

SECTION 235223 - CAST-IRON BOILERS

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. Section includes cast-iron boilers, trim, and accessories for generating **[hot water]** **[and]** **[steam]**.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for boilers.
 - 2. Include rated capacities, operating characteristics, and furnished specialties and accessories.
- B. Shop Drawings: For boilers, boiler trim, and accessories.
 - 1. Include plans, elevations, sections, and **[mounting]** **[attachment]** 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.
- C. Delegated-Design Submittal: For each boiler.
 - 1. Design calculations and vibration isolation base details, signed and sealed by a qualified professional engineer.
 - a. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.

- b. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

1.4 INFORMATIONAL SUBMITTALS

- A. Seismic Qualification Certificates: For boiler, accessories, and components, from manufacturer.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 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. Source quality-control reports.
- C. Field quality-control reports.
- D. Sample Warranty: For special warranty.
- E. Other Informational Submittals:
 - 1. CSA B51 pressure vessel Canadian Registration Number (CRN).
 - 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.

1.6 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to repair or replace controls and heat exchangers of boilers that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period for Controls: [**Two**] <Insert number> years from date of Substantial Completion.
 - 2. Warranty Period for Heat Exchangers: [**Five**] [**10**] [**20**] <Insert number> years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. 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.

- B. ASME Compliance: Fabricate and label boilers to comply with 2010 ASME Boiler and Pressure Vessel Code.
- C. ASHRAE/IES 90.1 Compliance: Boilers shall have minimum efficiency according to "Gas and Oil Fired Boilers - Minimum Efficiency Requirements."
- D. DOE Compliance: Minimum efficiency shall comply with 10 CFR 430, Subpart B, Appendix N.
- E. I=B=R Compliance: Boilers shall be tested and rated according to AHRI's "Rating Procedure for Heating Boilers" and "Testing Standard for Commercial Boilers," with I=B=R emblem on a nameplate affixed to boiler.
- F. UL Compliance: Test boilers for compliance with [UL 726] [UL 726 and UL 795] [UL 795]. Boilers shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.
- G. CSA Compliance: Test boilers for compliance with CSA B51.
- H. Mounting Frame: Steel rails used to mount assembled boiler package on concrete base.
 - 1. Seismic Fabrication Requirements: Fabricate mounting base and attachment to boiler, accessories, and components with reinforcement strong enough to withstand seismic forces defined in Section 230548 "Vibration and Seismic Controls for HVAC" when mounting base is anchored to building structure.

2.2 MANUFACTURERS

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

2.3 MANUFACTURED UNITS

- A. Description: Factory fabricated and [**field**] assembled.
 - 1. Cast-iron sections shall be sealed pressure tight and held together with tie rods[**set on an insulated steel base**], including insulated jacket and flue-gas vent connection.
 - 2. Ship cast-iron sections disassembled with all materials and equipment, including seals, tie rods, and insulated jacket and flue-gas vent connection for field assembly.
- B. Cast-Iron Section Design:
 - 1. Configuration: Wet [**base**] [**back**] [**leg**].
 - 2. Number of Passes: [**Single**] [**Multiple**].
 - 3. Sectional Joints: High-temperature sealant to seal flue-gas passages not in contact with heating medium, [**tapered cast-iron push nipples,**] [**O-ring gaskets,**] [**fiber roping,**] and held together with tie rods.
 - 4. Drain and blowdown tappings.
 - 5. Return injection tube to equalize water flow to all sections.
 - 6. Crown inspection tappings with brass plugs.
 - 7. Built-in air separator.

- C. Combustion Chamber: Equipped with [**ceramic-fiber target wall**] [**refractory**] [**insulation**] [**and**] flame observation ports, front and back.
- D. Casing:
 - 1. Jacket: [**Galvanized sheet**] [**Sheet**] metal, with snap-in or interlocking closures and [**baked-enamel**] [**powder-coated**] protective finish.
 - 2. Insulation: Minimum [**1-inch- (25-mm-)**] [**2-inch- (50-mm-)**] thick, mineral-fiber insulation surrounding the heat exchanger.
 - 3. Combustion Chamber Access: Refractory lined, hinged, front.
 - 4. Access: For cleaning between cast-iron sections.
 - 5. Draft Hood: Flue canopy and [**top**] [**rear**] flue connection shall be constructed of [**aluminized**] [**stainless**] steel containing adjustable outlet damper assembly.
 - 6. Insulated base constructed of aluminized steel to permit boiler to be installed on combustible floor.
 - 7. Control Cabinet: Sheet metal casing shall cover all controls, gas train, and burner.
- E. Draft Diverter: [**Steel assembly integral with boiler casing**] [**Separate galvanized-steel assembly**].

2.4 ATMOSPHERIC-GAS BURNER

- A. Burner Tubes and Orifices: [**Stainless steel**] [**Cast iron**], for [**natural**] [**propane**] gas.
- B. Gas Train: Control devices and [**full-modulation**] [**on-off**] [**low-high-low**] control sequence shall comply with requirements in [**ASME CSD-1**] [**FM Global**] [**IRI**] [**UL**].
- C. Gas Train: Combination-gas valve with manual shutoff, pressure regulator, and pilot adjustment.
- D. Pilot: [**Standing**] [**Intermittent-electric-spark**] pilot ignition with 100 percent main-valve and pilot-safety shutoff with electronic supervision of burner flame.

2.5 SEALED-COMBUSTION BURNER

- A. Burner Tubes and Orifices: [**Stainless steel**] [**Cast iron**], for [**natural**] [**propane**] gas.
- B. 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.
 - 1. Motors: Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
 - a. Motor Sizes: Minimum size as indicated; if not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
- C. Gas Train: Combination gas valve with manual shutoff, pressure regulator, and pilot adjustment.

- D. Pilot: **[Standing]** **[Intermittent-electric-spark]** pilot ignition with 100 percent main-valve and pilot-safety shutoff with electronic supervision of burner flame.

2.6 FORCED-DRAFT BURNER

- A. Burner: Welded construction with multivane, stainless-steel, flame-retention diffuser for **[natural]** **[propane]** gas.
- B. 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.
 - 1. Motors: Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
 - a. Motor Sizes: Minimum size as indicated; if not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
- C. Gas Train: Control devices and **[modulating]** **[on-off]** **[low-high-low]** control sequence shall comply with requirements in **[ASME CSD-1]** **[FM Global]** **[IRI]** **[UL]**.
- D. Pilot: **[Intermittent]** **[Interrupted]**-electric-spark pilot ignition with 100 percent main-valve and pilot-safety shutoff with electronic supervision of burner flame.
- E. Flue-Gas Recirculation: Burner connections shall be equipped for recirculating flue gas.
 - 1. Maximum Oxides of Nitrogen Emissions: **[20]** **[30]** **<Insert number>** ppm.

2.7 OIL BURNER

- A. Burner: Welded construction with multivane, stainless-steel, flame-retention diffuser for fuel oil.
- B. 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.
 - 1. Motors: Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
 - a. Motor Sizes: Minimum size as indicated; if not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
- C. Oil Supply: Control devices and **[modulating]** **[on-off]** **[low-high-low]** control sequence shall comply with requirements in **[ASME CSD-1]** **[FM Global]** **[IRI]** **[UL]**.
 - 1. Oil Pump: Two-stage, gear-type oil pump **[integral to and directly driven by blower]** shall be capable of producing **300-psig (2070-kPa)** discharge pressure and **15-inch Hg (50.7-kPa)** vacuum.
 - 2. Oil Piping Specialties:

- a. Suction-line, manual gate valve.
 - b. Removable-mesh oil strainer.
 - c. 0- to 30-inch Hg (0- to 101.3-kPa) vacuum; 0- to 30-psig (0- to 207-kPa) vacuum-pressure gage.
 - d. 0- to 300-psig (0- to 2070-kPa) oil-nozzle pressure gage.
 - e. Nozzle-line, solenoid-safety-shutoff oil valve.
- D. Pilot: **[Intermittent]** **[Interrupted]**-electric-spark pilot ignition with 100 percent main-valve and pilot-safety shutoff solenoid using **[cadmium sulfide]** **[UV scanner]** flame-safety control.
- E. Flue-Gas Recirculation: Burner connections shall be equipped for recirculating flue gas.
- 1. Maximum Oxides of Nitrogen Emissions: **[20]** **[30]** **<Insert number>** ppm.

2.8 COMBINATION GAS AND OIL BURNER

- A. Burner: Welded construction with multivane, stainless-steel, flame-retention diffuser for fuel oil and **[natural]** **[propane]** gas.
- B. 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.
- 1. Motors: Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
 - a. Motor Sizes: Minimum size as indicated; if not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
- C. Oil Supply: Control devices and **[modulating]** **[on-off]** **[low-high-low]** control sequence shall comply with requirements in **[ASME CSD-1]** **[FM Global]** **[IRI]** **[UL]**.
- 1. Oil Pump: Two-stage, gear-type oil pump **[integral to and directly driven by blower]** shall be capable of producing **300-psig** (2070-kPa) discharge pressure and **15-inch Hg** (50.7-kPa) vacuum.
 - 2. Oil Piping Specialties:
 - a. Suction-line, manual, gate valve.
 - b. Removable-mesh oil strainer.
 - c. 0- to 30-inch Hg (0- to 101.3-kPa) vacuum; 0- to 30-psig (0- to 207-kPa) vacuum-pressure gage.
 - d. 0- to 300-psig (0- to 2070-kPa) oil-nozzle pressure gage.
 - e. Nozzle-line, solenoid-safety-shutoff oil valve.
- D. Gas Train: Control devices and **[modulating]** **[on-off]** **[low-high-low]** control sequence shall comply with requirements in **[ASME CSD-1]** **[FM Global]** **[IRI]** **[UL]**.
- E. Gas Pilot: **[Intermittent]** **[Interrupted]**-electric-spark pilot ignition with 100 percent main-valve and pilot-safety shutoff with electronic supervision of burner flame.

- F. Oil Pilot: **[Intermittent]** **[Interrupted]**-electric-spark pilot ignition with 100 percent main-valve and pilot-safety shutoff solenoid with **[cadmium sulfide]** **[UV scanner]** flame-safety control.
- G. Flue-Gas Recirculation: Burner connections shall be equipped for recirculating flue gas.
 - 1. Maximum Oxides of Nitrogen Emissions: **[20]** **[30]** **<Insert number>** ppm.

2.9 TRIM FOR HOT-WATER BOILERS

- A. Include devices sized to comply with ASME B31.9.
- B. Aquastat Controllers: Operating[, **firing rate**,] and high limit.
- C. Safety Relief Valve: ASME rated.
- D. Pressure and Temperature Gage: Minimum **3-1/2-inch- (89-mm-)** diameter, combination water-pressure and -temperature gage. Gages shall have operating-pressure and -temperature ranges, so normal operating range is about 50 percent of full range.
- E. Boiler Air Vent: **[Automatic]** **[Manual]**.
- F. Drain Valve: Minimum **NPS 3/4 (DN 20)** hose-end gate valve.
- G. Tankless Heater: Carbon-steel header with copper-tube heat exchanger, mounted in an upper port of cast-iron sections and sealed with fiber gasket.
 - 1. Tappings **NPS 2 (DN 50)** and Smaller: Threaded ends according to ASME B1.20.1 for pipe threads.
 - 2. Tappings **NPS 2-1/2 (DN 65)** and Larger: Flanged ends according to ASME B16.5 for steel and stainless-steel flanges, and according to ASME B16.24 for copper and copper-alloy flanges.

2.10 TRIM FOR STEAM BOILERS

- A. Include devices sized to comply with ASME B31.9.
- B. Pressure Controllers: Operating[, **firing rate**,] and high limit.
- C. Safety Relief Valve:
 - 1. Size and Capacity: As required for equipment according to 2010 ASME Boiler and Pressure Vessel Code.
 - 2. Description: Fully enclosed steel spring with adjustable pressure range and positive shutoff; factory set and sealed.
 - a. Drip-Pan Elbow: Cast iron and having threaded inlet and outlet with threads complying with ASME B1.20.1.

- D. Pressure Gage: Minimum 3-1/2-inch (89-mm) diameter. Gage shall have normal operating pressure about 50 percent of full range.
- E. Water Column: Minimum 12-inch (300-mm) glass gage with shutoff cocks.
- F. Drain Valves: Minimum NPS 3/4 (DN 20) or nozzle size with hose-end connection.
- G. Blowdown Valves: Factory-installed bottom and surface, slow-acting blowdown valves same size as boiler nozzle.
- H. Stop Valves: Boiler inlets and outlets, except safety relief valves or preheater inlet and outlet, shall be equipped with stop valve in an accessible location as near as practical to boiler nozzle and same size as or larger than nozzle. Valves larger than NPS 2 (DN 50) shall have rising stem.
- I. 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.
- J. Tankless Heater: Carbon-steel header with copper-tube heat exchanger, mounted in an upper port of cast-iron sections and sealed with fiber gasket.
 - 1. Tappings NPS 2 (DN 50) and Smaller: Threaded ends according to ASME B1.20.1 for pipe threads.
 - 2. Tappings NPS 2-1/2 (DN 65) and Larger: Flanged ends according to ASME B16.5 for steel and stainless-steel flanges, and according to ASME B16.24 for copper and copper-alloy flanges.

2.11 CONTROLS

- A. Refer to Section 230923 "Direct Digital Control (DDC) System for HVAC" and Section 230993.11 "Sequence of Operations for HVAC DDC."
- B. Boiler operating controls shall include the following devices and features:
 - 1. Control transformer.
 - 2. Set-Point Adjust: Set points shall be adjustable.
 - 3. Operating Pressure Control: Factory wired and mounted to cycle burner.
 - 4. Low-Water Cutoff and Pump Control: Cycle feedwater pump(s) for makeup water control.
 - 5. Sequence of Operation: Electric, factory-fabricated and field-installed panel to control burner firing rate to maintain space temperature in response to thermostat with heat anticipator located in heated space.
 - a. Include automatic, alternating-firing sequence for multiple boilers to provide equal runtime for boilers.
 - 6. Sequence of Operation: Electric, factory-fabricated and field-installed panel to control burner firing rate to reset supply-water temperature inversely with outside-air temperature. At [0 deg F (minus 17 deg C)] <Insert temperature> outside-air temperature, set supply-water temperature at [200 deg F (93 deg C)] <Insert

temperature>; at [**60 deg F (15 deg C)**] <Insert **temperature**> outside-air temperature, set supply-water temperature at [**140 deg F (60 deg C)**] <Insert **temperature**>.

- a. Include automatic, alternating-firing sequence for multiple boilers to provide equal runtime for boilers.
7. Sequence of Operation: Electric, factory-fabricated and field-installed panel to control burner firing rate to maintain a constant steam pressure. Maintain pressure set point plus or minus 10 percent.
 - a. Include automatic, alternating-firing sequence for multiple boilers to provide equal runtime for boilers.
- C. Safety Controls: To maintain safe operating conditions, burner safety controls limit burner operation.
1. High Cutoff: [**Manual**] [**Automatic**] reset stops burner if operating conditions rise above maximum boiler design [**temperature**] [**pressure**].
 2. Low-Water Cutoff Switch: [**Electronic**] [**Float and electronic**] probe shall prevent burner operation on low water. Cutoff switch shall be [**manual**] [**automatic**]-reset type.
 3. Blocked Vent Safety Switch: Manual-reset switch factory mounted on draft diverter.
 4. Rollout Safety Switch: Factory mounted on boiler combustion chamber.
 5. Audible Alarm: Factory mounted on control panel with silence switch; shall sound alarm for above conditions.
- D. Building Management System Interface: Factory install hardware and software to enable building management system to monitor, control, and display boiler status and alarms.
1. Hardwired Points:
 - a. Monitoring: On/off status, [**common trouble alarm**] [**low-water-level alarm**] <Insert **monitoring**>.
 - b. Control: On/off operation, [**hot-water-supply temperature set-point adjustment**] [**steam pressure adjustment**] <Insert **control**>.
 2. A communication interface with building management system shall enable building management system operator to remotely control and monitor the boiler from an operator workstation. Control features available and monitoring points displayed, locally at boiler control panel shall be available through building management system.

2.12 ELECTRICAL POWER

- A. Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified in electrical Sections.
- B. 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. House in NEMA 250, Type [**1**] <Insert **type**> enclosure.

2. Wiring shall be numbered and color coded to match wiring diagram.
3. Install factory wiring outside of an enclosure in a [metal]raceway.
4. Field power interface shall be to [wire lugs] [fused disconnect switch] [nonfused disconnect switch] [circuit breaker].
5. Provide branch power circuit to each motor and to controls[with disconnect switch or circuit breaker].
6. Provide each motor with overcurrent protection.

2.13 CAPACITIES AND CHARACTERISTICS

A. Hot-Water Heating:

1. Design Water-Pressure Rating: [30 psig (207 kPa)] [50 psig (345 kPa)] [80 psig (550 kPa)] <Insert pressure rating>.
2. Safety Relief Valve Setting: <Insert psig (kPa)>.
3. Entering-Water Temperature: <Insert deg F (deg C)>.
4. Leaving-Water Temperature: <Insert deg F (deg C)>.
5. Design Water Flow Rate: <Insert gpm (L/s)>.
6. Design Pressure Drop: <Insert psig (kPa)>.

B. Steam Heating:

1. Design Steam-Pressure Rating: [Steam, 15 psig (104 kPa)] <Insert pressure rating>.
2. Safety Relief Valve Setting: <Insert psig (kPa)>.
3. Steam Operating Pressure: <Insert psig (kPa)>.
4. Steam Flow Rate: <Insert lb/h (kg/s)>.

C. Minimum Efficiency AFUE: <Insert number> percent.

D. Minimum Thermal Efficiency: <Insert number> percent.

E. Minimum Combustion Efficiency: <Insert number> percent.

F. Number of Passes: [One] [Two] <Insert number>.

G. Input Rating Method:

1. AGA Input: <Insert MBh (kW)>.
2. I=B=R Input: <Insert MBh (kW)>.
3. Gas Input: <Insert cfh (mL/s)>.
4. Oil Input: <Insert gph (mL/s)>.

H. Output Capacity

1. AGA Output Capacity: <Insert MBh (kW)>.
2. DOE Output Capacity: <Insert MBh (kW)>.
3. Net I=B=R Output Capacity: <Insert MBh (kW)>.
4. Gross I=B=R Output Capacity: <Insert MBh (kW)>.
5. Equivalent Direct Radiation: <Insert EDR (W)>.

I. Tankless Water Heater:

1. Design Water Flow: <Insert **gpm (L/s)**>.
2. Design Pressure Drop: <Insert **psig (kPa)**>.
3. Entering-Water Temperature: <Insert **deg F (deg C)**>.
4. Leaving-Water Temperature: <Insert **deg F (deg C)**>.

J. Blower:

1. Motor Horsepower: <Insert **number**> hp.
2. RPM: <Insert **number**>.

K. Electrical Characteristics:

1. Volts: [**115**] [**208**] [**230**] [**460**] <Insert **number**> V.
2. Phase: [**Single**] [**Three**].
3. Hertz: [**50**] [**60**] <Insert **number**> Hz.
4. Full-Load Amperes: <Insert **number**> A.
5. Minimum Circuit Ampacity: <Insert **number**> A.
6. Maximum Overcurrent Protection: <Insert **number**> A.

2.14 SOURCE QUALITY CONTROL

- A. Test and inspect factory-assembled boilers, before shipping, according to [**2010 ASME Boiler and Pressure Vessel Code**] [**CSA B51**].
- B. Burner and Hydrostatic Test: Factory adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions, and carbon monoxide in flue gas and to achieve combustion efficiency; perform hydrostatic test.
- C. Allow Owner access to source quality-control testing of boilers. Notify Architect 14 days in advance of testing.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. 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 of the Work.
 1. Final boiler locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections.
- B. Examine mechanical spaces for suitable conditions where boilers will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 BOILER INSTALLATION

A. Equipment Mounting:

1. Install boilers 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-restraint 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 gas-fired boilers according to NFPA 54.

C. Install oil-fired boilers according to NFPA 31.

D. Assemble boiler sections in sequence and seal between each section.

E. Assemble and install boiler trim.

F. Install electrical devices furnished with boiler but not specified to be factory mounted.

G. Install control wiring to field-mounted electrical devices.

3.3 CONNECTIONS

A. Piping installation requirements are specified in [Section 232113 "Hydronic Piping"] [and] [Section 232213 "Steam and Condensate Heating Piping."]. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to boiler to allow service and maintenance.

C. Connect gas piping to boiler gas-train inlet with union. Piping shall be at least full size of gas-train connection. Provide a reducer if required.

D. Connect oil piping full size to burner inlet with shutoff valve and union.

E. Connect hot-water piping to supply- and return-boiler tapings with shutoff valve and union or flange at each connection.

F. Connect steam and condensate piping to supply-, return-, and blowdown-boiler tapings with shutoff valve and union or flange at each connection.

G. Install piping from safety relief valves to nearest floor drain.

H. Install piping from safety valves to drip-pan elbow and to nearest floor drain.

I. 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.

- J. Connect breeching full size to boiler outlet. Comply with requirements in Section 235116 "Fabricated Breechings and Accessories" for venting materials.
- K. Install flue-gas recirculation duct from vent to burner. Comply with requirements in Section 235123 "Gas Vents" for recirculation duct materials.

3.4 FIELD QUALITY CONTROL

- A. Testing Agency: **[Owner will engage]** **[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. Leak Test: Hydrostatic 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 **[water temperature]** **[steam pressure]**.
 - c. Set field-adjustable switches and circuit-breaker trip ranges as indicated.
- D. Remove and replace malfunctioning units and retest as specified above.
- E. Performance Tests:
 - 1. 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 to comply.
 - 3. Perform field performance tests to determine capacity and efficiency of boilers.
 - a. For dual-fuel boilers, perform tests for each fuel.
 - b. Test for full capacity.
 - c. Test for boiler efficiency at **[low fire 20, 40, 60, 80, 100, 80, 60, 40, and 20]** **<Insert range>** percent of full capacity. Determine efficiency at each test point.
 - 4. Repeat tests until results comply with requirements indicated.
 - 5. Provide analysis equipment required to determine performance.
 - 6. Provide temporary equipment and system modifications necessary to dissipate the heat produced during tests if building systems are inadequate.

7. Notify Architect in advance of test dates.
8. Document test results in a report and submit to Architect.

F. Boiler will be considered defective if it does not pass tests and inspections.

G. Prepare test and inspection reports.

3.5 ADJUSTING

- A. Occupancy Adjustments: When requested within **[12 months]** **<Insert time period>** of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to **[two]** **<Insert number>** visits to Project during other-than-normal occupancy hours for this purpose.

3.6 DEMONSTRATION

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

END OF SECTION 235223