

## SECTION 23 52 70 – FIRE-TUBE 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. This Section includes packaged, factory-fabricated and -assembled, high efficiency natural gas fired, condensing boilers, trim, and accessories for generating hot water.

#### 1.3 SUBMITTALS

- A. The installing contractor is required to submit the applicable PA L and I forms prior to boiler installation. See Part 3.
- B. Product Data: Include performance data, operating characteristics, furnished specialties and accessories. Prior to flue vent installation, provide engineered calculations and drawings to thoroughly demonstrate that size and configuration conform to recommended size, length and footprint for each submitted boiler.
- C. Efficiency Curves: At a minimum, submit efficiency curves for 100%, 80%, 60%, 40% 20%, and 7% input firing rates at incoming water temperatures ranging from 80°F to 160°F.
- D. Pressure Drop Curve: Submit pressure drop curve for flows ranging from 0 GPM to maximum value of boiler. If submitted material is different from that of the design basis, boiler manufacturer shall in-cur all costs associated with reselection of necessary pumps.
- E. Shop Drawings: For boilers, boiler trim, and accessories. Provide wiring diagram for power, signal, and control wiring.
- F. Operation and Maintenance Data: For boilers to include in emergency, operation, and maintenance manuals.

#### 1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. ASME Compliance: Fabricate and label boilers to comply with ASME Boiler and Pressure Vessel Code.
- C. ASHRAE/IESNA 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, "Uniform Test Method for Measuring the Energy Consumption of Furnaces and Boilers."

FIRE-TUBE CONDENSING BOILERS

- E. UL Compliance: Test boilers for compliance with UL 795, "Commercial-Industrial Gas Heating Equipment." Boilers shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.

1.5 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases.

1.6 WARRANTY

- A. Special Warranty: 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.

1. Warranty Period for Fire-Tube Condensing Boilers:

- a. The pressure vessel/heat exchanger shall carry a 10 year from shipment, prorated, limited warranty against any failure due to condensate corrosion, thermal stress, mechanical defects or workmanship.
- b. Manufacturer labeled control panels and other boiler components are to be warranted against failure for (1) year after the date of substantial completion of the final phase of the project.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to review and compliance with the project requirements provide FlexCore condensing boilers manufactured by RBI which is the basis of design. Boilers manufactured by the following will be reviewed for compliance:
  - 1. Aerco Benchmark.
  - 2. Fulton Endura
  - 3. LAARS Magnatherm.
- B. Description: Factory-fabricated, assembled, and tested boiler, with tubes sealed into headers pressure tight, and set on a steel base; including insulated jacket, flue-gas vent, combustion-air-intake connections, water supply and return connections, and controls.

2.2 BOILER DESIGN

- A. Boilers shall be CSA design certified as a condensing boiler. Boilers shall be designed for a minimum of 5:1 continuous turn down with constant CO<sub>2</sub> over the turndown range. 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. 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. 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. 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

FIRE-TUBE CONDENSING BOILERS

designed to prevent pooling and accessible condensate trap shall be provided. Boiler shall be able to vent a horizontal distance of 100 equivalent feet with a vent diameter equivalent to the combustion chamber outlet diameter.

- B. The boiler 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.
- C. 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.

2.3 BOILER COMPONENTS

- A. Combustion chamber shall be a down-fired design and constructed of stainless steel.
- B. Heat Exchanger: Boilers shall be a stainless-steel fire tube unit designed for pressure firing and shall be constructed and tested for 160 P.S.I water working pressure and 210 deg. F maximum operating temperature, in accordance with the A.S.M.E. Section IV Rules for the Construction of Heating Boilers. The fire tubes shall be of a down-fired counter-flow single-pass design. Stainless steel tubes will be rounded, rectangular tubes with an integral dimpled design. The tube sheet is fully symmetrical and conical in shape to allow it to act as a piston to reduce the intra-tubular stresses. This allows the unit to absorb expansion and contraction evenly across the tube sheet. The design will provide for equal temperature rise across the heat exchanger. The heat exchanger design should have no restrictions to inlet water temperature, a maximum temperature rise of 100 deg. (f)
- C. Provide boiler jackets fabricated from carbon steel and factory painted.
- D. Gas Burner: The burner shall be metal fiber mesh construction, allowing high turndown of the fuel-air mixture. The burner flame shall burn horizontally and be of the pre-mix type with a forced draft fan. Burner shall fire to provide equal distribution of heat throughout the entire heat exchanger. The burner shall be easily removed for maintenance without the disruption of any other major component of the boiler. Provide a window view port for visual inspection of the boiler during firing.
- E. Ignition Components: Ignition system shall incorporate the 'sure fire' Turbo Pilot design. The Turbo Pilot is completely independent of the burner system and installed as a single pilot 'gun' type arrangement. This pilot system shall provide a strengthened pin point flame. Pilot systems utilizing hot surface ignition or direct spark to burner design shall not be accepted. The ignition hardware shall consist of Alumina ceramic insulated ignition electrodes and UV sensing tube permanently arranged to ensure proper ignition electrode and UV alignment.
- F. The boiler shall be capable of operating at rated capacity with pressures as low as 3" W.C. at the inlet to the burner gas valve. Boiler shall operate at altitudes up to 6,000 feet above sea level without additional parts or adjustments.
- G. The burner and gas train shall be provided with the following trim and features:
  - 1. The burner shall be a premix design and constructed of woven stainless steel.
  - 2. The burner shall be capable of and provide variable modulating firing rates.
  - 3. The burner shall be capable of operating with repeatable CO<sub>2</sub> at both low fire and high fire modulating firing rates.
  - 4. The burner shall be capable of operating without exceeding 20ppm of NO<sub>x</sub>

FIRE-TUBE CONDENSING BOILERS

5. The boiler shall be supplied with a zero-governor gas valve coupled with a variable speed blower system, to precisely control the fuel/air mixture for maximum combustion efficiency.
6. Burner Ignition: Pilot with Intermittent spark
7. Safety Controls: Energize ignition, limit time for establishing flame, prevent opening of gas valve until pilot flame is proven, stop gas flow on ignition failure, and allow gas valve to open.
8. Flue Gas Collector: Enclosed combustion chamber with integral combustion air blower and single venting connection.
9. 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.
10. 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.

H. Boiler blower motor shall be a variable speed blower.

## 2.4 BOILER TRIM

- A. Safety Relief Valve: ASME rated, factory set to protect boiler and piping as per the drawings with 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. Flow Sensor: Boiler shall be provided with a digital flow sensing device integral to the boiler control system, mounted in a by-pass and mapped to indicate the boiler flow in (g.p.m.), the flow sensor utilizes vortex technology which is then converted to an electronic signal sent directly to the Boiler Control System for real time flow annunciation. The set-point is fully adjustable throughout the boiler model operating range.
- D. 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.
- E. 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.

## 2.5 BOILER CONTROLS

- A. The boiler control package shall be provided with an integrated boiler management system. The control system must be integral to each boiler, creating a control network that eliminates the need for a "wall mount" stand-alone boiler system control. Additional stand-alone control panels, independent of a Building Management System (BMS), shall not be allowed to operate the boiler network.
- B. The boiler control system shall be capable of the following:
  1. As a stand-alone boiler control system using the standard protocol, with one "Master" and multiple "Member" units.
  2. As a boiler network, enabled by a Building Management System (BMS), using the controller protocol, with one "Master" and multiple "Member" units.
  3. As "Member" boilers to a Building Management System (BMS) with multiple input control methods.
  4. Adaptive Modulation - Lowers the modulation rate of all currently operating boilers before a newly added boiler enters operation.

FIRE-TUBE CONDENSING BOILERS

5. Priority Firing - Allows mixing of condensing, non-condensing base load and/or other combination of (2) functional boiler types utilizing (2) priority levels.
  6. Available priority start/stop qualifiers shall be done using any combination of: Modulation Percentage, Outdoor Air Temperature or Return Water Temperature.
  7. Base Loading - Provides the ability to control (1) base load boiler with enable/disable and 4-20mA modulating signal (if required).
- C. Each boiler controller in the boiler system shall have the following features:
1. Digital communications: boiler to boiler.
  2. Analog 4-20 and 0-10 vdc is supported.
  3. Distributed control using protocol for up to 16 total boilers.
  4. English text display.
  5. Interlock, Event, and System logging with a time stamp.
  6. Advanced PID algorithm optimized for FlexCore boilers.
  7. Four dedicated temperature sensor inputs for: Outside Air Temperature, Supply (Outlet Temperature, Return Temperature (Inlet)), and Header Temperature.
  8. Automatically detects the optional temperature sensors on startup.
  9. Touch Screen Display.
  10. (8) Dedicated 24vac interlock monitors and 8 dedicated 120vac system monitors used for diagnostics and providing feedback of faults and system status.
  11. Multiple boiler pump or motorized boiler valve control modes.
  12. Combustion Air Damper control with proof time.
  13. Optional USB/RS485 network plug-in to allow firmware updates or custom configurations.
  14. Optional BACnet, LONWORKS and N2 interface.
  15. Alarm contacts.
  16. Runtime hours.
  17. Outdoor Air Reset with programmable ratio.
  18. Time of Day clock to provide up to four (4) night setback temperatures.
  19. Failsafe mode when a Building Management System (BMS) is controlling set point. If communications are lost, the boiler/ system shall run off the Local Set point.
  20. Support for domestic hot water (DHW) using a 10k sensor or a dry contact input from a tank thermostat and a domestic hot water relay (pump/valve).
  21. Continuous Daily Runtime Restart feature that monitors the runtime of each boiler and if any in the network have exceeded the maximum hours of continuous runtime, the boiler will restart to protect the UV flame scanner.
  22. Allows for selection of any boiler in the network to act as Lead Boiler.
  23. Adaptive Modulation feature in which the Master boiler adjusts the system modulation rate to a lower value when a new boiler in the network is started to compensate for the added BTU's to the system. Once the newly added boiler fires and the adjustable time expire, the Master resumes control of the system modulation to maintain set-point temperature.
  24. Priority firing - Allows mixing of condensing and non-condensing, base load and/or other combination of (2) functional boiler types utilizing (2) priority levels.
  25. Available priority start/stop qualifiers shall be done using any combination of: A) modulation percentage, B) outdoor air temperature, (or) C) return water temperature.
  26. Base Loading - Provides the ability to control (1) base load boiler with enable/disable and 4-20mA modulating signal (if required).
  27. Boiler(s) to be equipped with an integral web-based monitoring system. The monitoring system shall provide an email or SMS text message notification upon detecting an out of tolerance condition. The integrated monitoring system shall provide a web portal with performance dashboard displaying key data points for the system and each boiler in the system. The portal shall provide the following capabilities:
    - a. Detailed status of data points and system set-points
    - b. Boiler and System runtime and cycle count

- c. Intelligent diagnostics and troubleshooting guide
- d. Provide original factory test data including as built bill of materials
- e. The ability to enter field service records with file upload capabilities
- f. The ability to view time stamped history of data points and settings
- g. The ability to view detailed event log entries
- h. Video tutorials explaining each section of the web portal.
- i. The monitoring system shall have the capability of connecting directly to a 10/100mbps TCP/IP network. Optionally when a facility network connection is not available the system shall be capable of utilizing wireless cellular network. The monitoring system shall utilize a non-public proprietary data encryption algorithm. Secure data transmission shall be directly to the cloud from control system without third party integration

## 2.6 BOILER INTAKE AND VENTING

- A. Provide exhaust vents meeting UL listing for use with Category III and IV appliances and compatible with operating temperatures up to 480°F, positive pressure, condensing flue gas service. UL listed vents of A1 29-4C stainless steel must be used with boilers. Provide all required venting to provide a complete and fully functional operating system.
- B. Combustion-Air Intake: Boilers shall be capable of drawing combustion air from the outdoors via a metal or PVC duct connected between the boiler and the outdoors.

## 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. Boiler locations indicated on Drawings are approximate. Determine exact locations before roughing-in for flue, piping, controls, and electrical connections. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 BOILER INSTALLATION

- A. The installing Contractor is required to complete the PA Department of Labor and Industry form LIBI-302, "Intent to Install Boiler." When submitting the form, the installing contractor shall include all required fees and provide the owner with (3) copies of the submitted forms. The forms are available at the L and I website.
- B. The installation is required to conform to all clearance requirements required by the PA Department of Labor and Industry. The installer is required to verify the completed installation will meet the clearance requirements. Should a clearance issue be encountered the installer is required to advise the engineer of the problem prior to completing the installation. The installer will be responsible for correcting clearance issues found after the installation is complete at no additional cost.
- C. Provide emergency shut-off switches at each exit from the Boiler Room per the requirements of the PA Department of Labor and Industry.
- D. Boiler Mounting: Install boilers on cast-in-place concrete equipment base. Coordinate sizes and locations of concrete bases with actual equipment provided. Construct concrete bases 6 inches high and extend base not less than 6 inches in all directions beyond the maximum dimensions of boiler. Install dowel rods

FIRE-TUBE CONDENSING BOILERS

to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base. Anchor boiler per manufacturer's installation instructions.

- E. Install gas-fired boilers according to NFPA 54.
- F. Assemble and install all boiler trim. Install all required electrical devices furnished with boiler but not specified to be factory mounted. Install control wiring to field-mounted electrical devices.

### 3.3 CONNECTIONS

- A. Where installing supply and return piping and all accessories in the area of the boiler(s), allow space for service and maintenance and clearances as required by PA Labor and Industry.
- B. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties. 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.
- D. Connect piping to boilers, except safety relief valve connections, with flexible connectors of materials suitable for service.
- E. Connect gas piping to boiler gas-train inlet with union. Piping shall be at least full size of gas train connection. Provide gas-train venting per FM or IRI recommendations depending on the Gas Train specified in Part 2.
- F. Connect hot-water piping to supply- and return-boiler tapplings with shutoff valve and union or flange at each connection.
- G. Install piping from safety relief valves to nearest floor drain. Piping shall be installed to avoid tripping hazards.
- H. Install condensate neutralization trap. Install piping from condensate drain piping from boiler to neutralization trap, then to nearest floor drain. Piping shall be installed to avoid tripping hazards.
- I. Boiler Venting: Provide all required venting as indicated on the drawings.

### 3.4 START-UP, TRAINING AND DEMONSTRATION

- A. Provide the services of a factory trained representative for boiler start-up. Start-up procedures are to conform to the requirements of the boiler manufacturer. Initial startup is required to be performed before the date of substantial completion for the project. The start-up to include verification the boiler system including the isolation control valves and system pumps are operating as required.
- B. Provide additional start-up services, after initial start-up, when outdoor weather conditions are such that sufficient heating load is present.
- C. Provide training and demonstration services to the owner's representative. The training will be on-site and consist of a minimum of two visits for a minimum duration of 4 hours. Schedule training through the owner providing a minimum of 40 hours' notice.

FIRE-TUBE CONDENSING BOILERS

- D. The contractor shall provide reports, to the Owner's representative, one after completion of initial startup, another after completion of the additional startup service and a third report after training and demonstration is completed.

END OF SECTION 23 52 70