Range	LRVE Setpoint	Feedwater Pressure	Correct Installation
LRVE						
Pressure Gage						

*Setpoint should be less than the max allowable economizer pressure and more than maximum feedwater pressure.

Item	Make	Max Stack Temp	MAWP
Economizer			



- With boiler offline use manual valves to isolate economizer and relief valve. Use hydrostatic tester to raise pressure and open relief valve (use view port to determine when valve is open). **DO NOT RAISE PRESSURE MORE THAN ALLOWABLE ECONOMIZER PRESSURE!**
- An alternate method is to raise economizer pressure by operating boiler with isolation valves closed.

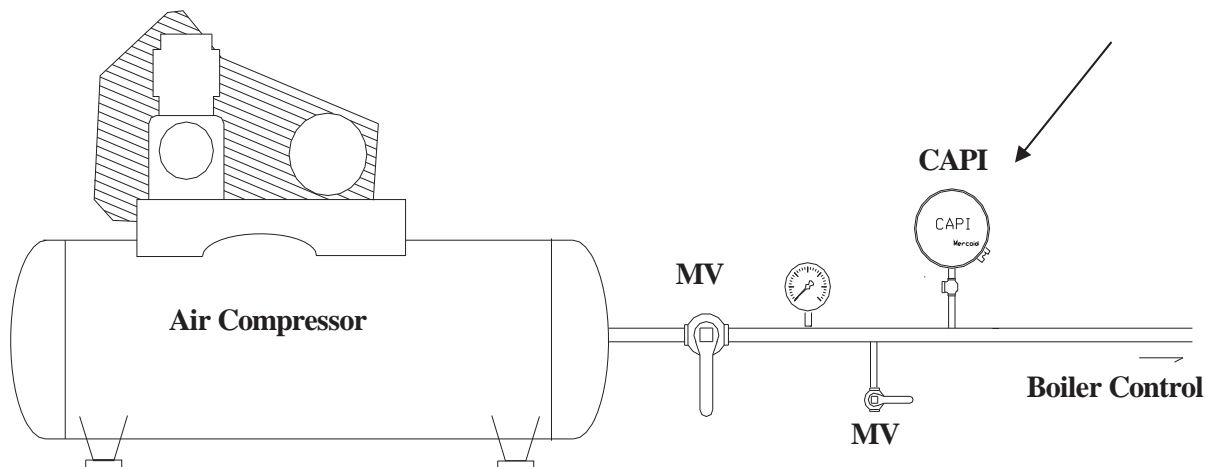
Result	Y/N	Pressure
Did the LRVE work correctly?		
What was the safety valve relief pressure?		
Maximum allowable economizer pressure?		
What is the re-seat pressure?		
View port in place to view water flow thru relief valve?		

Comment:

Checklist for Control Air Pressure Interlock (CAPI)

Item	Make	Range (psig)	Switch Setpoint	Regulated Pressure	Required Pressure	Correct Location Y/ N
CAPI						
Pressure Gage						

*Setpoint should be more than pressure required to actuate any pneumatic control device.



- Slowly close manual test valve to lower air supply pressure. Observe the pressure at which boiler shuts down. **DO NOT LOWER PRESSURE BELOW REQUIRED PRESSURE TO ACTUATE ANY PNEUMATIC CONTROL DEVICE!**

Result	Y/N	Trip Point
Did the CAPI work correctly?		
Is a lockable manual test valve in place as shown in figure?		
What was the interlock trip point?		
Is the setpoint higher than pressure required to actuate any pneumatic control device		

Comment:

Checklist for Propane Pilot Backup System

-
- Connect and/or align propane system to boiler.
 - Attempt to light boiler FIRING ON FUEL OIL.
-

Result	Y/N
Is system in place and operable?	

Comment:

Checklist for Carbon Monoxide and Combustible Gas Alarms in the Boiler Plant

Item	Make	Number of Alarms	Alarm Setpoint	Test Gas Y/N	Correct Location Y / N
Combustible Alarm					
CO Alarm					

*CO setpoint should be 50 ppm or less.

*Combustible setpoints should be 10% or less of the LEL.

*Test gasses for CO and combustibles should be 225-250 ppm.

*Location and number of CO and combustible sensors determined by VA directive.

-
- Supply proper test in accordance with manufacturers recommendation to test alarms.
-

Result	Y/N
Did the combustibles alarm work correctly?	
Did the CO alarm work correctly?	
Are the number and locations of the sensors adequate?	

Comment:

Checklist for Outside Air Damper Interlock (OADI)

- If OADI exists, close outside air damper and prove that interlock shuts off boiler.
- If OADI does not exist measure fixed air intake area (fixed area required is 1.5 times the total combustion inlet air area for all boilers).

Result	Y/N	Manufacturer
Is there adequate FIXED opening to supply combustion air?		
If there is not adequate fixed opening, is there and OADI?		
If OADI exists, did it work?		

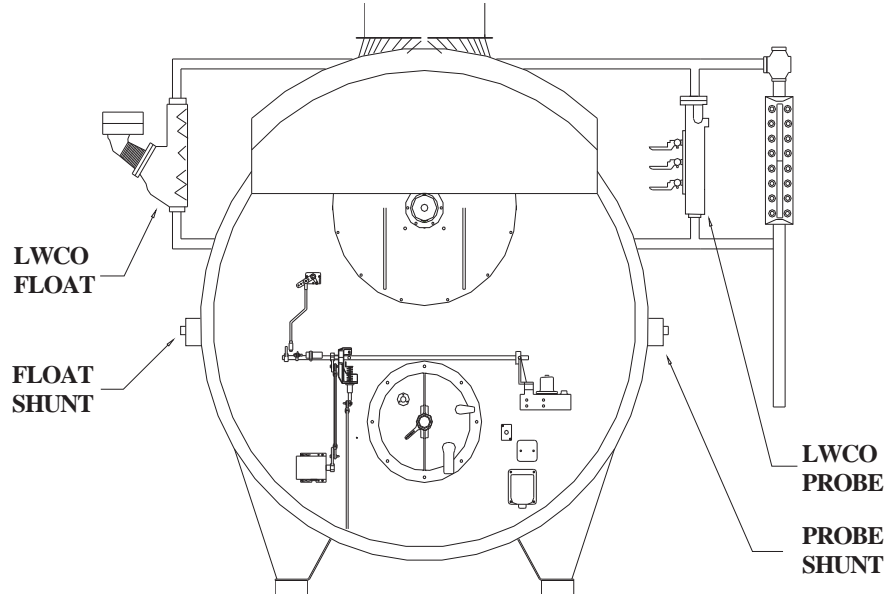
*Fixed intake area should be 1.5 times intake area for all boilers.

Comment:

Checklist for Low Water Alarm and Cutoffs on Boiler (LWA/LWCO/ALWCO)

Item	Make	Float / Probe	Correct Installation
LWA			
LWCO			
ALWCO			

*Independent shunt switches should be installed for each LWCO



- IN PERFORMING TEST NEVER LET WATER LEVEL LEAVE SIGHT GLASS!!!
- Drain sight glass without draining alarm column and quickly close drain valve. Water level should quickly rise in sight glass indicating good communication with tank.
- With boiler in manual at low fire, close the feedwater valve to generate a slow drain. You may “crack” the blowdown valve but do not exceed a drain rate of 1 inch per minute. Use water level in sight glass to observe alarm point. The alarm should sound first.
- Continue to drain until the primary cutoff activates.
- If shunt exists verify that it **ONLY** isolates the LWCO.
- Jumper or shunt the primary cutoff, restart the boiler, and set up drain as described above.
- Continue the drain until the secondary cutoff activates.

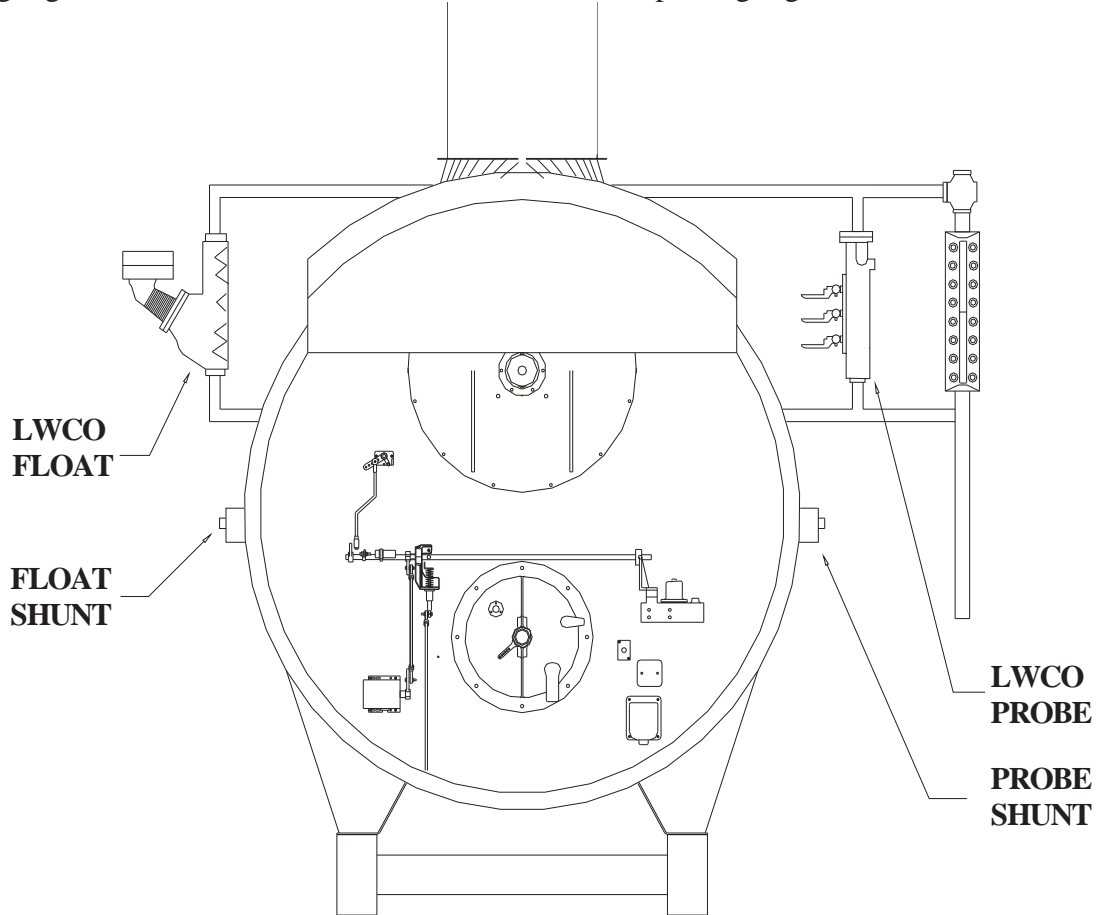
Result	Y/N	Water Level
Did the LWA work correctly? Record Level.		
Did the Primary cutoff work correctly? Record Level.		
Did the secondary cutoff work correctly?		
Was the alarm point above the primary and secondary cutoff point?		
Overall, did alarm and 2 low water cutoffs work correctly?		

Comment:

Checklist for High Water Alarm on Boiler (HWAB)

Item	Make	Float / Probe	Correct Installation
HWA			

*Sight glass water level should be 1" or more below top of sight glass at alarm.



- Drain sight glass without draining alarm column and quickly close drain valve. Water level should quickly rise in sight glass indicating good communication with tank.
- With boiler off, open the bypass feedwater valve to fill the boiler. Use water level in sight glass to observe alarm point. The alarm should sound before water level leaves sight glass. **DO NOT ALLOW WATER LEVEL TO LEAVE SIGHT GLASS**
- Close the bypass on feedwater line

Result	Y/N	Water Level
Did the alarm work correctly?		
What was the water level in sight glass at alarm point?		

Comment:

Checklist for Recycle and Non-Recycle Boiler Steam Pressure Limit Switches (RBSPLS & NRBSPLS)

Item	Make	Range (psig)	Switch Setpoint	Normal Steam Pressure (psig)	Lowest SVB Setpoint (psig)	Correct Setpoint Y / N
RBSPLS						
NRBSPLS						
Pressure Gage						

*RBSPLS setpoint should be 10 psig or more of normal steam pressure.

*NRBSPLS setpoint should be 5 psig or more of the RBSPLS setpoint & 5 psig or more less than the lowest SVB setpoint.

-
- Never exceed the boiler MAWP during this test.
 - Place boiler in minimum fire and manually close the steam supply valves from the boiler.
 - Raise the steam pressure slowly by firing the boiler.
 - Raise until RBSPLS activates – record activation pressure in table below.
 - Jumper the recycle switch out of the circuit.
 - Fire boiler and raise the steam pressure slowly.
 - Raise until NRSBPLS activates – record activation pressure in table below .

Result	Y/N	Pressure
Did the RBSPLS work correctly? Record Pressure.		
Did the NRSBPLS work properly? Record Pressure.		

Comment:

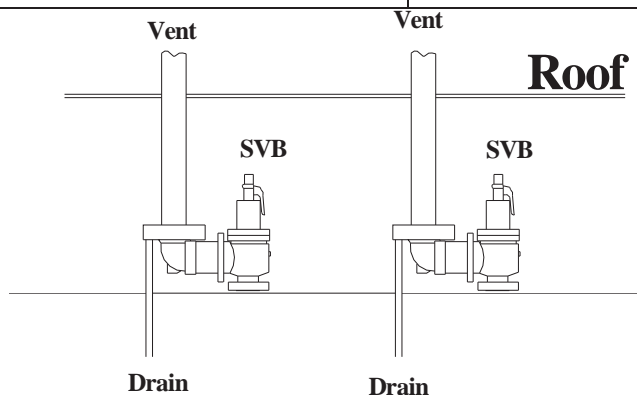
Checklist for Steam Safety Valves on Boiler (SVB)

Item	Make	Capacity (Lb/hr)	Range	SVB Setpoint	Normal Steam Pressure	Correct Installation / Capacity
SVB 1						
SVB 2						
SVB 3						
Pressure Gage						

*SVB1 should be set 5 psig higher than NRBSPLS & 10 psig below boiler MAWP.

*SVB2 should be set 5 psig or higher than SVB1 & 5 psig or more below boiler MAWP.

Item	MAWP (psig)	Capacity (lb/hr)
Boiler		



- NEVER ALLOW BOILER PRESSURE TO EXCEED MAWP
- With boiler off, jumper recycle and non-recycle steam pressure switches.
- Close the steam supply valves from the boiler and test the drains on the safety valve drip pan ells by pouring water into them and noting that water flows freely. Unstop drains before proceeding.
- Raise the steam pressure slowly by firing the boiler at low fire.
- Note the pressure that the first & second safety valve opened. (may require increasing firing rate).
- Place boiler in high fire and determine if steam pressure rises with both SVB open.
- Shut boiler off and note the pressure that the safety valves close.

Result	Y/N	Lift (P)	Reseat (P)
Did the first SVB correctly? Record Pressure.			
Did the second SVB work correctly? Record Pressure.			
Did the third SVB work correctly? Record Pressure.			
Maximum pressure observed during accumulation test?			
Is SVB vent plumbing adequate?			

*Max lift pressure of 3% higher than rated lift pressure. Blowdown should be less than the greater of 2 psig or 2% of the set pressure, and shall not exceed 6% of set pressure.

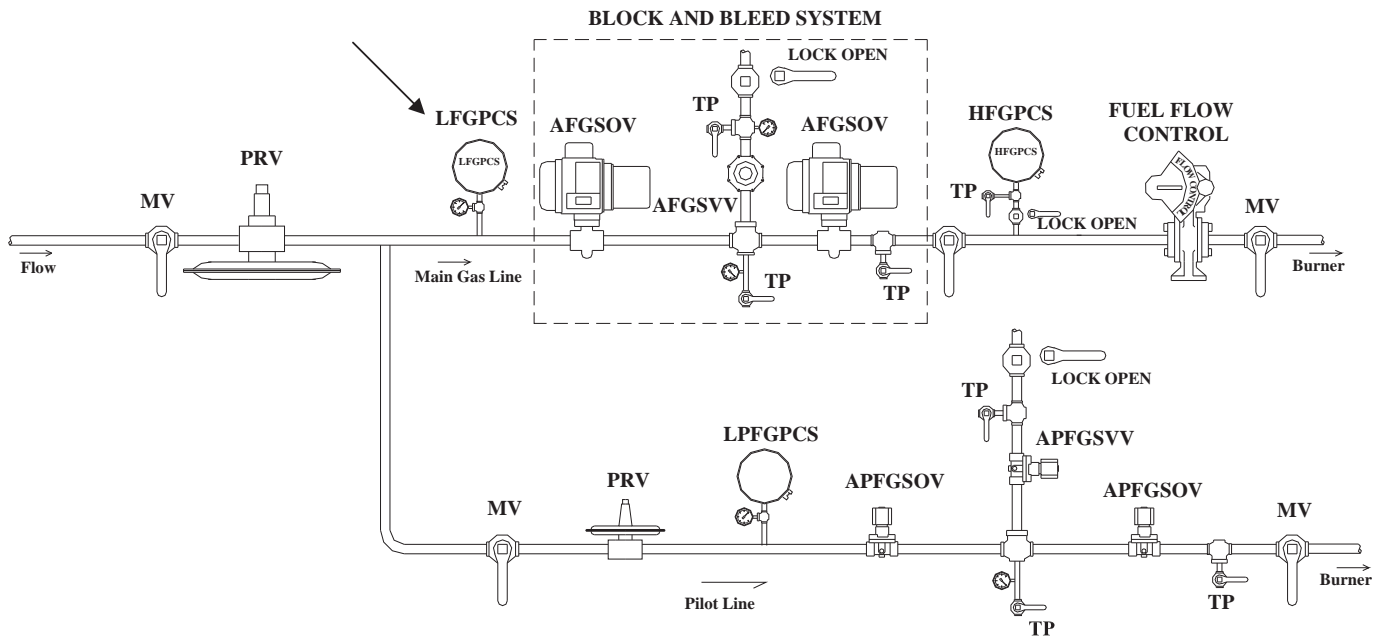
*Maximum accumulation pressure seen should not exceed 110% of highest SVB setpoint and never exceed boiler rated pressure.

Comment:

Checklist for Low Fuel Gas Pressure Cutoff Switch (LFGPCS)

Item	Make	Range (inwc/psig)	Switch Setpoint (inwc/ psig)	Regulated Pressure (inwc/psig)	Correct Location Y / N
LFGPCS					
Pressure Gage					

*LFGPCS must be downstream of PRV and upstream of AFGSOV with a setpoint of 80% or higher than regulated pressure.



In low fire, throttle upstream fuel valve slowly until switch trips the boiler offline due to low fuel pressure but NO LOWER THAN 80% OF REGULATED PRESSURE

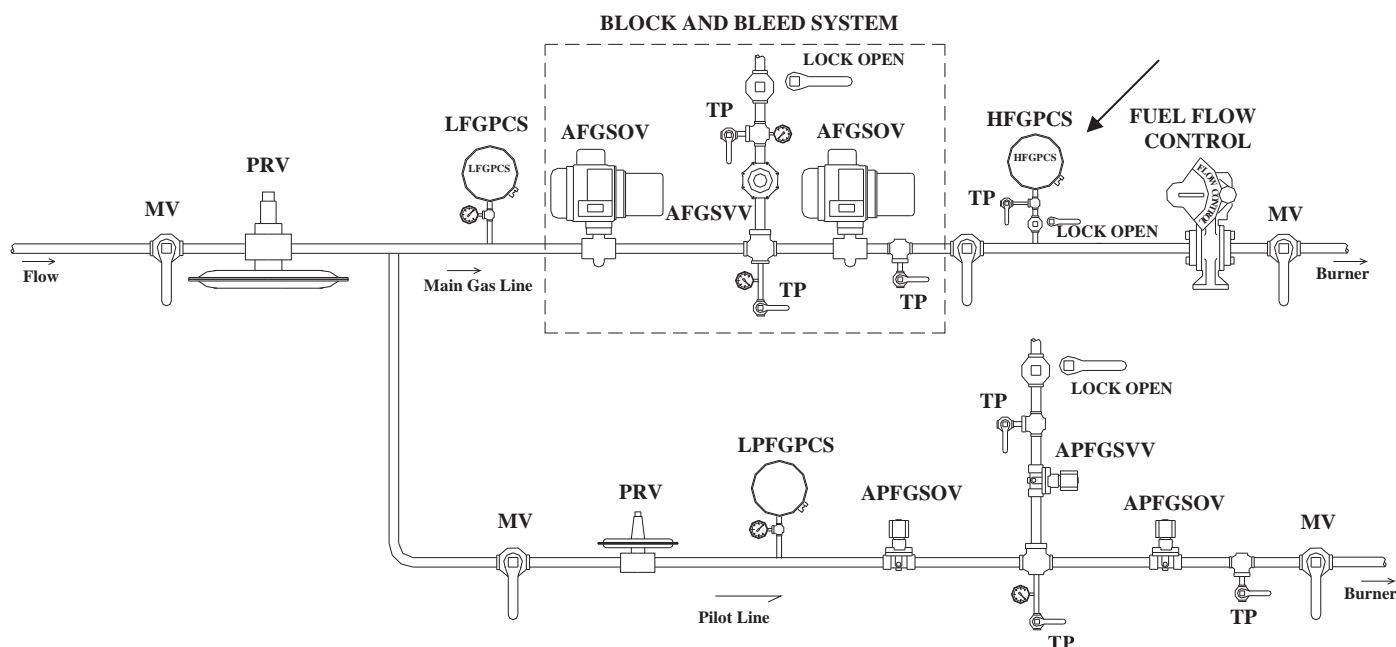
Result	Y/N	Pressure
Did the switch work correctly? Record pressure.		
Is switch trip point 80% or more of regulated pressure?		

Comment:

Checklist for High Fuel Gas Pressure Cutoff Switch (HFGPCS)

Item	Make	Range (inwc/psig)	Switch Setpoint (inwc/ psig)	Regulated Pressure (inwc/psig)	Correct Location Y / N
HFGPCS					
Pressure Gage					

*HFGPCS must be downstream of PRV and upstream of flow control with a setpoint of less than 120% of regulated pressure.



- With boiler in low fire close lockable manual valve isolating the HFGPCS.
- Open test port between lockable manual valve and HFGPCS and pressurize with compressed air or nitrogen.
- Slowly raise pressure until switch trips boiler offline due to high test gas pressure, BUT NO HIGHER THAN 120% OF REGULATED PRESSURE.

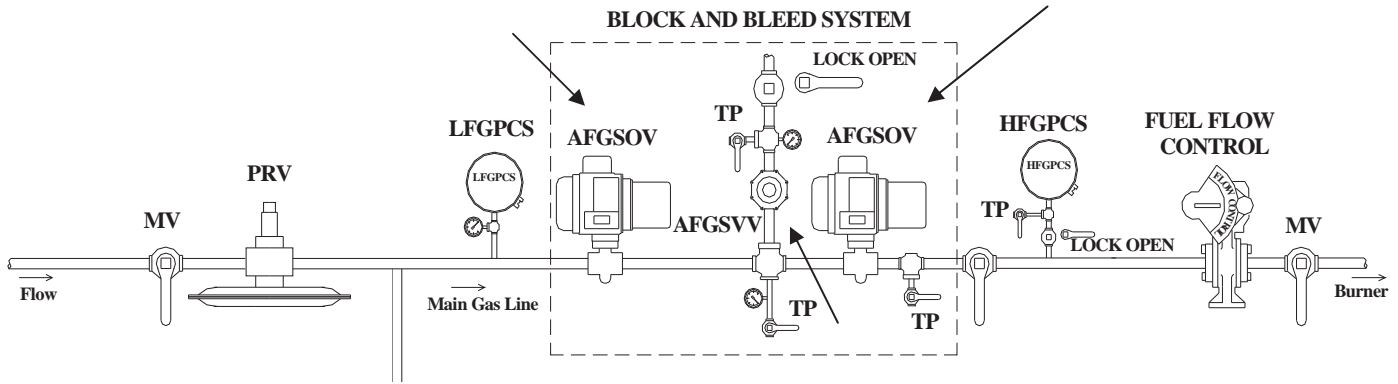
Result	Y/N	Switch Trip Point
Did the switch work correctly?		
Are manual test valves and test port valves in place as shown?		
What was the switch trip point?		
Is switch trip point 120% or less of regulated pressure?		

Comment:

Checklist for Automatic Fuel Gas Shutoff Valves and Solenoid Vent Valve Seat Leakage (AFGSOV & AFGSVV) – Main Gas Line

Item	Make	Range (inwc/psig)	Correct Installation Y/N
AFGSOV			
AFGSVV			
Pressure Gage			

*Maximum allowable leak rate is zero bubbles in 2 minutes.



- Verify all test port valves are closed and manual valve in vent line is open. Connect flexible tubing to the 3 test ports as shown.
- The test utilizes placing the flex line no more than ¼ inch in water. This test can be accelerated by pressurizing the flex line before submerging in water.
- With the boiler in low fire, close manual lockable valve in vent line and open test port valve in vent line. Verify that no bubbles appear.
- Provide regulated gas pressure (or more) before upstream AFGSOV and between AFGSOVs.
- Using the two test ports in the main gas line and the test port in the vent line, open the test port valves and observe water for sign of bubbles for 2 minutes.
- If no bubbles appear, the respective valve is not leaking.
- Open and lock manual vent valve and shut boiler off and verify that the pressure between AFGSOV is atmospheric.

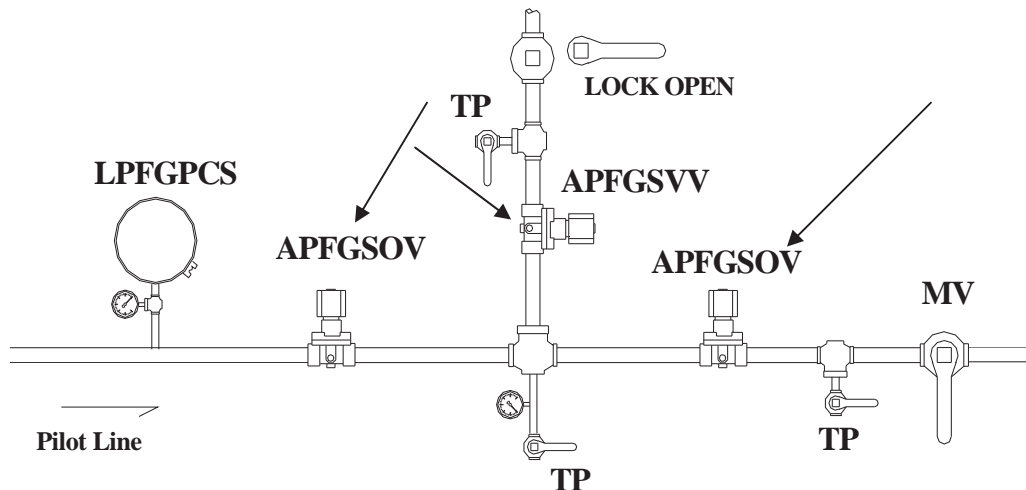
Result	Y/N
Did upstream AFGSOV leak?	
Did downstream AFGSOV leak?	
Did AFGSVV leak?	
Did AFGSVV open with boiler off	

Comment:

Checklist for Automatic Pilot Fuel Gas Shutoff Valves and Automatic Pilot Fuel Gas Solenoid Vent Valve Seat Leakage (APFGSOV & APFGSVV) – Pilot Line

Item	Make	Range (inwc/PSIG)	Correct Installation Y/N
APFGSOV			
APFGSVV			
Pressure Gage			

*Maximum allowable leak rate is zero bubbles in 2 minutes.



- Verify all test port valves are closed and manual valve in vent line is open. Connect flexible tubing to the 3 test ports as shown.
- The test utilizes placing the flex line no more than ¼ inch in water. This test can be accelerated by pressurizing the flex line before submerging in water.
- With the boiler in low fire, close manual lockable valve in vent line and open test port valve in vent line. Verify that no bubbles appear.
- Provide regulated gas pressure (or more) before upstream APFGSOV and between APFGSOVs.
- Using the two test ports in the main gas line and the test port in the vent line, open the test port valves and observe water for sign of bubbles for 2 minutes.
- If no bubbles appear, the respective valve is not leaking.
- Open and lock manual vent valve and shut boiler off and verify that the pressure between APFGSOV is atmospheric.

Result	Y/N
Did upstream APFGSOV leak?	
Did downstream APFGSOV leak?	
Did APFGSVV leak?	
Did APFGSVV open with boiler off	

Comment:

Checklist for Proof of Closure on Automatic Fuel Shutoff Valves (POC-AFGSOV) – Natural Gas

Item	Make
POC-AFGSOV	

*Switch should open with a very slight opening of the valve.

*Switches should be wired in series.

-
- Close manual fuel valve downstream of AFGSOV. Perform the following test on each AFGSOV separately.
 - Remove cover on both automatic shut off valves to provide access to two wires connected across proof of closure switch. Can also access wires in appropriate junction box. Disconnect both leads from switch going to control circuit.
 - Temporarily connect the two wires that were disconnected from the POC switch in order to electrically bypass the switch.
 - Start boiler and verify that switch opens with a very slight opening of the valve by measuring resistance across switch.
 - Shut boiler down and disconnect two wires going to control circuit. Try to start boiler and verify that the boiler does not allow ignition sequence to begin.
 - Repeat procedure for switch on 2nd valve.

Result	Y/N
Is POC present in both valves?	
Did either valve being open allow the boiler to fire?	
Did both switches open with very slight opening of valve?	

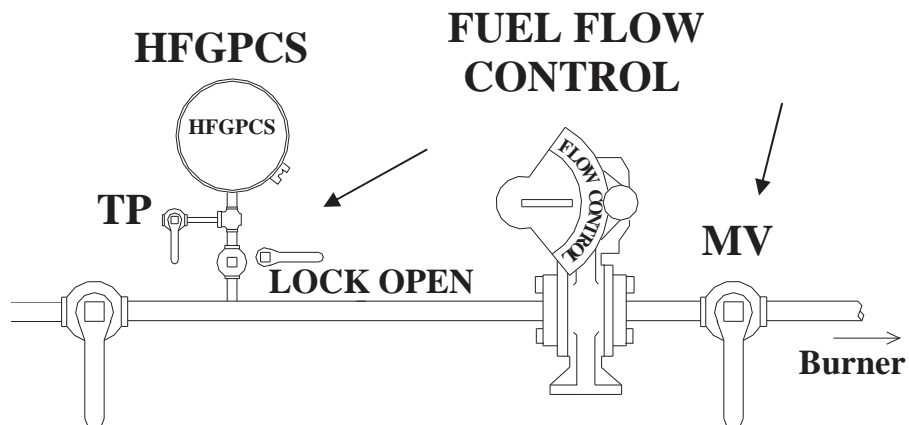
Comment:

Checklist for Flame Scanner-for main flame out (FSMFO)

Item	Make	Model	UV or IR	Self-Checking Y/N	Correct Scanner Y/N
Flame Scanner					

*Maximum allowable timing is 4 sec.

*Only a UV– Self checking scanner is allowed. If scanner is IR, system must be replaced.



- Close the lockable manual valve between the fuel line and the HFGPCS.
- Quickly close the manual valve in fuel line before burner.
- Observe the time required for the flame scanner to close the automatic fuel safety shutoff valves. (Valves should close within 3 to 4 seconds from the time the flame goes out in the firebox).

Result	Y/N	Time (seconds)
Did the scanner work correctly?		
Time to close fuel valves?		

Comment:

Checklist for Flame Scanner Not Sensing Igniter Spark (FSNSIS)

Item	Make	Model	Rebuilt Y/N
Programmer			

*The scanner should not indicate a voltage-voltage indicates that scanner senses spark.

-
- Close manual valves in main fuel line and pilot gas line.
 - Attempt to start boiler.
 - Determine if the scanner output indicates a voltage.

Result	Y/N
Did the scanner work correctly?	

Comment:

Checklist for Igniter Timing (IT)

Item	Make	Model
Programmer		

* Maximum allowable duration is 10 sec.

-
- Close manual valves in main fuel line and pilot gas line.
 - Start boiler.
 - View igniter by means of furnace front or back view port and time the ignition spark. (You can hear the igniter click on and off so that it may not be necessary to view the spark if not easily visible).
 - Observe the duration of the ignition spark with a stop watch.

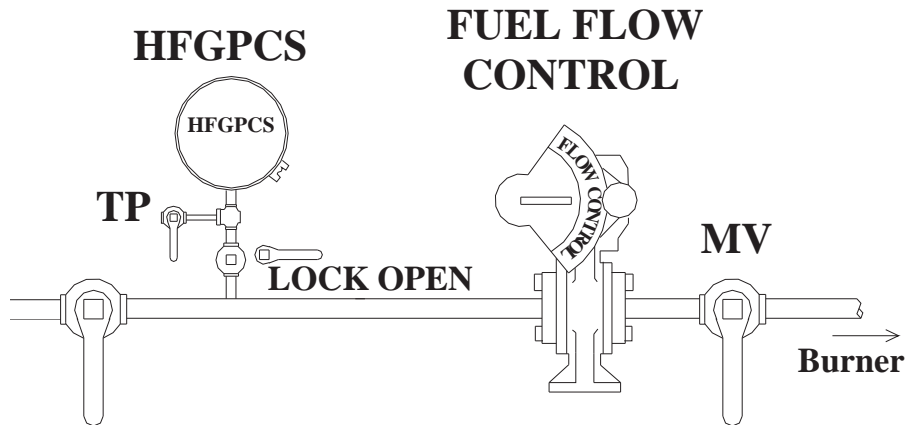
Result	Y/N	Time (seconds)
Did the scanner work correctly?		
Igniter timing?		

Comment:

Checklist for Main Flame Ignition Timing (MFIT)

Item	Make	Model
Programmer		

* Maximum timing should be 14 seconds.



-
- Close the lockable manual valve between the fuel line and the HFGPCS..
 - Close manual valves in main fuel line.
 - Attempt to start boiler.
 - Time the AFGSOV from the time they begin to open until they close with a stopwatch.
-

Result	Y/N	Time (seconds)
Did the programmer work correctly?		
Time to AFGSOVs?		

Comment:

Checklist for Pre-Purge and Post-Purge Timing (PPT)

Item	Make	Model	Adjustable Timing Y/N
Purge Timer			

Boiler make	Fire Tube / Water tube	Boiler Fireside Volume (ft ³)

* Eight air changes are required for a water tube boiler and 4 air changes for a fire tube boiler.

-
- Begin firing boiler and record the pre-purge time in the table below.
 - Repeat this step for post purge cycle.

Result	Time (sec)	Y/N
Low fire to high fire?		
Time in high fire?		
High fire to low fire?		
Time in post purge?		
Equivalent High Purge Time?		
Is purge adequate?		

*Equivalent purge is all time spent at high fire plus half of the time spent in getting to high fire and returning to low fire.

Comment:

Checklist for Low-Fire Proving Switch (LFPS)

Item	Make	Model
LFPS		

*Should not be made above a 5% point load increase above low fire.

*LFPS must be separate from the control system that modulates the firing rate.

-
- Measure the voltage across the switch during the purge cycle. (The switch should be closed at start up (no voltage) and should open with less than a 5% point increase in load).
 - Disconnect one electrical lead from switch. Allow boiler to complete the purge cycle and return to low fire. Boiler should not start.

Result	Y/N	Switch Trip point
Did the switch work correctly?		
What was the switch trip point?		

Comment:

Checklist for Forced Draft Damper Wide-Open Pre-Purge Proving Switch (FDDWOPS)

Item	Make	Model
FDDWOPS		

* Must be open at positions lower than 90% of wide open (damper vanes).

-
- Measure the voltage across the switch during the purge cycle to determine if the switch is open or closed. Note load that switch closes.
 - Disconnect one electrical lead from switch. Let boiler go through purge cycle. (Boiler should stay at high purge).

Result	Y/N	Load that switch closes.
Did the switch work correctly?		

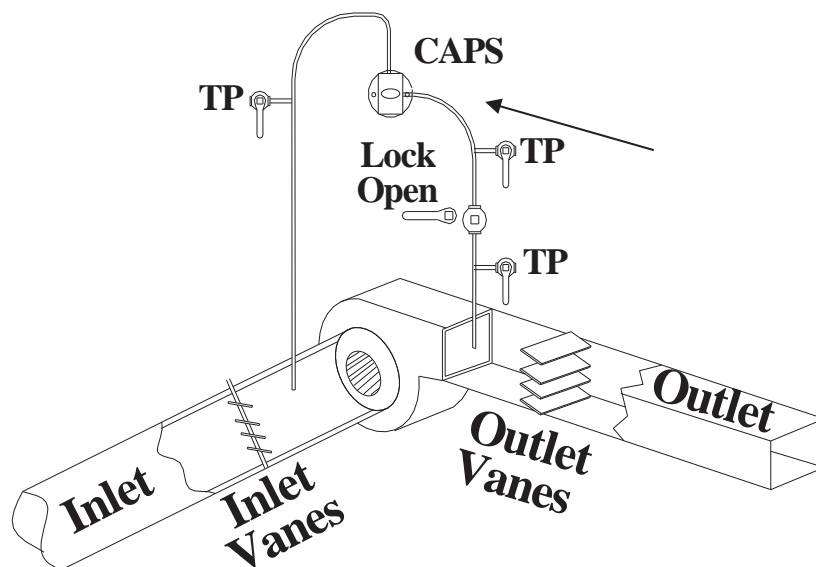
Comment:

Checklist for Combustion Air Pressure Switch (CAPS)

Item	Make	Low Pressure Tap Location	High Pressure Tap Location	Switch Range (inwc)	Switch Setpoint (inwc)
CAPS					

*CAPS should open if pressure drops to 80% of minimum pressure difference.

* If the switch senses the correct pressure difference, the variation in pressure difference from low to high fire will vary only a few percent.



- Install appropriate flex tubing to a manometer from the test ports closest to CAPS to measure the pressure difference that the switch senses by opening the lockable test ports across the switch.
- Start the boiler and record the pressure difference read by manometer from the low fire to high fire position.
- Slowly allow the pressure to drop in the high pressure leg by using the test port closest to the fan outlet and observe the pressure at which the switch opens and shuts off boiler.
- It may be necessary to partially close the Lock Open valve to actuate the switch.
- Record value of pressure difference at which switch tripped.

Firing Rate	Pressure Difference (inwc)	Minimum Pressure Difference (inwc)	Switch Trip (Break) Point (inwc)
Low			
Med			
High			

*Switch trip point should be 80% of the minimum pressure difference.

Result	Y/N	Switch Trip (Break) point (inwc)
Did the switch work correctly?		

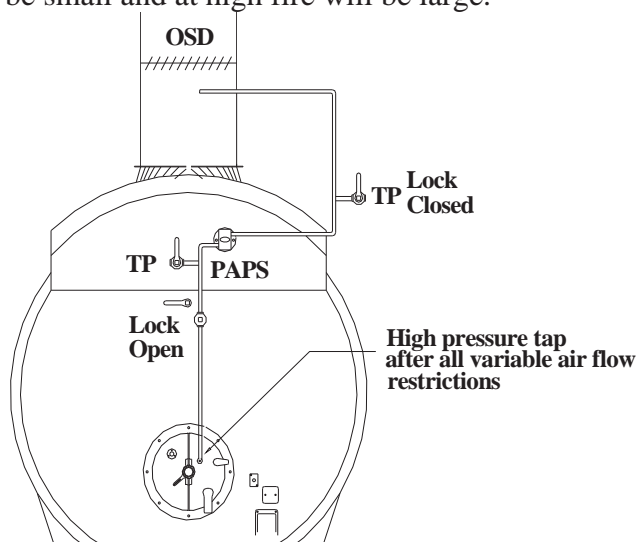
Comment:

Checklist for Purge Airflow Proving Switch (PAPS)

Item	Make	Low Pressure Tap Location	High Pressure Tap Location	Switch Range (inwc)	Switch Setpoint (inwc)
PAPS					

*Should make at 80% maximum pressure signal.

* If the switch senses the correct pressure difference, the variation in pressure difference at low fire will be small and at high fire will be large.



- Connect a manometer to measure the pressure difference that the switch senses by opening the test ports across the switch and installing appropriate flex tubing to the manometer from the test ports.
- Start the boiler and record the pressure difference indicated by manometer from low fire to high fire positions.
- With boiler offline disconnect one lead from the PAPS.
- Close lock open valve and slowly pressurize the high pressure leg with air. Determine switch trip point using a manometer and measuring electrical resistance across the switch.
- With lock open valve open and high pressure leg test port open attempt to restart boiler. Boiler should hold in purge.
- Open lock open valve and close test port. Boiler should light.

Firing Rate	Pressure Difference	Maximum Pressure Difference (inwc)	Switch Trip (Make) Point (inwc)
Low			
Med			
High			

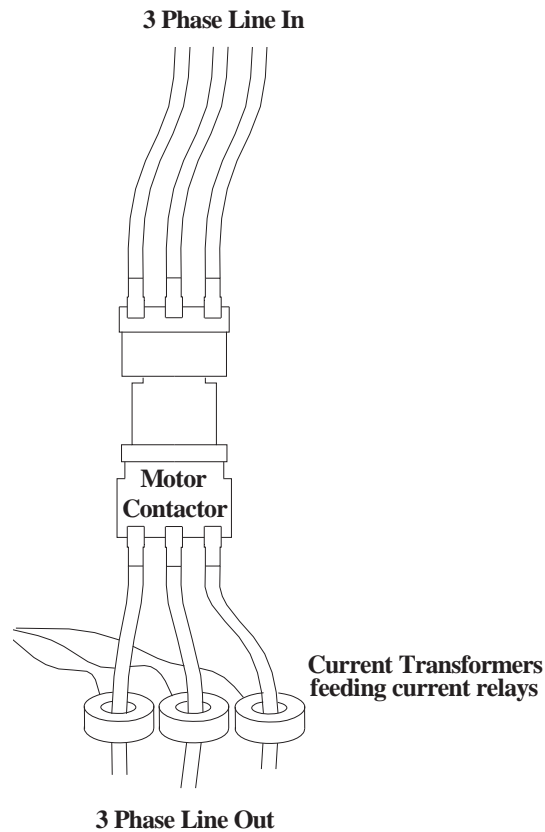
Result	Y/N	Switch Trip (Make) point (inwc)
Did the switch work correctly?		

Comment:

Checklist for Forced Draft Motor Interlock Switches (FDMIS)

Item	Make	Type of Switch: Aux. Contact Phase Monitor Current Relays
FDMIS		

*Current relays are the only acceptable FDMIS



-
- If current relays are not in place, abort test.
 - With power to fan off, remove one electrical power lead to fan from terminal block and slip power lead out of the current transformer ring. Reconnect power lead to fan. (Note some “donut” rings are in form of a clamp and can be removed without disconnecting power lead).
 - Attempt to start boiler. Boiler should shut down quickly.
 - Repeat above process for each of three power leads to fan.
-

Result	Y/N
Did the switch work correctly?	

Comment:

Checklist for Outlet Stack Damper Interlock Switch (OSDI)

Item	Make
OSDI	

*Must be open if dampers are not at least 80% open.

*Not required if damper is welded in the wide open position and there are no other potential obstructions.

-
- Connect a multimeter across the switch and measure voltage.
 - Start the boiler and monitor voltage across the switch. The switch should be open (no voltage) until the damper opens to wide open position.
 - Stop boiler and turn off power to controls.
 - Disconnect one lead from switch.
 - Start boiler. The boiler should not complete purge sequence.

Result	Y/N
Did the switch work correctly?	

•

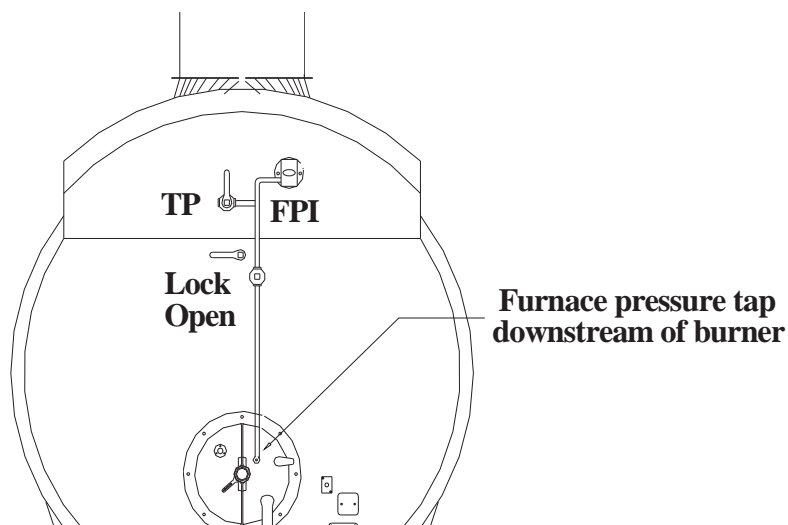
Comment:

Checklist for Furnace Pressure Interlock (FPI)

Item	Make	Low Pressure Tap Location	High Pressure Tap Location	Switch Setpoint (inwc)
FPI				

*Not required on boilers with no outlet stack damper or other possible obstructions in the flue gas outlet system.

*Required trip point is the greater of 1"wc or 20% above maximum boiler furnace pressure.



- Open the test port valve and connect a manometer using appropriate flex tubing to the high pressure test port with other side of manometer open to atmosphere.
- Start the boiler and record the pressure sensed by the switch over the entire firing rate.
- Return the boiler to low fire.
- Open the TP valve.
- Close manual lockable valve in high pressure leg.
- Connect flex tubing to TP.
- Slowly pressurize the switch.
- Note the pressure that the boiler trips off line.

Firing Rate	Pressure Difference	Maximum Pressure Difference (inwc)	Switch Trip Point (inwc)
High			
Mid			
Low			

* The boiler should trip off line at less than 120% of furnace pressure at high fire.

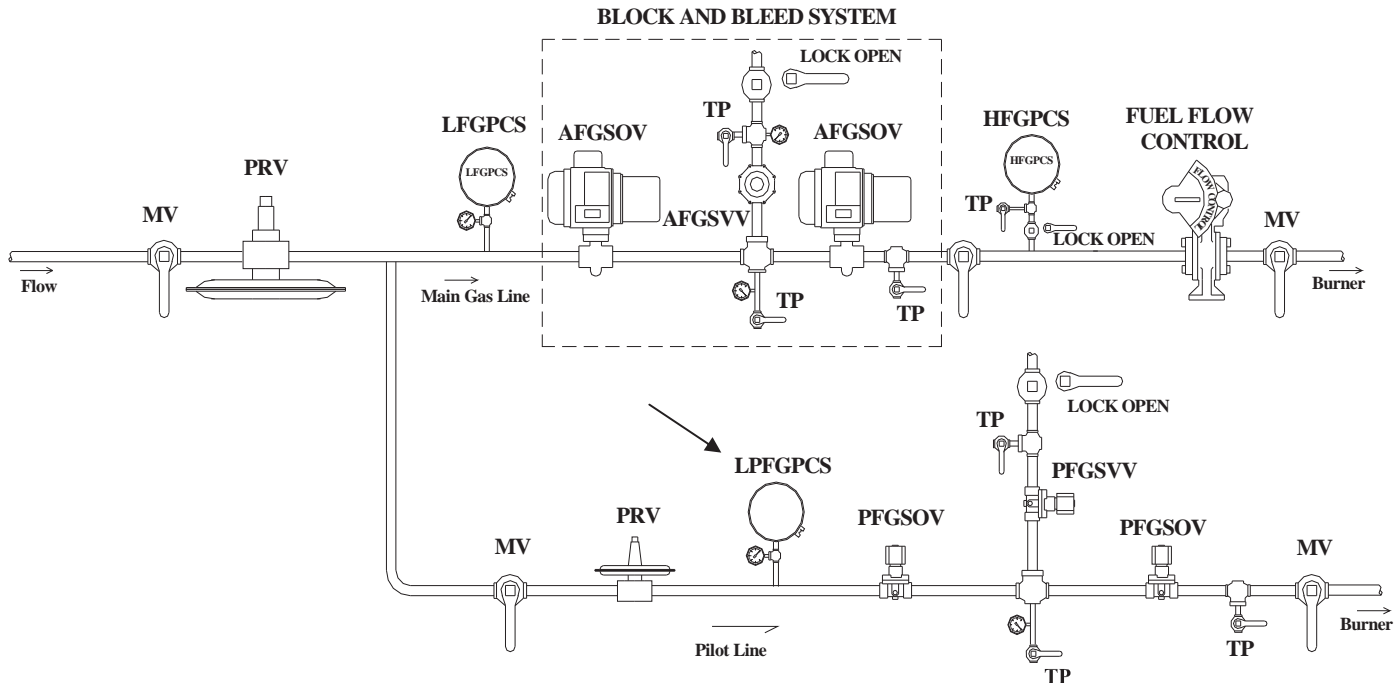
Result	Y/N	Switch Trip point
Did the switch work correctly?		

Comment:

Checklist for Low Pilot Fuel Gas Pressure Cutoff Switch (LPFGPCS)

Item	Make	Range (inwc/psig)	Switch Setpoint	Regulated Pressure	Correct Location Y/N
LPFGPCS					
Pressure Gage					

*Switch setpoint should be 80% of regulated pressure.



- Close the main fuel valve and allow the pilot burner to light and place programmer in check mode while holding in the pilot cycle.
- In low fire throttle manual valve upstream of the LPFGPCS slowly until switch trips the boiler offline due to low pilot fuel pressure.
- Open the pilot gas valve and again put boiler in check mode with pilot lit. Slowly close the pilot gas valve and regulate the pilot gas pressure to a value just above the trip point.
- Open the main gas valve, place the programmer in the “run” mode, and carefully observe that the main burner ignites immediately and smoothly.
- Be prepared to stop the burner immediately if this does not occur.

Result	Y/N	Switch Trip point
Did the boiler light smoothly with low pilot gas pressure?		

Comment:

Checklist for Flue Gas Recirculation Damper Interlock (FGRDI)

Item	Make
FGRDI	

*Open switch should prevent completion of the pre purge cycle.

*Dampers should be at least 80% open to close the switch.

-
- Connect a multimeter across the switch and measure voltage.
 - Start the boiler and monitor voltage across the switch. The switch should be open (no voltage) until the damper opens to wide open position.
 - Stop boiler and turn off power to controls
 - Disconnect one lead from switch
 - Start boiler. The boiler should not complete the purge sequence.
-

Result	Y/N	Switch Trip Point
Did the switch work correctly?		

Comment:

Checklist for Low Flue Gas Oxygen Level Interlock (LFGOLI)

Item	Make	Alarm or Interlock
LFGOLI		

*Low oxygen alarm only is inadequate and should be replaced with interlock and alarm.

*Interlock should prevent boiler from operating with more than 200 ppm CO or combustibles in the flue gas.

- Measure the property values listed in the table below.

% Load	Steam P (psig)	O ₂ (%)	CO (ppm)	EFF (%)	T-Stack	NO _x	Economizer Temp IN OUT	
Low								
Med								
High								

- Use an flue gas analyzer to measure % O₂ and CO with the boiler at approximately 30% load.
- Slowly block the boiler air intake or increase fuel without increasing air. USE EXTREME CARE NOT TO CREATE A DANGEROUS CONDITION. NEVER ALLOW THE CO CONTENT OF FLUE GAS TO EXCEED 200 PPM!

Item	O ₂ % where interlock activated	CO (ppm) where interlock activates
LFGOLI		

Result	Y/N
Did the interlock work correctly?	
Did the LFGOLI activate with less than 200 ppm of CO?	

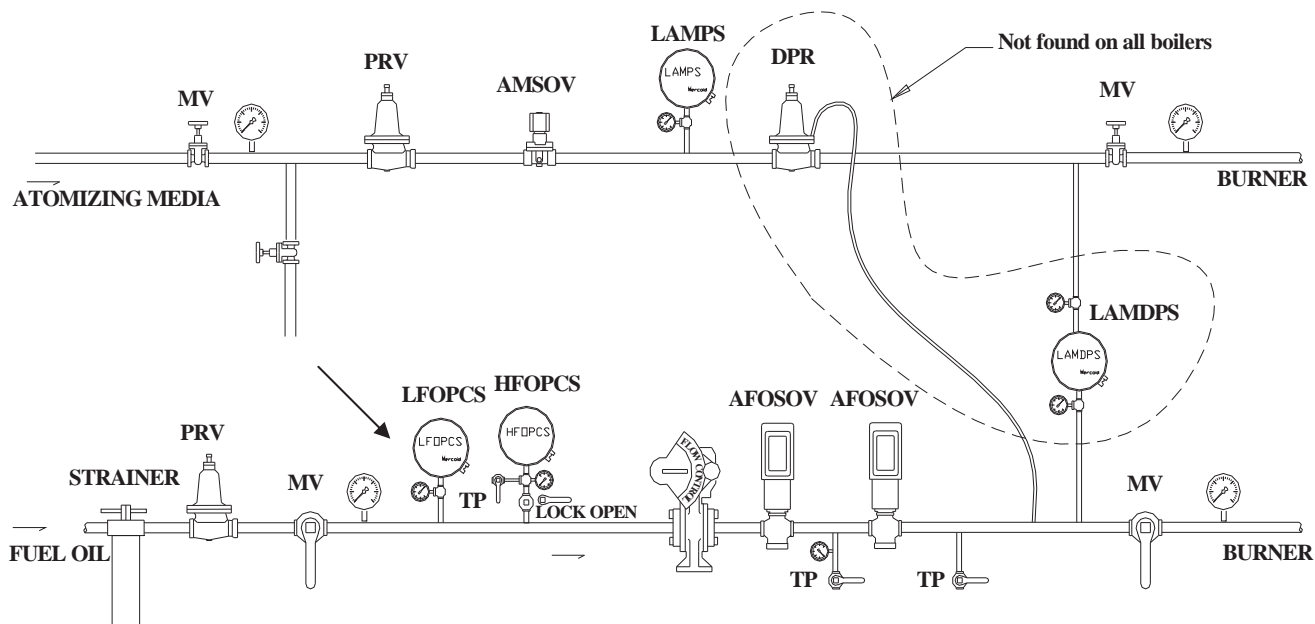
Comment:

Checklist for Low Fuel Oil Pressure Cutoff Switch (LFOPCS)

Item	Make	Range (inwc/psig)	Switch Setpoint	Regulated Pressure	Correct Location Y/N
LFOPCS					
Pressure Gage					

*The LFOPCS location must be downstream of PRV and upstream of flow control valve.

*Trip point of LFOPCS should be equal to or greater than 90% of regulated pressure.



- In low fire, throttle upstream fuel valve slowly until switch trips the boiler offline due to low fuel pressure but **NO LOWER THAN 80% OF REGULATED PRESSURE**.

Result	Y/N	Switch Trip point
Did the switch work correctly?		
Is switch setpoint 90% or more of regulated pressure?		

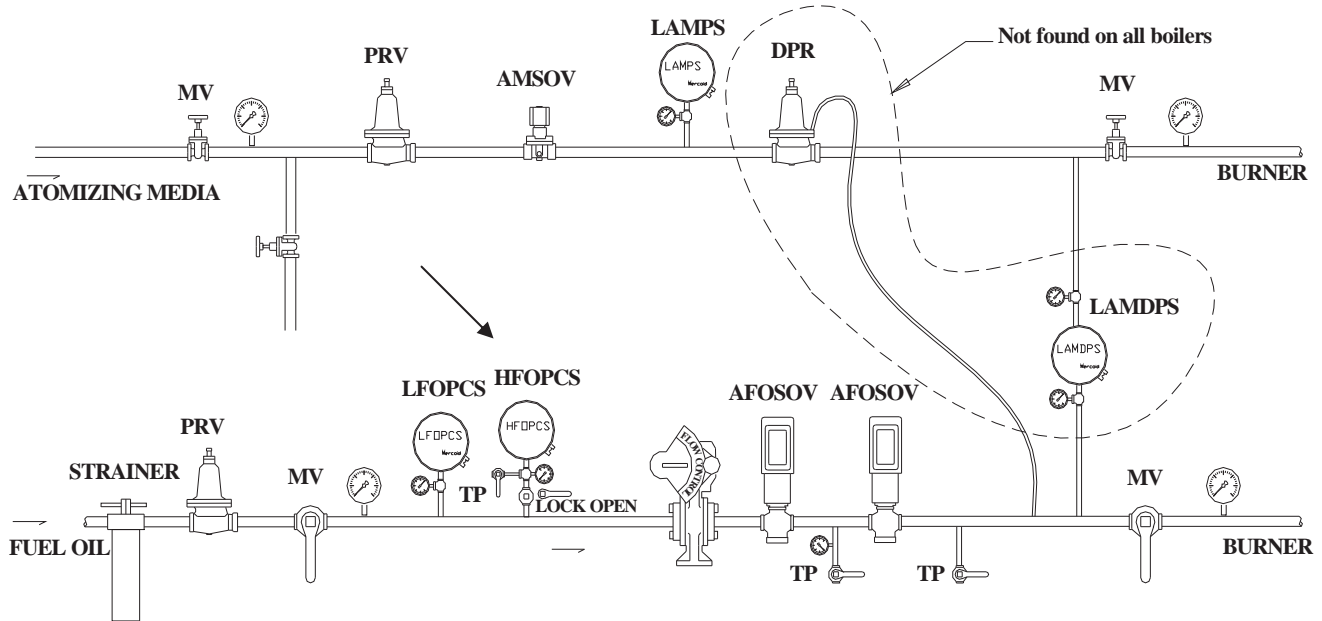
Comment:

Checklist for High Fuel Oil Pressure Cutoff Switch (HFOPCS)

Item	Make	Range (inwc/psig)	Switch Setpoint	Regulated Pressure	Correct Location Y/N
HFOPCS					
Pressure Gage					

*The HFOPCS location must be downstream of PRV and upstream of flow control valve.

*Trip point of HFOPCS should be equal to or less than 110% of regulated pressure.



- With boiler in low fire close lock open manual valve isolating the HFOPCS.
- Open test port between lockable manual valve and HFOPCS; pressurize switch with compressed air or nitrogen.
- Slowly raise pressure until switch trips boiler offline due to high fuel pressure.

Result	Y/N	Switch Trip Point
Did the switch work correctly?		
Is switch setpoint 110% or less of regulated pressure?		

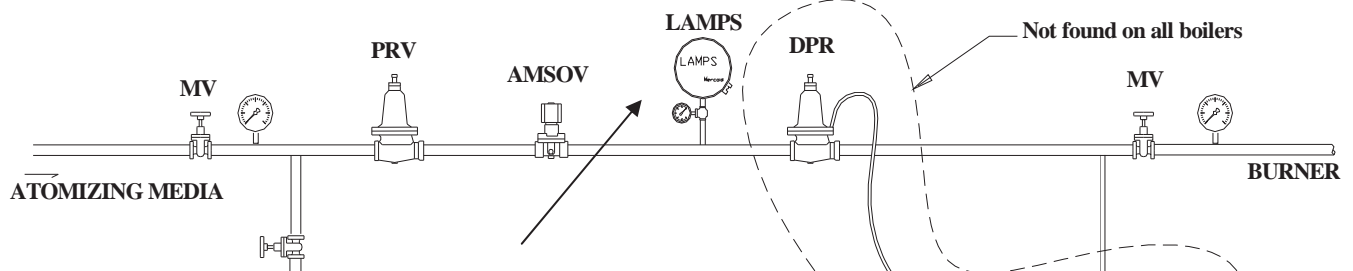
Comment:

Checklist for Low Atomizing Media Pressure Switch (LAMPS)

Item	Pressure
Atomizing media pressure at low fire	

Item	Make	Range (inwc/psig)	Switch Setpoint	Regulated Pressure	Correct Location Y/N
LAMPS					
Pressure Gage					

*Setpoint Should be 80% or more of atomizing media pressure at low fire



- Operate boiler and determine data in following table.

Item	Minimum Fire (psig)	Mid Fire (psig)	High Fire (psig)
Oil pressure at burner			
Atomizing Pressure at burner			
Oil pressure downstream PRV			
Atomizing pressure downstream PRV			

- In low fire throttle manual valve in atomizing media line before the switch slowly until switch trips the boiler offline due to low atomizing media pressure but NO LOWER THAN 80% OF ATOMIZING MEDIA PRESSURE AT LOW FIRE.

Result	Y/N	Switch Trip Point
Did the switch work correctly?		

Comment:

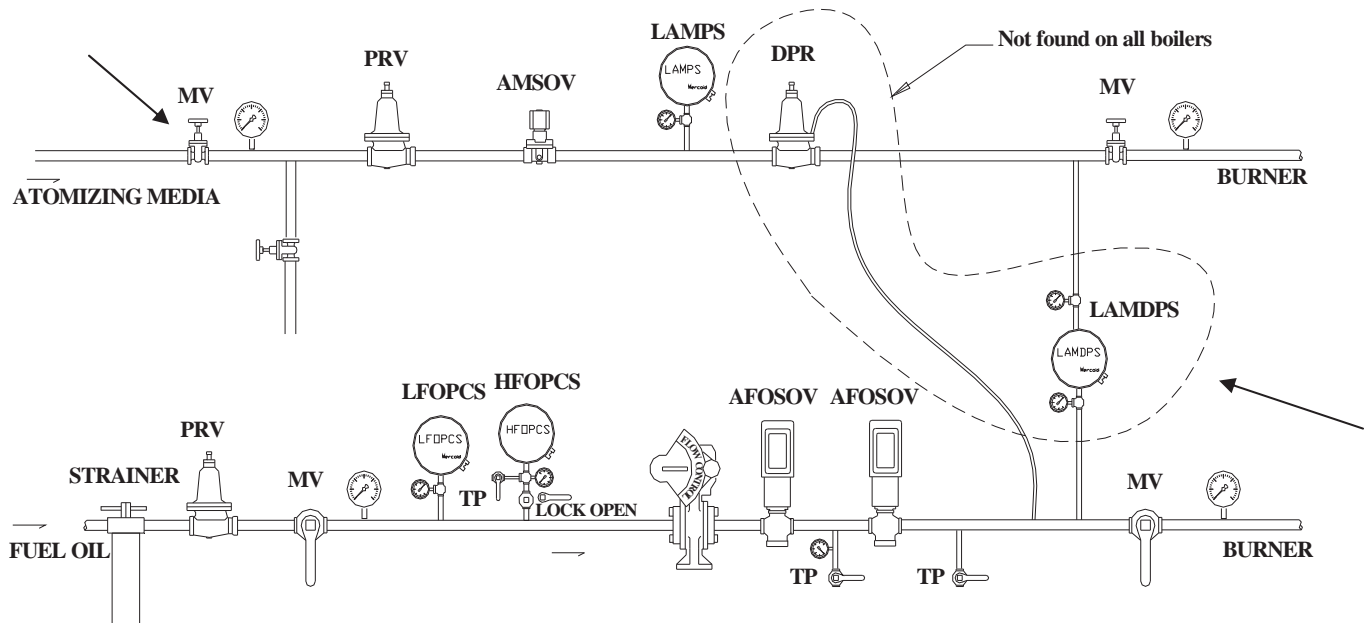
Checklist for Low Atomizing Media Differential Pressure Switch (LAMDPS)

Item	Make	Range (inwc/PSIG)	Switch Setpoint	Minimum Diff Pressure	Correct Location Y/N
LAMDPS					
Pressure Gage Fuel Oil Burner					
Pressure Gage Atomizing media					

*This switch is not required if oil pressure exceeds atomizing pressure at any firing rate.

*For this case the LOLI is the only protection against inadequate atomizing media.

*Setpoint should be 80% or more of minimum differential pressure between oil and atomizing media.



- Determine the minimum differential pressure from data table in LAMPS checklist and record in above table.
- In low fire throttle manual valve in atomizing media line before the LAMDPS slowly until switch trips the boiler offline due to low differential pressure but NO LOWER THAN 80% OF MINIMUM ATOMIZING MEDIA DIFFERENTIAL PRESSURE.

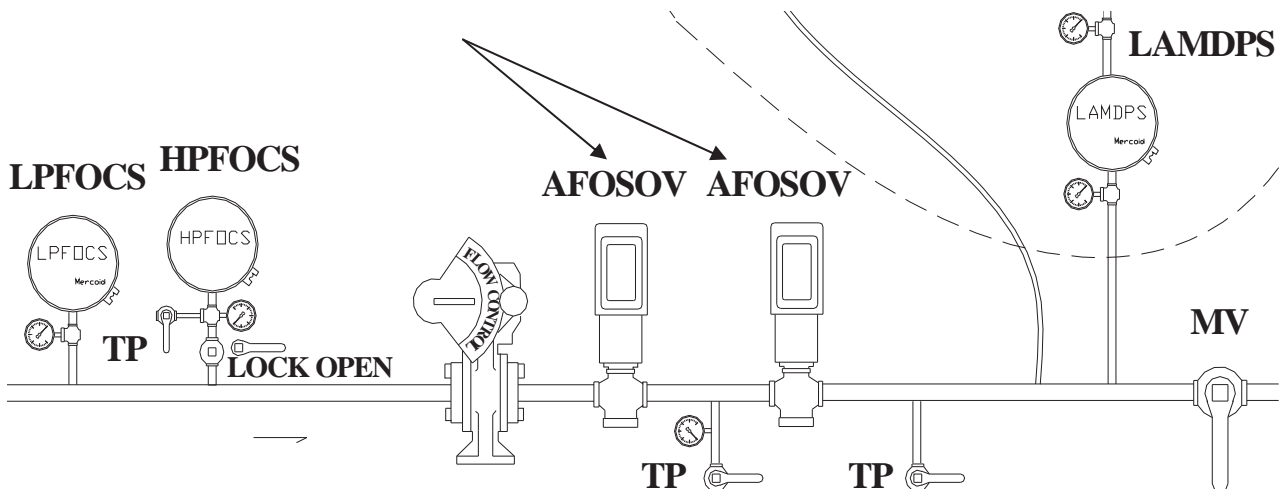
Result	Y/N	Switch Trip point
Did the switch work correctly?		

Comment:

Checklist for Automatic Fuel Oil Shutoff Valves (AFOSV) - for Seat Leakage

Item	Make	Range (inwc/psig)	Correct Installation Y/N
AFOSV			
Pressure Gage			

*After equilibrium is established, leak rate should be less than one drop in 10 seconds.



- While the boiler is firing quickly close the manual valve in oil line located after the automatic shut off valves.
- Place a container under the test port downstream of both automatic shut off valves. Open the downstream test port valve and observe oil flow. In order to consider the valve as not leaking, oil flow should be less than 1 drop in 10 seconds. Some time is needed to establish equilibrium. Make sure that the pressure gage between the 2 auto shut off valves indicates pressure approximately equal to regulated pressure or higher. If downstream shut off valve leaks this pressure will fall.
- Place a container under the test port between the automatic shut off valves. Open the downstream test port valve between the automatic shut off valves and observe oil flow. In order to consider the valve as not leaking, oil flow should be less than 1 drop in 10 seconds. Some time is needed to establish equilibrium.

Result	Y/N
Did upstream AFOSV leak?	
Did downstream AFOSF leak?	

Comment:

Checklist for Proof of Closure on Automatic Fuel Oil Shutoff Valves (POC-AFOSV) – Oil

Item	Make
POC-AFOSV	

*Switch should open with a very slight opening of the valve.

*Switches on the two valves must be wired in series.

-
- Close manual fuel valve downstream of AFOSOV. Perform the following test on each AFOSOV separately.
 - Remove cover on both automatic shut off valves to provide access to two wires connected across proof of closure switch. Can also access wires in appropriate junction box. Disconnect both leads from switch going to control circuit.
 - Temporarily connect the wires disconnected from the POC switch in order to bypass the switch.
 - Start boiler and verify that switch opens with a very slight opening of the valve by measuring resistance across switch.
 - Shut boiler down and disconnect two wires going to control circuit. Try to start boiler and verify that the boiler does not allow ignition sequence to begin.
 - Repeat procedure for switch on 2nd valve.

Result	Y/N
Is proof of closure present in both valves?	
Did either valve being open allow the boiler to fire?	
Did both switches open with very slight opening of valve?	

Comment:

Checklist for Oil Burner Position Switch (OBPS)

Item	Make
OBPS	

*If no switch is present this test is not required and test is complete.

-
- Retract the gun enough to disengage the switch. Attempt to start the boiler. The boiler controls should not allow the purge process to begin. IF BOILER BEGINS TO MOVE TO THE PURGE POSITION SHUT THE BOILER DOWN IMMEDIATELY. IN THIS CASE THE OBPS SWITCH IS DEFECTIVE.

Result	Y/N
Did the switch work correctly?	

Comment:

Checklist for Water Treatment

Sample	TDS ()	Sulfite (ppm)	Phosphate (ppm)	()-Alk (ppm)	Hardness (ppm)	pH
Boiler						
Feedwater						
Condensate						
Makeup						

$$\% \text{ Makeup} = \frac{\text{Conductivity of Feedwater} - \text{Conductivity of Condensate}}{\text{Conductivity of MU} - \text{Conductivity of Condensate}} * 100$$

$$\% \text{ Blowdown} = \frac{\text{Conductivity of Feedwater}}{\text{Conductivity of Boiler} - \text{Conductivity of Feedwater}} * 100$$

Checklist for General Plant Safety & Reliability

Item	Present Y/N
Deaerator Tank Bypass.	
Condensate Tank Bypass.	
Softener Bypass.	
Auxiliary makeup to Deaerator.	
Emergency water to Boilers.	
High Oil Alarm on Oil Tanks.	
High Gas Pressure Cutout on Main Gas Line Coming into plant.	
Emergency Kill Switch (Oil and Gas) in Office and ALL Points of Egress.	

Sign In Sheet

<u>PRINT</u> Name	VA Location

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

PART 1 - GENERAL

1.1 DESCRIPTION:

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

1.2 RELATED WORK:

- A. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA and SAMPLES.
- B. Section 23 05 10, COMMON WORK RESULTS FOR BOILER PLANT and STEAM GENERATION.
- C. Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.
- D. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.
- E. Section 26 24 19, MOTOR-CONTROL CENTERS.
- F. Section 26 29 11, LOW-VOLTAGE MOTOR STARTERS.

1.3 SUBMITTALS:

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA and SAMPLES, and Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.
- B. Shop Drawings:
 - 1. Provide documentation to demonstrate compliance with drawings and specifications.
 - 2. Include electrical ratings, efficiency, bearing data, power factor, frame size, dimensions, mounting details, materials, horsepower, voltage, phase, speed (RPM), enclosure, starting characteristics, torque characteristics, code letter, full load and locked rotor current, service factor, and lubrication method.
- C. Manuals:
 - 1. Submit simultaneously with the shop drawings, companion copies of complete installation, maintenance and operating manuals, including technical data sheets and application data.
- D. Certification: Two weeks prior to final inspection, unless otherwise noted, submit four copies of the following certification to the Resident Engineer:
 - 1. Certification that the motors have been applied, installed, adjusted, lubricated, and tested according to manufacturer published recommendations.
- E. Completed System Readiness Checklists provided by the Commissioning Agent and completed by the contractor, signed by a qualified technician and

dated on the date of completion, in accordance with the requirements of
Section 23 08 00 COMMISSIONING OF HVAC SYSTEMS.

1.4 APPLICABLE PUBLICATIONS:

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

PART 2 - PRODUCTS

2.1 MOTORS:

- A. For alternating current, fractional and integral horsepower motors, NEMA Publications MG 1 and MG 2 shall apply.
- B. All material and equipment furnished and installation methods shall conform to the requirements of Section 26 29 11, LOW-VOLTAGE MOTOR STARTERS; and Section 26 05 21, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW). Provide all electrical wiring, conduit, and devices necessary for the proper connection, protection and operation of the systems. Provide premium efficiency type motors as scheduled. Unless otherwise specified for a particular application, use electric motors with the following requirements.
- C. Single-phase Motors: Motors for centrifugal fans and pumps may be split phase or permanent split capacitor (PSC) type. Provide capacitor-start type for hard starting applications.
 - 1. Contractor's Option - Electrically Commutated motor (EC Type): Motor shall be brushless DC type specifically designed for applications with heavy duty ball bearings and electronic commutation. The motor shall

- be speed controllable down to 20% of full speed and 85% efficient at all speeds.
- D. Poly-phase Motors: NEMA Design B, Squirrel cage, induction type.
1. Two Speed Motors: Each two-speed motor shall have two separate windings. Provide a time- delay (20 seconds minimum) relay for switching from high to low speed.
- E. Voltage ratings shall be as follows:
1. Single phase:
 - a. Motors connected to 120-volt systems: 115 volts.
 - b. Motors connected to 208-volt systems: 200 volts.
 - c. Motors connected to 240 volt or 480 volt systems: 230/460 volts, dual connection.
 2. Three phase:
 - a. Motors connected to 208-volt systems: 200 volts.
 - b. Motors, less than 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.
- F. 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.
- G. Motors shall be designed for operating the connected loads continuously in a 40°C (104°F) environment, where the motors are installed, without exceeding the NEMA standard temperature rises for the motor insulation. If the motors exceed 40°C (104°F), the motors shall be rated for the actual ambient temperatures.
- H. Motor designs, as indicated by the NEMA code letters, shall be coordinated with the connected loads to assure adequate starting and running torque.

I. Motor Enclosures:

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

J. Special Requirements:

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

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

K. Additional requirements for specific motors, as indicated in the other sections listed in Article 1.2, shall also apply.

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

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

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

PART 3 - EXECUTION

3.1 INSTALLATION:

A. 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.
- D. All test data shall be compiled into a report form for each motor and provided to the contracting officer or their representative.

3.3 STARTUP AND TESTING

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

3.4 COMMISSIONING

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

3.5 DEMONSTRATION AND TRAINING

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

- - - E N D - - -

SECTION 23 05 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 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- B. Section 23 05 10, COMMON WORK RESULTS FOR BOILER PLANT, and STEAM GENERATION.
- C. Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.
- D. Section 23 08 11, DEMONSTRATIONS and TESTS FOR BOILER PLANT.
- E. Section 23 21 11, BOILER PLANT PIPING SYSTEMS.

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 pumps, fans, compressors and drivers. Align shafts of pumps, fans, and drivers to limit noise and vibration to specified values. Level and anchor equipment as necessary to achieve and maintain alignment. Refer to Section 23 05 10, COMMON WORK RESULTS FOR BOILER PLANT and STEAM GENERATION, and Section 23 21 11, BOILER PLANT PIPING SYSTEMS.

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 all burners, fans, blowers, pumps, compressors, control valves, pressure reducing valves, motors, turbines.
- B. Sound levels shall not exceed 85 dBA when measured 1400 mm (4.5-feet) above the floor and 910 mm (3-feet) horizontally from each surface of the smallest imaginary rectangular box which could completely enclose the entire unit which contains the sound source. Sound level limitations apply to the operation of the equipment at all loads within the equipment requirements.
- C. Tests will be performed by the Government using a standard sound level meter on the "A" scale, slow response. At the option and expense of the Government, a testing company may be employed to conduct tests using methods conforming to the referenced ABMA publication.
- D. If sound levels exceed requirements, modify or replace the equipment as necessary to achieve required sound levels and other specified requirements.
 - 1. Submit all proposed modifications or replacements for review prior to starting the work.
 - 2. After completing the work, provide complete retest of equipment operation and performance.

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. Balancing air distribution systems; adjustment of total system to provide design performance; and testing performance of equipment and automatic controls.
 - 2. Vibration and sound measurements.
 - 3. Recording and reporting results.
- B. Definitions:
 - 1. Basic TAB used in this Section: Chapter 38, "Testing, Adjusting and Balancing" of 2011 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.
 - 6. Air Systems: Includes make-up air systems.
 - 7. Flow rate tolerance: The allowable percentage variation, minus to plus, of actual flow rate from values (design) in the contract documents.

1.2 RELATED WORK

- A. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES
- B. Section 23 05 10, COMMON WORK RESULTS FOR BOILER PLANTS and STEAM GENERATION
- C. Section 23 05 51, NOISE AND VIBRATION CONTROL FOR Boiler Plant
- D. Section 23 07 11, HVAC and BOILER PLANT INSULATION
- E. Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS
- F. SECTION 23 31 00, HVAC DUCTS AND CASINGS

1.3 QUALITY ASSURANCE

- A. Refer to Articles, Quality Assurance and Submittals, in Section 23 05 11, COMMON WORK RESULTS FOR HVAC, Section 23 05 10, COMMON WORK RESULTS FOR BOILER PLANTS and STEAM GENERATION, and Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.

B. Qualifications:

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

- a. Shall directly supervise all TAB work.
 - b. Shall sign the TAB reports that bear the seal of the TAB standard. The reports shall be accompanied by report forms and schematic drawings required by the TAB standard, AABC or NEBB.
 - c. Would follow all TAB work through its satisfactory completion.
 - d. Shall provide final markings of settings of all HVAC adjustment devices.
 - e. Permanently mark location of duct test ports.
5. All TAB technicians performing actual TAB work shall be experienced and must have done satisfactory work on a minimum of 3 projects comparable in size and complexity to this project. Qualifications must be certified by the TAB agency in writing. The lead technician shall be certified by AABC or NEBB
- C. Test Equipment Criteria: The instrumentation shall meet the accuracy/calibration requirements established by AABC National Standards or by NEBB Procedural Standards for Testing, Adjusting and Balancing of Environmental Systems and instrument manufacturer. Provide calibration history of the instruments to be used for test and balance purpose.
- D. Tab Criteria:
1. One or more of the applicable AABC, NEBB or SMACNA publications, supplemented by ASHRAE Handbook "HVAC Applications" Chapter 38, and requirements stated herein shall be the basis for planning, procedures, and reports.
 2. Flow rate tolerance: Following tolerances are allowed. For tolerances not mentioned herein follow 2011 ASHRAE Handbook "HVAC Applications", Chapter 38, as a guideline. Air Filter resistance during tests, artificially imposed if necessary, shall be at least 100 percent of manufacturer recommended change over pressure drop values for pre-filters and after-filters.
 - a. Air handling unit and all other fans, cubic meters/min (cubic feet per minute): Minus 0 percent to plus 10 percent.
 - b. Individual room air outlets and inlets, and air flow rates not mentioned above: Minus 5 percent to plus 10 percent except if the air to a space is 100 CFM or less the tolerance would be minus 5 to plus 5 percent.
 3. Systems shall be adjusted for energy efficient operation as described in PART 3.

4. Typical TAB procedures and results shall be demonstrated to the Resident Engineer for one air distribution system (including all fans, three terminal units, three rooms randomly selected by the Resident Engineer) and one hydronic system (pumps and three coils) as follows:
 - a. When field TAB work begins.
 - b. During each partial final inspection and the final inspection for the project if requested by VA.

1.4 SUBMITTALS

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- B. Submit names and qualifications of TAB agency and TAB specialists within 60 days after the notice to proceed. Submit information on three recently completed projects and a list of proposed test equipment.
- C. For use by the Resident Engineer staff, submit one complete set of applicable AABC or NEBB publications that will be the basis of TAB work.
- D. Submit Following for Review and Approval:
 1. Design Review Report within 90 days for conventional design projects after the system layout on air and water side is completed by the Contractor.
 2. Systems inspection report on equipment and installation for conformance with design.
 3. Duct Air Leakage Test Report.
 4. Systems Readiness Report.
 5. Intermediate and Final TAB reports covering flow balance and adjustments, performance tests, vibration tests and sound tests.
 6. Include in final reports uncorrected installation deficiencies noted during TAB and applicable explanatory comments on test results that differ from design requirements.
- E. Prior to request for Final or Partial Final inspection, submit completed Test and Balance report for the area.

1.5 APPLICABLE PUBLICATIONS

- A. The following publications form a part of this specification to the extent indicated by the reference thereto. In text the publications are referenced to by the acronym of the organization.
- B. American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc. (ASHRAE):
 - 2011HVAC Applications ASHRAE Handbook, Chapter 38, Testing, Adjusting, and Balancing and Chapter 48, 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
- E. Sheet Metal and Air Conditioning Contractors National Association (SMACNA):
 - 3rd Edition 2002HVAC SYSTEMS Testing, Adjusting and Balancing

PART 2 - PRODUCTS

2.1 PLUGS

- A. Provide plastic plugs to seal holes drilled in ductwork for test purposes.

2.2 INSULATION REPAIR MATERIAL

- A. See Section 23 07 11, HVAC and BOILER PLANT INSULATION Provide for repair of insulation removed or damaged for TAB work.

PART 3 - EXECUTION

3.1 GENERAL

- A. Refer to TAB Criteria in Article, Quality Assurance.
- B. Obtain applicable contract documents and copies of approved submittals for HVAC equipment and automatic control systems.

3.2 TAB PROCEDURES

- A. Tab shall be performed in accordance with the requirement of the Standard under which TAB agency is certified by either AABC or NEBB.
- B. General: During TAB all related system components shall be in full operation. Fan and pump rotation, motor loads and equipment vibration shall be checked and corrected as necessary before proceeding with TAB. Set controls and/or block off parts of distribution systems to simulate design operation of variable volume air or water systems for test and balance work.
- C. Coordinate TAB procedures with existing systems and any phased construction completion requirements for the project. Provide TAB reports for each phase of the project prior to partial final inspections of each phase of the project.
- D. Air Balance and Equipment Test: Include fans and drum louvers.
 - 1. Artificially load air filters by partial blanking to produce air pressure drop of manufacturer's recommended pressure drop.
 - 2. Adjust fan speeds to provide design air flow. V-belt drives, including fixed pitch pulley requirements, are specified in Section 23 05 10, COMMON WORK RESULTS FOR BOILER PLANTS.
 - 3. Test and balance systems in all specified modes of operation, including variable volume, and fire emergency modes. Verify that dampers and other controls function properly.
 - 5. Record final measurements for air handling equipment performance data sheets.

3.3 VIBRATION TESTING

- A. Furnish instruments and perform vibration measurements as specified in Section 23 05 51, NOISE and VIBRATION CONTROL FOR BOILER PLANTS. Field vibration balancing is specified in Section 23 05 10, COMMON WORK RESULTS FOR BOILER PLANTS. Provide measurements for all rotating HVAC equipment of 373 watts (1/2 horsepower) and larger, including centrifugal/screw compressors, cooling towers, pumps, fans and motors.
- B. Record initial measurements for each unit of equipment on test forms and submit a report to the Resident Engineer. Where vibration readings exceed the allowable tolerance Contractor shall be directed to correct the problem. The TAB agency shall verify that the corrections are done and submit a final report to the Resident Engineer.

3.4 MARKING OF SETTINGS

- A. Following approval of Tab Final Report, the setting of all HVAC adjustment devices including valves, splitters and dampers shall be permanently marked by the TAB Specialist so that adjustment can be restored if disturbed at any time. Style and colors used for markings shall be coordinated with the Resident Engineer.

3.5 IDENTIFICATION OF TEST PORTS

- A. The TAB Specialist shall permanently and legibly identify the location points of duct test ports. If the ductwork has exterior insulation, the identification shall be made on the exterior side of the insulation. All penetrations through ductwork and ductwork insulation shall be sealed to prevent air leaks and maintain integrity of vapor barrier.

3.6 PHASING

- A. Phased Projects: Testing and Balancing Work to follow project with areas shall be completed per the project phasing. Upon completion of the project all areas shall have been tested and balanced per the contract documents.
- B. Existing Areas: Systems that serve areas outside of the project scope shall not be adversely affected. Measure existing parameters where shown to document system capacity.

3.7 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.

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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
 - 1. Boiler Plant mechanical systems.
- B. Definitions
 - 1. ASJ: All service jacket, white finish facing or jacket.
 - 2. Air conditioned space: Space having air temperature and/or humidity controlled by mechanical equipment.
 - 3. Cold: Equipment, ductwork or piping handling media at design temperature of 16 degrees C (60 degrees F) or below.
 - 4. Concealed: Ductwork and piping above ceilings and in chases, and pipe spaces.
 - 5. Exposed: Piping, ductwork, and equipment exposed to view in finished areas including mechanical, Boiler Plant and electrical equipment rooms or exposed to outdoor weather. Attics and crawl spaces where air handling units are located are considered to be mechanical rooms. Shafts, chases, unfinished attics, crawl spaces and pipe basements are not considered finished areas.
 - 6. FSK: Foil-scrim-kraft facing.
 - 7. Hot: HVAC equipment or piping handling media above 41 degrees C (105 degrees F); Boiler Plant breechings and stack temperature range 150-370 degrees C (300-700 degrees F) and piping media and equipment 32 to 230 degrees C (90 to 450 degrees F).
 - 8. Density: kg/m³ - kilograms per cubic meter (Pcf - pounds per cubic foot).
 - 9. 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).
 - 10. Thermal Conductivity (k): Watt per meter, per degree C (BTU per inch thickness, per hour, per square foot, per degree F temperature difference).

11. Vapor Retarder (Vapor Barrier): A material which retards the transmission (migration) of water vapor. Performance of the vapor retarder is rated in terms of permance (perms). For the purpose of this specification, vapor retarders shall have a maximum published permance of 0.1 perms and vapor barriers shall have a maximum published permance of 0.001 perms.
12. HPS: High pressure steam (415 kPa [60 psig] and above).
13. HPR: High pressure steam condensate return.
14. MPS: Medium pressure steam (110 kPa [16 psig] thru 414 kPa [59 psig].
15. MPR: Medium pressure steam condensate return.
16. LPS: Low pressure steam (103 kPa [15 psig] and below).
17. LPR: Low pressure steam condensate gravity return.
18. PC: Pumped condensate.
19. FWPD: Feedwater pump discharge.
20. FWPS: Feedwater pump suction.
21. CTPD: Condensate transfer pump discharge.
22. CTPS: Condensate transfer pump suction.
23. PC: Pumped Condensate.
24. R: Pump recirculation.
25. FOS: Fuel oil supply.
26. FOR: Fuel oil return.
27. PVDC: Polyvinylidene chloride vapor retarder jacketing, white.

1.2 RELATED WORK

- A. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- B. Section 23 05 10, COMMON WORK RESULTS FOR BOILER PLANTS.
- C. Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.
- D. SECTION 23 21 11, BOILER PLANT PIPING SYSTEMS
- E. Section 23 50 11, BOILER PLANT MECHANICAL EQUIPMENT
- F. Section 23 51 00, BREECHINGS, CHIMNEYS, and STACKS

1.3 QUALITY ASSURANCE

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

4.3.3.3 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).

4.3.10.2.6 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.

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

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.
- B. 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

- A. 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):

B209-07.....Standard Specification for Aluminum and
Aluminum-Alloy Sheet and Plate

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

C547-07.....Standard Specification for Mineral Fiber Pipe
Insulation

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

E. National Fire Protection Association (NFPA):

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

255-06.....Standard Method of tests of Surface Burning
Characteristics of Building Materials

F. Underwriters Laboratories, Inc (UL):

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

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

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

PART 2 - PRODUCTS

2.1 MINERAL FIBER OR FIBER GLASS

- A. ASTM C612 (Board, Block), Class 1 or 2, density 48 kg/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 C547 (Pipe Fitting Insulation and Preformed Pipe Insulation), Class 1, k = 0.037 (0.26) at 24 degrees C (75 degrees F), for use at temperatures up to 230 degrees C (450 degrees F) with an all service vapor retarder jacket with polyvinyl chloride premolded fitting covering.

2.2 MINERAL WOOL OR REFRACTORY FIBER

- A. Comply with Standard ASTM C612, Class 3, 450 degrees C (850 degrees F).

2.3 RIGID CELLULAR PHENOLIC FOAM

- A. Preformed (molded) pipeinsulation, ASTM C1126, type III, grade 1, k = 0.021(0.15) at 10 degrees C (50 degrees F), for use at temperatures up to 121 degrees C (250 degrees F) with all service vapor retarder jacket with polyvinyl chloride premolded fitting covering.
- B. Equipment and Duct Insulation, ASTM C 1126, type II, grade 1, k = 0.021 (0.15) at 10 degrees C (50 degrees F), for use at temperatures up to 121 degrees C (250 degrees F) with rigid cellular phenolic insulation and covering, and all service vapor retarder jacket.

2.4 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) at 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

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

2.6 REMOVABLE INSULATION JACKETS

- A. Insulation and Jacket:
 - 1. Non-Asbestos Glass mat, type E needled fiber.
 - 2. Temperature maximum of 450°F, Maximum water vapor transmission of 0.00 perm, and maximum moisture absorption of 0.2 percent by volume.
 - 3. Jacket Material: Silicon/fiberglass and LFP 2109 pure PTFE.
 - 4. Construction: One-piece jacket body with three-ply braided pure Teflon or Kevlar thread and insulation sewn as part of jacket. Belt fastened.

2.7 PIPE COVERING PROTECTION SADDLES

- A. Boiler Plant Pipe supports: MSS SP58, Type 39. Apply at all pipe support points, except where MSS SP58, Type 3 pipe clamps provided as part of the support system.

2.8 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.

2.9 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.

2.10 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. Hexagonal wire netting: 25 mm (one inch) mesh, 0.85 mm thick (22 gage) galvanized steel.
- D. 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.
- E. 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.

2.11 FLAME AND SMOKE

- A. Unless shown otherwise all assembled systems shall meet flame spread 25 and smoke developed 50 rating as developed under ASTM, NFPA and UL standards and specifications. See paragraph 1.3 "Quality Assurance".

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS

- A. Required pressure tests of duct and piping joints and connections shall be completed and the work approved by the Resident Engineer for application of insulation. Surface shall be clean and dry with all foreign materials, such as dirt, oil, loose scale and rust removed.
- B. Except for specific exceptions, insulate entire specified equipment, piping (pipe, fittings, valves, accessories), and duct systems. Insulate each pipe and duct individually. Do not use scrap pieces of insulation where a full-length section will fit.
- C. Insulation materials shall be installed in a first-class manner with smooth and even surfaces, with jackets and facings drawn tight and smoothly cemented down at all laps. Insulation shall be continuous through all sleeves and openings, except at fire dampers and 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. Boiler plant work not to be insulated(NI)or if insulated the insulation shall be removal jacket type (RJ):
 - 1. Pipes, valves and fittings:
 - a. Gas fuel(NI)
 - b. Oil unheated (NI)
 - c. Compressed Air (NI)
 - d. Flowmeter sensing piping and blowdown (NI)
 - e. Level sensor piping and blowdown (NI)
 - f. Tank drains (NI)
 - g. Vents-tank, safety and back pressure valves except protective.
(NI)
 - h. Continuous blowdown and boiler water sampling except protective.
(NI)
 - i. Threaded valves (RJ)
 - j. Check valves (RJ)
 - k. Unions (RJ)
 - l. Orifice flanges (RJ)
 - m. Dielectric flanges and unions (RJ)
 - n. Steam header drains (NI)
 - o. Non-return stop and check valve drains (NI)
 - p. Pneumatic controls (NI)
 - q. Pressure transmission to gages (NI)
 - r. Piping in control panels (NI)
 - s. Tube cleaning piping (NI)
 - t. Chemical feed from pump-type feeders (NI)
 - 2. Boilers:
 - a. Water column, piping and blowdown (NI)
 - b. Auxiliary low water cutoff, piping and blowdown(NI)
 - c. Remote water level indicators and piping blowdown(NI)
 - d. Steam gage piping(NI)
 - e. Safety valves and drip pan ells(NI)
 - f. Water level sensors and piping except where required by equipment manufacturer(NI)
 - g. Control piping and devices or interlocks(NI)

3. Equipment:

- a. Pumps-inlet to outlet(NI)
- b. Safety valves(NI)
- c. Water meters(NI)
- d. Oil meters(NI)
- e. Air compressors and tanks(NI)
- f. Chemical feeders(NI)
- g. Boiler and feedwater sampler(NI)
- h. All nameplates (NI)

4. Specialties:

- a. Pressure reducing valves(RJ)
- b. Control valves-water and steam(NI)
- c. Level sensors-piping, valves and blowdown(NI)
- d. Back pressure regulators-oil and steam(NI)
- e. Strainers under 65 mm (2-1/2 inch) pipe size(RJ)
- f. Flexible connectors(RJ)

I. Apply insulation materials subject to the manufacturer's recommended temperature limits. Apply adhesives, mastic and coatings at the manufacturer's recommended minimum coverage.

J. Elbows, flanges and other fittings shall be insulated with the same material as is used on the pipe straights. The elbow/ fitting insulation shall be field-fabricated, mitered or factory prefabricated to the necessary size and shape to fit on the elbow/fitting. Use of polyurethane spray-foam to fill a PVC elbow jacket is prohibited on cold applications.

3.2 INSULATION INSTALLATION

A. Mineral Fiber Board:

- 1. Faced board: Apply board on pins spaced not more than 300 mm (12 inches) on center each way, and not less than 75 mm (3 inches) from each edge of board. In addition to pins, apply insulation bonding adhesive to entire underside of horizontal metal surfaces. Butt insulation edges tightly and seal all joints with laps and butt strips. After applying speed clips cut pins off flush and apply vapor seal patches over clips.
- 2. Plain board:
 - a. Insulation shall be scored, beveled or mitered to provide tight joints and be secured to equipment with bands spaced 225 mm (9 inches) on center for irregular surfaces or with pins and clips

on flat surfaces. Use corner beads to protect edges of insulation.

- b. For hot equipment: Stretch 25 mm (1 inch) mesh wire, with edges wire laced together, over insulation and finish with insulating and finishing cement applied in one coat, 6 mm (1/4 inch) thick, trowel led to a smooth finish.
3. Hot equipment: 40 mm (1-1/2 inch) thick insulation faced with ASJ.
 - a. steam condensate pump receivers.
- B. Molded Mineral Fiber Pipe and Tubing Covering:
 1. Fit insulation to pipe or duct, aligning longitudinal joints. Seal longitudinal joint laps and circumferential butt strips by rubbing hard with a nylon sealing tool to assure a positive seal. Staples may be used to assist in securing insulation. Seal all vapor retarder penetrations on cold piping with a generous application of vapor barrier mastic. Provide inserts and install with metal insulation shields at outside pipe supports. Install freeze protection insulation over heating cable.
 2. Contractor's options for fitting, flange and valve insulation:
 - a. Insulating and finishing cement for sizes less than 100 mm (4 inches) operating at surface temperature of 16 degrees C (61 degrees F) or more.
 - b. Factory premolded, one piece PVC covers with mineral fiber, (Form B), inserts. Provide two insert layers for pipe temperatures below 4 degrees C (40 degrees F), or above 121 degrees C (250 degrees F). Secure first layer of insulation with twine. Seal seam edges with vapor barrier mastic and secure with fitting tape.
 - c. Factory molded, ASTM C547 or field mitered sections, joined with adhesive or wired in place. For hot piping finish with a smoothing coat of finishing cement. For cold fittings, 16 degrees C (60 degrees F) or less, vapor seal with a layer of glass fitting tape imbedded between two 2 mm (1/16 inch) coats of vapor barrier mastic.
 - d. Fitting tape shall extend over the adjacent pipe insulation and overlap on itself at least 50 mm (2 inches).
 3. Nominal thickness in millimeters and inches specified in the schedule at the end of this section.

C. Rigid Cellular Phenolic Foam:

1. Rigid closed cell phenolic insulation may be provided for piping, ductwork and equipment for temperatures up to 121 degrees C (250 degrees F).
2. Note the NFPA 90A burning characteristics requirements of 25/50 in paragraph 1.3.B
3. Provide secure attachment facilities such as welding pins.
4. Apply insulation with joints tightly drawn together
5. Apply adhesives, coverings, neatly finished at fittings, and valves.
6. Final installation shall be smooth, tight, neatly finished at all edges.
7. Minimum thickness in millimeters (inches) specified in the schedule at the end of this section.
8. Exposed, unlined supply and return ductwork exposed to outdoor weather: 50 mm (2 inch) thick insulation faced with a multi-layer vapor barrier with a maximum water vapor permeance of 0.00 perms.

D. 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 120 to 230 degrees C (251 to 450 degrees F);

1. Application; Steam service 110 kpa (16 psig nominal) and higher, high pressure and medium pressure condensate to trap assembly, boiler bottom blowoff from boiler to blowoff valve closest to boiler.
2. Insulation and Jacket:
 - a. Calcium silicate for piping from zero to 1800 mm (6 feet) above boiler room floor, feedwater heater mezzanine floor or access platform and any floors or platforms on which tanks or pumps are located.
 - b. Mineral fiber for remaining locations.
 - c. ASJ with PVC premolded fitting coverings.
 - d. Aluminum jacket from zero to 1800 mm (6 feet) above floor on atomizing steam and condensate lines at boilers and burners.

3. Thickness:

Nominal Thickness of Calcium Silicate Insulation	
(Boiler Plant)	
Pipe Diameter mm (in)	Insulation Thickness mm (in)
<25 (Less than 1)	125 (5)
25 to 38 (1 to 1-1/4)	125 (5)
38 (1-1/2) and above	150 (6)

Nominal Thickness of Mineral Fiber Insulation	
(Boiler Plant)	
Pipe Diameter mm (in)	Insulation Thickness mm (in)
<25 (Less than 1)	75 (3)
25-32 (1 to 1-1/4)	100 (4)
38 (1-1/2) and above	113 (4.5)

B. Temperature range 100 to 121 degrees C (212 to 250 degrees F):

1. Application: Steam service 103 kpa (15 psig) and below, low pressure condensate to trap assembly, high and medium pressure condensate from trap assembly, boiler feedwater from feedwater heater to boiler feed pump recirculation, feedwater heater overflow and vent piping from PRV safety valves.
2. Insulation and Jacket:
 - a. Calcium silicate for piping from zero to 1800 mm (0 to 6 feet) above boiler room floor, feedwater heater mezzanine floor and access platform, and any floors or access platforms on which tanks or pumps are located.
 - b. Mineral Fiber or rigid closed cell phenolic foam for remaining locations.
 - c. ASJ with PVC premolded fitting coverings.
 - d. Aluminum jacket from zero to 1800 mm (6 feet) above floor on condensate lines at boilers and burners.
3. Thickness-calcium silicate and mineral fiber insulation:

Nominal Thickness of Insulation	
Pipe Diameter mm (in)	Insulation Thickness mm (in)
<25 (Less than 1)	62 (2.5)
25 to 38 (1 to 1-1/4)	62 (2.5)
38 (1-1/2) and above	75 (3)

4. Thickness-rigid closed-cell phenolic foam insulation:

Nominal Thickness of Insulation	
Pipe Diameter mm (in)	Insulation Thickness mm (in)
<25 (Less than 1)	50 (2)
25 to 32 (1 to 1-1/4)	50 (2)
38 (1-1/2) and above	75 (3)

C. Temperature range 32 to 99 degrees C (90 to 211 degrees F):

1. Application: Pumped condensate, condensate transfer, condensate transfer pump recirculation, low pressure condensate return from trap assembly.

2. Insulation Jacket:

a. Calcium silicate for piping from zero to 1800 mm (six feet above boiler room floor, feedwater heater mezzanine floor and access platform and any floor or access platform on which tanks or pumps are located.

b. Mineral fiber or rigid closed-cell phenolic foam for remaining locations.

c. ASJ with PVC premolded fitting coverings.

3. Thickness-calcium silicate and mineral fiber insulation:

Nominal Thickness of Insulation	
Pipe Diameter mm (in)	Insulation Thickness mm (in)
<25 (Less than 1)	38 (1.5)
25 to 32 (1 to 1-1/4)	50 (2)
38 (1-1/2) and above	75 (3)

4. Thickness-rigid closed-cell phenolic foam insulation:

Nominal Thickness of Insulation	
Pipe Diameter mm (in)	Insulation Thickness mm (in)
<25 (Less than 1)	25 (1)
25 to 32 (1 to 1-1/4)	38 (1.5)
38 (1-1/2) and above	50 (2)

D. Protective insulation to prevent personnel injury:

1. Application: Piping from zero to 1800 mm (6 feet) above all floors and access platforms including continuous blowoff, feedwater and

boiler water sample, blowoff tank vent, condensate tank vent, fire tube boiler bottom blowoff after valves, valve by-passes.

2. Insulation thickness: 25 mm (1 inch).
3. Insulation and jacket: Calcium silicate with ASJ except provide aluminum jacket on piping at boilers within 1800 mm (6 feet) of floor. Use PVC premolded fitting coverings when all service jacket is utilized.

E. Installation:

1. At pipe supports, weld pipe covering protection saddles to pipe, except where MS-SP58, type 3 pipe clamps are utilized.
2. Insulation shall be firmly applied, joints butted tightly, mechanically fastened by stainless steel wires on 300 mm (12 inch) centers.
3. At support points, fill and thoroughly pack space between pipe covering protective saddle bearing area.
4. Terminate insulation and jacket hard and tight at anchor points.
5. Terminate insulation at piping facilities not insulated with a 45 degree chamfered section of insulating and finishing cement covered with jacket.
6. On calcium silicate, mineral fiber and rigid closed-cell phenolic foam systems, insulated flanged fittings, strainers and valves with sections of pipe insulation cut, fitted and arranged neatly and firmly wired in place. Fill all cracks, voids and coat outer surface with insulating cement. Install jacket. Provide similar construction on welded and threaded fittings on calcium silicate systems or use premolded fitting insulation.
7. On mineral fiber systems, insulate welded and threaded fittings more than 50 mm (2 inches) in diameter with compressed blanket insulation (minimum 2/1) and finish with jacket or PVC cover.
8. Insulate fittings 50 mm (2 inches) and smaller with mastic finishing material and cover with jacket.
9. Insulate valve bonnet up to valve side of bonnet flange to permit bonnet flange removal without disturbing insulation.
10. Install jacket smooth, tight and neatly finish all edges. Over wrap ASJ butt strips by 50 percent. Secure aluminum jacket with stainless steel bands 300 mm (12 inches) on center or aluminum screws on 200 mm (4 inch) centers.
11. Do not insulate basket removal flanges on strainers.

3.4 APPLICATION-BOILER FLUE GAS SYSTEMS

- A. Temperature range 150 to 370 degrees C (300 to 700 degrees F):
 - 1. Application: Transitions, stacks and breechings from boiler outlet to stack outlet; flue gas recirculation fans and ductwork (if provided).
 - 2. Thickness:
 - a. Single-wall duct systems: 50 mm (2 inches).
 - b. Double-wall factory-fabricated duct systems with air space between walls: None.
 - 3. Insulation and jacket: Calcium Silicate with aluminum sheet metal jacket.
- B. Protective Insulation to Prevent Personnel Injury:
 - 1. Application: Double wall factory-fabricated duct system with uninsulated air space between walls within 900 mm (3 feet) horizontally and 1800 mm (6 feet) vertically of platform or floor.
 - 2. Insulation thickness; 25 mm (1 inch).
 - 3. Insulation and jacket: Calcium Silicate with aluminum sheet metal jacket.
- C. Insulating:
 - 1. Provide attachment facilities such as angles, welded studs, clip angles.
 - 2. Apply insulation with joints tightly butted and staggered. Seal joints with high temperature cement.
 - 3. Provide metal corner beads.
 - 4. Band insulation firmly in place to provide a smooth surface. Maximum band spacing shall not be more than 300 mm (12 inches).
 - 5. Install jacket. All surfaces outside of building must be weather tight. At termination of stub stacks, provide metal closure system which is connected and sealed to perimeter of stack to prevent water penetration of insulation.

3.5 APPLICATION-TANKS

- A. Temperature range 38 to 120 degrees C (100 to 250 degrees F)
 - 1. Application: Condensate surge tanks, heat exchangers, blowoff tank.
 - 2. Insulation Thickness:
 - b. Condensate surge tanks: 50 mm (2 inches)
 - c. Blowoff tank, heat exchangers: 25 mm (1 inch).
 - 3. Insulation and covering: Calcium silicate with glass cloth jacket.

B. Insulating:

1. Insulate tanks with an assembly of chamfered block to fit curvature. Secure with 1.6 mm diameter (16 gage) wire or stainless steel bands 300 mm (12 inches) on centers, fill all voids and interstices with finishing cement coat, imbed hexagonal wire mesh in first finish coat. Provide a second finish coat and a glass cloth covering.
2. Apply glass cloth with adhesive, smooth, tight and neatly finished at all cloth edges; prime to receive paint.
3. Do not insulate over nameplates and data plates. Nameplates and data plates must be legible.

3.6 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.

3.7 PIPE INSULATION SCHEDULE

A. 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 - 1½)	38 - 75 (1½ - 3)	100 (4) and Above
251-450 degrees F (HPS, MPS, HPR to trap)	Mineral Fiber	75 (3)	100 (4)	113 (4.5)	113 (4.5)
251-450 degrees F (HPS, MPS, HPR to trap, BBD from boiler to first valve)	Calcium Silicate	125 (5)	125 (5)	150 (6)	150 (6)
212-250 degrees F (LPS, HPR, MPR, FWPD, vent piping from PRV Safety Valves)	Mineral Fiber (above 6 feet) Calcium Silicate (below 6 feet)	62(2.5)	62 (2.5)	75 (3)	75 (3)
212-250 degrees F (LPS, HPR, MPR, FWPD, vent piping from PRV Safety Valves)	Rigid Cellular Phenolic Foam (above 6 feet)	50(2)	50 (2)	75 (3)	75 (3)
90-211 degrees F (LPR, PC, CTPS, CTPD)	Mineral Fiber (above 6 feet) Calcium Silicate (below 6 feet)	38 (1.5)	50 (2)	75 (3)	75 (3)
90-211 degrees F (LPR, PC, CTPS, CTPD)	Rigid Cellular Phenolic Foam (above 6 feet)	25 (1)	38 (1.5)	50 (2)	50 (2)

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SECTION 23 08 00

COMMISSIONING OF HVAC SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

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

1.2 RELATED WORK

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

1.3 SUMMARY

- A. This Section includes requirements for commissioning the Facility exterior closure, related subsystems and related equipment. This Section supplements the general requirements specified in Section 01 91 00 General Commissioning Requirements.
- B. Refer to Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS for more details regarding processes and procedures as well as roles and responsibilities for all Commissioning Team members.

1.4 DEFINITIONS

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

1.5 COMMISSIONED SYSTEMS

- A. Commissioning of a system or systems specified in Division 23 is part of the construction process. Documentation and testing of these systems, as well as training of the VA's Operation and Maintenance personnel in accordance with the requirements of Section 01 91 00 and of Division 23, is required in cooperation with the VA and the Commissioning Agent.

1.6 SUBMITTALS

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

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 CONSTRUCTION INSPECTIONS

- A. Commissioning of HVAC systems will require inspection of individual elements of the HVAC systems construction throughout the construction period. The Contractor shall coordinate with the Commissioning Agent in accordance with Section 01 91 00 and the Commissioning plan to schedule HVAC systems inspections as required to support the Commissioning Process.

3.2 PRE-FUNCTIONAL CHECKLISTS

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

resubmission. Refer to SECTION 01 91 00 GENERAL COMMISSIONING REQUIREMENTS for submittal requirements for Pre-Functional Checklists, Equipment Startup Reports, and other commissioning documents.

3.3 CONTRACTORS TESTS

- A. Contractor tests as required by other sections of Division 23 shall be scheduled and documented in accordance with Section 01 00 00 GENERAL REQUIREMENTS. All testing shall be incorporated into the project schedule. Contractor shall provide no less than 7 calendar days' notice of testing. The Commissioning Agent will witness selected Contractor tests at the sole discretion of the Commissioning Agent. Contractor tests shall be completed prior to scheduling Systems Functional Performance Testing.

3.4 SYSTEMS FUNCTIONAL PERFORMANCE TESTING:

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

3.5 TRAINING OF VA PERSONNEL

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

*Replace Boilers - Bldg. 100 Energy Center
CW Bill Young VA Medical Center - Bay Pines, FL*

*100% Design Documents
May 15, 2017*

----- END -----

SECTION 23 08 11
DEMONSTRATIONS AND TESTS FOR BOILER PLANT

PART 1 - GENERAL

1.1 REQUIREMENTS INCLUDED

- A. Procedures for on-site demonstration and testing of equipment and systems, including temporary facilities.
- B. Instruction of Government operating personnel.
- C. All demonstrations, instructions and testing must be completed prior to Government acceptance for beneficial use. All safety devices must pass 100 percent before the boiler plant can be accepted 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 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- B. Section 23 05 10, COMMON WORK RESULTS FOR BOILER PLANT and STEAM GENERATION.
- C. Section 23 05 51, NOISE and VIBRATION CONTROL FOR BOILER PLANT.
- D. Section 23 21 11, BOILER PLANT PIPING SYSTEMS.
- E. Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.
- F. Section 23 09 11, INSTRUMENTATION and CONTROL FOR BOILER PLANT.
- G. Section 23 50 11, BOILER PLANT MECHANICAL EQUIPMENT.
- H. Section 23 52 39, FIRE-TUBE BOILERS.

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
 - 2. Burners
 - 3. Control systems.
 - 4. Instrumentation.
 - 5. Condensate Surge Tank
- B. Experienced technicians shall demonstrate and provide instructions on the following equipment:
 - 1. Pumps and piping systems
 - 2. Ventilation and heating systems
 - 3. Compressed air systems
 - 4. Control and safety valves
- C. The person responsible for programming the computer workstation shall demonstrate and provide instructions on hardware, software and programming.
- D. The RE, 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 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.

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 tapes.
- 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, burners, burner controls, combustion controls, instrumentation.
- B. At least 16 total instructor hours to include computer workstation and programs.
- C. At least 16 total instructor hours to include pumps, steam turbine, feedwater deaerator, and other equipment.
- D. Do not exceed three trainees per session, one four-hour session, per day, per trainee.

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**SECTION 23 09 11
INSTRUMENTATION AND CONTROL FOR BOILER PLANT**

PART 1 - GENERAL:

1.1 DESCRIPTION:

- A. Automatic controls, instruments, monitoring and data management systems and accessories for the boilers, burners and other boiler plant mechanical equipment. The specification classifies the systems into automatic boiler and burner control systems, burner management systems (flame safeguard), and data management and instrumentation systems.

1.2 RELATED WORK:

- A. Section 01 33 23, SHOPDRAWINGS, PRODUCT DATA, and SAMPLES.
- B. Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION
- C. Section 23 05 51, NOISE and VIBRATION CONTROL FOR BOILER PLANT.
- D. Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.
- E. Section 23 08 11, DEMONSTRATIONS and TESTS FOR BOILER PLANT.
- F. Section 23 10 00, FACILITY FUEL SYSTEMS.
- G. Section 23 21 11, BOILER PLANT PIPING SYSTEMS.
- H. Section 23 50 11, BOILER PLANT MECHANICAL EQUIPMENT.
- I. Section 23 51 00, BREECHINGS, CHIMNEYS, and STACKS.
- J. Section 23 52 39, FIRE-TUBE BOILERS.
- K. Section 26 05 11, REQUIREMENTS for ELECTRICAL INSTALLATIONS.
- L. Section 26 05 19, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS and CABLES.
- M. Section 26 05 33, RACEWAY and BOXES for ELECTRICAL SYSTEMS.
- N. Section 26 27 26, WIRING DEVICES.
- O. Section 26 29 11, LOW-VOLTAGE MOTOR STARTERS.

1.3 QUALITY ASSURANCE:

- A. The boiler and burner control, monitoring, data gathering, instrumentation and associated systems specified in this section shall be provided by one company that has been in business at least three years engineering, designing and servicing industrial and institutional boiler control and instrumentation systems similar to those specified herein, as a primary business. That company shall furnish all components and provide complete calibration, programming, start-up, testing, demonstrations, instructions and training services.
- B. Submit documented evidence, including start-up and acceptance test data, and references, that the company has performed satisfactory work on at least six systems similar to those specified, list any VA boiler plant projects completed in the past. 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. Submit in writing that all specs were read and fully understood.

C. The burner manufacturer shall be responsible for the burner management system (flame safeguard), including interlocks, all accessories and for coordination with other control and monitoring systems.

D. Equipment Experience Requirements: Refer to Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.

E. Code Approval:

1. All burner management and combustion control systems and devices shall comply with NFPA 85, regardless of boiler type or size. Locations and arrangements of safety devices on fuel trains shall comply with diagrams included in "Annex A" in the code, as modified by the VA standard details and safety device testing requirements.
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, or current.
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, and that the equipment submitted meets all VA specs.
3. Information on all the specific systems that are sufficient to allow complete troubleshooting. As a minimum, this should include explanation of the control logic, and wiring diagrams of equipment and systems to include locations and wire numbers of any safety device test points that will be required to complete safety device testing in accordance with VA requirements, and sequence of operation of all components of the system.
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, all safety devices shall be easily accessible for testing.

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 (remove all paper charts from the specs.
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):
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. Flue gas recirculation (FGR).
- D. Boiler outlet draft.
- E. Boiler water level, 1 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/panels for each boiler and for the master steam pressure control. Fuel/air control loops, including flue gas recirculation (FGR) and oxygen trim may be incorporated into one station for each boiler. Boiler 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. VA Boiler Plants DO NOT ALLOW for any boiler to be automatically or remotely started. Lead lag control systems are not allowed within the VA boiler plants, regardless of the size or type of boiler. The boiler shall be started by an operator standing at the boiler.
 - d. 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. Bumbles 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 shutdown 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. Refer to Paragraph, COMPUTER WORK STATION AND PROGRAMMING. 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. Examples of acceptable controllers: Hays-Cleveland "AC Station", MicroMod "Mod 30 ML", Moore 323, Preferred "PCC III", Toshiba "LC500".
- C. Power Supplies: Provide separate uninterrupted power supply for each 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 set point 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, Feed Water 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.
7. Provide a means of proving fan rpm to control set point at any firing rate. Deviation from set point rpm or greater than 10 percent will cause a safety shut down of the boiler.

G. Transmitters:

1. See Paragraphs, PRESSURE SENSORS AND TRANSMITTERS, TEMPERATURE SENSORS AND TRANSMITTERS.

H. Final Control Elements:

1. Fuel flow control valves, forced draft fan dampers, flue gas recirculation (FGR) dampers (if provided), variable frequency forced draft fan drives (VFD)(if provided), feed water control valves: Refer to Section 23 52 39, FIRE-TUBE BOILERS.
2. Dampers in stacks and breechings: Refer to Section 23 51 00, BREECHINGS, CHIMNEYS, and STACKS.

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, UL1449-rated, interactive digital display. Automatic internal bypass. Smooth sine wave output.
3. Suitable for ambient temperature of 44 degrees C (110 degrees F) in boiler room panel.
4. Hot swappable batteries.
5. Audible and visual alarms to signal failure of power supply.
6. This UPS system can be deleted from the project if controls furnished have integral protection from power supply irregularities listed above, and if software can be immediately reloaded by plant personnel.

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 100 psi.
Individual set point adjustment range: +/- 140 kPa (20 psi).
 - c. Control Stations: Individual control stations for master and submaster controllers. Locate control stations on main instrumentation panel unless otherwise shown. Master controller shall have capability for two set points with easy selection.
 - d. Low fire hold capability and user definable optimum ignition position.
 - e. Interface with burner management system for automatic positioning of forced draft fan damper, forced draft fan speed and fuel flow control valves during pre-purge, ignition, shutdown and post-purge.
 - f. Interlocks to prove proper positions of forced draft fan damper, forced draft fan speed, boiler outlet damper, 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 submaster controller provides firing rate signals to separate drive units (actuators) for forced draft fan dampers and for each of the fuel flow control valves and to the variable frequency drive (VFD) of the forced draft fan. Air/fuel ratio maintained by firmware and software programming of the submaster controller. Software shall be factory-programmed for the specific application. Only tuning and scaling shall be performed in the field.
 - b. Hardware, firmware and software shall comply with UL 1998, or current revision of UL1998 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. Cross-limiting and deviation limiting shall be tested and proven. If at any time, it is found this was not preprogrammed at the factory and UL tested and listed the controller shall be replaced at NO ADDITIONAL COST to the government.
 - c. Provide feedback signals from drives and actuators. Fuel flow shall not increase until appropriate combustion air flow increase is proven. Combustion air flow shall not decrease until appropriate fuel flow decrease is proven. VFD feedback transmitters shall have "no-drift" guarantee.
 - d. Accuracy of control of drive units shall result in fuel-air positioning ratios that are specified by the burner manufacturer for efficient and safe operation with a maximum hysteresis of 2 percent. Excess air in flue gas shall conform to limits given below.
 - e. Manual control function accessible to operating personnel shall be confined to base loading the firing rate of the burner and shall not permit separate control of fuel or combustion air. All other manual functions shall be password protected intended to be accessible only to qualified technicians. If system is improperly

placed in a manual control mode, the system shall shut down the boiler or maintain safe excess air levels at all times, within parameters that limit the carbon monoxide emissions to specified limits.

- f. From low fire to high fire the air/fuel ratio (excess air) shall be programmed over at least ten evenly spaced increments of fuel input.
 - g. Control positions and display indications shall be linear in relation to firing rate. For example, 20% control position shall be 20% firing rate (20% of full load).
 - h. Mechanical connections between drive units and dampers and valves shall not have hysteresis and shall be keyed to eliminate slippage. Use of linkage systems must be minimized and submitted for approval as a deviation to the contract.
 - i. Excess Air and Emissions Limits - New Burners: Refer to the boiler and burner specification.
3. Automatic Flue Gas Oxygen Trim System:
- a. Boiler/burner submaster air/fuel controller shall utilize signal from flue gas oxygen analyzer and vary the combustion air flow to maintain the specified air/fuel ratio (excess air) at all firing rates 20 percent of maximum firing rate and greater.
 - b. Operation and Performance:
 - 1) Separate characterized set point curves for each fuel, minimum ten points per fuel. A single curve with biasing for the other fuel is not acceptable. Automatic changeover 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 submaster air/fuel ratio controller. Analyzer failure shall cause system to go to null position.

- 6) Manual trim output shall revert to null setting when system is placed in automatic control.
 - c. During burner start-up and adjustment of air/fuel ratios (excess air) by service technician, trim shall be on manual control at null position.
 - d. Refer to Paragraph, FLUE GAS OXYGEN ANALYZERS.
4. Flue Gas Recirculation (FGR) Control:
- a. Automatic operation of FGR damper to control NOx emissions to required limits and to provide purging of combustibles from the FGR ducts during the pre-purge cycle.
 - b. Automatically disable FGR during burner start-up cycle due to potential for flame instability. Automatically enable the FGR after the boiler flue gas outlet temperature reaches a minimum of 150 degrees C (300 degrees F).
 - c. Interface with burner management system with interlocks to prove FGR dampers in proper position for pre-purge prior to ignition. Refer to Paragraph, BURNER MANAGEMENT SYSTEMS WITH SAFETY INTERLOCKS AND ACCESSORIES.
5. Boiler Outlet Draft Control:
- a. Automatically modulate position of boiler outlet damper to maintain constant negative pressure (draft) at the flue gas outlet of the boiler. Utilize feed forward signal from the boiler/burner submaster air/fuel controller to enhance control response. Position damper open and closed during boiler start-up and shut-down cycles.
 - b. Maintain draft at negative 25 Pa (0.1 inches WC) plus or minus 10 Pa (0.05 inches WC). Provide local gauge with remote indication at operator interface.
 - c. Panel-mounted automatic controller, with manual/automatic feature and set point adjustment, for each boiler. Locate on main instrumentation panel unless otherwise shown.
 - d. Draft sensor, transmitter, and outlet damper actuator for each boiler. Refer to Article, PRESSURE SENSORS AND TRANSMITTERS.
 - e. Automatically position damper as required for pre-purge, burner ignition and shut down. Provide damper position switch interlocked with burner management system. Refer to Paragraph, BURNER MANAGEMENT SYSTEMS WITH SAFETY INTERLOCKS AND ACCESSORIES.

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) Single Element System: Utilize signal from water level sensor on boiler.
 - c. Boiler Water Level Sensors:
 - 1) Differential Pressure Transmitters: Provide on water tube boilers. Refer to Paragraph, PRESSURE SENSORS AND TRANSMITTERS.
 - 2) Water Level Sensing and Safety Control Systems: Provide on fire tube boilers. Refer to Section 23 52 39, FIRE-TUBE BOILERS.
 - 3) Probe-Type Capacitance Systems: Optional control for fire tube and water tube boilers. Dual probes mounted in water column controlled by microprocessor system. Provisions to compensate for shrink and swell of water level due to load changes. Self-checking function comparing the signals from each probe and causing burner shutdown if water level movement is not detected.
 - d. Steam Flow Sensors: Refer to Paragraph, FLOW METERS.
 - e. Feedwater Pressure Sensors: Refer to Paragraph, PRESSURE SENSORS AND TRANSMITTERS.
 - f. Controller: Controllers for two and three element systems shall include: manual/auto control station and indicators showing signal level to actuator, set point and actual water level, steam flow rates and totals and boiler feedwater flow rates and totals if flow meters are included. Locate on main instrumentation panel unless otherwise shown. For controller requirements for fire tube boilers, refer to Section 23 52 39, FIRE-TUBE BOILERS.
 - g. Set point position as recommended by boiler manufacturer.
7. Boiler 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 boiler, 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, 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, and in accordance with the most recent edition of the VHA Boiler Plant Safety Device Testing Manual.
 - 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.
 - 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.
- 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 shall be a maximum of four seconds.
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:
 - a. Flame failure.
 - b. Purge airflow low.
 - c. Combustion air low.
 - d. False combustion air (switch activated with combustion air flow).
 - e. High main gas fuel pressure.
 - f. Low main gas fuel pressure.
 - g. High oil pressure.
 - h. Low oil pressure.
 - i. Low igniter (pilot) gas pressure.
 - j. Low oil temperature (heated oil systems only).
 - k. Fuel safety shut-off valves not closed prior to ignition cycle.
 - l. Low fire position not attained prior to ignition cycle.
 - m. Low atomizing media (steam or air) static pressure at atomizing media service connection to burner piping.
 - n. Low atomizing steam/oil differential pressure. Where burner does not maintain differential pressure provide low atomizing media pressure at burner.
 - o. High steam pressure.
 - p. Low water cutoff.
 - q. Low control air pressure (if pneumatic feedwater control valve drive units or other controls are furnished).
 - r. Flue gas recirculation (if provided) improper damper position.
 - s. Low flue gas oxygen.
 - t. High furnace pressure (if outlet draft control system furnished).
 - u. Building combustion air intake louver closed or make-up air ventilation system not operating.
6. Audible alarm (horn): Sounds upon all burner shutdowns except automatic recycle shutdowns on steam pressure. Provide silencing control, which automatically resets when burner control is reset.
- L. Pre-Purge Timing: Integral with the programmer. Non-adjustable after initially set to suit boiler pre-purge requirements.
- M. Auxiliary relays: Industrial type rated for the service, enclosed contacts.
- N. Selector switches, push buttons and control switches: Heavy duty, industrial type.
- O. Safety shut down and manual reset required for, but not limited to:

1. Flame signal detected prior to ignition cycle.
 2. Pre-ignition interlock open during pre-purge.
 3. High fire purge interlock fails to close within ten minutes or less after firing rate drive unit is commanded to drive to high fire.
 4. Low fire interlock fails to close within ten minutes or less after firing rate drive unit is commanded to drive to low fire.
 5. Igniter (pilot) or main burner fails to ignite.
 6. Malfunction of flame detector.
 7. Malfunction of programmer.
 8. Malfunction of flame signal amplifier.
 9. Combustion air proving switch actuated prior to start-up of forced draft fan.
 10. Lock-out interlock open during pre-purge (after 15 seconds), ignition or run period.
 11. Interlock open.
 12. Flame failure.
- 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. All safety devices shall be hardwired directly to the flame safe guard controller without passing thru any other device or control system.
 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. No safety device is allowed to be PLC dependent or be included in any program where the input or output can be forced, or if the program is changed updated etc could have any effect on the safety device setting or function. All safety devices shall be hard wired from the device or sensor to the flame safe guard controller directly.
 - d. 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.
 - e. Provide written step by step safety device test procedures that follow the most recent edition of the VHA Boiler Plant Safety Device Testing Manual, and any test procedure that varies from this manual must be submitted to VACO CFM Consulting Support Services and VHA OCAMS for review and approvals.
3. Forced Draft Fan Motor Operation Interlock: Provide current relays on each phase of power circuits to fan motor. For variable speed drives, provide signals to control system from VFD fault and run contacts and signals from VFD shaft speed feedback to prove proper fan speed for purging, low fire ignition, and for each burner load point. Any disconnects or other power shut-off devices between the location of the interlock devices and the motor shall also shut down the power supply to the burner management control system.
4. Atomizing Air Compressor (when provided) Motor Energized Interlock: Provide current relays on each phase of power circuits to the motor. In the power supply to the motor there shall be no disconnects or other power shut-off devices between the location of the interlock devices and the motor.
5. Forced Draft Fan Damper and Boiler Flue Gas Outlet Damper Pre-Purge Position Interlock: Prove dampers wide open for pre-purge. Actuate

sealed snap-action switches by levers attached directly to dampers or to damper linkages, which are pinned to prevent slippage. Parallel positioning systems may have the interlock switches in the drive units.

6. Flue Gas Recirculation (FGR) Dampers (if provided) Position Interlock: Prove dampers positioned as required by burner manufacturer for pre-purge and firing. Actuate sealed snap-action switches by levers attached directly to dampers or to damper linkages, which are pinned to prevent slippage.
7. Pre-Purge Airflow Interlock:
 - a. Sense differential pressure between two points in combustion air system where the differential pressure at high fire is significant, such as several inches water column. There must be no intervening dampers. This is typically between the windbox and boiler outlet.
 - b. Diaphragm-actuated snap-action switch designed for maximum system pressure, adjustable set point, graduated set point indicating scales.
 - c. UL listed, FM approved.
 - d. Provide air pressure sensing connections for test manometer so that air flow switch settings can be verified.
 - e. Trip point shall prove at least 70% of maximum airflow.
8. Combustion Air Proving Interlock:
 - a. Sense differential air pressure across the forced draft fan with no intervening dampers.
 - b. Diaphragm-actuated snap-action switch designed for maximum system pressure, adjustable set point, graduated set point indicating scales.
 - c. UL listed, FM approved. Provide switch designed for "false combustion air" feature on start-up interlock.
 - d. Provide air pressure sensing connections for test manometer so that switch settings can be verified. Demonstrate that trip point is within 10% of minimum differential pressure over the firing range of the burner.
9. High and Low Main Burner Fuel (Gas and Oil) And Low Igniter (Pilot) Gas Pressure Interlocks:
 - a. Solid-state sensor, mercury switch, automatic reset. Provide graduated set point indicator, switch position indicator,

- adjustable set point coordinated with burner requirements either on the switch or as a part of the controller. Switch movements shall have bushings to eliminate metal-to-metal wear.
- b. Gas pressure switch ratings: Sustained pressure capability shall exceed two times lock-up of nearest upstream regulator.
 - c. Oil pressure switch ratings: Sustained pressure capability shall exceed set pressure, plus accumulation, of oil pump safety relief valve. On heated oil system, sustained temperature capability shall exceed maximum operating temperature.
 - d. Low gas pressure switches shall include impulse dampener to reduce the effects of pressure dips during start-up.
 - e. Mechanical movements shall have bushings to eliminate wear of metal parts.
 - f. Approvals: UL listed, FM approved.
 - g. Switch Locations: Must be located where pressure is constant, as controlled by pressure regulator (if provided) on fuel train. Must be upstream of modulating fuel flow control valves.
 - h. Set points shall be within 20% of the normal operating pressure.
 - i. High pressure switches shall be piped to the service with lockable isolation valve and valved test connection so that switch can be set and tested using compressed air.
10. Low Atomizing Media Pressure, Differential Pressure and Flow Interlocks:
- a. Type: Mercury switches, graduated set point indicator, switch position indicator, adjustable set point coordinated with burner requirements, automatic reset. Switch movements shall have bushings to eliminate metal-to-metal wear.
 - b. Rating: Shall exceed pressure setting of nearest upstream relief valve.
 - c. Provide siphon on steam connection to protect sensing element from live steam.
 - d. Approvals: UL listed.
 - e. Locations and types of switches on atomizing media piping: Two switches required for each burner, a static pressure switch on atomizing media supply ahead of differential pressure control valve, and differential pressure flow switch with flow meter orifice on atomizing piping adjacent to burner. On burners that maintain an approximately constant differential pressure between

the atomizing steam and oil, provide a steam/oil differential pressure switch instead of the flow switch at the oil burner.

Burners with individual air compressors for air atomization shall be provided with one air pressure switch and compressor motor interlocks as specified above.

11. 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.
12. 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 (internal snap acting switches within the actuator a pot may not act as this safety device.) on the motor which positions the jackshaft to which all the operating levers are pinned.
13. 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 39, FIRE-TUBE BOILERS.
14. Low Boiler Water Level Interlocks: Primary and auxiliary low water burner shut down interlocks. Refer to Paragraph, BOILER TRIM, in Section 23 52 39, FIRE-TUBE BOILERS. Operation of auxiliary low water cutoff shall interrupt the power supply to the burner management control system.
15. 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.

16. 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.
 17. 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.
 18. Building Combustion Air Intake Interlock: Not used.
- 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. Fully Open all air dampers fully. This includes all dampers (if provided) in the boiler outlet breeching and stack system.
 4. Position flue gas recirculation damper (if provided) as required by burner manufacturer to purge flue gas from recirculation duct.
 5. Prove 70% of maximum air flow through the boiler and prove all air dampers open wide and flue gas recirculation damper (if provided) in proper position.
 6. Pre-purge eight air changes for water tube boilers and four air changes for fire tube boilers.
 7. Return forced draft fan dampers and fuel flow control valves to low fire position.
 8. If boiler outlet damper is provided, retain outlet damper wide open. If outlet draft damper modulating control system is provided and excessive draft due to wide-open damper is incompatible with the burner, automatically position the outlet damper to an acceptable position for burner ignition.
 9. Prove low fire start position.

10. Sensing of flame prior to this shall cause shutdown.
 11. Energize igniter and open igniter fuel automatic safety shut-off valves. Prove igniter flame in ten seconds or provide shutdown.
 12. On systems with ultraviolet flame scanners, terminate ignition spark five seconds before main fuel valves open.
 13. Open main fuel safety shut-off valves for fuel selected. Close igniter fuel valves within ten seconds after main fuel valves open (15 seconds on heated oil).
 14. Prove main flame or provide shutdown.
 15. Place flue gas recirculation damper (if provided) in modulating or in fixed position as required by design of burner furnished.
 16. If provided, release boiler outlet draft control damper to modulation.
 17. Release burner from low fire position to automatic or manual firing rate control.
 18. Provide 15 second post purge at end of burner firing cycle.
 19. Close all dampers upon completion of post purge.
- R. Spare Parts:
1. One flame control programmer chassis complete.
 2. One flame control amplifier complete.
 3. One flame scanner complete with connecting leads.
 4. Twelve lamps for each type of replaceable lamp.
 5. Two of each type of relay and timer.

2.3 MAIN INSTRUMENTATION AND CONTROL PANEL:

- A. Type: One free-standing factory-assembled steel enclosure with control stations, control switches, instruments and indicators on panel front and controllers, relays and other components mounted on interior sub-bases. NEMA ICS-6, Type 12 rating. Refer to drawings for arrangement and overall dimensions.
- B. Panel Construction:
1. Minimum 3.5 mm (0.134-inch) thick steel sheet with steel angle or bar reinforcement. Provide vertical reinforcement from top to bottom of panel between each large instrument opening. Provide horizontal reinforcement above and below each large instrument opening.
 2. Provide sufficient reinforcement to prevent any warping or displacement due to weight of equipment mounted on and within panel.
 3. All corners and edges shall be smooth.

4. Rear Access Doors: Sufficient quantity to cover full height and width of panel, three-point latches with key-type locks, three hinges per door, or piano-type hinges.
5. Finish:
 - a. Exterior: Undercoat of rust-resistant primer, finish coats of textured spatter paint, dark gray.
 - b. Interior: Undercoat of rust-resistant primer, finish coats of enamel, light gray or white.
6. Provide duplex 120-volt GFI receptacle inside the panel.
7. Provide fan-type ventilation if necessary to protect equipment from overheating. Assume boiler room temperature of 38 degrees C (100 degrees F).
- C. Master Steam Pressure Control Station: Refer to Paragraph, AUTOMATIC BOILER AND BURNER CONTROL SYSTEMS. Unit shall be flush mounted on panel front.
- D. Boiler/Burner Submaster Control Stations: Refer to Paragraph, AUTOMATIC BOILER AND BURNER CONTROL SYSTEMS. Units shall be flush mounted on panel front.
- E. Touch Screens: Refer to Paragraph, AUTOMATIC BOILER/BURNER CONTROL SYSTEM.
- F. Pressure Gages: Flush mounted, $\frac{1}{2}$ percent accuracy, 150 mm (6-inch) dial diameter, micrometer adjustable pointer, solid front, blow-out disk in rear, back connected, and of indicated range. Provide gage cock within panel for each gage. Provide gages for steam header pressure, boiler feed header pressure for each boiler, fuel header pressures.
- G. Push Button Stations and Indication Lights for Pump Control: Refer to Section 26 29 11, LOW-VOLTAGE MOTOR STARTERS. Lights shall be oil-tight, standard industrial construction, 120-volt, utilizing lamps which are readily available. Lenses shall be red and green colored, held in place by threaded ring. Push button stations shall be flush mounting, oil tight, momentary contact. Provide non-latching lamp test control on main panel.
- H. Annunciator:
 1. Provide system for monitoring alarm functions listed below.
Annunciator shall include alarm lights, alarm bell, integral test and acknowledge push buttons. Include Modbus communications for use with computer workstation.

2. Type: Multiple rectangular back-lighted windows on which alarm functions are engraved; separate window for each function. Provide test and acknowledge controls. All alarm lights shall operate independent of the PLC or if PLC fails all indicator lights will still function.
3. Construction:
 - a. Window Size: 44 x 75 mm (1.75 x 3 inches) minimum.
 - b. Lamps: Minimum of two per window.
 - c. Operating Mechanisms: Solid state electronic, accessible for repair without removing entire annunciator from panel. Provide all equipment for complete system.
 - d. Bell: 150 mm (6 inch) diameter, surface mounted.
4. Operating Sequence:
 - a. Condition Normal: Bell and light off.
 - b. Condition Abnormal: Bell on; light flashing.
 - c. Acknowledge: Bell off; light on steady.
 - d. Condition Returns to Normal: Bell and light off.
 - e. Test: Bell on; light flashing.
5. Alarm Sensing Systems: Provide complete wiring, controls, conduits, and accessories.
 - a. Condensate Storage Tank and Feedwater Deaerator Storage Tank High and Low Water Level Alarms (4 functions): Actuated by sensors mounted on storage tanks. Refer to Section 23 50 11, BOILER PLANT MECHANICAL EQUIPMENT.
 - b. High and Low Steam Header Pressure (2 functions): Actuated by adjustable automatic reset UL listed pressure switches. Range of adjustable set point 40-180 psi, 5 psi maximum differential. Provide steam siphon loops, shut-off valves.
 - c. Emergency Gas Valve Closed: Actuated by switch provided with valve assembly.
 - d. Oil Tanks - High and Low Level (2 functions per tank): Separate high and low level indications for each tank. Actuated by oil tank level monitor system.
 - e. Low Excess Air - Boiler (1 function per boiler): Actuated by flue gas oxygen analyzers. Refer to Paragraph, AUTOMATIC BOILER AND BURNER CONTROL SYSTEMS.
 - f. High Natural Gas Header Pressure: Actuated by adjustable, automatic reset, pressure switch connected to gas header. Switch

- shall be UL listed for natural gas service. Provide shut-off cock between gas header and switch.
- g. LP Igniter (Pilot) Gas in Use - For Emergency Only: Actuated by adjustable, automatic reset, UL listed, FM approved, high pressure switch mounted on LPG header. Range of set point 1-10 psi, emergency rating 30 psi.
 - h. Low feedwater pressure (1 function per header): Actuated by pressure switches on feedwater headers.
 - i. Input/Output (I/O) Modules: Provide 20% (2 minimum) installed spare I/O of each type for computer data acquisition system.
 - I. Emergency Fuel Safety Shut-Off Valve Control: Provide maintained contact, emergency safety shut-off push-pull control switches with mushroom heads on outside face of panel and at outside personnel doorways. The shut-off shall shut down main and igniter emergency safety shut-off valves from power source shown and shut down all other fuel sources. Valves shall close when switch is pulled out.
 - J. Clock: Microprocessor-driven digital, 60 mm (2.5 inch) high wide angle LED display, selectable 12/24 hours, enable/disable automatic daylight savings time changeover, enable/disable alternating time and date, seven-year battery-back-up memory, time base accurate to plus or minus two minutes per year.
 - K. Nameplates: Provide engraved plastic laminated nameplates for all devices on front of panel. Nameplates shall have white letters on black background. Mount with screws or rivets. List equipment title and identification number, such as "BOILER FEED PUMP P-1." Do not use abbreviations.
 - L. Auxiliary relays: Industrial type rated for the service, enclosed contacts.
 - M. Selector switches, push buttons and control switches: Heavy duty, industrial type.
 - N. Wiring and Piping Methods:
 - 1. All devices mounted in and on panel shall be factory-wired and piped.
 - 2. All electrical contacts shall switch the phase conductor.
 - 3. Electric wiring: Conform to NFPA-70, all wiring in troughs, terminations in industrial class terminal blocks, terminals numbered for identification, 20 percent extra terminals. All wiring color coded and numbered using numbering system that identifies the

destination. There shall be no exposed wiring connections exceeding 120-volts inside the panels. Refer to Section 23 21 11, BOILER PLANT PIPING SYSTEMS, and Section 26 05 21, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS and CABLES (600 VOLTS AND BELOW).

4. Piping: Stainless steel tubing, securely mounted, terminate in fittings at top of the cabinets.

O. Spare Parts Required:

Lamps: Six of each type in panel and instruments.

Touch-up paint for panel: One pint.

2.4 BOILER/BURNER CONTROL PANELS:

- A. Type: Individual boiler/burner control panels with control stations, control switches, instruments and indicators on panel fronts and controllers, relays and other components mounted on interior sub-bases. Panels shall be boiler-mounted.

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. Boiler-mounted panels shall be minimum 1.9 mm (0.075 inch) thick steel sheet. 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. Forced draft fan start-stop for D-type water tube boilers.
 - 6. Burner stop switch with mushroom head.
 - 7. 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 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 Business operating system. Minimum requirements are Intel Core i7 4770, 8 MB L3 cache, 3.4 GHz, 8 GB

- DDR3 SDRAM memory ECC(2 DIMMS); dual hard drives each 1 TB SATA, nVIDIA QUADROFX4400 512 MB graphics, DVD+/-RW optical drive, integrated gigabit Ethernet, 250 MB Iomega Zip internal drive, sound card, audible alarm and a battery-backed clock which counts seconds, minutes, hours, days and years. Provide two parallel ports and two serial ports, minimum.
3. Digital Flat Panel Color Monitor: TFT, minimum 27 inch diagonal (nominal) screen with 4K Ultra HD capability of 3840 x 2160 pixels resolution and response time of 1ms. Energy-Star compliant.
 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.

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 black and white or 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 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 stack opacity (if opacity monitors are provided).
- 8) Boiler flue gas outlet draft (if outlet draft control system is provided), inches WC.
- 9) Boiler feedwater inlet temperature, °F.
- 10) Signal to feedwater control valve.
- 11) Water level in boiler plus or minus inches from normal level.
- 12) Boiler "Heat Loss" combustion efficiency not including radiation and unaccounted losses.
- 13) Fuel flow rate and totalization if individual boiler fuel meters are provided scfh; gpm. Totalization calculations shall be accomplished at the meters, not in the SCADA software.
- 14) 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.
- 15) Trends of all flow, pressure and temperature data as listed above.

b. Boiler Plant:

- 1) Feedwater deaerator storage tank water level, inches of water.
- 2) Condensate storage tank water level, inches of water.
- 3) Oil tanks oil level, gallons of oil.
- 4) Pumps in operation.
- 5) Chemical feeders in operation.
- 6) Steam header pressure, psi.
- 7) Feedwater deaerator steam pressure, psi.
- 8) Emergency gas valve status (open or closed).
- 9) Natural gas header pressure, psi.
- 10) Fuel oil header pressure, psi.
- 11) Boiler feed header pressure - each header, psi.
- 12) LP igniter gas header pressure psi.
- 13) Instrument air pressure psi.
- 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; percent opacity (if opacity monitor is provided); fuel flow rate (if fuel meters are provided on the boilers), scfh, 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, scfh, gpm.
- c. Display No. 3: Outside air temperature, °F; feedwater temperature, °F; steam header pressure, psi.

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) Boilers high stack opacity (if opacity monitors are provided).
 - 5) 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) High and low fuel oil temperature (if heated oil is provided).
 - 14) Propane igniter gas header pressurized (normal is zero pressure).
 - 15) High and low oil level in each oil tank.
 - 16) Oil tank and piping system leak detected.
 - 17) Carbon monoxide (CO) or combustible gas in building.
 - 18) Control system faults.
- 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, 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. 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.
 2. Low flue gas oxygen alarm on main panel annunciator. 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. Set points shall not be adjustable from the front of the panel. 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 20/1 for plant meters and 10/1 for individual boiler meters with minimum accuracy one percent of flow rate over the entire range.
3. Construction:
 - a. Meter: Design for 850 kPa (125 psi). Pipe connections flanged 850 or 1025 kPa (125 or 150 psi) ANSI. All bearings and gearing shall be in areas sealed from contaminants. Metering transducers operated through magnetic coupling. The measuring devices shall be contained within a module that can be removed from the meter body for service and calibration without breaking the main gas piping connections. Corrosion-resistant material of construction or coating.
 - b. Indication Devices on Meter: Electronic type which provides a totalized continuous volume flow digital indication in cubic feet automatically continuously corrected to the local contract base temperature and pressure from actual varying line temperatures and pressures. Unit shall also display a totalized uncorrected volume flow indication. The display shall show actual line temperature and pressure at the meter and pressure-temperature

correction factor. Smallest corrected flow indication shall be one thousand cubic feet, and indicator shall have at least six digits. Unit shall be watertight where drawings show an outdoor location.

4. Calibration: Factory calibrated. Furnish three-point curve spanning required flow range on actual meter furnished.

5. Accessories:

- a. 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.

2.8 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.

2.9 BOILER DRAFT GAGES:

- A. For fire tube boilers, provide gages for boiler 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 and boiler 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 main instrumentation panel.

2.10 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 controller's computer workstation.
- C. Minimum accuracy one percent of actual temperature.
- D. Boiler flue gas temperature sensors shall be averaging type and shall extend across width of stack or breeching.
- E. Provide stainless steel weather hood on outside air temperature sensor, which shields the sensor from direct sunlight.

2.11 GAGES, PRESSURE AND COMPOUND, PIPE OR TANK-MOUNTED:

- A. Construction:
 - 1. Case: Solid armored front between measuring element and dial, blowout back, bottom connection, phenol turret type.
 - 2. Dial: Non-corrosive, 110 mm (4-1/2 inch) diameter face with black markings on white background.
 - 3. Measuring Element: Bourdon tube designed for the required service. Provide bellows designed for service for pressure ranges under 100 kPa (15 psi).
 - 4. Movement: Stainless steel, rotary.
 - 5. Pointer: Micrometer adjustable, black color.
 - 6. Window: Plastic.
 - 7. Liquid Filled Gages: Provide at inlet and outlet of all pumps, on compressed air systems, and on fuel and atomizing media lines at

- locations closest to burners where bourdon tube gages are utilized. Gage filling shall be glycerin or silicone oil. Purpose of filling is to provide pulsation dampening. As an option to liquid filling, provide dry gages that have built-in fluid clutch dampeners that are not vulnerable to plugging due to foreign material.
- B. Accuracy: ASME B40.100, Grade 2A, ½ percent, on all gages; except Grade A, one percent permitted on diaphragm actuated gages, liquid filled gages, and compound gages.
- C. Accessories:
1. Red set hands on gages located at automatic pressure regulator valve outlets.
 2. Needle valve or gage cock rated for the service.
 3. Syphon on all steam gages.
 4. Pulsation snubbers on diaphragm-type gages located adjacent to gas burners.
- D. Scale Ranges: Provide English scales:
1. Low pressure steam to 100 kPa (15 psi): 0 to 200 kPa/0 to 30 psi.
 2. Medium pressure steam to 407 kPa (59 psi): 0 to 700 kPa/0 to 100 psi.
 3. High pressure steam above 407 kPa (59 psi): 0 to 200 psi.
 4. Natural and LP gas: 0 to 200 kPa/0 to 30 psi.
 5. LP gas at tanks: 0 to 2100 kPa/0 to 300 psi.
 6. Gas burner, 125 percent of full load pressure, kPa/inches WC.
 7. Oil pump suction: 100 kPa vacuum to 100 kPa/30 inches Hg vacuum to 15 psi.
 8. Oil pump discharge: 0 to 1400 kPa/0 to 200 psi.
 9. Oil burner, 125 percent of full load pressure, kPa/psi.
 10. Compressed air, 345 kPa & higher (50 psi & higher): 0 to 1100 kPa/0 to 160 psi.
 11. Feedwater pump discharge: 0 to 2100 kPa/0 to 300 psi.
 12. Feedwater pump suction: 100 kPa vacuum to 200 kPa/30 inches Hg vacuum to 30 psi.
 13. Pumped condensate: 0 to 400 kPa/0 to 60 psi.
 14. Condensate transfer pump discharge: 0 to 400 kPa/0 to 60 psi.
 15. Condensate transfer pump suction: 100 kPa vacuum to 100 kPa/30 inches Hg vacuum to 15 psi.
 16. Feedwater deaerator: 100 kPa vacuum to 200 kPa/30 inches Hg vacuum to 30 psi.

17. Other services, 200 percent of maximum operating pressure.

E. Boiler Steam Pressure Gages: Refer to Section 23 52 39, FIRE-TUBE BOILERS.

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

2.12 THERMOMETERS, PIPE OR TANK-MOUNTED:

A. General: Thermometer locations are shown on the drawings.

B. Construction:

1. Industrial type, separable well and socket, union connected.
2. Scales: Red reading mercury combination 30 to 300 degrees Fahrenheit/0 to 150 degrees Celsius scales, unless otherwise shown. Scale length 220 mm (9 inch) except 170 mm (7 inch) scale length acceptable on oil burner piping. Mercury sealed under pressure with inert gas to prevent oxidation and separation of column.
3. Case: Corrosion resistant with glass or plastic front.
4. Form: Straight or back form except thermometers located more than 2100 mm (7 feet) above floor or platform shall be adjustable angle.
5. Wells: Sized to suit pipe diameter without restricting flow. Provide snug sliding fit between socket and well.
6. Accuracy: One percent of scale range.

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

A. Automatic microprocessor-based industrial-class system that monitors the concentration levels of carbon monoxide and combustible gases in the boiler room and associated spaces. The system shall include displays of the concentration levels of the gases detected by each sensor and provide audible and visual alarms when these gases are detected. Control/transmitter panels with displays and control functions shall be located 1500 mm (5 feet) above the boiler room floor. Provide 2 combustibles sensors and 6 carbon monoxide sensors at locations shown or as directed. Provide RS485 Modbus communications protocol (i.e. Modbus RTU, etc.) of detected gas concentration levels and alarms to computer workstation and central control panel. Transmit alarm signal to designated location outside the boiler plant:_____ Audible and visual alarm shall be provided at this location.

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.
2. Combustible Gas Sensors: Plug-in type, infrared detection, no moving parts, range 0-100% lower explosive limit. On-board storage of calibration data, peak values, time and date stamped. Set point: 10% of lower explosive limit.
3. Controller/Transmitters: Separate from sensors, non-intrusive calibration. NEMA 4 enclosure, sensors connected to transmitter with easily operated connection devices. Universal transmitter which can accept infrared, catalytic bead, or toxic sensor and auto-configure when sensor connector is inserted. LED display of gas type and concentration, alarm horn and strobe, output compatible for computer work station, integral non-volatile memory, automatic resume on power failure, sensor and controller diagnostics, menu-driven calibration. Networked with computer work station SCADA program or central control panel via RS-485 four-wire bus, such as Modbus RTU.
4. Additional Features:
 - a. Capability to remotely mount sensor from transmitter to allow calibration at convenient point up to 100 feet away.
 - b. Sensor/transmitter display shall indicate all diagnostic check/fault conditions with detailed message displays.
 - c. Full-function keypad or magnetic touch points to allow setting alarm set points, change span gas values and display date of last calibration.
5. 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 hose for remote-mounted sensors.
6. Approvals: NEC and CEC for explosion proof or non-incendive, when required.

7. Product Support: Supplier shall have organization, located within 150 miles of site, with capability of complete on-site product
8. Power Supply: Provide protected power supply to protect system from surges, spikes, transients, overloads in the incoming power supply.

2.14 TOOLS:

- A. Calibration Gases for Boiler Flue Gas Oxygen Analyzers and Building Carbon Monoxide and Combustible Gas Detection System:
 1. Type: Compressed gases in transportable cylinders, certified analyses. One cylinder of each mixture for each analyzer. Composition of mixtures and quantity of mixtures as recommended in written instructions by analyzer and gas detection system manufacturers.
 2. Cylinders: Minimum capacity 100 liters of gas, approx. 75 x 360 mm (3 x 14 inch) cylinder.
 3. Delivery: Deliver to Resident Engineer prior to initial calibration of instrumentation. Contractor personnel may use gases. Provide new full cylinders, to replace gases used during start-up and testing after boiler plant testing is complete.
- B. Communication Devices for Programming Instrumentation and Controls: Furnish all devices necessary to configure all programs and obtain all data from instruments and controls. Deliver to Resident Engineer.

PART 3 - EXECUTION

3.1 INSTALLATION, BOILER PLANT INSTRUMENTATION, AUTOMATIC BOILER CONTROL SYSTEMS, BURNER MANAGEMENT SYSTEMS, COMPUTER WORK STATION (IF PROVIDED):

- A. General:
 1. Nameplates, Labels and Identification: Refer to Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION.
 2. Electrical Work and Safety Requirements: Comply with NFPA 70 and referenced electrical sections of these specifications.
 3. Electrical Wiring: Comply with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS; Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS; Section 26 05 19, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW); and Section 26 27 26, WIRING DEVICES. The term "wiring" includes furnishing of wire, conduit, miscellaneous material and labor to install a complete working system as specified.

4. All devices plumbing and wiring shall comply with and be arranged as shown in the most recent edition of the "VHA Boiler Plant Safety Device Testing Manual".
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 1500 mm (5 feet) above the boiler room floor.
 2. Sampling point shall be upstream of smoke density monitor in non-turbulent area. Locate probe within 4.5 meters (15 feet) of floor or accessible from platform.
 3. Reference Air: Provide dry, filtered, pressure-regulated compressed air service to each unit. Provide isolating valve at each unit.
 4. Calibration Gases: Provide permanently installed valved piping connections, pressure regulators and gages in flue gas sampling system for connection of required calibration gases. Locate within 1200 mm (4 feet) of main floor.
 5. Interconnection of Instruments: Provide shielded wiring as recommended by instrument manufacturer.
 6. Power Circuits: Provide dedicated circuits from a plant panel.
Analyzers shall remain powered when burner control is off.
- E. Wiring and Piping: Is generally not shown on the drawings. All wiring and piping must be provided in accordance with NFPA 70 and ASME B31.1.
- F. Combustion Control Linkage Systems: After completion of burner adjustments, counter sink all lever set screws into shafts or pin levers to shafts to prevent levers from slipping on the shafts.

- G. Boiler Stack Opacity Monitors (if provided): Locate downstream from oxygen sensing systems so that opacity monitor air purge does not affect flue gas oxygen reading. Locate sensor within 4.5 m (15 feet) of floor or accessible from platform without use of portable ladder. Locate air purge blower unit within 2400 mm (eight feet) of floor or accessible from platform without use of portable ladder.
- H. Compressed Air Filters: Pipe drain to nearest floor drain.

3.2 INSTALLATION, NATURAL GAS FLOW METERS:

- A. 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:

- A. 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:

- A. 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:

- A. 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:

- 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 test shall be based on the most recent edition of the "VHA Boiler Plant Safety Device Testing Manual", also Refer to Section 23 52 39, FIRE-TUBE BOILERS.
- 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:

- A. 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 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Section 22 31 11, WATER SOFTENERS.
- C. SECTION 22 67 21, WATER DEALKALIZING SYSTEM.
- D. Section 23 05 10, COMMON WORK RESULTS FOR BOILER PLANT AND STEAM GENERATION
- E. Section 23 05 51, NOISE AND VIBRATION CONTROL FOR BOILER PLANT.
- F. Section 23 07 11, HVAC AND BOILER PLANT INSULATION.
- G. Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.
- H. Section 23 09 11, INSTRUMENTATION AND CONTROL FOR BOILER PLANT.
- I. Section 23 50 11, BOILER PLANT MECHANICAL EQUIPMENT.
- J. Section 23 52 39, FIRE-TUBE BOILERS.

1.3 QUALITY ASSURANCE:

- A. Entire installation shall comply with ASME Power Piping Code, ASME B31.1 and appendices.
- B. Boiler External Piping, as defined in the ASME Boiler and Pressure Vessel Code, Section I, is required to be constructed and inspected in conformance with the ASME Code.
- C. Mechanics shall be skilled in their work or trade. Welders on pressure vessels or piping shall show evidence of qualification in accordance with the ASME Power Piping Code and the ASME Boiler and Pressure Vessel Code. Certify that each welder has passed American Welding Society (AWS) qualification tests for the welding processes involved, and that certification is current. Each welder shall utilize a stamp to identify all work performed by the welder. The Government reserves the right to reject any personnel found unqualified in the performance of work for which they are employed.

1.4 SUBMITTALS:

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- B. Piping:
 - 1. ASTM material specification number.
 - 2. Grade, class or type, schedule number.
 - 3. Manufacturer.
- C. Pipe Fittings, Unions, Flanges:
 - 1. ASTM material specification number.
 - 2. ASME standards number.
 - 3. Catalog cuts.
 - 4. Pressure and temperature ratings.
- D. Valves - Gate, Globe, Check, Plug, Butterfly, Ball:
 - 1. Catalog cuts showing design and construction.
 - 2. Pressure and temperature ratings.
 - 3. Materials of construction.
 - 4. Accessories.
- E. Sight flow indicators:
 - 1. Catalog cuts showing design and construction.
 - 2. Pressure and temperature ratings.
 - 3. Materials of construction.
- F. Quick-Couple Hose Connectors and Steam Hose:
 - 1. Catalog cuts showing design and construction.
 - 2. Pressure and temperature ratings.
 - 3. Materials of construction.
 - 4. Type of seal between couplings.
 - 5. Flexibility of steam hose.
- G. Pressure Reducing and Regulating Valves, Back Pressure Relief Valves, Safety Valves, Relief Valves:
 - 1. Catalog cuts showing design and construction.
 - 2. Service limitations (type of fluid, maximum pressure and temperatures).
 - 3. Materials of construction.
 - 4. Flow capacity at required set pressure.
 - 5. Predicted sound levels, at operating condition, for steam pressure reducing valves.

H. Strainers:

1. Catalog cuts showing design and construction.
2. Pressure and temperature ratings.
3. Materials of construction.
4. Strainer basket or liner mesh.
5. Pressure loss and flow rate data.

I. Emergency Gas Safety Shutoff Valves, Automatic Earthquake Gas Valves:

1. Catalog cuts showing design and construction.
2. Maximum pressure rating.
3. Material of construction.
4. Pressure loss and flow rate data.

J. Steam Traps:

1. Catalog cuts showing design and construction.
2. Service limitations (maximum pressures and temperatures).
3. Materials of construction.
4. Flow rates at differential pressures shown on drawings.
5. Orifice size for each trap.

K. Flexible Connectors:

1. Catalog cuts showing design and construction.
2. Pressure and temperature ratings.
3. Materials of construction.
4. Maximum allowable lateral and axial movements.
5. Description of type of movement permitted, intermittent offset or continuous vibration.

L. Pipe Support Systems:

1. Credentials of technical personnel who will design the support systems.
2. Validation of computer program for pipe support selection.
3. Input and output data for pipe support selection program for all piping systems with pipe sizes 60 mm (2-1/2 inches) and above.
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.
10. Stress analyses on the boiler plant piping systems under all possible load conditions as part of the design. Once all piping is completed another stress analysis is required on the as built systems.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING:

- A. 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 100 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 and boilers are designed for a normal maximum temperature of 138 °C (280 °F), and emergency temperature of 213 °C (415 °F). Design pressure is the greater of: boiler feed pump shut off head; or 1896 kPa (275 psi) set pressure plus accumulation.
- D. Condensate collection and transfer systems to suction of boiler feed pumps are designed for maximum temperatures to 100 °C (212 °F), and pressures 276 kPa (40 psi).
- E. Natural gas fuel systems are designed and materials and equipment are applied to prevent failure under gas pressure of 5psig entering the boiler plant. LP gas systems for igniters (pilots) are designed for maximum LP tank pressure of 1725 kPa (250 psig).

- F. Fuel oil system pressures are determined by the requirements of the burners and fuel trains. No. 2 oil systems are designed for maximum temperatures of 55 °C (130 °F), and pressures of 1025 kPa (150 psi).
- G. Water service pressures are 100-psig maximum. Systems are designed to operate under conditions of maximum available pressure.
- H. 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 103 kPa (15 psi) saturated steam.
- J. Compressed air systems are designed to accommodate a maximum pressure of 850 kPa (125 psi).
- 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
- C. American Society of Mechanical Engineers (ASME):
- Boiler and Pressure Vessel Code: 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
- 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:

2.1 STEAM PIPING:

- A. Pipe: Carbon steel, ASTM A53 Grade B or ASTM A106 Grade B, seamless or electric resistance welded (ERW). Schedule 40 for piping up to 862 kPa (125 psig) with welded ends, Schedule 80 for piping with threaded ends and piping over 862 kPa (125 psig) with welded ends.
- B. Joints:
1. Pipe sizes 65 mm (2-1/2 inches) and above: Butt-welded
 2. Pipe sizes 50 mm (2 inches) and below: Threaded, butt-welded, or socket-welded.
- C. Fittings:
1. Welded joints: Steel, ASTM A234, Grade B, ASME B16.9, same schedule as adjoining pipe, all elbows long radius.
 2. Threaded joints: Forged steel, ASME B16.11, 13,790 kPa (2000 psi class; or malleable iron, ASTM A47 or A197, ASME B16.3, 2050 kPa (300 psi) class.

- 3. Socket-welded joints: Forged steel, ASME B16.11, 13,790 kPa (2000 psi) class.
- D. Unions on Threaded Piping: Forged steel, 13,800 kPa (2000 psi) class or 20,680 kPa (3000 psi) class; or malleable iron, 2050 kPa (300 psi) on piping 50 mm (2 inches) and under.
- E. Flanges and Bolts: Forged steel weld neck, ASME B16.5, ASTM A105, 1025 kPa (150 psi) pressure class, except 2050 kPa (300 psi) class required adjacent to 1725 kPa (250 psi) and 2050 kPa (300 psi) class valves. Bolts shall be high strength steel ASTM A193, Class 2, Grade B8. Nuts shall be ASTM A194.

2.2 STEAM CONDENSATE PIPING:

- A. Includes all gravity, drip return, pumped and vacuum systems. Does not include piping system between boiler feed pumps and boilers.
- B. Pipe: Carbon steel, ASTM A53 Grade B or ASTM A106 Grade B, seamless or ERW, Schedule 80.
- C. Joints:
 - 1. Pipe sizes 65 mm (2-1/2 inches) and above: Butt-welded.
 - 2. Pipe sizes 50 mm (2 inches) and below: Threaded, butt-welded or socket-welded.
- D. Fittings:
 - 1. Welded joints: Steel, ASTM A234, Grade B, ASME B16.9, same schedule as adjoining pipe.
 - 2. Threaded joints: Forged steel, ASME B16.11, 13,790 kPa (2000 psi) class; or malleable iron, ASTM A47 or A197, ASME B16.3, 2050 kPa (300 psi) class.
 - 3. Socket-welded joints: Forged steel, ASME B16.11, 13,800 kPa (2000 psi) class.
- E. Unions on Threaded Piping: Forged steel, 13,800 kPa (2000 psi) class or 20,680 kPa (3000 psi) class; or malleable iron, 2050 kPa (300 psi). On piping 50 mm (2 inches) and under.
- F. Flanges: Forged steel weld neck, ASTM A105, ASME B16.5, 1025 kPa (150 psi).

2.3 FUEL PIPING:

- A. Natural gas, LP gas (propane), fuel oil (No. 2) for main burner and igniter (pilot) fuels, gas vent piping. Comply with ASME B31.1.
- B. Piping: Carbon steel, ASTM A53 Grade B or ASTM A106 Grade B, seamless or ERW, Schedule 40. Fuel oil piping shall be seamless downstream of burner automatic shutoff valves.

C. Joints:

1. Pipe sizes 65 mm (2-1/2 inches) and above: Butt-welded.
2. Pipe sizes 50 mm (2 inches) and below: Socket-welded or butt-welded.

D. Fittings:

1. Butt-welded joints: Steel, ASTM A234, Grade B, ASME B16.9, same schedule as adjoining pipe.
2. Socket-welded joints: Forged steel, ASME B16.11, 13,790 kPa (2000 psi class).

E. Unions on piping 50 mm (2 inches) and under: Forged steel, 13,800 kPa (2000 psi) class or 20,680 kPa (3000 psi) class.

F. Flanges: Forged steel weld neck, ASME B16.5, ASTM A105, 1025 kPa (150 psi).

G. Companion flanges: Flanges and bolting shall conform to ASME B16.5.

H. Burner Piping: Furnished as part of the factory-assembled burners may be manufacturer's standard materials and assembly. Comply with ASME B31.1, for the actual operating conditions.

I. Igniter (Pilot) Piping: Furnished as part of the factory assembled burners may have 2050 kPa (300 psi) ASTM A47, ASME B16.3 malleable iron threaded fittings in lieu of welded steel. If threaded fittings are provided, piping shall be Schedule 80.

2.4 BOILER FEEDWATER PIPING:

A. Piping from boiler feedwater pump discharge to inlet of boilers.

B. Pipe: Carbon steel, ASTM A53 Grade B or ASTM A106 Grade B, seamless or ERW. Piping with threaded joints shall be Schedule 80; welded joints Schedule 40.

C. Joints:

1. Pipe sizes 65 mm (2-1/2 inches) and above: Butt-welded.
2. Pipe sizes 50 mm (two inches) and below: Threaded, butt-welded, or socket-welded.

D. Fittings:

1. Butt-welded Joints: Steel, ASTM A234, Grade B, ASME B16.9, same schedule as adjoining pipe.
2. Threaded Joints: Forged steel, ASME B16.11, 13,790 kPa (2000 psi class; or malleable iron, ASTM A47, ASME B16.3, 2050 kPa (300 psi) class.
3. Socket-welded joints: Forged steel, ASME B16.11, 13,800 kPa (2000 psi) class.

- E. Unions: Forged steel, 13,800 kPa (2000 psi) class or 20,680 kPa (3000 psi) class; or malleable or ductile iron, 2050 kPa (300 psi) class.
- F. Flanges and Bolts: Forged steel weld neck, ASME B16.5, ASTM A105, 2050 kPa (300 psi) pressure class. Bolts shall be High strength ASTM A193, Class 2, Grade B8. Nuts shall be ASTM A194.

2.5 BOILER BLOWDOWN PIPING:

- A. From boiler bottom blowoff connection to blowoff tank. Connections between boiler accessories drain valves and blowoff lines.
- B. Pipe: Carbon steel, ASTM A106, Grade B, seamless, Schedule 80.
- C. Joints: Butt-welded.
- D. Fittings: Steel, ASTM A234, Grade B, ASME B16.9, same schedule as adjoining pipe, all elbows long radius, no tees or crosses permitted.
- E. Flanges: Forged steel weld neck, ASME B16.5, ASTM A105, 2050 kPa (300 psi).
- F. At no point shall the bottom blow down lines raise above the point of connection to the boiler.

2.6 DRAIN PIPING FROM BOILER ACCESSORIES TO DRAIN VALVE:

- A. Drain piping from water column, low water cutoffs, gage glass, water level sensor, remote water level devices (where applied).
- B. Pipe: Carbon steel, ASTM A106, seamless, Schedule 40.
- C. Joints: Threaded.
- D. Fittings: Forged steel, ASME B16.11, 13,790 kPa (2000 psi class); or malleable iron, ASTM A47 or A197, ASME B16.3, 2050 kPa (300 psi) class.
- E. Unions: Forged steel, 13,800 kPa (2000 psi) class or 20,680 kPa (3000 psi) class; or malleable iron, 2050 kPa (300 psi) class.

2.7 VENT LINES FROM TANKS AND SAFETY AND RELIEF VALVES:

- A. Pipe: Carbon steel, ASTM A53 Grade B or A106 Grade B, seamless or ERW, Schedule 40.
- B. Joints:
 - 1. Pipe sizes 65 mm (2-1/2 inches) and above: Butt-welded.
 - 2. Pipe sizes 50 mm (2 inches) and below: Threaded or butt-welded.
- C. Fittings:
 - 1. Welded Joints: Steel, ASTM A234 Grade B, ASME B16.9, same schedule as adjoining pipe.
 - 2. Threaded Joints: Cast iron, ASME B16.4, 850 kPa (125 psi).
- D. Unions: Forged steel, 13,800 kPa (2000 psi) class or 20,680 kPa (3000 psi) class; or malleable iron, 1025 kPa (150 psi) class.

- E. Flanges: Forged steel weld neck, ASME B16.5, ASTM A105, 1025 kPa (150 psi).

2.8 COLD WATER PIPING:

- A. Soft Water: See Section 22 31 11, WATER SOFTENERS.
- B. City Water: See Section 22 11 00, FACILITY WATER DISTRIBUTION.
- C. All copper pipe shall use only soldered fittings.

2.9 COMPRESSED AIR PIPING (FUEL OIL ATOMIZING SERVICE):

- A. Pipe: Carbon steel, ASTM A53 Grade B or ASTM A106 Grade B, seamless or ERW Schedule 40.
- B. Joints: Threaded.
- C. Fittings: Forged steel, ASME B16.11, 13,790 kPa (2000 psi class); or malleable iron ASTM A47 or A197, ASME B16.3, 1025 kPa (150 psi) class.
- D. Unions: Forged steel, 13,800 kPa (2000 psi) class or 20,680 kPa (3000 psi) class; or malleable iron, 1025 kPa (150 psi) class.

2.10 BOILER WATER SAMPLING, CONTINUOUS BLOWDOWN:

- A. Pipe: Steel, ASTM A106 Grade B, seamless, Schedule 80.
- B. Joints: Threaded.
- C. Fittings: Forged steel, ASME B16.11, 13,790 kPa (2000 psi class); or malleable iron, ASTM A47 or A197, ASME B16.3, 2050 kPa (300 psi) class. Fittings between boiler and first stop valve must be forged steel, ASME B16.11, 13,790 kPa (2000 psi) or 20,700 kPa (3000 psi) class.
- D. Unions: Malleable iron, 2050 kPa (300 psi) class.

2.11 FEEDWATER SAMPLING AND CHEMICAL FEED PIPING:

- A. Pipe: Stainless steel tubing, ASTM A269, Type 316.
- B. Fittings: Stainless steel Type 316 welding fittings.

2.12 MISCELLANEOUS PIPING:

- A. Instrument and Control Piping (Sensing Point to Transmitter, Controller, or Other Instrument): Construction shall be same as specified for main service.
- B. Drain Piping (All Drain Piping Discharging to Floor Drain-From Drain Valve to Floor Drain):
 - 1. Pipe: Carbon steel, ASTM A53 Grade B or ASTM A106 Grade B, seamless or ERW, Schedule 40.
 - 2. Fittings and Unions: Forged steel, ASME B16.11, 13,790 kPa (2000 psi class); or malleable iron, 1025 kPa (150 psi), threaded.

C. Pump Recirculation:

1. Pipe: Carbon steel, ASTM A53 Grade B or ASTM A106 Grade B, seamless or ERW, double extra strong. Schedule 40 permitted on all lines 1500 mm (5 feet) or more from the recirculation orifice.
2. Joints: Threaded.
3. Fittings: Forged steel, ASME B16.11, 13,790 kPa (2000 psi class); or malleable iron, ASTM A47 or A197, ASME B16.3, 2050 kPa (300 psi) class, except 1025 kPa (150 psi) class permitted on all lines 1500 mm (5 feet) or more from the recirculation orifice.
4. Unions: Forged steel, 13,800 kPa (2000 psi) class or 20,680 kPa (3000 psi) class; or malleable iron, ASTM A47 or A197, same pressure class as nearest fittings.

2.13 DIELECTRIC FITTINGS:

- A. Provide threaded dielectric unions for pipe sizes 50 mm (2 inches) and under. For 65 mm (2-1/2 inches) and above, provide copper and steel flanges electrically isolated at gasket and by sleeves at bolts. Fittings on cold water and soft water lines shall be rated for 690 kPa (100 psi), 27 °C (80 °F). Fittings on steam condensate lines shall be rated at 510 kPa (75 psi), 120 °C (250 °F). Fittings on other services shall be rated for the maximum pressure and temperature conditions of the service.

2.14 VALVES; GATE, GLOBE, PLUG, CHECK, BALL, BUTTERFLY, VENT COCKS:

- A. Valves for particular services are generally specified as Type Numbers. The Type Numbers are defined below. All valves of the same type shall be the products of a single manufacturer. Comply with MSS SP-45, MSS SP-80, and ASME B31.1. Design valves for the service fluids and conditions. Pressure-temperature ratings listed are minimum requirements. Packing and gaskets shall not contain asbestos.
- B. Valve Type Designations:
1. Gate Valves:
 - a. Type 101: Cast steel body ASTM A216 WCB, rated for 1025 kPa at 260 °C (150 psi at 500 °F), 11-1/2 to 13 percent chromium stainless steel flexible wedge and hard faced (stellite) or nickel copper alloy seats, 1025 kPa (150 psi) ASME flanged ends, OS&Y, rising stem, bolted bonnet.
 - 1) Provide factory installed globe-valved warm-up bypass when main valve is 75 mm (3 inch) pipe size or greater and serves steam main longer than 6 m (20 feet). Conform to MSS SP-45.

- 2) Drill and tap bosses for connection of drains. Conform to MSS SP-45.
 - b. Type 102: Cast iron body ASTM A126 Class B, rated for 1725 kPa (250 psi) saturated steam, 3440 kPa (500 psi) WOG, bronze wedge and seats, 1725 kPa (250 psi) ASME flanged ends, OS&Y, rising stem, bolted bonnet, renewable seat rings.
 - 1) Provide factory installed globe-valved bypass when main valve is 75 mm (3 inch) pipe size or greater and serves steam main longer than 6 m (20 feet). Conform to MSS SP-45.
 - 2) Drill and tap bosses for connection of drains if valve is in steam service. Conform to MSS SP-45.
 - c. Type 103: Cast iron body ASTM A126 Class B, rated for 850 kPa (125 psi) saturated steam, 1375 kPa (200 psi) WOG, bronze or bronze faced wedge and seats, 850 kPa (125 psi) ASME flanged ends, OS&Y, rising stem, bolted bonnet, renewable seat rings.
 - 1) Provide factory installed globe-valved bypass when main valve is 75 mm (3 inch) pipe size or greater and serves steam main longer than 6 m (20 feet). Conform to MSS SP-45.
 - 2) Drill and tap bosses for connection of drains if valve is in steam service. Conform to MSS SP-45.
 - d. Type 104: Bronze body ASTM B61, rated for 1375 kPa (200 psi) saturated steam, 2750 kPa (400 psi) WOG, bronze wedges and Monel or stainless steel seats, threaded ends, rising stem, union bonnet.
 - e. Type 105: Forged steel body ASTM A105, rated for 2050 kPa at 216 °C (300 psi at 420 °F) minimum, Class 4130 kPa (600 psi) or Class 5500 kPa (800 psi), hardened stainless steel or stellite wedge and seats, threaded ends, OS&Y, rising stem, bolted bonnet.
2. Globe Valves:
- a. Type 201: Cast steel body ASTM A216 WCB, rated for 1025 kPa at 260 °C (150 psi at 500 °F), 11-1/2 to 13 percent chromium stainless steel or stellite disc and seat, 1025 kPa (150 psi) ASME flanged ends, OS&Y, rising stem, bolted bonnet, renewable seat rings. Drill and tap bosses for connection of drains where shown. Conform to MSS SP-45.
 - b. Type 202: Cast iron body ASTM A126 Class B, rated for 1725 kPa (250 psi) saturated steam, 3440 kPa (500 psi) WOG, bronze or bronze faced disc and seat, 1725 kPa (250 psi) ASME flanged ends,

OS&Y, rising stem, bolted bonnet, renewable seat rings. Drill and tap bosses for connection of drains where shown. Conform to MSS SP-45.

- c. Type 203: Cast iron body ASTM A126 Class B, rated for 850 kPa (125 psi) saturated steam, 1375 kPa (200 psi) WOG, bronze or bronze-faced disc (Teflon or composition facing permitted) and seat, 850 kPa (125 psi) ASME flanged ends, OS&Y, rising stem, bolted bonnet, renewable seat rings.
 - d. Type 204: Bronze body ASTM B61, rated for 1375 kPa (200 psi) saturated steam, 2750 kPa (400 psi) WOG, hardened stainless steel disc and seat, threaded ends, rising stem, union bonnet, renewable seat rings.
 - e. Type 205: Forged steel body ASTM A105, rated for 2050 kPa at 216 °C (300 psi at 420 °F) minimum, Class 4130 kPa (600 psi) or Class 5500 kPa (800 psi), stainless steel disc, stellite seat, threaded ends, OS&Y, rising stem, bolted bonnet.
3. Plug Valves: Cast iron body ASTM A126 Class B, rated for 1200 kPa (175 psi) WOG, one-fourth turn to open. 850 kPa (125 psi) ASME flanged ends for pipe sizes above 50 mm (2 inches), threaded ends for pipe sizes 50 mm (2 inches) and under. All components designed for service to which applied: natural gas, LP gas (propane), or fuel oil. Furnish lever handle for each valve.
- a. Type 301: Two-way valves up through 100 mm (4 inches) pipe size. Eccentric action, non-lubricated plug with resilient seal molded into groove on plug face providing bubble-tight shut off. O-ring stem seal, corrosion-resistant bearings, corrosion-resistant seat coating, seal materials as recommended by valve manufacturer for the service. Valves on natural gas service AGA approved.
 - b. Type 302: Two-way valves 125 mm (5 inches) pipe size and above, all sizes of three way valves. Lubricated full-port plug type with lubricant for intended service. Reinforced Teflon stem seal, valve plug floated on Teflon surfaces, lubricant injection system that has sufficient pressure to fully lubricate all sealing surfaces. Provide laminated plastic label attached to each valve stating, "Lubricate with (Insert appropriate description) once a year".

4. Check Valves:

- a. Type 401: Not used.
 - b. Type 402: Swing-type, cast iron body ASTM A126 Class B, rated for 1725 kPa (250 psi) saturated steam, 3440 kPa (500 psi) WOG, bronze or bronze-faced disc and seat, 1725 kPa (250 psi) ASME flanged ends, bolted cover, renewable disc and seat.
 - c. Type 403: Swing-type, cast iron body ASTM A126 Class B, rated for 850 kPa (125 psi) saturated steam, 1375 kPa (200 psi) WOG, bronze or bronze-faced disc and seat, 850 kPa (125 psi) ASME flanged ends, bolted cover, renewable disc and seat.
 - d. Type 404: Swing-type, bronze body ASTM B61, rated for 1375 kPa (200 psi) saturated steam, 2750 kPa (400 psi) WOG, bronze disc, threaded ends, regrinding disc.
 - e. Type 405: Lift-type, forged steel body ASTM A105, rated for 2050 kPa at 216 °C (300 psi at 420 °F) minimum (Class 4130 kPa (600 psi) or 5500 kPa (800 psi)), hardened stainless steel disc, hard faced seat, bolted cover, threaded ends.
 - f. Type 406: Swing-type, Type 316 stainless steel body, disc and hanger, rated for 1725 kPa at 182 °C (250 psi at 360 °F) minimum.
 - g. Type 407: Silent spring-loaded wafer type, cast iron body ASTM A48 or A126 Class B, rated for 850 kPa (125 psi) water, 121 °C (250 °F).
 - h. Type 408: Silent spring-loaded wafer type, cast steel ASTM A216 WCB or cast iron ASTM A48 or A126 body, rated for 2050 kPa (300 psi) water, 121 °C (250 °F), stainless steel trim.
5. Ball Valves: Reduced port permitted for bypass (throttling) service; full port required for all other services, one-fourth turn to open.
- a. Type 501: Type 316 stainless steel body, ball and stem, rated for 1025 kPa at 185 °C (150 psi at 365 °F), 4130 kPa at 93 °C (600 psi at 200 °F); reinforced TFE seat, stem seal and thrust washer; end entry, threaded ends.
 - b. Type 502: Bronze body, rated for 1025 kPa at 185 °C (150 psi at 365 °F), 1725 kPa at 121 °C (250 psi at 250 °F), reinforced TFE seat, stem seal and thrust washer; end entry, threaded ends, UL-listed for natural or LP gas shut off service when used on those services.

- c. Type 503: Carbon steel or ASTM B61 bronze body, steam service, rated for 1380 kPa at 200 °C (200 psi at 390 °F), stainless steel ball and stem, Polyfil seat, live-loaded or adjustable stem seal, threaded ends.
 - d. Type 504: Carbon steel or ASTM A536 ductile iron body, saturated steam service, rated for 1030 kPa (150 psi), stainless steel ball and stem, Polyfil seat, live-loaded stem seal, ASME flanged ends.
6. Butterfly Valves:
- a. Type 601: Ductile iron body ASTM A395 or A536, wafer style, rated for 850 kPa at 120 °C (125 psi at 250 °F), bronze disc, stainless steel stem, EPDM liner, EPDM stem seal and body seal, neck extending beyond pipe insulation, lever operator.
 - b. Type 602: Carbon steel body, triple-offset design, lug or flanged type, rated for steam service at 1025 kPa at 260 °C (150 psi at 500 °F), stainless steel nitrided disc, stainless steel seat, stainless steel shaft, stainless steel/graphite laminated seal ring, neck extending beyond pipe insulation, geared handwheel operator for valves 100 mm (4 inch) pipe size and over, lever operator for valves 75 mm (3 inch) pipe size and under.
7. Gas Vent Cocks:
- a. Type 701: Bronze body, tee handle, rated for 205 kPa at 38 °C (30 psi at 100 °F), ground plug, rated for tight shut-off on fuel gas service.

C. Boiler Valves:

1. Steam Non-Return Stop Check Valves:
- a. Type: Straight-way Y-pattern, with dash-pot and piston and tapped drain openings, OS&Y, bolted bonnet, rising stem. Provide angle pattern only if shown on the contract drawings.
 - b. Construction: Cast steel body ASTM A216 WCB, rated for 2050 kPa (300 psi) saturated steam, stellite faced steel disc, alloy steel seat, 2050 kPa (300 psi) ASME flanged ends.
 - c. Operation: Valves shall automatically close tightly when boiler steam pressure becomes less than that of the steam header. Valves shall operate without sticking or chattering.

2. Stop Valves for Steam Vents on Boiler Drums and Steam Lead, Steam Pressure Gage:
 - a. Installation of steam pressure gage shut-off valves shall conform to ASME Boiler and Pressure Vessel Code, Section I.
 - b. Gate valves, two inches and under: Type 105.
3. Valves in Drain Lines from Steam Stop-Check Valve, Water Column, Gage Glass, Low Water Cut-offs, Soot Blower:
 - a. Gate valves, two inches and under: Type 105.
 - b. Check valves, two inches and under: Type 405.
4. Bottom Blowoff Valves:
 - a. Type: Seatless, sliding plunger, OS&Y, designed for blowoff service. Sliding disc-type or globe-type valves are not permitted.
 - b. Construction: ASTM A216 WCB cast steel body, rated for 2050 kPa (300 psi) saturated steam, 2050 kPa (300 psi) ANSI flanged ends. Valves shall have handwheel with rotating handle.
 - c. Conform to ASME B31.1.
- D. Steam above 100 kPa (15 psi), all valves in steam pressure reducing stations:
 1. Gate valves, 50 mm (2 inches) and under: Type 105.
 2. Gate valves, 65 mm (2-1/2 inches) and above: Type 101.
 3. Globe valves, 50 mm (2 inches) and under: Type 205.
 4. Globe valves, 65 mm (2-1/2 inches) and above: Type 201.
 5. Butterfly valves, 75 mm (3 inches) and above: Type 602.
 6. Ball valves, 50 mm (2 inches) and under: Type 503.
 7. Ball valves, 65 mm (2-1/2 inches) and above: Type 504.
- E. Steam 100 kPa (15 psi) and under:
 1. Gate Valves, 50 mm (2 inches) and under: Type 104.
 2. Gate valves, 65 mm (2-1/2 inches) and above: Type 103.
 3. Globe valves, 50 mm (2 inches) and under: Type 204.
 4. Globe valves, 65 mm (2-1/2 inches) and above: Type 203.
 5. Butterfly valves, 75 mm (3 inches) and above: Type 602.
 6. Ball valves, 50 mm (2 inches) and under: Type 503.
 7. Ball valves, 65 mm (2-1/2 inches) and above: Type 504.

F. Boiler Feedwater from Pumps to Boilers, Recirculation:

1. Gate valves, 50 mm (2 inches) and under: Type 105.
2. Gate valves, 65 mm (2-1/2 inches) and above: Type 102.
3. Globe valves, 50 mm (2 inches) and under: Type 204 or 205.
4. Globe valves, 65 mm (2-1/2 inches) and above: Type 202.
5. Check valves, at boiler feed pump discharge: Type 408.
6. Check valves, at boiler, 50 mm (2 inches) and under: Type 405.
7. Check valves, at boiler, 65 mm (2-1/2 inches) and above: Type 402.

G. Condensate, Condensate Transfer, Boiler Feedwater from Feedwater Deaerator to Boiler Feed Pump Suction, Overflow, Control and Instrument Piping for Condensate Storage Tank and for Feedwater Deaerator:

1. Gate valves, 50 mm (2 inches) and under: Type 104.
2. Gate valves, 65 mm (2-1/2 inches) and above: Type 103.
3. Globe valves, 50 mm (2 inches) and under: Type 204.
4. Globe valves, 65 mm (2-1/2 inches) and above: Type 203.
5. Butterfly valves, 65 mm (2-1/2 inches) and above Type 601.
6. Ball valves, 50 mm (2 inches) and under: Type 502.
7. Ball valves, 65 mm (2-1/2 inches) and above: Type 504.
8. Check valves 50 mm (2 inches) and under: Type 404.
9. Check valves, 65 mm (2-1/2) inches and above: Type 403.
10. Check valves on pump discharge, all sizes: Type 407.

H. Boiler Water Sampling, Continuous Blowdown:

1. Gate Valves, 50 mm (2 inches) and under: Type 104.
2. Globe valves, 50 mm (2 inches) and under: Type 204.
3. Check valves, 50 mm (2 inches) and under: Type 404.
4. Ball valves, 50 mm (2 inches) and under: Type 502.

I. Feedwater Sampling:

1. Ball valves, 50 mm (2 inches) and under: Type 501.
2. Check valves, 50 mm (2 inches) and under: Type 406.

J. Chemical Feed System (including inlet and drain valves on shot type chemical feeders):

1. Ball valves, 50 mm (2 inches) and under: Type 501.
2. Check valves, 50 mm (2 inches) and under: Type 406.

K. Fuel Oil: Discharge side of pumps. Conform to NFPA Code Nos. 30 and 31.

1. Gate valves, 50 mm (2 inches) and under: Type 104.
2. Gate Valves, 65 mm (2-1/2 inches) and above: Type 101 or 102.
3. Globe valves, 50 mm (2 inches) and under: Type 204.

4. Plug valves, 100 mm (4 inches) and under: Type 301. (Tank isolating valve on return line.)
5. Check valves, 50 mm (2 inches) and under: Type 404 or 408.
6. Check valves, 65 mm (2-1/2 inches) and above: Type 402 or 408.
7. Ball valves, 50 mm (2 inches) and under: Type 502.
- L. Fuel Gas: Main fuel and igniter (pilot) systems.
 1. Plug valves, 100 mm (4 inches) and under: Type 301.
 2. Ball valves, 50 mm (2 inches) and under: Type 502. May be applied where plug valves are shown.
 3. Plug valves, 125 mm (5 inches) and above: Type 302.
 4. Plug valves, three-way, all sizes: Type 302.
 5. Check valves, 50 mm (2 inches) and under: Type 404.
 6. Vent cocks, 15 mm (1/2 inch) and under: Type 701.
- M. Compressed Air:
 1. Gate valves, 50 mm (2 inches) and under: Type 104.
 2. Ball valves, 50 mm (2 inches) and under: Type 502.
- N. City (Cold) Water: See Section 22 11 00, FACILITY WATER DISTRIBUTION.
- O. Soft Water: See Section 22 11 00, FACILITY WATER DISTRIBUTION.
- P. Instrumentation and Control Piping:

Ball valves, 50 mm (2 inches) and under: Type 502.
- Q. Non-Boiler Blowdowns, Drains, Flow Sensing Lines:
 1. Gate valves, 50 mm (2 inches) and under: Type 104.
 2. Ball valves, 50 mm (2 inches) and under: Type 503

2.15 SIGHTFLOW INDICATORS:

- A. Provide, where shown, to allow observation of flow in piping systems.
- B. Type: In line, dual portholes on opposite sides, with safety shield, with or without rotor as shown on the drawings. Where provided, rotor shall have minimum of three vanes.
- C. Construction: Cast iron or bronze body, tempered borosilicate window, PTFE seals (except Buna-N on oil service), threaded ends on pipe sizes under 65 mm (2-1/2 inches), flanged ends on sizes 65 mm (2-1/2 inches) and above. Pressure and temperature ratings shall be equivalent to requirements for valves on the same pipelines.
- D. Safety Shield: Transparent wrap-around overlap covering entire sight flow indicator, designed to protect personnel from failure of indicator. Shield shall fit the indicator tightly and be suitable for 1030 kPa, 150 °C (150 psi, 300 °F).

2.16 QUICK-COUPLE HOSE CONNECTORS AND STEAM HOSES:

- A. Provide on all Y-strainer drains and where shown to allow quick connection of length of hose to piping drain or blowoff so that discharge fluid (water or steam) can be conveyed to a drainage system.
- B. Type: Straight through, plug and socket, screw type or cam locking connections, all units 20 mm (3/4-inch) pipe size. Integral shut-off devices not required.
- C. Service: Design for water and steam at 100 kPa (15 psi), 154 °C (310 °F).
- D. Spare Parts: Furnish one socket and one plug.
- E. Accessories: Furnish two hoses 6 m (20 feet) long, 20 mm (3/4-inch) inside diameter, rated for steam service at 690 kPa, 149 °C (100 psi, 300 °F). Hose must be sufficiently flexible to be placed in 1200 mm (4 foot) diameter coil. Provide connector on one end of each hose to mate with connectors on drains. Provide hose rack for holding both hoses. Securely mount rack in location selected by Resident Engineer.

2.17 SAFETY VALVES, RELIEF VALVES, SAFETY RELIEF VALVES AND ACCESSORIES:

- A. Provide valves and accessories to protect piping systems and pressure vessels from over-pressure. All valves shall comply with ASME Boiler and Pressure Vessel Code (Section I and VIII). Flow capacities shall be certified by National Board of Boiler and Pressure Vessel Inspectors (NB).
- B. Boiler Service: Refer to Section 23 52 39, FIRE-TUBE BOILERS.
- C. Steam Service (Pressure Vessels and Piping Systems): Refer to schedules on drawings for set pressures and capacities. Provide lifting levers, stainless steel trim, lapped seats on cast iron valves, EPDM O-rings on bronze valves.
- D. Fuel Oil Service: Refer to Section 23 50 11, BOILER PLANT MECHANICAL EQUIPMENT.
- E. Compressed Air Service: Refer to Section 23 50 11, BOILER PLANT MECHANICAL EQUIPMENT.
- F. Drip Pan Ells: Cast iron factory-built safety valve discharge fitting with pipe-within-pipe slip-type connection to vertical vent pipe, basin for collecting condensate from vent pipe, drain connections on basin and at base of ell.

2.18 STEAM PRESSURE REDUCING VALVES

- A. Type: Single-seated, diaphragm operated, spring-loaded, steam pilot-controlled, normally closed, packless, adjustable set pressure. Pilot shall sense controlled pressure downstream of main valve.
- B. Service: Provide controlled reduced pressure to steam piping systems. Design for saturated steam at pressures shown on drawings or equipment requirements.
- C. Performance: Pressure control shall be smooth, continuous. Maximum 10 percent deviation from set pressure over an 18/1 turndown. Refer to schedules on drawings for flow and pressure requirements. Maximum flow capability of each valve shall not exceed capacity of downstream safety valves.
- D. Construction:
 - 1. Main Valve: Cast iron body rated for 1725 kPa (250 psi), threaded ends, for pipe sizes 50 mm (2 inches) and under. Cast steel body rated for 1025 kPa (150 psi) ASME flanged ends, or cast iron body 1725 kPa (250 psi) ASME flanged ends, for pipe sizes above 50 mm (2 inches). Valve plug and seat shall be replaceable, Type 316 stainless steel or Monel. Stainless steel stem.
 - 2. Pilot Valve: Valve plug and seat shall be replaceable, stainless steel or Monel.
- E. Direct Digital Control Valves: May be furnished in lieu of steam operation. All specification requirements for steam operated valves shall apply. Valves shall be normally closed.
- F. Sound Levels: Refer to requirements in Section 23 05 51, NOISE and VIBRATION CONTROL FOR BOILER PLANT.

2.19 STRAINERS, Y-TYPE

- A. Provide as shown on steam, water and compressed air piping systems.
- B. Type: Open-end removable cylindrical screen. Threaded blow-off connection.
- C. Construction:
 - 1. Steam Service 420 to 1025 kPa (61 to 150 psi): Cast steel rated for 1025 kPa (150 psi) saturated steam with 1025 kPa (150 psi) ASME flanged ends, or cast iron with 1725 kPa (250 psi) ASME flanged ends, for pipe sizes above 50 mm (2 inches). Cast iron or bronze, rated for saturated steam at 1025 kPa (150 psi) threaded ends, for pipe sizes 50 mm (2 inches) and under.

2. Steam Service 415 kPa (60 psi) and under, water (except boiler feed between feedwater pumps and boilers), compressed air: Cast iron rated for 850 kPa (125 psi) saturated steam, 1200 kPa (175 psi) WOG, with 850 kPa (125 psi) ASME flanged ends for pipe sizes above 50 mm (2 inches). Cast iron or bronze, threaded ends, rated for 850 kPa (125 psi) saturated steam, 1200 kPa (175 psi) WOG, for pipe sizes 50 mm (2 inches) and under.
3. Boiler Feed between Feedwater Pumps and Boilers: Cast steel rated for 1725 kPa at 232 °C (250 psi at 450 °F) with 2050 kPa (300 psi) ASME flanged ends, or cast iron with 1725 kPa (250 psi) ASME flanged ends, for pipe sizes above 50 mm (2 inches). Cast iron or bronze, threaded ends, rated for 1725 kPa at 232 °F (250 psi at 450 °F) for pipe sizes 50 mm (2 inches) and under.
- D. Screen: Monel or stainless steel, free area not less than 2-1/2 times flow area of pipe. For strainers 80 mm (3 inch) pipe size and smaller, diameter of openings shall be 0.8 mm (0.033 inch) or less on steam service, 1.3 mm (0.05 inch) or less on water service, 0.3 mm (0.01-inch) or less on compressed air service. For strainers 100 mm (4 inch) pipe size and greater, diameter of openings shall be 1.3 mm (0.05 inch) on steam service, 3 mm (0.125 inch) on water service. Provide 80 mesh stainless steel screen liner on all strainers installed upstream of water meters or control valves.
- E. Accessories: Gate or ball valve and quick-couple hose connection on all blowoff connections. These items are specified elsewhere in this section.

2.20 EMERGENCY GAS SAFETY SHUT-OFF VALVE:

- A. Permits remote shut-off of fuel gas flow to boiler plant.
- B. Type: Manually opened, electrically held open, automatic closing upon power interruption. Pneumatic operator is not permitted.
- C. Performance: Shall shut bubble tight within one second after power interruption. Refer to the drawings for pressure, flow, and valve size requirements.
- D. Service: Natural gas and LP gas.
- E. Construction: UL listed, FM approved, 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. Cast iron, cast steel or bronze body, open and shut indicator. Valves for LP gas service shall be rated at 1725 kPa (250 psi).

- F. Control Switch: Mounted in Control Room and at exterior doorways (multiple switches). Switch shall also cut the power to the fuel oil pump set. Refer to Section 23 09 11, INSTRUMENTATION and CONTROL FOR BOILER PLANT. Provide auxiliary switch to provide signal to Computer Work Station.

2.21 STEAM TRAPS

- A. Application: Steam line drip points and heat exchangers. Each type furnished by a single manufacturer.
- B. Type: Inverted bucket type with thermostatic vent in bucket except closed float-thermostatic on discharge side of pressure reducing stations and on all heat exchangers. Refer to the drawings for trap locations, capacity and size, differential operating pressures, and design pressure.
- C. Bodies: Cast iron or stainless steel. Construction shall permit ease of removal and servicing working parts without disturbing connected piping, 4 bolt flanged ends with flexitallic gaskets.
- D. Floats: Stainless steel.
- E. Valves: Hardened chrome-steel.
- F. Mechanism and Thermostatic Elements: Stainless steel mechanisms. Bimetallic strip air vent on inverted bucket traps.
- G. Provision for Future Trap Monitoring System: All traps shall include ports for future installation of monitoring devices. Ports shall be plugged. To facilitate future removal of the plugs, install them with Teflon tape on the threads.
- H. Identification: Label each trap at the factory with an identification number keyed to number that is shown on the drawings. Label shall be a metal tag permanently affixed to the trap.
- I. Factory-Packaged Trap Station: As an option for drip points requiring isolating valves, strainer, trap, trap monitoring device or ports for future monitoring device, and valved test ports, provide factory-packaged trap station including these features

2.22 FLEXIBLE CONNECTORS

- A. Provide flexible connectors as shown to allow differential movements of pumps and piping systems subject to thermal expansion, to serve as vibration isolators between air compressors and piping systems, and to allow connection of steam or compressed air atomizing media for oil burners on water tube boilers.

B. Units for Water Service

1. Service: Refer to schematic diagrams for pressure, temperature and movement requirements. If requirements are not shown on the drawings, units shall be designed for maximum system pressure, temperature, axial movement and lateral movement.
2. Construction
 - a. Teflon Bellows Type: Molded Teflon bellows with metal reinforcing rings, flanged ends, bolted limit rods.
 - b. Stainless Steel Bellows Type: Multi-ply stainless steel with flanged ends, bolted limit rods.
 - c. Flexible Metal Hose Type: Corrugated stainless steel or bronze hose wrapped with wire braid sheath. Ends shall be threaded, with union connectors, for pipe sizes 50 mm (2 inches) and below, flanged for pipe sizes 65 mm (2-1/2 inches) and greater.

C. Units for Compressed Air Service Only:

1. Service: Designed for 93 °C (200 °F), 1025 kPa (150 psi), 13 mm (1/2-inch) intermittent offset.
2. Construction. Flexible corrugated stainless steel or bronze hose wrapped with wire braid sheath. Provide threaded ends with union connectors.

D. Units for Atomizing Media Service(Steam, Compressed Air) and Steam Safety Valve Drip Pan Ell Drains:

1. Service: Designed for saturated steam at set pressure of boiler safety valves or for set pressure of compressor relief valve, whichever is greater. Hose shall be designed for bend radii to suit location of connection points to burner piping system. Hose shall also be designed for intermittent flexing.
2. Construction: Flexible corrugated stainless steel or bronze hose wrapped with wire braid sheath. Provide threaded ends with union connectors.

2.23 PIPING SUPPORT SYSTEMS

- A. Provide an engineered piping support system with all hangers, supports and anchors designed and located by experienced technical pipe support specialists, utilizing piping system design and analysis software. The system design must be completely documented and submitted for review.
- B. All pipe hangers and supports, and selection and installation shall comply with MSS SP-58, SP-69, SP-89, SP-90, SP-127.

- C. All pipe hanger and support devices must be in compliance with specified MSS SP-58 type numbers, have published load ratings, and be products of engineered pipe support manufacturers.
- D. All pipe stresses and forces and moments on connecting equipment and structures shall be within the allowances of the ASME B31.1 code, applicable building codes, and equipment manufacturer's design limits.
- E. Piping that expands and contracts horizontally including steam, steam condensate, boiler feed, condensate transfer, shall be supported by roller or sliding type hangers and supports except when long vertical hanger rods permit sufficient horizontal movement with the vertical angles of the rods less than 4 degrees.
- F. Piping that expands and contracts vertically including steam, steam condensate, boiler feed, condensate transfer, shall be supported by engineered variable spring and spring cushion hangers. Utilize MSS SP-69 selection requirements and guidelines. Vibration isolator hanger types are not permitted.
- G. Piping system anchors shall be engineered and located to control movement of piping that is subject to thermal expansion.
- H. Prior to construction, submit complete engineering calculation methods and results, descriptions of all devices with MSS numbers, sizes, load capabilities and locations. Submit calculations on all moments and forces at anchors and guides, all hanger loads, all pipe stresses that are within 20% of the code allowable or exceed the ASME B31.1 code allowable, all pipe movements at supports.
- I. Detailed Design Requirements:
 - 1. Piping system design and analysis software shall be current state of the art that performs B31.1 Code analyses, and shall be utilized to analyze pipe movement and deflection, pipe stresses, pipe support forces and moments, and for selection of pipe support types and sizes.
 - 2. Each support for piping 60 mm (2-1/2 inches) and above shall be completely engineered to include location, type and size, hot and cold loads and movement. Submit layout drawings showing precise support locations and submit individual drawings for each support assembly showing all components, sizes, loadings.
 - 3. Supports for piping 50 mm (2 inches) and below shall be engineered in general terms with approximate locations, typical support types

- and sizes, approximate movements. Submit layout drawings showing general locations and support types and sizes.
4. Obtain permissible loadings (forces and moments) for equipment nozzles (pipe connections) from the manufacturer of the boilers, the feedwater deaerator and any other equipment as necessary. Professional structural engineer shall verify capability of building structure to handle piping loads.
 5. The project drawings may show locations and types of resilient supports including rollers and springs, and may also show special supports including anchors, guides and braces. Comply with the drawing requirements unless it is determined that piping may be overstressed or supports overloaded. Refer conflicts to the 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.

J. Hangers and Supports - Products:

1. Factory-built products of a manufacturer specializing in engineered pipe supports. All components must have published load ratings. All spring type supports shall have published spring rates and movement limits. All support assemblies shall include threaded connections that permit vertical position adjustment. Supports shall comply with MSS SP-58 Type Numbers as listed below.
2. Upper Attachments to Building Structure: Types 18, 20, 21, 22, 23, 29, and 30.

3. Roller Supports: Types 41, 43, and 46. Provide vertical adjustment for Type 41 with threaded studs and nuts adjacent to the roller.
4. Variable Spring Hanger Assembly:
 - a. Type 51 variable spring, with Type 3 pipe clamp or Type 1 clevis. Type 53 variable spring trapeze may also be used. Locate Type 51 variable spring within 300 mm (1 foot) above pipe attachment. Attach rod to top of variable spring with Type 14 clevis.
 - b. Typical features of variable spring hangers include spring rates under 150 lb/in, enclosed spring, load and travel indicator, sizes available with load capabilities ranging from 50 lb to multiples of 10,000 lb.
5. Spring Cushion Hanger Assembly: Double Rod: Type 41 and 49.
6. Light Duty Spring Hanger Assembly: Type 48 light duty spring, with Type 3 pipe clamp or Type 1 clevis. Locate Type 48 light duty spring within 300 mm (1 foot) above pipe attachment.
7. Clevis Hangers: Type 1.
8. Wall Brackets: Type 31, 32, and 33.
9. Pipe Stands: Type 38.
10. Riser Clamps: Type 42.
11. Roller Guides: Type 44. Construct guides to restrain movement perpendicular to the long axis of the piping. All members shall be welded steel.
12. Trapeze Supports: May be used where pipes are close together and parallel. Construct with structural steel channels or angles. Bolt roller supports to steel to support piping subject to horizontal thermal expansion. Attach other piping with U-bolts.
13. Pipe Covering Protection Saddles: Type 39. Provide at all support points on insulated pipe except where Type 3 pipe clamp is provided. Insulation shields are not permitted. Refer to Section 23 07 11, HVAC and BOILER PLANT INSULATION.
14. Sliding Supports: Type 35. Welded steel attachments to pipe and building structure with Teflon or graphite sliding surfaces bonded to the attachments. Provide steel guides, except at expansion bends, to prevent lateral movement of the pipe.
15. Piping Anchors: Provide engineered designs to accommodate the calculated loads.

2.24 PIPE AND VALVE FLANGE GASKETS

- A. 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.

2.25 THREAD SEALANTS:

- A. As recommended by the sealant manufacturer for the service.

2.26 PIPE SLEEVES:

- A. Service: For pipes passing through floors, walls, partitions.
- B. Construction: Steel pipe, schedule 10 minimum.
- C. Sleeve Diameter: Not less than 25 mm (1 inch) larger than the diameter of the enclosed pipe and thermal insulation, vapor barrier, and protective covering for insulated pipe; sleeves for un-insulated pipe shall be not less than 25 mm (1 inch) larger than the diameter of the enclosed pipe.

PART 3 - EXECUTION

3.1 ARRANGEMENT OF PIPING

- A. The piping arrangement shown is a design based on currently available equipment. The plans show typical equipment to scale and show practical arrangement. Modification will be necessary during construction, at no additional cost to the Government, to adapt the equipment layout and piping plans to the precise equipment purchased by the Contractor. Accessibility for operation and maintenance must be maintained.
- B. All piping shall be installed parallel to walls and column centerlines (unless shown otherwise). Fully coordinate work of each trade to provide the designed systems without interference between systems. All piping shall be accurately cut, true, and beveled for welding. Threaded piping shall be accurately cut, reamed and threaded with sharp dies. Copper piping work shall be performed in accordance with best practices requiring accurately cut clean joints and soldering in accordance with the recommended practices for the material and solder employed, compression type fittings are not allowed.
- C. All piping shall be pitched for drainage at a constant slope of 25 mm in 12 m (1 inch in 40 feet). Steam, condensate, trap discharge, drip, drain, air, gas and blowdown piping shall pitch down in direction of flow. Service water, pumped condensate, pumped boiler feedwater, oil, shall pitch up in direction of flow. Provide valved air vents at top of rise and valved drains at low points. Gas piping may be run level as it

is presumed to be dry, but dirt pockets shall be provided at base of risers.

- D. Valves shall be located and stems oriented to permit proper and easy operation and access to valve bonnet for maintenance of packing, seat and disc. Valve stems shall not be below centerline of pipe. Refer to plans for stem orientation. Where valves are more than 2100 mm (7 feet) above the floor or platform, stems shall be horizontal unless shown otherwise. Gate and globe valves more than 3 m (10 feet) above floor or platform, shall have chain wheel and chain for operation from floor or platform. Provide hammer-blow wheel on any valve that cannot be opened or tightly closed by one person. Steam line gate and butterfly type isolation valves 750 mm (3 inch) pipe size and above shall have factory or field-fabricated 20 mm or 25 mm (3/4 or one inch) globe-valved warm-up bypasses if the steam line length is 6 m (20 feet) or longer.
- E. Provide union adjacent to all threaded end valves.
- F. Bolt wafer-type butterfly valves between pipe flanges.
- G. Provide valves as necessary to permit maintenance of a device or sub-system without discontinuing service to other elements of that service or system.
- H. Do not install any piping within 600 mm (2 feet) of 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 to 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. All welds will be visually inspected by the COR.
 - 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

- A. The design includes provision for piping expansion due to pressure, thermal, weight and seismic (where applicable) effects. It is the Contractor's responsibility to avoid reduction in flexibility and increase in stress in piping systems. Major deviation will be shown by submittal for review of scale working drawings and stress calculations for the piping systems. Contractor shall provide any necessary

additional construction and materials to limit stresses to safe values as directed by the RE and at no additional cost to the Government.

3.6 PIPE BENDING

- A. Pipe bending shall be in accordance with the recommended practices of PFI ES24. Only ASTM A106 seamless pipe may be bent. Sizes below 50 mm (2 inches) may be bent in field; sizes 65 mm (2-1/2 inches) and larger shall have factory fabricated bends. Minimum radii and tangent lengths for field bent piping are shown in the following table:

Size	Minimum Radius	Minimum Tangent
1/2 inch	2-1/2 inches	1-1/2 inches
3/4 inch	2-3/4 inches	1-3/4 inches
1-inch	5-inches	2-inches
1-1/4 inches	6-1/4 inches	2-inches
1-1/2 inches	7-1/2 inches	2-1/2 inches

3.7 SIZE CHANGES

- A. Piping size changes shall be accomplished by use of line reducers, reducing ell, reducing tee. Apply eccentric reduction in all piping requiring continuous drainage; steam, condensate, vacuum, blowdown. Concentric reduction may be applied in run of piping involving pressure water systems except at pump inlets. Use concentric increasers where flow is in direction of increased size. Eccentric reduction, top flat, at all pump connections.

3.8 ADDITIONAL DRIPS AND TRAPS

- A. Where additional rises or drops in steam or gas lines are provided, provide additional drip pockets with steam trap assemblies on steam lines and additional dirt pockets on gas lines.

3.9 MINOR PIPING

- A. Minor piping associated with instrumentation and control is generally not shown. Interconnection of sensors, transducers, control devices, instrumentation panels, combustion control panel, burner control panels is the responsibility of the contractor. Small piping associated with water cooling, drips, drains and other minor piping may not be shown to avoid confusion in the plan presentation but shall be provided as part of contract work.

3.10 DIELECTRIC CONNECTION

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

3.11 INSTALLATION - BOILER EXTERNAL STEAM PIPING FROM BOILER TO MAIN HEADER

- A. From Boiler to Second Stop Valve: Fabricate from boiler nozzle through second stop valve under the rules for boiler external piping of the ASME Boiler and Pressure Vessel Code, Section I. Full compliance will be required, including qualification of welders, Code inspection, and certification with ASME Form P4A. Deliver original of Form P4A properly executed to RE.
- B. Construction shall include: non-return stop and check valve at the boiler, welding coupling for 20 mm (3/4-inch) vent, second stop valve, steam flowmeter primary element, welding coupling for IPT calorimeter connection located to provide clear space and access for temporary test calorimeter, and header stop valve. Second stop valve may be deleted if the entire steam line from the non-return valve to the header valve is constructed in accordance with the rules for boiler external piping, ASME Section I.
- C. Companion flange at 2050 kPa (300 psi) valves shall be 2050 kPa (300 psi) weld neck; at 1025 kPa (150 psi) valves shall be 1025 kPa (150 psi) weld neck.
- D. Equip header stop valve with factory applied warm-up bypass connected to drilled and tapped bosses in valve body located above and below valve wedge. Connect valved drain to header valve body boss located above valve wedge.
- E. Equip steam pipe with 20 mm (3/4-inch) vent, 1375 kPa (200 psi) bronze gate valve, as specified.
- F. Support and slope boiler steam line to drain; apply variable spring hangers (MSS-SP58, Type 51 or 53).
- G. Provide screwed fitting for calorimeter (temporary test instrument) on side of pipe as shown. Allow 600 mm (2 feet) horizontal and vertical clearance for calorimeter.
- H. Handwheel and drain valve on non-return stop-check valve shall be within easy reach of boiler platform.
- I. Disassemble, clean and reassemble entire mechanism of non-return stop check valve after conclusion of boiler testing.

3.12 INSTALLATION - BOILER BOTTOM BLOWOFF PIPING

- A. Fabricate with long sweeping radius ells, Y-form laterals. Tees and crosses are not permitted.

3.13 INSTALLATION - EXHAUST HEAD MOUNTED ABOVE ROOF

- A. Provide drain line from connection on exhaust head to roof drain.
Provide pipe size same as drain connection size.

3.14 INSTALLATION - SIGHT FLOW INDICATORS

- A. Locate to permit view from floor or platform.

3.15 INSTALLATION - PRESSURE AND TEMPERATURE REGULATORS, CONTROL VALVES, SAFETY SHUT-OFF VALVES

- A. Provide sufficient clearance on all sides of valve to permit replacement of working parts without removing valve from pipeline.

3.16 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).

3.17 INSTALLATION - FLEXIBLE CONNECTORS

- A. Install units for water and compressed air service in a straight run of pipe. Units for atomizing media service may be installed with bends if necessary. Designer of atomizing media piping must coordinate hose connection points with allowable bend radius of hose.

3.18 INSTALLATION - SAFETY VALVES, RELIEF VALVES AND SAFETY-RELIEF VALVES

- A. Orient valves so that lifting levers are accessible from nearest walkway or access platform. Valves must be removable without requiring disassembling of vents, except where otherwise specifically provided.
- B. Provide a drip pan elbow at discharge of each steam valve with slip joint in vent discharge line, arranged to prevent vent line from imposing any force on valve and to prevent any moisture accumulation in valve. Connected drip pan ell drains to drain piping to floor drain. Provide flexible connector on drain line, adjacent to drip pan ell.
- C. Support vent line from above. Each steam valve must have separate vent line to atmosphere unless shown otherwise.
- D. Relief valves in steam piping shall have a manual valve downstream of the relief valve to allow for testing of the valve in place without risk of over pressurizing downstream equipment.

3.19 INSTALLATION - Y-TYPE STRAINERS ON STEAM SERVICE

- A. Install with basket level with the steam pipe so that condensate is not trapped in the strainer.

3.20 INSTALLATION - QUICK COUPLE HOSE CONNECTORS

- A. Install male plugs on each piping drain. Connect socket to one end of steam hose.

3.21 INSTALLATION - VIBRATION ISOLATORS IN PIPING

- A. Install on all air lines and water supply lines to air compressors.
- B. Also install on pump connections as shown.

3.22 INSTALLATION - PIPE SLEEVES

- A. Accurately locate and securely fasten sleeves to forms before concrete is poured; install in walls or partitions during the construction of the walls.
- B. Sleeve ends shall be flush with finished faces of walls and partitions.
- C. Pipe sleeves passing through floors shall project 25 mm (1 inch) minimum above the finished floor surface and the bottom of the sleeve shall be flush with the underside of the floor slab.

3.23 INSTALLATION - PIPE SUPPORT SYSTEMS

- A. Coordinate support locations with building structure prior to erection of piping. Also refer to approved shop drawings of equipment and approved piping layout and hanger layout drawings when locating hangers. Arrangement of supports shall facilitate operating, servicing and removal of valves, strainers, and piping specialties. Hanger parts must be marked at the factory with a numbering system keyed to hanger layout drawings. Layout drawings must be available at the site.
- B. Upper attachments to Building Structure:
 - 1. 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.

3.24 CLEANING OF PIPING AFTER INSTALLATION

- A. Flush all piping sufficiently to remove all dirt and debris. Fill piping completely. Velocity shall be equivalent to that experienced during normal plant operation at maximum loads. During flushing, all control valves, steam traps and pumps must be disconnected from the system. After cleaning is complete, remove, clean and replace all strainer baskets and elements. Reconnect all equipment. Provide safe points of discharge for debris blown from pipes.

3.25 TESTING

- A. Testing of piping components is not required prior to installation. Valves and fittings shall be capable of withstanding hydrostatic shell test equal to twice the primary design service pressure except as modified by specifications on fittings, ASME B16.5. This test capability is a statement of quality of material. Tests of individual items of pipe, fittings or equipment will be required only on instruction of 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. All steam piping prior to insulation shall be subjected to steam at final operating pressure. Inspect all joints for leaks and workmanship. Corrections shall be made as specified.
2. Test main gas piping with compressed air at twice the service pressure entering VA property from utility service. Test LP gas piping at the maximum tank pressure, 1725 kPa (250 psig), with compressed air. Test joints with soap solution, check thoroughly for leaks.
3. Test boiler feedwater, condensate, vacuum and service water systems under service conditions and prove tight.
4. Test oil and compressed air systems under service conditions at pressure equal to highest setting of safety and relief valves in the individual systems.
5. Make corrections and retests to establish systems that have no leaks. Replace or recut any defective fittings or defective threads. Soldered material shall be thoroughly cleaned prior to resoldering. Back welding of threads will not be permitted.

D. Hydrostatically test boiler external steam piping from boiler to header in approved manner with water of same time boiler is hydrostatically tested under the supervision of RE. Prior to hydrostatic test, remove all valves not rated for hydrostatic test pressure. Replace valves after tests are satisfactorily completed. Hydrostatic test pressure shall be 1.5 times design pressure and performed in accordance with ASME Boiler and Pressure Vessel Code, Section I.

E. Generally, insulation work should not be performed prior to testing of piping. Contractor may, at own option and hazard, insulate piping prior to test, but any damaged insulation shall be replaced with new quality as specified for original installation at Contractor's cost and time.

F. Safety, Safety-Relief, Relief Valves: After installation, test under pressure in presence of RE. Test operation, including set pressure, flow, and blowdown in accordance with ASME Boiler and Pressure Vessel Code. Any deficiencies must be corrected and retest performed. Refer to

Section 23 52 39, FIRE-TUBE BOILERS for boiler safety valve test requirements.

3.26 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 31 00
HVAC DUCTS AND CASINGS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Ductwork and accessories for HVAC including the following:
 - 1. Make-up air systems.
- B. Definitions:
 - 1. SMACNA Standards as used in this specification means the HVAC Duct Construction Standards, Metal and Flexible.
 - 2. Seal or Sealing: Use of liquid or mastic sealant, with or without compatible tape overlay, or gasketing of flanged joints, to keep air leakage at duct joints, seams and connections to an acceptable minimum.
 - 3. Duct Pressure Classification: SMACNA HVAC Duct Construction Standards, Metal and Flexible.

1.2 RELATED WORK

- A. General Mechanical Requirements: Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.
- B. Noise Level Requirements: Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING and EQUIPMENT.
- C. Section 23 34 00, HVAC FANS.
- D. Testing and Balancing of Air Flows: Section 23 05 93, TESTING, ADJUSTING, and BALANCING FOR HVAC.

1.3 QUALITY ASSURANCE

- A. Refer to article, QUALITY ASSURANCE, in Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.
- B. Duct System Construction and Installation: Referenced SMACNA Standards are the minimum acceptable quality.
- C. Duct Sealing, Air Leakage Criteria, and Air Leakage Tests: Ducts shall be sealed as per duct sealing requirements of SMACNA HVAC Air Duct Leakage Test Manual for duct pressure classes shown on the drawings.
- D. Duct accessories exposed to the air stream, such as dampers of all types (except smoke dampers) and access openings, shall be of the same material as the duct or provide at least the same level of corrosion resistance.

1.4 SUBMITTALS

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- B. Manufacturer's Literature and Data:
 - 1. Rectangular ducts:
 - a. Schedules of duct systems, materials and selected SMACNA construction alternatives for joints, sealing, gage and reinforcement.
 - b. Duct liner.
 - c. Sealants and gaskets.
 - d. Access doors.
 - 2. Round and flat oval duct construction details:
 - a. Manufacturer's details for duct fittings.
 - b. Duct liner.
 - c. Sealants and gaskets.
 - d. Access sections.
 - e. Installation instructions.
 - 3. Volume dampers, back draft dampers.
 - 4. Upper hanger attachments.
- C. Coordination Drawings: Refer to article, SUBMITTALS, in Section 23 05 11 - Common Work Results for HVAC and Steam Generation.

1.5 APPLICABLE PUBLICATIONS

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. American Society for Testing and Materials (ASTM):
 - A653-09.....Standard Specification for Steel Sheet,
Zinc-Coated (Galvanized) or Zinc-Iron Alloy
coated (Galvannealed) by the Hot-Dip process
 - B209-07.....Standard Specification for Aluminum and
Aluminum-Alloy Sheet and Plate
- C. Sheet Metal and Air Conditioning Contractors National Association (SMACNA):
 - 2nd Edition - 2005.....HVAC Duct Construction Standards, Metal and Flexible
 - 1st Edition - 1985.....HVAC Air Duct Leakage Test Manual

PART 2 - PRODUCTS

2.1 DUCT MATERIALS AND SEALANTS

- A. General: Except for systems specified otherwise, construct ducts, casings, and accessories of galvanized sheet steel, ASTM A653, coating G90; or, aluminum sheet, ASTM B209, alloy 1100, 3003 or 5052.
- B. Joint Sealing: Refer to SMACNA HVAC Duct Construction Standards, paragraph S1.9.
 - 1. Sealant: Elastomeric compound, gun or brush grade, maximum 25 flame spread and 50 smoke developed (dry state) compounded specifically for sealing ductwork as recommended by the manufacturer. Generally, provide liquid sealant, with or without compatible tape, for low clearance slip joints and heavy, permanently elastic, mastic type where clearances are larger. Oil base caulking and glazing compounds are not acceptable because they do not retain elasticity and bond.
 - 2. Tape: Use only tape specifically designated by the sealant manufacturer and apply only over wet sealant. Pressure sensitive tape shall not be used on bare metal or on dry sealant.
 - 3. Gaskets in Flanged Joints: Soft neoprene.
- C. Approved factory made joints may be used.

2.2 DUCT CONSTRUCTION AND INSTALLATION

- A. Regardless of the pressure classifications outlined in the SMACNA Standards, fabricate and seal the ductwork in accordance with the following pressure classifications:
- B. Duct Pressure Classification:
 - 0 to 50 mm (2 inch)
 - Show pressure classifications on the floor plans.
- C. Seal Class: All ductwork shall receive Class A Seal
- D. Round Ducts: Furnish duct and fittings made by the same manufacturer to insure good fit of slip joints. When submitted and approved in advance, round and flat oval duct, with size converted on the basis of equal pressure drop, may be furnished in lieu of rectangular duct design shown on the drawings.
 - 1. Elbows: Diameters 80 through 200 mm (3 through 8 inches) shall be two sections die stamped, all others shall be gored construction, maximum 18-degree angle, with all seams continuously welded or standing seam. Coat galvanized areas of fittings damaged by welding with corrosion resistant aluminum paint or galvanized repair compound.

2. Provide bell mouth, conical tees or taps, laterals, reducers, and other low loss fittings as shown in SMACNA HVAC Duct Construction Standards.
3. Ribbed Duct Option: Lighter gage round/oval duct and fittings may be furnished provided certified tests indicating that the rigidity and performance is equivalent to SMACNA standard gage ducts are submitted.
 - a. Ducts: Manufacturer's published standard gage, G90 coating, spiral lock seam construction with an intermediate standing rib.
 - b. Fittings: May be manufacturer's standard as shown in published catalogs, fabricated by spot welding and bonding with neoprene base cement or machine formed seam in lieu of continuous welded seams.
- E. Volume Dampers: Single blade or opposed blade, multi-louver type as detailed in SMACNA Standards. Refer to SMACNA Detail Figure 2-12 for Single Blade and Figure 2.13 for Multi-Blade Volume Dampers.
- F. Duct Hangers and Supports: Refer to SMACNA Standards Section IV. Avoid use of trapeze hangers for round duct.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with provisions of Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION, particularly regarding coordination with other trades and work in existing buildings.
- B. Fabricate and install ductwork and accessories in accordance with referenced SMACNA Standards:
 1. Drawings show the general layout of ductwork and accessories but do not show all required fittings and offsets that may be necessary to connect ducts to equipment, boxes, diffusers, grilles, etc., and to coordinate with other trades. Fabricate ductwork based on field measurements. Provide all necessary fittings and offsets at no additional cost to the government. Coordinate with other trades for space available and relative location of HVAC equipment and accessories on ceiling grid. Duct sizes on the drawings are inside dimensions which shall be altered by Contractor to other dimensions with the same air handling characteristics where necessary to avoid interferences and clearance difficulties.

2. Provide duct transitions, offsets and connections to dampers, coils, and other equipment in accordance with SMACNA Standards, Section II. Provide streamliner, when an obstruction cannot be avoided and must be taken in by a duct. Repair galvanized areas with galvanizing repair compound.
 3. Provide bolted construction and tie-rod reinforcement in accordance with SMACNA Standards.
 4. Construct casings, eliminators, and pipe penetrations in accordance with SMACNA Standards, Chapter 6. Design casing access doors to swing against air pressure so that pressure helps to maintain a tight seal.
- C. Install duct hangers and supports in accordance with SMACNA Standards, Chapter 4.
- D. Control Damper Installation:
1. Provide necessary blank-off plates required to install dampers that are smaller than duct size. Provide necessary transitions required to install dampers larger than duct size.
 2. Assemble multiple sections dampers with required interconnecting linkage and extend required number of shafts through duct for external mounting of damper motors.
 3. Provide necessary sheet metal baffle plates to eliminate stratification and provide air volumes specified. Locate baffles by experimentation, and affix and seal permanently in place, only after stratification problem has been eliminated.
 4. Install all damper control/adjustment devices on stand-offs to allow complete coverage of insulation.
- E. Protection and Cleaning: Adequately protect equipment and materials against physical damage. Place equipment in first class operating condition, or return to source of supply for repair or replacement, as determined by Resident Engineer. Protect equipment and ducts during construction against entry of foreign matter to the inside and clean both inside and outside before operation and painting. When new ducts are connected to existing ductwork, clean both new and existing ductwork by mopping and vacuum cleaning inside and outside before operation.

3.2 DUCT LEAKAGE TESTS AND REPAIR

- A. Ductwork leakage testing shall be performed by the Testing and Balancing Contractor directly contracted by the General Contractor and independent of the Sheet Metal Contractor.
- B. Ductwork leakage testing shall be performed for the entire air distribution system (including all supply, return, exhaust and relief ductwork), section by section, including fans, coils and filter sections. Based upon satisfactory initial duct leakage test results, the scope of the testing may be reduced by the Resident Engineer on ductwork constructed to the 500 Pa (2" WG) duct pressure classification. In no case shall the leakage testing of ductwork constructed above the 500 Pa (2" WG) duct pressure classification or ductwork located in shafts or other inaccessible areas be eliminated.
- C. Test procedure, apparatus and report shall conform to SMACNA Leakage Test manual. The maximum leakage rate allowed is 4 percent of the design air flow rate.
- D. All ductwork shall be leak tested first before enclosed in a shaft or covered in other inaccessible areas.
- E. All tests shall be performed in the presence of the Resident Engineer and the Test and Balance agency. The Test and Balance agency shall measure and record duct leakage and report to the Resident Engineer and identify leakage source with excessive leakage.
- F. If any portion of the duct system tested fails to meet the permissible leakage level, the Contractor shall rectify sealing of ductwork to bring it into compliance and shall retest it until acceptable leakage is demonstrated to the Resident Engineer.
- G. All tests and necessary repairs shall be completed prior to insulation or concealment of ductwork.
- H. Make sure all openings used for testing flow and temperatures by TAB Contractor are sealed properly.

3.3 TESTING, ADJUSTING AND BALANCING (TAB)

- A. Refer to Section 23 05 93, TESTING, ADJUSTING, and BALANCING FOR HVAC.

3.4 OPERATING AND PERFORMANCE TESTS

- A. Refer to Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION

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SECTION 23 34 00
HVAC FANS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Fans for heating, ventilating and air conditioning.
- B. Product Definitions: AMCA Publication 99, Standard 1-66.

1.2 RELATED WORK

- A. Section 01 00 00, GENERAL REQUIREMENTS.
- B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- C. Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION.
- D. Section 23 05 12, GENERAL MOTOR REQUIREMENTS FOR HVAC AND STEAM GENERATION EQUIPMENT.
- E. Section 23 05 41, NOISE and VIBRATION CONTROL FOR HVAC PIPING AND EQUIPMENT.
- F. Section 23 05 93, TESTING, ADJUSTING, AND BALANCING FOR HVAC.
- G. Section 23 09 11, INSTRUMENTATION AND CONTROL FOR BOILER PLANT.
- H. Section 26 29 11, LOW-VOLTAGE MOTOR STARTERS.

1.3 QUALITY ASSURANCE

- A. Refer to paragraph, QUALITY ASSURANCE, in Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION.
- B. Fans and power ventilators shall be listed in the current edition of AMCA 261, and shall bear the AMCA performance seal.
- C. Operating Limits for Centrifugal Fans: AMCA 99 (Class I, II, and III).
- D. Fans and power ventilators shall comply with the following standards:
 - 1. Testing and Rating: AMCA 210.
 - 2. Sound Rating: AMCA 300.
- E. Vibration Tolerance for Fans and Power Ventilators: Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING and EQUIPMENT.
- F. Performance Criteria:
 - 1. The fan schedule shall show the design air volume and static pressure. Select the fan motor HP by increasing the fan BHP by 10 percent to account for the drive losses and field conditions.
 - 2. Select the fan operating point as follows:
 - a. Air Foil, Backward Inclined: At or near the peak static efficiency
- G. Safety Criteria: Provide manufacturer's standard screen on fan inlet and discharge where exposed to operating and maintenance personnel.

H. Corrosion Protection:

1. Except for fans in fume hood exhaust service, all steel shall be mill-galvanized, or phosphatized and coated with minimum two coats, corrosion resistant enamel paint. Manufacturers paint and paint system shall meet the minimum specifications of: ASTM D1735 water fog; ASTM B117 salt spray; ASTM D3359 adhesion; and ASTM G152 and G153 for carbon arc light apparatus for exposure of non-metallic material.

1.4 SUBMITTALS

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- B. Manufacturers Literature and Data:
 1. Power roof and wall ventilators.
- C. Certified Sound power levels for each fan.
- D. Motor ratings types, electrical characteristics and accessories.
- E. Roof curbs.
- F. Belt guards.
- G. Maintenance and Operating manuals in accordance with Section 01 00 00, GENERAL REQUIREMENTS.
- H. Certified fan performance curves for each fan showing cubic feet per minute (CFM) versus static pressure, efficiency, and horsepower for design point of operation.

1.5 APPLICABLE PUBLICATIONS

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. Air Movement and Control Association International, Inc. (AMCA):
 - 99-86.....Standards Handbook
 - 210-06.....Laboratory Methods of Testing Fans for
Aerodynamic Performance Rating
 - 261-09.....Directory of Products Licensed to bear the AMCA
Certified Ratings Seal - Published Annually
 - 300-08.....Reverberant Room Method for Sound Testing of
Fans
- C. American Society for Testing and Materials (ASTM):
 - B117-07a.....Standard Practice for Operating Salt Spray
(Fog) Apparatus

- D1735-08.....Standard Practice for Testing Water Resistance
of Coatings Using Water Fog Apparatus
- D3359-08.....Standard Test Methods for Measuring Adhesion by
Tape Test
- G152-06.....Standard Practice for Operating Open Flame
Carbon Arc Light Apparatus for Exposure of Non-
Metallic Materials
- G153-04.....Standard Practice for Operating Enclosed Carbon
Arc Light Apparatus for Exposure of Non-
Metallic Materials

1.6 EXTRA MATERIALS

- A. Provide one additional set of belts for all belt-driven fans.

PART 2 - PRODUCTS

2.1 POWER ROOF VENTILATOR

- A. Standards and Performance Criteria: Refer to Paragraph, QUALITY ASSURANCE.
- B. Type: Filtered Louvered Roof Supply Fan with backward inclined blades.
- C. Construction: Exterior base panels, louver sections and insulated cover all of aluminum construction, curb cap with pre-punched mounting holes, blower and motor assembly isolated on shock mounts, forward curved steel fan wheel, adjustable motor plate, ball bearing motor, fan shaft mounted in ball bearing pillow block, static free belts, corrosion resistant fasteners, Miami Dade NOA approved, washable aluminum filters, duct adapter.
- D. Motor and Drive: Refer to Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION. Bearings shall be pillow block ball type with a minimum L-50 life of 200,000 hours. Motor shall be located out of air stream.

2.3 PREFABRICATED ROOF CURBS

- A. Galvanized steel or extruded aluminum 300 mm (12 inches) above finish roof service, continuous welded corner seams, treated wood nailer, 40 mm (1-1/2 inch) thick, 48 kg/cubic meter (3 pound/cubic feet) density rigid mineral fiberboard insulation with metal liner, built-in cant strip (except for gypsum or tectum decks). For surface insulated roof deck, provide raised cant strip (recessed mounting flange) to start at the upper surface of the insulation. Curbs shall be constructed for pitched roof or ridge mounting as required to keep top of curb level.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install fan, motor and drive in accordance with manufacturer's instructions.
- B. Align fan and motor sheaves to allow belts to run true and straight.
- C. Bolt equipment to curbs with galvanized lag bolts.
- D. Install vibration control devices as shown on drawings and specified in Section 23 05 41, NOISE and VIBRATION CONTROL FOR HVAC PIPING and EQUIPMENT.

3.2 PRE-OPERATION MAINTENANCE

- A. Lubricate bearings, pulleys, belts and other moving parts with manufacturer recommended lubricants.
- B. Rotate impeller by hand and check for shifting during shipment and check all bolts, collars, and other parts for tightness.
- C. Clean fan interiors to remove foreign material and construction dirt and dust.

3.3 START-UP AND INSTRUCTIONS

- A. Verify operation of motor, drive system and fan wheel according to the drawings and specifications.
- B. Check vibration and correct as necessary for air balance work.
- C. After air balancing is complete and permanent sheaves are in place perform necessary field mechanical balancing to meet vibration tolerance in Section 23 05 41, NOISE and VIBRATION CONTROL FOR HVAC PIPING and EQUIPMENT.

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SECTION 23 37 00
AIR OUTLETS AND INLETS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Air Outlets and Inlets: Diffusers, Registers, and Grilles.

1.2 RELATED WORK

A. Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.

B. Section 23 05 93, TESTING, ADJUSTING, and BALANCING FOR HVAC.

1.3 QUALITY ASSURANCE

A. Refer to article, QUALITY ASSURANCE, in Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.

1.4 SUBMITTALS

A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.

B. Manufacturer's Literature and Data:

1. Air intake/exhaust hoods.
2. Diffusers, registers, grilles and accessories.

C. Coordination Drawings: Refer to article, SUBMITTALS, in Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.

1.5 APPLICABLE PUBLICATIONS

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

B. Air Diffusion Council Test Code:

1062 GRD-84.....Certification, Rating, and Test Manual 4th
Edition

PART 2 - PRODUCTS

2.1 AIR OUTLETS AND INLETS

A. Materials:

1. Aluminum. Provide manufacturer's standard gasket.
2. Exposed Fastenings: The same material as the respective inlet or outlet. Fasteners for aluminum may be stainless steel.
3. Contractor shall review all ceiling drawings and details and provide all ceiling mounted devices with appropriate dimensions and trim for the specific locations.

B. Performance Test Data: In accordance with Air Diffusion Council Code 1062GRD. Refer to Section 23 05 41, NOISE and VIBRATION CONTROL FOR HVAC PIPING and EQUIPMENT for NC criteria.

C. Air Supply Outlets:

1. Drum Louvers: Aluminum construction, drum louver, with pivoted blades and rotating drum to adjust length of throw and direction.
 - a. Register shall have integral; face adjustable, opposed blade damper constructed of heavy gauge steel. Damper shall be operable from the face of the register. Units shall be nozzle type with adjustable discharge pattern.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with provisions of Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION, particularly regarding coordination with other trades and work in existing buildings.
- B. Protection and Cleaning: Protect equipment and materials against physical damage. Place equipment in first class operating condition, or return to source of supply for repair or replacement, as determined by Resident Engineer. Protect equipment during construction against entry of foreign matter to the inside and clean both inside and outside before operation and painting.

3.2 TESTING, ADJUSTING AND BALANCING (TAB)

Refer to Section 23 05 93, TESTING, ADJUSTING, and BALANCING FOR HVAC.

- - - E N D - - -

SECTION 23 50 11
BOILER PLANT MECHANICAL EQUIPMENT

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Condensate pumps, condensate surge tank, blowoff tank, blowdown heat recovery, chemical treatment systems, and other equipment that supports the operation of the boilers.

1.2 RELATED WORK

- A. Section 09 91 00, PAINTING.
- B. Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION.
- C. Section 23 05 51, NOISE and VIBRATION CONTROL FOR BOILER PLANT.
- D. Section 23 07 11, HVAC, PLUMBING, AND BOILER PLANT INSULATION.
- E. Section 23 21 11, BOILER PLANT PIPING SYSTEMS.
- F. Section 22 31 11, WATER SOFTENERS.
- G. Section 22 67 21, WATER DEALKALIZING SYSTEM.
- 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 SUBMITTALS

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- B. Condensate Surge Tank and Accessories:
 - 1. Drawings showing arrangement and overall dimensions of tank and supports. Show locations and sizes of all pipe connections and access openings.
 - 2. Weight of entire assembly empty and flooded.
 - 3. Design and construction (including pressure and temperature limitations) of tank, continuous blowdown heat exchanger (if provided), control valves, water level control system, level alarm switches and all accessories.
 - 4. Performance data on control valves and continuous blowdown heat exchanger (if provided). Refer to drawings (Schedules) for requirements.
 - 5. Interior Coating: Material specification, service limitations, instructions for application, experience record under the required service conditions.

C. Blowdown Separator and Accessories; Continuous blow down heat exchanger and accessories:

1. Drawing showing outline dimensions, arrangement and weight of tank and accessories. Locations and sizes of all pipe connections and access openings.
2. Design and construction of tank, supports and accessories.
3. Design and performance of blowdown separator temperature control valve.
4. Relief valves
5. Heat recovery coil materials of construction and performance data.
6. Temperature gauge panel and gauges.
7. Tank water level control system.
8. Site glasses
9. Valves and fittings.
10. Cleaning procedures and access for heat recovery coil.

D. Condensate Transfer Pumps:

1. Drawings with dimensions of assemblies of pumps and drivers.
2. Catalog data and specification sheets on design and construction of pumps, drivers and couplings (flexible-coupled units).
3. Motor efficiency and power factor at full load.
4. Performance curves showing discharge head, required flow plus recirculation, NPSH required, efficiency, driver power, impeller diameter to be furnished. Refer to drawings for requirements.
5. Pressure and temperature limitations of pump unit and accessories.
6. Size and capacity of recirculation orifice.
7. Data on variable frequency drive units and pressure controllers (if VFD specified).

E. Boiler Water and Deaerator Water Sample Coolers:

1. Drawings with dimensions, and sizes and location of piping connections.
2. Catalog data and specification sheets on the design and construction.
3. Pressure and temperature limitations.
4. Amount of heat exchange surface.

F. Chemical Feed Systems:

1. Catalog data, specification sheets, and performance data on the design and construction of pump.
2. Cutsheets on stainless steel injection quills.

G. Automatic Continuous Blowdown Control System:

1. Drawings with arrangement and dimensions of entire unit. Include locations and sizes of all pipe connections.
2. Catalog data and specification sheets on design and construction of conductivity sensor, control valves, controller.
3. Performance data on control valves.
4. Pressure and temperature limitations of valves and conductivity sensor.

H. Test Data - Acceptance Tests, On-Site: Four copies all specified tests.

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

A285/A285M-03(2007).....Standard Specification for Pressure Vessel
Plates, Carbon Steel, Low- and Intermediate -
Tensile Strength

A414/A414M-10.....Standard Specification for Steel, Sheet,
Carbon, and High-Strength, Low-Alloy for
Pressure Vessels

A515/A515M-03(2007).....Standard Specification for Pressure Vessel
Plates, Carbon Steel, for Intermediate- and
Higher-temperature Service

A516/A516M-06.....Standard Specification for Pressure Vessel
Plates, Carbon Steel, for Moderate-and
Lower-Temperature Service

C. American Society of Mechanical Engineers (ASME):

Boiler and Pressure Vessel Code: 2007 Edition with Amendments.
Section VIII.....Pressure Vessels, Division I and II.
Performance Test Code:

D. Society for Protective Coatings (SSPC):

SP 5-2007.....White Metal Blast Cleaning

PART 2 - PRODUCTS

2.1 CONDENSATE SURGE TANK AND ACCESSORIES

- A. Horizontal cylindrical welded steel tank, including accessory equipment, suitable for rigging into the available space. Comply with overall dimensions and arrangement of the tank and accessories shown on contract drawings. Accessories include make-up water controls and control valves, thermometer, water level gage, and other devices as specified.
- B. Service: Receiving and storing steam condensate and make-up water. Vent the tank to the atmosphere. Contents of tank may vary in temperature from 4 °C to 100 °C (40 °F to 212 °F).
- C. Construction:
 - 1. Construct tank and appurtenances in accordance with ASME Boiler and Pressure Vessel Code, Section VIII. Tank shall have cylindrical shell and dished heads.
 - 2. Material of construction shall be carbon steel ASTM A285, A414, A515, or A516.
 - 3. Design tank for 170 kPa (25 psi) working pressure with a minimum material thickness of 10 mm (3/8 inch). Thickness of head material at any point shall not vary more than 10 percent from the nominal thickness.
 - 4. Tank joints shall be double-welded butt joints or single-welded butt joints with backing strips.
 - 5. Provide 300 mm by 400 mm (12 inches by 16 inches) elliptical manway located as shown.
 - 6. Provide nozzles for piping connections located as shown. Nozzles shall have threaded pipe connections for pipe sizes 50 mm (2 inches) and under, flanged connections for pipe sizes over 50 mm (2 inches). Flanged nozzles shall have 1025 kPa (150 psi) ASME flanges. Tank opening for pump suction pipes shall include vortex spoilers.
 - 7. Furnish completed ASME Form U-1 or U-1A MANUFACTURERS' DATA REPORT FOR PRESSURE VESSELS. Hydrostatically test tank at 1-1/2 times the design pressure.
 - 8. Horizontal tank shall be supported by steel saddles, supplied by the tank manufacturer, welded to tank and anchored to the concrete bases. Design saddles to support tank (full of water), accessories, and portions of connecting piping to first hanger.

9. Affix tank nameplate to bracket that projects beyond the field-applied tank insulation. Nameplate shall include ASME stamp and data to show compliance with design, construction and inspection requirements of the Code, and tank manufacturer information.
- D. Provide overflow pipe inside tank with siphon breaker as shown.
- E. Overflow and vent pipe sizing (minimums):

Boiler Plant Capacity* (kg/sec)	Boiler Plant Capacity* (klb/hr)	Overflow Pipe Size (mm)	Overflow Pipe Size (in)	Vent Pipe Size (mm)	Vent Pipe Size (in)
3.9 - 8.3	31 - 70	100	4	75	3

*"Boiler Plant Capacity" refers to one boiler on standby and all other boilers at high fire.

- F. Cleaning and Painting: Remove all foreign material to bare metal from interior and exterior of tank. In preparation for interior coating, sandblast interior to white metal in accordance with SSPC-SP5. Coat exterior of tank with rust-resisting primer (See Section 09 91 00, PAINTING).
- G. Interior Coating: Coat entire interior surface, including nozzles, with water-resistant epoxy polymerized with amine adduct-type curing agent. Coating shall be suitable for continuous service at 100 °C (212 °F) immersed in demineralized water and exposed to steam vapor. Surface preparation, application of coating, number of coats, and curing shall comply with printed instructions of coating manufacturer. Ingredients of coating shall comply with U.S. Food and Drug Regulations as listed under Title 21, Chapter 1, 175.300. Coating shall be smooth, even thickness, with no voids. Holiday test at low voltage with wet sponge method and repair all holidays.
- H. Insulation: Field apply insulation as specified in Section 23 07 11, HVAC, PLUMBING, and BOILER PLANT INSULATION.
- I. Water Level Indicators:
1. Gage Glasses: Red line type, overlapping glasses if multiple glasses are utilized. Provide automatic offset-type gage valves that stop the flow if a glass is broken. Drain cock on lower gage valve. Gage glass protecting rods.

J. High and Low Level Alarm Switches:

1. Low Level Alarm Switch: Integral unit consisting of float, float housing, hermetically sealed mercury switch. Locate external to tank on a vertical header with valved tank connections and valved drain. Switch elevation shall be 150 mm (6 inches) below the soft water make up level.
2. High Level Alarm Switch: Integral unit consisting of conductivity probes, probe housing. Float type not acceptable. Locate external to tank on a vertical header, along with the low-level switch, with valved tank connections and valved drain. High level alarm indication shall occur 100 mm (4 inches) below the overflow level. Probes shall be AC, not DC, stainless steel with virgin Teflon insulation.
3. Provide signals to local annunciator system and computer workstation specified in Section 23 09 11, INSTRUMENTATION AND CONTROL FOR BOILER PLANT.
4. All devices exposed to tank service conditions, including sensing devices and transmitters shall be rated for 120 degrees C, 200 kPa (250 degrees F, 30 psi) minimum.

K. Automatic Water Level Controls:

1. Separate modulating water inlet flow control valves for normal soft water make-up and for emergency city water makeup. Actuated by electronic controller with input signals from water level transmitter. Manual/auto control capability.
2. Performance: Maintain a minimum water level, plus or minus 25 mm (1 inch), in the tank by controlling the flow of soft water to the tank. Soft water makeup shall be activated if water level falls to 30% of tank diameter plus 300 mm (12 inches). If water level falls to 30% of tank diameter, automatically operate the emergency city water makeup valve to bring the water level up 150 mm (6 inches).
3. Water Level Transmitter: Programmable electronics, sealed diaphragms, direct sensing electronics, no mechanical force or torque transfer devices, external span and zero adjustment.
4. Controller: Proportional plus reset control, adjustable proportional band, reset rate and level set points. Provide manual-automatic control station on main instrument panel. Control station shall indicate actual water level, soft water and emergency city water level set points and valve positions. Provide same indicating and

- control features on computer workstation specified in Section 23 09 11, INSTRUMENTATION AND CONTROL FOR BOILER PLANT. If new boiler combustion controls are furnished as part of this contract, the water level controller and transmitter shall be the same makes and models as furnished for the combustion controls.
5. Water Flow Control Valves:
- a. Electrically-actuated, characterized rotary.
 - b. Characterized rotary valve, operated by 120-volt AC electric drive actuator with top mount integrated digital positioner. Positioner shall utilize 4-20mA signal for control and feedback. Provide linear valve flow characteristics.
 - c. Refer to drawings for pressure temperature and flow requirements. Valve shall provide bubble tight shut off. Size valve for minimum 5 psi loss at maximum flow rate.
 - d. Valve shall be three-piece carbon steel body, 216 stainless steel ball and stem, with RTFE seat, 260-degree minimum temperature rating. Provide flanged body for valves larger than 2 inches and threaded body valves for valves below 2 inches in diameter.
 - e. Sound Levels: Conform to 23 05 51 NOISE AND VIBRATION CONTROL FOR BOILER PLANT.
 - f. Electrical drive unit for shall have sufficient power to operate valve under all operating conditions. All parts of linkage between drive unit and valve shall be free-working, securely attached, and shall not distort under all operating conditions.
 - g. Provide manual handwheel and means to disengage actuator to permit manual operation.

2.2 BLOWDOWN SEPARATOR AND ACCESSORIES

- A. Blow down separator shall be ASME Construction and ASME Stamped suitable for associated boiler operating pressure but not less than **150 psig** design pressure.
- B. Furnish unit with inlet, vent, and drain connections, and stainless steel striking plate. Threaded pipe connections 2 inches and smaller. Piping connections larger than 2 inches shall be flanged. Unless otherwise indicated, inlet size of blow down separator to be equal to boiler bottom blow down connection size.

- C. Furnish unit complete with floor supports, aftercooler, automatic water temperature regulator valve with remote temperature sensor, strainer and remote mounted thermometer.
- D. Temperature regulator valve to automatically control the flow of cold water by responding to temperature changes sensed at the thermostatic bulb in the aftercooler fitting.

2.3 CENTRIFUGAL SINGLE-STAGE CONDENSATE TRANSFER PUMPS

- A. Type: Single stage, centrifugal diffuser type, direct-coupled, vertical shaft, in-line, base-mounted, motor-driven, arranged as shown.
- B. Service: Design pumps and accessories for continuous service, 116 °C (240 °F) water, with flow rates ranging from maximum scheduled on the drawings (plus manufacturer's recommended recirculation) to 10 percent of maximum (plus manufacturer's recommended recirculation). Pumps shall be suitable for parallel operation without surging or hunting.
- C. Performance: Refer to schedules on drawings. Pump head-flow performance curve shall slope continuously upward to shut-off.
- D. Control - Condensate Transfer: Constant speed operation. Flow rate will be controlled by automatic modulating water level control valve on condensate transfer inlet to deaerator.
- E. Construction:
 - 1. Rotating elements shall be designed and balanced to conform to sound and vibration limits specified in Section 23 05 51, NOISE and VIBRATION CONTROL FOR BOILER PLANT.
 - 2. Mechanical seals shall have sealing face materials of carbon and tungsten or silicon carbide.
 - 3. Design bearings for two-year minimum life with continuous operation at maximum pump operating load. Bearings and shaft seals shall be water-cooled if recommended by pump manufacturer for the service.
 - 4. Materials of Construction:
 - Chambers: Stainless steel
 - Impellers: Stainless steel
 - Diffusers: Stainless steel
 - Shaft: Stainless steel
 - Suction-Discharge Chamber: Cast iron or stainless steel
- F. Recirculation Orifice: Provide stainless steel recirculation orifice selected by pump manufacturer to protect pump from overheating at shut-off and designed for low noise under the service conditions. Orifices

must not exceed sound level limits in Section 23 05 51, NOISE and VIBRATION CONTROL FOR BOILER PLANT.

- G. Spare Parts: Provide complete rotating assembly for each pump size and type suitable for field installation by plant personnel. Assembly shall include impellers, diffusers, chambers, shaft, seals, bearings.
- H. Shaft Couplings: Pump manufacturers standard. Provide coupling guard.
- I. Electric Motor Drives: High efficiency type, open drip proof. Select motor size so that the motor is not overloaded at any point on the pump head-flow performance curve. Design motor for 40 °C ambient temperature. For efficiency and power factor requirements refer to Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.
- J. Interface with Computer Workstation: Provide devices to signal computer work station that motor is on or off.

2.4 BOILER WATER SAMPLE COOLERS

- A. Type: Factory-built shell and coiled tube heat exchanger with sample in tube, cooling water in shell, designed for wall mounting.
- B. Construction:
 - 1. Shell and Head: Iron, steel or stainless steel shell, bolted or threaded into head. Head shall have wall mounting brackets and piping connections for sample in and out and cooling water out. Minimum design pressure for shell and head, 1025 kPa (150 psi). Shell removable without disturbing piping connections.
 - 2. Sample Coil: Shall be 6 mm (1/4-inch) outside diameter stainless steel tubing, 0.11 square meter (1.2 square feet) minimum heat exchange surface. Minimum design for 1025 kPa (150 psi), 188 °C (370 °F). Design coil to relieve stresses due to thermal expansion.
 - 3. Arrangement: Shall be as shown on the drawings.

2.5 CHEMICAL FEED SYSTEMS

- A. Existing Nalco PORTAFEED chemical feed systems will be utilized for injecting chemicals into each boiler, the main steam header, and the deaerator. The scope of this project is to provide new chemical feed pumps on the existing PORTAFEED systems, relocate PORTAFEED systems as necessary for installation of new boilers, providing new stainless steel injection quills for the boilers, main steam header, and deaerator. Refer to 232111 for new stainless steel piping between pumps and quills.
- B. Chemical Feed Pump shall be diaphragm type. Each pump shall be suitable for pumping required chemicals and shall produce required flow

rate at pressure encountered in system. Provide relief valve and relief piping to tank for each pump. Pump motor shall be totally enclosed with thermal overload protection.

- C. Injection Quills shall be stainless steel, retractable, with stainless steel ball valves.

2.6 AUTOMATIC CONTINUOUS BOILER BLOWDOWN CONTROL SYSTEM (BBC)

- A. Type: One factory-assembled system per boiler to automatically sense boiler water conductivity and operate automatic electric-powered blowdown valve to maintain desired total dissolved solids content in boiler water. Micrometer-type adjustable manual blowdown valve piped to bypass the automatic blowdown valve and conductivity sensor.
- B. Service: Design valves, sensors and piping for steam and water at 1035 kPa (150 psi), 186 °C (366 °F) minimum. Controller shall be suitable for 50 °C (120 °F) ambient and resist splashing water. Design automatic and manual blowdown valves for maximum blowdown flow rate equivalent to two percent of boiler steam output. System shall automatically maintain boiler water total dissolved solids at any set point between 1000 ppm and 4000 ppm.
- C. Operation: Programmable timer cycles to intermittently operate the blowdown valve to obtain conductivity samples, and to maintain the valve open for a time until the conductivity of the boiler water reaches the set point. Provide an automatic temperature compensating circuit.
- D. Controller: Shall be microprocessor-based sealed unit mounted at the boiler.
 - 1. Indicators on Panel Front: One-half inch high digital display showing conductivity and indicating normal or out-of-range conditions. Valve status indicators.
 - 2. Membrane Keypad on Panel Front: Allows manual operation of the blowdown valve, setting of conductivity set points and alarm set points, setting of timers, calibration data input.
- E. Automatic Valve Construction: Carbon steel body, Type 316 stainless steel ball and stem, TFE coated stainless steel body seal. Electric actuator with NEMA-1 enclosure. Rated for 1025 kPa (150 psi) minimum saturated steam.
- F. Manual Valve Construction: Bronze or forged steel angle-type body, hardened stainless steel disc and seat, threaded ends, rising stem, union bonnet, graduated micrometer-type dial and pointer showing amount

of valve opening. Rated for 1025 kPa (150 psi) minimum saturated steam. Furnish valve blowdown chart showing flow rate versus valve opening based on 125 psi boiler pressure.

- G. Provide gate valves and unions at inlet of conductivity sensor and outlet of automatic control valve so that these items can be removed from the system while maintaining the manual control valve in service. Comply with Section 23 21 11, BOILER PLANT PIPING SYSTEMS.

PART - 3 EXECUTION

3.1 INSTALLATION

- A. Condensate Surge Tank and Condensate Transfer Pumps, Blowdown Separator, Continuous Blowdown Heat Exchanger, Boiler Blowdown Controller.
1. Coordinate location with structural requirements of the building.
 2. Location shall permit access to and removal of all internal and external features without removing other items of equipment or piping.
 3. Bolt to building as recommended by manufacturer or as shown. Arrange anchorage to allow thermal expansion of unit.
 4. Clean interior of equipment before placing in service.
 5. All controls, safeties, set points, etc must conform to the most recent edition of the VHA Boiler Plant Safety Device Testing Manual.
- B. Condensate Transfer Pumps:
1. Align pumps and drivers at the factory. At job site, a millwright shall level, shim, bolt, and grout the base plates or base frames onto the concrete pads, and shall also check the alignments of flexible-coupled pumps and drivers and make corrections necessary. Check alignment when both pump and driver are at normal operating temperature.
 2. If water-cooled bearings or quenched or flushed or water-cooled stuffing boxes are provided on pumps, contractor shall install on each pump valved 15 mm (1/2-inch) piping connections to cold water supply, and 15 mm (1/2-inch) drains to nearest open sight drain. Provide unions at all connections to pumps.
- C. Boiler Blowdown Controller: Locate each controller on floor-supported angle at four feet above the floor at the boiler adjacent to the continuous blowdown valves. Keypad and indicator must face aisle.

3.2 STARTUP AND TESTING

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

3.3 COMMISSIONING

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

3.4 DEMONSTRATION AND TRAINING

- A. Provide services of manufacturer's technical representative for four hours to instruct each VA personnel responsible 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 51 00
BREECHINGS, CHIMNEYS, AND STACKS

PART 1 - GENERAL:

1.1 DESCRIPTION:

- A. This section specifies flue gas exhaust system and all accessories from the boiler outlet to the stack outlet to the atmosphere. Flue gas recirculation (FGR) ductwork (if required by burners furnished) is also specified.

1.2 RELATED WORK:

- A. Section 07 60 00, FLASHING and SHEET METAL: Roof Penetrations.
- B. Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.
- C. Section 23 05 51, NOISE and VIBRATION CONTROL FOR BOILER PLANT.
- D. Section 23 07 11, HVAC, PLUMBING, and BOILER PLANT INSULATION.
- E. Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS. Requirements for commissioning, systems readiness checklists, and training
- F. Section 23 52 39, FIRE-TUBE BOILERS
- G. Section 23 09 11, INSTRUMENTATION and CONTROL FOR BOILER PLANT: Boiler Draft Control System.

1.3 QUALITY ASSURANCE:

- A. Provide scale drawings showing nominal dimensions and weight of the systems.
- B. Boiler and burner manufacturer shall review complete system from boiler flue gas outlet to stack outlet to atmosphere and advise the Government of any changes required to meet boiler and burner performance requirements. Note the altitude of plant site.
- C. If a double wall, factory-fabricated, positive pressure breeching and stack system is provided, the manufacturer shall completely engineer the entire system and provide all components. Manufacturer's representative shall provide installation instructions prior to start of construction, train the installers and certify in writing to the Resident Engineer (RE) that the entire installation complies with the official standards of the manufacturer and with the project specifications.
- D. Flue gas recirculation ductwork shall be designed and provided by the burner manufacturer.
- E. Conform to NFPA 54 and NFPA 31 for installation of fuel burning equipment and appliances.

1.4 SUBMITTALS:

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- B. Design, materials, weights, construction, pressure and temperature limitations of breeching and stack systems, flue gas recirculation system.
- C. Drawings showing all components, system arrangement and dimensions.
- D. Design, construction, allowable movements, movement forces, pressure and temperature limitations of expansion joints.
- E. Damper design, construction, pressure and temperature limitations, pressure loss at design flow, and leakage of closed damper.
- F. Support designs, locations and loads for entire assembly.
- G. Written statement from boiler/burner manufacturer that the design of the system is satisfactory to achieve the required boiler/burner performance.

1.5 APPLICABLE PUBLICATIONS:

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. American Institute of Steel Construction (AISC):
Steel Construction Manual, Thirteenth Edition
- C. ASTM International (ASTM):
A242/A242M-04(2009).....Standard Specification for High-Strength Low-Alloy Structural Steel
A568/A568M-09a.....Standard Specification for Steel, Sheet, Carbon, and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, General Requirements For
- D. Manufacturer's Standardization Society of the Valves and Fittings Industry (MSS):
SP-58-2009.....Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation
- E. National Fire Protection Association:
NFPA 54-2006.....National Fuel Gas Code
NFPA 31-2006.....Standard for the Installation of Oil-Burning Equipment

NFPA 211.....Standard for Chimneys, Fireplaces, Vents, and
Solid Fuel-Burning Appliances

PART 2 - PRODUCTS:

2.1 BREECHING, STACKS, FGR DUCTWORK:

- A. Refer to drawings for arrangement and dimensions, except FGR ductwork shall be designed by the burner manufacturer. Connections to boilers must comply with the written recommendations of the boiler manufacturers. Ninety-degree tee sections are not permitted. Intersections must be made with lateral tees.
- B. Service: Design for continuous 315 °C (600 °F), 12 kPa (50 inches WC) positive and negative internal pressure, wind-loading for outside stacks 120mph, exposure B, importance factor 1.15.
- C. Pre-engineered, Pre-Fabricated, Double-Wall System for both Vertical Stack and Horizontal Breeching:
 - 1. Complete factory-built system, all components and installation engineered and provided by manufacturer of system.
 - 2. Provide double wall metal stacks, tested to [UL 103] [UL 127] [UL 641] and UL listed, for use with building heating equipment, in compliance with NFPA 211.
 - 3. Corrosion-resistant steel, double-wall, circular cross section, positive pressure, blanket insulation between walls.
 - 4. Factory-built standard sections, connected in the field with joining system designed and provided by system manufacturer. Designed to be pressure and vacuum-tight, no deformation, at the service conditions specified.
 - 5. System manufacturer's engineered support system, attached to structural members of the building, with expansion joints between rigid supports. Thermal expansion shall be handled by expansion joints and variable spring hangers. Thermal expansion and weight of system shall not impose loads in excess of that allowed by manufacturer of boiler or any other equipment, or exceed capabilities of building structure. Spring hangers shall conform to MSS SP-58, Type 51, variable spring.
 - 6. Inner Wall: Stainless steel, Type 304, 0.9 mm (0.035-inch) minimum thickness for diameters 900 mm (36 inches) and smaller and 1.2 mm (0.048 inches) minimum thickness for diameters greater than 900 mm (36 inches) and 1200 mm (48 inches) and less.

7. Outer Wall: Aluminized or galvanized steel except 304 stainless steel outside of building, 0.6 mm (0.025 inch) minimum thickness for inner wall diameter 800 mm (32 inches) and less, 0.9 mm (0.034 inch) minimum thickness for inner wall diameter over 800 mm (32 inches) and 1200 mm (48 inches) and less.
8. Insulation Between Walls: Fiberglass or mineral wool, 315 °C (600 °F). Minimum thickness 50 mm (2 inches).
9. Bands for Joining Sections: Same material as section being joined. Utilize sealant provided by system manufacturer.
10. Roof and wall penetrations shall be manufacturer's standard ventilated thimble. Conform to Section 07 60 00, FLASHING and SHEET METAL.
11. Drain Section: Provide at bottom of vertical stack to drain rain water from stack. Extend drain pipe to floor drain.

2.2 BOILER OUTLET DAMPERS AND ACCESSORIES

- A. Type: Multi-blade, opposed horizontal blades, automatically controlled. Open-shut operation. Also, modulating operation on systems requiring automatic draft control. Boiler outlet draft control is specified in Section 23 09 11, INSTRUMENTATION and CONTROL FOR BOILER PLANT.
- B. Service: Design for 315 °C (600 °F), 1.2 kPa (5 inches W.C.) positive and negative pressure. Maximum leakage, when closed, shall be ten percent of maximum required flow. Maximum pressure loss at maximum boiler steam output, 0.01 kPa (0.05 inches WC).
- C. Construction:
 1. Blades: ASTM A242 carbon steel, air foil, dowelled to shafts.
 2. Shafts: Stainless steel. Provide seals at casing penetrations.
 3. Bearings: External to flow stream, carbon, self-contained, bushing, packing-gland assemblies, self-lubricating.
 4. Linkages: Control arms dowelled to shafts. All control arms linked to drive motor. External to flow stream. All steel construction.
- D. Accessories:
 1. Interlock Switch Mounting: Rigid mounting located to allow switch to sense damper linkage position. Switch is connected to burner control system specified in Section 23 09 11, INSTRUMENTATION and CONTROL FOR BOILER PLANT
 2. Damper Drive Unit: Electric type that shall operate damper without overload. Provide 100 percent duty cycle maintenance-free motors that never overheat or burnout under stalled conditions. Constant

speed coordinated with the controlled process so that performance parameters remain within requirements. Drive unit shall automatically open damper 90 degrees on boiler purge cycle, position damper as required for proper burner ignition, modulate damper during boiler firing to maintain constant outlet draft, close damper on boiler shut down.

2.3 EXPANSION JOINTS

- A. Provide sufficient types, quantities, and locations of expansion joints to completely absorb all thermal expansion of the system without imposing excessive loads on equipment or building structure. Fabric joints shall be used on single-wall stack and breeching system. On factory-fabricated double wall stack or breeching system, use slip-type, bellows-type, or fabric expansion joints engineered by designer of the stack and breeching system.
- B. Service: Design for 300 °C (575 °F), 5 kPa (20 inches) WC positive and negative internal pressure, continuous duty.
- C. Construction, Fabric Joints:
 - 1. Fabric: High strength, designed for dewpoint service.
 - 2. Internal Baffles: Carbon steel with stiffeners. Designed to protect interior surfaces of fabric from wiping action of the flue gases.
 - 3. Welded frame, 6 mm (1/4 inch) thick ASTM A568 steel with 100mm (4 inch) minimum flange height, flat-belt design, fabricated by expansion joint manufacturer. Fabric element bolting, 9 mm (3/8 inch) diameter, 150 mm (6 inch) maximum centers.
- D. Construction, Factory-Fabricated Double-Wall System Joints:
 - 1. Materials: Same as factory-fabricated breeching system.
 - 2. Packing Gland: High temperature rating. Provide seal between sliding and fixed portions of joint.

2.4 ACCESSORIES

- A. Drains: Provide threaded pipe connection to allow drainage at all low points and drain connections in stack and breeching systems. Slope piping system to the drain. Pipe size shall be 25 mm (1 inch) minimum.
- B. Instrument Ports: Locate on individual stack or breeching serving each boiler. Locate accessible from platform. Provide separate ports for the following:
 - 1. Flue gas oxygen analyzer: Coordinate with analyzer furnished.
 - 2. Opacity monitor (if required): Coordinate with sensor furnished. Locate downstream from oxygen analyzer.

3. Stack temperature sensor: Coordinate with sensor furnished.
 4. Draft gauge: 25 mm (1 inch) diameter coupling, plugged.
 5. Test instruments: 25 mm (1 inch) diameter coupling, plugged.
- C. Access Doors: Bolted, gasketed, insulated, with handles. Provide where shown. Minimum opening 400 mm x 400 mm (16 inches x 16 inches).

PART 3 - EXECUTION

3.1 INSTALLATION - PRE-ENGINEERED, PRE-FABRICATED DOUBLE WALL SYSTEM

- A. Supports: Completely support all systems from the building structure without overloading the building structure or the connected equipment. Support system shall be engineered by the system manufacturer and shall accommodate thermal expansion.
- B. Factory-Fabricated Stack System:
1. Install in accordance with manufacturer's printed instructions, NFPA 54 and NFPA 31.
 2. Deliver a copy of the instructions to the RE/COTR prior to commencing the installation.
 3. Representative of manufacturer shall provide field training on all installation techniques to all installers.
- B. Connect 25 mm (1 inch) minimum pipes with ball valves to breeching and stack drains. Extend to floor drain.
- C. Pitch breechings with positive slope up from fuel-fired equipment to chimney or stack.

3.2 COMMISSIONING

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

- - - E N D - - -

SECTION 23 52 39
FIRE-TUBE BOILERS

PART 1 - GENERAL

1.1 DESCRIPTION:

- A. This section specifies packaged fire tube boiler with trim (accessories), dual fuel (natural gas and No. 2 oil) burner, fuel valve and piping trains, and other accessories.

1.2 RELATED WORK:

- A. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- B. 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 08 00, COMMISSIONING OF HVAC SYSTEMS.
- F. Section 23 08 11, DEMONSTRATIONS and TESTS FOR BOILER PLANT.
- G. Section 23 09 11, INSTRUMENTATION and CONTROL FOR BOILER PLANT.
- H. Section 23 21 11, BOILER PLANT PIPING SYSTEMS.
- I. Section 23 51 00, BREECHINGS, CHIMNEYS, and STACKS.
- J. Section 26 05 33, RACEWAY and BOXES for ELECTRICAL SYSTEMS.

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 valve and piping trains, gas pressure regulators and available gas pressure, required fuel oil train pressures and fuel oil header back pressure regulator on house oil pump set, compressed air system for oil atomization, control systems, 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 applied to at least three fire tube boilers which are similar in size, proportion, number of passes and furnace dimensions to the proposed boiler. In each of the three installations, burner performance shall have conformed to requirements specified in the Subparagraph, "Performance" under the Article, BURNER, AND FUEL TRAINS of Part 2. Provide list of these installations, and name, address, and telephone number of person familiar with each project who will serve as a reference source.

- D. Regardless of fuel input rating, the equipment, installation and operation shall conform to NFPA 85. Where conflicts exist between NFPA 85 and this specification, this specification will govern.

1.4 SUBMITTALS:

- A. Before executing any work, submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- B. Boiler:
1. Complete catalog information and outline drawings of boiler, burner, and accessories with dimensions including tube removal space and access door opening space.
 2. Catalog cuts showing arrangement and construction of pressure parts, casing, internals, and support frame.
 3. Piping connection sizes, locations, types (threaded or flanged).
 4. Technical data including temperature rating and arrangement of refractory and insulation.
 5. Steam nozzle construction. Capability of steam nozzle and attachment to boiler shell to withstand forces and moments imposed by connecting piping.
 6. Amount of heating surface and combustion volume.
 7. Weight of boiler empty and flooded including burner and boiler and burner accessories.
 8. Design pressures and temperatures.
 9. Loading diagram of support frame. Evidence that boiler support requirements have been coordinated with foundation design.
 10. Recommended anchorage of boiler support frame to foundation.
 11. Furnace viewport construction, locations.
 12. Dimensioned location of normal water line, lowest and highest permissible water level, set points of water level alarms and cutoffs.
 13. Predicted external surface temperature of front, rear and sides of boiler.
- C. Boiler Trim: Includes bottom blowoff valves, water level alarm and cutoff devices, water level gage, low water cutoffs, piping, all valves and fittings furnished by boiler manufacturer, feedwater control system, steam safety valves, steam pressure gage, stack thermometer, draft gage, and steam pressure switches.
1. Design, construction, arrangement on the boiler.
 2. Pressure and temperature limitations.

3. ASTM numbers and schedule numbers of piping.
 4. Type and pressure ratings of pipe fittings.
 5. Flow and pressure drop data on feedwater regulating valves.
 6. Technical data on water level control system.
 7. Scale ranges of gages, thermometers and pressure switches.
 8. Location of water level sensing and indicating device set points in relation to normal water line and lowest and highest permissible water levels of boiler.
 9. Set pressure and capacity of safety valves.
- D. Burner and Fuel Valve and Piping Trains:
1. Catalog data and drawings showing burner assembly and fuel train arrangement.
 2. Outline drawings of flue gas recirculation (FGR) ductwork (if applicable).
 3. Outline drawings of sound attenuators on forced draft fan intake or discharge.
 4. Drawings showing assembly of throat refractory into furnace.
 5. Type and temperature rating of throat refractory.
 6. Drawings and catalog data on all equipment in igniter (pilot) train, main fuel trains, and atomizing media train. Include data on pressure and temperature ratings, flow versus pressure drop, performance characteristics. Include complete data on air compressors (for oil atomizing) with sound attenuators and motors.
 7. ASTM numbers 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 air pressures and flows at maximum required firing rate.
 - b. Igniter (pilot) fuel flow and burner pressure.
 - c. Natural gas main fuel pressure at inlet and outlet of main burner pressure regulator.
 - d. Igniter (pilot) fuel pressures (natural gas and LP gas) at inlet and outlet of burner-mounted pressure regulators.
 - e. Forced draft fan static pressure, power and air flow at maximum firing rate.
 - f. Oil pressure required at boiler fuel oil pump inlet (if applicable).
 10. Full load efficiency and power factor of all motors.

11. Predicted sound level at maximum firing rate on each main fuel.
 12. Weight of burner assembly.
- E. Burner Management (Flame Safeguard) System: Refer to Section 23 09 11, INSTRUMENTATION and CONTROL FOR BOILER PLANT.
- F. Boiler and Burner Predicted Performance Data:
1. At Maximum Required Output: On each fuel at site altitude, at 15 percent excess air. Data must include fuel and steam flow, boiler flue gas outlet temperature, steam quality, boiler efficiency, windbox and furnace pressures, and predicted boiler radiation and unaccounted losses.
 2. At low fire, 25%, 50%, 75% of Maximum Required Output. Excess air, CO ppm, NOx ppm on each fuel.
- G. ASME "P" Forms, Manufacturer's Data Report, on boiler construction - submit after boiler is fabricated.
- H. Pretest Data - Boiler, Burner, Controls: As required by Part 3.
- I. 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, No. 2 fuel oil.
- B. Igniter (Pilot) Fuels: Natural Gas and LP gas (propane).
- C. Natural Gas: High heating value is reported as 1200 Btu per cubic foot at gas company base pressure and temperature. Pressure provided to the inlet of the boiler-mounted regulators will be 15 psi gage as maintained by main regulator station.
- D. Fuel Oil: Will be furnished under Government contract. House pumping system is designed to provide 120 psi gage nominal to the fuel train entrance on each burner. Pressure will vary in accordance with characteristics of backpressure regulator on oil pump set (Refer to Section 23 50 11, BOILER PLANT MECHANICAL EQUIPMENT. Oil grade (No. 2) refers to ASTM D396. No burner-mounted pump or relief valve is required.
- E. Oil Atomizing Media: Low-pressure air atomizing burners are required and each boiler must include a dedicated air compressor system furnished by burner manufacturer.
- F. LP Gas: Propane furnished directly to the Government for igniter (pilot) fuel by a local supplier. Regulators at tank area will be set

at 35 kPa (5 psi) gage. 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
 - 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):
 - 85-2007.....Boiler and Combustion Systems Hazards Code.
- E. Environmental Protection Agency (EPA):
 - CFR 40, PART 60, Appendix A, Method 9, Visual Determination of the Opacity of Emissions from Stationary Sources

PART 2 - PRODUCTS

2.1 BOILER:

- A. Type: Factory-assembled packaged Scotch marine horizontal fire tube high pressure steam boiler. Two pass wet back design with internal furnace located below center of boiler shell. Designed for natural gas and No. 2 fuel oil firing.
- B. Service: Continuous long term generation of steam throughout the burner firing range in conformance to the specified performance requirements with feedwater supply at 100 degrees C (212 degrees F).

C. Performance:

1. Steam Output Quantity and Pressure: Refer to schedules on drawings.
2. Steam Output Quality: 99 percent minimum at all steam flow rates.
Based on water quality in boiler of 2200-ppm maximum total solids, 15-ppm maximum suspended solids, 440-ppm maximum alkalinity.
3. Minimum Efficiency at Required Maximum Output:
 - a. Natural Gas Fuel (37.3 MJ/cu. meter) (1000 Btu/cu. ft.): 82 percent at 15 percent excess air.
 - b. Fuel Oil (ASTM D396, Grade 2): 85 percent at 15 percent excess air.

D. Heating Surface: Heating surface is defined as the fireside area of the furnace and combustion chamber plus inside (gas side) circumferential area of all convection tubes. Minimum surface shall be 2 square feet per boiler horsepower.

E. Design Pressure: 1375 kPa (200 psi) gage. Purpose of high design pressure is to provide additional corrosion allowance.

F. Construction:

1. Codes: Comply with ASME Boiler and Pressure Vessel Code, Sections I, II, VII, and IX.
2. Tubes: ASTM A178 Grade A, smooth wall inside and outside. Minimum thickness 2.7 mm (0.105 inches). Flue gas spinners or turbulators are not allowed.
3. Manway: Cover and yokes shall be forged steel. Manway shall seal tight with no leakage. Provide non-asbestos gaskets.
4. Handholes: Covers and yokes shall be forged steel. Handholes shall seal tight with no leakage. Provide non-asbestos gaskets.
5. Access to Tubes and Furnace: Provide hinged and davited doors and access panels to permit access to all tubes and furnace for cleaning, repairs and replacement. Doors wider than the radius of the boiler shell shall be davited and shall be operable by one person. Hinges or davits are not required for access panels less than 610 mm (two feet) in width and height. All doors and panels shall have non-asbestos gaskets and shall be sealed tight with capscrews threaded into brass nuts. Panels shall have handles.
6. Shell Piping Connections: Flanged, except threaded is permitted for pipe sizes under 65 mm (2-1/2 inches). Connections shall include, but not be limited to:

- a. Steam nozzle shall be 2050 kPa (300 psi) ASME flanged. Design nozzle and shell assembly to withstand forces and moments imposed by connected piping. Studding nozzle will not be permitted.
 - b. Locate manual steam vent on top of boiler shell to permit access to vent gate valve from platform located above boiler.
 - c. Locate safety valve outlets to permit straight run of vents through roof and to permit valve handle access from platform located above boiler.
 - d. Connections for water level control, alarm and indication devices.
 - e. Connections for boiler feed water, chemical admission, combined continuous blowdown and water sampling. Locate below normal water level and as shown.
 - f. Bottom blowoffs. Locate to permit complete collection of sediment and complete drainage.
 - g. Pressure gage and pressure switch connections. (May be connected to water level controller steam piping.)
7. Support System: Provide proper support of all elements of the boiler, burner, and accessories during shipment, rigging, and in final installation. Arrange supports to permit thermal expansion and to resist seismic shocks (in seismic areas). No element of the boiler or accessories shall be overstressed, displaced, have cracks, broken welds, or excessive deflection. All vertical elements of the boiler and accessories shall be plumb, and all horizontal elements shall be level.
 - a. Base Frame: Design for mounting on flat concrete base. All elements shall be level. Provide attachments for anchorage to the concrete foundation.
 - b. Rigging and Jacking: Provide lifting lugs and provisions for jacking. Painted stencils shall identify jacking locations.
 - c. Platform Support Brackets: Provide brackets attached to boiler shell to support field-installed valve and manway access catwalk alongside top of boiler.
8. Refractory and Insulation: Boiler manufacturer's standard and experience proven design except insulation on the boiler shell shall be a minimum of 50 mm (two inches) thick. No part of the external casing shall exceed 33 degrees C (60 degrees F) above ambient,

- except for areas within 300 mm (one foot) of the casing penetrations.
9. Casing: Sheet steel covering all areas of boiler shell. Flash or seal all openings at top of boiler at piping and flue connections to prevent leakage of water into insulation. Provide a 300 mm (one foot) minimum width section of heavy gage reinforced casing or heavy density insulation (minimum 96 kg per cubic meter, six pounds per cubic foot) along the top centerline of the entire length of the boiler to permit walking on top of the boiler without denting the casing.
10. Observation Port: Provide single port at rear of furnace located to permit flame observation. Furnish with one clear and one tinted interchangeable heat resisting glass, gas-tight operable metal closure between furnace and glass, forced air cooling to reduce moisture condensation on glass.
- G. Factory Inspection and Certification: Inspect the completed boiler assembly in accordance with the requirements of the ASME Boiler and Pressure Vessel Code, Section I, RULES FOR CONSTRUCTION OF POWER BOILERS. The boiler inspection shall be certified. Submit four copies of ASME Form P-2 for each boiler.
- H. Finish: Provide surface preparation, heat-resistant prime and finish coats using standard color of the boiler manufacturer. Refer to Section 09 91 00, PAINTING.

2.2 BOILER TRIM (ACCESSORIES):

- A. Conform to ASME Boiler and Pressure Vessel Code, Section I
- B. Steam Safety Valves:
1. Capacities certified by National Board of Boiler and Pressure Vessel Inspectors (NB).
 2. Type: Bronze or cast iron bodies, side outlet, flanged or threaded inlet and outlet, lifting lever, dual control rings, stainless steel trim, O-ring EPDM seats on bronze valves.
 3. Settings and Adjustments: Factory set, sealed, and stamped on nameplate. Set pressures as shown. Set pressure of lowest pressure valve shall not exceed normal boiler plant operating pressure by more than 210 kPa (30 psi). Provide 30 kPa (5 psi) difference in setting between each of the valves.
 4. Provide two safety valves per boiler.

C. Steam Pressure Gage:

1. Case: Turret-style, bottom connection, threaded ring, blowout disc in rear.
2. Dial: 200 mm (8 inch) minimum diameter, non-corrosive, black markings on white background.
3. Measuring Element: Bourdon tube designed for steam service.
4. Movement: Stainless steel, rotary.
5. Pointer: Micrometer adjustable, black color.
6. Window: Laminated safety glass, or plastic.
7. Accuracy: One half percent of the full span.
8. Range: 0 - 300 psi gage.
9. Installation: Stop valve, steel piping, valved blowdown, siphon, union at gauge, valved connection for inspector's gauge. Refer to Detail, FIRETUBE BOILER.

D. Water Level Safety and Operating Controls and Indicators:

1. Provide high and low water warning alarms, primary and auxiliary low water burner cutoffs, automatic electronic modulating feedwater level control system, gage glass.
 - a. High and low water warning alarms shall operate bell and separate high and low water level indicating lights on boiler control panel and shall not shut down the burner.
 - b. Primary and auxiliary low water burner cutoff devices shall be in two separate water columns, piped individually to the boiler water spaces. One device shall be float-type, the other device shall be conductivity probes. Primary and auxiliary cutoffs shall require manual reset. Auxiliary cutoff shall shut down power to the burner management system. Non-latching shunt switches shall allow blowdown of water columns without shutting down the burner.
 - c. Water level set points for all devices shall be as recommended by boiler manufacturer.
 - d. Water level control system shall maintain the water level within limits established by boiler manufacturer for normal water level with no tripping of high and low level alarms with instantaneous load swings of 25 percent of boiler capacity. Feedwater pump will operate continuously.

- e. Refer to Section 23 09 11, INSTRUMENTATION and CONTROL FOR BOILER PLANT for detailed operation of all indication, monitoring, alarm and control devices.
- 2. Water Column Unit with Water Level Controller, Gage Glass, Water Level Sensor for Primary Low Water Cutoff:
 - a. Float-type electric or electronic modulating water level control device and primary low water cutoff. As an option to the float type device, electronic self-checking magnetostrictive or capacitance devices may be provided.
 - b. Height of water column and gage glass shall be sufficient to show water level in the gage glass at least 12 mm (0.5 inches) above high water alarm set point and at least 12 mm (0.5 inches) below auxiliary low water cutoff set point.
 - c. Control system shall automatically modulate an electric feedwater flow control valve. Feedwater pump will operate continuously.
 - d. Gage Glass and Gage Valves: Single vertical tubular gage glass, tempered borosilicate, red line, rated for 315 degrees C (600 degrees F). Provide automatic off-set gage valves with ball checks to prevent fluid flow if gage breaks. Provide gage rods to protect glass.
- 3. Auxiliary Water Column with Water Level Sensors for High and Low Level Alarms and Auxiliary Low Water Cutoff:
 - a. Conductivity probe type high and low level alarm sensors and auxiliary low water cutoff sensor.
 - b. UL listed, factory-built probe and chamber unit mounted externally from the boiler.
 - c. Stainless steel conductivity probes and grounding probe. Virgin Teflon insulation.
- 4. Water columns shall be rated for 1400 kPa (200 psi) minimum saturated steam and have boiler and drain connections.
- 5. Water Column Piping to Boiler and to Drains: ASTM A106 Grade B, seamless or ERW piping, Schedule 80 threaded. Fittings shall be 300 lb. malleable iron or forged steel. All changes in direction shall be with crosses, no ells. Provide valved drain piping connected to the lowest part of each of the water columns.
- 6. Electrical: Provide circuit breakers, transformers, all devices for complete control system. All control electronics and relays shall be in waterproof NEMA 4X panels.

7. Modulating Feedwater Control Valve:

- a. Characterized rotary or sliding gate valve. Operated by electric drive unit actuator with top mount integrated digital positioner. Equal-percent valve flow characteristics. Modified linear valve flow characteristics shall be utilized when digital positioner is furnished.
 - b. Performance: Refer to schedules on the drawings for pressure, temperature and flow requirements. If not shown on the drawings, the valve shall be designed for maximum flow rate of 125% of the maximum boiler steam output with 70 kPa (10 psi) pressure drop, maximum inlet pressure of 2000 kPa (300 psi), maximum temperature of 138 °C (280 °F). Shut-off seat leakage less than 0.0001 percent of valve CV.
 - c. Rotary Valve: Three-piece carbon steel body, 316 SS ball and stem, Polyfil seat, TFE coated SS seal, 2000 kPa (300 psi) 138 °C (280 °F) minimum ratings. Flanged ends or wafer type for pipe sizes over 50 mm (2 inches), threaded ends for pipe sizes 50 mm (2 inches) and under.
 - d. Sliding Gate Valve: Stainless steel body, head section, actuator springs valve stem and fixed disc. Triballoy (STN2) self-aligning sliding disc. Carbon filled PTFE packing. Minimum ratings 2000 kPa (300 psi), 138 degrees C (280 degrees F).
 - e. Sound Levels: Conform to Section 23 05 51, NOISE AND VIBRATION CONTROL FOR BOILER PLANT.
 - f. Electric Drive Unit for Rotary Valve: Shall have sufficient power to operate valve under all operating conditions. All parts of linkage between drive unit and valve shall be free-working, securely attached, and shall not distort under all operating conditions.
8. Shunt Switches for Primary Low Water Cutoff and Auxiliary Low Water Cutoff: Provide separate non-latching shunt switches for each of the low water cutouts to allow manual blowdown of water column without tripping burner. Locate each switch adjacent to the drain valve for the low water cutout that is affected by the switch.
9. Low Water Cutout Operation: Manual reset of primary low water cutoff shall be combined with the burner management manual reset. The burner management system annunciator and associated alarm horn shall indicate the primary and auxiliary low water cutoff operation.

Operation of auxiliary low water cutoff shall shut down power to burner management system.

- E. Stack Thermometer: Dial-type, bi-metal element, stainless steel case and stem, adjustable angle, one percent of full scale accuracy, dual scale, 100 - 550 °C and 200 - 1000 °F, minimum diameter 125 mm (5 inches). Locate at flue gas outlet.
- F. High Steam Pressure Burner Cutouts:
1. Provide two UL listed, FM approved units with different set points. Unit with lowest set point shall be automatic reset; unit with highest set point shall be manual reset.
 2. Bellows actuated sealed snap-acting switch or mercury switch with adjustable set point and adjustable differential pressure (automatic reset unit); switch position indicator.
 3. Rated for 1375 kPa (200 psi) minimum emergency pressure.
 4. Set pressure range: To 150 percent of required set pressure.
 5. Provide indicators with graduated scales for set point and differential pressure.
 6. Mounting: Connect to water column piping. There shall be no valves between cutoff and boiler shell. Provide siphons at each switch to protect bellows from high temperature.
 7. Set Points:
 - a. Automatic Reset Unit: Refer to boiler schedule shown on the drawings. If not shown, set at 35 kPa (5 psi) below the set pressure of the manual reset unit.
 - b. Manual Reset Unit: 35 kPa (5 psi) below lowest safety valve set pressure. Subtractive differential not to exceed 70 kPa (10 psi).
 8. Refer to Section 23 09 11, INSTRUMENTATION and CONTROL FOR BOILER PLANT for the operation of the cutouts.

2.3 BURNER AND FUEL TRAINS:

- A. Burner Type: Parallel position with oxygen trim. Combination natural gas and fuel oil, packaged, forced draft, modulating firing, variable speed forced draft fan. Design for low NOx emissions.
1. Gas Burner: Ring type with multiple ports or spuds.
 2. Oil Burner: Gun type, inside mix, low pressure air atomizing.
 3. Igniter (Pilot): Interrupted, electrically ignited, natural gas and propane.

B. Service:

1. Continuous operation at all firing rates on each fuel listed under Article, PROJECT CONDITIONS of 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.
2. Igniter (Pilot) Fuels: Normal fuel will be natural gas. Propane will be used if there is an interruption in natural gas service.
3. Main Fuels: After boilers are accepted for operation, choice of fuels will be based on cost and availability.

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 at the burner.
 - b. Flame stable with no blowoff from the burner or flashback into the burner. No pulsations.
 - c. No deposits of unburned fuel or carbon at any location.
 - d. No carryover of flame beyond the end of the first pass (furnace tube).
4. Operation:
 - a. Minimum turndown 10/1 firing natural gas and 8/1 firing No. 2 fuel oil.
 - b. Operate at all loads on any one fuel without any manual changes to burners, fuel trains or fuel pressures, atomizing media trains or pressures.
 - c. 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

- d. Performance at any load point shall be repeatable after increasing or decreasing the firing rate. Repeatability plus or minus five percent excess air, at 25 percent and higher boiler loading except excess air must remain within ranges specified above.
 - e. 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.
 - f. 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.
5. Flue Gas Emissions Limits:
- a. Carbon Monoxide: Shall not exceed 200 PPM.
 - b. Smoke: On natural gas and No. 2 oil shall not be visible and shall not exceed No. 1 on the Bacharach smoke scale.
 - c. NOx: 30 ppm maximum, corrected to 3 percent oxygen, dry basis on natural gas and low nitrogen No. 2 fuel oil.
- D. Construction:
- 1. Burner Access (Main Burner and Igniter): Arrange fuel valve and piping trains, controls and other devices so that they do not interfere with the removal and replacement of burner parts.
 - 2. Arrangement of Fuel Valve and Piping Trains: All devices shall be accessible for maintenance or replacement without removal of other devices. 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 and Flue Gas Recirculation (FGR) System (if provided):
 - 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. Provide induced type flue gas recirculation (FGR) system if FGR is necessary to achieve specified NOx limits. All FGR ductwork shall comply with Section 23 51 00, BREECHINGS, CHIMNEYS, and STACKS.

- d. 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, 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 Attenuators: Provide attenuators on forced draft air intakes 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: Mount burner and controls on boiler at factory and fire-test at all load points.

E. Natural Gas Main Fuel 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 (if required), 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. 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, as required by burner and fuel trains furnished, 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.
 - c. Performance: Maximum outlet pressure droop 5 percent of the set pressure over the burner firing range. Maximum lock-up pressure 1.5 times regulated pressure. Speed of response to opening of automatic safety shut off valves shall be sufficient to allow set pressure of low pressure switch to be within 20% of the normal operating pressure with no nuisance burner trips.
 - d Construction, Main Valve: Cast iron body, replaceable plug and seat. Downstream pressure-sensing line.
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. Closed position interlock switch on each valve. Valved leak test fittings before and after each valve.
 - e. Approval: FM approved, UL listed for burner service.
 - f. Proof of Closure Test: Provide non-latching push button controls in the proof of closure circuit to complete the circuit when the valves are open and interrupt the circuit when the valves are closed.
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 CONTROL FOR BOILER PLANT. Switch settings must be within 20% of the controlled pressure. High pressure switches shall have lockable service isolating valves and valved connections for pressurizing the switches and testing the set and trip points.
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).
 - 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. Valve Requirement for Single Point Positioning Jackshaft Control Systems: Valve shall have adjustable characterization cam shaped by at least twelve adjustment screws.
9. Pressure Gages, Flow Meter: Refer to Section 23 09 11, INSTRUMENTATION AND CONTROL FOR BOILER PLANT.
- F. Fuel Oil 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, flow meter (if specified), 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. Pressure Regulator: Do not provide unless required by the burner furnished. Pressure control is provided by a back pressure control valve on the house fuel oil pump set.

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 exceeding upstream safety relief valve set pressure plus accumulation.
 - c. Performance: Timed opening of six seconds or less to safely and smoothly ignite oil burner, one-second closure.
 - d. Construction: Threaded ends, valve position indicator visible from front or side of boiler. Closed position interlock switch on each valve.
 - e. Approval: FM approved, UL listed for burner service.
 - f. Provide valved leak test connections between the two safety shut-off valves and after the second safety shut-off valve.
 - g. Proof of Closure Test: Provide non-latching push button controls in the proof of closure circuit to complete the circuit when the valves are open and interrupt the circuit when the valves are closed.
5. Pressure Switches: Refer to the article on burner management system in Section 23 09 11, INSTRUMENTATION and CONTROL FOR BOILER PLANT. Switch settings must be within 20% of the controlled pressure. High pressure switches shall have lockable service isolating valves and valved connections for pressurizing the switches and testing the set and trip points.
6. Fuel Flow Control Valve:
 - a. Type: Throttling, controlled by combustion control system (Refer to Section 23 09 11, INSTRUMENTATION and CONTROL FOR BOILER PLANT).
 - 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. Valve Requirement for Single Point Positioning Jackshaft Control Systems: Valve shall have adjustable characterization cam shaped by at least twelve adjustment screws.
7. Pressure Gages, Thermometers, Flow Meter: Refer to Section 23 09 11, INSTRUMENTATION and CONTROL FOR BOILER PLANT.

8. Boiler/Burner-Mounted Oil Pump and Relief Valve: Do not provide.
House pumps are provided that include relief valves.

G. Low Pressure Air Atomizing System:

1. Complete system for each burner, furnished by burner manufacturer, including compressor and drive, air filter, after cooler, low pressure switch and all piping systems.
2. Motor: Premium efficiency type. Refer to the Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.
3. Motor Controls: Provide motor starter in NEMA 4 enclosure. 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 control interlock proving power supply to motor.
4. Shaft couplings: All metal, flexible.
5. Sound Attenuators: Provide compressor enclosure, air intake silencer, or other means to reduce sound levels to those required. Refer to the Section 23 05 51, NOISE AND VIBRATION CONTROL FOR BOILER PLANT.
6. Pressure Gages and Pressure Switches: Refer to Section 23 09 11, INSTRUMENTATION AND CONTROL FOR BOILER PLANT.

H. Igniter (Pilot) Fuel 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
 - 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: Propane regulator must be designed for LP gas.
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 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

2.4 BURNER MANAGEMENT (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 NEMA 4 enclosure on side of boiler or on burner. 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.

2.5 TOOLS:

- A. Oil Burner Vise and Wrenches: Deliver to Contracting Officers Technical Representative (COTR)/ Resident Engineer (RE) for mounting by VA personnel. Furnish only if burners require vise and wrenches not stocked by local tool suppliers.
- B. Boiler Tube Brushes: Furnish hand brushes of sizes, and with handle lengths, to clean full length of all tubes in boiler. Provide handle and extension sections 1800 mm (6 feet) long or less to permit storage. Coupled lengths shall be suitable for use from front of boiler.

2.6 SPARE PARTS:

- A. Fuel Trains:
 - 1. One of each type and size of main and pilot fuel motorized and solenoid automatic safety shut-off valves and automatic vent valves.
 - 2. Complete set of filter elements and gaskets for each gas filter for each boiler.
 - 3. Complete set of all gaskets for each edge-type oil filter for each boiler.
- B. Boiler, Burner, Trim, Feedwater Control System:
 - 1. One assembly of electrodes, transformer, and high voltage lead with end connectors for igniters.
 - 2. Two complete sets of gaskets, for each boiler, to fit all doors, handholes, manholes.
 - 3. One clear lens and one tinted lens for each furnace and burner observation port on each boiler.
 - 4. Sufficient tubular glass inserts and gaskets to re-equip water level gage glasses on each boiler.
 - 5. One set of drive belts for each belt-driven apparatus for each boiler.
 - 6. One gallon oil for atomizing air compressor.
 - 7. Complete set of air compressor intake filter elements for each compressor, for each boiler, if disposable filters are provided.

8. One complete feedwater control valve and actuator.

PART 3 - EXECUTION

3.1 INSTALLATION:

- A. Refer to Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.
- B. Boiler and Burner Access Openings: Arrange all equipment and piping to allow access to openings without disassembly of equipment or piping. Provide space that permits full opening of all boiler and burner doors, panels and other access openings. Provide space for pulling full length of all boiler tubes directly from their installed location.
- C. Drainage Facilities for Boiler Water Column, Gage Glass, Low Water Cutoffs, Water Level Alarms:
 1. Refer to Detail, FIRETUBE BOILER.
 2. Locate and orient sight flow indicators so that one person can view the fluid flow while simultaneously operating drain valves and low water cutoff shunt switches.
- D. Boiler Flue Gas Outlet Location: Drawings show a location based on an assumption on the number of passes of the boilers. If the boilers submitted have a different flue gas outlet location, redesign and relocate the stack and breeching systems, at no additional cost to the Government.
- E. Boiler Casing Flashing: Flash or seal all openings in the casing at the top of the boiler at the piping and the flue penetrations to prevent leakage of water into the boiler insulation.

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 and under supervision of boiler manufacturer, the initial firing of the burner shall be performed to boil out all internal surfaces with chemical solution, recommended by boiler manufacturer, to remove all mill scale, corrosion products and other foreign material. Following boil out, boiler shall be washed and flushed until water leaving the boiler is clear. Drain boiler, inspect internal surfaces for cleanliness, then refill boiler with softened and treated water.
 2. Refer to the Article INSPECTIONS AND TESTS for requirements for cleaning boiler after operational tests are completed.

C. Protection from Corrosion:

1. Protect the boilers from fire-side and water-side corrosion at all times.
2. Dry Storage: When the boilers are not filled with water, protect the water-sides and fire-sides 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.
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 Government has accepted the boilers for operation. All chemicals utilized must conform to FDA guidelines applicable for steam used in food preparation.

3.3 INSPECTIONS AND TESTS:

- A. The following tests and demonstrations must be witnessed by the Resident Engineer (RE) or his/her representative, and must prove that boilers, burners, controls, instruments, and accessories comply with requirements. Refer to Section 23 08 11, DEMONSTRATIONS and TESTS FOR BOILER PLANT for general requirements. When test results are not acceptable, make corrections and repeat tests at no additional cost to the Government. Pretests do not require the presence of the RE.
- B. Condition of Boiler After Delivery, Rigging, Placement: After setting boiler on foundation, and prior to making any connections to boiler, the Contractor and RE shall jointly inspect interior and exterior for damage. Correct all damage by repair or replacement to achieve a like new condition.
- C. Hydrostatic Tests:
 1. Boiler: Contractor shall provide inspector certified by National Board of Boiler and Pressure Vessel Inspectors to conduct tests after equipment is installed and connected for operation and prior to initial firing. Test pressure shall be 1-1/2 times the design

- pressure of the boiler 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 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 tests are completed.
- D. Boiler Steam Safety Valves:
1. Test each valve set pressure and blowdown pressure with boiler steam pressure. Perform accumulation test by operating burner at high fire to verify that safety valve flow capacity is sufficient to handle the maximum boiler steaming rate. 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) gage.
 3. Valve Blowdown Tolerance: Reset at not less than 6 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 highest pressure setting and shall remain below the maximum allowable working pressure of the boiler.
- E. Burner Control (Flame Safeguard-Burner Management) System:
1. Demonstrate operation of all control, interlock 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 functions have been pretested.
 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, Combustion Control, Boiler Plant Instrumentation:

1. Perform tests on each boiler on all main burner fuels.
2. If required by local emissions authorities, provide services of testing firm to determine NOx and carbon monoxide. Test firm shall be acceptable to emissions authorities.
3. Test No. P-1:
 - a. Operate boiler on each fuel and record data for at least ten (10) evenly spaced steam loads from low fire start to 100% of full steam output, and in the same sequence back to low fire. Demonstrate performance and efficiency required by paragraphs under Articles BOILER and BURNER AND FUEL TRAINS, and by boiler equipment lists on drawings.
 - b. Demonstrate proper operation of combustion controls, draft control (if provided), feedwater level controls, and instrumentation systems (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. After completion of tests with trim control on manual control, repeat the tests on one fuel with the trim control on automatic control.
4. Test No. P-2:
 - a. Demonstrate sound level of fans and burner systems and atomizing air compressor.
 - b. Test point shall be 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 prepurge and at 100 percent of maximum boiler load.
 - b. Current draw shall not exceed full load current stamped on motor nameplate.
 - c. This test may be combined with Test No. P-1.

6. Test Methods:

- a. Utilize permanent instrumentation systems for data. All systems shall be operable and in calibration.
- b. Utilize portable thermocouple pyrometer furnished and retained by Contractor to measure stack temperature as a verification of permanent stack temperature recorder.
- c. Use portable electronic flue gas analyzer to determine constituents of flue gas. Analyzer shall be capable of measuring oxygen in per cent with accuracy of plus or minus 0.5 percent oxygen 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. Calibrate instrument with certified test gases within three months prior to use and immediately after analyzer cell replacement.
- d. In Test No. P-1 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 tests may be furnished by the hospital systems, by operation of the steam silencer vent system, or by a combination of the above. If variable hospital loads interfere with testing, conduct tests at night or on weekends when loads are more stable.
- f. Utilize 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. NO_x emissions shall be tested with electronic analyzer reading in parts per million. Analyzer shall be calibrated with certified test gas within three months prior to use. Analyzer shall be accurate to plus or minus 5% of reading.

- j. An additional efficiency test will be required, conforming to ASME Performance Test Code PTC 4, if the boiler efficiency determined in the Test P-1 above, does not comply with requirements. Utilize ASME Test Forms PTC 4.1.a, 4.1.b, and the abbreviated input-output and heat balance methods.

7. 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 start-up data sheets 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 at each fuel valve controller position, starting at minimum position, proceeding to the maximum position and returning to the minimum position.
 - 1) Fuel flow and air flow controller position.
 - 2) Fuel pressures: At burner and also upstream of fuel flow control valve.
 - 3) Fuel flow rate.
 - 4) Boiler feed pressure, upstream of feedwater regulator (at minimum, 50 percent, maximum firing positions only).
 - 5) Boiler feed temperature (at minimum, 50 percent, maximum firing positions only).
 - 6) Stack temperature: Boiler outlet.
 - 7) Flue gas oxygen and carbon monoxide (utilize flue gas analyzer which has been calibrated with certified test gases).
 - 8) Steam flow rate (at minimum, 50 percent, maximum firing position only).
 - 9) Steam pressure - Boiler, Header (at minimum, 50 percent, maximum positions only).
 - 10) Opacity of flue gas.
 - 11) Flue gas NOx (if limit specified).
 - 12) Combustion air temperature - dry bulb and wet bulb.
 - 13) Barometric pressure (one reading).
- d. Calibrate all pressure gages prior to pretest.

G. 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, deposits, and any other type of damage or defect.
2. In preparation for the inspection, open all manways, handholes, and access doors or panels at the ends of the boiler. Drain and clean the interior of all pressure parts and clean all soot and debris from furnace and fire tubes.
3. Any corrosion, damage or defect shall be corrected to a like new condition in the judgment of the boiler inspector.
4. After the boiler inspector has approved the boiler, all manways, handholes, and the access doors shall be closed with new gaskets.

H. If burner operation results in deposits of carbonaceous materials in the furnace or tubes clean the furnace and tubes, modify the burners as necessary, and retest the burner performance.

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
01-01-16

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section applies to all sections of Division 26.
- B. Furnish and install electrical systems, materials, equipment, and accessories in accordance with the specifications and drawings. Capacities and ratings of motors, transformers, conductors and cable, switchboards, switchgear, panelboards, motor control centers, generators, automatic transfer switches, and other items and arrangements for the specified items are shown on the drawings.
- C. Conductor ampacities specified or shown on the drawings are based on copper conductors, with the conduit and raceways sized per NEC. Aluminum conductors are prohibited.

1.2 MINIMUM REQUIREMENTS

- A. The latest International Building Code (IBC), Underwriters Laboratories, Inc. (UL), Institute of Electrical and Electronics Engineers (IEEE), and National Fire Protection Association (NFPA) codes and standards are the minimum requirements for materials and installation.
- B. The drawings and specifications shall govern in those instances where requirements are greater than those stated in the above codes and standards.

1.3 TEST STANDARDS

- A. All materials and equipment shall be listed, labeled, or certified by a Nationally Recognized Testing Laboratory (NRTL) to meet Underwriters Laboratories, Inc. (UL), standards where test standards have been established. Materials and equipment which are not covered by UL standards will be accepted, providing that materials and equipment are listed, labeled, certified or otherwise determined to meet the safety requirements of a NRTL. Materials and equipment which no NRTL accepts, certifies, lists, labels, or determines to be safe, will be considered if inspected or tested in accordance with national industrial standards, such as ANSI, NEMA, and NETA. Evidence of compliance shall include certified test reports and definitive shop drawings.

B. Definitions:

1. Listed: Materials and equipment included in a list published by an organization that is acceptable to the Authority Having Jurisdiction and concerned with evaluation of products or services, that maintains periodic inspection of production or listed materials and equipment or periodic evaluation of services, and whose listing states that the materials and equipment either meets appropriate designated standards or has been tested and found suitable for a specified purpose.
2. Labeled: Materials and equipment to which has been attached a label, symbol, or other identifying mark of an organization that is acceptable to the Authority Having Jurisdiction and concerned with product evaluation, that maintains periodic inspection of production of labeled materials and equipment, and by whose labeling the manufacturer indicates compliance with appropriate standards or performance in a specified manner.
3. Certified: Materials and equipment which:
 - a. Have been tested and found by a NRTL to meet nationally recognized standards or to be safe for use in a specified manner.
 - b. Are periodically inspected by a NRTL.
 - c. Bear a label, tag, or other record of certification.
4. Nationally Recognized Testing Laboratory: Testing laboratory which is recognized and approved by the Secretary of Labor in accordance with OSHA regulations.

1.4 QUALIFICATIONS (PRODUCTS AND SERVICES)

- A. Manufacturer's Qualifications: The manufacturer shall regularly and currently produce, as one of the manufacturer's principal products, the materials and equipment specified for this project, and shall have manufactured the materials and equipment for at least three years.
- B. Product Qualification:
 1. Manufacturer's materials and equipment shall have been in satisfactory operation, on three installations of similar size and type as this project, for at least three years.
 2. The Government reserves the right to require the Contractor to submit a list of installations where the materials and equipment have been in operation before approval.

- C. Service Qualifications: There shall be a permanent service organization maintained or trained by the manufacturer which will render satisfactory service to this installation within four hours of receipt of notification that service is needed. Submit name and address of service organizations.

1.5 APPLICABLE PUBLICATIONS

- A. Applicable publications listed in all Sections of Division 26 shall be the latest issue, unless otherwise noted.
- B. Products specified in all sections of Division 26 shall comply with the applicable publications listed in each section.

1.6 MANUFACTURED PRODUCTS

- A. Materials and equipment furnished shall be of current production by manufacturers regularly engaged in the manufacture of such items, and for which replacement parts shall be available. Materials and equipment furnished shall be new, and shall have superior quality and freshness.
- B. When more than one unit of the same class or type of materials and equipment is required, such units shall be the product of a single manufacturer.
- C. Equipment Assemblies and Components:
 - 1. Components of an assembled unit need not be products of the same manufacturer.
 - 2. Manufacturers of equipment assemblies, which include components made by others, shall assume complete responsibility for the final assembled unit.
 - 3. Components shall be compatible with each other and with the total assembly for the intended service.
 - 4. Constituent parts which are similar shall be the product of a single manufacturer.
- D. Factory wiring and terminals shall be identified on the equipment being furnished and on all wiring diagrams.
- E. When Factory Tests are specified, Factory Tests shall be performed in the factory by the equipment manufacturer, and witnessed by the contractor. In addition, the following requirements shall be complied with:
 - 1. The Government shall have the option of witnessing factory tests.
The Contractor shall notify the Government through the COR a minimum

- of thirty (30) days prior to the manufacturer's performing of the factory tests.
2. When factory tests are successful, contractor shall furnish four (4) copies of the equipment manufacturer's certified test reports to the COR fourteen (14) days prior to shipment of the equipment, and not more than ninety (90) days after completion of the factory tests.
 3. When factory tests are not successful, factory tests shall be repeated in the factory by the equipment manufacturer, and witnessed by the Contractor. The Contractor shall be liable for all additional expenses for the Government to witness factory re-testing.

1.7 VARIATIONS FROM CONTRACT REQUIREMENTS

- A. Where the Government or the Contractor requests variations from the contract requirements, the connecting work and related components shall include, but not be limited to additions or changes to branch circuits, circuit protective devices, conduits, wire, feeders, controls, panels and installation methods.

1.8 MATERIALS AND EQUIPMENT PROTECTION

- A. Materials and equipment shall be protected during shipment and storage against physical damage, vermin, dirt, corrosive substances, fumes, moisture, cold and rain.
 1. Store materials and equipment indoors in clean dry space with uniform temperature to prevent condensation.
 2. During installation, equipment shall be protected against entry of foreign matter, and be vacuum-cleaned both inside and outside before testing and operating. Compressed air shall not be used to clean equipment. Remove loose packing and flammable materials from inside equipment.
 3. Damaged equipment shall be repaired or replaced, as determined by the COR.
 4. Painted surfaces shall be protected with factory installed removable heavy kraft paper, sheet vinyl or equal.
 5. Damaged paint on equipment shall be refinished with the same quality of paint and workmanship as used by the manufacturer so repaired areas are not obvious.

1.9 WORK PERFORMANCE

- A. All electrical work shall comply with requirements of the latest NFPA 70 (NEC), NFPA 70B, NFPA 70E, NFPA 99, NFPA 110, OSHA Part 1910 subpart J – General Environmental Controls, OSHA Part 1910 subpart K – Medical and First Aid, and OSHA Part 1910 subpart S – Electrical, in addition to other references required by contract.
- B. Job site safety and worker safety is the responsibility of the Contractor.
- C. Electrical work shall be accomplished with all affected circuits or equipment de-energized. However, energized electrical work may be performed only for the non-destructive and non-invasive diagnostic testing(s), or when scheduled outage poses an imminent hazard to patient care, safety, or physical security. In such case, all aspects of energized electrical work, such as the availability of appropriate/correct personal protective equipment (PPE) and the use of PPE, shall comply with the latest NFPA 70E, as well as the following requirements:
 - 1. Only Qualified Person(s) shall perform energized electrical work. Supervisor of Qualified Person(s) shall witness the work of its entirety to ensure compliance with safety requirements and approved work plan.
 - 2. At least two weeks before initiating any energized electrical work, the Contractor and the Qualified Person(s) who is designated to perform the work shall visually inspect, verify and confirm that the work area and electrical equipment can safely accommodate the work involved.
 - 3. At least two weeks before initiating any energized electrical work, the Contractor shall develop and submit a job specific work plan, and energized electrical work request to the COR, and Medical Center's Chief Engineer or his/her designee. At the minimum, the work plan must include relevant information such as proposed work schedule, area of work, description of work, name(s) of Supervisor and Qualified Person(s) performing the work, equipment to be used, procedures to be used on and near the live electrical equipment, barriers to be installed, safety equipment to be used, and exit pathways.

4. Energized electrical work shall begin only after the Contractor has obtained written approval of the work plan, and the energized electrical work request from the COR, and Medical Center's Chief Engineer or his/her designee. The Contractor shall make these approved documents present and available at the time and place of energized electrical work.
5. Energized electrical work shall begin only after the Contractor has invited and received acknowledgment from the COR, and Medical Center's Chief Engineer or his/her designee to witness the work.
- D. For work that affects existing electrical systems, arrange, phase and perform work to assure minimal interference with normal functioning of the facility. Refer to Article OPERATIONS AND STORAGE AREAS under Section 01 00 00, GENERAL REQUIREMENTS.
- E. New work shall be installed and connected to existing work neatly, safely and professionally. Disturbed or damaged work shall be replaced or repaired to its prior conditions, as required by Section 01 00 00, GENERAL REQUIREMENTS.
- F. Coordinate location of equipment and conduit with other trades to minimize interference.

1.10 EQUIPMENT INSTALLATION AND REQUIREMENTS

- A. Equipment location shall be as close as practical to locations shown on the drawings.
- B. Working clearances shall not be less than specified in the NEC.
- C. Inaccessible Equipment:
 1. Where the Government determines that the Contractor has installed equipment not readily accessible for operation and maintenance, the equipment shall be removed and reinstalled as directed at no additional cost to the Government.
 2. "Readily accessible" is defined as being capable of being reached quickly for operation, maintenance, or inspections without the use of ladders, or without climbing or crawling under or over obstacles such as, but not limited to, motors, pumps, belt guards, transformers, piping, ductwork, conduit and raceways.
- D. Electrical service entrance equipment and arrangements for temporary and permanent connections to the electric utility company's system shall conform to the electric utility company's requirements. Coordinate fuses, circuit breakers and relays with the electric utility

company's system, and obtain electric utility company approval for sizes and settings of these devices.

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, transformers, pull boxes, future intercept provisions, fused and non-fused safety switches, generators, automatic transfer switches, separately enclosed circuit breakers, individual breakers and controllers in switchboards, switchgear and motor control assemblies, control devices and other significant equipment.
- B. Identification signs for Normal Power System equipment shall be laminated black phenolic resin with a white core with engraved lettering. Identification signs for Essential Electrical System (EES) equipment, as defined in the NEC, shall be laminated red phenolic resin with a white core with engraved lettering. Lettering shall be a minimum of 12 mm (1/2 inch) high. Identification signs shall indicate equipment designation, rated bus amperage, voltage, number of phases, number of wires, type of EES power branch as applicable, source panel and circuit number, and room number of source. Secure nameplates with screws.
- C. Install adhesive arc flash warning labels on all equipment as required by the latest NFPA 70E. Label shall show specific and correct information for specific equipment based on its arc flash calculations. Label shall show the followings:
 - 1. Nominal system voltage.
 - 2. Equipment/bus name, date prepared, and manufacturer name and address.
 - 3. Arc flash boundary.
 - 4. Available arc flash incident energy and the corresponding working distance.
 - 5. Minimum arc rating of clothing.
 - 6. Site-specific level of PPE.
- D. Unless noted otherwise or accomplished by requirements in other section, labels shall be provided for all receptacles, junction boxes, switches, enclosures, and all wall plates provided under this project. At a minimum, labels installed as required by this paragraph shall include source panel and circuit number.

1.12 SUBMITTALS

- A. Submit to the COR in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. The Government's approval shall be obtained for all materials and equipment before delivery to the job site. Delivery, storage or installation of materials and equipment which has not had prior approval will not be permitted.
- C. All submittals shall include six copies of adequate descriptive literature, catalog cuts, shop drawings, test reports, certifications, samples, and other data necessary for the Government to ascertain that the proposed materials and equipment comply with drawing and specification requirements. Catalog cuts submitted for approval shall be legible and clearly identify specific materials and equipment being submitted. In addition, contractor shall provide electronic version of submittal to A/E firm.
- D. Submittals for individual systems and equipment assemblies which consist of more than one item or component shall be made for the system or assembly as a whole. Partial submittals will not be considered for approval.
 - 1. Mark the submittals, "SUBMITTED UNDER SECTION_____".
 - 2. Submittals shall be marked to show specification reference including the section and paragraph numbers.
 - 3. Submit each section separately.
- E. The submittals shall include the following:
 - 1. Information that confirms compliance with contract requirements. Include the manufacturer's name, model or catalog numbers, catalog information, technical data sheets, shop drawings, manuals, pictures, nameplate data, and test reports as required.
 - 2. 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.
 - 3. Parts list which shall include information for replacement parts and ordering instructions, as recommended by the equipment manufacturer.
 - 4. Explicit statement from manufacturer indicating that each of the specific items being submitted are "BUY AMERICAN ACT" compliant. Explicit statement of compliance shall be included with product submittals.

F. Maintenance and Operation Manuals:

1. Submit as required for systems and equipment specified in the technical sections. Furnish in hardcover binders or an approved equivalent.
2. Inscribe the following identification on the cover: the words "MAINTENANCE AND OPERATION MANUAL," the name and location of the system, material, equipment, building, name of Contractor, and contract name and number. Include in the manual the names, addresses, and telephone numbers of each subcontractor installing the system or equipment and the local representatives for the material or equipment.
3. Provide a table of contents and assemble the manual to conform to the table of contents, with tab sheets placed before instructions covering the subject. The instructions shall be legible and easily read, with large sheets of drawings folded in.
4. The manuals shall include:
 - a. Internal and interconnecting wiring and control diagrams with data to explain detailed operation and control of the equipment.
 - b. A control sequence describing start-up, operation, and shutdown.
 - c. Description of the function of each principal item of equipment.
 - d. Installation instructions.
 - e. Safety precautions for operation and maintenance.
 - f. Diagrams and illustrations.
 - g. Periodic maintenance and testing procedures and frequencies, including replacement parts numbers.
 - h. Performance data.
 - i. Pictorial "exploded" parts list with part numbers. Emphasis shall be placed on the use of special tools and instruments. The list shall indicate sources of supply, recommended spare and replacement parts, and name of servicing organization.
 - j. List of factory approved or qualified permanent servicing organizations for equipment repair and periodic testing and maintenance, including addresses and factory certification qualifications.

- G. Approvals will be based on complete submission of shop drawings, manuals, test reports, certifications, and samples as applicable.

- H. After approval and prior to installation, furnish the COR with one sample of each of the following:
1. A minimum 300 mm (12 inches) length of each type and size of wire and cable along with the tag from the coils or reels from which the sample was taken. The length of the sample shall be sufficient to show all markings provided by the manufacturer.
 2. Each type of conduit coupling, bushing, and termination fitting.
 3. Conduit hangers, clamps, and supports.
 4. Duct sealing compound.
 5. Each type of receptacle, toggle switch, lighting control sensor, outlet box, manual motor starter, device wall plate, engraved nameplate, wire and cable splicing and terminating material, and branch circuit single pole molded case circuit breaker.

1.13 SINGULAR NUMBER

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

1.14 ACCEPTANCE CHECKS AND TESTS

- A. Checks and tests shall be witnessed by the COR and VA Electrical Shop supervisor; signatures shall be obtained.
- B. The Contractor shall furnish the instruments, materials, and labor for tests.
- C. Where systems are comprised of components specified in more than one section of Division 26, the Contractor shall coordinate the installation, testing, and adjustment of all components between various manufacturer's representatives and technicians so that a complete, functional, and operational system is delivered to the Government.
- D. When test results indicate any defects, the Contractor shall repair or replace the defective materials or equipment, and repeat the tests for the equipment. Repair, replacement, and re-testing shall be accomplished at no additional cost to the Government.

1.15 WARRANTY

- A. All work performed and all equipment and material furnished under this Division shall be free from defects and shall remain so for a period of one year from the date of acceptance of the entire installation by the Contracting Officer for the Government.

1.16 INSTRUCTION

- A. Instruction to designated Government personnel shall be provided for the particular equipment or system as required in each associated technical specification section.
- B. Furnish the services of competent and factory-trained instructors to give full instruction in the adjustment, operation, and maintenance of the specified equipment and system, including pertinent safety requirements. Instructors shall be thoroughly familiar with all aspects of the installation, and shall be factory-trained in operating theory as well as practical operation and maintenance procedures.
- C. A training schedule shall be developed and submitted by the Contractor and approved by the COR at least 30 days prior to the planned training.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

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SECTION 26 05 19
LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES
07-01-13

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section specifies the furnishing, installation, connection, and testing of the electrical conductors and cables for use in electrical systems rated 600 V and below, indicated as cable(s), conductor(s), wire, or wiring in this section.

1.2 RELATED WORK

- A. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS:
Requirements that apply to all sections of Division 26.
- B. 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.
- C. Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS: Conduits for conductors and cables.

1.3 QUALITY ASSURANCE

- A. Refer to Paragraph, QUALIFICATIONS (PRODUCTS AND SERVICES), in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1.4 FACTORY TESTS

- A. Conductors and cables shall be thoroughly tested at the factory per NEMA to ensure that there are no electrical defects. Factory tests shall be certified.

1.5 SUBMITTALS

- A. Submit six copies of the following in accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.
 - 1. Shop Drawings:
 - a. Submit sufficient information to demonstrate compliance with drawings and specifications.
 - b. Submit the following data for approval:
 - 1) Electrical ratings, insulation type, and color for each conductor and cable.
 - 2) Splicing materials and pulling lubricant.

2. Certifications: Two weeks prior to final inspection, submit the following.

- a. Certification by the manufacturer that the conductors and cables conform to the requirements of the drawings and specifications.
- b. Certification by the Contractor that the conductors and cables have been properly installed, adjusted, and tested.

1.6 APPLICABLE PUBLICATIONS

- A. Publications listed below (including amendments, addenda, revisions, supplements and errata) form a part of this specification to the extent referenced. Publications are reference in the text by designation only.
- B. American Society of Testing Material (ASTM):
 - D2301-10.....Standard Specification for Vinyl Chloride
Plastic Pressure-Sensitive Electrical
Insulating Tape
 - D2304-10.....Test Method for Thermal Endurance of Rigid
Electrical Insulating Materials
 - D3005-10.....Low-Temperature Resistant Vinyl Chloride
Plastic Pressure-Sensitive Electrical
Insulating Tape
- C. National Electrical Manufacturers Association (NEMA):
 - WC 70-09.....Power Cables Rated 2000 Volts or Less for the
Distribution of Electrical Energy
- D. National Fire Protection Association (NFPA):
 - 70-11.....National Electrical Code (NEC)
- E. Underwriters Laboratories, Inc. (UL):
 - 44-10.....Thermoset-Insulated Wires and Cables
 - 83-08.....Thermoplastic-Insulated Wires and Cables
 - 467-07.....Grounding and Bonding Equipment
 - 486A-486B-03.....Wire Connectors
 - 486C-04.....Splicing Wire Connectors
 - 486D-05.....Sealed Wire Connector Systems
 - 486E-09.....Equipment Wiring Terminals for Use with
Aluminum and/or Copper Conductors
 - 493-07.....Thermoplastic-Insulated Underground Feeder and
Branch Circuit Cables
 - 514B-04.....Conduit, Tubing, and Cable Fittings

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

- A. Conductors and cables shall be in accordance with NEMA, UL, as specified herein, and as shown on the drawings.
- B. All conductors shall be copper.
- C. Single Conductor and Cable:
 - 1. No. 12 AWG: Minimum size, except where smaller sizes are specified herein or shown on the drawings.
 - 2. No. 12 AWG and larger: Stranded.
 - 3. No. 14 AWG and smaller: Solid; except shall be stranded for final connection to motors, transformers, and vibrating equipment.
 - 4. Insulation: THHN-THWN.
- D. Color Code:
 - 1. All conductors regardless of size: Solid color insulation or solid color coating.
 - 2. For modifications and additions to existing wiring systems, color coding shall conform to the existing wiring system.
 - 3. Conductors shall be color-coded as follows:

208/120 V	Phase	480/277 V
Black	A	Brown
Red	B	Orange
Blue	C	Yellow
White	Neutral	Gray *
* or white with colored (other than green) tracer.		

- 4. Lighting circuit "switch legs", and 3-way and 4-way switch "traveling wires," shall have color coding that is unique and distinct (e.g., pink and purple) from the color coding indicated above. The unique color codes shall be solid and in accordance with the NEC. Coordinate color coding in the field with the COR.

2.2 SPLICES

- A. Splices shall be in accordance with NEC and UL.
- B. Above Ground Splices for No. 10 AWG and Smaller:
 - 1. Solderless, screw-on, reusable pressure cable type, with integral insulation, approved for copper and aluminum conductors.
 - 2. The integral insulator shall have a skirt to completely cover the stripped conductors.

3. The number, size, and combination of conductors used with the connector, as listed on the manufacturer's packaging, shall be strictly followed.

C. Above Ground Splices for No. 8 AWG to No. 4/0 AWG:

1. Compression, hex screw, or bolt clamp-type of high conductivity and corrosion-resistant material, listed for use with copper and aluminum conductors. Contractor shall obtain written COR or VA Electrical Shop approval prior to use.
2. Insulate with materials approved for the particular use, location, voltage, and temperature. Insulation level shall be not less than the insulation level of the conductors being joined.
3. Splice and insulation shall be product of the same manufacturer.
4. All bolts, nuts, and washers used with splices shall be zinc-plated steel.

D. Above Ground Splices for 250 kcmil and Larger:

1. Long barrel "butt-splice" or "sleeve" type compression connectors, with minimum of two compression indents per wire, listed for use with copper and aluminum conductors.
2. Insulate with materials approved for the particular use, location, voltage, and temperature. Insulation level shall be not less than the insulation level of the conductors being joined.
3. Splice and insulation shall be product of the same manufacturer.

E. Plastic electrical insulating tape: Per ASTM D2304, flame-retardant, cold and weather resistant.

2.3 CONNECTORS AND TERMINATIONS

- A. Mechanical type of high conductivity and corrosion-resistant material, listed for use with copper and aluminum conductors.
- B. Long barrel compression type of high conductivity and corrosion-resistant material, with minimum of two compression indents per wire, listed for use with copper and aluminum conductors.
- C. All bolts, nuts, and washers used to connect connections and terminations to bus bars or other termination points shall be zinc-plated steel.

2.4 CONTROL WIRING

- A. Unless otherwise specified elsewhere in these specifications, control wiring shall be as specified herein, except that the minimum size shall be not less than No. 14 AWG.

- B. Control wiring shall be sized such that the voltage drop under in-rush conditions does not adversely affect operation of the controls.

2.5 WIRE LUBRICATING COMPOUND

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

PART 3 - EXECUTION

3.1 GENERAL

- A. Install conductors in accordance with the NEC, as specified, and as shown on the drawings.
- B. Install all conductors in raceway systems.
- C. Splice conductors only in outlet boxes, junction boxes, pullboxes, manholes, or handholes.
- D. Conductors of different systems (e.g., 120 V and 277 V) shall not be installed in the same raceway. This requirement shall also apply to conductors of separate power branches (e.g., Critical and Equipment).
- E. Install cable supports for all vertical feeders in accordance with the NEC. Provide split wedge type which firmly clamps each individual cable and tightens due to cable weight.
- F. In panelboards, cabinets, wireways, switches, enclosures, and equipment assemblies, neatly form, train, and tie the conductors with non-metallic ties.
- G. Use expanding foam or non-hardening duct-seal to seal conduits entering a building, after installation of conductors.
- H. Conductor and Cable Pulling:
 - 1. Provide installation equipment that will prevent the cutting or abrasion of insulation during pulling. Use lubricants approved for the cable.
 - 2. Use nonmetallic pullropes.
 - 3. Attach pull ropes by means of either woven basket grips or pulling eyes attached directly to the conductors.
 - 4. All conductors in a single conduit shall be pulled simultaneously.
 - 5. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- I. No more than three branch circuits shall be installed in any one conduit.
- J. When stripping stranded conductors, use a tool that does not damage the conductor or remove conductor strands.

3.2 SPLICE AND TERMINATION INSTALLATION

- A. Splices and terminations shall be mechanically and electrically secure, and tightened to manufacturer's published torque values using a torque screwdriver or wrench.
- B. Where the Government determines that unsatisfactory splices or terminations have been installed, replace the splices or terminations at no additional cost to the Government.
- C. Plan all work to minimize splices.

3.3 FEEDER CONDUCTOR IDENTIFICATION

- A. In each interior pullbox and each underground manhole and handhole, install plastic tags on all feeder conductors to clearly designate their circuit identification and voltage. The tags shall be the engraved type, 1-1/2 inches in diameter and 40 mils thick. Attach tags with plastic ties.

3.4 EXISTING CONDUCTORS

- A. Unless specifically indicated on the plans, existing conductors shall not be reused.

3.5 CONTROL WIRING INSTALLATION

- A. Unless otherwise specified in other sections, install control wiring and connect to equipment to perform the required functions as specified or as shown on the drawings.
- B. Install a separate power supply circuit for each system, except where otherwise shown on the drawings.

3.6 CONTROL WIRING IDENTIFICATION

- A. Install a permanent wire marker on each wire at each termination.
- B. Identifying numbers and letters on the wire markers shall correspond to those on the wiring diagrams used for installing the systems.
- C. Wire markers shall retain their markings after cleaning.
- D. In each manhole and handhole, install engraved plastic tags to identify the system served and function.

3.7 ACCEPTANCE CHECKS AND TESTS

- A. Checks and tests shall be witnessed by COR and VA Electrical Shop supervisor; signatures must be obtained for each check or test.

B. Perform in accordance with the manufacturer's recommendations. In addition, include the following:

1. Visual Inspection and Tests: Inspect physical condition.
2. Electrical tests:
 - a. After installation but before connection to utilization devices, such as fixtures, motors, or appliances, test conductors phase-to-phase and phase-to-ground resistance with an insulation resistance tester. Existing conductors to be reused shall also be tested.
 - b. Applied voltage shall be 500 V DC for 300 V rated cable, and 1000 V DC for 600 V rated cable. Apply test for one minute or until reading is constant for 15 seconds, whichever is longer. Minimum insulation resistance values shall not be less than 25 megohms for 300 V rated cable and 100 megohms for 600 V rated cable.
 - c. Perform phase rotation test on all three-phase circuits.

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SECTION 26 05 26
GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS
12-01-15

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section specifies the furnishing, installation, connection, and testing of grounding and bonding equipment, indicated as grounding equipment in this section.
- B. "Grounding electrode system" refers to grounding electrode conductors and all electrodes required or allowed by NEC, as well as made, supplementary, and lightning protection system grounding electrodes.
- C. The terms "connect" and "bond" are used interchangeably in this section and have the same meaning.

1.2 RELATED WORK

- A. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS:
Requirements that apply to all sections of Division 26.
- B. Section 26 05 19, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES:
Low-voltage conductors.
- C. Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS: Conduit and boxes.
- D. Section 26 24 16, PANELBOARDS: Low-voltage panelboards.

1.3 QUALITY ASSURANCE

- A. Refer to Paragraph, QUALIFICATIONS (PRODUCTS AND SERVICES), in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1.4 SUBMITTALS

- A. Submit six copies of the following in accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.
 - 1. Shop Drawings:
 - a. Submit sufficient information to demonstrate compliance with drawings and specifications.
 - b. Submit plans showing the location of system grounding electrodes and connections, and the routing of aboveground and underground grounding electrode conductors.
 - 2. Test Reports:
 - a. Two weeks prior to the final inspection, submit ground resistance field test reports to the COR.

3. Certifications:

- a. Certification by the Contractor that the grounding equipment has been properly installed and tested.

1.5 APPLICABLE PUBLICATIONS

- A. Publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by designation only.
- B. American Society for Testing and Materials (ASTM):
- B1-07.....Standard Specification for Hard-Drawn Copper Wire
- B3-07.....Standard Specification for Soft or Annealed Copper Wire
- B8-11.....Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
- C. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
- 81-83.....IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System Part 1: Normal Measurements
- D. National Fire Protection Association (NFPA):
- 70-11.....National Electrical Code (NEC)
- 70E-12.....National Electrical Safety Code
- 99-12.....Health Care Facilities
- E. Underwriters Laboratories, Inc. (UL):
- 44-10Thermoset-Insulated Wires and Cables
- 83-08Thermoplastic-Insulated Wires and Cables
- 467-07Grounding and Bonding Equipment

PART 2 - PRODUCTS

2.1 GROUNDING AND BONDING CONDUCTORS

- A. Equipment grounding conductors shall be insulated stranded copper, except that sizes No. 12 AWG and smaller shall be solid copper. Insulation color shall be continuous green for all equipment grounding conductors, regardless of size. Use of colored tape is not acceptable.

- B. Bonding conductors shall be bare stranded copper, except that sizes No. 10 AWG and smaller shall be bare solid copper. Bonding conductors shall be stranded for final connection to motors, transformers, and vibrating equipment.
- C. Conductor sizes shall not be less than shown on the drawings, or not less than required by the NEC, whichever is greater.
- D. Insulation: THHN-THWN.

2.2 GROUND CONNECTIONS

- A. Above Grade:
 - 1. Bonding Jumpers: Listed for use with aluminum and copper conductors. For wire sizes No. 8 AWG and larger, use compression-type connectors. For wire sizes smaller than No. 8 AWG, use mechanical type lugs. Connectors or lugs shall use zinc-plated steel bolts, nuts, and washers. Bolts shall be torqued to the values recommended by the manufacturer.
 - 2. Connection to Grounding Bus Bars: Listed for use with aluminum and copper conductors. Use mechanical type lugs, with zinc-plated steel bolts, nuts, and washers. Bolts shall be torqued to the values recommended by the manufacturer.
 - 3. Connection to Equipment Rack and Cabinet Ground Bars: Listed for use with aluminum and copper conductors. Use mechanical type lugs, with zinc-plated steel bolts, nuts, and washers. Bolts shall be torqued to the values recommended by the manufacturer.

2.3 EQUIPMENT RACK AND CABINET GROUND BARS

- A. Provide solid copper ground bars designed for mounting on the framework of open or cabinet-enclosed equipment racks. Ground bars shall have minimum dimensions of 6.3 mm (0.25 inch) thick x 19 mm (0.75 inch) wide, with length as required or as shown on the drawings. Provide insulators and mounting brackets.

2.4 GROUND TERMINAL BLOCKS

- A. At any equipment mounting location (e.g., backboards and hinged cover enclosures) where rack-type ground bars cannot be mounted, provide mechanical type lugs, with zinc-plated steel bolts, nuts, and washers. Bolts shall be torqued to the values recommended by the manufacturer.

2.5 GROUNDING BUS BAR

- A. Pre-drilled rectangular copper bar with stand-off insulators, minimum 6.3 mm (0.25 inch) thick x 100 mm (4 inches) high in cross-section, length as shown on the drawings, with hole size, quantity, and spacing per detail shown on the drawings. Provide insulators and mounting brackets.

PART 3 - EXECUTION

3.1 GENERAL

- A. Install grounding equipment in accordance with the NEC, as shown on the drawings, and as specified herein.
- B. System Grounding:
 - 1. Separately derived systems (transformers downstream from the service entrance): Ground the secondary neutral.
- C. Equipment Grounding: Metallic piping, building structural steel, electrical enclosures, raceways, junction boxes, outlet boxes, cabinets, machine frames, and other conductive items in close proximity with electrical circuits, shall be bonded and grounded.

3.2 INACCESSIBLE GROUNDING CONNECTIONS

- A. Make grounding connections, which are normally buried or otherwise inaccessible, by exothermic weld.

3.3 SECONDARY VOLTAGE EQUIPMENT AND CIRCUITS

- A. Main Bonding Jumper: Existing to remain.
- B. Metallic Piping, Building Structural Steel, and Supplemental Electrode(s): Existing to remain.
- C. Switchboards, Panelboards, and other electrical equipment:
 - 1. Connect the equipment grounding conductors to the ground bus.
 - 2. Connect metallic conduits by grounding bushings and equipment grounding conductor to the equipment ground bus.
- D. Transformers:
 - 1. Separately derived systems (transformers downstream from service equipment): Ground the secondary neutral at the transformer. Provide a grounding electrode conductor from the transformer to the nearest component of the grounding electrode system, unless directed otherwise on the drawings.

3.4 RACEWAY

A. Conduit Systems:

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

B. Feeders and Branch Circuits: Install equipment grounding conductors with all feeders, and power and lighting branch circuits.

C. Boxes, Cabinets, Enclosures, and Panelboards:

1. Bond the equipment grounding conductor to each pullbox, junction box, outlet box, device box, cabinets, and other enclosures through which the conductor passes (except for special grounding systems for intensive care units and other critical units shown).
2. Provide lugs in each box and enclosure for equipment grounding conductor termination.

D. Wireway Systems:

1. Bond the metallic structures of wireway to provide electrical continuity throughout the wireway system, by connecting a No. 6 AWG bonding jumper at all intermediate metallic enclosures and across all section junctions.
2. Install insulated No. 6 AWG bonding jumpers between the wireway system, bonded as required above, and the closest building ground at each end and approximately every 16 M (50 feet).
3. Use insulated No. 6 AWG bonding jumpers to ground or bond metallic wireway at each end for all intermediate metallic enclosures and across all section junctions.

4. Use insulated No. 6 AWG bonding jumpers to ground cable tray to column-mounted building ground plates (pads) at each end and approximately every 15 M (49 feet).
- E. Receptacles shall not be grounded through their mounting screws. Ground receptacles with a jumper from the receptacle green ground terminal to the device box ground screw and a jumper to the branch circuit equipment grounding conductor.
- F. Ground lighting fixtures to the equipment grounding conductor of the wiring system. Fixtures connected with flexible conduit shall have a green ground wire included with the power wires from the fixture through the flexible conduit to the first outlet box.
- G. Fixed electrical appliances and equipment shall be provided with a ground lug for termination of the equipment grounding conductor.

3.5 CORROSION INHIBITORS

- A. When making grounding and bonding connections, apply a corrosion inhibitor to all contact surfaces. Use corrosion inhibitor appropriate for protecting a connection between the metals used.

3.6 CONDUCTIVE PIPING

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

---END---

SECTION 26 05 33
RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS
05-01-14

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 09 91 00, PAINTING: Identification and painting of conduit and other devices.
- B. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements and items that are common to more than one section of Division 26.
- C. Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS: Requirements for personnel safety and to provide a low impedance path for possible ground fault currents.

1.3 QUALITY ASSURANCE

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

1.4 SUBMITTALS

- A. Submit six copies of the following in accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.
 - 1. Shop Drawings:
 - a. Size and location of main feeders.
 - b. Size and location of panels and pull-boxes.
 - c. Layout of required conduit penetrations through structural elements.
 - d. Submit the following data for approval:
 - 1) Raceway types and sizes.
 - 2) Conduit bodies, connectors and fittings.
 - 3) Junction and pull boxes, types and sizes.
 - 2. Certifications: Two weeks prior to final inspection, submit the following:

- a. Certification by the manufacturer that raceways, conduits, conduit bodies, connectors, fittings, junction and pull boxes, and all related equipment conform to the requirements of the drawings and specifications.
- b. Certification by the Contractor that raceways, conduits, conduit bodies, connectors, fittings, junction and pull boxes, and all related equipment have been properly installed.

1.5 APPLICABLE PUBLICATIONS

- A. Publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by designation only.
- B. American National Standards Institute (ANSI):
 - C80.1-05.....Electrical Rigid Steel Conduit
 - C80.3-05.....Steel Electrical Metal Tubing
 - C80.6-05.....Electrical Intermediate Metal Conduit
- C. National Fire Protection Association (NFPA):
 - 70-11.....National Electrical Code (NEC)
- D. Underwriters Laboratories, Inc. (UL):
 - 1-05.....Flexible Metal Conduit
 - 5-11.....Surface Metal Raceway and Fittings
 - 6-07.....Electrical Rigid Metal Conduit - Steel
 - 50-95.....Enclosures for Electrical Equipment
 - 360-13.....Liquid-Tight Flexible Steel Conduit
 - 467-13.....Grounding and Bonding Equipment
 - 514A-13.....Metallic Outlet Boxes
 - 514B-12.....Conduit, Tubing, and Cable Fittings
 - 514C-07.....Nonmetallic Outlet Boxes, Flush-Device Boxes
and Covers
 - 651-11.....Schedule 40 and 80 Rigid PVC Conduit and
Fittings
 - 651A-11.....Type EB and A Rigid PVC Conduit and HDPE
Conduit
 - 797-07.....Electrical Metallic Tubing
 - 1242-06.....Electrical Intermediate Metal Conduit - Steel
- E. National Electrical Manufacturers Association (NEMA):
 - TC-2-13.....Electrical Polyvinyl Chloride (PVC) Tubing and
Conduit

TC-3-13.....PVC Fittings for Use with Rigid PVC Conduit and
Tubing

FB1-12.....Fittings, Cast Metal Boxes and Conduit Bodies
for Conduit, Electrical Metallic Tubing and
Cable

FB2.10-13.....Selection and Installation Guidelines for
Fittings for use with Non-Flexible Conduit or
Tubing (Rigid Metal Conduit, Intermediate
Metallic Conduit, and Electrical Metallic
Tubing)

FB2.20-12.....Selection and Installation Guidelines for
Fittings for use with Flexible Electrical
Conduit and Cable

F. American Iron and Steel Institute (AISI):

S100-2007.....North American Specification for the Design of
Cold-Formed Steel Structural Members

PART 2 - PRODUCTS

2.1 MATERIAL

A. Conduit Size: In accordance with the NEC, but not less than 3/4 inch
unless otherwise shown.

B. Conduit:

1. Rigid Steel Conduit (RMC): 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 105 mm (4 inches) and shall be
permitted only with cable rated 600 V or less.

4. Flexible Metal Conduit: Shall conform to UL 1.

5. Liquid-tight Flexible Metal Conduit: Shall conform to UL 360.

C. Conduit Fittings:

1. Rigid Steel and Intermediate Metallic Conduit Fittings:

a. Fittings shall meet the requirements of UL 514B and NEMA FB1.

b. Standard threaded couplings, locknuts, bushings, conduit bodies,
and elbows: Only steel or malleable iron materials are
acceptable. Integral retractable type IMC couplings are also
acceptable.

- c. Locknuts: Bonding type with sharp edges for digging into the metal wall of an enclosure.
 - d. Bushings: Metallic insulating type, consisting of an insulating insert, molded or locked into the metallic body of the fitting. Bushings made entirely of metal or nonmetallic material are not permitted.
 - e. Erickson (Union-Type) and Set Screw Type Couplings: Approved for use in concrete are permitted for use to complete a conduit run where conduit is installed in concrete. Use set screws of case-hardened steel with hex head and cup point to firmly seat in conduit wall for positive ground. Tightening of set screws with pliers is prohibited.
 - f. Sealing Fittings: Threaded cast iron type. Use continuous drain-type sealing fittings to prevent passage of water vapor. In concealed work, install fittings in flush steel boxes with blank cover plates having the same finishes as that of other electrical plates in the room.
 - g. Rigid steel conduit (RMC) with integral coupling fittings is not acceptable.
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. Compression couplings and connectors allowed for all sizes of EMT conduits.
 - d. Setscrew Couplings and Connectors: Use setscrews of case-hardened steel with hex head and cup point, to firmly seat in wall of conduit for positive grounding. Connectors shall have insulated throats. Setscrew couplings and connectors allowed for EMT conduits larger than 2" diameter (trade-size).
 - e. Indent-type connectors or couplings are prohibited.
 - f. Die-cast or pressure-cast zinc-alloy fittings or fittings made of "pot metal" are prohibited.
 - g. EMT conduit with integral coupling fittings is not acceptable.
3. Flexible Metal Conduit Fittings:
- a. Conform to UL 514B. Only steel or malleable iron materials are acceptable.

- b. Clamp-type, with insulated throat.
- 4. Liquid-tight Flexible Metal Conduit Fittings:
 - a. Fittings shall meet the requirements of UL 514B and NEMA FB1.
 - b. Only steel or malleable iron materials are acceptable.
 - c. Fittings must incorporate a threaded grounding cone, a steel or plastic compression ring, and a gland for tightening. Connectors shall have insulated throats.
- 5. Expansion and Deflection Couplings:
 - a. Conform to UL 467 and UL 514B.
 - b. Accommodate a 19 mm (0.75-inch) deflection, expansion, or contraction in any direction, and allow 30 degree angular deflections.
 - c. Include internal flexible metal braid, sized to guarantee conduit ground continuity and a low-impedance path for fault currents, in accordance with UL 467 and the NEC tables for equipment grounding conductors.
 - d. Jacket: Flexible, corrosion-resistant, watertight, moisture and heat-resistant molded rubber material with stainless steel jacket clamps.
- D. Conduit Supports:
 - 1. Parts and Hardware: Zinc-coat or provide equivalent corrosion protection.
 - 2. Individual Conduit Hangers: Designed for the purpose, having a pre-assembled closure bolt and nut, and provisions for receiving a hanger rod.
 - 3. Multiple Conduit (Trapeze) Hangers: Not less than 38 mm x 38 mm (1.5 x 1.5 inches), 12-gauge steel, cold-formed, lipped channels; with not less than 9 mm (0.375-inch) diameter steel hanger rods.
 - 4. Solid Masonry and Concrete Anchors: Self-drilling expansion shields, or machine bolt expansion.
- E. Outlet, Junction, and Pull Boxes:
 - 1. UL-50 and UL-514A.
 - 2. Rustproof cast metal where required by the NEC or shown on drawings.
 - 3. Sheet Metal Boxes: Galvanized steel, except where shown on drawings.
- F. Metal Wireways: Equip with hinged covers, except as shown on drawings. Include couplings, offsets, elbows, expansion joints, adapters, hold-

down straps, end caps, and other fittings to match and mate with wireways as required for a complete system.

PART 3 - EXECUTION

3.1 PENETRATIONS

A. Cutting or Holes:

1. Cut holes in advance where they should be placed in the structural elements, such as ribs or beams. Obtain the approval of the COR prior to drilling through structural elements.
2. Cut holes through concrete and masonry in new and existing structures with a diamond core drill or concrete saw. Pneumatic hammers, impact electric, hand, or manual hammer-type drills are not allowed, except when permitted by the COR where working space is limited.
3. Refer to drawings regarding use of X-ray or similar technology prior to penetrating floor slabs. The requirement to survey floors slabs prior to penetration shall apply to all thru-floor and thru-roof penetrations with division 26, 27, and 28 items.

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.

C. Waterproofing: At floor, exterior wall, and roof conduit penetrations, completely seal the gap around conduit to render it watertight.

3.2 INSTALLATION, GENERAL

- A. In accordance with UL, NEC, NEMA, as shown on drawings, and as specified herein.
- B. Raceway systems used for Essential Electrical Systems (EES) shall be entirely independent of other raceway systems.
- C. Install conduit as follows:
1. In complete mechanically and electrically continuous runs before pulling in cables or wires.
 2. Unless otherwise indicated on the drawings or specified herein, installation of all conduits shall be concealed within finished walls, floors, and ceilings.
 3. Flattened, dented, or deformed conduit is not permitted. Remove and replace the damaged conduits with new conduits.
 4. Assure conduit installation does not encroach into the ceiling height head room, walkways, or doorways.

5. Cut conduits square, ream, remove burrs, and draw up tight.
 6. Independently support conduit at 2.4 M (8 feet) on centers with specified materials and as shown on drawings.
 7. Do not use suspended ceilings, suspended ceiling supporting members, lighting fixtures, other conduits, cable tray, boxes, piping, or ducts to support conduits and conduit runs.
 8. Support within 300 mm (12 inches) of changes of direction, and within 300 mm (12 inches) of each enclosure to which connected.
 9. Close ends of empty conduits with plugs or caps at the rough-in stage until wires are pulled in, to prevent entry of debris.
 10. Conduit installations under fume and vent hoods are prohibited.
 11. Secure conduits to cabinets, junction boxes, pull-boxes, and outlet boxes with bonding type locknuts. For rigid steel and IMC conduit installations, provide a locknut on the inside of the enclosure, made up wrench tight. Do not make conduit connections to junction box covers.
 12. Conduit bodies shall only be used for changes in direction, and shall not contain splices.
- D. Conduit Bends:
1. Make bends with standard conduit bending machines.
 2. Conduit hickey may be used for slight offsets and for straightening stubbed out conduits.
 3. Bending of conduits with a pipe tee or vise is prohibited.
- E. Layout and Homeruns:
1. Install conduit with wiring, including homeruns, as shown on drawings.
 2. Deviations: Make only where necessary to avoid interferences and only after drawings showing the proposed deviations have been submitted and approved by the //Resident Engineer// //COR//.

3.3 EXPOSED WORK INSTALLATION

- A. Unless otherwise indicated on drawings, exposed conduit is only permitted in mechanical and electrical rooms.
- B. Conduit for Conductors 600 V and Below: Rigid steel, IMC, or EMT. Mixing different types of conduits in the system is prohibited.
- C. Align and run conduit parallel or perpendicular to the building lines.
- D. Install horizontal runs close to the ceiling or beams and secure with conduit straps.

E. Support horizontal or vertical runs at not over 2.4 M (8 feet) intervals.

F. Painting:

1. Raceway system for F/A components shall be painted red.

3.4 WET OR DAMP LOCATIONS

- A. Use rigid steel or IMC conduits unless as shown on drawings.
- B. Provide sealing fittings to prevent passage of water vapor where conduits pass from warm to cold locations, i.e., refrigerated spaces, constant-temperature rooms, air-conditioned spaces, building exterior walls, roofs, or similar spaces.
- C. Conduits run on roof shall be supported with integral galvanized lipped steel channel, attached to UV-inhibited polycarbonate or polypropylene blocks every 2.4 M (8 feet) with 9 mm (3/8-inch) galvanized threaded rods, square washer and locknut. Conduits shall be attached to steel channel with conduit clamps.

3.5 MOTORS AND VIBRATING EQUIPMENT

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

3.6 EXPANSION JOINTS

- A. Conduits 75 mm (3 inch) and larger that are secured to the building structure on opposite sides of a building expansion joint require expansion and deflection couplings. Install the couplings in accordance with the manufacturer's recommendations.
- B. Provide conduits smaller than 75 mm (3 inch) with junction boxes on both sides of the expansion joint. Connect flexible metal conduits to junction boxes with sufficient slack to produce a 125 mm (5 inch) vertical drop midway between the ends of the flexible metal conduit. Flexible metal conduit shall have a green insulated copper bonding jumper installed. In lieu of this flexible metal conduit, expansion and deflection couplings as specified above are acceptable.

- C. Install expansion and deflection couplings at each expansion joint crossed. See plans for approximate locations.

3.7 CONDUIT SUPPORTS

- A. Safe working load shall not exceed one-quarter of proof test load of fastening devices.
- B. Use pipe straps or individual conduit hangers for supporting individual conduits.
- C. Support multiple conduit runs with trapeze hangers. Use trapeze hangers that are designed to support a load equal to or greater than the sum of the weights of the conduits, wires, hanger itself, and an additional 90 kg (200 lbs). Attach each conduit with U-bolts or other approved fasteners.
- D. Support conduit independently of junction boxes, pull-boxes, fixtures, suspended ceiling T-bars, angle supports, and similar items.
- E. Fasteners and Supports in Solid Masonry and Concrete:
 - 1. New Construction: Use steel or malleable iron concrete inserts set in place prior to placing the concrete.
 - 2. Existing Construction:
 - a. Steel expansion anchors not less than 6 mm (0.25-inch) bolt size and not less than 28 mm (1.125 inch) in embedment.
 - b. Power set fasteners not less than 6 mm (0.25-inch) diameter with depth of penetration not less than 75 mm (3 inch).
 - c. Use vibration and shock-resistant anchors and fasteners for attaching to concrete ceilings.
- F. Hollow Masonry: Toggle bolts.
- G. Bolts supported only by plaster or gypsum wallboard are not acceptable.
- H. Metal Structures: Use machine screw fasteners or other devices specifically designed and approved for the application.
- I. Attachment by wood plugs, rawl plug, plastic, lead or soft metal anchors, or wood blocking and bolts supported only by plaster is prohibited.
- J. Chain, wire, or perforated strap shall not be used to support or fasten conduit.
- K. Spring steel type supports or fasteners are prohibited for all uses except horizontal and vertical supports/fasteners within walls.
- L. Vertical Supports: Vertical conduit runs shall have riser clamps and supports in accordance with the NEC and as shown. Provide supports for

cable and wire with fittings that include internal wedges and retaining collars.

3.8 BOX INSTALLATION

- A. Boxes for Concealed Conduits:
 - 1. Flush-mounted.
 - 2. Provide raised covers for boxes to suit the wall or ceiling, construction, and finish.
- B. In addition to boxes shown, install additional boxes where needed to prevent damage to cables and wires during pulling-in operations or where more than the equivalent of 4-90 degree bends are necessary.
- C. Locate pullboxes so that covers are accessible and easily removed. Coordinate locations with piping and ductwork where installed above ceilings.
- D. Remove only knockouts as required. Plug unused openings. Use threaded plugs for cast metal boxes and snap-in metal covers for sheet metal boxes.
- E. Outlet boxes mounted back-to-back in the same wall are prohibited. A minimum 600 mm (24 inch) center-to-center lateral spacing shall be maintained between boxes.
- F. Flush-mounted wall or ceiling boxes shall be installed with raised covers so that the front face of raised cover is flush with the wall. Surface-mounted wall or ceiling boxes shall be installed with surface-style flat or raised covers.
- G. Minimum size of outlet boxes for ground fault circuit interrupter (GFCI) receptacles is 100 mm (4 inches) square x 55 mm (2.125 inches) deep, with device covers for the wall material and thickness involved.
- H. Stencil or install phenolic nameplates on covers of the boxes to identify circuit number and source.
- I. On all branch circuit junction box covers, identify the circuits with black marker.

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SECTION 26 22 00
LOW-VOLTAGE TRANSFORMERS
12-01-2015 VERSION

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section specifies the furnishing, installation, connection, and testing of low-voltage dry-type general-purpose transformers, indicated as transformers in this section.

1.2 RELATED WORK

- A. Section 03 30 00, CAST-IN-PLACE CONCRETE: Requirements for concrete equipment pads.
- B. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: Requirements that apply to all sections of Division 26.
- C. Section 26 05 19, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES: Low-voltage conductors.
- D. Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS: Requirements for personnel safety and to provide a low impedance path for possible ground fault currents.
- E. Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS: Conduit.

1.3 QUALITY ASSURANCE

Refer to Paragraph, QUALIFICATIONS (PRODUCTS AND SERVICES), in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1.4 SUBMITTALS

- A. Submit six copies of the following in accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.
1. Shop Drawings:
 - a. Submit sufficient information to demonstrate compliance with drawings and specifications.
 - b. Include electrical ratings, dimensions, mounting details, materials, required clearances, terminations, weight, temperature rise, wiring and connection diagrams, plan, front, side, and rear elevations, accessories, and device nameplate data.
 2. Manuals:
 - a. Submit, simultaneously with the shop drawings, companion copies of complete maintenance and operating manuals including technical data sheets and wiring diagrams.

- 1) Schematic signal and control diagrams, with all terminals identified, matching terminal identification in the transformers.
- 2) Include information for testing, repair, troubleshooting, assembly, disassembly, and factory recommended/required periodic maintenance procedures and frequency.
- b. If changes have been made to the maintenance and operating manuals originally submitted, submit updated maintenance and operating manuals two weeks prior to the final inspection.
3. Certifications: Two weeks prior to final inspection, submit the following.
 - a. Certification by the manufacturer that the transformers conform to the requirements of the drawings and specifications.
 - b. Certification by the Contractor that the transformers have been properly installed, adjusted, and tested.

1.5 APPLICABLE PUBLICATIONS

- A. Publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by designation only.
- B. International Code Council (ICC):
IBC-15.....International Building Code
- C. National Fire Protection Association (NFPA):
70-14.....National Electrical Code (NEC)
- D. National Electrical Manufacturers Association (NEMA):
TR 1-13.....Transformers, Step Voltage Regulators and
Reactors
ST 20-14.....Dry Type Transformers for General Applications
- E. Underwriters Laboratories, Inc. (UL):
UL 506-08.....Standard for Specialty Transformers
UL 1561-11.....Dry-Type General Purpose and Power Transformers
- F. United States Department of Energy
10 CFR Part 431.....Energy Efficiency Program for Certain
Commercial and Industrial Equipment

PART 2 - PRODUCTS

2.1 TRANSFORMERS

- A. Unless otherwise specified, transformers shall be in accordance with NEMA, NEC, UL and as shown on the drawings.
- B. Transformers shall have the following features:
 - 1. Self-cooled by natural convection, isolating windings, indoor dry-type. Autotransformers will not be accepted, except as specifically allowed for buck-boost applications.
 - 2. Rating and winding connections shall be as shown on the drawings.
 - 3. Ratings shown on the drawings are for continuous duty without the use of cooling fans.
 - 4. Copper windings.
 - 5. Insulation systems:
 - a. Transformers 30 kVA and larger: UL rated 220 °C (428 °F) system with an average maximum rise by resistance of 150 °C (302 °F) in a maximum ambient of 40 °C (104 °F).
 - b. Transformers below 30 kVA: Same as for 30 kVA and larger or UL rated 185 °C (365 °F) system with an average maximum rise by resistance of 115 °C (239 °F) in a maximum ambient of 40 °C (104 °F).
 - 6. Core and coil assemblies:
 - a. Rigidly braced to withstand the stresses caused by short-circuit currents and rough handling during shipment.
 - b. Cores shall be grain-oriented, non-aging, and silicon steel.
 - c. Coils shall be continuous windings without splices except for taps.
 - d. Coil loss and core loss shall be minimized for efficient operation.
 - e. Primary and secondary tap connections shall be brazed or pressure type.
 - f. Coil windings shall have end filters or tie-downs for maximum strength.
 - 7. Average audible sound levels shall comply with NEMA.
 - 8. If not shown on drawings, nominal impedance shall be as permitted by NEMA.
 - 9. Single phase transformers rated 15 kVA through 25 kVA shall have two 5% full capacity taps below normal rated primary voltage. All

- transformers rated 30 kVA and larger shall have two 2.5% full capacity taps above, and four 2.5% full capacity taps below normal rated primary voltage.
10. Core assemblies shall be grounded to their enclosures with adequate flexible ground straps.
 11. Enclosures:
 - a. Comprised of not less than code gauge steel.
 - b. Outdoor enclosures shall be NEMA 3R.
 - c. Temperature rise at hottest spot shall conform to NEMA Standards, and shall not bake and peel off the enclosure paint after the transformer has been placed in service.
 - d. Ventilation openings shall prevent accidental access to live components.
 - e. The enclosure at the factory shall be thoroughly cleaned and painted with manufacturer's prime coat and standard finish.
 12. Standard NEMA features and accessories, including ground pad, lifting provisions, and nameplate with the wiring diagram and sound level indicated.
 13. Dimensions and configurations shall conform to the spaces designated for their installations.
 14. Transformers shall meet the energy conservation standards for transformers per the United States Department of Energy's 10 CFR Part 431.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Installation of transformers shall be in accordance with the NEC, as recommended by the equipment manufacturer and as shown on the drawings.
- B. Anchor transformers with rustproof bolts, nuts, and washers, in accordance with manufacturer's instructions, and as shown on drawings.
- C. Install transformers with manufacturer's recommended clearance from wall and adjacent equipment for air circulation. Minimum clearance shall be 150 mm (6 inches).
- D. Install transformers on vibration pads designed to suppress transformer noise and vibrations.
- E. Transformer shall be installed on 4" min. thick concrete housekeeping slab with ½" chamfered edges. Housekeeping slab shall be painted yellow.

3.2 ACCEPTANCE CHECKS AND TESTS

A. Perform tests in accordance with the manufacturer's recommendations.

In addition, include the following:

1. Visual Inspection and Tests:

- a. Compare equipment nameplate data with specifications and approved shop drawings.
- b. Inspect physical and mechanical condition.
- c. Inspect all field-installed bolted electrical connections, using the calibrated torque-wrench method to verify tightness of accessible bolted electrical connections.
- d. Perform specific inspections and mechanical tests as recommended by manufacturer.
- e. Verify correct equipment grounding.
- f. Verify proper secondary phase-to-phase and phase-to-neutral voltage after energization and prior to connection to loads.

3.3 FOLLOW-UP VERIFICATION

A. Upon completion of acceptance checks, settings, and tests, the contractor shall demonstrate that the transformers are in good operating condition, and properly performing the intended function.

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SECTION 26 24 16
PANELBOARDS
05-01-14

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section specifies the furnishing, installation, and connection of panelboards.

1.2 RELATED WORK

- A. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS:
Requirements that apply to all sections of Division 26.
- B. Section 26 05 19, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES:
Low-voltage conductors.
- C. Section 26 05 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.

1.3 QUALITY ASSURANCE

- A. Refer to Paragraph, QUALIFICATIONS (PRODUCTS AND SERVICES), in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1.4 SUBMITTALS

- A. Submit six copies of the following in accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.
 - 1. Shop Drawings:
 - a. Submit sufficient information to demonstrate compliance with drawings and specifications.
 - b. Include electrical ratings, dimensions, mounting details, materials, required clearances, terminations, weight, circuit breakers, wiring and connection diagrams, accessories, and nameplate data.
 - c. Submit breakers that are to be installed in existing panelboards, motor control centers, etc.
 - 2. Manuals:
 - a. Submit, simultaneously with the shop drawings, complete maintenance and operating manuals including technical data sheets, wiring diagrams, and information for ordering circuit breakers and replacement parts.

- 1) Include schematic diagrams, with all terminals identified, matching terminal identification in the panelboards.
- 2) Include information for testing, repair, troubleshooting, assembly, and disassembly.
- b. If changes have been made to the maintenance and operating manuals originally submitted, submit updated maintenance and operating manuals two weeks prior to the final inspection.
3. Certifications: Two weeks prior to final inspection, submit the following.
 - a. Certification by the manufacturer that the panelboards conform to the requirements of the drawings and specifications.
 - b. Certification by the Contractor that the panelboards have been properly installed, adjusted, and tested.

1.5 APPLICABLE PUBLICATIONS

- A. Publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by designation only.
- B. International Code Council (ICC):
IBC-12.....International Building Code
- C. National Electrical Manufacturers Association (NEMA):
PB 1-11.....Panelboards
250-08.....Enclosures for Electrical Equipment (1,000V Maximum)
- D. National Fire Protection Association (NFPA):
70-11.....National Electrical Code (NEC)
70E-12.....Standard for Electrical Safety in the Workplace
- E. Underwriters Laboratories, Inc. (UL):
50-95.....Enclosures for Electrical Equipment
67-09.....Panelboards
489-09.....Molded Case Circuit Breakers and Circuit Breaker Enclosures

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. Panelboards shall be in accordance with NEC, NEMA, UL, as specified, and as shown on the drawings.
- B. Panelboards shall have main breaker or main lugs, bus size, voltage, phases, number of circuit breaker mounting spaces, top or bottom feed,

flush or surface mounting, branch circuit breakers, and accessories as shown on the drawings.

- C. Panelboards shall be completely factory-assembled with molded case circuit breakers and integral accessories as shown on the drawings or specified herein.
- D. Non-reduced size copper bus bars, rigidly supported on molded insulators, and fabricated for bolt-on type circuit breakers.
- E. Bus bar connections to the branch circuit breakers shall be the "distributed phase" or "phase sequence" type.
- F. Mechanical lugs furnished with panelboards shall be cast, stamped, or machined metal alloys listed for use with the conductors to which they will be connected.
- G. Neutral bus shall be 100% rated, mounted on insulated supports, copper.
- H. Grounding bus bar shall be equipped with screws or lugs for the connection of equipment grounding conductors.
- I. Bus bars shall be braced for the available short-circuit current as shown on the drawings, but not be less than 10,000 A symmetrical for 120/208 V and 120/240 V panelboards, and 14,000 A symmetrical for 277/480 V panelboards.
- J. In two-section panelboards, the main bus in each section shall be full size. The first section shall be furnished with subfeed lugs on the line side of main lugs only, or through-feed lugs for main breaker type panelboards, and have field-installed cable connections to the second section as shown on the drawings. Panelboard sections with tapped bus or crossover bus are not acceptable.
- K. Series-rated panelboards are not permitted.

2.2 ENCLOSURES AND TRIMS

- A. Enclosures:
 - 1. Provide galvanized steel enclosures, with NEMA rating as shown on the drawings or as required for the environmental conditions in which installed.
 - 2. Enclosures shall not have ventilating openings.
 - 3. Enclosures may be of one-piece formed steel or of formed sheet steel with end and side panels welded, riveted, or bolted as required.
 - 4. Provide manufacturer's standard option for prepunched knockouts on top and bottom endwalls.
 - 5. Include removable inner dead front cover, independent of the panelboard cover.

B. Trims:

1. Hinged "door-in-door" type.
2. Interior hinged door with hand-operated latch or latches, as required to provide access only to circuit breaker operating handles, not to energized parts.
3. Outer hinged door shall be securely mounted to the panelboard enclosure with factory bolts, screws, clips, or other fasteners, requiring a key or tool for entry. Hand-operated latches are not acceptable.
4. Inner and outer doors shall open left to right.
5. Trims shall be flush or surface type as shown on the drawings.

2.3 MOLDED CASE CIRCUIT BREAKERS

- A. Circuit breakers shall be per UL, NEC, as shown on the drawings, and as specified.
- B. Circuit breakers shall be bolt-on type.
- C. Circuit breakers shall have minimum interrupting rating as required to withstand the available fault current, but not less than:
 1. 120/208 V Panelboard: 10,000 A symmetrical.
 2. 277/480 V Panelboard: 14,000 A symmetrical.
- D. Circuit breaker adjustability:
 1. Less than 225A frame: Circuit breakers shall have automatic, trip free, non-adjustable, inverse time, and instantaneous magnetic trips, unless noted otherwise.
 2. 225A frames and above: Circuit breakers shall have magnetic trip, adjustable from 5x to 10x, unless noted otherwise.
 3. Breaker trip setting shall be set in the field, based on the approved protective device study as specified in Section 26 05 71, ELECTRICAL SYSTEM PROTECTIVE DEVICE STUDY.
 4. Provide breakers with long-time, short-time, instantaneous, and ground fault alarm or trip adjustable settings as called out in drawings - regardless of frame size. LSI, LSIG, and LSIA breakers shall have fully adjustable delays and pickups for long, short, and instantaneous (and ground as applicable).
- E. Circuit breaker features shall be as follows:
 1. A rugged, integral housing of molded insulating material.
 2. Silver alloy contacts.
 3. Arc quenchers and phase barriers for each pole.
 4. Quick-make, quick-break, operating mechanisms.

5. A trip element for each pole, thermal magnetic type with long time delay and instantaneous characteristics, a common trip bar for all poles and a single operator.
6. Electrically and mechanically trip free.
7. An operating handle which indicates closed, tripped, and open positions.
8. An overload on one pole of a multi-pole breaker shall automatically cause all the poles of the breaker to open.
9. Ground fault current interrupting breakers, shunt trip breakers, lighting control breakers (including accessories to switch line currents), or other accessory devices or functions shall be provided where shown on the drawings.
10. For circuit breakers being added to existing panelboards or other equipment, coordinate the breaker type with existing panelboards. Contractor shall be fully responsible for confirming breaker compatibility with existing equipment prior to shop drawing submittal. Modify the panel directory accordingly.
11. Note: this project includes providing new breakers in existing panels that were not yet existing at the time of bid document production. Contractor shall verify existing panel characteristics and modify breaker submittal accordingly.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Installation shall be in accordance with the manufacturer's instructions, the NEC, as shown on the drawings, and as specified.
- B. Locate panelboards so that the present and future conduits can be conveniently connected.
- C. Install a printed schedule of circuits in each panelboard after approval by the COR. Schedules shall reflect final load descriptions, room numbers, and room names connected to each circuit breaker. Schedules shall be printed on the panelboard directory cards and be installed in the appropriate panelboards. Schedules shall be in place prior to substantial inspection.
- D. Mount panelboards such that the maximum height of the top circuit breaker above the finished floor shall not exceed 1980 mm (78 inches).
- E. Provide blank cover for each unused circuit breaker mounting space.
- F. Panelboard enclosures shall not be used for conductors feeding through, spliced, or tapping off to other enclosures or devices.

3.2 ACCEPTANCE CHECKS AND TESTS

A. Perform in accordance with the manufacturer's recommendations. In addition, include the following:

1. Visual Inspection and Tests:

- a. Compare equipment nameplate data with specifications and approved shop drawings.
- b. Inspect physical, electrical, and mechanical condition.
- c. Verify appropriate anchorage and required area clearances.
- d. Verify that circuit breaker sizes and types correspond to approved shop drawings.
- e. To verify tightness of accessible bolted electrical connections, use the calibrated torque-wrench method or perform thermographic survey after energization.
- f. Vacuum-clean enclosure interior. Clean enclosure exterior.

3.3 FOLLOW-UP VERIFICATION

A. Upon completion of acceptance checks, settings, and tests, the Contractor shall demonstrate that the panelboards are in good operating condition and properly performing the intended function.

---END---

SECTION 26 24 19
MOTOR CONTROL CENTERS
08-01-14

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section specifies the furnishing, installation, connection, and testing of the motor control centers.

1.2 RELATED WORK

- A. Section 03 30 00, CAST-IN-PLACE CONCRETE: Requirements for concrete equipment pads.
- B. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: Requirements that apply to all sections of Division 26.
- C. Section 26 05 19, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES: Low-voltage conductors.
- D. Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS: Requirements for personnel safety and to provide a low impedance path for possible ground fault currents.
- E. Section 26 29 11, MOTOR CONTROLLERS: Control and protection of motors.
- F. SECTION 26 43 13, SURGE PROTECTIVE DEVICES.

1.3 QUALITY ASSURANCE

- A. Refer to Paragraph, QUALIFICATIONS (PRODUCTS AND SERVICES), in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1.4 SUBMITTALS

- A. Submit six copies of the following in accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS:
 - 1. Shop Drawings:
 - a. Submit sufficient information to demonstrate compliance with drawings and specifications.
 - b. Prior to fabrication of motor control centers, submit the following data for approval:
 - 1) Single line diagram showing each bus, instrument and control power transformer, relay, motor starter, circuit breaker, fuse, motor circuit protector, overload, and other components.
 - 2) Control wiring diagram for each motor starter.
 - 3) Complete electrical ratings for all components.
 - 4) Interrupting ratings.
 - 5) Safety features.

- 6) Accessories and nameplate data.
 - 7) Dimensioned exterior views of the motor control centers.
 - 8) Dimensioned section views of the motor control centers.
 - 9) Floor plan of the motor control centers.
 - 10) Approximate design weights.
2. Manuals:
- a. Submit, simultaneously with the shop drawings, companion copies of complete maintenance and operating manuals, including technical data sheets, wiring diagrams, and information for ordering replacement parts.
 - 1) Schematic control diagrams, with all terminals identified, matching terminal identification in the motor control centers.
 - 2) Include information for testing, repair, troubleshooting, assembly, disassembly, and factory recommended periodic maintenance procedures and their frequency.
 - 3) Provide a replacement and spare parts list. Include a list of tools, and instruments for testing and maintenance purposes.
 - b. If changes have been made to the maintenance and operating manuals originally submitted, submit updated maintenance and operating manuals two weeks prior to the final inspection.
3. Test Reports:
- a. Two weeks prior to the final inspection, submit certified field test reports and data sheets to the COR.
4. Certifications: Two weeks prior to final inspection, submit the following.
- a. Certification by the manufacturer that the motor control centers conform to the requirements of the drawings and specifications.
 - b. Certification by the Contractor that the motor control centers have been properly installed, adjusted, and tested.

1.5 APPLICABLE PUBLICATIONS

- A. Publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by designation only.
- B. International Code Council (ICC):
IBC-12.....International Building Code
- C. National Electrical Manufacturers Association (NEMA):
ICS 1-08.....Industrial Control and Systems: General Requirements

- ## PART 2 - PRODUCTS

26 24 19 - 3

5. All vertical section parts shall be accessible from the front for maintenance rearrangement.
6. Screws in the removable panels shall remain in the panels when the panels are removed. Self-aligning, self-retaining nuts, which are parts of the screw assembly, shall remain intact.
7. Each vertical section shall have a minimum 300 mm (12 inches) high horizontal wireway at the top, section and a minimum 150 mm (6 inches) high horizontal wireway at the bottom.
8. Each vertical section shall have minimum 100 mm (4 inches) wide vertical full height wireways. Vertical wireways shall connect with both the top and bottom horizontal wireways.
9. Each vertical section for motor controller units shall be equipped with all necessary hardware and busing for the units to be added or relocated. All unused space shall be covered by hinged doors and equipped to accept future units.

2.2 BUS BARS AND INTERCONNECTIONS

- A. Horizontal and vertical bus ratings shall be as shown on drawings. Horizontal bus bars shall be fully rated for the entire length of the motor control centers.
- B. Bus bars shall be tin-plated copper.
- C. All bolts, nuts, and washers shall be zinc-plated steel, torqued to the values recommended by the manufacturer.
- D. A ground bus shall extend across the entire length of the motor control centers.
- E. Bus bars and interconnections shall include provisions to extend the motor control center horizontal bus into additional future vertical sections.
- F. Provide shutter mechanism to isolate vertical bus when the motor controller unit is withdrawn.

2.3 MOTOR CONTROLLERS

- A. Product of the same manufacturer as the motor control centers.
- B. Shall conform to the applicable requirements in Section 26 29 11, MOTOR CONTROLLERS.
- C. Plug-in, draw-out type up through NEMA size 4. NEMA size 5 and above require bolted connections.
- D. Doors for each space shall be interlocked to prevent their opening unless disconnect is open. A "defeater" mechanism shall be incorporated for inspection by qualified personnel.

2.4 FEEDER UNITS

- A. Circuit breaker: shall conform to the applicable portions of Section 26 24 16, PANELBOARDS.
- B. Fusible Switches: shall conform to the applicable portions of Section 26 29 21, ENCLOSED SWITCHES AND CIRCUIT BREAKERS.

2.5 METERS

- A. Meters shall be provided as shown on the plans.

2.6 SURGE SUPPRESSION

- A. Provide surge protection device in MCC per SECTION 26 43 13, SURGE PROTECTIVE DEVICES and drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install motor control centers in accordance with the NEC, as shown on the drawings, and as recommended by the manufacturer.
- B. Anchor motor control centers with rustproof bolts, nuts, and washers not less than 13 mm (1/2 inch) diameter, in accordance with manufacturer's instructions, and as shown on drawings.
- C. Interior Location. Mount motor control centers on concrete slab. Unless otherwise indicated, the slab shall be at least 100 mm (4 inches) thick. The top of the concrete slab shall be approximately 100 mm (4 inches) above finished floor. Edges above floor shall have 15 mm (1/2 inch) chamfer. The slab shall be of adequate size to project at least 100 mm (8 inches) beyond the equipment. Provide conduit turnups and cable entrance space required by the equipment to be mounted. Seal voids around conduit openings in slab with water- and oil-resistant caulking or sealant. Cut off and bush conduits 75 mm (3 inches) above slab surface. Concrete work shall be as specified in Section 03 30 00, CAST-IN-PLACE CONCRETE. Slab below motor control center shall be painted yellow.

3.2 ACCEPTANCE CHECKS AND TESTS

- A. Perform in accordance with the manufacturer's recommendations. In addition, include the following:
 - 1. Visual Inspection and Tests:
 - a. Compare equipment nameplate data with specifications and approved shop drawings.
 - b. Inspect physical, electrical, and mechanical condition.
 - c. Verify appropriate anchorage and required area clearances.

- d. Verify that circuit breaker, fuse, motor circuit protector, and motor controller sizes and types correspond to approved shop drawings.
 - e. Use calibrated torque-wrench method to verify the tightness of accessible bolted electrical connections, or perform a thermographic survey after energization.
 - f. Vacuum-clean motor control center enclosure interior. Clean motor control center enclosure exterior.
 - g. Inspect insulators for evidence of physical damage or contaminated surfaces.
 - h. Exercise all active components.
 - i. Verify the correct operation of all indicating devices.
 - j. If applicable, inspect control power transformers.
2. Electrical Tests:
- a. Perform insulation-resistance tests on each bus section.
 - b. Perform insulation-resistance test on control wiring. Do not perform this test on wiring connected to electronic components.

3.3 FOLLOW-UP VERIFICATION

- A. Upon completion of acceptance checks, settings, and tests, the Contractor shall demonstrate that the motor control centers are in good operating condition and properly performing the intended function.

3.4 TRAINING

- A. Furnish the services of a competent, factory-trained engineer or technician for a 2-hour period to instruct VA personnel in operation and maintenance of the equipment, including review of the operation and maintenance manual, on a date requested by the COR.

---END---

SECTION 26 27 26
WIRING DEVICES
01-01-16

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section specifies the furnishing, installation, connection, and testing of wiring devices.

1.2 RELATED WORK

- A. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements that are common to more than one section of Division 26.
- B. Section 26 05 19, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES: 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 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS: Conduit and boxes.

1.3 QUALITY ASSURANCE

- A. Refer to Paragraph, QUALIFICATIONS (PRODUCTS AND SERVICES), in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1.4 SUBMITTALS

- A. Submit six copies of the following in accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.
 - 1. Shop Drawings:
 - a. Submit sufficient information to demonstrate compliance with drawings and specifications.
 - b. Include electrical ratings, dimensions, mounting details, construction materials, grade, and termination information.
 - 2. Manuals:
 - a. Submit, simultaneously with the shop drawings, companion copies of complete maintenance and operating manuals, including technical data sheets and information for ordering replacement parts.
 - b. If changes have been made to the maintenance and operating manuals originally submitted, submit updated maintenance and operating manuals two weeks prior to the final inspection.

3. Certifications: Two weeks prior to final inspection, submit the following.
 - a. Certification by the manufacturer that the wiring devices conform to the requirements of the drawings and specifications.
 - b. Certification by the Contractor that the wiring devices have been properly installed and adjusted.

1.5 APPLICABLE PUBLICATIONS

- A. Publications listed below (including amendments, addenda, revisions, supplements and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by basic designation only.
- B. National Fire Protection Association (NFPA):
 - 70-14.....National Electrical Code (NEC)
 - 99-15.....Health Care Facilities
- C. National Electrical Manufacturers Association (NEMA):
 - WD 1-10.....General Color Requirements for Wiring Devices
 - WD 6-12Wiring Devices - Dimensional Specifications
- D. Underwriter's Laboratories, Inc. (UL):
 - 5-11.....Surface Metal Raceways and Fittings
 - 20-10.....General-Use Snap Switches
 - 231-08.....Power Outlets
 - 467-13.....Grounding and Bonding Equipment
 - 498-12.....Attachment Plugs and Receptacles
 - 943-15.....Ground-Fault Circuit-Interrupters
 - 1449-14.....Surge Protective Devices
 - 1472-15.....Solid State Dimming Controls

PART 2 - PRODUCTS

2.1 RECEPTACLES

- A. General: All receptacles shall comply with NEMA, NFPA, UL, and as shown on the drawings.
 1. Mounting straps shall be nickel plated brass, brass, nickel plated steel or galvanize steel with break-off plaster ears, and shall include a self-grounding feature. Terminal screws shall be brass, brass plated or a copper alloy metal.
 2. Receptacles shall have provisions for back wiring with separate metal clamp type terminals (four minimum) and side wiring from four captively held binding screws.

- B. Duplex Receptacles - Hospital-grade: shall be listed for hospital grade, single phase, 20 ampere, 120 volts, 2-pole, 3-wire, NEMA 5-20R, with break-off feature for two-circuit operation.
1. Bodies shall be ivory in color.
 2. Switched duplex receptacles shall be wired so that only the top receptacle is switched. The lower receptacle shall be unswitched.
 3. Duplex Receptacles on Emergency Circuit:
 - a. In rooms without emergency powered general lighting, the emergency receptacles shall be of the self-illuminated type.
 4. Ground Fault Current Interrupter (GFCI) Duplex Receptacles: Shall be an integral unit, hospital-grade, suitable for mounting in a standard outlet box, with end-of-life indication and provisions to isolate the face due to improper wiring. GFCI receptacles shall be self-test receptacles in accordance with UL 943.
 - a. Ground fault interrupter shall consist of a differential current transformer, self-test, solid state sensing circuitry and a circuit interrupter switch. Device shall have nominal sensitivity to ground leakage current of 4-6 milliamperes and shall function to interrupt the current supply for any value of ground leakage current above five milliamperes (+ or - 1 milliampere) on the load side of the device. Device shall have a minimum nominal tripping time of 0.025 second.
 - b. Self-test function shall be automatically initiated within 5 seconds after power is activated to the receptacles. Self-test function shall be periodically and automatically performed every 3 hours or less.
 - c. End-of-life indicator light shall be a persistent flashing or blinking light to indicate that the GFCI receptacle is no longer in service.
 5. Tamper-Resistant Duplex Receptacles:
 - a. Bodies shall be gray in color.
 - 1) Shall permit current to flow only while a standard plug is in the proper position in the receptacle.
 - 2) Screws exposed while the wall plates are in place shall be the tamperproof type.
- C. Duplex Receptacles - Non-hospital Grade: shall be the same as duplex receptacles - hospital grade in accordance with sections 2.1A and 2.1B of this specification, except for the hospital grade listing.

- a. Bodies shall be brown nylon.
- D. Receptacles - 20, 30, and 50 ampere, 250 Volts: Shall be complete with appropriate cord grip plug.
- E. Weatherproof Receptacles: Shall consist of a duplex receptacle, mounted in box with a gasketed, weatherproof, cast metal cover plate and cap over each receptacle opening. The cap shall be permanently attached to the cover plate by a spring-hinged flap. The weatherproof integrity shall not be affected when heavy duty specification or hospital grade attachment plug caps are inserted. Cover plates on outlet boxes mounted flush in the wall shall be gasketed to the wall in a watertight manner.
- F. Surge Protective (TVSS) Receptacles shall have integral surge suppression in line to ground, line to neutral, and neutral to ground modes.
 - 1. TVSS Components: Multiple metal-oxide varistors; with a nominal clamp-level rating of 400 Volts, and minimum single transient pulse energy dissipation of 210 Joules.
 - 2. Active TVSS Indication: LED, visible in face of device to indicate device is active or no longer in service.

2.2 TOGGLE SWITCHES

- A. Toggle switches shall be totally enclosed tumbler type with nylon bodies. Handles shall be ivory in color unless otherwise specified or shown on the drawings.
 - 1. Switches installed in hazardous areas shall be explosion-proof type in accordance with the NEC and as shown on the drawings.
 - 2. Shall be single unit toggle, butt contact, quiet AC type, heavy-duty general-purpose use with an integral self-grounding mounting strap with break-off plaster ears and provisions for back wiring with separate metal wiring clamps and side wiring with captively held binding screws.
 - 3. Switches shall be rated 20 amperes at 120-277 Volts AC.

2.3 WALL PLATES

- A. Wall plates for switches and receptacles shall be type 302 stainless steel, unless noted otherwise. Oversize plates are not acceptable.
- B. For receptacles or switches mounted adjacent to each other, wall plates shall be common for each group of receptacles or switches.
- C. In areas requiring tamperproof wiring devices, wall plates shall be type 302 stainless steel, and shall have tamperproof screws and beveled edges.

D. Duplex Receptacles on Emergency Circuit: Wall plates shall be red nylon with the word "EMERGENCY" engraved in 6 mm (1/4 inch) white letters.

E. In un-finished areas, wall plates shall be type 302 stainless steel.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation shall be in accordance with the NEC and as shown as on the drawings.

B. Install wiring devices after wall construction and painting is complete.

C. The ground terminal of each wiring device shall be bonded to the outlet box with an approved green bonding jumper, and also connected to the branch circuit equipment grounding conductor.

D. Outlet boxes for toggle switches and manual dimming controls shall be mounted on the strike side of doors.

E. Provide barriers in multi-gang outlet boxes to comply with the NEC.

F. Coordinate the electrical work with the work of other trades to ensure that wiring device flush outlets are positioned with box openings aligned with the face of the surrounding finish material. Pay special attention to installations in cabinet work, and in connection with laboratory equipment.

G. Exact field locations of floors, walls, partitions, doors, windows, and equipment may vary from locations shown on the drawings. Prior to locating sleeves, boxes and chases for roughing-in of conduit and equipment, the Contractor shall coordinate exact field location of the above items with other trades.

H. Install wall switches 1.2 M (48 inches) above floor, with the toggle OFF position down.

I. Install wall dimmers 1.2 M (48 inches) above floor.

J. Install receptacles 450 mm (18 inches) above floor, and 152 mm (6 inches) above counter backsplash or workbenches. Install specific-use receptacles at heights shown on the drawings.

K. Install horizontally mounted receptacles with the ground pin to the right.

L. When required or recommended by the manufacturer, use a torque screwdriver. Tighten unused terminal screws.

M. Label device plates with a permanent adhesive label listing panel and circuit feeding the wiring device.

3.2 ACCEPTANCE CHECKS AND TESTS

A. Perform manufacturer's required field checks in accordance with the manufacturer's recommendations, and the latest NFPA 99. In addition, include the following:

1. Visual Inspection and Tests:

- a. Inspect physical and electrical conditions.
- b. Vacuum-clean surface metal raceway interior. Clean metal raceway exterior.
- c. Test wiring devices for damaged conductors, high circuit resistance, poor connections, inadequate fault current path, defective devices, or similar problems using a portable receptacle tester. Correct circuit conditions, remove malfunctioning units and replace with new, and retest as specified above.
- d. Test GFCI receptacles.

---END---

SECTION 26 29 11
MOTOR CONTROLLERS
08-01-14

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section specifies the furnishing, installation, connection, and testing of motor controllers, including all low-voltage motor controllers and manual motor controllers, indicated as motor controllers in this section, and low-voltage variable speed motor controllers.
- B. Motor controllers, whether furnished with the equipment specified in other sections or otherwise shall meet this specification and all related specifications.

1.2 RELATED WORK

- A. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS:
Requirements that apply to all sections of Division 26.
- B. Section 26 05 19, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES:
Low-voltage conductors.
- C. Section 26 05 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.
- E. Section 26 24 19, MOTOR CONTROL CENTERS: For multiple motor control assemblies which include motor controllers.

1.3 QUALITY ASSURANCE

- A. Refer to Paragraph, QUALIFICATIONS (PRODUCTS AND SERVICES), in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1.4 SUBMITTALS

- A. Submit six copies of the following in accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.
 - 1. Shop Drawings:
 - a. Submit sufficient information to demonstrate compliance with drawings and specifications.
 - b. Include electrical ratings, dimensions, weights, mounting details, materials, overcurrent protection devices, overload relays, sizes of enclosures, wiring diagrams, starting characteristics, interlocking, and accessories.

2. Manuals:

- a. Submit, simultaneously with the shop drawings, companion copies of complete maintenance and operating manuals, including technical data sheets, wiring diagrams, and information for ordering replacement parts.
 - 1) Wiring diagrams shall have their terminals identified to facilitate installation, maintenance, and operation.
 - 2) Wiring diagrams shall indicate internal wiring for each item of equipment and interconnections between the items of equipment.
 - 3) Elementary schematic diagrams shall be provided for clarity of operation.
 - 4) Include the catalog numbers for the correct sizes of overload relays for the motor controllers.
 - b. If changes have been made to the maintenance and operating manuals originally submitted, submit updated maintenance and operating manuals two weeks prior to the final inspection.
3. Certifications: Two weeks prior to final inspection, submit the following.
- a. Certification by the manufacturer that the motor controllers conform to the requirements of the drawings and specifications.
 - b. Certification by the Contractor that the motor controllers have been properly installed, adjusted, and tested.

1.5 APPLICABLE PUBLICATIONS

- A. Publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by basic designation only.
- B. Institute of Electrical and Electronic Engineers (IEEE):
 - 519-92.....Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems
 - C37.90.1-02.....Standard Surge Withstand Capability (SWC) Tests for Relays and Relay Systems Associated with Electric Power Apparatus
- C. International Code Council (ICC):
 - IBC-12.....International Building Code
- D. National Electrical Manufacturers Association (NEMA):

- ICS 1-08.....Industrial Control and Systems: General Requirements
- ICS 1.1-09.....Safety Guidelines for the Application, Installation and Maintenance of Solid State Control
- ICS 2-05.....Industrial Control and Systems Controllers, Contactors, and Overload Relays Rated 600 Volts
- ICS 4-05.....Industrial Control and Systems: Terminal Blocks
- ICS 6-06.....Industrial Control and Systems: Enclosures
- ICS 7-06.....Industrial Control and Systems: Adjustable-Speed Drives
- ICS 7.1-06.....Safety Standards for Construction and Guide for Selection, Installation, and Operation of Adjustable-Speed Drive Systems
- MG 1 Part 31.....Inverter Fed Polyphase Motor Standards
- E. National Fire Protection Association (NFPA):
 - 70-11.....National Electrical Code (NEC)
- F. Underwriters Laboratories Inc. (UL):
 - 508A-07.....Industrial Control Panels
 - 508C-07.....Power Conversion Equipment
 - UL 1449-06.....Surge Protective Devices

PART 2 - PRODUCTS

2.1 MOTOR CONTROLLERS

- A. Motor controllers shall comply with IEEE, NEMA, NFPA, UL, and as shown on the drawings.
 - B. Motor controllers shall be separately enclosed, unless part of another assembly. For installation in motor control centers, provide plug-in, draw-out type motor controllers up through NEMA size 4. NEMA size 5 and above require bolted connections.
 - C. Motor controllers shall be combination type, with magnetic controller per Paragraph 2.3 below and with circuit breaker disconnecting means, unless noted otherwise on plans, with external operating handle with lock-open padlocking positions and ON-OFF position indicator.
- 1. Circuit Breakers:
 - a. Bolt-on thermal-magnetic type with a minimum interrupting rating as indicated on the drawings.
 - b. Equipped with automatic, trip free, non-adjustable, inverse-time, and instantaneous magnetic trips for less than 400A. The magnetic

trip shall be adjustable from 5x to 10x for breakers 400A and greater.

c. Additional features shall be as follows:

- 1) A rugged, integral housing of molded insulating material.
- 2) Silver alloy contacts.
- 3) Arc quenchers and phase barriers for each pole.
- 4) Quick-make, quick-break, operating mechanisms.
- 5) A trip element for each pole, a common trip bar for all poles, and one operator for all poles.

D. Enclosures:

1. Enclosures shall be NEMA-type rated 1, 3R, or 12 as indicated on the drawings or as required per the installed environment.
2. Enclosure doors shall be interlocked to prevent opening unless the disconnecting means is open. A "defeater" mechanism shall allow for inspection by qualified personnel with the disconnect means closed. Provide padlocking provisions.
3. All metal surfaces shall be thoroughly cleaned, phosphatized, and factory primed prior to applying light gray baked enamel finish.

E. Motor control circuits:

1. Shall operate at not more than 120 Volts.
2. Shall be grounded, except where the equipment manufacturer recommends that the control circuits be isolated.
3. For each motor operating over 120 Volts, incorporate a separate, heavy duty, control transformer within each motor controller enclosure.
4. Incorporate primary and secondary overcurrent protection for the control power transformers.

F. Overload relays:

1. Thermal, Induction, Temperature Probe Thermal Relay, or Electronic type as noted on plans. Devices shall be NEMA type.
2. One for each pole.
3. External overload relay reset pushbutton on the door of each motor controller enclosure.
4. Overload relays shall be matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.

5. Thermal overload relays shall be tamperproof, not affected by vibration, manual reset, sensitive to single-phasing, and shall have selectable trip classes of 10, 20 and 30.
6. Induction overload relays shall have changeable heater elements, manual reset, ambient temperature compensation, sensitivity to single-phasing, and shall have selectable trip classes of 10, 20 and 30.
7. Temperature probe relays shall be connected to thermistors or resistance temperature detectors (RTD) embedded in the motor winding.
8. Electronic overload relays shall utilize internal current transformers and electro-mechanical components. The relays shall have ambient temperature compensation, single-phase protection, manual or automatic reset, and trip classes of 10, 15, 20 and 30. The relay shall provide fault cause indication, including jam/stall, ground fault, phase loss, and overload.
- G. Hand-Off-Automatic (H-O-A) switch is required unless specifically stated on the drawings as not required for a particular controller. H-O-A switch shall be operable without opening enclosure door. H-O-A switch is not required for manual motor controllers.
- H. Incorporate into each control circuit a 120 Volt, electronic time-delay relay (ON delay), minimum adjustable range from 0.3 to 10 minutes, with transient protection. Time-delay relay is not required where H-O-A switch is not required.
- I. Unless noted otherwise, equip each motor controller with not less than two normally open (N.O.) and two normally closed (N.C.) auxiliary contacts.
- J. Provide green (RUN) and red (STOP) pilot lights.
- K. Motor controllers incorporated within equipment assemblies shall also be designed for the specific requirements of the assemblies.
- L. Additional requirements for specific motor controllers, as indicated in other specification sections, shall also apply.

2.2 MANUAL MOTOR CONTROLLERS

- A. Shall be in accordance with applicable requirements of 2.1 above.
- B. Manual motor controllers shall have the following features:
 1. Controllers shall be NEMA ICS 2 general-purpose Class A (AC air-break type), manually operated type with full voltage controller for induction motors, rated in horsepower, enclosure as required by environment or as listed in equipment schedule.

2. Units shall include thermal overload relays, on-off operator, red "run" pilot light, green "ready" pilot light, normally open and normally closed auxiliary contacts.

C. Fractional horsepower manual motor controllers shall have the following features:

1. Controllers shall be general-purpose Class A, manually operated type with full voltage controller for fractional horsepower induction motors.
2. Units shall include thermal overload relays, red pilot light, and toggle operator.

2.3 MAGNETIC MOTOR CONTROLLERS

- A. Shall be in accordance with applicable requirements of 2.1 above.
- B. Controllers shall be general-purpose, NEMA ICS 2 Class A magnetic controllers for induction motors rated in horsepower. Minimum NEMA size 0.
- C. Where combination motor controllers are used, combine controller with protective or disconnect device in a common enclosure.
- D. Provide phase loss protection for each controller, with contacts to de-energize the controller upon loss of any phase.
- E. Unless otherwise indicated, provide full voltage non-reversing across-the-line mechanisms for motors less than 75 HP, closed by coil action and opened by gravity. For motors 75 HP and larger, provide reduced-voltage or variable speed controllers as shown on the drawings. Equip controllers with 120 VAC coils and individual control transformer unless otherwise noted.

2.4 LOW-VOLTAGE VARIABLE SPEED MOTOR CONTROLLERS (VSMC)

- A. VSMC shall be in accordance with applicable portions of 2.1 above.
- B. VSMC shall be electronic, with adjustable frequency and voltage, three phase output, capable of driving standard NEMA B three-phase induction motors at full rated speed. The control technique shall be pulse width modulation (PWM), where the VSMC utilizes a full wave bridge design incorporating diode rectifier circuitry. Silicon controlled rectifiers or other control techniques are not acceptable.
- C. VSMC shall be suitable for variable torque loads, and shall be capable of providing sufficient torque to allow the motor to break away from rest upon first application of power.

- D. VSMC shall be capable of operating within voltage parameters of plus 10 to minus 15 percent of line voltage, and be suitably rated for the full load amps of the maximum watts (HP) within its class.
- E. Minimum efficiency shall be 95 percent at 100 percent speed and 85 percent at 50 percent speed.
- F. The displacement power factor of the VSMC shall not be less than 95 percent under any speed or load condition.
- G. VSMC current and voltage harmonic distortion shall not exceed the values allowed by IEEE 519.
- H. Operating and Design Conditions: Drives to be installed in ventilated (non-conditioned) boiler room in Bay Pines, Florida. De-rate equipment as required for installation location.
- I. VSMC shall have the following features:
 - 1. Isolated power for control circuits.
 - 2. Manually resettable overload protection for each phase.
 - 3. Adjustable current limiting circuitry to provide soft motor starting. Maximum starting current shall not exceed 200 percent of motor full load current.
 - 4. Independent acceleration and deceleration time adjustment, manually adjustable from 2 to 2000 seconds. Set timers to the equipment manufacturer's recommended time in the above range.
 - 5. Control input circuitry that will accept 4 to 20 mA current or 0-10 VDC voltage control signals from an external source.
 - 6. Automatic frequency adjustment from 1 Hz to 300 Hz.
 - 7. Circuitry to initiate an orderly shutdown when any of the conditions listed below occur. The VSMC shall not be damaged by any of these electrical disturbances and shall automatically restart when the conditions are corrected. The VSMC shall be able to restart into a rotating motor operating in either the forward or reverse direction and matching that frequency.
 - a. Incorrect phase sequence.
 - b. Single phasing.
 - c. Overvoltage in excess of 10 percent.
 - d. Undervoltage in excess of 15 percent.
 - e. Running overcurrent above 110 percent (VSMC shall not automatically reset for this condition.)
 - f. Instantaneous overcurrent above 150 percent (VSMC shall not automatically reset for this condition).

- g. Short duration power outages of 12 cycles or less (i.e., distribution line switching, generator testing, and automatic transfer switch operations.)
- 8. Provide automatic shutdown upon receiving a power transfer warning signal from an automatic transfer switch. VSMC shall automatically restart motor after the power transfer.
- 9. Automatic Reset/Restart: Attempt three restarts after VSMC fault or on return of power after an interruption and before shutting down for manual reset or fault correction, with adjustable delay time between restart attempts.
- 10. Power-Interruption Protection: To prevent motor from re-energizing after a power interruption until motor has stopped, unless "Bidirectional Autospeed Search" feature is available and engaged.
- 11. Bidirectional Autospeed Search: Capable of starting VSMC into rotating loads spinning in either direction and returning motor to set speed in proper direction, without causing damage to VSMC, motor, or load.
- J. VSMC shall include an input circuit breaker which will disconnect all input power, interlocked with the door so that the door cannot be opened with the circuit breaker in the closed position.
- K. VSMC shall include a 5% line reactor and a RFI/EMI filter.
- L. Surge Suppression: Provide three-phase protection against damage from supply voltage surges in accordance with UL 1449.
- M. VSMC shall include front-accessible operator station, with sealed keypad and digital display, which allows complete programming, operating, monitoring, and diagnostic capabilities.
 - 1. Typical control functions shall include but not be limited to:
 - a. HAND-OFF-AUTOMATIC-RESET, with manual speed control in HAND mode.
 - b. NORMAL-BYPASS.
 - c. NORMAL-TEST, which allows testing and adjusting of the VSMC while in bypass mode.
 - 2. Typical monitoring functions shall include but not be limited to:
 - a. Output frequency (Hz).
 - b. Motor speed and status (run, stop, fault).
 - c. Output voltage and current.

3. Typical fault and alarm functions shall include but not be limited to:
 - a. Loss of input signal, under- and over-voltage, inverter overcurrent, motor overload, critical frequency rejection with selectable and adjustable deadbands, instantaneous line-to-line and line-to-ground overcurrent, loss-of-phase, reverse-phase, and short circuit.
 - b. System protection indicators indicating that the system has shut-down and will not automatically restart.
- N. VSMC shall include two N.O. and two N.C. dry contacts rated 120 Volts, 10 amperes, 60 Hz.
- O. Hardware, software, network interfaces, gateways, and programming to control and monitor the VSMC by control systems specified in other specification sections, including but not limited to Divisions 22 and 23.
- P. Network communications ports: As required for connectivity to control systems specified in other specification sections, including but not limited to Divisions 22 and 23.
- Q. Communications protocols: As required for communications with control systems specified in other specification sections, including but not limited to Divisions 22 and 23.
- R. Bypass controller: Provide contactor-style bypass, arranged to bypass the inverter.
 1. Inverter Output Contactor and Bypass Contactor: Load-break NEMA-rated contactor.
 2. Motor overload relays.
 3. HAND-OFF-AUTOMATIC bypass control.
- S. Bypass operation: Transfers motor between inverter output and bypass circuit, manually, automatically, or both. VSMC shall be capable of stable operation (starting, stopping, and running), and control by fire alarm and detection systems, with motor completely disconnected from the inverter output. Transfer between inverter and bypass contactor and retransfer shall only be allowed with the motor at zero speed.
- T. Inverter Isolating Switch: Provide non-load-break switch arranged to isolate inverter and permit safe troubleshooting and testing of the inverter, both energized and de-energized, while motor is operating in bypass mode. Include padlockable, door-mounted handle mechanism.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install motor controllers in accordance with the NEC, as shown on the drawings, and as recommended by the manufacturer.
- B. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and electronic overload relay pickup and trip ranges.
- C. Program variable speed motor controllers per the manufacturer's instructions and in coordination with other trades so that a complete and functional system is delivered.
- D. Adjust trip settings of circuit breakers and motor circuit protectors with adjustable instantaneous trip elements. Initially adjust at six times the motor nameplate full-load ampere ratings and attempt to start motors several times, allowing for motor cooldown between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed eight times the motor full-load amperes (or 11 times for NEMA Premium Efficiency motors if required). Where these maximum settings do not allow starting of a motor, notify COR before increasing settings.

3.2 ACCEPTANCE CHECKS AND TESTS

- A. Perform manufacturer's required field tests in accordance with the manufacturer's recommendations. In addition, include the following:
 - 1. Visual Inspection and Tests:
 - a. Compare equipment nameplate data with specifications and approved shop drawings.
 - b. Inspect physical, electrical, and mechanical condition.
 - c. Verify appropriate anchorage, required area clearances, and correct alignment.
 - d. Verify that circuit breaker, motor circuit protector, and fuse sizes and types correspond to approved shop drawings.
 - e. Verify overload relay ratings are correct.
 - f. Vacuum-clean enclosure interior. Clean enclosure exterior.
 - g. Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data.
 - h. Test all control and safety features of the motor controllers.

- i. For low-voltage variable speed motor controllers, final programming and connections shall be by a factory-trained technician. Set all programmable functions of the variable speed motor controllers to meet the requirements and conditions of use.

3.3 FOLLOW-UP VERIFICATION

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

3.4 SPARE PARTS

- A. Two weeks prior to the final inspection, provide one complete set of spare fuses for each motor controller.

3.5 INSTRUCTION

- A. Furnish the services of a factory-trained technician for two 4-hour training periods for instructing personnel in the maintenance and operation of the motor controllers, on the dates requested by the COR.

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SECTION 26 29 21
ENCLOSED SWITCHES AND CIRCUIT BREAKERS
12-01-12

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section specifies the furnishing, installation, and connection of fused and unfused disconnect switches (indicated as switches in this section), and separately-enclosed circuit breakers for use in electrical systems rated 600 V and below.

1.2 RELATED WORK

- A. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS:
Requirements that apply to all sections of Division 26.
- B. Section 26 05 19, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES:
Low-voltage conductors.
- C. Section 26 05 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.
- E. Section 26 24 16, PANELBOARDS: Molded-case circuit breakers.

1.3 QUALITY ASSURANCE

- A. Refer to Paragraph, QUALIFICATIONS (PRODUCTS AND SERVICES), in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1.4 SUBMITTALS

- A. Submit six copies of the following in accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.
1. Shop Drawings:
 - a. Submit sufficient information to demonstrate compliance with drawings and specifications.
 - b. Submit the following data for approval:
 - 1) Electrical ratings, dimensions, mounting details, materials, required clearances, terminations, weight, fuses, circuit breakers, wiring and connection diagrams, accessories, and device nameplate data.
 2. Manuals:
 - a. Submit complete maintenance and operating manuals including technical data sheets, wiring diagrams, and information for ordering fuses, circuit breakers, and replacement parts.

- 1) Include schematic diagrams, with all terminals identified, matching terminal identification in the enclosed switches and circuit breakers.
- 2) Include information for testing, repair, troubleshooting, assembly, and disassembly.
- b. If changes have been made to the maintenance and operating manuals originally submitted, submit updated maintenance and operating manuals two weeks prior to the final inspection.
3. Certifications: Two weeks prior to final inspection, submit the following.
 - a. Certification by the manufacturer that the enclosed switches and circuit breakers conform to the requirements of the drawings and specifications.
 - b. Certification by the Contractor that the enclosed switches and circuit breakers have been properly installed, adjusted, and tested.

1.5 APPLICABLE PUBLICATIONS

- A. Publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by designation only.
- B. International Code Council (ICC):
IBC-12.....International Building Code
- C. National Electrical Manufacturers Association (NEMA):
FU 1-07.....Low Voltage Cartridge Fuses
KS 1-06.....Enclosed and Miscellaneous Distribution
Equipment Switches (600 Volts Maximum)
- D. National Fire Protection Association (NFPA):
70-11.....National Electrical Code (NEC)
- E. Underwriters Laboratories, Inc. (UL):
98-07.....Enclosed and Dead-Front Switches
248-00.....Low Voltage Fuses
489-09.....Molded Case Circuit Breakers and Circuit
Breaker Enclosures

PART 2 - PRODUCTS

2.1 FUSED SWITCHES RATED 600 AMPERES AND LESS

- A. Switches shall be in accordance with NEMA, NEC, UL, as specified, and as shown on the drawings.
- B. Shall be NEMA classified General Duty (GD) for 240 V switches, and NEMA classified Heavy Duty (HD) for 480 V switches.
- C. Shall be horsepower (HP) rated.
- D. Shall have the following features:
 - 1. Switch mechanism shall be the quick-make, quick-break type.
 - 2. Copper blades, visible in the open position.
 - 3. An arc chute for each pole.
 - 4. External operating handle shall indicate open and closed positions, and have lock-open padlocking provisions.
 - 5. Mechanical interlock shall permit opening of the door only when the switch is in the open position, defeatable to permit inspection.
 - 6. Fuse holders for the sizes and types of fuses specified.
 - 7. Solid neutral for each switch being installed in a circuit which includes a neutral conductor.
 - 8. Ground lugs for each ground conductor.
 - 9. Enclosures:
 - a. Shall be the NEMA types shown on the drawings.
 - b. Where the types of switch enclosures are not shown, they shall be the NEMA types most suitable for the ambient environmental conditions.
 - c. Shall be finished with manufacturer's standard gray baked enamel paint over pretreated steel.

2.2 UNFUSED SWITCHES RATED 600 AMPERES AND LESS

- A. Shall be the same as fused switches, but without provisions for fuses.

2.3 MOTOR RATED TOGGLE SWITCHES

- A. Type 1, general purpose for single-phase motors rated up to 1 horsepower.
- B. Quick-make, quick-break toggle switch with external reset button and thermal overload protection matched to nameplate full-load current of actual protected motor.

2.4 CARTRIDGE FUSES

- A. Shall be in accordance with NEMA FU 1.
- B. Motor Branch Circuits: Class RK1, time delay.
- C. Other Branch Circuits: Class RK1, time delay.
- D. Control Circuits: Class CC, fast acting.

2.5 SEPARATELY-ENCLOSED CIRCUIT BREAKERS

- A. Provide circuit breakers in accordance with the applicable requirements in Section 26 24 16, PANELBOARDS.
- B. Enclosures shall be the NEMA types shown on the drawings. Where the types are not shown, they shall be the NEMA type most suitable for the ambient environmental conditions.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Installation shall be in accordance with the manufacturer's instructions, the NEC, as shown on the drawings, and as specified.
- B. Fused switches shall be furnished complete with fuses. Arrange fuses such that rating information is readable without removing the fuses.

3.2 ACCEPTANCE CHECKS AND TESTS

- A. Perform in accordance with the manufacturer's recommendations. In addition, include the following:
 - 1. Visual Inspection and Tests:
 - a. Compare equipment nameplate data with specifications and approved shop drawings.
 - b. Inspect physical, electrical, and mechanical condition.
 - c. Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method.
 - d. Vacuum-clean enclosure interior. Clean enclosure exterior.

3.3 SPARE PARTS

- A. Two weeks prior to the final inspection, furnish one complete set of spare fuses for each fused disconnect switch installed on the project. Deliver the spare fuses to the COR.

---END---

SECTION 26 41 00
FACILITY LIGHTNING PROTECTION
01-01-17

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section specifies the furnishing and installation of a modification to an existing lightning protection system.
- B. Project shall include UL Master Label certification inspection of Building 100 lighting protection system. Any noted deficiencies in boiler project work shall be corrected under this project. Isolated deficiencies outside of the boiler project scope of work shall be reported to the VA.

1.2 RELATED WORK

- A. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS:
Requirements that apply to all sections of Division 26.
- B. Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS:
Requirements for personnel safety and to provide a low impedance path to ground for possible ground faults.
- C. Section 26 43 13, SURGE PROTECTIVE DEVICES: Surge protective device installed at the electrical service entrance.

1.3 QUALITY ASSURANCE

- A. Quality Assurance shall be in accordance with Paragraph, QUALIFICATIONS (PRODUCTS AND SERVICES) in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1.4 SUBMITTALS

- A. Submit in accordance with Paragraph, SUBMITTALS in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, and the following requirements:
 - 1. Shop Drawings:
 - a. Submit sufficient information to demonstrate compliance with drawings and specifications.
 - b. Show locations of air terminals, connections to required metal surfaces, down conductors, and grounding means.
 - c. Show the mounting hardware and materials used to attach air terminals and conductors to the structure.

2. Certifications: Two weeks prior to final inspection, submit the following.
 - a. Certification by the manufacturer that the lightning protection system conforms to the requirements of the drawings and specifications.
 - b. Certification by the Contractor that the lightning protection system has been properly installed and inspected.
 - c. Certification that the lightning protection system has been inspected by a UL representative and has been approved by UL without variation.

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 Fire Protection Association (NFPA):
 - 70-17.....National Electrical Code (NEC)
 - 780-17.....Standard for the Installation of Lightning Protection Systems
- C. Underwriters Laboratories, Inc. (UL):
 - 96-16.....Lightning Protection Components
 - 96A-16.....Installation Requirements for Lightning Protection Systems
 - 467-13.....Standard for Grounding and Bonding Equipment

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. Lightning protection components shall conform to NFPA 780 and UL 96, for use on Class II structures. Aluminum materials are not allowed unless specifically selected to match existing on roof.
 1. Class II conductors: Copper.
 2. Class II air terminals: Solid copper, 460 mm (18 inches) long unless noted otherwise on drawings, not less than 12.7 mm (1/2 inch) diameter, with sharp bare copper points.
 3. Ground rods: Existing to remain.
 4. Bonding plates: Bronze, 50 square cm (8 square inches).

5. Anchors and fasteners: Bronze bolt and clamp type shall be used for all applications except for membrane roof. Adhesive type are allowed only for attachment to membrane roof materials, using adhesive that is compatible with the membrane material.
6. Connectors: Bronze clamp-type connectors shall be used for roof conductor splices, and the connection of the roof conductor to air terminals and bonding plates. Crimp-type connectors are not allowed.
7. Exothermic welds: Exothermic welds shall be used for splicing the roof conductor to the down conductors, splices of the down conductors, and for connection of the down conductors to ground rods, ground plates, and the ground ring.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Installation shall be in accordance with the NEC, as shown on the drawings, and manufacturer's instructions.
- B. Coordinate installation with the roofing manufacturer and roofing installer.
- C. Install the conductors as inconspicuously as practical.
- D. Make connections of dissimilar metal with bimetallic type fittings to prevent electrolytic action.
- E. Bond down conductors to building structural steel.
- F. Connect roof conductors to all metallic projections and equipment above the roof as indicated on the drawings.
- G. Connect exterior metal surfaces, located within 900 mm (3 feet) of the conductors, to the conductors to prevent flashovers.
- H. Maintain horizontal or downward coursing of main conductor and insure that all bends have at least an 200 mm (8 inches) radius and do not exceed 90 degrees.
- I. Conductors shall be rigidly fastened every 900 mm (3 feet) along the roof and down to the building to ground.
- J. Air terminals shall be secured against overturning either by attachment to the object to be protected or by means of a substantial tripod or other braces permanently and rigidly attached to the building or structure.
- K. Install air terminal bases, cable holders and other roof-system supporting means without piercing membrane or metal roofs.

3.2 ACCEPTANCE CHECKS AND TESTS

- A. Test the ground resistance to earth by standard methods, and conform to the ground resistance requirements specified in Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS.
- B. A UL representative shall inspect the lightning protection system. Obtain and install a UL numbered master label for each of the lightning protection systems at the location directed by the UL representative and the COR. If certification is denied due to existing deficiencies beyond the scope of the boiler project, contractor shall provide report to COR.

---END---

SECTION 26 43 13
SURGE PROTECTIVE DEVICES
01-01-17

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section specifies the furnishing, installation, and connection of Type 2 Surge Protective Devices, as defined in NFPA 70, and indicated as SPD in this section.

1.2 RELATED WORK

- A. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: Requirements that apply to all sections of Division 26.
- B. SECTION 26 24 19, MOTOR CONTROL CENTERS.
- C. Section 26 24 16, PANELBOARDS: For factory-installed or external SPD.

1.3 QUALITY ASSURANCE

- A. Quality Assurance shall be in accordance with Paragraph, QUALIFICATIONS (PRODUCTS AND SERVICES) in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1.4 SUBMITTALS

- A. Submit in accordance with Paragraph, SUBMITTALS in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, and the following requirements:
 - 1. Shop Drawings:
 - a. Submit sufficient information to demonstrate compliance with drawings and specifications.
 - b. Include electrical ratings and device nameplate data.
 - 2. Manuals:
 - a. Submit, simultaneously with the shop drawings, companion copies of complete maintenance and operating manuals including technical data sheets, wiring diagrams, and information for ordering replacement parts.
 - b. If changes have been made to the maintenance and operating manuals originally submitted, submit updated maintenance and operating manuals two weeks prior to the final inspection.
 - 3. Certifications: Two weeks prior to final inspection, submit the following.
 - a. Certification by the manufacturer that the SPD conforms to the requirements of the drawings and specifications.

- b. Certification by the Contractor that the SPD has been properly installed.

1.5 APPLICABLE PUBLICATIONS

- A. Publications listed below (including amendments, addenda, revisions, supplement and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by the basic designation only.
- B. Institute of Engineering and Electronic Engineers (IEEE):
IEEE C62.41.2-02.....Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits
IEEE C62.45-08.....Surge Testing for Equipment Connected to Low-Voltage (1000 V and Less) AC Power Circuits
- C. National Fire Protection Association (NFPA):
70-17.....National Electrical Code (NEC)
- D. Underwriters Laboratories, Inc. (UL):
UL 1283-15.....Electromagnetic Interference Filters
UL 1449-14.....Surge Protective Devices

PART 2 - PRODUCTS

2.1 SWITCHGEAR/SWITCHBOARD/MCC SPD

- A. General Requirements:
1. Comply with IEEE and UL.
 2. Modular design with field-replaceable modules, or non-modular design.
 3. Integral disconnect switch.
 4. Redundant suppression circuits.
 5. LED indicator lights for power and protection status.
 6. Audible alarm, with silencing switch, to indicate when protection has failed.
 7. Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of protection status.
Contacts shall reverse on failure of any surge diversion module or on opening of any current-limiting device.
 8. Four-digit transient-event counter.
- B. Surge Current per Phase: Minimum 240kA per phase.

2.2 PANELBOARD SPD

A. General Requirements:

1. Comply with UL 1449 and IEEE C62.41.2.
2. Modular design with field-replaceable modules, or non-modular design.
3. Fuses, rated at 200 kA interrupting capacity.
4. Bolted compression lugs for internal wiring.
5. Integral disconnect switch.
6. Redundant suppression circuits.
7. LED indicator lights for power and protection status.
8. Audible alarm, with silencing switch, to indicate when protection has failed.
9. Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of protection status.
Contacts shall reverse on failure of any surge diversion module or on opening of any current-limiting device.
10. Four-digit transient-event counter.

B. Surge Current per Phase: Minimum 120kA per phase.

2.3 ENCLOSURES

A. Enclosures: NEMA 1.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Installation shall be in accordance with the NEC, as shown on the drawings, and manufacturer's instructions.
- B. Factory-installed SPD: Switchgear, switchboard, motor control center or panelboard manufacturer shall install SPD at the factory.
- D. Do not perform insulation resistance tests on switchgear, switchboards, panelboards, motor control centers or feeders with the SPD connected.
Disconnect SPD before conducting insulation resistance tests, and reconnect SPD immediately after insulation resistance tests are complete.

3.2 ACCEPTANCE CHECKS AND TESTS

- A. Perform in accordance with the manufacturer's recommendations. In addition, include the following:
 - 1. Visual Inspection and Tests:
 - a. Compare equipment nameplate data with specifications and approved shop drawings.
 - b. Inspect physical, electrical, and mechanical condition.
 - c. Verify that disconnecting means and feeder size and maximum length to SPD corresponds to approved shop drawings.
 - d. Verifying tightness of accessible bolted electrical connections by calibrated torque-wrench method.
 - e. Vacuum-clean enclosure interior. Clean enclosure exterior.
 - f. Verify the correct operation of all sensing devices, alarms, and indicating devices.

3.3 FOLLOW-UP VERIFICATION

- A. After completion of acceptance checks and tests, the Contractor shall show by demonstration in service that SPD are in good operating condition and properly performing the intended function.

3.4 INSTRUCTION

- A. Provide the services of a factory-trained technician for one 2-hour training period for instructing personnel in the maintenance and operation of the SPD, on the date requested by the COR.

`---END---

SECTION 26 51 00
INTERIOR LIGHTING
08-01-14

PART 1 - GENERAL

1.1 DESCRIPTION:

- A. This section specifies the furnishing, installation, and connection of the interior lighting systems. The terms "lighting fixture," "fixture," and "luminaire" are used interchangeably.

1.2 RELATED WORK

- A. Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT: Disposal of lamps.
- B. Section 02 41 00, DEMOLITION: Removal and disposal of lamps and ballasts.
- C. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: Requirements that apply to all sections of Division 26.
- D. Section 26 05 19, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES: Low-voltage conductors.
- E. 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.
- F. Section 26 27 26, WIRING DEVICES: Wiring devices used for control of the lighting systems.

1.3 QUALITY ASSURANCE

- A. Refer to Paragraph, QUALIFICATIONS (PRODUCTS AND SERVICES), in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1.4 SUBMITTALS

- A. Submit six copies of the following in accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.
1. Shop Drawings:
- a. Submit the following information for each type of lighting fixture designated on the LIGHTING FIXTURE SCHEDULE, arranged in order of lighting fixture designation.
 - b. Material and construction details, include information on housing and optics system.
 - c. Physical dimensions and description.
 - d. Wiring schematic and connection diagram.
 - e. Installation details.
 - f. Energy efficiency data.

- g. Photometric data based on laboratory tests complying with IES Lighting Measurements testing and calculation guides.
 - h. Lamp data including lumen output (initial and mean), color rendition index (CRI), rated life (hours), and color temperature (degrees Kelvin).
 - i. Ballast data including ballast type, starting method, ambient temperature, ballast factor, sound rating, system watts, and total harmonic distortion (THD).
 - j. For LED lighting fixtures, submit US DOE LED Lighting Facts label, and IES L70 rated life.
2. Manuals:
- a. Submit, simultaneously with the shop drawings, complete maintenance and operating manuals, including technical data sheets, wiring diagrams, and information for ordering replacement parts.
 - b. If changes have been made to the maintenance and operating manuals originally submitted, submit updated maintenance and operating manuals two weeks prior to the final inspection.
3. Certifications: Two weeks prior to final inspection, submit the following.
- a. Certification by the Contractor that the interior lighting systems have been properly installed and tested.

1.5 APPLICABLE PUBLICATIONS

- A. Publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by designation only.
- B. American National Standards Institute (ANSI):
 - C78.1-91.....Fluorescent Lamps - Rapid-Start Types -
Dimensional and Electrical Characteristics
 - C78.376-01.....Chromaticity of Fluorescent Lamps
- C. American Society for Testing and Materials (ASTM):
 - C635-07.....Manufacture, Performance, and Testing of Metal
Suspension Systems for Acoustical Tile and Lay-
in Panel Ceilings
- D. Environmental Protection Agency (EPA):
 - 40 CFR 261.....Identification and Listing of Hazardous Waste
- E. Federal Communications Commission (FCC):

- CFR Title 47, Part 15...Radio Frequency Devices
- CFR Title 47, Part 18...Industrial, Scientific, and Medical Equipment
- F. Illuminating Engineering Society (IES):
 - LM-79-08.....Electrical and Photometric Measurements of
Solid-State Lighting Products
 - LM-80-08.....Measuring Lumen Maintenance of LED Light
Sources
 - LM-82-12.....Characterization of LED Light Engines and LED
Lamps for Electrical and Photometric Properties
as a Function of Temperature
- G. Institute of Electrical and Electronic Engineers (IEEE):
 - C62.41-91.....Surge Voltages in Low Voltage AC Power Circuits
- H. International Code Council (ICC):
 - IBC-12.....International Building Code
- I. National Fire Protection Association (NFPA):
 - 70-11.....National Electrical Code (NEC)
 - 101-12.....Life Safety Code
- J. National Electrical Manufacturer's Association (NEMA):
 - C82.1-04.....Lamp Ballasts - Line Frequency Fluorescent Lamp
Ballasts
 - C82.2-02.....Method of Measurement of Fluorescent Lamp
Ballasts
 - C82.4-02.....Lamp Ballasts - Ballasts for High-Intensity
Discharge and Low-Pressure Sodium (LPS) Lamps
(Multiple-Supply Type)
 - C82.11-11.....Lamp Ballasts - High Frequency Fluorescent Lamp
Ballasts
 - LL-9-09.....Dimming of T8 Fluorescent Lighting Systems
 - SSL-1-10.....Electronic Drivers for LED Devices, Arrays, or
Systems
- K. Underwriters Laboratories, Inc. (UL):
 - 496-08.....Lampholders
 - 542-0599.....Fluorescent Lamp Starters
 - 844-12.....Luminaires for Use in Hazardous (Classified)
Locations
 - 924-12.....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
1598-08.....	Luminaires
1574-04.....	Track Lighting Systems
2108-04.....	Low-Voltage Lighting Systems
8750-09.....	Light Emitting Diode (LED) Light Sources for Use in Lighting Products

PART 2 - PRODUCTS

2.1 LIGHTING FIXTURES

- A. Shall be in accordance with NFPA, UL, 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.
 - 4. Hinged door frames shall operate smoothly without binding. Latches shall function easily by finger action without the use of tools.
- C. Drivers, Ballasts and lamps shall be serviceable while the fixture is in its normally installed position. Ballasts shall not be mounted to removable reflectors or wireway covers unless so specified.
- D. Recessed fixtures mounted in an insulated ceiling shall be listed for use in insulated ceilings.
- E. Mechanical Safety: Lighting fixture closures (lens doors, trim frame, hinged housings, etc.) shall be retained in a secure manner by captive screws, chains, aircraft cable, 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.

2.2 LED LIGHT FIXTURES

A. General:

1. LED light fixtures shall be in accordance with IES, NFPA, UL, as shown on the drawings, and as specified.
2. LED light fixtures shall be Reduction of Hazardous Substances (RoHS)-compliant.
3. LED drivers shall include the following features unless otherwise indicated:
 - a. Minimum efficiency: 85% at full load.
 - b. Minimum Operating Ambient Temperature: -20° C. (-4° F.)
 - c. Input Voltage: 120 - 277V (±10%) at 60 Hz.
 - d. Integral short circuit, open circuit, and overload protection.
 - e. Power Factor: ≥ 0.95.
 - f. Total Harmonic Distortion: ≤ 20%.
 - g. Comply with FCC 47 CFR Part 15.
4. LED modules shall include the following features unless otherwise indicated:
 - a. Comply with IES LM-79 and LM-80 requirements.
 - b. Minimum CRI 80 and color temperature 3000° K unless otherwise specified in LIGHTING FIXTURE SCHEDULE.
 - c. Minimum Rated Life: 50,000 hours per IES L70.
 - d. Light output lumens as indicated in the LIGHTING FIXTURE SCHEDULE.

B. LED Downlights:

1. Housing, LED driver, and LED module shall be products of the same manufacturer.

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. Wall-mounted fixtures shall be attached to the studs in the walls, or to a 20 gauge metal backing plate that is attached to the studs in the walls. Lighting fixtures shall not be attached directly to gypsum board.
- D. 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 6 mm (1/4 inch) 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 25 kg (56 pounds) 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 6.8 kg (15 pounds) in weight and occupying less than 3715 sq cm (two square feet) 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.
5. Single or double pendant-mounted lighting fixtures:
- a. Each stem shall be supported by an approved outlet box mounted swivel joint and canopy which holds the stem captive and provides spring load (or approved equivalent) dampening of fixture oscillations. Outlet box shall be supported vertically from the building structure.
6. Outlet boxes for support of lighting fixtures (where permitted) shall be secured directly to the building structure with approved devices or supported vertically in a hung ceiling from the building structure with a nine gauge wire hanger, and be secured by an approved device to a main ceiling runner or cross runner to prevent any horizontal movement relative to the ceiling.
- E. Furnish and install the new lamps as specified for all lighting fixtures installed under this project, and for all existing lighting fixtures reused under this project.
- F. The electrical and ceiling trades shall coordinate to ascertain that approved lighting fixtures are furnished in the proper sizes and installed with the proper devices (hangers, clips, trim frames, flanges, etc.), to match the ceiling system being installed.
- G. Bond lighting fixtures to the grounding system as specified in Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS.
- H. At completion of project, replace all defective components of the lighting fixtures at no cost to the Government.
- I. Dispose of lamps per requirements of Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT, and Section 02 41 00, DEMOLITION.

3.2 ACCEPTANCE CHECKS AND TESTS

A. Perform the following:

1. Visual Inspection:

- a. Verify proper operation by operating the lighting controls.
- b. Visually inspect for damage to fixtures, lenses, reflectors, diffusers, and louvers. Clean fixtures, lenses, reflectors, diffusers, and louvers that have accumulated dust, dirt, or fingerprints during construction.

2. Electrical tests:

- a. 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 specifically recommended otherwise by the lamp manufacturer. Replace any lamps and ballasts which fail during burn-in.

3.3 FOLLOW-UP VERIFICATION

- A. Upon completion of acceptance checks and tests, the Contractor shall show by demonstration in service that the lighting systems are in good operating condition and properly performing the intended function.

---END---