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SECTION 235216 – FIRE-TUBE CONDENSING BOILERS

This Section uses the term "Architect." Change this term to match that used to identify the design professional as defined in the General and Supplementary Conditions.

Verify that Section titles referenced in this Section are correct for this Project's Specifications; Section titles may have changed.

1. GENERAL
   * + 1. RELATED DOCUMENTS
          1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
       2. SUMMARY
          1. This Section includes packaged, factory-fabricated and -assembled, gas-fired, fire-tube condensing boilers, trim, and accessories for heating hot water.
       3. SUBMITTALS
          1. Product Data: Include performance data, operating characteristics, furnished specialties, and accessories.
          2. Shop Drawings: For boilers, boiler trim, and accessories.

Include plans, elevations, sections, details, and attachments to other work.

Wiring Diagrams: Power, signal, and control wiring.

Retain subparagraph and associated subparagraphs below if boilers are required to withstand specific design loads and Architect either has delegated design responsibility to Contractor or wants to review structural data as another way to verify equipment's compliance with performance requirements. Professional engineer qualifications are specified in Division 01 Section "Quality Requirements."

Retain subparagraph below if equipment includes wiring.

Retain first paragraph and subparagraphs below if required by seismic criteria applicable to Project. Coordinate with Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."

* + - * 1. Source quality-control test reports: Indicate and interpret test results for compliance with performance requirements before shipping.
        2. Field quality-control test reports: Indicate and interpret test results for compliance with performance requirements.
        3. Efficiency Data Points: Data shall be submitted per ASHRAE 155 Method of Testing for Rating Commercial Space Heating Boiler Systems. This data shall cover steady state thermal efficiency, part load efficiency, and idling energy input rate. Efficiency data not supported by a third party published test standard shall not be permitted.
        4. Warranty: Standard warranty specified in this Section.
      1. CLOSEOUT SUBMITTALS
         1. Operation and Maintenance Data: For boilers to include in emergency, operation, and maintenance manuals.
      2. QUALITY ASSURANCE
         1. Manufacturer Qualifications: The manufacturer must have been involved in the manufacture of fire tube condensing hydronic boilers for no less than 5 years. The manufacturer must be headquartered in North America and manufacture in an ASME-certified facility wholly owned by the manufacturer. The specifying engineer, contractor and end customer must have the option to visit the factory to witness test fire and other relevant procedures.
         2. 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.
         3. ASME Compliance: Fabricate and label boilers to comply with ASME Boiler and Pressure Vessel Code.

"ASHRAE/IESNA 90.1 Compliance" Paragraph may be required to comply with Project requirements or authorities having jurisdiction. Also, LEED Prerequisite EA 2 requires compliance with ASHRAE/IESNA 90.1.

* + - * 1. ASHRAE/IESNA 90.1 Compliance: Boilers shall have minimum efficiency according to "Gas and Oil Fired Boilers - Minimum Efficiency Requirements."

Delete first paragraph below if boiler rating exceeds 300,000 Btu/h (87.9 kW).

* + - * 1. AHRI Compliance: Boilers shall be AHRI listed and must meet the minimum efficiency specified under AHRI BTS-2000 as defined by Department of Energy in 10 CFR Part 431.
        2. ANSI Compliance: Boilers shall be compliant with ANSI Z21.13 test standards for US and Canada. Boilers shall be tested in an ISO 17025 recognized laboratory. Boilers tested to UL 795 shall not be permitted.

ANSI Z21.13 pertains to gas-fired low-pressure steam and hot water boilers. UL 795 pertains to commercial-industrial gas heating equipment.

* + - * 1. CSA Compliant: Boilers shall be compliant with CSA certification.
      1. COORDINATION
         1. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.
      2. WARRANTY

When warranties are required, verify with Owner's counsel that special warranties stated in this Article are not less than remedies available to Owner under prevailing local laws. Coordinate with Division 01 Section "Product Requirements." See discussion about warranties in "Common Boiler Characteristics" Article in the Evaluations in Division 23 Section "Heating Boilers."

* + - * 1. Standard Warranty: Boilers shall include manufacturer's standard form in which manufacturer agrees to repair or replace components of boilers that fail in materials or workmanship within specified warranty period.

Verify available warranties for units and components and insert number below.

Warranty Period for Fire-Tube Condensing Boilers:

Heat Exchanger, Pressure Vessel and Condensation Collection Basin shall carry a 10 year limited warranty against defects in materials or workmanship.

Heat exchangers/pressure vessel are warranted against thermal shock for the lifetime of the boiler.

The burner shall carry a five (5) year limited warranty against defective material or workmanship from the date of shipment.

All other components shall carry a one year limited warranty from date of boiler start up or 18 months from shipment if start up cannot be proven.

1. PRODUCTS
   * + 1. MANUFACTURERS

See Editing Instruction No. 1 in the Evaluations in Division 23 Section "Heating Boilers" for cautions about naming manufacturers and products. Retain one of three paragraphs and list of manufacturers in this Article. See Division 01 Section "Product Requirements."

* + - * 1. Basis-of-Design Product: Lochinvar Crest Boiler as specified on Drawings. All others must be submitted by Voluntary alternate.
        2. Manufacturer shall have the capability to design, engineer, and build package systems for the above-mentioned boilers. These can include hydronic heating, domestic hot water, and pool heating applications. Design of such systems shall be collaborative between the customer and the manufacturer.

Retain one of four lists below.

Retain list below for pulse-combustion condensing boilers.

Retain list below for fire-tube condensing boilers.

Retain list below for water-tube condensing boilers.

Retain list below for water-jacketed condensing boilers.

Retain one of four "Manufactured Units" articles below.

* + - 1. CONSTRUCTION

Retain this article for fire-tube condensing boilers.

* + - * 1. Description: Boiler shall be natural gas fired, fully condensing, and fire tube design. The boiler shall be factory-fabricated, factory-assembled, and factory-tested, fire-tube condensing boiler with heat exchanger sealed pressure tight, built on a steel base; including insulated jacket; flue-gas vent; combustion-air intake connections; water supply, return, and condensate drain connections; and controls.
        2. Heat Exchanger: The heater exchanger shall bear the ASME “H” stamp for 160 psi working pressure and shall be National Board listed. The heat exchanger shall be constructed of a fully welded 316L stainless steel interior with a carbon steel shell and of fire tube design. Fire tube shall be of the Wave Fire Tube design and capable of transferring 16,000 to 20,000 Btu’s per tube. The Wave Fire Tube shall be manufactured via a liquid impact process. The Wave Fire Tube shall have an OD = 1.654” and a wall thickness = 0.039”. The top and bottom tubesheets shall have a minimum thickness = ¼” (0751-2001) or 3/8” (2501,6001). There shall be no overlapping welds with the Wave Fire Tube to tubesheet welds. The heat exchanger shall be designed for a single-pass water flow to limit the water side pressure drop. There shall be no banding material, bolts, gaskets or “O” rings in the heat exchanger design. Cast iron, aluminum, or copper tube or water tube boilers will not be accepted.
        3. Condensate Collection Basin: Fully welded 316L stainless steel.
        4. Intake Filter and Dirty Filter Switch: Boiler shall include an intake air filter with a factory installed air pressure switch. The pressure switch will alert the end user on the screen of the boiler that the intake filter is dirty and needs to be changed.
        5. Pressure Vessel: The pressure vessel shall be in accordance with ASME Section IV pressure vessel code. The pressure vessel shall be designed for a single-pass water flow to limit the water side pressure drop. Pressure drop shall be no greater than 6.5 psi at 180 gpm. The pressure vessel shall contain a volume of water no less than:

|  |  |
| --- | --- |
| Input MBH | Water Content |
| 750 | 73 gallons |
| 999 | 77 gallons |
| 1,250 | 87 gallons |
| 1,500 | 94 gallons |
| 1,750 | 106 gallons |
| 1,999 | 111 gallons |
| 2,500 | 157 gallons |
| 3,000 | 156 gallons |
| 3,500 | 202 gallons |
| 3,999 | 201 gallons |
| 4,999 | 254 gallons |
| 6,000 | 304 gallons |

* + - * 1. Burner: Natural gas, forced draft single burner premix design. Operation of the burner shall not exceed that of 5.7% oxygen level or 40% excess air. The burner shall be high temperature stainless steel with a woven Fecralloy outer covering to provide modulating firing rates. The burner shall be capable of the stated gas train turndown without loss of combustion efficiency. The burner shall be removable from the boiler without removing the gas/air manifold. The burner shall have an independent laboratory rating for Oxides of Nitrogen (NOx) to meet requirements of South Coast Air Quality Management District (SCAQMD) as compliant with Rule 1146.2 (FB 0751 – FB 2001), Bay Area Quality Management District as compliant with Regulation 9 Rule 7 (FB 2501 – FB 6001) and Texas Commission on Environmental Quality (FB 0751 – FB 2001) as being compliant with Section 117.465.
        2. Blower: Boiler shall be equipped with a pulse width modulating blower system to precisely control the fuel/air mixture to provide modulating boiler firing rates for maximum efficiency. The burner firing sequence of operation shall include pre-purge, firing, modulation, and post-purge operation.

Motor characteristics such as NEMA designation, temperature rating, service factor, enclosure type, and efficiency are specified in Division 23 Section "Common Motor Requirements for HVAC Equipment." If different characteristics are required, add subparagraphs below to suit Project.

Motors: Comply with requirements specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."

* + - * 1. Gas Train: The boiler shall be supplied with two gas valves designed with negative pressure regulation and shall be capable of the following minimum turndowns:

|  |  |  |  |
| --- | --- | --- | --- |
| Input MBH | Turndown | Minimum Input | Maximum Input |
| 750 | 15:1 | 50,000 | 750,000 |
| 999 | 20:1 | 50,000 | 999,000 |
| 1,250 | 20:1 | 62,500 | 1,250,000 |
| 1,500 | 25:1 | 60,000 | 1,500,000 |
| 1,750 | 25:1 | 70,000 | 1,750,000 |
| 1,999 | 25:1 | 80,000 | 1,999,000 |
| 2,500 | 20:1 | 125,000 | 2,500,000 |
| 3,000 | 20:1 | 150,000 | 3,000,000 |
| 3,500 | 20:1 | 175,000 | 3,500,000 |
| 3,999 | 12:1 | 333,300 | 3,999,000 |
| 4,999 | 10:1 | 499,900 | 4,999,000 |
| 6,000 | 10:1 | 600,000 | 6,000,000 |

* + - * 1. Ignition: Spark ignition with 100 percent main-valve shutoff with electronic flame supervision. Boilers using a pilot for ignition and/or UV scanners for flame supervision shall be deemed unacceptable.
        2. High Altitude: Boiler shall operate at altitudes up to 4,500 feet above sea level without additional parts or adjustments. High altitude operation shall be certified at a minimum of 4,500 feet above sea level by a third party organization. High altitude boilers shall be certified to 3,000 to 12,000 feet above sea level. The boilers shall carry a CSA certification for high altitude operation up to 12,000 feet. High altitude operation shall be 3rd party certified and be conducted in an ISO 17025 recognized laboratory; boilers without this high-altitude certification shall be deemed unacceptable.
        3. Casing:

Jacket: Heavy gauge primed and painted steel jacket with snap-in closures. Jacket panels shall be fully removal; the front door and side panels shall not require tools for removal. The jacket shall be mounted on a steel base with a minimum thickness = ¼”.

Control Compartment Enclosures: NEMA 250, Type 1A.

If retaining second option in "Jacket" Subparagraph above, delete first subparagraph below.

Insulation: Minimum ½ inch thick, mineral fiber insulation surrounding the heat exchanger.

Combustion-Air Connections: Inlet and vent duct collars.

Clearances: Boilers shall feature zero (0) clearance to combustibles. Boilers shall have the ability to be placed side by side in multiples with no clearance in between if necessary. Local codes should be considered.

* + - * 1. Outdoor Capability: Manufacturer shall offer an outdoor certified boiler to allow outdoor installation in suitable climates.
        2. Rigging and Placement: Boiler shall include lifting lugs and fork truck accessibility for rigging.
        3. Characteristics and Capacities:

Heating Medium: Hot water.

Design Water Pressure Rating: 160 psi working pressure.

Safety Relief Valve Setting: 50 psig

Minimum Water Flow Rate:

|  |  |
| --- | --- |
| Input MBH | Minimum Flow |
| 750 | 18 gpm |
| 999 | 18 gpm |
| 1,250 | 18 gpm |
| 1,500 | 25 gpm |
| 1,750 | 25 gpm |
| 1,999 | 25 gpm |
| 2,500 | 25 gpm |
| 3,000 | 25 gpm |
| 3,500 | 45 gpm |
| 3,999 | 45 gpm |
| 4,999 | 50 gpm |
| 6,000 | 60 gpm |

* + - * 1. Oxygen Sensor

An O2 sensor shall be offered as an optional package with this boiler. The O2 sensor shall be made by a top automotive supplier and is only available through Lochinvar. The O2 sensor shall be located in the combustion chamber. Boilers with O2 sensors placed elsewhere on the unit shall not be permitted.

If Project has more than one type or configuration of boiler, delete paragraph and subparagraphs below and schedule boilers on Drawings.

Retain one of first two subparagraphs below.

Retain one of two "Trim" articles below.

* + - 1. TRIM

Retain this Article for steam boilers.

In paragraph below, retain first option if boiler operating pressure exceeds 15 psig (104 kPa).

* + - * 1. Safety Relief Valve:

Size and Capacity: 50 lb.

System pressures should be confirmed.

Custom relief valve sizes can be ordered.

Description: Fully enclosed steel spring with adjustable pressure range and positive shutoff; factory set and sealed.

* + - * 1. Pressure Gage: Minimum 3-1/2 inch diameter. Gage shall have normal operating pressure about 50 percent of full range.
        2. Drain Valves: Minimum NPS 3/4 or nozzle size with hose-end connection.

In first paragraph below, retain option if boiler operating pressure exceeds 100 psig (690 kPa).

* + - * 1. Condensate Trap: Factory supplied condensate trap with condensate trip sensor.

Retain paragraph below for boilers equipped with manhole openings that operate at more than 15 psig (104 kPa) and supply steam to a common steam header with other boilers.

* + - 1. CONTROLS

Retain paragraph below if controls are specified in Division 23 Section "Instrumentation and Control for HVAC."

* + - * 1. Refer to Division 23 Section "Instrumentation and Control for HVAC."
        2. Boiler controls shall feature the following standard features:

8” LCD screen display displaying status, modulation percentage, setpoints, and sensor data at a minimum on the home screen. Additional information such as history and parameters can be accessed via the touchscreen display without the need for navigation buttons. A screen saver mode shall be available with the display.

Variable Speed Boiler Pump Control: Boiler may be programmed to send a 0-10V DC output signal to an ECM or VFD boiler pump to maintain a designed temperature rise across the heat exchanger. The boiler shall be able to operate in this mode with a minimum temperature rise of 20 degrees F and a maximum temperature rise of 60 degrees F. Project specific temperature rise shall be \_\_\_\_.

Password Security: Boiler shall have a different password security code for the User and the Installer to access adjustable parameters.

Outdoor air reset: Boiler shall calculate the set point using a field installed, factory supplied outdoor sensor and an adjustable reset curve.

Pump exercise: Boiler shall energize any pump it controls for an adjustable time if the associated pump has been off for a time period of 24 hours.

Ramp delay: Boiler may be programmed to limit the firing rate based on six limits steps and six time intervals.

Boost function: Boiler may be programmed to automatically increase the set point a fixed number of degrees (adjustable by installer) if the setpoint has been continuously active for a set period of time (time adjustable by installer). This process will continue until the space heating demand ends.

Domestic hot water priority: Boiler shall make the domestic hot water call for heat a priority over any space heating call and adjust the boiler setpoint to the domestic hot water boiler setpoint.

Domestic hot water modulation limiting: Boiler may be programmed to limit the maximum domestic hot water firing rate to match the input rating of the indirect tank coil.

Domestic hot water night setback: Boiler may be programmed to reduce the domestic hot water tank set point during a certain time of the day.

PC port connection: Boiler shall have a PC port allowing the connection of PC boiler software.

Time clock: Boiler shall have an internal time clock with the ability to time and date stamp lock-out codes and maintain records of runtime.

Service reminder: Boiler shall have the ability to display a yellow colored service notification screen based upon months of installation, hours of operation, and number of boiler cycles. All notifications are adjustable by the installer.

Three pump control: Boiler shall have the ability to control the boiler pump, system pump and the domestic hot water pump.

Anti-cycling control: Boiler shall have the ability to set a time delay after a heating demand is satisfied allowing the boiler to block a new call for heat. The boiler will display an anti-cycling blocking on the screen until the time has elapsed or the water temperature drops below the anti-cycling differential parameter. The anti-cycling control parameter is adjustable by the installer.

Night setback: Boiler may be programmed to reduce the space heating temperature set point during a certain time of the day.

Freeze protection: Boiler shall turn on the boiler and system pumps when the boiler water temperature falls below 45 degrees. When the boiler water temperature falls below 37 degrees the boiler will automatically turn on. Boiler and pumps will turn off when the boiler water temperature rises above 43 degrees.

Isolation valve control: Boiler shall have the ability to control a 2-way motorized control valve. Boiler shall also be able to force a fixed number of valves to always be energized regardless of the number of boilers that are firing.

BMS integration with 0-10V DC input: The Control shall allow an option to Enable and control set point temperature or control firing rate by sending the boiler a 0-10V input signal.

Data logging: Boiler shall have non-volatile data logging memory including last 10 lockouts, hours running and ignition attempts and should be able to view on boiler screen.

* + - * 1. The boiler shall have a built in Cascade controller to sequence and rotate lead boiler to ensure equal runtime while maintaining modulation of up to 8 boilers of different btu inputs without utilization of an external controller. The factory installed, internal cascade controller shall include:

Lead lag: The Control module shall minimize the number of boilers firing to achieve the heating load.

Efficiency optimization: The Control module shall allow multiple boilers to fire at minimum firing rate in lieu of Lead/Lag.

Front end loading: The Control modulate shall have the ability to communicate with other Lochinvar boilers featuring the SmartTouch™ and Smart System™ control platforms. This allows for a combination of units that feature condensing and non-condensing operation if so desired.

Rotation of lead boiler: The Control module shall change the lead boiler every hour for the first 24 hours after initializing the Cascade. Following that, the leader will be changed once every 24 hours.

Redundancy: The Control module shall have a built in feature to continue operating with follow boilers if the Lead boiler is not operational.

Delete paragraph above and retain first two paragraphs and associated subparagraphs below if controls are components of boilers. Coordinate with Division 23 Section "Instrumentation and Control for HVAC."

* + - * 1. Boiler operating controls shall include the following devices and features:

Set-Point Adjust: Set points shall be adjustable.

Retain two subparagraphs below for steam boilers.

Operating Pressure Control: Factory wired and mounted to cycle burner.

Retain one of three subparagraphs below for operating control sequences. Retain one of first two subparagraphs for hot-water boilers; or third, for steam boilers.

Sequence of Operation: Factory installed controller to modulate burner firing rate to maintain system water temperature in response to call for heat.

Sequence of Operation: Electric, factory-fabricated and factory-installed panel to control burner firing rate to reset supply-water temperature inversely with outside-air temperature. At 10 deg F outside-air temperature, set supply-water temperature at 180 deg F; at 60 deg F outside-air temperature, set supply-water temperature at 140 deg F.

* + - * 1. Burner Operating Controls: To maintain safe operating conditions, burner safety controls limit burner operation.

In subparagraph below, retain "temperature" option for hot-water boiler and "pressure" option for steam boiler.

High Temperature Limit: Automatic and manual reset stops burner if operating conditions rise above maximum boiler design temperature. Limit switch to be manually reset on the control interface.

In first subparagraph below, retain first option for hot-water boilers and second option for steam boilers.

Low-Water Cutoff Switch: Electronic probe shall prevent burner operation on low water. Cutoff switch shall be manually reset on the control interface.

Blocked Inlet Safety Switch: Manual-reset pressure switch field mounted on boiler combustion-air inlet.

High and Low Gas Pressure Switches: Pressure switches shall prevent burner operation on low or high gas pressure. Pressure switches to be manually reset on the control interface.

Proof of Closure Valve (FB 6001 only): Proof of closure valve (POC) shall prevent the boiler from firing if the POC valve seat is detected open. Upon a call for heat, once the POC valve seat is proven to be closed, the pre-purge cycle will begin and the POC valve will begin to open.

Blocked Drain Switch: Blocked drain switch shall prevent burner operation when tripped. Switch to be manually reset on the control interface.

Low air pressure switch: Pressure switches shall prevent burner operation on low air pressure. Switch to be manually reset on the control interface.

Audible Alarm: Factory mounted on control panel with silence switch; shall sound alarm for any lockout conditions.

Retain paragraph and subparagraphs below if boiler controls interface with building automation system.

* + - * 1. Building Automation System Interface: Factory installed Modbus and BACnet MSTP gateway interface to enable building automation system to monitor, control, and display boiler status and alarms.

BACnet IP and LonWorks gateways are available as optional equipment.

* + - * 1. Software Update: The control shall have the ability to receive updates in the field without hardware component replacement. This update can be performed via USB flash drive, internet connection, or via wireless connection. This service shall be provided at no additional and/or annual cost to the owner.
        2. CON•X•US Remote Connect: Integral remote connectivity technology that allows a mobile device to monitor and control boiler functionality. Internet connection is available on the Crest via Wi-Fi or hardwired Ethernet connection. This service shall be provided at no additional and/or annual cost to the owner.
        3. RealTime O2 Feedback™: Boiler, if equipped with the optional RealTime O2 Feedback™ package, shall provide real time sensing of O2. Free air calibration of the sensor shall occur after every combustion cycle. The O2 value shall also auto correct for conditions such as altitude. O2 information shall be displayed in real time via a gauge on both the boiler touchscreen as well as the CON•X•US Remote Connect screen.

Retain subparagraph and associated subparagraphs below if interface with building automation system is through hardwired points and minimal interface is required. If extensive interface is required, delete below and retain second subparagraph below.

Retain subparagraph below if extensive interface with building automation system is required and is beyond that than can be provided by hardwired points. Requirement may exclude some manufacturers listed.

* + - 1. ELECTRICAL POWER

Retain one of two paragraphs and associated subparagraphs in this Article. Retain first if single-point field power connection is not applicable; retain second if single-point field power connection is applicable.

* + - * 1. Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified in Division 26 Sections.
        2. Single-Point Field Power Connection: Factory-installed and factory-wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point field power connection to boiler.
        3. Electrical Characteristics:

See Drawings

Voltage

120V/1PH - FB 0751 through FB 2001

208V/3PH - FB 2501 through FB 3501

480V/3PH – FB 4001 through 6001

Frequency: 60 Hz

Factory supplied 208V, 480V or 600V transformers are available for optional voltage.

* + - 1. VENTING

Some boiler manufacturers offer venting kits that can be included with boiler. Retain this Article if venting kit is included with boiler; otherwise, specify kit in Division 23 Section "Breechings, Chimneys, and Stacks."

* + - * 1. Exhaust flue for the FB 0751 – FB 4001 must be Category IV approved PVC, CPVC, PP or stainless steel sealed vent material from one of the approved manufacturers listed in the Installation and Operation manual. Boilers exhaust vent length must be able to extend to 100 equivalent feet.
        2. Exhaust flue for the FB 5001 – FB 6001 must be UL listed, Category IV approved stainless steel sealed vent material from one of the approved manufacturers listed in the Installation and Operation manual. Boilers exhaust vent length must be able to extend to 100 equivalent feet.
        3. Intake piping for all models must be of approved material as listed in the Installation and Operations manual. Boilers intake pipe length must be able to extend to 100 equivalent feet.
        4. Boiler venting and intake piping configuration shall be installed per one of the approved venting methods shown in the Installation and Operation manual.
        5. Boiler shall come standard with a flue sensor to monitor and display flue gas temperature on factory provided LCD display.
        6. Boilers using common venting must contact the factory for sizing.
        7. Refer to manufacturer’s Installation and Operations manual for detailed venting instructions and approved manufacturers.
      1. SOURCE QUALITY CONTROL
         1. 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.
         2. Test and inspect factory-assembled boilers, before shipping, according to ASME Boiler and Pressure Vessel Code.

Retain paragraph below if Owner wants to witness source quality-control testing.

* + - * 1. Allow Owner access to source quality-control testing of boilers. Notify Architect 14 days in advance of testing.

1. EXECUTION
   * + 1. EXAMINATION
          1. Before boiler 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 boiler performance, maintenance, and operations.

Final boiler locations indicated on Drawings are approximate. Determine exact locations before roughing-in of piping and electrical connections.

* + - * 1. Examine mechanical spaces for suitable conditions where boilers will be installed.
        2. Proceed with installation only after unsatisfactory conditions have been corrected.
      1. BOILER INSTALLATION

Retain one of three "Equipment Mounting" paragraphs below. Coordinate with Drawings and Sections specifying vibration and seismic controls.

Retain first "Equipment Mounting" Paragraph for equipment supported on cast-in-place concrete equipment bases without vibration isolation devices.

* + - * 1. Install equipment on 4” concrete housekeeping pad.
        2. Install gas-fired boilers according to NFPA 54.
        3. Assemble and install boiler trim.
        4. Install electrical devices furnished with boiler but not specified to be factory mounted.
        5. Install control wiring to field-mounted electrical devices.
      1. CONNECTIONS

Coordinate piping installations and specialty arrangements with schematics on Drawings and with requirements specified in piping systems. If Drawings are explicit enough, these requirements may be reduced or omitted.

* + - * 1. Install boilers level on concrete bases. Concrete base is specified in Division 23 Section "Common Work Results for HVAC," and concrete materials and installation requirements are specified in Division 03.
        2. Install piping adjacent to boiler to allow service and maintenance.
        3. 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.
        4. Connect gas piping to boiler gas-train inlet with union. Piping shall be at least full size of equipment connection. Provide a reducer if required. Gas regulator shall also be installed per IOM. Manufacturer shall offer a 2 and 5 psi gas regulator offering for each boiler model.
        5. Connect hot-water piping to supply and return boiler tappings with shutoff valve and union or flange at each connection.

Retain paragraph above for hot-water boilers and first paragraph below for steam boilers.

* + - * 1. Install piping from safety relief valves to nearest floor drain.

Retain paragraph above for hot-water boilers and first paragraph below for steam boilers. Delete both if safety valves are specified in Division 23 Section "Steam and Condensate Heating Piping" or "Hydronic Piping."

* + - * 1. Boiler Venting:

Install flue venting kit and combustion-air intake.

Delete option in subparagraph below if vent kit is specified in this Section.

Connect full size to boiler connections. Comply with requirements in Division 23 Section “Breechings, Chimneys, and Stacks.

* + - * 1. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
        2. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
      1. FIELD QUALITY CONTROL
         1. Perform tests and inspections and prepare test reports.

Retain subparagraph below to require a factory-authorized service representative to assist Contractor with inspections, tests, and adjustments.

Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

* + - * 1. Tests and Inspections:

Perform installation and startup checks according to manufacturer's written instructions. Complete startup form included with Boiler and return to Manufacturer as described in the instructions.

Leak Test: Hydrostatic test. Repair leaks and retest until no leaks exist.

Operational Test: Start units to confirm proper motor rotation and unit operation. Adjust air-fuel ratio and combustion.

Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

Check and adjust initial operating set points and high- and low-limit safety set points of fuel supply, water level and water temperature.

Set field-adjustable switches and circuit-breaker trip ranges as indicated.

* + - * 1. 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.

Retain paragraph and subparagraphs below if performance tests are required. Performance verification based on field tests is not typically required because of the associated cost. Consult Owner.

* + - * 1. Performance Tests:

Engage a factory-authorized service representative to inspect component assemblies and equipment installations, including connections, and to conduct performance testing.

Boilers shall comply with performance requirements indicated, as determined by field performance tests. Adjust, modify, or replace equipment to comply.

Perform field performance tests to determine capacity and efficiency of boilers.

Repeat tests until results comply with requirements indicated.

Provide analysis equipment required to determine performance.

Provide temporary equipment and system modifications necessary to dissipate the heat produced during tests if building systems are not adequate.

Notify Architect in advance of test dates.

Perform a combustion analysis after installation and adjust gas valve per the Installation and Operations manual and note in startup report.

Document test results in a report and submit to Architect.

* + - 1. DEMONSTRATION
         1. Engage a factory representative or a factory-authorized service representative for boiler startup and to train Owner's maintenance personnel to adjust, operate, and maintain boilers. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 235216