

**SECTION 23 50 11  
BOILER PLANT MECHANICAL EQUIPMENT**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. Feedwater deaerator, condensate and boiler feed pumps, condensate storage tank, fuel oil pumping and heating, compressed air systems, blowoff tank, blowdown heat recovery, chemical treatment systems, steam vent silencer, and other equipment that supports the operation of the boilers.
- B. A complete listing of common acronyms and abbreviations are included in Section 23 05 10, COMMON WORK RESULTS FOR BOILER PLANT AND STEAM GENERATION.

**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 10, COMMON WORK RESULTS FOR BOILER PLANT AND STEAM GENERATION.
- D. Section 23 07 11, HVAC AND BOILER PLANT INSULATION.
- E. Section 23 21 11, BOILER PLANT PIPING 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. Where conflicts occur these specifications and the VHA standard will govern. Use current version of the following documents:
- B. American Society of Mechanical Engineers (ASME):
  - B16.9.....Factory-Made Wrought Butt welding Fittings
  - B16.34.....Valves Flanged, Threaded and Welding End
  - PTC 12.3.....Performance Test Code on Deaerators
  - ASME Boiler and Pressure Vessel Code - BPVC Section VIII.....Rules for Construction of Pressure Vessels, Divisions 1 and 2
- C. American Society for Testing and Materials (ASTM):
  - A53/A53M.....Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless

- A106/A106M.....Standard Specification for Seamless Carbon Steel Pipe for High Temperature Service
- A234/A234M.....Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service
- A285/A285M.....Standard Specification for Pressure Vessel Plates, Carbon Steel, Low- and Intermediate-Tensile Strength
- A414/A414M.....Standard Specification for Steel, Sheet, Carbon, and High-Strength, Low-Alloy for Pressure Vessels
- A515/A515M.....Standard Specification for Pressure Vessel Plates, Carbon Steel, for Intermediate- and Higher-Temperature Service
- A516/A516M.....Standard Specification for Pressure Vessel Plates, Carbon Steel, for Moderate- and Lower-Temperature Service
- D. Environmental Protection Agency (EPA):  
CFR 40,264.193-2014.....Containment and Detection of Releases
- E. Department of Health and Human Services, Food and Drug Administration (FDA):  
CFR 21,175.300-2019.....Resinous and Polymeric Coatings
- F. Society for Protective Coatings (SSPC):  
SP 5.....White Metal Blast Cleaning
- G. Underwriters Laboratories (UL):  
574.....Standard for Electric Oil Heaters
- H. Department of Veterans Affairs (VA):  
PG-18-10.....Physical Security and Resiliency Design Manual  
VHA Boiler Plant Safety Devices Testing Manual, Third Edition

#### **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 23 50 11, BOILER PLANT MECHANICAL EQUIPMENT", 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.

D. Blowoff Tank and Accessories, Flash Tank:

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 blowoff tank temperature control valve.

E. 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.

F. Test Data - Acceptance Tests, on-site: Four copies all specified tests.

G. Complete operating and maintenance manuals including wiring diagrams, technical data sheets, information for ordering replacement parts, and troubleshooting guide:

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.

### **1.5 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, VA approved substitutions and construction revisions shall be in electronic version on CD or DVD inserted into a three-ring binder. All aspects of system operation and maintenance procedures, including applicable 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 Red-lined drawings of each completed phase for verification; and, shall provide the complete set at the time of final systems certification testing. 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. Provide record drawings as follows:
1. Red-lined, hand-marked drawings are to be provided, with one paper copy and a scanned PDF version of the hand-marked drawings provided on CD or DVD.
- D. Certification documentation shall be provided to COR 21 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 provide documentation/certification that all results of tests were within limits specified. Test results shall contain written sequence of test procedure with written test results annotated at each step along with the expected outcome or setpoint. The results shall include all readings, including but not limited to data on device (make, model and performance characteristics), normal pressures, switch ranges, trip points, amp readings, and calibration data to include equipment serial numbers or individual identifications, etc.

## **PART 2 - PRODUCTS**

### **2.1 GENERAL**

- A. Electric motor control cabinets/enclosures including VFDs in the boiler plant shall be minimum NEMA 4 or better. The design AE shall determine at the design stage based on the environmental condition and location. This shall also be indicated on the drawings.

### **2.2 BOILER BLOWOFF TANK AND ACCESSORIES**

- A. Type: Cylindrical welded steel tank mounted vertically. Tank shall include accessory equipment and shall be suitable for rigging into the

available space. Overall dimensions and arrangement of the tank and accessories shall conform to the drawings. Tank volume shall be twice the volume of a 100 mm (4 inch) blowoff (reduction in boiler water level) from the largest boiler connected to the tank.

B. Service: Suitable for receiving, venting, storing, cooling and discharging into the drain the effluent from the boilers resulting from the intermittent operation of the boiler bottom blowoffs, boiler accessory drains, and the use of continuous blowdowns.

C. Construction:

1. Construct tank and appurtenances in accordance with ASME BPVC Section VIII. Tank shall have cylindrical shell and dished heads.
2. Material of construction shall be carbon steel ASTM A285/A285M, ASTM A414/A414M, ASTM A515/A515M or ASTM A516/A516M.
3. Design tank for 275 kPa (40 psig) working pressure; the minimum material thickness shall be 10 mm (3/8 inch). Thickness of head material at any point shall not vary more than 10 percent from the nominal thickness.
4. All tank joints shall be double-welded butt joints or single-welded butt joints with backing strips.
5. Provide 300 mm by 406 mm (12 inches by 16 inches) elliptical manhole located at the vertical centerline of the tank.
6. Provide 10 mm (3/8 inch) thick carbon steel wear plate welded to interior of tank adjacent to tangential blowoff inlet as shown.
7. Provide nozzles for piping connections and provide tangential blowoff inlet located above the normal water level. Tangential pipe for blowoff inlet shall be Schedule 80, ASTM A53/A53M or ASTM A106/A106M, seamless steel pipe with beveled end for field-welding of blowoff from boilers. All other nozzles shall have threaded pipe connections for pipe sizes 50 mm (2 inches) and under, 1035 kPa (150 psig) ASME flanged connections for pipe sizes over 50 mm (2 inches). Nozzle sizes listed below are based on National Board of Boiler and Pressure Vessel Inspectors recommendations.

**Pipe Connection Sizes, mm (inches)**

<b>Boiler Blowoff</b>	<b>Water Outlet</b>	<b>Vent</b>
25 (1)	25 (1)	65 (2.5)
32 (1.25)	32 (1.25)	75 (3)
40 (1.5)	40 (1.5)	100 (4)

<b>Boiler Blowoff</b>	<b>Water Outlet</b>	<b>Vent</b>
50 (2)	50 (2)	125 (5)
65 (2.5)	65 (2.5)	150 (6)

8. Furnish completed ASME Form U-1 or U-1A MANUFACTURERS' DATA REPORT FOR PRESSURE VESSELS. Hydrostatically test tank at 1.3 times the design pressure.
  9. Tank nameplate shall be affixed to bracket which projects beyond the tank insulation that will be applied in the field. Apply ASME data stamp to nameplate to show compliance with design, construction and inspection requirements of the Code.
  10. Support tank by steel legs welded to shell of tank. Design saddles or legs to support tank (full of water), accessories, and portions of connecting piping to first hanger.
- D. Cleaning and Painting: Remove all dirt, heavy rust, mill scale, oil, welding debris from interior and exterior of tank. Prime exterior of tank with rust-resisting paint. Refer to Section 09 91 00, PAINTING.
- E. Insulation: Field apply insulation as specified in Section 23 07 11, HVAC AND BOILER PLANT INSULATION.
- F. Accessories:
1. Install red line type gauge glasses with protecting rods. Provide off set type gauge valves with ball-check feature to automatically prevent flow when glass is broken. Provide drain cock on lower gauge valve. Glass shall be at least 300 mm (12 inches) long and centered at the overflow level.
  2. Provide thermometer and pressure gauge. Conform to Section 23 09 11, INSTRUMENTATION AND CONTROL FOR BOILER PLANT.
  3. Water Outlet Temperature Control Valve:
    - a. Type: Self-contained, reverse-acting thermal bulb-operated water flow control valve.
    - b. Performance: Control valve shall operate automatically to control blowoff tank water outlet temperature to 60 degrees C (140 degrees F) maximum by regulating the flow of cold water which mixes with the blowoff water and reduces the temperature of the blow-off water. Provide valve designed for modulating and tight shut-off service. Valve flow rates and pressure drops shall be as shown. Temperature control range shall be adjustable, 38 to 77 degrees C (100 to 170 degrees F) minimum.

- c. Service: Provide valve designed to control the flow of city water with temperature 4 to 27 degrees C (40 to 80 degrees F), and pressure up to 690 kPa (100 psig). Thermal bulb will be inserted in blowoff tank outlet pipe and will be subjected to water temperatures up to 100 degrees C (212 degrees F).
  - d. Construction: Cast iron or bronze valve body designed for 850 kPa (123 psig) minimum WOG. Design of valve shall permit access to internal valve parts. Thermal bulb shall be separable socket type with well.
4. Provide blowoff water outlet pipe inside tank as shown to provide a water seal. Locate a 20 mm (3/4 inch) hole in top of this pipe inside tank to act as siphon breaker.

### **2.3 FLASH TANK**

- A. Type: Cylindrical welded steel tank with accessories as shown. Refer to detail on drawings.
- B. Service: Suitable for receiving, venting, storing and discharging to condensate return pump the effluent discharged from steam traps on high and medium pressure steam systems.
- C. Construction:
  - 1. Conform to ASME BPVC Section VIII. Fabricate from steel sheets and plates or from steel pipe and pipe caps.
  - 2. Materials of Construction:
    - a. Steel sheets and plates: ASTM A285/A285M, ASTM A414/A414M, ASTM A515/A515M, ASTM A516/A516M.
    - b. Steel pipe and pipe caps: Pipe ASTM A53/A53M A-S, A53/A53M A-E, A53/A53M B-S, A53/A53M B-E. Pipe Caps ASTM A234/A234M, ASME B16.9.
  - 3. Design tank for 850 kPa (123 psig), 178 degrees C (353 degrees F).
  - 4. Piping Connections: Threaded half couplings for pipe sizes under 65 mm (2-1/2 inches). Flanged 1035 kPa (150 psig) ASME for pipe sizes over 50 mm (2 inches).
  - 5. ASME Forms: Furnish U-1 or U-1A, MANUFACTURERS' DATA REPORT FOR PRESSURE VESSELS.
  - 6. Supports: Unless shown otherwise, provide floor-mounted frame constructed with steel angles.
  - 7. Condensate Pipe: Provide perforated Schedule 80 steel pipe inside tank as shown.

- D. Cleaning and Painting: Remove all dirt, heavy rust, mill scale, oil, welding debris from interior and exterior of tank. Coat exterior with rust-resisting primer. Refer to Section 09 91 00, PAINTING.
- E. Insulation: Insulate per Section 23 07 11, HVAC AND BOILER PLANT INSULATION.

#### **2.4 BOILER WATER AND DEAERATOR 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, 1035 kPa (150 psig). 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 1035 kPa (150 psig), 188 degrees C (370 degrees F). Design coil to relieve stresses due to thermal expansion.
  - 3. Arrangement: Shall be as shown on the drawings.

#### **2.5 AUTOMATIC CONTINUOUS BOILER BLOWDOWN CONTROL SYSTEM**

- A. Type: One factory-assembled system per boiler to automatically sense boiler water conductivity and operate automatic electric-powered blowdown valve to maintain desired total dissolved solids content in boiler water. Micrometer-type adjustable manual blowdown valve piped to bypass the automatic blowdown valve and conductivity sensor.
- B. Service: Design valves, sensors and piping for steam and water at 1035 kPa (150 psig), 186 degrees C (366 degrees F) minimum. Controller shall be suitable for 50 degrees C (120 degrees F) ambient and resist splashing water. Design automatic and manual blowdown valves for maximum blowdown flow rate equivalent to two percent of boiler steam output. System shall automatically maintain boiler water total dissolved solids at any set point between 1000 ppm and 4000 ppm.
- C. Operation: Programmable timer cycles to intermittently operate the blowdown valve to obtain conductivity samples, and to maintain the valve open for a time period until the conductivity of the boiler water reaches the set point. Provide an automatic temperature compensating circuit.

- D. Controller: Shall be microprocessor-based sealed unit mounted at the boiler.
1. Indicators on Panel Front: One-half inch high digital display showing conductivity and indicating normal or out-of-range conditions. Valve status indicators.
  2. Membrane Keypad on Panel Front: Allows manual operation of the blowdown valve, setting of conductivity set points and alarm set points, setting of timers, calibration data input.
- E. Automatic Valve Construction: Carbon steel body, Type 316 stainless steel ball and stem, TFE coated stainless steel body seal. Electric actuator with NEMA-4 or better enclosure. Rated for 1035 kPa (150 psig) 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 1035 kPa (150 psig) minimum saturated steam. Furnish valve blowdown chart showing flow rate versus valve opening based on 861 kPa (125 psig) 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.

## **2.6 CONTINUOUS BLOWDOWN HEAT RECOVERY SYSTEM**

- A. ASME code welded combined flash tank and heat exchanger vessel 1035 kPa (150 psig) construction.
- B. U tubes of type 304 stainless steel. Tubes shall be easily removed for inspection, cleaning and replacement.
- C. Accessories:
1. Pressure gauge.
  2. External float valve of balanced pressure design.
  3. Temperature gauge panel that shows performance of unit.
  4. Customized inlet flow control manifold for all boilers.
  5. Relief valve.
  6. Gauge glass set.
  7. 150 mm (6 inch) by 200 mm (8 inch) hand hole for inspection.
  8. Heavy duty saddle type mounting base.
  9. High level float with alarm.
  10. Makeup water inlet flanged connection.

11. Makeup water outlet flanged connection.
  12. Flanged flash steam vent connection.
- D. The Contractor shall furnish and install flow control for continuous boiler blowdown. This equipment shall have a maximum design working pressure of 1725 kPa (250 psig). The meter shall be capable of precise flow control of continuous boiler blowdown using the straight edge orifice principle at a boiler operating pressure of 110 psig.
- E. The flow control shall consist of a multiple orifice meter with an attached filter and sediment chamber designed to trap scale and suspended solids that could clog the small orifice holes. The stainless-steel filter screen mesh will be smaller than the smallest hole in the orifice plate. The flow control will have a hardened stainless-steel plate with not less than seventeen (17) graduated orifices, spaced and indexed so only one of the orifices will be opened to flow at a time. The orifices will be graduated in size to provide a range in rate of flow to cover the minimum and maximum continuous blowdown requirements of the boiler. The orifice plates shall be machined, heat treated, and along with the mating selector disc be ground and lapped to a flatness of three light bands to prevent leakage and wire drawing damage. The unit will have a gear driven indexing mechanism with a removable key to prevent tampering. A drain valve will be provided to flush the filter and sediment chamber.
- F. A flowchart shall be provided showing the blowdown flow in pounds per hour at the boiler operating pressure for each orifice setting.
- G. Provide one orifice meter unit for each boiler.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

- A. If an installation is unsatisfactory to the COR, the Contractor shall correct the installation at no additional cost or time to the Government.
- B. Feedwater Deaerator with Storage Tank and Accessories, Condensate Storage Tank, Blowoff Tank, Flash Tank.
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. Comply with seismic requirements in Section 13 05 41, SEISMIC RESTRAINT

- REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS. Arrange anchorage to allow thermal expansion of unit.
4. Clean interior of equipment before placing in service.
  5. Deaerator vent pipes must extend vertically through roof. Horizontal runs are prohibited.
  6. All controls, safeties, set points, etc. must conform to the VHA Boiler Plant Safety Devices Testing Manual.
- C. Boiler Feed and Condensate Transfer Pumps:
1. For base-mounted horizontal-shaft pumps, connect base drain to 20 mm (3/4 inch) pipe. Extend pipe to nearest open sight or floor drain.
  2. 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.
  3. Where packaged deaerator-feed pump unit is required, boiler feed pump base plates shall be welded or bolted to deaerator support frame.
  4. 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.
- D. Mechanical Condensate Pump: Provide sufficient elevation difference between the receiver condensate inlet and outlet and the trap inlet to assure the required head for proper functioning and capacity. Steam supply line shall include gate valve and Y-type strainer.
- E. Condensate Return Pump Units (Sump Type): Provide the exterior of new receiver tanks with two heavy coats of asphalt or bituminous waterproofing compound. Mounting into the floor shall include waterproofing gaskets and grouting that will prevent ground water from entering the building from around the receiver. Unit shall be level.
- F. Fuel Oil Pumping Equipment and Fuel Oil Heaters and Accessories: Locate equipment to permit access to all valves and controls, and to permit removal and cleaning of heat exchanger tubes.

- G. Compressed Air System: Pipe all drain connections individually to nearest floor drain. Use 15 mm (1/2 inch) piping. Provide union at each drain connection on the equipment.
- H. Automatic Continuous Boiler Blowdown Control System: Locate controller on floor-supported angle at four feet above the floor at the boiler adjacent to the continuous blowdown valves. Keypad and indicator must face aisle.

### **3.2 TESTING AND BALANCING FEEDWATER DEAERATOR WITH STORAGE TANK AND ACCESSORIES**

- A. Demonstrate the ability of the deaerator to perform as specified in regard to oxygen removal and outlet temperature, over the required output flow range and input temperature range of unit. Test performance at 5 percent and 100 percent of capacity, and at two intermediate points to be selected by the COR. Repeat test two times at each load point.
- B. Determine temperatures and pressures by calibrated thermometers and pressure gauges.
- C. Utilize the specified colorimetric comparator type dissolved oxygen test kit. After completion of tests, clean the test kit apparatus, replace all ampoules used and parts missing or broken, and deliver the kit to the COR.
- D. Various impurities in feed water can interfere with the colorimetric test. When impurities are present, the Contractor shall be prepared to test for dissolved oxygen using the titration test as described in ASME PTC 12.3. COR may permit other test methods.
- E. This test shall be performed in conjunction with any boiler tests that are specified.
- F. Prior to requesting final tests, pretest unit using method specified for final test. All final tests must include at the minimum the tests listed in the VHA Boiler Plant Safety Devices Testing Manual. Submit test data for review.
- G. All permanent work platforms shall be in place before testing. The use of or need for step ladders to perform any inspection, test, or maintenance shall be considered a failure to install the equipment in accordance with specifications that require access to equipment. The contractor shall correct at no additional cost or time to the Government before beneficial use can start.

**3.3 STARTUP AND TESTING**

- A. Perform tests as recommended by product manufacturer and listed standards and under actual or simulated operating conditions and prove full compliance with design and specified requirements. Tests of the various items of equipment shall be performed simultaneously with the system of which each item is an integral part.
- B. When any defects are detected, correct defects and repeat test at no additional cost or time to the Government.
- C. The Commissioning Agent will observe startup and contractor testing of selected equipment. Coordinate the startup and contractor testing schedules with the COR and Commissioning Agent. Provide a minimum notice of 10 working days prior to startup and testing.

**3.4 DEMONSTRATION AND TRAINING**

- A. Provide services of manufacturer's technical representative for 4 hours to instruct each VA personnel responsible in operation and maintenance of the system.
- B. Submit training plans and instructor qualifications.

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