

SECTION 23 52 33**WATER-TUBE BOILERS****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. Section includes packaged, factory-fabricated and -assembled, gas-fired, finned water-tube boilers for generating hot water.
- B. Section includes packaged, factory- assembled, water-tube boilers for generating steam.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product, include the following:
 - 1. Construction details, material descriptions, dimensions, and weights of individual components, profiles, and finishes for boilers.
 - 2. Rated capacities, operating characteristics, and furnished specialties and accessories.
 - 3. Predicted boiler efficiency while operating at design capacity and at varying part loads with basis indicated.
 - 4. Predicted emissions levels while operating at design capacity and at varying part loads with basis indicated. Indicate operation that produces worst-case emissions.
 - 5. Technical data for refractory and insulation, including temperature rating, thermal performance, attachment, and arrangement.
 - 6. Calculations showing predicted surface temperature of boiler jacket with basis indicated.
 - 7. Force and moment capacity of each piping and flue connection.
 - 8. Dimensioned location of low, high, and normal water level, showing operating set point and each alarm set point.
 - 9. Temperature and pressure rating, size, and materials of construction for boiler trim components, including piping, fittings, flanges, unions, and valves. Provide valve manufacturer's product data for each valve furnished. For safety valves, include trip and reset settings and flow capacity.
 - 10. Manufacturer's product data showing size, scale range, and accuracy of thermometers and pressure gages.
 - 11. Pressure rating, size, and materials of construction for boiler fuel train components, including piping, fittings, flanges, unions, switches, and valves. Provide manufacturer's product data for each valve and switch furnished.
 - 12. Detailed information of controls, including product data with technical performance, operating characteristics, and sequence of operation.
 - 13. Product data for each motor, including performance, operating characteristics, and materials of construction.
- B. Shop Drawings: For boilers, boiler trim, and accessories.

1. Include plans, elevations, sections, and mounting details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring. Differentiate between factory and field installation.
4. Include piping diagrams of factory-furnished piping that indicate size and each piping component.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Plan and elevation views, drawn to scale, indicating equipment manufacturers' service clearances, structure and base attachment, piping, power, controls, and flues. Each view shows a screened background with the following:
 1. Column grids, beams, columns, and concrete housekeeping pads.
 2. Room layout with walls, floors, and roofs, including each room name and number.
 3. Equipment and products of other trades that are located in vicinity of boilers and are part of final installation, such as lighting, fire-suppression systems, and plumbing systems.
- B. Installation instructions.
- C. Source quality-control reports.
- D. Field quality-control reports.
- E. Sample Warranty: For special warranty.
- F. Other Informational Submittals:
 1. ASME "A" Stamp Certification and Report: Submit "A" stamp certificate of authorization as required by authorities having jurisdiction, and document hydrostatic testing of piping external to boiler.
 2. Startup service reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For boilers, components, and accessories to include in emergency, operation, and maintenance manuals.
- B. Spare Parts List: Recommended spare parts list with quantity for each.
- C. Touch-up Paint Description: Detailed description of paint used in application of finish coat to allow for procurement of a matching paint.
- D. Instructional Videos: Including those that are prerecorded and those that are recorded during training.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Tool kit to include the following:

1. A tool kit specially designed by boiler manufacturer for use in servicing boiler(s) furnished.
 2. Special tools required to service boiler components not readily available to Owner service personnel in performing routine maintenance.
 3. Lockable case with hinged cover, marked with large and permanent text to indicate the special purpose of tool kit, such as "Boiler Tool Kit." Text size shall be at least 1 inch high.
 4. A list of each tool furnished. Permanently attach the list to underside of case cover. Text size shall be at least 0.5 inch high.
- B. Touch-up Paint: 32-oz. container of paint used for finish coat. Label on outside of container shall have a detailed description of paint to allow for procurement of a matching paint in the future.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Ship boilers from the factory free of water. Drain water and blow dry with compressed air if required to remove all water before shipping.
- B. Cover and protect flue, electrical controls, and piping connections before shipping. Protect and seal openings and connections with blinds, caps, plugs, and other materials during delivery, storage, and handling.
- C. Protect boiler components with removable temporary enclosures to prevent damage during shipping, storage, and installation.
- D. Package boiler for export shipping in totally enclosed crate with bagging.

1.8 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace heat exchangers damaged by thermal shock and vent dampers of boilers that fail in materials or workmanship within specified warranty period.
1. Warranty Period for Heat Exchangers: 20 years from date of Substantial Completion.
 2. Warranty Period for Vent Dampers: Five years from date of Substantial Completion.
- B. Special Warranty: Manufacturer agrees to repair or replace drums, tubes, headers, cabinets, atmospheric gas burners, and pressure vessels of boilers that fail in materials or workmanship within specified warranty period.
1. Warranty Period for Drums, Tubes, Headers, Cabinets, and Atmospheric Gas Burner: Five years from date of Substantial Completion, pro rata.
 2. Warranty Period for Pressure Vessel: 20 years from date of Substantial Completion, for thermal shock.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fuel-to steam efficiency indicated shall be based on the following:

1. Efficiency Testing Method: BTS-2000.
 2. Efficiency Testing Method: ASME Performance Test Code (PTC) 4, Input-Output method.
- B. Gas-Fired Boiler Emissions: Not to exceed allowable ambient-air quality standards in governing jurisdiction and indicated values.
1. Carbon monoxide:
 - a. 50 parts per million at any point from 100 percent to 50 percent fire.
 - b. 150 parts per million at any point below 50percent fire.
 2. Nitrogen compounds: 30 parts per million (dry volume basis and corrected to 3 percent oxygen) at any point from 100 percent to low fire.
 3. Sulfur compounds: One part per million (dry volume basis and corrected to 3 percent oxygen) at any point from 100 percent to low fire.
 4. Hydrocarbon and Volatile Organic Compounds: 10 parts per million (dry volume basis and corrected to 3 percent oxygen) at any point from 100 percent to low fire.
 5. Particulate Matter: 0.01 lb/MMBtu.
 6. Smoke: Not visible and not to exceed No. 1 on the Bacharach smoke scale.
- C. Operation Following Loss of Normal Power:
1. Equipment, associated factory- and field-installed controls, and associated electrical equipment and power supply connected to back-up power system shall automatically return equipment and associated controls to the operating state occurring immediately before loss of normal power without need for manual intervention by an operator when power is restored either through a back-up power source or through normal power if restored before back-up power is brought online.
 2. Refer to Drawings for equipment served by back-up power systems.
 3. Provide means and methods required to satisfy requirement even if not explicitly indicated.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- E. ASME Compliance: Fabricate and label boilers to comply with 2010 ASME Boiler and Pressure Vessel Code.
- F. ASHRAE/IES 90.1 Compliance: Boilers shall have minimum efficiency according to "Gas and Oil Fired Boilers - Minimum Efficiency Requirements."
- G. UL Compliance: Test boilers for compliance with UL 795. Boilers shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.

2.2 STEEL OR FLEXIBLE WATER-TUBE BOILERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Rite Boilers.
 2. Hurst Boiler.
 3. Harsco Industrial, Patterson-Kelley.
 4. Cleaver-Brooks
 5. Parker

6. Bryan Boilers

- B. Description: Factory-fabricated and field-assembled water-tube boiler, with heat exchanger sealed pressure tight, and built on a steel base; including insulated jacket, flue-gas vent, supply and return connections, and controls.
- C. Heat-Exchanger Design: Straight steel tubes rolled into steel headers.
 - 1. Accessible head plates at both ends.
 - 2. Handholes or couplings in headers for waterside inspections.
 - 3. Accessible drain and blowdown tappings, both high and low, for surface and mud removal.
 - 4. Lifting lugs on top of boiler.
- D. Heat-Exchanger Design: Bent steel tubes swaged into steel headers.
 - 1. Limit tube configurations to two.
 - 2. Accessible drain and blowdown tappings, both high and low, for surface and mud removal.
 - 3. Accessible inspection ports in drum, mud legs, and tube manifolds.
 - 4. Lifting lugs on top of boiler.
- E. Combustion Chamber: Equipped with minimum 2-1/2-inch, 2700 deg F poured refractory on floor and minimum 2-inch lap-jointed cast refractory with fiber-blanket joint seals on side walls. Combustion chamber shall have flame observation ports in front and back.
- F. Casing:
 - 1. Insulation: Minimum 2-inch thick, lightweight refractory; 1-inch thick insulating board; galvanized-steel membrane; and 2-inch thick, mineral-fiber insulation surrounding the heat exchanger and combustion chamber.
 - 2. Top Flue Connection: Constructed of aluminized or stainless steel.
 - 3. Jacket: Galvanized sheet metal, with screw-fastened closures and baked-enamel protective finish.
 - 4. Mounting Base: Secures boiler to concrete base.
- G. Barometric Damper: Galvanized-steel assembly with flue-gas thermometer.
- H. Forced-Draft Gas Burner:
 - 1. Burner: Welded construction with multivane, stainless-steel, flame-retention diffuser for natural gas. Mount burner on hinged access door to permit access to combustion chamber.
 - 2. Blower: Forward-curved centrifugal fan integral to burner, directly driven by motor; with adjustable, dual-blade damper assembly and locking quadrant to set air-fuel ratio.
 - 3. Gas Train: Control devices and modulating control sequence shall comply with ASME CSD-1 and UL requirements.
 - 4. Pilot: Intermittent-electric-spark pilot ignition with 100 percent main-valve and pilot-safety shutoff with electronic supervision of burner flame.
- I. Motors: Comply with requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment" unless more stringent requirements are indicated below:
 - 1. Efficiency: Premium efficient .
 - 2. Enclosure: Open dripproof.

3. Insulation Class: F.
4. Service Factor: 1.15.
5. Motors operated through variable-frequency controllers shall be inverter duty rated according to NEMA MG-1.
6. Motor Sizes: Minimum size as indicated and large enough so driven load does not require motor to operate in service factor.

J. Flue-Gas Recirculation System:

1. Equip boiler with packaged flue-gas recirculation system if required to satisfy emission requirements.
2. Complete package integrating burner, combustion-air blower and damper, fuel train, and controls. Provide interconnecting external ducting if required by manufacturer's design.

K. Steam Boiler Trim:

1. Include devices sized to comply with ASME B31.9.
2. Pressure Controllers: Operating, firing rate, and high limit.
3. Safety Relief Valve:
 - a. Size and Capacity: As required for equipment according to 2010 ASME Boiler and Pressure Vessel Code.
 - b. Description: Fully enclosed steel spring with adjustable pressure range and positive shutoff; factory set and sealed.
 - 1) Drip-Pan Elbow: Cast iron and having threaded inlet and outlet with threads complying with ASME B1.20.1.
 - 2) Exhaust Head: Install exhaust head on vent pipe connected to safety relief valve.
4. Pressure Gage: Minimum 3-1/2-inch diameter. Gage shall have normal operating pressure of about 50 percent of full range.
5. Water Column: Minimum 12-inch glass gage with gage rods to protect glass, ball check and shutoff cocks, water column blowdown valves, and vacuum breaker. Midpoint of gauge shall be at normal operating water level.
6. Bottom Blowdown Valves: Factory-installed, duty-rated, slow-acting blowdown valves and interconnecting piping same size as boiler nozzle. Blowdown valves shall be combination of slow and quick acting as required by ASME B31.1.
7. Surface Blowdown Valves: Factory-installed, duty-rated isolation valves and interconnecting piping. In addition, provide electrically operated control valve, duty rated, to control total dissolved solids (TDS) through boiler controls.
8. Stop Valves: Boiler outlets, except safety relief valves, shall be equipped with stop valve in an accessible location as near as is practical to boiler nozzle and same size or larger than nozzle. Valves larger than NPS 2 shall have rising stem.
9. Stop-Check Valves: Factory-installed, stop-check valve and stop valve at boiler outlet with free-blow drain valve factory installed between the two valves and visible when operating stop-check valve.
10. Feedwater Valves: Factory-installed, duty-rated stop and check valves and interconnecting piping. Stop valves larger than NPS 2 shall have rising stem.
11. Chemical Injection Assembly: Factory-installed, duty-rated injection quill with ball check valve and isolation valve compatible with dispensed chemical.
12. Sample Cooler: Factory installed, with needle valve for each connection. Constructed of 316 stainless steel.

L. Controls:

1. Boiler operating controls shall include the following devices and features:
 - a. Control transformer(s) with fuse protection, as required by manufacturer, to implement requirements indicated. Provide transformer with 25 percent spare capacity.
 - b. Set-Point Adjust: Operating and alarm set points shall be field adjustable.
2. Pressure Control for Steam Boilers:
 - a. Operating-Pressure Control: Factory wired and mounted to control boiler to maintain boiler at constant pressure within 2 percent of set point.
 - b. High-Pressure Cutoff with Automatic Reset: Control stops burner if operating conditions rise above normal operating-pressure set point. Set point shall be adjustable.
 - c. High-Pressure Cutoff with Manual Reset: Control stops burner operation upon reaching adjustable high limit set point that is below safety valve setting.
3. Water-Level Control for Steam Boilers:
 - a. Operating Water-Level Control: Cycle feedwater pump(s) for water-level control.
 - b. Low-Water Cutoff Switch: Float and electronic probe shall prevent burner operation on low water. Cutoff switch shall be automatic-reset type.
 - c. Auxiliary Low-Water Cutoff Switch: Float and electronic probe shall prevent burner operation on low-water alarm limit. Cutoff switch shall be manual-reset type.
 - d. Microprocessor-based control.
 - e. Accuracy within 0.01 inch.
 - f. Visual indication of level, alarms, and errors through alphanumeric display.
 - g. Features:
 - 1) Continuous water-level indication.
 - 2) Low-water cutoff and alarm.
 - 3) High-water alarm.
 - 4) Low- and high-water warning.
 - 5) Control of feedwater pump.
 - 6) Control of modulating feedwater control valve.
 - 7) Continuous monitoring of float operation.
 - 8) Column blowdown detection and reminder.
 - 9) Auxiliary low-water cutoff check.
 - 10) Auto and manual reset.
4. Boiler Emergency Shutdown: Interlock with field-installed boiler emergency shutdown switch to shut down boiler when activated. Manufacturer to furnish break-glass-type switch with permanent nameplate titled "Boiler Emergency Shutdown" for field installation.
5. Chemical Feed System Interface: Dry contacts to interface control and operation of chemical feed pump.
6. Burner Safety Controls for Steam Boilers: To maintain safe operating conditions, burner safety controls limit burner operation.
 - a. High Cutoff: Automatic and Manual reset stops burner if operating conditions rise above maximum boiler operating pressure.
 - b. Low-Water Cutoff Switch: Float and electronic probe shall prevent burner operation on low water. Cutoff switch shall be automatic-reset type.
 - c. Auxiliary Low-Water Cutoff Switch: Float and electronic probe shall prevent burner operation on low-water alarm limit. Cutoff switch shall be manual-reset type.

- d. Audible Alarm: Factory mounted on control panel with silence switch; shall sound alarm for above conditions.
- 7. Burner Flame Safeguard Controls:
 - a. Factory equipped with flame safeguard control and infrared flame scanner.
 - b. Microprocessor-based, solid-state control having sequence and flame-on visual indication and fault code indications of flame safeguard trip functions.
 - c. Control shall include dynamic self-check logic.
 - d. Control shall have a fixed operating sequence incapable of being manually altered that includes start, pre-purge, pilot and main fuel ignition run, and post-purge cycles.
 - e. Control shall be non-recycle type for maximum safety that shall shut down the burner and indicate, as a minimum, the following trip functions:
 - 1) Pilot and main flame failure.
 - 2) High- and low-fire proving switch faults.
 - 3) Running interlocks open.
 - 4) False flame signal and fuel valve open.
 - f. Control shall include a run/test switch to allow interruptions to sequence just after pre-purge and during pilot ignition trial, and run cycles for adjustments to firing rate motor, damper linkages, and pilot flame for minimum turndown tests.
- 8. Combustion-Air Controls: Factory equipped with motor-operated combustion-air damper and blower control to regulate burner fire according to load demand.
- 9. Oxygen Trim Control:
 - a. Provide oxygen trim system to continuously monitor and display oxygen concentrations in boiler flue gas and adjust fuel and airflow to maintain an adjustable oxygen-level set point.
 - b. System shall compensate for changes in ambient temperature, barometric pressure, humidity, and variations in fuel characteristics.
- 10. Surface Blowdown Control: Provide a conductivity sensor and control circuitry to operate an automatic control valve in surface blowdown piping to maintain total dissolved solids (TDS) within boiler manufacturer's prescribed level.
- 11. DDCSystem Interface: Factory install hardware and software to enable system to monitor, control, and display boiler status and alarms.
 - a. Hardwired I/O Points:
 - 1) Monitoring: On/off status, common trouble alarm low-water-level alarm.
 - 2) Control: On/off operation, steam pressure adjustment.
 - b. Communication Interface: ASHRAE 135 (BACnet) communication interface shall enable control system operator to remotely control on/off and capacity of boiler and monitor the boiler operation from an operator workstation. Control features are available, and monitoring points are displayed locally at boiler control panel through the interface.
- 12. Integrated Boiler Control System:
 - a. Integral control of burner management for flame safety, boiler modulation, and operator interface functions with features and functions indicated.

- b. Factory preconfigured.
 - c. Utilizing solid-state controls and sensors to provide various control functions, including the following:
 - 1) Automatic sequencing of the boiler through standby, prepurge, pilot flame establishing period, main flame establishing period, run, flame proving and lockout, and postpurge.
 - 2) Full modulating control of air and fuel through Proportional-Integral-Derivative (PID) algorithm.
 - 3) Thermal shock protection.
 - 4) High and low limit alarms and shutdowns.
 - d. Local operator interface through nominal 10-inch color touch screen graphical display for setup, monitoring, and data acquisition.
 - 1) Manual control of the boiler firing rate using control screens to increment or decrement firing rate.
 - 2) Indication of burner management controller status and diagnostics.
 - 3) Display of system alarms and faults.
 - 4) Display of history of alarms and faults.
 - 5) Display of recommendations for troubleshooting of fault conditions.
 - 6) Display of water-level indication and alarm(s).
 - 7) Stack flue-gas, combustion-air, and shell water-temperature indication.
 - 8) Boiler efficiency calculation and display.
 - 9) Low-fire hold with minimum temperature control.
 - 10) Assured low-fire cutoff (ALFCO).
 - 11) High stack temperature annunciation with auto cutoff.
 - 12) Audible alarm and silencing through touch screen intervention.
 - e. Fully integrated control of the following:
 - 1) Blower operation and combustion-air damper for varying operating conditions.
 - 2) Oxygen trim and monitoring to compensate for combustion-air variations.
 - 3) Draft control for maintaining proper and consistent draft for enhanced fuel efficiency.
 - f. E-mail and paging feature to multiple contacts via Internet and phone line independent of control system interface.
 - g. LAN/WAN interface with remote monitoring software to allow remote monitoring independent of control system interface.
13. Control Enclosures:
- a. NEMA 250, Type 1.
 - 1) Provide enclosure with integral vents, fans, heater, and air conditioner as required to automatically control temperature inside enclosure within safe operating limits of devices installed within the enclosure.
 - b. Wiring shall be numbered and color-coded to match wiring diagram. Provide a laminated wiring diagram located inside enclosure.
 - c. Mounted on boiler assembly at a location convenient to operator.
 - d. Provide hinged full-size door with key lock. Provide common key for all locks.

- e. Enclosure shall consist of multiple sections divided by a partition with a separate hinged door for each section. One section shall house low-voltage controls and other section shall house line voltage controls.
 - f. Enclosure shall house the following:
 - 1) Control transformers with fuses.
 - 2) Labeled terminal strips.
 - 3) Controller(s) to provide control and alarm functions indicated.
 - 4) Audible indication of safety alarms.
 - g. Face of enclosure shall provide the following:
 - 1) Visual indication of operating components and alarms.
 - 2) Auto/local capability to allow operator to manually operate boiler locally.
 - 3) Audible alarm-silence capability.
 - 4) Labels for switches, lights, and displays to provide clear indication of service.
14. Control Instrument Enclosures: Control instruments and devices that are mounted on the boiler assembly and cannot be installed inside the control enclosure shall have same or higher level of protection indicated for control enclosures.
15. Control Cable and Wire:
- a. Control cable and wiring shall be numbered and color-coded to match wiring diagram.
 - b. Install cable and wiring located outside of enclosure(s) in a metal raceway. Use flexible conduit to make final terminations. Provide watertight installation for applications exposed to moisture.

2.3 ELECTRICAL POWER

- A. Single-Point Field Power Connection: Factory-installed and -wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point field power connection to boiler.
- 1. Enclosure: NEMA 250, Type 1.
 - a. Enclosure shall have integral vents, fans, heat, and air conditioner as required to automatically control temperature inside enclosure within safe operating limits of devices installed within the enclosure.
 - b. Mounted on boiler assembly at a location convenient to operator.
 - c. Enclosure shall have hinged full-size door with key lock with common key for all locks.
 - 2. Wiring shall be numbered and color-coded to match wiring diagram. Provide a laminated wiring diagram located inside enclosure.
 - 3. Install factory wiring outside of an enclosure in a metal raceway. Make final connections to motors using flexible conduit. Provide watertight installation for applications exposed to moisture.
 - 4. Field power interface shall be to fused disconnect switch. Withstanding rating of disconnecting means shall protect equipment. Coordinate requirements with field electrical power source.
 - 5. Provide branch power circuit to each motor and to controls with disconnect switch or circuit breaker.
 - 6. Provide each motor with NEMA-rated motor controller, hand-off-auto switch, and overcurrent protection. Provide variable-frequency controller with manual bypass and line reactors for each variable-speed motor indicated.

7. Provide transformer with fuses and power wiring to power a 20-A 120-V duplex receptacle mounted in each boiler control panel for use in connecting analytical and testing equipment.

2.4 VENTING KITS

- A. Vent Damper: Motorized; UL listed for use on atmospheric burner boiler equipped with draft hood; motor to open and close damper; stainless-steel vent coupling and damper blade; keyed wiring harness connector plug; and dual-position switches to permit burner operation.
- B. Kit: Complete system, ASTM A959, Type 29-4C stainless steel, pipe, vent terminal, thimble, indoor plate, vent adapter, condensate trap, and sealant.
- C. Combustion-Air Intake: Stainless steel, pipe, vent terminal with screen, inlet air coupling, and sealant.

2.5 SOURCE QUALITY CONTROL

- A. Test and inspect factory-assembled boilers, before shipping, according to 2010 ASME Boiler and Pressure Vessel Code.
- B. Burner and Hydrostatic Test:
 1. Factory adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions, and carbon monoxide in flue gas and to achieve performance requirements indicated.
 2. Perform hydrostatic test of pressure vessel, piping, and trim of assembled boiler.
- C. Witness Testing:
 1. Allow Owner access to witness source quality-control testing of boilers.
 2. Notify Owner 15 days in advance of testing.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Before boiler installation, examine roughing-in for concrete equipment bases, anchor-bolt sizes and locations, and flue; piping; controls; and electrical connections to verify actual locations, sizes, and other conditions affecting boiler performance, maintenance, and operations.
 1. Boiler locations indicated on Drawings are approximate. Determine exact locations before roughing-in for flue, piping, controls, and electrical connections.
- B. Examine areas where boilers will be installed for suitable conditions.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 BOILER INSTALLATION

- A. Coordinate size and location of bases. Cast anchor-bolt inserts into concrete bases. Concrete, reinforcement, and formwork requirements are specified with concrete.
- B. Equipment Mounting:
 - 1. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."
- C. Install gas-fired boilers according to NFPA 54.
- D. Assemble and install boiler trim, components, and accessories that are not factory installed.
- E. Install control and electrical devices furnished with boiler that are not factory mounted.
- F. Install control and power wiring to field-mounted control and electrical devices furnished with boiler that are not factory installed.
- G. Perform boil-out and cleaning procedures according to manufacturer's written instructions after completion of hydrostatic testing and before performing other field tests. Boiler manufacturer's factory-authorized representative shall witness boil-out and cleaning procedures. Following boil-out and cleaning procedures, boiler shall be washed and flushed until water leaving boiler is clear.
- H. Protect boiler fireside and waterside from corrosion.
 - 1. Before boiler is filled with water, protect by dry storage method recommended by boiler manufacturer.
 - 2. After boiler is filled with water, and left not fired for more than 10 days, protect by wet storage method recommended by boiler manufacturer.
 - 3. Chemical Treatment: Quality of water in boilers shall be maintained by a professional water-treatment organization that shall provide on-site supervision to maintain the required water quality during periods of boiler storage as well as during operating, standby, and test conditions.

3.3 PIPING CONNECTIONS

- A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Where installing piping adjacent to boiler(s), allow space for service and maintenance.
- C. Connect gas piping to boiler gas-train inlet with dirt leg, shutoff valve, and union or flange. Piping shall be at least full size of gas-train connection. Provide a reducer if required.
- D. Connect steam and condensate piping to supply-, return-, and blowdown-boiler connections with union or flange at each connection. Provide each connection with shutoff valve if shutoff valves are not factory furnished with boiler trim.
- E. Install piping from safety valves and drip-pan elbows. Extend piping from safety valves and terminate to vent outdoors. Extend piping from drip-pan elbow drain to nearest floor drain.

- F. Install piping from equipment drain connection to nearest floor drain. Piping shall be at least full size of connection. Provide an isolation valve if required.
- G. Hot equipment drains connected to sanitary drainage system shall be cooled before discharging into the system if required to comply with more stringent of governing code requirements and requirements indicated.

3.4 FLUE CONNECTIONS

- A. Boiler Flue Venting:
 - 1. Install venting kit and combustion-air intake.
 - 2. Connect full size to boiler connections. Comply with requirements in Section 235123 "Gas Vents."
- B. Connect breeching to full size of boiler outlet. Comply with requirements in Section 235116 "Fabricated Breechings and Accessories" for venting materials.
- C. Install flue-gas recirculation duct from vent to burner if not factory furnished and installed. Comply with requirements in Section 235116 "Fabricated Breechings and Accessories" for recirculation duct materials.
- D. Install easily accessible test ports for field testing of flue gas from each boiler.

3.5 ELECTRICAL POWER CONNECTIONS

- A. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- B. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

3.6 CONTROLS CONNECTIONS

- A. Install control and electrical power wiring to field-mounted control devices.
- B. Connect control wiring between boilers and other equipment to interlock operation as required, to provide a complete and functioning system.
- C. Connect control wiring between boiler control interface and DDC control system for remote monitoring and control of boilers.

3.7 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- C. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Perform installation and startup checks according to manufacturer's written instructions.
 2. Hydrostatic Leak Test: Repair leaks and retest until no leaks exist.
 3. Operational Test: Start units to confirm proper motor rotation and unit operation. Adjust air-fuel ratio and combustion.
 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - a. Burner Test: Adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions, and carbon monoxide in flue gas and to achieve combustion efficiency.
 - b. Check and adjust initial operating set points and high- and low-limit safety set points of fuel supply, water level, and steam pressure.
 - c. Set field-adjustable switches and circuit-breaker trip ranges as indicated.
- D. Boiler will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.
- F. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.
- G. Performance Tests:
1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect component assemblies and equipment installations, including connections, and to conduct performance testing.
 2. Boilers shall comply with performance requirements indicated, as determined by field-performance tests. Adjust, modify, or replace equipment in order to comply.
 3. Perform field-performance tests to determine the capacity and efficiency of the boilers.
 - a. Test for full capacity.
 - b. Test for boiler efficiency at low fire, 10, 20, 30, 40, 50, 60, 70, 80, 90, and high fire (100) percent of full capacity. Determine and document efficiency at each test point.
 4. Test each safety valve. Record pressure at valve blowdown and reset. Test valve(s) with boiler operating at full capacity to ensure valve has capacity to prevent further rise in pressure.
 5. For boilers equipped with automatic oxygen trim control, conduct tests with automatic oxygen trim control on manual at zero trim and record performance. Repeat tests with automatic oxygen trim control under automatic control and record performance.
 6. Repeat tests until results comply with requirements indicated.
 7. Provide measurement and analysis equipment required to determine performance.
 8. Provide temporary equipment and system modifications necessary to dissipate the heat produced during tests if building systems are inadequate.
 9. Notify Owner 20 days in advance of test dates.
 10. Document test results in a report and submit with informational submittals.

3.8 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain boilers. Video training sessions and provide electronic copy of video to Owner. Refer to Section 017900 "Demonstration and Training."

END OF SECTION 23 52 33