

## SECTION 23 5216 - CONDENSING BOILERS

### 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 gas-fired, fire-tube condensing boilers, trim, and accessories for generating hot water.

#### 1.3 ACTION SUBMITTALS

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

1. ASME Stamp Certification and Report: Submit "A," "S," or "PP" stamp certificate of authorization, as required by authorities having jurisdiction, and document hydrostatic testing of piping external to boiler.
2. CSA B51 pressure vessel Canadian Registration Number (CRN).

D. Installation and Operation Instructions

E. Product Warranty

1.4 CLOSEOUT SUBMITTALS

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

1.5 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of boilers that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Fire-Tube Condensing Boilers:

- a. Leakage and Materials: 10 years from date of Substantial Completion.
- b. Heat Exchanger Damaged by Thermal Stress and Corrosion: Nonprorated for five 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. UL Compliance: Test boilers for compliance with UL 795. Boilers shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.
- F. Kentucky Boiler Code: Provide boilers in accordance with Kentucky Boiler Code.
- G. CSA Compliance: Test boilers for compliance with CSA B51.
- H. Mounting Base: For securing boiler to concrete base.

1. Seismic Fabrication Requirements: Fabricate mounting base and attachment to boiler pressure vessel, 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 FORCED-DRAFT, FIRE-TUBE CONDENSING BOILERS

### A. Manufacturers:

Lochinvar (Basis of Design)  
RBI, Mestek Company  
Cleaver Brooks

### B. Design: Boilers shall be CSA design certified as a condensing boiler. Boilers shall be designed for a minimum of 25:1 continuous turn down with constant CO<sub>2</sub> over the turndown range.

1. The boiler shall operate with natural gas and have a CSA International certified input rating as noted on the drawings, and a thermal efficiency rating up to 99% at minimum input.
2. The boiler shall be symmetrically air-fuel coupled such that changes in combustion air flow or flue flows affect the BTUH input without affecting combustion quality. The boiler will automatically adjust input for altitude and temperature induced changes in air density.
3. The boiler will use a proven pilot interrupted spark ignition system. The boiler shall use a UL approved flame safeguard ignition control system using UV detection flame sensing. The UV detector shall be air cooled to prevent condensate formation and so designed as to prevent misalignment.
4. The design shall provide for silent burner ignition and operation. The boiler shall be down-fired counter-flow such that formed condensate always moves toward a cooler zone to prevent re-evaporation. A corrosion resistant condensate drain designed to prevent pooling and accessible condensate trap shall be provided. In some jurisdictions, a means of neutralizing the condensate pH levels may be required. Boiler shall be able to vent a horizontal distance of 100 equivalent feet, 30.5m with a vent diameter equivalent to the combustion chamber outlet diameter.
5. Service Access: The boilers shall be provided with access covers for easily accessing all serviceable components. The boilers shall not be manufactured with large enclosures, which are difficult to remove and reinstall. All accesses must seal completely as not to disrupt the sealed combustion process. All components must be accessible and able to adjust with the removal of a single cover or cabinet component.
6. Indicating lights: Each boiler shall include a diagnostic control panel with a full text display indicating the condition of all interlocks and the BTUH input percentage. Access to the controls shall be through a completely removable cover leaving diagnostic panel intact and not disrupted.
7. COMPONENTS
  - a. Shall be capable of following performance: 25:1 turndown; minimum input of 80,000MBH; maximum input 1,999,000MBH.
  - b. Shall bear the ASME "H" stamp for 160 psi working pressure and shall be National Board listed. Shall have a fully welded 316L stainless steel interior with a carbon steel shell fire tube heat exchanger. There shall be a single pressure vessel. Multiple pressure vessels are

not acceptable. There shall be no banding material, bolts, gaskets or "O" rings in the heat exchanger construction. The heat exchanger 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 condensate collection basin shall be constructed of welded 316L stainless steel. The complete heat exchanger assembly shall carry a ten (10) year limited warranty.

- c. The heat exchanger shall contain a volume of water no less than 111 gal.
- d. Shall be certified and listed by C.S.A. International under the latest edition of the harmonized ANSI Z21.13 test standard for the U.S. and Canada. The BOILER shall comply with the energy efficiency requirements of the latest edition of the ASHRAE 90.1 Standard and the minimum efficiency requirements of the latest edition of the AHRI BTS-2000 Standard as defined by the Department of Energy in 10 CFR Part 431. The BOILER shall operate at a minimum of 96% thermal efficiency at full fire as registered with AHRI. The registered combustion efficiency must be equal or greater than the registered thermal efficiency. All models shall operate up to 98% thermal efficiency with return water temperatures at 70°F or below at 20°F temperature rise. The BOILER shall be certified for outdoor and indoor installation.
- e. The BOILER shall be constructed with a heavy gauge steel jacket assembly, primed and pre-painted on both sides. The jacket shall be designed and sealed for outdoor installations. The combustion chamber shall be sealed and completely enclosed, independent of the outer jacket assembly, so that integrity of the outer jacket does not affect a proper seal. Two burner/flame observation ports shall be provided. The single burner shall be a premix design constructed of high temperature stainless steel with a woven Fecralloy outer covering to provide modulating firing rates. The BOILER shall be supplied with two gas valves designed with negative pressure regulation and be equipped with a pulse width modulation blower system, to precisely control the fuel/air mixture to provide modulating boiler firing rates for maximum efficiency. The BOILER shall operate in a safe condition with gas supply pressures as low as 4 inches of water column on Natural Gas. The OF 6001 shall be supplied with a proof of closure valve (POC) and 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. The burner flame shall be ignited by direct spark ignition with flame monitoring via a flame sensor.
- f. The BOILER shall utilize a 24 VAC control circuit and components. The control system shall have a display for boiler set-up, boiler status, and boiler diagnostics. All components shall be easily accessed and serviceable from the front and top of the jacket. The BOILER shall be equipped with a temperature/pressure gauge; high limit temperature control with manual reset; ASME certified pressure relief valve set for 50 psi (standard); outlet water temperature sensor (dual thermistor); return water temperature sensor; outdoor air sensor, flue temperature sensor (dual thermistor); high and low gas pressure switches, low water cut off with manual reset, blocked drain switch and a condensate trap for the heat exchanger condensate drain.
- g. Flue Gas Collector: Enclosed combustion chamber with integral combustion air blower and single venting connection.
- h. Gas Train: Manual ball type gas valves (2), main gas valve, manual leak test valve, pilot gas pressure regulator, and automatic pilot gas valve. All components to be factory mounted and CSD-1 compliant. Safety Devices: Low gas pressure switch, air flow switch, and blocked flue detection switch, low water cutoff (manual reset), high temperature manual reset. All safeties to be factory mounted.

## 2.3 CONTROLS

- A. The BOILER shall feature the "SMART TOUCH" control with CON-X-US or equivalent which is standard and factory installed with an 8" liquid crystal touch screen display, password security, outdoor air reset, pump delay with freeze protection, pump exercise, ramp delay featuring six steps, domestic hot water prioritization with limiting capabilities and PC port connection. A secondary control that is field mounted outside or inside the appliance is not acceptable. The BOILER shall have alarm contacts for any failure,

runtime contacts and data logging of runtime at given modulation rates, ignition attempts and ignition failures. The BOILER shall have a built-in “Cascade” to sequence and rotate while maintaining modulation of up to eight boilers of different Btu inputs without utilization of an external controller. The internal “Cascade” function shall be capable of lead-lag, efficiency optimization, front-end loading, and rotation of lead boiler every 24 hours. The control must include cascade redundancy to allow a member boiler to become the temporary leader if the original lead boiler shall loose communication with the members. The BOILER shall be capable of controlling an isolation valve (valve shall be offered by manufacturer) during heating operation and rotation of open valves in standby operation for full flow applications. The control must be equipped with standard BACnet MSTP communication protocol with a minimum 55 readable points. The BOILER shall have an optional gateway device which will allow integration with LON or BACnet (IP) protocols.

- B. The CON-X-US or equivalent communication platform that will allow remote access via a smart phone or Tablet. This will allow the ability to monitor and manage multiple Boilers and send alerts via text or e-mail notifying of changes in system status. A user shall have the ability to check system status or re-program any boiler function remotely.
- C. The “SMART TOUCH” or equivalent control shall increase fan speed to boost flame signal when a weak flame signal is detected during normal operation. A 0 -10 VDC output signal shall control a variable speed boiler pump (pump to be offered by manufacturer) to keep a fixed delta t across the boiler regardless of the modulation rate. The BOILER shall have the capability to receive a 0 – 10 VDC input signal from a variable speed system pump to anticipate changes in system heat load in order to prevent flow related issues and erratic temperature cycling.
- D. The BOILER shall have available as an option RealTime O<sub>2</sub> Feedback. The O<sub>2</sub> sensor shall be made by a top automotive supplier and is only available through Lochinvar. The O<sub>2</sub> sensor shall be located in the combustion chamber. The feedback shall be in real time and displayed via a gauge on both the boiler touchscreen and the CON-X-US communication platform.
- E. the BOILER shall be equipped with two terminal strips for electrical connection. A low voltage connection board with 30 data points for safety and operating controls, i.e., Alarm Contacts, Runtime Contacts, Louver Proving Switch, Tank Thermostat, Remote Enable/Disable, System Supply Sensor, Outdoor Sensor, Tank Sensor, Modbus Building Management System signal and Cascade control circuit. A high voltage terminal strip shall be provided for Supply voltage. Supply voltage shall be 120V/1PH/60Hz (OF 751 – OF 2001), 208V/3PH/60Hz (OF 2501 – OF 3501), or 480V/3PH/60Hz (OF 4001 – OF 6001). The boiler may be factory trimmed for optional supply voltages, i.e. 208V/3PH/60Hz, 480V/3PH/60Hz and 600V/3PH/60Hz. The high voltage terminal strip plus integral relays are provided for independent pump control of the System pump, the Boiler pump and the Domestic Hot Water pump.
- F. The **BOILER** shall be installed and vented with a:
  - 1. Vent system with Vertical rooftop or Horizontal sidewall exhaust with the combustion air intake in different pressure zones. The flue shall be Category IV approved Stainless Steel (OF 0751- 6001) sealed vent material terminating at the rooftop or sidewall with the manufacturer’s specified vent termination. A separate pipe shall supply combustion air directly to the boiler from the outside in a different pressure zone from that of the exhaust vent. The air inlet pipe must be sealed and may be other materials listed in the Installation manual. The boiler’s total combined air intake length shall not exceed 100 equivalent feet. The boiler’s total combined exhaust venting length shall not exceed 100 equivalent feet.
  - 2. The BOILER shall operate at altitudes up to 4,500 feet above sea level without additional parts or adjustments.
- G. **STANDARD CONSTRUCTION**
  - 1. The BOILER shall be constructed in accordance with the following code requirements as standard equipment. Manufacturing of special models to meet the below code requirements is not acceptable.

- a. California Code
- b. CSD1 / Factory Mutual / GE Gap
- c. KY Kentucky Code
- d. Note: Due to the large disparity in CSD-1 interpretation from state to state, please confirm to the factory all controls required in your jurisdiction.

## 2.4 BOILER TRIM

- A. Safety Relief Valve: ASME rated, factory set to protect boiler and piping as per schedule/drawings. 160 psi maximum allowable working pressure.
- B. Gauge: Combination water pressure and temperature shipped factory installed. LCD outlet temperature readout to be an integral part of the front boiler control panel display to allow for consistent easy monitoring of temperatures factory mounted and wired.
- C. Burner Controls: Boiler shall be provided with a Honeywell RM7800 series digital flame safe guard with UV rectification. The flame safe guard shall be capable of both pre and post purge cycles.
- D. High Limit: Temperature control with manual reset limits boiler water temperature in series with the operating control. High Limit shall be factory mounted and sense the outlet temperature of the boiler through a dry well.
- E. Low Air Pressure Switch
- F. Blocked Flue Switch
- G. Modulation Control
- H. Temperature/Pressure Gauge
- I. Manual Reset High Limit (CSD-1 Factory Mounted and Wired)
- J. Low Gas Pressure Switch (Above 2500 MBH)
- K. Low Water Cutoff with Manual Reset (CSD-1 Factory mounted and wired)
- L. Supply Outlet Temperature Display
- M. Air Inlet Filter
- N. Combustion Air Fan with Safety Interlock
- O. Condensate Drain
- P. High Gas Pressure Switch (Above 2500 MBH)
- Q. Flow Switch Mounted & Wired
- R. Relief Valve
- S. Low Gas Pressure Switch
- T. High Gas Pressure Switch

U. Valve Proving Switch

V. Isolation Valve Wiring

W. Pump Starter

X. MOTORS

1. Refer to Division 15 Section "Motors" for factory installed motors.
2. Boiler Blower Motor: The Blower shall be a variable speed blower.

## 2.5 NEUTRALIZING KITS

A. Manufacturer:

1. JJM Boiler Works or equivalent.

B. Components:

1. Two 6" mounting Steel Strut channels.
2. Two 4" Strut Clamps.
3. Pre-charged Magnesium Oxide Pellet Tube.
4. Two: .75" NPT x .75 O.D. Barb fittings.
5. Inline Tube maybe Opaque color Tubing.
6. Inline tube shall have two inlet ports .75" (1) @ 3:00 (1)@ 9:00
7. Inline tube shall have (1) .75" Outlet Port @ 12:00
8. Inline tube shall have (1) 3" removable plug for servicing.
9. Inline tube shall be supplied with (1).75" PVC Threaded Plug.
10. All packing material shall be recyclable paper and cardboard. No form shall be used in packing.

C. Product Rating:

1. Rated up to 2,000 MBH
2. Flow rate shall be up to 16.0 GPH
3. Horizontal Mounting Only.

## 2.6 SOURCE QUALITY CONTROL

- A. 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.
- B. Test and inspect factory-assembled boilers, before shipping, according to 2010 ASME Boiler and Pressure Vessel Code.
- C. Allow Owner access to source quality-control testing of boilers. Notify Engineer 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).
- B. Install gas-fired boilers according to NFPA 54.
- C. Assemble and install boiler trim.
- D. Install electrical devices furnished with boiler but not specified to be factory mounted.
- E. Install control wiring to field-mounted electrical devices.

### 3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to boiler to allow service and maintenance.
- C. 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. Install neutralizing kit between boiler connection and floor drain.
- D. Connect piping to boilers, except safety relief valve connections, with flexible connectors of materials suitable for service. Flexible connectors and their installation are specified in Section 232116 "Hydronic Piping Specialties."
- E. 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. Extend vent piping from burner manifold and gas regulators, full size, up through roof or wall.
- F. Connect hot-water piping to supply- and return-boiler tappings with shutoff valve and union or flange at each connection.



- G. Connect steam and condensate piping to supply-, return-, and blowdown-boiler tapplings with shutoff valve and union or flange at each connection.
- H. Install piping from safety relief valves to nearest floor drain.
- I. Install piping from safety valves to drip-pan elbow and to nearest floor drain.
- J. Boiler Venting:
  - 1. Install flue venting kit and combustion-air intake.
  - 2. Connect full size to boiler connections. Comply with requirements in Section 235123 "Gas Vents."
- K. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- L. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

### 3.4 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. 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. 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].
    - b. 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. 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. Test for full capacity.

- b. Test for boiler efficiency at low fire 20, 40, 60, 80, 100, 80, 60, 40, and 20percent 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 Engineer 24 hours minimum in advance of test dates.
8. Document test results in a report and submit to Architect.

### 3.5 DEMONSTRATION

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

END OF SECTION 23 5216