

SECTION 23 50 11
BOILER PLANT MECHANICAL EQUIPMENT

PART 1 - GENERAL

1.1 DESCRIPTION

Feedwater deaerator, condensate and boiler feed pumps, 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.

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 23 08 11, DEMONSTRATIONS and TESTS FOR BOILER PLANT.
- H. 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. Feedwater Deaerator with Storage Tank and Accessories:
 - 1. Drawings showing arrangement and overall dimensions of feedwater deaerator including storage tank. Show locations of tank-mounted devices. Show locations and sizes of pipe connections, access openings, and access platform. Show design of all shell, head and nozzle welds.
 - 2. Weight of entire assembly empty and flooded.
 - 3. Catalog data, drawings and specification sheets showing design and construction of feedwater deaerator, storage tank, recycle pumps, water flow control valves, safety valve, overflow control valve, water level and overflow control systems, vent orifice, vacuum breaker, alarm switches and all accessories.
 - 4. Performance data and pressure and temperature limitations of feedwater deaerator, recycle pumps, water flow/level control valve and control system, safety valve, overflow control valve, vent orifice, vacuum breaker, alarm switches and all accessories.
 - 5. Catalog data on oxygen test kit.
 - 6. Oxygen sample and chemical feed probe design.
 - 7. Deaerator inlet pressure requirements - steam and water.

8. Packaged feedwater deaerator/feedwater pump units: Boiler feedwater pump suction and discharge pipe sizing and arrangement. Design of support framework and access platforms.
9. Control Panel for control of:
 - a. DA tank level, including fill and overflow valves.
 - b. Feedwater pumps.
 - c. Condensate Hot Well level, including fill valves.
 - d. Condensate transfer pumps.
- C. Condensate Storage Accessories:
 1. Design and construction (including pressure and temperature limitations), control valves, water level control system, level alarm switches and all accessories.
 2. Performance data on control valves. Refer to drawings (Schedules) for requirements.
- D. Blowoff Tank Accessories:
 1. Design and performance of blowoff tank temperature control valve.
- E. Boiler Feed and 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).
- F. Vacuum Heating Pump Units:
 1. Drawings with dimensions of entire unit. Drawing shall include locations and sizes of all pipe connections.
 2. Catalog data and specification sheets on design and construction of pumps, receiver and accessories.
 3. Catalog cuts and schematic diagram of controls.
 4. Electric pump performance curves showing discharge head, flow, NPSH required, efficiency, motor power and impeller diameter to be furnished. Mechanical pump performance showing discharge head, flow, required inlet head and steam pressure. Refer to drawings for requirements.
 5. Pressure and temperature limitations of pump unit.

G. Fuel Oil Pumping Equipment:

1. Drawings with overall dimensions and arrangement of pumps, motors, couplings, bases, drip pans, duplex strainer, relief valves, back-pressure control valve, control panel, and supports and all accessories.
2. Catalog data and specification sheets on the design and construction of pumps, motors, couplings, bases, drip pans, duplex strainer, relief valves, back pressure control valves, all valves and accessories, and control panel.
3. Motor efficiency and power factor at full load.
4. Pressure and temperature limitations of pumps, duplex strainer, relief valves, back pressure control valve and all valves.
5. ASTM number and pressure rating of pipe and fittings.
6. Performance data on pumps including discharge head, flow, suction lift and motor power required at viscosity range shown. Refer to drawings for requirements.
7. Sound level test data on similar pump in similar installation. Refer to Section 23 05 51, NOISE AND VIBRATION CONTROL FOR BOILER PLANT.
8. Performance data on relief valves and back-pressure control valves.
9. Sequence of operation control narrative for pump operation and sequencing.

H. 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.

I. Chemical Feed Systems (Pump Type):

1. Drawings with dimensions of entire unit. Include locations and sizes of all pipe connections.
2. Catalog data and specification sheets on the design and construction of pump, mixer, tank, controls.
3. Performance data on pump including head, flow, motor power. Refer to schedules on drawings for requirements.
4. Pressure and temperature limitations of unit and accessories.
5. Information on suitability of materials of construction for chemicals to be utilized.

J. 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.
- K. For all Control Panels required, provide panel the following:
1. Construction
 2. Layout of components comprising operator interface on front door
 3. Layout and description of all internal mechanical, electrical, and electronic components
 4. Wiring diagrams
 5. Functional description of panel control functions and annunciators.
 6. UL compliance
 7. Communication interface with Boiler Plant Control System computer workstation.
 8. Refer to Section 23 09 11 for additional control panel requirements.
- L. Test Data - Acceptance Tests, On-Site: Four copies all specified tests.
- M. 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):
- A53/A53M-07.....Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
- A106/A106M-08.....Standard Specification for Seamless Carbon Steel Pipe for High Temperature Service
- A234/A234M-10.....Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service
- 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:

PTC 12.3-1997.....Performance Test Code for Deaerators

B16.9-2007.....Factory-Made Wrought Butt Welding Fittings

B16.34-2009.....Valves, Flanged, Threaded and Welding End

D. National Board of Boiler and Pressure Vessel Inspectors:

NB-23-2007.....Inspection Code

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

ASHRAE Handbook.....2008 HVAC Systems and Equipment

F. Society for Protective Coatings (SSPC):

SP 5-2007.....White Metal Blast Cleaning

PART 2 - PRODUCTS

2.1 MOTORS FOR BOILER PLANT MECHANICAL EQUIPMENT

A. All motors provided under this section shall be TEFC type.

2.2 ACUATED VALVES

A. Electric drive units are required.

B. Does not include:

1. Safety Valves.
2. Steam Pressure Reducing Valves.
3. Valves provided with boilers.

C. 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.

2.3 FEEDWATER DEAERATOR WITH STORAGE TANK AND ACCESSORIES

A. Pressurized (14-35 kPa) (2-5 psi) unit designed to heat and deaerate boiler feedwater by direct contact with low pressure steam. Tray type

deaerating section. Horizontal feedwater storage tank. Provide accessories including vacuum breaker, safety valve, water inlet and overflow controls and control valves, water level indicators and alarms and other devices as specified and shown.

B. Performance and Operating Characteristics:

1. Oxygen Content of Feedwater Output: 7 parts per billion maximum over turndown range with minimum and normal feedwater input temperatures as listed.
2. Turndown: 20/1.
3. Required Maximum Feedwater Flow Output: as scheduled on drawings.
4. No carbon dioxide in feedwater output; maximum steam vent loss 1/2 percent of input steam at maximum load.
5. Feedwater Input Temperature: Minimum temperature is 15 °C (60 °F) and normal range is 60 - 82 °C (140 - 180 °F).
6. Steam Pressure Loss in Unit: 7 kPa (1 psi) maximum.

C. Feedwater Storage Capacity to the Overflow Line: Sufficient for twenty minutes operation at maximum required feedwater output with no input water, unless shown otherwise on the drawings. Overflow line (elevation) shall be set by feedwater deaerator manufacturer so that there is no water hammer when water is at this level.

D. Construction:

1. Storage Tank and Deaerator Pressure Vessels:
 - a. Conform to ASME Boiler and Pressure Vessel Code, Section VIII. Design for saturated steam at 200 kPa (30 psi) with 3 mm (0.125 inch) corrosion allowance.
 - b. Carbon steel, ASTM A285 Grade C or ASTM A516 Grade 70. Weld metal strength shall approximate the strength of the base metal. All welds shall be double-vee type. No single vee welds allowed. Weld undercut not allowed. All welding must be constructed to allow future internal weld inspections, utilizing non-destructive-testing methods.
 - c. Post Weld Heat Treatment (PWHT) to stress-relieve pressure vessel to 620 °C (1150 °F) not to exceed ASME hold-time or temperature.
 - d. Provide 100 percent radiography of all longitudinal and circumferential welded seams. Test nozzle-to-shell welds by wet magnetic-particle method. Hydrostatically test final assembly at 1.3 times design pressure.
 - e. Furnish completed applicable ASME Forms U-1, U-1A or U-2.
2. Trays: Stainless steel, Type 430, no spot welds.

3. All other parts in deaerator section exposed to undeaerated liquids or gases must be constructed of stainless steel, cupro-nickel or equivalent.
4. Provide two 300 mm (12 inches) x 400 mm (16 inches) elliptical manways in storage tank, located below the normal water level, but near the tank centerline, and away from the deaeration section or internal piping. Manway locations must allow unrestricted access to tank interior with no interference from internal equipment and piping and with easy access from outside the tank. Second manway is to facilitate the annual internal inspections.
5. Provide access openings in deaeration section to allow inspection and replacement of trays.
6. Support: Steel saddles or legs welded to storage tank. Coordinate location with structural design of building.
7. Access Platform: Provide access platform and ladder as indicated on drawings, to provide maintenance access to all serviceable components. Platform support shall be an integral part of the structural support steel for the entire assembly.
9. Nameplates: Attach to bracket projecting beyond field-applied insulation. Provide all ASME pressure vessel nameplate information as required by the Code along with information identifying the designer and manufacturer of the storage tank and the deaeration section.
10. Pipe Connections:
 - a. Threaded for sizes 50 mm (2 inches) and under.
 - b. Flanged, 1025 kPa (150 psi) ASME, for sizes above 50 mm (2 inches).
 - c. Vortex breaker in boiler feedwater pump suction connection.
 - d. Overflow Pipe:
 - 1) Overflow pipe inside tank terminating 150 mm (6 inches) below low level alarm set point. Operation of overflow control system must not allow water level to fall to the level of the overflow pipe inlet.
 - 2) Overflow pipe sizing, based on required maximum feedwater flow output of feedwater deaerator:

Feedwater Flow Rate (kg/sec)	Feedwater Flow Rate (klb/hr)	Overflow Pipe Minimum Size (mm)	Overflow Pipe Minimum Size (in)
0 thru 3.8	0 thru 30	75	3
3.9 thru 7.6	31 thru 60	100	4

7.7 thru 12.6	61 thru 100	150	6
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- E. Steam Safety Valve: Mount on feedwater deaerator pressure vessel. Set pressure 100 kPa (15 psi). Capacity as shown. If not shown, minimum capacity 0.12 kg/sec (900 lb/hr). For safety valve construction requirements, refer to Section 23 21 11, BOILER PLANT PIPING SYSTEMS.
- F. Oxygen and Non-Condensable Gas Venting: Straight vertical pipe extending through roof from deaeration section. Provide gate valve in vent pipe, with hole drilled in wedge. Hole size selected by feedwater deaerator manufacturer for normal venting with gate valve closed.
- G. Thermometers and Pressure Gages: Refer to Section 23 09 11, INSTRUMENTATION and CONTROL FOR BOILER PLANT for construction requirements. Provide thermometers on deaeration section and on storage tank. Provide compound gage with shut-off valve and siphon on deaerator.
- H. Vacuum Breaker: Sized by deaerator manufacturer to protect unit. Bronze swing check valve, rated for 1030 kPa (150 psi), PTFE seat, stainless steel hinge pin.
- I. Water Sample and Chemical Feed Probes: Type 304 or 316 stainless steel, multi-ported, minimum length 300 mm (1 foot), accessible for removal from exterior of tank.
- J. Dissolved Oxygen Test Kit: Provide a colorimetric-comparator type kit, utilizing Rhodazine D methodology, for use during acceptance testing and for future use by the Medical Center. Kit shall include self-filling ampoules, color comparator, oxygen-resistant tubing, sampling devices, sealed glass ampoules containing reagent, carrying case, all equipment necessary for complete test. Range 0-20 parts per billion of dissolved oxygen.
- K. Cleaning and Painting: Remove all foreign material to bare metal. Coat exterior of pressure vessel with rust-preventative primer. Refer to Section 09 91 00, PAINTING. Do not coat interior of pressure vessel.
- L. Insulation: Field-applied. Refer to Section 23 07 11, HVAC, PLUMBING, and BOILER PLANT INSULATION.
- M. 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.
 3. Vertical pipe type header shall be connected to top and bottom of storage tank with tank isolation valves and valved header drain. Viewable gages shall cover entire diameter of tank.

4. Minimum rating 120 degrees C, 200 kPa (250 degrees F, 30 psi).
- N. Low Level Alarm Switch: Float type unit with hermetically sealed mercury switch. Locate external to tank on a vertical header with valved tank connections and valved drain. Switch elevation shall be at the tank centerline. Minimum rating 120 degrees C, 200 kPa (250 degrees F, 30 psi). Provide signals to annunciator system specified in Section 23 09 11, INSTRUMENTATION and CONTROL FOR BOILER PLANT.
- O. High Level Alarm Switch and Overflow Control Switch:
 1. Conductivity probe type electronic level switches providing relay contacts for separate high level alarm operation and overflow control valve operation completely separate from control system for inlet water flow control valves. Overflow control valve shall automatically open when the water level rises approximately 100 mm (4 inches) above the high water alarm level. Provide high level and overflow signals to annunciator system specified in Section 23 09 11, INSTRUMENTATION and CONTROL FOR BOILER PLANT.
 2. The principle of operation shall be differential resistivity of steam and water at the operating temperatures and pressures. The system shall include electronics unit, electrodes, special cable between the electrodes and electronics unit, and electrode cover. The unit shall be designed to fail safe.
 3. Electronics Unit:
 - a. Each unit shall be capable for signal discrimination of two electrode channels.
 - b. Each electrode and its associated circuitry shall be powered by an independent power source. Power distribution system within the electronics shall be separate for each channel with its own transformer and shall be electrically isolated from other channels.
 - c. Input power 110 V, 60 Hz, single phase.
 - d. All input power to each electrode shall be a low voltage, low frequency AC voltage. DC voltages shall not be allowed because this may cause electroplating at the electrodes.
 - e. The signal discrimination and fault detection system for each electrode channel shall be independent of the other channel and any fault in the electronics circuitry of one channel shall not be transferred to the other channel.
 - f. The system shall have a continuous on-line fault detection system. The following faults shall be detected: Electrode failure, contamination from dirt on electrodes, electrode open circuit

failure, electrode cable short to ground, electrode cable ground sense failure, power source failure, any electronic component failure. Electronic circuitry not monitored by the fault detection system shall be provide with triple redundancy, where the circuit shall continue to operate and provide contact output with up to two component failures.

- g. Faults shall be annunciated through separate NO and NC contacts.
 - h. The front of the unit shall have a LED display for each electrode channel indicating steam or water and status of each electrode.
 - i. NEMA 4X enclosure suitable for operating temperature of -20 to 70 degrees C (-4 to 158 degrees F), with up to 100% relative humidity.
4. Electrodes:
- a. Suitable for 120 degrees C, 200 kPa (250 degrees F, 30 psi) minimum.
 - b. Electrodes without gaskets are preferred.
 - c. Teflon insulator media.
 - d. Electrodes fitted into shrouded inserts which are directly welded onto the stand-pipe. Design to minimize faulty indication due to falling condensate into the electrodes.
5. Electrode Cable:
- a. Pure nickel wires for at least the first two meters at the electrode end, with pure nickel crimps. PTFE insulation capable of withstanding up to 265 degrees C (500 degrees F).
 - b. Continuous cables from the electrodes to the electronic unit. No junction boxes allowed.
- P. Overflow Water Control Valve and Controller: Open-shut electrically-actuated overflow control valve actuated by conductivity probe-type water level sensor and control system.
- 1. Performance: When water level reaches the overflow level as set by the feedwater deaerator manufacturer, automatically open the overflow control valve to reduce the water level. Automatically close the overflow valve when the water level has been lowered to a point 100 mm (4 inches) below the high level alarm set point. Valve operational speed shall not exceed 30 seconds for 90 degree valve movement.
 - 2. Controller: Automatic control shall be from the high level alarm and overflow control switch system. Provide a manual/auto switch on the main instrument panel that indicates valve position. Communicate valve position with computer work station. Control valve shall fail

open. A limit switch on the valve actuator shall initiate alarm on control station and in computer work station when valve is open.

3. Control Valve:

- a. High performance butterfly valve, double offset design.
- b. Carbon steel 17-4PH steel valve body conforming to ASME B16.34, Class 150, lug style, 316 stainless steel nitrided disc.
- c. Self-energizing TFE seat providing bubble-tight shut off service on vacuum and low pressure and pressure sealed for high pressures. Bi-directional seating.
- d. Packing adjustable, chevron design with TFE seals.
- e. 7 kPa (1 psi) maximum pressure loss at maximum flow rate (120% of peak deaerator capacity if valve flow and pressure drop is not scheduled).

4. Valve Actuator:

- b. Suitable for 480 degrees F (250 degrees C).
- d. Equip with limit switch containing two SPDT, proximity type switches to provide position indication.
- e. Size actuator with a 30% safety factor to ensure enough spring capacity to open the valve after long periods of closure.

Q. Storage Tank Automatic Water Level Controls:

1. Separate electrically-actuated modulating water inlet flow control valves for normal condensate transfer water and for emergency soft water makeup. Actuated by dedicated electronic controller with input signals from water level transmitter. Manual/auto control capability.
2. Performance: Maintain a constant water level, plus or minus 25 mm (1 inch), in the feedwater deaerator storage tank by controlling the flow of condensate transfer water to the deaerator. Normal water level 200 mm (8 inches) below the overflow level. If water level falls to 100 mm (4 inches) below low water alarm setpoint, automatically operate the emergency soft water makeup valve to bring the water level to 100 mm (4 inches) above low water alarm setpoint.
3. Water Level Transmitter and Controller: Transmitter shall have programmable electronics, sealed diaphragms, direct sensing electronics, no mechanical force or torque transfer devices, external span and zero adjustment. Controller shall have 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, normal and emergency 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 shall be the same make and model as the combustion controls.

4. Condensate Transfer and Soft Water Flow Control Valves and Actuators:
 - a. Electrically-actuated, globe style.
 - b. Bronze or cast iron bodies, threaded ends for pipe sizes 50 mm (2 inches) and under rated at 1700 kPa (250 psi), ASME flanged ends for pipe sizes over 50 mm (2 inches) rated at 850 kPa (125 psi) or 1025 kPa (150 psi).
 - c. Replaceable Type 316 stainless steel plugs and seats. RTFE seal for bubble-tight shut off. Linear flow characteristics.
 - d. Flow pressure loss 35 kPa (5 psi) maximum at maximum deaerator output.
 - f. Electronic positioner with 4 - 20 ma DC control input. Mounted integral with actuator. Digital positioner with capability to self-calibrate. Maintenance diagnostic data retained in memory. Design for 120 degrees C (250 degrees F) continuous service.

2.4 CONDENSATE STORAGE ACCESSORIES

- A. Accessories shall be installed to control inflow of makeup water and level of water in existing hot wells serving as the plant condensate receiver.
- B. Accessories include make-up water controls and control valves, thermometer, water level gage, and other devices as specified.
- C. Service: Receiving and storing steam condensate and make-up water. Contents of tank may vary in temperature from 4 °C to 100 °C (40 °F to 212 °F).
- D. High and Low Level Alarm Switches:
 1. Low Level Alarm Switch: Integral unit consisting of float, float housing, hermetically sealed mercury switch. 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. 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 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.

E. Automatic Water Level Controls:

1. Separate electrically-actuated 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 depth plus 300 mm (12 inches). If water level falls to 30% of tank depth, 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, globe style.
 - b. Bronze or cast iron bodies, threaded ends for pipe sizes 50 mm (2 inches) and under rated at 1700 kPa (250 psi), ASME flanged ends for pipe sizes over 50 mm (2 inches) rated at 850 kPa (125 psi) or 1025 kPa (150 psi).
 - c. Replaceable Type 316 stainless steel plugs and seats. RTFE seal for bubble-tight shut off. Linear flow characteristics.
 - d. Flow pressure loss 35 kPa (5 psi) maximum at maximum flow rating. Unless otherwise shown, maximum flow rate shall be equivalent to 50% make-up rate with plant at maximum load (2 boilers at high fire).

- f. Electronic positioner with 4 - 20 ma DC control input. Mounted integral with actuator. Digital positioner with capability to self-calibrate. Maintenance diagnostic data retained in memory. Design for 120 degrees C (250 degrees F) continuous service.

2.5 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 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 1034 kPa (150 psi) 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 400 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 or A106, 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, 1025 kPa (150 psi) ASME flanged connections for pipe sizes over 50 mm (2 inches). Nozzle sizes listed below are based on "National Board" recommendations.

Pipe Connection Sizes, mm (inches)

Boiler Blowoff	Water Outlet	Vent
25(1)	25(1)	63(2.5)
32(1.25)	32(1.25)	80(3)
38(1.5)	38(1.5)	100(4)
50(2)	50(2)	130(5)
64(2.5)	64(2.5)	64(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 (See Section 09 91 00, PAINTING).
- E. Insulation: Field apply insulation as specified in Section 23 07 11, HVAC, PLUMBING, AND BOILER PLANT INSULATION.
- F. Accessories:
1. Install red line type gage glasses with protecting rods. Provide off set type gage valves with ball-check feature to automatically prevent flow when glass is broken. Provide drain cock on lower gage valve. Glass shall be at least 300 mm (12 inches) long and centered at the overflow level.
 2. Provide thermometer and pressure gage. 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 °C (140 °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 °C (100 to 170 °F) minimum.

c. Service: Provide valve designed to control the flow of city water with temperature 4 to 27 °C (40 to 80 °F), and pressure up to 690 kPa (100 psi). Thermal bulb will be inserted in blowoff tank outlet pipe and will be subjected to water temperatures up to 100 °C (212 °F).

d. Construction: Cast iron or bronze valve body designed for 850 kPa (125 psi) 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.

2.6 CENTRIFUGAL MULTI-STAGE BOILER FEEDWATER PUMPS

A. Type: Two or more stages, 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 - Boiler Feed: Pumps shall have variable frequency drives controlled by boiler feed header pressure electronic control system which must be provided. Control the header pressure at 150 psi. For VFD requirements refer to Section 26 29 11, LOW-VOLTAGE MOTOR STARTERS.

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, TEFC. 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.

2.7 CONDENSATE TRANSFER PUMPS

- A. Type: Factory-assembled units consisting of vertical, extended shaft, submerged, motor-driven condensate pumps mounted on a horizontal base plate for field-mounting to concrete cover of a vented underground concrete receiver. Motors shall be above the base plate, arranged as shown.
- B. Service: Design pumps and accessories for continuous condensate transfer service, 93 °C (200 °F) water, with flow rates ranging from maximum scheduled on 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 the drawings. Pump head-flow performance curve shall slope continuously upward to shutoff.
- D. Pump Size: Shall be such that a minimum of 10 percent increase in head can be obtained at the maximum required flow rate by installing larger impellers.
- E. Pump Construction: Centrifugal or turbine-type, vertical extended shaft, bronze-fitted, flexible-coupled, designed for submerged operation.

Provide regreaseable ball thrust shaft bearings located at least six inches above the base plate, bronze shaft bearings adjacent to the pump designed for water lubrication, intermediate water-lubricated shaft bearings where required by length of shaft. Bearings rated for two year minimum life with continuous operation at maximum pump load. Shaft shall be stainless steel. Provide mechanical shaft seal at base plate with bronze packing gland. Pump manufacturer shall terminate the pump discharge pipes above the base plate. Bolt pump-motor units to brackets that are bolted to the base plate. Removal of one pump shall not affect operation of second pump in duplex configuration. Provide stainless steel recirculation orifice selected by pump manufacturer to protect pump from over-heating at shutoff. Refer to Section 23 05 51, NOISE and VIBRATION CONTROL FOR BOILER PLANT for sound level limitations.

- F. Electric Motor Drives: TEFC, high efficiency, standard HP base. Motor bearings shall be grease-lubricated designed to carry all radial and thrust loads of the pump and motor assemblies. Select motor size so that the motors are not overloaded at any point on the pump head-flow performance curve. Motor shall be designed for 40 °C ambient temperature. For efficiency and power factor requirements, refer to Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.
- G. Pump Base Plate: Heavy gage steel designed to support weight of pumps, motors, and accessories with no deflection. Cover plate shall include provisions for mounting of pumps, motors and accessories by bolting and shall be designed to allow easy removal of same. Provide threaded or flanged openings for piping connections. Openings for pipe sizes above 50 mm (2 inches) must be flanged. Cover plate shall be designed to fit existing receiver tank or sump as shown. Provide bolted inspection plate for viewing interior of receiver. All bolted connections to cover plate and between cover plate and receiver shall be gasketed so that no vapor will escape into the room.
- H. Controls:
 - 1. Pump Operation: Pumps shall have variable frequency drives controlled by condensate discharge header pressure electronic control system which must be provided. For VFD requirements refer to Section 26 29 11, LOW-VOLTAGE MOTOR STARTERS.
 - 2. Indicating Lights: Provide red light for each pump to show that the pump is running, green lights to show power is on.
 - 3. Manual Selector Switches: Provide "on-off-automatic" switch for each pump.

4. Electrical Wiring: Enclose in liquid-tight flexible metal conduit.

Wiring shall be suitable for 93 °C (200 °F) service.

5. Control Cabinet: As specified in this section.

NEMA 250, Type 4, enclosing all controls, with manual switches and indicating lights mounted on the outside of the panel. Provide rigid mounting to adjacent building wall or column as shown on the drawings.

I. Interface with Computer Workstation: Provide devices to signal computer workstation that motor is on or off.

2.8 VACUUM HEATING PUMP UNITS

A. Type: Factory-assembled units consisting of water storage and air separating facilities, duplex water pumps, duplex air pumps (separate from water pumps), motors, controls, and accessories. Units must be suitable for the space available for rigging and placement and shall be arranged as shown on the drawings.

B. Service: Design units to receive, store and pump the steam condensate from a vacuum heating system. The units shall also produce the required vacuum. Air and water pumps and motors shall be suitable for continuous service.

C. Performance: Refer to schedules on the drawings. Base pump ratings on condensate at 70 °C (160 °F) and 19 kPa (5-1/2 inches Hg) vacuum.

D. Water and Air Pumps: Centrifugal type, bronze-fitted, vertical shafts, with mechanical shaft seals. Shafts shall be stainless steel. Design pumps to allow removal of rotating elements without disturbing connecting piping or pump casing mounting. Bearings shall be grease-lubricated ball or roller-type. Provide casing wearing rings.

E. Receiver Tank: Cast iron or galvanized steel with water storage and air separation chambers. Water storage capacity and inlet height shall be as shown. Provide threaded pipe connections for sizes 50 mm (2 inches) and smaller, flanged connections for pipe sizes above 50 mm (2 inches).

F. Electric Motor Drives: TEFC. Select motor sizes so that the motors are not overloaded at any point on the pump characteristic curve. Motors shall be designed for 40 °C ambient temperature.

G. Motor Controls:

1. Air and Water Pump Operation: Provide float switches mounted on receiver tank to start and stop water pumps in response to changes in the water level in the receiver. Float switches shall be adjustable to permit the controlled water level to be changed. Floats and connecting rods shall be copper, stainless steel, or bronze. Provide adjustable vacuum switches mounted on receiver tank to start and stop

- air pumps in response to vacuum requirements of the heating system. Air and water pump controls shall include alternators and also controls to automatically start the second air or water pump when the first pump fails to meet the air or water demand.
2. Starters: Provide combination magnetic starters with fusible disconnect switches or circuit breakers. Provide low voltage control circuits (120 volt maximum).
 3. Indicating Lights: Provide red lights for each pump to show that the pump is running, green lights to show power is on.
 4. Manual Selector Switches: Provide "on-off-automatic" switch for each pump.
 5. Electrical Wiring: Shall be enclosed in liquid-tight flexible metal conduit. Wiring shall be suitable for 93 °C (200 °F) service.
 6. Control Cabinet: NEMA 250, Type 2 or 4, enclosing all controls, with manual switches and indicating lights mounted on the outside of the panel. Attach to pump set with rigid steel framework unless other mounting is shown on the drawings.

H. Accessories Required:

1. Thermometer on receiver below minimum water level. Thermometer shall conform to requirements in Section 23 05 51, NOISE and VIBRATION CONTROL FOR BOILER PLANT.
2. Basket-type inlet strainer with bolted cover, designed for 275 kPa (40 psi), 100 °C (210 °F). Provide basket with 3 mm (1/8-inch) diameter perforations.
3. Water level gage on each compartment of receiver. Provide gage cocks which automatically stop the flow of water when the glass is broken. Provide gage glass protection rods and drain on lower gage cock.
4. Compound pressure/vacuum gage which shall conform to requirements in Section 23 09 11, INSTRUMENTATION and CONTROL FOR BOILER PLANT.
5. Temperature limit switch to automatically admit cooling water to the air separation chamber when the air separation water temperature exceeds the recommended limit.
6. Automatic water make-up to the air separation chamber consisting of float switch and solenoid valve. Provide manual bypass valve.
7. When air vent produces a sound exceeding 85 dB on the A scale at a distance of 1800 mm (6 feet) from the unit, provide a silencer to reduce the sound to 85 dB on the A scale maximum. Silencer shall be as recommended by pump manufacturer for the service.
8. Provide 15 mm (1/2-inch) valved drains from condensate receiver and air separation chamber to nearest floor drain.

9. Provide adjustable vacuum breaker to protect pump unit from excessive vacuum. Minimum adjustment range shall be 17 to 51 kPa (5 to 15 inches Hg).

I. Sound and Vibration: Pump units shall conform to sound and vibration limits specified in Section 23 05 51, NOISE and VIBRATION CONTROL FOR BOILER PLANT.

2.9 FUEL OIL PUMPING EQUIPMENT (BURNER FUEL)

A. Pump and Motors:

1. Type: Constant displacement, rotary, three-screw-type, horizontal shaft, flexible-coupled, motor-driven, base-mounted, arranged as shown.
2. Service: Pumps, motors and accessories shall be designed for continuous fuel oil service as shown on the drawings.
3. Performance: Refer to schedules on the drawings. Vendor shall submit complete data to certify that pumps offered will perform in accordance with requirements for suction lift, discharge pressure, sound level limitations and flow rate at viscosity range shown.
4. Pump Construction:
 - a. Pump Casing: Cast iron or steel designed for 1025 kPa (150 psi) minimum. Casing shall have removable bolted sections to allow access to internal parts.
 - b. Power Rotor: Alloy steel.
 - c. Idler Rotors: Pearlitic gray iron.
 - d. Shaft Seals and Bearing: Provide mechanical seals and ball bearings as recommended by pump manufacturer for the service.
 - a. Internal Relief Valves: Shall not be provided.
5. Electric Motor Drives: High efficiency, TEFC. Select motor sizes so that motors are not overloaded under all operating conditions. Motors shall be designed for 40 °C ambient temperature. For efficiency and power factor requirements, refer to Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.
6. Mounting - Pumps and Motors: Mount on steel or cast iron base plates. Align pumps and motors at the factory.
7. Shaft Couplings: Shall be all metal, grid-type, flexible design that permits parallel, angular, and axial misalignment. Coupling shall be sufficiently flexible to reduce transmission of shock loads significantly. Coupling size selection shall be based on manufacturer's recommendation for service. Provide coupling guard bolted to base plate.

8. Sound and Vibration: Each combination of pump and driver shall conform to sound and vibration limits specified in Section 23 05 51, NOISE and VIBRATION CONTROL FOR BOILER PLANT.
- B. Duplex Strainers: Provide duplex, basket-type cast iron strainers designed to allow one basket to be removed for cleaning while the other is in service. Strainer shall include diverter valve with handle that will select the strainer to be in use. Operation of the diverter valve shall not stop the flow of fluid. Basket covers shall be clamp-type. Ratio of free straining area to area of strainer pipe size shall be at least 4 to 1. Strainer baskets shall be brass or stainless steel. Provide 60 mesh basket liners for No. 2 fuel oil, baskets with 3 mm (1/8-inch) to 5 mm (3/16-inch) perforations for No. 5 and No. 6 fuel oil. Strainers on suction side of pumps shall be 345 kPa (50 psi), 93 °C (200 °F) minimum design; discharge side 1375 kPa (200 psi), 93 °C (200 °F) minimum.
- C. Pressure Relief Valves (Overpressure Protection): Provide at discharge of each oil pump. Size valves to relieve the maximum pumping capability of each oil pump furnished, 965 kPa (140 psi) set pressure of the relief valves plus 25 percent accumulation. Pressure settings shall be adjustable. Valves shall have solid ungrooved plug and shall close bubble-tight.
- D. Back Pressure Control Valve (Pump Pressure Control): Valve shall operate to maintain an essentially constant pump discharge pressure as required by the burners furnished, with a set pressure as scheduled on the drawings. Pressure rise shall not exceed five percent of set pressure. Flow range shall exceed the flow of the largest oil pump in the set. Set pressure shall be adjustable plus or minus 20 percent of set pressure. Valve shall have stainless steel disc and seat, bronze body. Valve disc and seat shall be renewable. Valve shall be designed for fuel oil service as shown on the drawings.
- E. Gate Valves, Globe Valves, Pipe, Pipe Fittings, Pressure Gages, Thermometers, Miscellaneous Piping Specialties: Refer to Section 23 21 11, BOILER PLANT PIPING SYSTEMS, and Section 23 09 11, INSTRUMENTATION and CONTROL FOR BOILER PLANT.
- F. Arrangement (Pump Set): Pumps, motors, valves, piping and accessories shall be furnished as a factory-built unit. All items of equipment shall be mounted on a steel drip pan base with an area sufficient to extend beyond the limits of all equipment, constructed of 3 mm (1/8-inch) steel with 50 mm (2 inch) high vertical sides. Provide threaded 13 mm

(1/2-inch) plugged opening for draining. Arrange valves and piping on rigid steel supports welded to the base. All items of equipment shall be readily accessible for operation and maintenance. Pump set shall be suitable for the space available for rigging and placement.

G. Spare Parts: Complete mechanical seal for one oil pump. Complete set of casing gaskets for one oil pump. Back pressure control valve, complete.

H. Motor Controls:

1. Provide a factory-wired and tested control panel for control of fuel oil pumps. Include the following features and equipment:

a. NEMA 4 enclosure.

b. The following items mounted and accessible on the outside of the enclosure door.

1) Individual disconnect switches for each pump.

2) Hand-Off-Auto selector switches for each pump.

3) Power On pilot light for each pump (white).

4) Run pilot light for each pump (green).

5) Lead pump failure pilot light (red).

6) P1 - Auto - P2 lead pump/alternating selector switch.

7) Emergency pushbutton shut-off switch.

c. Individual motor protectors and transformers.

d. Magnetic motor starters.

e. Terminal strip.

f. Control circuit fusing.

g. UL508/CSA listing and label for entire panel.

2. Provide the following communication with the Boiler Plant Control System computer workstation:

a. Motor run status for each pump.

b. Pump failure status.

2.10 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, 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.

2.11 CHEMICAL FEED SYSTEMS, PUMP TYPE

- A. Type: Factory-assembled packaged units, each consisting of chemical tank, pump, mixer, support base, controls, accessories.
- B. Service: Design units for storing mixture of boiler or deaerator water treatment chemicals, or steam distribution system treatment chemicals, and pumping the chemicals at an adjustable controlled rate into the boilers or deaerator or steam header as shown. Units shall be suitable for boiler and feedwater deaerator water treatment chemicals including: Caustic soda, soda ash, trisodium phosphate, disodium phosphate, sodium metaphosphate, sodium sulfite, amines and various commercially available water and steam line treatment compounds.
- C. Pump: Continuous duty, Teflon diaphragm-type, actuated with seal-less hydraulics, submerged oil bath lubricated power train, 316 stainless steel cartridge type double ball check valves on suction and discharge, totally-enclosed standard NEMA frame motor. 316 stainless steel casings designed for 1725 kPa (250 psi) minimum. Check valves shall be removable for cleaning or replacement without disturbing piping. Pump capacity must be adjustable through 100% of range by micrometer dial while the pump is running or stopped. Mount pump under tank with cast iron strainer and ball valve on suction pipe and ball valve in discharge pipe.
- D. Mixer: Direct drive, 1750 RPM, mounted on tank with angle adjustment. Totally enclosed motor, stainless steel propeller.
- E. Tank: Polyethylene with hinged cover. 190 liter (50 gallon) capacity. Provide 5 gallon indicating increments molded into side of tank. Steel support frame and mixer bracket.
- F. Controls: NEMA 250, Type 12 panel with stop-start switches, motor protection and pilot lights indicating each motor in operation and "power on". Provide low level pump cut off with indicating light. Provide devices to signal computer work station that pumps are on or off.
- G. Relief Valve: Rated for maximum pump capacity, set at 1200 kPa (175 psi).

2.12 AUTOMATIC CONTINUOUS BOILER BLOWDOWN CONTROL SYSTEM

- A. Type: One factory-assembled system per boiler to automatically sense boiler water conductivity and operate automatic electric-powered blowdown valve to maintain desired total dissolved solids content in

boiler water. Micrometer-type adjustable manual blowdown valve piped to bypass the automatic blowdown valve and conductivity sensor.

- B. Service: Design valves, sensors and piping for steam and water at 1035 kPa (150 psi), 186 °C (366 °F) minimum. Controller shall be suitable for 50 °C (120 °F) ambient and resist splashing water. Design automatic and manual blowdown valves for maximum blowdown flow rate equivalent to two percent of boiler steam output. System shall automatically maintain boiler water total dissolved solids at any set point between 1000 ppm and 4000 ppm.
- C. Operation: Programmable timer cycles to intermittently operate the blowdown valve to obtain conductivity samples, and to maintain the valve open for a time period until the conductivity of the boiler water reaches the set point. Provide an automatic temperature compensating circuit.
- D. Controller: Shall be microprocessor-based sealed unit mounted at the boiler.
 - 1. Indicators on Panel Front: One-half inch high digital display showing conductivity and indicating normal or out-of-range conditions. Valve status indicators.
 - 2. Membrane Keypad on Panel Front: Allows manual operation of the blowdown valve, setting of conductivity set points and alarm set points, setting of timers, calibration data input.
- E. Automatic Valve Construction: Carbon steel body, Type 316 stainless steel ball and stem, TFE coated stainless steel body seal. Electric actuator with NEMA-1 enclosure. Rated for 1025 kPa (150 psi) minimum saturated steam.
- F. Manual Valve Construction: Bronze or forged steel angle-type body, hardened stainless steel disc and seat, threaded ends, rising stem, union bonnet, graduated micrometer-type dial and pointer showing amount of valve opening. Rated for 1025 kPa (150 psi) minimum saturated steam. Furnish valve blowdown chart showing flow rate versus valve opening based on 125 psi boiler pressure.
- G. Provide gate valves and unions at inlet of conductivity sensor and outlet of automatic control valve so that these items can be removed from the system while maintaining the manual control valve in service. Comply with Section 23 21 11, BOILER PLANT PIPING SYSTEMS.

2.13 CONTROL PANELS

- A. Provide control panels meeting the requirements of this section, and Section 23 090 11 Instrumentation and Control for Boiler Plant.

PART - 3 EXECUTION

3.1 INSTALLATION

- A. Feedwater Deaerator with Storage Tank, Hot Well Condensate Storage Tanks, and Accessories.
 - 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. Deaerator vent pipes must extend vertically through roof. Horizontal runs not permitted.
 - 6. All controls, safeties, set points, etc must conform to the most recent edition of the VHA Boiler Plant Safety Device Testing Manual.
- B. 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.
- C. Fuel Oil Pumping Equipment and Accessories: Locate equipment to permit access to all valves and controls, and to permit removal and cleaning of heat exchanger tubes.
- D. 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.
- E. Mount control panels adjacent to the primary equipment controlled, and in accordance with the requirements of Section 23 09 11 Instrumentation and Control for Boiler Plant.

3.2 TESTING AND BALANCING FEEDWATER DEAERATOR WITH STORAGE TANK AND ACCESSORIES, HOT WELL LEVEL CONTROLS:

- 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 Contracting Officer's Technical Representative (COTR). Repeat test two times at each load point.

- B. Determine temperatures and pressures by calibrated thermometers and pressure gages.
- 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 COTR.
- 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. COTR 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 test must include at the minimum the test listed in the most recent edition of the VHA Boiler Plant Safety Device Testing Manual. Submit test data for review.
- G. Demonstrate operation of hot well and deaerator tank level controls, and pump operation in response to condensate and feedwater header pressure controls.

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 COTR 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 each VA personnel responsible in operation and maintenance of units.

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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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