

1.5-3 MMBTU CFR Boiler Series with Edge Control

SECTION 235239 – FIRE TUBE BOILERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the contract apply to this section, including General and Supplementary Conditions and Division 01 Specification Sections.

1.2 SUMMARY

- A. This section includes packaged, factory-fabricated and assembled, gas-fired, fire tube boilers, trim and accessories for generating hot water.

1.3 SUBMITTALS

- A. Product Data: Include performance data, operating characteristics, furnished specialties and accessories.
 - 1. Prior to flue vent installation, engineered calculations and drawings must be submitted to Architect/Engineer to thoroughly demonstrate that size and configuration conform to recommended size, length and footprint for each submitted boiler.
- C. Pressure Drop Curve. Submit pressure drop curve for the following flow ranges per designated capacities below
 - 1. 1500 MBH: 25 - 250 GPM
3000 MBH: 25 - 350 GPM
- D. Shop Drawings: For boilers, boiler trim and accessories include:
 - 1. Plans, elevations, sections, details and attachments to other work
 - 2. Wiring Diagrams for power, signal and control wiring
- E. Source Quality Control Test Reports: Reports shall be included in submittals.
- F. Field Quality Control Test Reports: Reports shall be included in submittals.
- G. Operation and Maintenance Data: Data to be included in boiler emergency, operation and maintenance manuals.
- H. Warranty: Standard warranty specified in this section
- I. Other Informational Submittals:

1. ASME Stamp Certification and Report: Submit "H" stamp certificate of authorization, as required by authorities having jurisdiction, and document hydrostatic testing of piping external to boiler.

1.4 QUALITY ASSURANCE

- A. Manufacturer Qualifications: The manufacturer must have been regularly engaged in the manufacture of high-efficiency hydronic boilers for not less than thirty (30) years. The manufacturer must be headquartered in North America and manufacture pressure vessels 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.
- B. Electrical Components, Devices and Accessories: Boilers must be listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- D. ASME Compliance: Boilers must be constructed in accordance with ASME Boiler and Pressure Vessel Code, Section IV "Heating Boilers".
- E. ASHRAE/IESNA 90.1 Compliance: Boilers shall have minimum efficiency according to "Gas and Oil Fired Boilers - Minimum Efficiency Requirements."
- F. DOE Compliance (CFR 3000): Minimum efficiency shall comply with 10 CFR 431, Subpart E, Appendix A to Subpart E of Part 431, "Uniform Test Method for the Measurement of Thermal Efficiency and Combustion Efficiency of Commercial Packaged Boilers."
- G. UL Compliance (CFR 3000): Boilers must be tested 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.
- H. NO_x Emission Standards: When installed and operated in accordance with manufacturer's instructions, the following boiler models shall comply with the NO_x emission standards outlined in South Coast Air Quality Management District (SCAQMD), Rule 1146.2 or the NO_x emissions referenced below:
 - CFR1500: 20 ppm NO_x corrected to 3% oxygen at all firing rates when firing on natural gas
 - CFR-3000: 20 ppm NO_x corrected to 3% oxygen at all firing rates when firing on natural gas

1.5 COORDINATION

- A. Coordinate size and location of concrete bases. Anchor unit to concrete base. Concrete, reinforcement and formwork requirements are specified in Division 03.

1.6 WARRANTY

- A. 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.
 - 1. Limited Warranty Period for Fire Tube Boilers
 - a. The pressure vessel/heat exchanger shall carry a 10-year from shipment, non-prorated, limited warranty against any failure due to condensate corrosion, thermal stress, mechanical defects or workmanship.
 - b. The pressure vessel is warranted against failure due to thermal shock for 20 years from date of shipment.
 - c. The burner shall be conditionally guaranteed against any failure for (5) five years from shipment.
 - d. Manufacturer labeled control panels are conditionally warranted against failure for (2) two years from shipment.
 - e. All other components, with the exception of the igniter and flame detector, are conditionally guaranteed against any failure for 18 months from shipment.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. This specification is based on the CFR Series boilers that are fitted with Edge control as manufactured by AERCO International Inc. Equivalent units and manufacturers must meet all performance criteria and will be considered upon prior approval.
- B. Basis-of-Design Product: Subject to compliance with requirements, provide AERCO International, CFR Series Boiler with Edge control:
 - 1. CFR 1500 and 3000 (1,500,000 and 3,000,000 BTU/hr input)
 - 2. Approved Equals:
 - a. Burnham C Series Fire Tube Boilers
 - b. Burnham 4FH Series Fire Tube Boilers
 - c. Request for substitutions will be considered in accordance with provisions of Section 235239 – Fire Tube Boilers, in writing no less than 30 days prior to bid date.
 - d. Note: Water tube boilers are not permitted without written approval. Request and written approval must be submitted and obtained 14 days prior to bid date.

2.2 CONSTRUCTION

- A. Description: Boiler shall be natural gas fired, fire tube design. It shall be designed to operate in variable primary or primary secondary piping configuration. Power burner shall be modulating, discharge into a negative pressure vent and the minimum firing rate shall not exceed the following per model:

- CFR1500: 500,000 BTU/hr input
- CFR3000: 1,000,000 BTU/hr input

Boilers that have an input greater than what is specified above at minimum fire will not be considered. Boiler efficiency shall increase with decreasing load (output), while maintaining setpoint. Boiler shall be factory-fabricated, factory-assembled and factory-tested, fire tube boiler with heat exchanger sealed pressure-tight, built on a steel base, including insulated jacket, flue-gas vent connections, combustion-air intake connections, water supply, condensate drain connections, and controls.

- B. Heat Exchanger: The heat exchanger shall be constructed of 439 stainless steel fire tubes and tube sheets, with a one-pass combustion gas flow design. The fire tubes shall be 3/4" or 5/8" OD, with no less than 0.049" wall thickness. The upper and lower stainless steel tube sheet shall be no less than 0.25" thick. The pressure vessel/heat exchanger shall be welded construction. The heat exchanger shall be ASME stamped for a working pressure not less than 160 psig. Access to the tube sheets and heat exchanger shall be available by burner and exhaust manifold removal. Minimum access opening shall be no less than 8-inch diameter.
- C. Pressure Vessel: The pressure vessel shall have a maximum water volume per each model as listed below:
- CFR1500: 45 gallons
 - CFR3000: 61 gallons

The boiler water pressure drop shall not exceed the following per model size:

- CFR1500: 3 psig @ 170 gpm
- CFR3000: 1.5 psig @ 200 gpm

The boiler water connections shall be flanged 150-pound, ANSI rated.

- CFR1500 - 3000: 4-inch flange

The pressure vessel shall be constructed of ASME SA53 carbon steel, with a 0.25 inch thick wall and 0.50 inch thick upper head. Inspection openings in the pressure vessel shall be in accordance with ASME Section IV pressure vessel code. The boiler shall be designed so that the thermal efficiency increases as the boiler firing rate decreases.

- E. Modulating Air/Fuel Valve and Burner: The boiler burner shall be capable of the following firing turndown ratios without loss of combustion efficiency or staging of gas valves. The turndown ratios shall be as follows and are based on BTU size:
- CFR1500: 3:1
 - CFR3000: 3:1

The burner shall not operate above 5.5% oxygen level or 55% excess air. The burner shall produce less than 20 ppm of NO_x, under standard calibration, corrected to 3% excess oxygen when firing on natural gas. The burner shall be metal-fiber mesh covering a stainless steel body with spark or proven pilot ignition and flame rectification. All burner material exposed to the combustion zone shall be of stainless steel construction. There

shall be no moving parts within the burner itself. A modulating air/fuel valve shall meter the air and fuel input. The modulating motor must be linked to both the gas valve body and air valve body with a single linkage. The linkage shall not require any field adjustment. A variable speed cast aluminum pre-mix blower shall be used to ensure the optimum mixing of air and fuel between the air/fuel valve and the burner.

- F. Fuel: The boiler shall be natural gas fired. The gas train shall be a ventless gas train and specifically designed and calibrated for natural gas fuel.
- G. Minimum boiler thermal efficiencies shall be 86% in compliance with AHRI-1500.

- H. Exhaust Manifold: The exhaust manifold shall be of corrosion resistant cast aluminum or 316 stainless steel. The exhaust manifold shall have a collecting reservoir and a gravity drain for the elimination of condensation.

The following choices of vent increaser diameter shall be factory supplied and field installed.

1. 8" x 10"
2. 8" x 18"

The exhaust manifold shall have a collecting reservoir and a gravity drain for the elimination of condensation.

- I. Blower: The boiler shall include a variable-speed, DC centrifugal fan to operate during the burner firing sequence and pre-purge the combustion chamber.
 - 1. Motors: Blower motors shall comply with requirements specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."
 - a. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require a motor to operate in the service factor range above 1.0.
- J. Ignition: Ignition shall be via spark or proven pilot ignition with 100 percent main-valve shutoff and electronic flame supervision
- K. Combustion Air: The boiler shall be designed such that the combustion air is drawn from the inside of the boiler enclosure, decoupling it from the combustion air supply and preheating the air to increase efficiency.
- L. Combustion Air Filter: The boiler shall be equipped with an automotive high flow air filter to ensure efficient combustion and unhindered burner components operation.
- M. Enclosure: The sheet metal enclosure shall be fully removable, allowing for easy access during servicing.

2.3 CONTROLS

- A. The boiler shall have an integrated boiler control that is capable of operating the boiler and associated accessories including but not limited to: its pumps, valves and dampers.

1. The control shall have a 5-inch color touch screen display as well as five function buttons that are separate from the display. User shall have the ability to navigate the menus via touchscreen or navigation buttons. Controls not equipped with navigation button options shall not be permitted.
 2. The control shall be equipped with a multi-color linear LED light to indicate the level of firing and/or air/fuel valve position.
 3. The control shall display two temperatures using two dedicated three-digit seven-segment displays.
 4. The control shall offer an Enable/Disable toggle switch as well as two buttons for Testing and Resetting the Low Water Cutoff.
- B. The Manager designated boiler control shall be capable of the following functions without the need for additional external controls:
1. Sequence up to 16 boilers,
 2. Control boiler variable speed or single speed pumps and/or modulating motorized valves,
 3. Operate or modulate a variable or single speed system pump or rotate two system pumps,
 4. Control and communicate with up to 6 SmartPlate domestic water heaters and their boiler water pump,
 5. The control shall connect to other plant boiler controls using RS485 and communicate using Modbus protocol.
- C. The control system shall be segregated into three components: "Edge" Control Panel, Power Panel and Input/Output Connection Box. The entire system shall be Underwriters Laboratories recognized.
- D. The control panel shall consist of seven individual circuit boards using surface-mount technology in a single enclosure. Each board shall be individually field replaceable. These circuit boards shall include:
1. A microcontroller board with integrated 5-inch touchscreen color display providing the user interface.
 2. A 7-segment display board. This board includes two 3-digit 7-segment displays. These displays shall be used to view a variety of temperature sensor values and operating and startup function status.
 3. An Interface board connects the microcontroller board to internal components using ribbon cables.
 4. An electric low-water cutoff board connects to the test and manual reset functions on the microcontroller board.
 5. A power supply board is designed to provide the different DC voltages to the rest of the boards. It also acts as voltage regulator and reduce power noise.
 6. An ignition and combustion board. This board controls the air/fuel valve and Safety Shutoff Valve, flame status and ignition transformer
 7. A connector board used to connect all external electrical connection.
- E. Stack Guard Sensor: The control shall include a stack guard sensor in the vent starter section to monitor and maintain flue temperatures above dewpoint, preventing condensation in the venting.

- F. Domestic Priority (Temperature Boost): The control panel shall be capable of increasing the setpoint when a domestic load is sensed via an aquastat or sensor. Once the domestic load is satisfied, the control panel will revert back to the original setpoint.
- G. System Pump lead/lag rotation: The control shall be capable of operating two system pumps. It shall rotate the lead pump based on user time setting. The use of an external pump lead-lag control shall not be permitted unless function is performed by building management system.
- H. Variable Speed Pump: The control shall be capable of modulating a variable speed pump. It shall modulate the pump based on the boiler firing rate or the boiler plant firing rate on a primary secondary piping application.
- I. Minimum number of boiler plant open valves: The control shall manage the minimum number of boiler motorized valves to reduce variable speed pump flow and energy used. The control shall offer a setting to control the number of valves open during low load and standby operation. Manufacturers without this feature shall offer additional pump controller and a smaller single speed pump to run during the low load and standby periods.
- J. Control settings transfer using USB: The control shall simplify and significantly lessen startup and boiler setting time by being able to use a USB flash drive to copy settings from one boiler to another boiler. Installers shall use successfully preconfigured boiler settings in their portfolio to newly installed boilers.
- K. Combustion calibration: The control shall offer at least 5 calibration points. The use of less than 5 calibration points is not permitted to improve overall system efficiency under all firing rates. Each combustion calibration point shall operate with 5 to 7% O₂ levels to improve operating efficiency. Deviating away from these values shall not be acceptable.
- L. Building Automation: The control shall be able to communicate to Building Management Systems using BACnet and Modbus without the use of external gateways. The control shall be able to communicate over each of the two protocols using IP as well as RS485. The use of external gateways is not acceptable. The control shall be able to communicate to the building management system using:
 - 1. BACnet MS/TP and BACnet IP/Ethernet. When communicating over BACnet IP, the control shall offer an additional layer of IP security by mapping all control BACnet IP communication to the BACnet server's IP and MAC addresses. Not having this level of security shall deem the IP communication insecure and shall not be acceptable.
 - 2. Modbus RTU and Modbus IP.
- M. Unit and Plant Status: The control shall provide a quick view of the unit status and plant status.
 - 1. The unit status screen shall provide temperature setpoint, all water inlet and outlet and supply air and exhaust temperature sensor values. It shall also provide unit current and target firing rates. Additional screens shall display unit run hours, cycle count and average cycles per hour.
 - 2. The plant status screens shall provide plant temperature setpoint, plant water supply temperature, outdoor temperature and domestic hot water setpoint and current temperatures. Additionally, a status screen shall show the boiler status of each plant unit, plant firing rate.

3. Unit and Plant event history: The manager control shall display the last 500 historical events per plant or 200 historical events for single unit installations.
- N. Software update: The control shall be capable of field software updates without a need for hardware component(s) replacement. This shall be performed either using software on a USB flash drive or via Internet connection. The software update mechanism shall be performed by a trained technician. The software update menus shall be secured using a password level. After the software update, the control shall retain all of its prior field settings.
- O. Copy settings from one boiler to the other: To significantly reduce installation time by reducing long repetitive work, the control shall have the capability of saving its settings to a USB flash drive. In addition, the control shall have the ability of copying new settings from a flash drive.
- P. Programmable Inputs and Outputs: The control shall be equipped with multiple relay and analog output and dry contact and analog input. Each shall be field programmable to meet installation needs. The following I/O options shall be available:
1. Relay outputs: There shall be two output relays that are programmable. The following relay functions shall be selectable:
 - a. System Pump
 - b. Damper
 - c. Louver
 2. Inputs and interlocks: The following control functions shall be available:
 - a. Damper end switch input
 - b. Louver end switch input
 3. Analog output: There shall be an analog output that can be used to monitor Fire Rate
 4. Analog input: There shall be an analog input that can be used for domestic boiler remote setpoint.
- Q. Backup boiler: The control shall be able to operate a lower efficiency back up boiler during peak periods when main plant boilers are at or close to peak load.
- R. Communication with SmartPlate: The control shall be capable of controlling and monitoring one or multiple plate heat exchanger(s). It shall be able to:
1. Change the domestic hot water temperature setpoint and read its current temperatures.
 2. Monitor 3-way valve position.
 3. Control the operation of the domestic boiler water pump.
- S. The controls shall annunciate boiler and sensor status and include extensive self-diagnostic capabilities.
- T. The control panel shall incorporate:
1. Setpoint High Limit: Setpoint high limit allows for a selectable maximum boiler outlet temperature and acts as temperature limiting governor. Setpoint limit is based on a PID function that automatically limits firing rate to maintain outlet temperature within a 0 to 10 degree selectable band from the desired maximum boiler outlet temperature.
 2. Setpoint Low Limit: Allow for a selectable minimum operating temperature.

3. Failsafe Mode: Failsafe mode allows the boiler to switch its mode to operate from an internal setpoint if its external control signal is lost, rather than shut off. This is a selectable mode, enabling the controller to shut off the unit upon loss of external signal, if so desired.
- U. The boiler control system shall incorporate the following additional features for enhanced external system interface:
1. System start temperature feature
 2. Pump delay timer
 3. Auxiliary start delay timer
 4. Auxiliary temperature sensor
 5. Analog output feature to enable simple monitoring of fire rate
 6. Remote interlock circuit
 7. Delayed interlock circuit
 8. Delta-T Limiter
 9. Freeze protection
 10. Fault relay for remote fault alarm
 11. Warm-weather shutdown
 12. The control shall offer multi-level user security access using different passwords. For additional security, the passwords shall expire if control display was not touched for an extended period 30 minutes.
- V. Each boiler shall include an electric, single-seated combination safety shutoff valve/regulator with proof of closure switch in its gas train. Each boiler shall incorporate dual over-temperature protection with manual reset, in accordance with ASME Section IV and CSD-1.
- W. Each boiler shall have integrated Boiler Sequencing Technology (BST), capable of multi-unit sequencing with lead-lag functionality and parallel operation. The system will incorporate the following capabilities:
1. Efficiently sequence 2-to-16 units on the same system to meet load requirement.
 2. Integrated control and wiring for seamless installation of optional modulating motorized valve. When valves are utilized, the system shall operate one motorized valve per unit as an element of load sequencing. Valves shall close with decreased load as units turn off, with all valves open under no-load conditions.
 3. Automatically rotate lead/lag amongst the units on the chain and monitor run hours per unit and balance load in an effort to equalize run hours among active units.
 4. Option to manually designate lead and last boiler
 5. Designated manager control, used to display and adjust key system parameters.
 6. Automatic bump-less transfer of manager function to next unit on the chain in case of designated manager unit failure; manager/client status shall be shown on the individual unit displays.
- X. For boiler plants greater than 16 units, the Boiler Manufacturer shall supply as part of the boiler package a completely integrated AERCO Control System (ACS) to control all operation and energy input of the multiple boiler heating plant. The ACS shall be comprised of a microprocessor-based control utilizing the MODBUS protocol to communicate with the Boilers via the RS-485 port. One ACS controller shall have the ability to operate up to 32 AERCO boilers.

The controller shall have the ability to vary the firing rate and energy input of each individual boiler throughout its full modulating range to maximize the thermal efficiency output of the entire heating plant. The ACS shall control the boiler outlet header temperature within $\pm 2^{\circ}\text{F}$. The controller shall be a PID type controller and uses Ramp Up/Ramp Down control algorithm for accurate temperature control with excellent variable load response. The ACS controller shall provide contact closure for auxiliary equipment such as system pumps and combustion air inlet dampers based upon outdoor air temperature.

The ACS shall have the following anti-cycling features:

- Manual designation of lead boiler and last boiler.
- Lead boiler rotation at user-specified time interval.
- Delay the firing/shutting down of boilers when header temperature within a predefined dead band.

When set on Internal Setpoint Mode, temperature control setpoint on the ACS shall be field adjustable. When set on Indoor/Outdoor Reset Mode, the ACS will operate on an adjustable inverse ratio in response to outdoor temperature to control the main header temperature. Reset ratio shall be fully field adjustable from 0.3 to 3.0 in operation. When set on 4ma to 20ma Temperature Control Mode, the ACS will operate the plant to vary header temperature setpoint linearly as an externally applied 4-20 ma signal is supplied.

When set on MODBUS Temperature Control Mode, the ACS will operate the plant to vary header temperature setpoint as an external communication utilizing the MODBUS protocol is supplied via the RS-232 port. The ACS controller shall have a vacuum fluorescent display for monitoring of all sensors and interlocks. Non-volatile memory backup of all control parameters shall be internally provided as standard. The controller will automatically balance the sequence of operating time on each boiler by a first-on first-off mode and provide for setback and remote alarm contacts. Connection between central ACS system and individual boilers shall be twisted pair low voltage wiring, with the boilers 'daisy-chained' for ease of installation.

2.4 ELECTRICAL POWER

- A. Controllers, Electrical Devices and Wiring: Electrical devices and connections are specified in Division 26 sections.
- B. Single-Point Field Power Connection: Factory-installed and factory-wired switches, motor controllers, transformers and other electrical devices shall provide a single-point field power connection to the boiler.
- C. Electrical Characteristics:

Electrical Specifications	Models		
	CFR1500	CFR3000	CFR3000
Voltage	120 V	208 V	460 V
Phase	1	3	3
Frequency	60 Hz	60 Hz	60 Hz
Full Load Current	13-16 Amps	10-23 Amps	5-12Amps

2.5 VENTING

- A. The boiler shall be capable of venting in Category I/Type B venting material. When venting into interior masonry chimneys, refer and adhere to the latest publication of NFPA54 for chimney lining material, sizing, and termination requirements.
- B. The exhaust system shall be sized in accordance with the latest publication of National Fuel Gas Code (ANSI Z223.1/ NFPA54) as a fan-assisted Category I appliance.
- C. 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.
- D. The minimum ducted combustion air duct size for each boiler is six inch (CFR1500) or 8 inch (CFR3000)
- E. Common vent and common combustion air must be an available option for boiler installation. To improve system efficiency, multi-boiler system shall utilize sequencing logic with common venting as well as individual boiler venting configuration. Manufacturers not allowing parallel modulation for common shall not be acceptable. Consult manufacturer for common vent and combustion air sizing.
- F. Follow guidelines specified in manufacturer's venting guide.

2.6 SOURCE QUALITY CONTROL

- E. 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 testing.
- F. Test and inspect factory-assembled boilers, before shipping, according to ASME Boiler and Pressure Vessel Code.
 - 1. If boilers are not factory assembled and fire-tested, the local vendor is responsible for all field assembly and testing.
- G. Allow Owner access to source quality-control testing of boilers. Notify Architect fourteen days in advance of testing.

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 BOILER INSTALLATION

- A. 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.
- 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 Division 23 sections. Drawings indicate general arrangement of piping, fittings and specialties.
- B. Install piping adjacent to boiler to permit 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 gas piping to boiler gas-train inlet with unions. Piping shall be at least full size of gas train connection. Provide a reducer if required.
- E. Connect hot water piping to supply and return boiler tapings with shutoff valve and union or flange at each connection.
- F. Install piping from safety relief valves to nearest floor drain.
- G. Boiler Venting
 - 1. Vent starter piece provided by boiler manufacturer.
 - 2. Vent system. Vent system shall meet Category I venting requirements.
 - 3. B. Combustion-Air Intake: Complete system, stainless steel, pipe, vent terminal with screen, inlet air coupling, and sealant.
 - 4. Connect venting full size to boiler connections. [Comply with requirements in Division 23 Section "Breechings, Chimneys and Stacks."]
- H. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- I. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.

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

B. Tests and Inspections

1. Perform installation and startup checks according to manufacturer's written instructions.
2. Perform hydrostatic test. Repair leaks and retest until no leaks exist.
3. 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 setpoints and high- and low-limit safety setpoints of fuel supply, water level and water temperature.
 - b. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

C. Remove and replace malfunctioning units and retest as specified above.

D. Occupancy Adjustments: When requested within 2 months of date of Substantial Completion, provide on-site assistance adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other than normal occupancy hours for this purpose.

E. Performance Tests:

The boiler manufacturer is expected to provide partial load thermal efficiency curves. These thermal efficiency curves must include at least three separate curves at various BTU input levels. If these curves are not available, it is the responsibility of the boiler manufacturer to complete the following 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 and 100 percent of full capacity. Determine efficiency at each test point.
4. Repeat tests until results comply with requirements indicated.
5. Provide analysis equipment required to determine performance.
6. Provide temporary equipment and system modifications necessary to dissipate the heat produced during tests if building systems are not adequate.
7. Notify Architect in advance of test dates.
8. Document test results in a report and submit to Architect.

END OF SECTION 235239