SECTION 23 50 11
BOILER PLANT MECHANICAL EQUIPMENT
05-11

PART 1 - GENERAL

1.1 DESCRIPTION

Packaged Feedwater deaerator with condensate storage tank, condensate and boiler feed pumps, condensate storage tank, fuel oil pumping and heating, compressed air systems, blowdown separator, continuous blowdown heat exchanger, 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 and access openings. Show design of all shell, head and nozzle welds, and permissible forces on nozzles.
   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, including materials of construction.

C. Condensate Storage 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. Show permissible forces on nozzles.
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.

D. 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.

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, and 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. Condensate Return Pumps (Electrical and/or Mechanical Types):
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, entire fuel oil heating system (if provided) 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.
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.

H. Steam Vent Silencer (Muffler):
1. Drawings with silencer dimensions and weights, and sizes and types of pipe connections.

2. Catalog data and specification sheets on the design and construction.
3. Sound attenuation data at required flow rates.

I. 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.

J. 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.

K. 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.

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

G. Underwriters Laboratories (UL):
574-03.....Standard for Electric Oil Heaters

PART 2 – PRODUCTS

2.1 PACKAGED OVER/UNDER DEAERATOR AND CONDENSATE STORAGE TANK SYSEM

A. Provide a packaged over/under deaerator and condensate storage tank system.

B. Provide dual level structural steel unit frame with tank supports for mounting the Deaerator above the Condensate Storage Tank.

1. The Deaerator and Condensate Storage Tank shall be mounted on dual level structural steel support stand with the deaerator mounted above the surge tank. The steel frame shall be constructed of wide flange beam. The stands shall elevate the bottoms of vessels to

allow for adequate NPSH for pump suction plus safety margin. Cross braces or gussets are required on the four sides of the stand to limit swaying of the structure. Overall dimensions for the package shall be no more than 31 feet high, by 21 feet long, by 14 feet wide.

C. All Deaerator and Condensate Storage Tank accessories shall be factory piped. Final location of level and pressure control sub-assemblies may be decided in the field. All accessories piped on tank shall be provided with block valve to facilitate isolation should repair or removal be necessary.

D. Provide OSHA complaint access ladder and platforms for all safety, shut-off and control valves, Deaerator head tray access man-way, Deaerator tank instrumentation and man-way, Condensate Storage Tank instrumentation and man-way. Refer to drawings for access platform/ladder general arrangement and intent. Structural steel for platforms and ladders shall be ASTM A36 structural shapes and steel grating material shall be designed for minimum 60 pounds per square foot for all platforms and walk-ways.

E. See drawings for schedule capacities.

F. Overall package dimension is approximately 20’ long x 14’ Wide x 33’ high.

2.2 FEEDWATER DEAERATOR WITH STORAGE TANK AND ACCESSORIES

A. Pressurized (35-55 kPa) (5-8 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: 60,000lb/hr.
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 21 °C (70 °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 50 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 (Tray-Type Units): 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 minimum 18 inch access opening in deaeration section to allow inspection and replacement of trays. Provide hinge or davited bolted access door at opening.
6. Support: Steel saddles or legs welded to storage tank. Coordinate location with structural design of building.
7. 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.

8. 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

E. Steam Safety Valve: Mount on feedwater deaerator pressure vessel. Set pressure 10 psi. Capacity as shown. If not shown, minimum capacity 1000 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.
2. 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.
3. 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 local annunciator and computer workstation 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 and computer workstation 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 electric-type overflow control valve actuated by 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 RFE 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:
      a. 120 volt AC electric actuator with permanently lubricated spur gear train system. Valve shall be fail open.
      b. Seals suitable for 480 degrees F (250 degrees C), using Viton elastomers.
      c. Actuator shall use 4-20 ma control signal and feedback for position.

Q. Storage Tank Automatic Water Level Controls:
   1. Separate electric-type 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. 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.
      b. 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.
      c. 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.
      d. Sound Levels: Conform to 23 05 51 NOISE AND VIBRATION CONTROL FOR BOILER PLANT.

e. 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.
f. Provide manual handwheel and means to disengage the actuator to permit manual operation.

2.3 CONDENSATE STORAGE 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 304L stainless steel, ASTM A.
   3. Design tank for 50 psi working. 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 308L filter material. Carbon steel wire brushes are not permitted.
   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)
0 – 3.8	0 – 30	75	3	60	2.5
3.9 – 8.3	31 – 70	100	4	75	3
8.4 – 12.6	71 – 100	150	6	100	4

*"Boiler Plant Capacity" refers to one boiler on standby and all other boilers at high fire.

F. Insulation: Field apply insulation as specified in Section 23 07 11, HVAC, PLUMBING, and BOILER PLANT INSULATION.

G. 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.
2. 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.
3. Minimum rating 120 degrees C, 200 kPa (250 degrees F, 30 psi).

H. 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.

I. Automatic Water Level Controls:

1. Separate electric-type 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. 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.

2.4 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.

2.5 CONTINUOUS BLOW DOWN HEAT EXCHANGER

A. Vertical type ASME code welded combined flash tank and heat exchanger vessel, with relief valve, gauge glass, 6″ x 8″ hand hole, and pressure gauge panel.

B. 150 psi construction Section VIII, Div. 1. With National Board Serial Number and “U” stamp

C. Safety pressure relief valve.

D. Flash steam outlet flange.

E. Pressure gauge.

F. Inlet manifold with five (5) 1″ inlets.

G. 304SS heat exchanger.

H. Blowdown water discharge fitting and temperature bulb.

I. Insulation: Field apply insulation as specified in Section 23 07 11, HVAC, PLUMBING, AND BOILER PLANT INSULATION.

J. Accessories:

1. Install red line type gage glasses with protecting rods. Provide offset 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 three gauge panel with dial thermometers indicating make up water inlet and outlet water temperatures and blow down drain water temperature. Conform to Section 23 09 11, INSTRUMENTATION AND CONTROL FOR BOILER PLANT.
3. Provide water level control trap with all internals constructed and 316 stainless steel.
4. Provide high level alarm switch.

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: Flow rates will be controlled by automatic modulating feedwater valves on each boiler. Pumps shall be started and stopped manually. Pumps shall have variable frequency drives controlled by boiler feed header pressure electronic control system which must be provided. Control the header pressure at 965kPa (140psi). For VFD requirements refer to Section 26 29 11, LOW-VOLTAGE MOTOR STARTERS.

E. Control - Condensate Transfer: Constant speed operation. Flow rate will be controlled by automatic modulating water level control valve on condensate transfer inlet to deaerator.

F. 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

G. 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.

H. 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, and bearings.

I. Shaft Couplings: Pump manufacturer’s standard. Provide coupling guard.

J. 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.

K. Interface with Computer Workstation: Provide devices to signal computer work station that motor is on or off.

2.7 CONDENSATE TRANSFER PUMPS, FLEXIBLE-COUPLED, END SUCTION, CENTRIFUGAL

A. Type: Single stage, end suction, centrifugal with volute casing, horizontal shaft, frame-mounted, flexible-coupled, driven by constant speed motor, arranged as shown. Pump frames and motors shall be base-mounted.

B. Service: Design pumps and accessories for continuous condensate transfer service, 93 °C (200 °F) water, with flow rates ranging from maximum shown 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 drawings. Pump head-flow characteristic 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. Construction:
   1. Bolt pump casing to a frame that supports the pump shaft and shaft bearings. Casing shall have back pull-out feature or bolted front suction cover to allow access to impeller.
   2. Frame which supports shaft and bearings shall provide easy access to seal.
   3. Rotating elements shall be designed and balanced so that vibration is limited to requirements of Section 23 05 51, NOISE and VIBRATION CONTROL FOR BOILER PLANT.
   4. Provide mechanical seal. Seal shall be exposed only to pump suction pressure.
   5. Provide replaceable shaft sleeve, water slinger on shaft, vent cock and drain on casing. Provide casing wearing rings at all locations of tight clearance between casing and impeller.
   6. Bearings: Rated for two year minimum life with continuous operation at maximum pump load.
   7. Material of construction:

Casing	cast iron
Impeller	bronze
Shaft	Stainless Steel
Shaft sleeve	bronze
Casing wear rings	bronze

F. Recirculation Orifice: Provide stainless steel recirculation orifice selected by pump manufacturer to protect pump from overheating at shutoff. Refer to Section 23 05 51, NOISE and VIBRATION CONTROL FOR BOILER PLANT for sound level limitations.
G. Spare Parts: Provide sufficient types and quantities to allow complete replacement of all such parts in one pump at one time:
   1. Casing wear rings
   2. Shaft sleeve
   3. Pump bearings
   4. Mechanical seal
H. Shaft Couplings: Shall be all metal, grid-type, flexible design which 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 coupling manufacturer's recommendations for the service. Coupling shall include no spacers made from organic material.

1. Pumps having back pull-out disassembly feature shall be provided with spacer couplings designed to allow disassembly of pump without moving the motor.
2. Provide coupling guard bolted to base plate.

I. Electric Motor Drives: High efficiency, open drip proof designed for the service. 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. Mounting: Mount pumps and motors on steel or cast iron base plates with drip-catching configuration. Align pumps and motor in the factory.

K. Sound and Vibration: Each pump and motor assembly shall conform to sound and vibration limits specified in Section 23 05 51, NOISE and VIBRATION CONTROL FOR BOILER PLANT.

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

2.8 CONDENSATE RETURN PUMP UNITS (ELECTRIC, PAD-MOUNTED)

A. Type: Factory-assembled units consisting of vented horizontal pad-mounted receiver tank, simplex or duplex motor-driven pumps as shown, interconnecting piping, motor controls, and accessories. Arrangement of pumps, tank and accessories shall be as shown or specified.

B. Service: Unit shall be designed to receive, store, and pump steam condensate having temperature as shown. Pumps and motors shall be suitable for continuous service.

C. Performance: Refer to schedules on the drawings.

D. Pumps: Centrifugal.

1. Centrifugal Pumps: Bronze-fitted, vertical shafts, with mechanical shaft seals. Stainless steel or alloy steel shafts with bronze shaft sleeves. Pump shall be designed 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. Electric Motor Drives: Open drip proof. Select motor sizes 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.

F. Receiver Tank: Cast iron, with storage capacity and height of inlet connection as shown. Provide threaded or flanged openings for all pipe connections and facilities for mounting float switches. Openings for pipe sizes above 50 mm (2 inch) must be flanged. Receivers for simplex

pumps shall include all facilities required for future mounting of additional pump and controls.

G. Controls:
   1. 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 levels to be changed. Floats and connecting rods shall be copper, stainless steel or bronze. When a duplex pump unit is used, provide an alternator and a control to automatically start the second pump, when the first pump fails in keeping the receiver water level from rising. Provide local audible alarm upon pump failure.
   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 light 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 must conform to requirements in Section 23 09 11, INSTRUMENTATION and 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 receiver. Provide gauge cocks that automatically stop the flow of water when the glass is broken. Provide gage glass protection rods, and drain on lower gage cock.

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.
   e. Internal Relief Valves: Shall be provided.
5. Electric Motor Drives: High efficiency, open drip proof. 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. Provide stainless steel trim.

D. Each pump shall have a non-adjustable ASME safety valve for pump protection. Valve shall be mounted on pump casing and discharge directly to the pump casing inlet to relieve overpressure in the pump casing. Provide stainless steel trim.

E. 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.

F. 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.

G. Arrangement (Pump Set): Pumps, motors, valves, oil heaters, 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. When oil heaters are required, they shall be part of the pump set and located for easy access.

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

I. Motor Controls: Provide devices to signal computer workstation that motors are on or off.

2.10 COMPRESSED AIR SYSTEM

A. Provide complete compressed air system to provide shop (cleaning and maintenance) air. Compressed air systems shall include compressors, motor drives, receivers, aftercoolers, filters, and accessories as scheduled, as shown on the drawings and as specified.

B. Compressors:
   1. Type: Reciprocating, two-stage, air-cooled, intercooled, V-belt drive.
   2. Performance: Shall be as shown on the drawings. Shall be suitable for continuous service.
   3. Construction:
      a. Lubrication: Splash type with low oil level automatic shutdown switch, or pressure type with low oil pressure automatic shutdown switch.
      b. Unloading: Provide automatic cylinder air pressure unloader to prevent compressor starting under load.
      c. Inlet Filter: Dry-type with replaceable cartridge.
      d. Cylinders: Shall be removable from crankcase.

C. Receivers: Vertical cylindrical tanks as shown on the drawings. Construct in accordance with the ASME Boiler and Pressure Vessel Code, Section VIII, with inspection under the rules of the National Board of Boiler and Pressure Vessel Inspectors. Design pressure 1025 kPa (150 psi) minimum.

D. Compressor and Receiver Accessories:
   1. Air-cooled Aftercooler: Provide one for each compressor, designed to cool the compressor output air. Mount on or adjacent to compressor.
   2. Automatic Condensate Traps: Provide on lowest point of receiver and on aftercooler if required by type of aftercooler furnished. Size shall be suitable for compressor air delivery.
   3. Safety Valve: Provide on receiver, set pressure lower than receiver design pressure. Capacity of valve at set pressure shall be greater than maximum output of all compressors supplying receiver. Provide Stainless steel trim.

4. Pressure Gauges: Provide on receiver and as shown. Refer to specification Section 23 09 11, INSTRUMENTATION and CONTROL FOR BOILER PLANT.
5. Receiver Piping Connections: Shall include air in, air out, safety valve, automatic drain, valved manual drain and valved pressure gauge.

E. Compressor Controls:
1. Controls shall operate on 120 volts maximum. Provide "on-off-automatic" control for each compressor.

F. Electrical Motors and V-Belt Drives: Motors shall be open drip proof designed for 40 °C ambient temperature. Select V-belt drives in accordance with manufacturer's recommendations for frequent start-stop service. Provide belt guard that encloses belts on all sides.

G. Vibration Isolation: Refer to specification Section 23 21 11, BOILER PLANT PIPING SYSTEMS for isolators required in piping.

H. Air Filter: Coalescing type, designed to remove oil, entrained water mist, and dirt from the compressed air.

I. Spare Parts:
1. Complete set of drive belts.
2. Two filter cartridges for each compressor intake filter.

2.11 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.

2.12 AUTOMATIC CHEMICAL FEED SYSTEMS, PUMP TYPE

A. Type: Factory-assembled packaged units, each consisting of chemical tank, pump, mixer, support base, controls, and 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).

2.13 AUTOMATIC CONTINUOUS BOILER BLOWDOWN CONTROL SYSTEM

A. Type: One factory-assembled system per boiler to automatically sense boiler water conductivity and operate automatic electric-powered blowdown valve to maintain desired total dissolved solids content in boiler water. Micrometer-type adjustable manual blowdown valve piped to bypass the automatic blowdown valve and conductivity sensor.

B. Service: Design valves, sensors and piping for steam and water at 1035 kPa (150 psi), 186 °C (366 °F) minimum. Controller shall be suitable for 50 °C (120 °F) ambient and resist splashing water. Design automatic and manual blowdown valves for maximum blowdown flow rate equivalent to two percent of boiler steam output. System shall automatically maintain boiler water total dissolved solids at any set point between 1000 ppm and 4000 ppm.

C. Operation: Programmable timer cycles to intermittently operate the blowdown valve to obtain conductivity samples, and to maintain the valve open for a time period until the conductivity of the boiler water reaches the set point. Provide an automatic temperature compensating circuit.

D. Controller: Shall be microprocessor-based sealed unit mounted at the boiler.
   1. Indicators on Panel Front: One-half inch high digital display showing conductivity and indicating normal or out-of-range conditions. Valve status indicators.
   2. Membrane Keypad on Panel Front: Allows manual operation of the blowdown valve, setting of conductivity set points and alarm set points, setting of timers, calibration data input.

E. Automatic Valve Construction: Carbon steel body, Type 316 stainless steel ball and stem, TFE coated stainless steel body seal. Electric actuator with NEMA-1 enclosure. Rated for 1025 kPa (150 psi) minimum saturated steam.

F. Manual Valve Construction: Bronze or forged steel angle-type body, hardened stainless steel disc and seat, threaded ends, rising stem, union bonnet, graduated micrometer-type dial and pointer showing amount of valve opening. Rated for 1025 kPa (150 psi) minimum saturated steam. Furnish valve blowdown chart showing flow rate versus valve opening based on 125 psi boiler pressure.

G. Provide gate valves and unions at inlet of conductivity sensor and outlet of automatic control valve so that these items can be removed from the system while maintaining the manual control valve in service. Comply with Section 23 21 11, BOILER PLANT PIPING SYSTEMS.

PART - 3 EXECUTION

3.1 INSTALLATION

A. Feedwater Deaerator with Storage Tank and Accessories, Condensate Storage Tank, Blowdown Separator, 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 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.
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.

C. 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.

D. 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.

E. 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.

F. 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 RE/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 RE/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. RE 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.

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 DEMONSTRATION AND TRAINING

A. Provide services of manufacturer’s technical representative for sixteen 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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