

## PFC-2000 Condensing Hot Water Boiler Specification

### 1: GENERAL

#### 1.1 SUMMARY

- A. This section includes condensing hot water boiler(s) for indoor space-heating applications.

#### 1.2 REFERENCES

- A. Intertek (ETL)
1. Certified to UL 795/CGA 3.1 Standards for Commercial-Industrial Gas Heating Equipment
  2. Certified to ANSI Z21.13/ CSA 4.9 Standards for Gas-Fired Low Pressure Steam And Hot Water Boilers
- B. American Society of Mechanical Engineers:
1. ASME Section IV - Boiler and Pressure Vessel Code - Heating Boilers
  2. ASME CSD-1 – Controls and Safety Devices for Automatically Fired Boilers
- C. American Society of Heating, Refrigeration and Air Conditioning Engineers
1. ASHRAE: Standard 90.1 Energy Standard for Buildings
- D. Hydronics Institute, Division of Air Conditioning, Heating & Refrigeration Institute (AHRI):
1. AHRI1500: Testing Standard to Determine Efficiency of Commercial Space Heating Boilers as defined by Department of Energy in 10 CFR Part 431.
- E. National Fire Protection Association:
1. NFPA 54 - National Fuel Gas Code (ANSI Z223.1)
- F. Relevant Local & Project Standards:

### 1.3 SUBMITTALS

- A. In accordance with Contract Documents. Minimum product data to include:
  - 1. Capacities, accessories and options included with boiler.
  - 2. General layout, dimensions, size and location of all required connections.
  - 3. Electrical characteristics
  - 4. Weight and mounting loads.
  - 5. Manufacturer's installation and start-up instructions.
  - 6. Equipment Operation and Maintenance Manuals.

### 1.4 QUALITY ASSURANCE

- A. Use an adequate number of skilled workers, trained and experienced in the necessary crafts, and who are completely familiar with the specified requirements, pertinent contract documents, and methods needed for proper performance of the work described therein.
- B. Provide the services of a manufacturer's factory-authorized representative to inspect and verify proper installation of this equipment, and to provide equipment start-up and operator training.

### 1.5 DELIVERY, STORAGE, AND HANDLING

- A. In accordance with Contract Documents.
- B. Accept equipment and accessories in Factory shipping packaging. Inspect for damage. Keep boiler in a horizontal position from time of delivery to final installation.
- C. While stored, all equipment must be protected from external elements such as inclement weather, job site construction activity, etc. Protect equipment from damage by leaving packaging in place until installation.

### 1.6 WARRANTY

- A. The boiler shall come with the warranties stated below from date of original installation.
  - 1. Heat Exchanger: 10-year pro-rated warranty.
  - 2. All other parts: 1-year limited warranty

## **PART 2: PRODUCTS**

### **2.1 ACCEPTABLE MANUFACTURERS**

- A. Peerless® PureFire® Commercial Condensing Boiler, Model PFC-2000.
- B. Refer to the Equipment Schedule in the Contract Drawings for the specific design and performance criteria.
- C. It shall be the responsibility of the Contractor to ensure that any substituted equipment is equivalent in fit, form and function to the specified equipment. The cost of any additional work caused by the substitution of equipment shall be borne by the Contractor.
- D. Or approved equal.

### **2.2 GENERAL REQUIREMENTS**

- A. Boiler
  - 1. The boiler shall be assembled, firetested and shipped as a factory-packaged unit, complete with jacket, gas manifold, burner and controls mounted & wired, with boiler connections specified in this Section.
  - 2. The boiler shall be constructed in conformance to ASME Section IV, ASME CSD-1 and UL 795. The boiler shall bear the ASME "H" stamp with a maximum allowable working pressure (MAWP) of 160 PSI. Pressure vessel shall be subjected to a hydrostatic pressure test of 240 PSIG at the factory.
  - 3. The boiler shall be an ultra-high efficiency condensing boiler with a pressure vessel, constructed of 316L stainless steel and of water tube design, which shall not require a refractory combustion chamber. Pressure vessel shall have a minimum heat transfer area of 153 square feet. Pressure vessel shall be capable of handling water flow rates between 71 gpm and 194 gpm. Refer to the Flow and Pressure Drop Table for the waterside pressure loss and flow rate for a given temperature difference between the supply and return water temperatures.

<b>FLOW AND PRESSURE DROP TABLE: PFC-2000</b>								
<b>Δ T (°F)</b>	20	25	30	35	40	45	50	55
<b>Flow (GPM)</b>	194	155	129	111	97	86	80	71
<b>Δ P (Ft. of Head)</b>	19.7	13.9	10.5	8.2	6.7	5.6	4.7	4.1

4. The boiler shall be equipped with an integral pre-mix, stainless steel forced draft burner for:
  - i. Fuel: **Natural Gas / Propane**Firing incorporates full modulation with 5:1 turndown. The burner shall be of high flame retention design and have a static swirl device to get uniform flame stability all around the combustion surface. Burner shall be equipped with a sliding guide rail with hinged door to gain full access and inspection of the burner and combustion chamber.
5. The boiler gas valve will be designed with zero pressure regulation and equipped with a variable speed blower system to precisely control the fuel/air mixture, providing fully modulating firing rates for maximum efficiency.
6. Water connections shall be located at the top of the boiler; flue gas exhaust, combustion air intake and condensate drain connections shall be located in the rear of the boiler and incoming gas connection shall be located on the left side of the boiler. A factory supplied oversized ASME relief valve shall be provided with the boiler(s).
7. The flue passages and combustion chamber shall be accessible from the front of the boiler for cleaning.
8. The boiler shall be provided with a heavy duty 16 gauge steel jacket with a rust resistant powder coat finish. Jackets made of plastic or resin material shall not be acceptable. The boiler jacket shall contain an internal electrical cabinet for power and limit circuit wiring, providing a clean finished look when the jacket is installed. Electrical connections shall be accessible from top side of the boiler on six (6) printed circuited boards (120VAC high and 24VAC/5VDC low voltage) with fused connections for protection and clear labeling for simple and accurate wiring.
  - a. The electrical components shall be separated from incoming combustion air gas, which may contain excess humidity, dust and other contaminants brought through ducted combustion air.
9. A polypropylene condensate trap with a float-actuated shut-off switch shall be supplied with the boiler.
10. Electrical input to the boiler shall be:
  - a. Voltage: **120 V / 208 V / 240 V / 480 V**
  - b. Phase: **1ph 60hz / 3ph 60hz**
11. The boiler shall be of compact design with no more than 48.1 cubic ft. and a footprint no larger than 15.8 sq. ft.
12. The boiler shall be of low profile type to allow the boilers to be stacked on a stand less than 120" in overall height.
13. Boiler shall be capable of variable primary or primary/secondary piping arrangements.
14. The boiler shall come on a base with forklift opening all sides and lifting lugs for ease of moving and rigging.

B. Boiler Control System

1. Scope of Supply

Boiler Control System shall provide safety interlocks and water temperature control. The control system shall be fully integrated into the boiler control cabinet and incorporate single and multiple boiler control logic, inputs, outputs and communication interfaces. The control system shall coordinate the operation of up to eight (8) fully modulating hot water boilers and circulation pumps. The control system shall simply control boiler modulation and on/off outputs based on the boiler water supply temperature and an operator-adjusted setpoint. However, using parameter menu selections, the control system shall allow the boiler to respond to remote system water temperature and outside air temperatures with domestic hot water priority (DHWP) and warm weather shut down (WWSD) or energy management system (EMS) firing rate demand, remote setpoint or remote start/stop commands. In order to support large domestic demands it shall be parameter selectable to start two boilers simultaneously in response to a DHWP demand.

2. Boiler Control

Using PID (proportional-integral-derivative) based control, the remote system water temperature shall be compared with a setpoint to establish a target boiler firing rate. When the remote system temperature is near the boiler high limit temperature, the boiler supply sensor shall limit the maximum boiler supply temperature to prevent boiler high limit events. Alternately, using parameter menu selections, the control system shall allow the boiler to respond directly to boiler supply temperature and setpoint to establish a target boiler firing rate while remote system water temperature is used for display purposes only. Each boiler's fuel flow control valve shall be mechanically linked to the air flow control device to assure an air rich fuel/air ratio. All the automated logic required to ensure that pre-purge, post-purge, light-off, and burner modulation shall be provided.

3. Hot Water Temperature Setpoint

When the controller is in the local control mode, the control system shall establish the setpoint based on outside air temperature and a reset function curve or be manually adjusted by the operator. When enabled, the setpoint shall be adjusted above a preset minimum setpoint upon sensing a domestic hot water demand contact input. When in remote mode, the control system shall accept a 4-20mA\* or Modbus remote setpoint or firing rate demand signal from an external EMS.

**\*OPTIONAL:** 0-10VDC Available with EMS Signal Converter Kit

4. Multiple Boiler Sequence

The controller shall incorporate its peer-to-peer communications on each connected boiler (up to eight [8] units) by using standard RJ45 ethernet cables. The control system shall allow the connected boilers to exchange signals as required to provide coordinated fully modulating lead/lag functions. It shall not be required to wire individual control signals between boilers. Multiple boilers shall be modulated in "Unison" (all at the same firing rate). To increase operational efficiency, the control system shall utilize both water temperature and firing rate based boiler sequencing algorithms to start and stop the boilers and shall maximize the total number of boilers in operation. The control system shall start and stop boilers when the water temperature is outside the adjustable temperature limit for longer than the adjustable time delay. In order to minimize temperature deviations, the control system shall start and stop the next boiler when the "lead" boiler is at an adjustable firing rate limit for longer than the adjustable time delay. The control system shall monitor both boiler lockout and limit circuits to automatically skip over those boilers that are powered down for maintenance, tripped or otherwise will not start. The boiler shall be run at low fire for warm-up for a preset low fire hold time. When enabled, warm weather shut down control logic shall prevent boiler operation. The controller shall also be capable of auto-rotation of the boilers based on user-selected run time hours.

5. User Interface

A touch screen message display shall be provided to display real time fan speed modulation, numeric data, startup and shutdown sequence status, alarm, system diagnostic, first-out messages, and boiler historical information. In the event of a fault condition, the display shall provide help screens to determine the cause of the problem and corrective actions. Historical information shall include graphical trends, lockout history, boiler & circulator cycle counts and run time hours.

6. Circulator Control

The controller shall be capable of sequencing the boiler, domestic hot water or system circulators. Simple parameter selections shall allow all three pumps to respond properly to various hydronic piping arrangements including either a boiler or primary piped indirect water heater. The controller shall perform circulator exercise to help prevent pump rotor seizing.

7. EMS Communication

Control and monitor the boiler via communication RS485 Modbus or direct wiring. The control shall allow for simultaneous communication for boiler peer-to-peer communication and EMS communication interfaces. Loss of EMS communication shall automatically transfer the boiler control to local operation. Boiler operation shall not be lost due to corrupt or loss of EMS communication. The boiler control system shall allow individual boiler limits, lockout, boiler and system temperatures and firing rate status to be readable and water setpoint, boiler firing rate, and start/stop command to be readable and writable. The control shall provide easy parameter selection and options for the following: Modulation Source (4-20mA\* or Modbus); Setpoint Source (4-20mA\* or Modbus); and Enable/Disable (contact wired or Modbus). The control shall allow a real time, live & convenient list of all interface signals to allow for quick interface verification.

\***OPTIONAL**: 0-10VDC Available with EMS Signal Converter Kit

\*\***OPTIONAL**: Communication gateway: The boiler control system shall network with a communication gateway to connect with **BACnet / LonWorks**

8. Archive History

All hard lockouts, sensor faults, Energy Management System (EMS) signal faults, sequencer faults and limit string faults shall be recorded with a time and date stamp. The time and date log shall stores up to 3000 alarm & events even after power cycle. Screenshots must be downloadable to a USB thumb drive. The control shall include collect and store supply & return temperature, flame intensity and firing rate for at least 4 months. It shall be a simple matter to page through the boiler's operation using the boiler mounted display or download screenshots to a USB thumb drive for off-site analysis.

9. Quality Assurance

The boiler control system shall be supplied as part of a factory-assembled and tested burner control cabinet.

C. Boiler Trim

1. Combination pressure-temperature gauge, 3-1/2 inch diameter.
2. Supply and return temperature sensors - shall be mounted on the supply and return connections outside of the boiler jacket. Each sensor shall be accessible from the top of the boiler. The boiler control shall measure supply and return temperatures and notify the operator if the direction of flow is reversed.
  - a. The boiler control shall adjust to impending temperature changes in such a way to minimize fuel consumption and maximize efficiency. The control shall measure temperatures and the rate of change in those temperatures and respond early, rather than waiting for temperatures to exceed limit control settings.
3. Flue gas temperature sensor shall be mounted in the flue vent connector to monitor flue gas temperatures and reduce the blower speed when flue gas temperatures exceed 189°F. If the flue temperatures exceed 195°F, a forced boiler recycle results.
4. ASME Section IV safety relief valve sized to exceed the gross output of the boiler which shall be factory set to relieve pressure at:
  - a. Safety Relief Valve Pressure (psig): **30 / 50 / 60 / 75 / 100 / 125 / 150**
5. Water flow switch to prevent the burner operation during low water flow conditions.
6. High Temperature Limit, automatic and manual reset, to prevent burner operation if water temperature conditions rise above maximum boiler design temperature, wired to put the boiler into a hard lockout, requiring manual reset of the boiler primary control.
7. High and low gas pressure switches with manual reset and a range of 4 - 14 in W.C., wired to put the boiler into a hard lockout, requiring manual reset of the boiler primary control.
8. Low water cutoff (LWCO) device with manual reset. Boiler shall be fitted with a probe type LWCO located above the lowest safe permissible water level established by the boiler manufacturer. LWCO shall be UL listed and suitable for commercial hydronic heating service.



D. Vent & Intake Air Connections

1. The exhaust vent must be UL 1738 listed for use with Category II and IV appliances and compatible with operating temperatures up to 210°F, positive pressure, condensing flue gas service. UL certified vent material shall be CPVC, Polypropylene or Stainless Steel.
2. The exhaust vent system shall be in accordance with National Fuel Code, NFPA 54/ANSI Z221.3 or CAN/CSA B149.1 Installation Code for Canada, or, applicable provisions of local building codes.
3. Combustion air intake shall be capable of drawing air from inside the room or ducted from outdoors. Ducted piping shall be PVC or galvanized smoke pipe that is sealed and pressure tight. Pipe must be at least the same size as the inlet air connection on the boiler.
4. Combustion air intake shall be connected into the boiler vestibule NOT directly into the boiler blower assembly. Combustion air shall be preheated by passing around the exterior of the boiler furnace section before entering the pre-mix gas/air assembly.
5. Boiler shall be capable of common venting with an engineered vent system.
6. Venting shall have an equivalent length of up to 200 feet maximum when drawing air from inside the room or Venting shall have an equivalent length of up to 100 feet maximum and ducted combustion intake air shall have an equivalent length of up to 100 feet maximum.

2.3 PERFORMANCE

- A. Boiler thermal efficiency shall be certified with no less than 97.0%.
- B. The burner shall emit low NO<sub>x</sub> (corrected to 3% O<sub>2</sub>) emissions at all firing rates.
- C. Provide services of a manufacturer's authorized representative to perform combustion test including boiler firing rate, gas flow rate, heat input, burner manifold gas pressure, percent carbon monoxide, percent oxygen, percent excess air, flue gas temperature at outlet, ambient temperature, net stack temperature, percent stack loss, percent combustion efficiency, and heat output. Perform test at minimum, mid-range, and high fire.

## **PART 3: EXECUTION**

### **3.1 INSTALLATION**

- A. In accordance with Contract Documents and boiler manufacturer's printed instructions.
- B. Flush and clean the boiler upon completion of installation in accordance with manufacturer's start-up instructions. The boiler must be isolated when any cleaning or testing of system piping is being performed.
- C. Install skid plumb and level, to plus or minus 1/16 inch over base.
- D. Maintain manufacturer's recommended clearances around and over equipment, and as required by local Code.
- E. Arrange all electrical conduit, piping, exhaust vent, and air intake with clearances for burner removal and service of all equipment.
- F. Connect exhaust vent to boiler vent connection.
- G. If shown in Contract Drawings, connect full sized air inlet vent to flanged connector on boiler.
- H. Connect fuel piping in accordance with NFPA 54. Pipe size to be the same, or greater, than the gas train inlet connection.
- I. Use full size (minimum) pipe/tubing on all gas vent connections.
- J. Connect water piping, full size, to supply and return connections.
- K. Install all piping accessories per the details on the contract drawings.
- L. Install discharge piping from relief valves (open termination for viewing) and all drains to nearest floor drain.
- M. Provide necessary water treatment to satisfy manufacturer's specified water quality limits.