

SECTION 235316 - DEAERATORS

TIPS:

To view non-printing **Editor's Notes** that provide guidance for editing, click on Masterworks/Single-File Formatting/Toggle/Editor's Notes.

To read **detailed research, technical information about products and materials, and coordination checklists**, click on Masterworks/Supporting Information.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes packaged, factory-assembled deaerators.

1.3 DEFINITIONS

- A. Feedwater Pump: Pump that moves feedwater from the deaerator to the boiler.
- B. Transfer Pump: Pump that moves feedwater from the surge tank to the deaerator.
- C. NPSH: Net-positive suction head.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated makeup water, feedwater, and steam flow rates; working pressure; tank capacities; storage capacity in minutes; temperature and NPSH required; pump performance curves with selection points clearly indicated; furnished specialties; and accessories.
- B. Shop Drawings: For deaerators, signed and sealed by a qualified professional engineer; include plans, elevations, sections, details, dimensions, weights, loadings, required clearances, and attachments to other work.
 - 1. For installed products indicated to comply with design loads, include structural analysis data.
 - 2. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing deaerator bases.
 - 3. Wiring Diagrams: Power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

- A. Manufacturer Seismic Qualification Certification: Submit certification that deaerators, accessories, and components will withstand seismic forces as indicated in Section 230548 "Vibration and Seismic Controls for HVAC." Include the following:
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
 - b. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- B. Field quality-control test reports.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For deaerators to include in emergency, operation, and maintenance manuals.

1.7 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. ASME Compliance: [ASME B31.1, "Power Piping," for systems more than 15 psig (104 kPa)] [ASME B31.9, "Building Services Piping," for systems equal to or less than 15 psig (104 kPa)]. Safety valves and pressure vessels shall bear the appropriate ASME label.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Protect flanges, pipe openings, nozzles, bearings, and couplings from damage during shipping and storage.
- B. Comply with manufacturer's written rigging instructions.
- C. Deliver deaerators as factory-assembled units with protective crating and covering.

1.9 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

1.10 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Gaskets: Furnish **[one]** **<Insert number>** replacement gasket(s) for each gasketed opening.
 - 2. Gage Glass: Furnish **[one]** **<Insert number>** replacement glass(es) for each gage glass.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)

2.2 MANUFACTURED UNITS

- A. **[Horizontal] [Vertical], [packed-column] [spray] [tray], single-compartment deaerator[, and a separate packaged surge tank with transfer and feedwater pumps and controls to supply feedwater to deaerator].**
- B. **[Horizontal] [Vertical], [packed-column] [spray] [tray], two-compartment deaerator.** One compartment for deaeration and one for surge volume, each with its own transfer and feedwater pumps and controls.
- C. **[Horizontal] [Vertical], [packed-column] [spray] [tray], single-compartment deaerator and separate surge tank,** both mounted on same factory-fabricated stand with necessary transfer and feedwater pumps and controls.
- D. Material for Wetted Components: Components in contact with water that has not been deaerated shall be made of Type **[304] [316]** stainless steel.
- E. Adjustable Spray Valves: Type 316 stainless steel. Arrange spray valves for counterflow of steam and condensate and so corrosive gases being vented do not contact deaerator's head or shell.
- F. Vent Condenser: Stainless steel, with automatic and manual vent valves.
- G. Deaerator and Storage Tank:
 - 1. Material: **[Welded carbon steel] [Welded carbon steel galvanized after fabrication] [Stainless steel].**
 - 2. Additional Corrosion Protection:

- a. **[0.07-inch (1.8-mm)] [0.13-inch (3.3-mm)] [0.19-inch (4.8-mm)]** <Insert thickness> thickness allowance.
 - b. Electrolytic corrosion-inhibitor anode.
- 3. Access: Manhole in deaerator and storage tank for access to internal components for inspection and service.
 - 4. Factory-Applied Insulation and Jacket: Minimum thickness of **[2 inches (50 mm)]** <Insert thickness> for mineral-fiber pipe and tank insulation. Cover insulation with **[painted steel] [stucco-embossed aluminum] [stainless-steel]** jacket.
 - 5. Factory-Installed Pipe, **NPS 2-1/2 (DN 65)** and Smaller: ASTM A 53/A 53M, Type S (seamless), Grade B; or ASTM A 106, Type S, Grade B, Schedule **[40] [80]**; with threaded joints and fittings.
 - a. Cast-Iron Threaded Fittings: ASME B16.4, Class **[125] [250]**.
 - b. Malleable-Iron Threaded Fittings: ASME B16.3, Class **[150] [300]**.
 - c. Forged-Steel Fittings: ASME B16.11, Class 3000.
 - d. Malleable-Iron Unions: ASME B16.39, Class **[150] [300]**.
 - e. Forged-Steel Unions: MSS SP-83, Class 3000.
 - 6. Factory-Installed Pipe, **NPS 3 (DN 80)** and Larger: ASTM A 53/A 53M, Type E (electric-resistance welded), Grade B; or ASTM A 106, Type S, Grade B, Schedule **[40] [80]**; with welded joints and carbon-steel fittings and flanges.
 - a. Wrought-Steel Fittings: ASME B16.9, wall thickness to match adjoining pipe.
 - b. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, Class **[150] [300]**, including bolts, nuts, and gaskets.

H. Accessories:

- 1. Lifting eyes.
- 2. Companion flanges.
- 3. Pump suction piping with vortex breaker, isolation valve, strainer, and flexible connector.
- 4. Pump discharge piping with check valve, isolation valve, and liquid-filled pressure gage graduated in **[pounds force per square inch] [kilopascals] [both pounds force per square inch and kilopascals]**.
- 5. Pump-discharge bypass **[relief valve] [orifice plate] [relief valve with orifice plate]**.
- 6. Makeup Water Assembly:
 - a. Factory-mounted modulating valve with mechanical level control, external float cage, and stainless-steel float.
 - b. **[Factory] [Field]**-mounted, electric, **[pilot-operated, solenoid] [modulating]** valve with factory-mounted, **[probe-type]** water-level controller.
 - c. **[Factory] [Field]**-mounted, pneumatic modulating valve with factory-mounted water-level controller.
 - d. **[Factory] [Field]**-mounted, three-valve bypass and inlet strainer.
- 7. Steam Pressure-Reducing Valve(s): **[Steam] [Electric] [Pneumatic]** operated **[with three-valve bypass]**, and sized to reduce boiler outlet pressure to the deaerator design pressure.
- 8. Tank Overflow Drain: Sized to relieve full capacity at operating pressure.

9. Safety Valve(s): ASME labeled and sized to relieve full capacity of pressure-reducing valve.
 10. Vents: Manual and automatic vent valves.
 11. Vacuum breaker.
 12. Meters and Gages:
 - a. Full-height, water-level gage glass[, **reflex flat type,**] and stop valve set.
 - b. [**Liquid-filled industrial**] [**Bimetal dial-type**] thermometer graduated in [**Fahrenheit**] [**Celsius**] [**both Fahrenheit and Celsius**] mounted to measure temperature in storage [**and steam**] section of tank.
 - c. Pressure gage graduated in [**pounds force per square inch**] [**kilopascals**] [**both pounds force per square inch and kilopascals**] mounted to measure pressure in steam section of tank.
 13. Provision for chemical injection quill.
 14. Chemical injection quill.
 15. Sampling connection with valve.
 16. Tank drain connection with valve.
 17. Oxygen test kit.
- I. Support Frame: Structural-steel frame for supporting tank and pumps. Weld or bolt to tank.
1. Fabricate support frame with bracing adequate for seismic forces according to authorities having jurisdiction and to allow installation by anchoring deaerators to floor only.
- J. Feedwater Pump: Cast-iron, [**flange**] [**base**]-mounted volute; with [**bronze**] [**stainless-steel**], [**multistage centrifugal**] [**turbine**] impeller, renewable bronze case ring, and stainless-steel shaft.
1. Seals: Mechanical, suitable for [**250 deg F (121 deg C)**] <Insert temperature>.
 2. Pump Motor: [**Vertical**] [**Horizontal**], [**open dripproof**] [**totally enclosed**] [**totally enclosed fan-cooled**] enclosure, [**close**] [**flexible**] coupled to pump. Comply with requirements in Section 230513 "Common Motor Requirements for HVAC Equipment."
- K. Feedwater Pump Control Panel: Factory mounted and wired and including the following:
1. NEMA 250, Type [**1**] [**4**] [**4X**] [**12**] <Insert type> enclosure.
 2. Single-point, field power connection to [**fused disconnect switch**] [**nonfused disconnect switch**] [**circuit breaker**].
 - a. Branch power circuit to each motor and to controls[**with a disconnect switch or circuit breaker**].
 3. NEMA-rated motor controller, hand-off-auto switch, and overcurrent protection for each motor.
 - a. Alternating control as indicated by control sequence for each pump.
 4. Terminal blocks with numbered and color-coded wiring to match wiring diagram.
 5. [**Metal raceway**] [**Raceway**] for factory-installed wiring outside of enclosures. Make connections to motor with liquidtight conduit.

6. Removable control mounting plate.
7. Visual indication of status and alarm[**with momentary test push button**].
8. Audible alarm and silence switch.
9. Visual indication of elapsed run time, graduated in hours.
10. Fusible, control-circuit transformer.
11. Microprocessor-based controller.

L. Feedwater Pump Start-Stop Control Sequence:

1. Boiler water-level controller starts and stops lead pump to maintain boiler water-level set point.
2. Lead and lag pumps alternate [**after each start**] [**to equalize run time**].
3. Lead pump failure, lag pump [**automatically starts if lead pump cannot maintain set point**] [**is started manually**].
4. Visual indication of pump on[**and off**] status.
5. Visual indication of pump lead/lag status.
6. Visual[**and audible**] alarm indication of pump failure.

M. Feedwater Pump Continuous Control Sequence:

1. Pump runs continuously while boiler operates. Electric interlock with boiler control starts lead pump when boiler starts.
2. Boiler water-level controller modulates feedwater control valve to maintain boiler water-level set point. Valve closes when boiler is off.
3. Lead and lag pumps alternate [**after each start**] [**to equalize run time**].
4. Lead pump failure automatically starts lag pump.
5. Feedwater pressure controller starts and stops lag pump to maintain feedwater pressure set point.
6. Visual indication of pump on[**and off**] status.
7. Visual indication of pump lead/lag status.
8. Visual[**and audible**] alarm indication of pump failure.

N. Makeup Water Control Sequence:

1. Electric level controller operates electric control valve to maintain tank water-level set point.
2. Pneumatic level controller operates pneumatic control valve to maintain tank water-level set point.
3. Mechanical float operates valve to maintain water-level set point.
4. Visual[**and audible**] alarm indication of low[**and high**] tank water level.

O. Building Management System Interface: Factory install hardware to enable building management system to monitor and display points.

1. Hardwired Monitoring Points: On/off status for each pump[, **failure alarm for each pump**] [, **low-water level alarm**] [, **high-water level alarm**] [, **feedwater temperature**] <Insert monitoring>.

2.3 SURGE TANK

- A. Description: Factory-assembled and -tested unit consisting of a condensate receiver, transfer pumps, and controls.
- B. Accessories:
 - 1. **[Liquid-filled industrial] [Bimetal dial-type]** thermometer graduated in **[Fahrenheit] [Celsius] [both Fahrenheit and Celsius]**.
 - 2. Level gage glass[, **reflex flat type**,] with stops at top and bottom.
 - 3. Lifting eyes.
 - 4. Companion flanges.
 - 5. Pump suction piping with vortex breaker, isolation valve, strainer, and flexible connector.
 - 6. Pump discharge piping with check valve, isolation valve, and liquid-filled pressure gage graduated in **[pounds force per square inch] [kilopascals] [both pounds force per square inch and kilopascals]**.
 - 7. Pump-discharge bypass **[relief valve] [orifice plate] [relief valve with orifice plate]**.
- C. Factory-Installed Pipe, **NPS 2-1/2 (DN 65)** and Smaller: ASTM A 53/A 53M, Type S (seamless), Grade B; or ASTM A 106, Type S, Grade B, Schedule **[40] [80]**; with threaded joints and fittings.
 - 1. Cast-Iron Threaded Fittings: ASME B16.4, Class **[125] [250]**.
 - 2. Malleable-Iron Threaded Fittings: ASME B16.3, Class **[150] [300]**.
 - 3. Forged-Steel Fittings: ASME B16.11, Class 3000.
 - 4. Malleable-Iron Unions: ASME B16.39, Class **[150] [300]**.
 - 5. Forged-Steel Unions: MSS SP-83, Class 3000.
- D. Factory-Installed Pipe, **NPS 3 (DN 80)** and Larger: ASTM A 53/A 53M, Type E (electric-resistance welded), Grade B; or ASTM A 106, Type S, Grade B, Schedule **[40] [80]**; with welded joints and carbon-steel fittings and flanges.
 - 1. Wrought-Steel Fittings: ASME B16.9, wall thickness to match adjoining pipe.
 - 2. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, Class **[150] [300]**, including bolts, nuts, and gaskets.
- E. Tank:
 - 1. Material: **[Welded carbon steel] [Welded carbon steel galvanized after fabrication] [Stainless steel]**.
 - 2. Additional Corrosion Protection:
 - a. **[0.07-inch (1.8-mm)] [0.13-inch (3.3-mm)] [0.19-inch (4.8-mm)]** <Insert thickness> thickness allowance.
 - b. Electrolytic corrosion-inhibitor anode.
 - 3. Access: Manhole in tank for access to internal components for inspection and service.
 - 4. Factory-Applied Insulation and Jacket: Minimum thickness of **[2 inches (50 mm)]** <Insert thickness> for mineral-fiber pipe and tank insulation. Cover insulation with **[painted steel] [stucco-embossed aluminum] [stainless-steel]** jacket.

- F. Support Frame: Structural-steel frame for supporting tank. Weld or bolt to tank.
1. Fabricate support frame with bracing adequate for seismic forces according to authorities having jurisdiction and to allow installation by anchoring deaerators to floor only.
- G. Transfer Pump: Vertical, flange-mounted, close-coupled, [**single-stage**] [**multistage**], radially split-case centrifugal pump; rated for [**175-psig (1205-kPa)**] <Insert pressure> minimum working pressure and a continuous water temperature of [**225 deg F (107 deg C)**] <Insert temperature>; with the following features:
1. Impeller: [**Bronze**] [**Stainless steel**].
 2. Seals: Mechanical.
 3. Motor: [**Open dripproof**] [**Totally enclosed**] [**Totally enclosed fan-cooled**] enclosure. Comply with requirements in Section 230513 "Common Motor Requirements for HVAC Equipment."
- H. Transfer Pump: Horizontal, base-mounted, [**single-stage**] [**multistage**], radially split-case centrifugal pump; rated for [**175-psig (1205-kPa)**] <Insert pressure> minimum working pressure and a continuous water temperature of [**225 deg F (107 deg C)**] <Insert temperature>; with the following features:
1. Impeller: [**Bronze**] [**Stainless steel**].
 2. Coupling: [**Close**] [**Flexible**].
 3. Seals: Mechanical.
 4. Motor: [**Open dripproof**] [**Totally enclosed**] [**Totally enclosed fan-cooled**] enclosure. Comply with requirements in Section 230513 "Common Motor Requirements for HVAC Equipment."
- I. Transfer Pump Control Panel: Factory mounted and wired and including the following:
1. NEMA 250, Type [**1**] [**4**] [**4X**] [**12**] <Insert type> enclosure.
 2. Single-point, field power connection to [**fused disconnect switch**] [**nonfused disconnect switch**] [**circuit breaker**].
 - a. Branch power circuit to each motor and to controls[**with a disconnect switch or circuit breaker**].
 3. NEMA-rated motor controller, hand-off-auto switch, and overcurrent protection for each motor.
 - a. Alternating control indicated by control sequence for each pump.
 4. Terminal blocks with numbered and color-coded wiring to match wiring diagram.
 5. [**Metal raceway**] [**Raceway**] for factory-installed wiring outside of enclosures. Make connections to motor with liquidtight conduit.
 6. Removable control mounting plate.
 7. Visual indication of on/off status and pump failure alarm[**with momentary test push button**].
 8. Audible alarm and silence switch.
 9. Visual indication of elapsed run time, graduated in hours.
 10. Fusible, control-circuit transformer.

11. Microprocessor-based controller.

- J. Transfer Pump Start-Stop Control Sequence: Deaerator water-level controller controls lead pump; alternator switches lead and lag pump(s) [after each start] [to equalize run time]; failure of lead pump switches to lag pump[and sounds audible alarm].
- K. Transfer Pump Continuous-Run Control Sequence: Lead pump runs continuously while deaerator is operating; deaerator water-level controller modulates water-level-control valve; lead and lag pump(s) switch to equalize run time; lag pump operates if lead pump fails[; pump failure sounds audible alarm].
- L. Building Management System Interface: Factory install hardware to enable building management system to monitor and display points.
 - 1. Hardwired Monitoring Points: On/off status for each pump[, failure alarm for each pump] [, low-water level alarm] [, high-water level alarm] <Insert monitoring>.

2.4 CAPACITIES AND CHARACTERISTICS

- A. Feedwater Flow Rate: <Insert **gpm (L/s)**>
- B. Steam Flow Rate: <Insert **lb/h (kg/h)**>
- C. Makeup Water Flow Rate: <Insert **gpm (L/s)**>
- D. Makeup Water Temperature: <Insert **deg F (deg C)**>
- E. Capacity: Capable of raising temperature of condensate and makeup water to within [**3 deg F (2 deg C)**] <Insert **temperature**> of saturated steam temperature.
- F. Minimum Working Pressure: [**50 psig (345 kPa)**] <Insert value>.
- G. Operating Pressure Range: [Atmospheric] [From **2 to 15 psig (14 to 104 kPa)**] <Insert pressure range>.
- H. Resultant Oxygen Content: Not more than [**0.03**] [**0.005**] cc/L through an operating range between [**0**] [**3**] [**5**] <Insert value> and 100 percent of full load.
- I. Storage Tank:
 - 1. Tank Capacity to Overflow: <Insert **gal. (L)**>
 - 2. Storage Time: [**10**] <Insert number> minutes.
- J. Feedwater Pumps:
 - 1. No. of Pumps: [**Duplex**] <Insert quantity>.
 - 2. Flow Rate: <Insert **gpm (L/s)**>
 - 3. NPSH Required: <Insert **psig (kPa)**>
 - 4. Rated Operating Temperature: <Insert **deg F (deg C)**>
 - 5. Head Pressure: <Insert **psig (kPa)**>
 - 6. Horsepower: <Insert **hp (kW)**>

7. Speed: <Insert rpm.>
8. Volts: [115] [208] [230] [460] <Insert value> V.
9. Phase: [Single] [Three].
10. Hertz: 60.

K. Surge Tank:

1. Tank Capacity to Overflow: <Insert gal. (L).>
2. Storage Time: <Insert number> minutes.

L. Transfer Pumps:

1. No. of Pumps: [Duplex] <Insert quantity>.
2. Flow Rate: <Insert gpm (L/s).>
3. NPSH Required: <Insert psig (kPa).>
4. Rated Operating Temperature: <Insert deg F (deg C).>
5. Head Pressure: <Insert psig (kPa).>
6. Horsepower: <Insert hp (kW).>
7. Speed: <Insert rpm.>
8. Volts: [115] [208] [230] [460] <Insert value> V.
9. Phase: [Single] [Three].
10. Hertz: 60.

2.5 FACTORY FINISHES

- A. Manufacturer's standard prime-coat finish ready for field painting.
- B. Manufacturer's standard paint in standard colors, applied to factory-assembled and -tested unit before shipping.
- C. Do not paint aluminum, galvanized-steel, and stainless-steel surfaces.

2.6 SOURCE QUALITY CONTROL

- A. Fabricate and label deaerator tanks according to ASME Boiler and Pressure Vessel Code: Section VIII, "Pressure Vessels," Division 1.
- B. Factory install and test piping that connects pumps to tanks according to [ASME B31.1, "Power Piping"] [ASME B31.9, "Building Services Piping]."
- C. Factory test performance and certify test results on packaged deaerator units, according to ASME PTC 12.3, before shipping to Project.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Before deaerator installation, examine roughing-in for concrete equipment bases, anchor-bolt sizes and locations, and piping and electrical connections to verify actual locations, sizes, and other conditions affecting performance, maintenance, and operations.
 - 1. Final deaerator locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections.
 - 2. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Equipment Mounting:
 - 1. Install deaerators on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in [Section 033000 "Cast-in-Place Concrete."] [Section 033053 "Miscellaneous Cast-in-Place Concrete."]
 - 2. Comply with requirements for vibration isolation and seismic control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
 - 3. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."
- B. Install deaerators to permit access for service and maintenance.
- C. Support piping independent of pumps.
- D. Install base-mounted pumps on concrete base with grouted base frame.
- E. Install all parts and materials not factory installed.
- F. Extend overflow drains to floor drains.
- G. Extend vent piping to outside and terminate with manufacturer-approved cap furnished with deaerator.
- H. Install piping adjacent to machine to allow service and maintenance.

3.3 CONNECTIONS

- A. Steam and condensate piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect steam and condensate piping to tank tapings with shutoff valves and unions or flanges at each connection.
- C. Connect condensate drains, pump-discharge piping, vents, overflow drains, makeup water, steam supply, and cooling water piping.

3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.
- B. Perform tests and inspections and prepare test reports.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- C. Tests and Inspections:
 - 1. Inspect field-assembled components and equipment installation, including piping and electrical connections, for compliance with requirements.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - 3. Verify bearing lubrication.
 - 4. Verify proper motor rotation.
 - 5. Test Reports: Prepare a written report to record the following:
 - a. Test procedures used.
 - b. Test results that comply with requirements.
 - c. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.
- D. Remove and replace malfunctioning equipment and retest as specified above.

3.5 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
- B. Complete installation and startup checks according to manufacturer's written instructions and do the following:
 - 1. Set deaerator makeup water-level controls.
 - 2. Verify bearing lubrication.
 - 3. Verify proper motor rotation.
 - 4. Start pumps according to manufacturer's written instructions.

3.6 ADJUSTING AND CLEANING

- A. Adjust initial temperature and pressure set points.
- B. Set field-adjustable switches and circuit-breaker trip ranges.
- C. Clean strainers.

3.7 DEMONSTRATION

- A. **[Train] [Engage a factory-authorized service representative to train]** Owner's maintenance personnel to adjust, operate, and maintain deaerators. Refer to Section 017900 "Demonstration and Training."

END OF SECTION 235316