

SECTION 235216 - CONDENSING BOILERS

PART 1 - GENERAL

1.1 SUMMARY

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

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Shop Drawings: For boilers, boiler trim, and accessories. Include product description, model number, dimensions, clearances, weights, components and options.
 - 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.
 - a. Schematic wiring diagram of boiler control system of the ladder-type showing all components, interlocks, etc. Schematic wiring diagram shall clearly identify factory wiring and field wiring by others.
 - b. Detail wiring for power, signal, and control systems.

1.3 INFORMATIONAL SUBMITTALS

- A. Seismic Calculations
- B. Source quality-control reports.
- C. Field quality-control reports.
- D. Manufacturer's Certification: The boiler manufacturer shall certify the following:
 - 1. The products and systems furnished are in strict compliance with the specifications.
 - 2. The boiler, burner, and other associated mechanical and electrical equipment have been properly coordinated and integrated to provide a complete and operable boiler package.
 - 3. ASME Certification in the form of ASME Stamp on the product and completed and signed data sheet.
 - 4. ASME CSD-1 Certification, in the form of completed data sheet.
 - 5. cULus Certification in the form of an affixed label to the equipment.
 - 6. The specified factory tests have been satisfactorily performed.
 - 7. The specified field tests have been satisfactorily performed.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

1. Manufacturer's printed operation and maintenance manuals shall be submitted prior to final acceptance by the engineer. Operation and maintenance manuals shall contain dimension and wiring drawings, product data, operating instructions, cleaning procedures, replacement parts list, maintenance and repair data, complete parts list, etc.
- B. Manufacturer's data reports.
- C. Start-up reports.

1.5 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to repair or provide replacement 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 shall be guaranteed against thermal shock for 20 years when utilized in a closed loop hydronic heating system with a temperature differential of 120 °F or less. The boiler pressure vessel shall be guaranteed accordingly without a minimum flow rate or return water temperature requirement. The boiler shall not require the use of flow switches or other devices to ensure minimum flow.
 - b. The pressure vessel, tubes and tube sheets (heat exchanger) shall be guaranteed against flue gas corrosion and materials/workmanship for a period of 10 years. The condensate collection box shall be guaranteed for 20 years. The burner cylinder shall be warranted for a period of 5 years.
 - c. All parts not covered by the above warranties shall carry a 1 year warranty from startup, or 18 months from shipment, whichever occurs first. This shall include all electrical components and burner components.

1.6 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 the current version of the 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. AHRI Testing: The boilers shall be tested and certified per AHRI requirements for efficiency ratings.
- E. UL Compliance: Test boilers for compliance with UL 795 and CAN1-3.1-77. Boilers shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.

- F. CSA or cULus certified as an indirect or direct vent boiler and comply with standard CAN1-3.1-77.
- G. Boiler and controls shall be compliant with ASME CSD-1 Code requirements.

1.7 For securing boiler to concrete base.

- A. Seismic Fabrication Requirements: Fabricate mounting base and attachment to boiler pressure vessel, accessories, and components with reinforcement strong enough to withstand seismic forces as required for jobsite when mounting base is anchored to building structure. The boiler manufacturer shall provide required anchoring provisions. Contractor shall anchor boilers to meet specification requirements.

PART 2 - PRODUCT

2.1 HIGH MASS FIRETUBE STAINLESS STEEL CONDENSING BOILERS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following available manufacturer offering products that may be incorporated into the Work shall include, but are not limited to, the following:
 - 1. Cleaver Brooks – Model Clearfire CFC-E (Basis of Design)
 - 2. Bosch/Buderus model SB625
 - 3. Viessmann Vitocrossal 300 model CT3
- B. Subject to compliance with requirements, provide Cleaver Brooks Clearfire Boiler(s) model CFC-E as indicated on Drawings or approved equal:
 - 1. "Near condensing" copper fin designs, watertube, cast iron, cast aluminum, or "add-on" secondary condensing exchangers will not be considered. Boilers with minimum flow requirements also will not be considered.
 - 2. Description: Each unit shall be a down-fired firetube type complete with burner and automatic controls. The boiler, with all piping and wiring, shall be a factory package. Each boiler shall be neatly finished, thoroughly tested and properly packaged for shipping. Boiler design and construction shall be in accordance with Section IV of the ASME Code for hot water heating boilers with a maximum working pressure of 125 PSIG.
- C. Heat Exchanger: Duplex stainless steel tubes, tube sheets, and combustion chamber. The heat exchanger shall be a single-pass, counter-flow arrangement.
 - 1. The firetubes shall be duplex stainless steel, fitted with aluminum internal heat transfer fins.
- D. Pressure Vessel: Carbon steel with welded heads and tube connections.
- E. The boiler shall have one supply connection with dual return water connections. The dual return water connections shall enable the boiler to operate in a condensing mode when as

little as 10% of the flow is returned to the low temperature return with a maximum temperature of 120°F.

- H. The boiler pressure vessel shall have a minimum of 46 gallons of water volume/1000 MBH input.
- I. The boiler shall be low flow tolerant without minimum flow requirements or the use of a flow switch.
- J. The boiler shall have a minimum of 250 sqft/1000 MBH of effective fireside heating surface.
- K. Burner: **[Natural] [Propane]** gas, forced draft burner mounted in and integral with the boiler hinged top door so when the door is opened the burner head, furnace, tubesheet, and tube entrances are exposed. The burner door shall utilize easy removable threaded handles, and the burner shall swing upward on gas assist piston arms, one on each side to provide open support of the burner assembly.
 - 1. The burner shall be a linkage-less, self-regulating, air-fuel ratio gas valve-venturi system. Burner regulation shall be accomplished without the use of fuel/air mixing valves.
 - 2. The burner shall be achieve sub 20 ppm NOx when firing on natural gas at all firing rates.
 - 3. Burner and fireside access shall be able to be performed by one service technician.
- L. Burner Head: shall be constructed of a stainless steel metal fiber for solid body radiation of the burner flame. Combustion shall take place on the surface of the burner mantle, which shall be constructed of a woven stainless steel metal fabric resulting a 360 degree low temperature radiant flame.
 - 1. Burner shall be minimum 5:1 **[500-2000 MBH]** or 10:1 **[3500-6000 MBH]** fully modulating turndown. (Natural gas)
 - 2. Burner shall maintain no more than 7% O2 levels throughout the firing rate without additional sensors, linkages, or controls.
 - a. The pre-mix design shall utilize a variable speed fan connected to a venturi to simultaneously modulate the fuel and air for a minimum 5:1**[500-2000 MBH]** or 10:1 **[3500-6000 MBH]** turndown. The valve-venturi design shall also act as a method for compensating for changes in barometric pressure, temperature, and humidity so the excess air levels are not adversely affected by changes in atmospheric conditions. External linkages and single speed fans shall not be acceptable.
- M. Blower: Centrifugal fan to operate during each burner firing sequence and to prepurge and postpurge the combustion chamber.
 - 1. The blower motor shall have a variable speed ECM motor with integrated drive electronics. Constant speed motors and variable frequency AC drives are not acceptable.
- N. Gas Train: The gas train shall meet the requirements of CSA/UL and ASME CSD-1 and shall include:
 - 1. Low Gas Pressure Interlock, manual reset.
 - 2. High Gas Pressure Interlock, manual reset.

3. Upstream and downstream manual test cocks.
 4. Ball Type manual shutoff valve upstream of the main gas valve.
 5. Unibody double safety gas valve assembly.
 6. Gas Pressure Regulator
 7. Union connection to permit burner servicing.
 8. Proof of Closure Valve (6000 MBH only)
- O. Ignition: Spark ignition [**500-2000 MBH**] or Pilot ignition [**3500-6000 MBH**] with 100 percent main-valve shutoff with UV scanner for flame supervision.
- P. Combustion air proving switch shall be furnished to ensure sufficient combustion airflow is present for burner ignition firing.
- Q. To ensure that the flue is not blocked, the burner shall include a High Air Pressure Switch sensing the outlet pressure connection relative to stack backdraft.
- R. Casing:
1. Jacket: 18 gauge metal cabinet with snap-in or interlocking closures.
 2. Control Compartment Enclosures: NEMA 250, Type 1A.
 3. Finish: Powder-coated protective finish.
 4. Insulation: Minimum 2-inch thick, mineral-fiber insulation surrounding the heat exchanger.
 5. Combustion-Air Connections: Inlet and vent duct collars.
 - a. [Combustion air inlet filter]

2.2 TRIM

- A. Safety valve(s) shall be ASME Section IV approved side outlet type mounted on the boiler air vent outlet. Size shall be in accordance with code requirements and set to open at [**30**] [**50**] [**60**] [**75**] [**80**] [**90**] [**100**] [**125**] psig.
- B. Temperature and pressure gauge shall be mounted on the water outlet.
- C. Solid State Low water cut-off probe control with manual reset and test switch.
- D. Manual Reset High Limit Temperature sensor; range not to exceed 210 deg F and shall be an integral device of the Boiler Burner Control and UL Recognized as a limit control.
- E. Outlet water supply sensing probe for operating water limit setpoint.
- F. Return water-sensing probe for operating limit setpoint.
- G. Drain valve
- H. Automatic air vent
- I. Auxiliary low water cutoff

- J. Alarm lights and horn (general alarm light – red, fuel valve light – green, load demand light – white, low water light - amber)
- K. Alarm horn (electronic sounder)
- L. Stack temperature sensor – UL Recognized as a limit control.
- M. Condensate neutralization kit **[tube] [tank] [combination tank and trap]**
- N. Automatic isolation valve, including valve, actuator, and transformer to power isolation valve through the boiler. The valve, actuator, and transformer shall ship loose for field installation and wiring.
 - 1. The isolation valve shall be Bray 2-way resilient seated butterfly valve, model ABL or approved equal, with ANSI 150# flanges, lugged style.
 - 2. The electric actuator shall a Bray Commercial actuator, or approved equal, 24VAC, fail in position, with auxiliary end switch.

2.3 CONTROLS

- A. The Boiler shall include a Falcon Computerized Boiler Burner control which shall be an integrated, solid state digital micro-processing modulating device, complete with sequence indication, fault reset, mode selection, and parameter set-point. It shall be mounted at the front of the boiler panel for easy access and viewing.
 - 1. Controller shall provide for both flame safeguard and boiler control through separate power supplied CPU's (to meet NFPA) and shall perform the following functions:
 - 2. Burner sequencing with safe start check, pre-purge, Electronic direct spark ignition and post purge. A UV scanner shall be used to prove combustion.
 - 3. Flame Supervision. The control shall provide pre-purge and post-purge and shall maintain a running history of operating hours, number of cycles, and the most recent fifteen lockouts. The control shall be connected to a touchscreen display interface that will display this information in clear English text descriptions.
 - 4. Safety Shutdown with display of lockout or hold condition.
 - 5. PID modulating control of the variable speed fan for firing capacity relative to load requirements; i.e. to meet supply water temperature set point.
 - 6. Gas pressure supervision, high and low.
 - 7. Combustion Air Proving Supervision.
 - 8. High Air Pressure [back draft too high] Supervision.
 - 9. The supply temperature and set-point temperature shall be displayed at all times on the touch screen display.

10. Controller shall be equipped with a touch screen display for set up, trouble shooting, and operational display, and shall include ModBus communication capability of this information.
11. Include the programming of circulating pump or isolation valve control and support the control of 2 heating demand loops.
 - B. All parameter input control set-points shall be factory pre-configured. Parameter settings are to be established to suit jobsite conditions -- settings are to be configured at the time of initial jobsite operation.
 - C. All controls to be panel mounted and so located on the boiler as to provide ease of servicing the boiler without disturbing the controls and also located to prevent possible damage by water according to UL and CSA requirements.
 - D. Electrical power supply shall be 115 volts, 60 cycle single phase.
 - E. When multiple boilers are to be installed together, a system integration control shall be provided to stage up to 8 boilers. The control shall include automatic selection of needed boilers based on energy demand, an adjustable outdoor reset schedule, domestic hot water priority, and a system digital display. The control shall stage and modulate the boilers utilizing firing rate threshold staging and parallel modulation to optimize condensing potential while minimizing energy wasting short cycling. This strategy takes full advantage of the inverse efficiency characteristic (lower fire rate, higher efficiency) of condensing boilers. The control shall monitor supply water temperature, return water temperature and shall communicate between boilers via RS-485 network wiring.
 - F. Boilers shall communicate with **[BACnet I/P] [BACnet MSTP] [LONWorks] [ModBus TCP/IP] [ModBus RTU] [Johnson Metasys N2]** building management system utilizing a protocol translator for requirements other than the native ModBus RTU.
 1. Protocol translator mounted in a NEMA 1 panel with power supply and terminals.
 2. Protocol translator shipped loose for installation in boiler control panel with required power supply.
 - G. The boiler controls shall include provisions for **[outside air reset] [night setback]**.
 - H. The boiler controls shall include provisions for sending signal to **[start/stop primary boiler pump] [start/stop primary boiler pump and vary pump speed based on boiler firing rate] [open/close automatic isolation valve]**.
 - I. Boiler shall have capability to have 24/7 remote monitor without connections to a BMS through an encrypted secure channel. The remote interface shall have the following features and capabilities
 - a. Display real time boiler system operation, cycle counts, temperature readings, and runs hours, firing rate, steam pressure, inlet/outlet water temps, alarms, stack temperature, and more
 - b. View data on mobile app and customizable online dashboard
 - c. Multiple user authorization with different levels of access
 - d. Multiple site integration to allow user to see all boiler plants and control individual plants

- e. Email and text alerts
- f. Data trending

2.4 ELECTRICAL POWER

- A. Single-Point Field Power Connection: Factory-installed and -wired electrical devices necessary shall provide a single-point field power connection to boiler. Separate power and control connections will not be allowed.
 - 1. Provide ship loose transformer to accommodate **[208/3/60]** **[575/3/60]** voltage.
 - 2. House in NEMA 250, Type 1 enclosure.
 - 3. Wiring shall be numbered and color coded to match wiring diagram.
 - 4. Install factory wiring outside of an enclosure in a metal raceway or conduit.
 - 5. Field power interface shall be to **[non-fused]** **[fused]** disconnect switch.

2.5 VENTING

- A. Exhaust Stack: Complete system, per UL 1738 for Category IV appliances, stainless steel, pipe, vent terminal, thimble, vent adapter, and sealant.
 - 1. Stack to be designed and manufactured by boiler manufacturer.
- B. Combustion-Air Intake: Complete system, **[PVC]** **[galvanized steel]** **[spiral duct]** **[stainless steel]**, pipe, vent terminal with screen, inlet air coupling, and sealant, by others.

2.6 SOURCE QUALITY CONTROL

- A. Burner and Hydrostatic Test: Factory pressure test gas train, test fire burner and gas train assembly, and perform a functional controls test for all safety devices; perform hydrostatic test.
- B. Test and inspect factory-assembled boilers, before shipping, according to most current ASME Boiler and Pressure Vessel Code.

PART 3 - EXECUTION

3.1 BOILER INSTALLATION

- A. Installation shall be provided by the contractor in accordance with the requirements of the codes specified hereinbefore. All of the contractor's work shall be performed by experienced personnel previously engaged in boiler plant construction and shall be under the supervision of a qualified installation supervisor.

B. Equipment Installation:

1. Install boilers on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases.
2. Comply with requirements for seismic-restraint devices.
3. Install equipment in strict compliance with manufacturer's installation instructions.
4. Install equipment in strict compliance with state and local codes and applicable NFPA standards.
5. Maintain manufacturer's recommended clearances around sides and over top of equipment.
6. Install components that were removed from equipment for shipping purposes.
7. Install components that were furnished loose with equipment for field installation.
8. Provide all interconnecting electrical control and power wiring.
9. Provide all fuel gas vent and service piping.
10. Provide all piping for boiler pipe connections.

3.2 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.
- D. 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. Piping shall be properly sized to minimize pressure drops for longer gas piping runs. Refer to boiler IOM for sizing and header recommendations.
- 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. Install flue venting and combustion-air intake.
- H. Ground equipment according to specification requirements.
- I. Connect wiring according to specification requirements.

3.3 FIELD QUALITY CONTROL

- A. General: The boiler supplier's factory authorized service organization shall be responsible for performance of inspections, start up and testing of the package boiler, and accessory equipment and materials furnished under this Section. A detailed written record of the startup performance, including burner setting data over the entire load range

shall be furnished to the engineer before final acceptance. All labor, equipment, and test apparatus shall be furnished by the authorized service organization. All equipment defects discovered by the tests shall be rectified either by the service organization or boiler manufacturer.

- B. Equipment inspection: Boiler representative shall inspect boilers and other equipment upon arrival, verifying completeness of equipment supplied and potential damages. All shipped loose components, to be mounted and installed on boiler by contractor.
- C. Equipment shall be flushed prior to start-up per the water treatment company guidelines and product installation manual requirements.
- D. Pre start-up walk through: Boiler representative shall review the installation with the mechanical contractor prior to start-up and note any required changes prior to start-up.
- E. Start-up shall be conducted by experienced and factory authorized technician in the regular employment of the authorized service organization, and shall include:
 - 1. Demonstrate that boiler, burner, controls, and accessories comply with requirements of this Section as proposed by the boiler and accessories supplier. Pre-test all items prior to scheduling the final testing that will be witnessed by the test engineer.
 - 2. Readings at different firing rates (20, 50, 75 and 100%) of load for the modulating burner shall be taken with a written report of the tests submitted to the engineer. The reports shall include readings for each firing rate tested and include stack temperatures, O₂, CO, NO_x, and overall boiler efficiency.
 - 3. Auxiliary Equipment and Accessories: Observe and check all valves, draft fans, electric motors and other accessories and appurtenant equipment during the operational and capacity tests for leakage, malfunctioning, defects, and non-compliance with referenced standards or overloading as applicable.
 - 4. Commissioning Requirements:
 - 1. Fireside inspection
 - 2. Set up fuel train and combustion air system
 - 3. Set up operating set points
 - 4. Check all safeties, including Flame safeguard, LWCO, Airflow, Fuel pressures, High limits.
 - 5. Set up and verify efficiencies at 20%, 50%, 75%, and 100%
 - 6. Set up and verify burner turndown.

Retain "Perform the following tests and inspections" Paragraph below to require Contractor to perform tests and inspections.

3.4 DEMONSTRATION

- A. Training to include all safety procedures, maintenance procedures, control operations, and diagnostic procedures. Training to be provided in a single ____ hour continuous session to accommodate operator's availability on site.

END OF SECTION 235216