SECTION 235216 - FIRETUBE CONDENSING BOILERS

1. GENERAL
	1. SUMMARY
		1. This Section includes packaged, factory-fabricated and -assembled, gas-fired, firetube stainless steel ultra-high efficiency condensing boilers, trim and accessories for generating hot water.
	2. REFERENCES
		1. ASME Section IV
		2. CAN-1.3.1-77, Industrial and Commercial Gas Fired Packaged Boilers
		3. CSD-1, Controls and Safety Devices
		4. AXA XL
		5. NEC, National Electric Code
		6. CSA 4.9, ANSI Z21.13
		7. AHRI-1500, BTS-2000
		8. ASHRAE 90.1
	3. SUBMITTALS
		1. Product Data: Include performance data, operating characteristics, technical product data, rated capacities of selected model, weights (shipping, installed and operating), installation and start-up instructions, and furnished accessory information.
		2. Shop Drawings: For boiler, standard boiler trim and accessories.
			1. End Assembly Drawing: Detail overall dimensions, connection sizes, connection locations, and clearance requirements.
			2. Wiring Diagrams: Detail electrical requirements for the boiler including ladder type wiring diagrams for power, interlock and control wiring. Clearly differentiate between portions of wiring that are factory installed and portions to be field installed.
		3. Certificate of Product Rating: Submit AHRI Certificate indicating Thermal Efficiency, Combustion Efficiency, Materials of Construction, Input, and Gross Output conform to the design basis.
		4. Thermal efficiency curves: Submit thermal efficiency curves between and including minimum and maximum rated capacities, for return water temperatures ranging from 80°F to 180°F.
		5. Water side pressure drop curve.
		6. Flue gas temperature curves: Submit flue gas temperature curves for minimum and maximum boiler capacity when operating on natural gas for return water temperatures ranging from 80°F to 160°F.
			1. If submitted flue gas temperatures or excess O2% levels, minimum or maximum inputs are different from that of the basis of design manufacturer and model, the manufacturer shall be responsible for draft calculations and potential costs associated with reselection of the flue gas exhaust vent system.
		7. Source quality-control test reports.
		8. Field quality-control test reports: Start-up by a factory authorized service company.
		9. Operation and Maintenance Data: Data to be included in Installation and Operation Manual.
		10. Warranty: Standard warranty specified in this Section.
	4. QUALITY ASSURANCE
		1. Manufacturer Qualifications: Firms regularly engaged in the manufacture of condensing hydronic boilers with welded steel pressure vessels, whose products have been in satisfactory use in service for not less than twenty-five (25) 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 of a similar boiler type.
		2. 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.
		3. ASME Compliance: Fabricate and label boilers to comply with ASME Boiler and Pressure Vessel Code, Section IV “Heating Boilers”, for a maximum allowable working pressure of 160 PSIG.
		4. CSD-1 Compliance: The boiler shall comply with ASME Controls and Safety Devices for Automatically Fired Boilers (CSD-1).
		5. ASHRAE/IESNA 90.1 Compliance: Boilers shall have minimum efficiency according to “Gas and Oil Fired Boilers - Minimum Efficiency Requirements.”
		6. UL Compliance: Boilers must be tested for compliance with UL 795, “Standard for Commercial-Industrial Gas Heating Equipment.” Boilers shall be listed and labeled by ETL.
		7. AHRI Compliance: Boilers shall be tested and rated according to the AHRI-1500 or BTS-2000 test standard and verified by AHRI.
		8. The equipment shall be of the type, design, and size that the manufacturer currently offers for sale and appears in the manufacturer’s current catalog.
		9. The equipment shall fit within the allocated space, leaving ample allowance for maintenance and inspection.
		10. The equipment shall be new and fabricated from new materials. The equipment shall be free from defects in materials and workmanship.
		11. In order to provide unit responsibility for the specified capacities, efficiencies, and performance, the boiler manufacturer shall certify in writing that the equipment being submitted shall perform as specified.
	5. COORDINATION
		1. Mechanical contractor shall coordinate the size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete reinforcement and formwork requirements are specified in Division 03.
	6. WARRANTY
		1. Standard 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 provided the boiler is installed, controlled, operated and maintained in accordance with the Installation, Operation and Maintenance Manual.
			1. Warranty Period for the Pressure Vessel and Heat Exchanger: The boiler manufacturer shall warranty against failure due to:
				1. Flue gas condensate corrosion, and/or defective material or workmanship for a period of ten (10) years, non-prorated, from the date of shipment from the factory.
				2. Thermal shock for the lifetime of the boiler.
			2. Warranty Period for all other components: The boiler manufacturer will repair or replace any part of the boiler that is found to be defective in workmanship or material for a period of two (2) years, non-prorated, from the date of shipment from the factory.
2. PRODUCTS
	1. MANUFACTURERS
		1. This specification is based on the Vantage series boilers as manufactured by Fulton. Equivalent units and manufacturers must meet all performance criteria, and will be considered upon prior approval.
		2. Basis-of-Design Product: Subject to compliance with requirements, provide Fulton:
			1. Vantage model **[VTG-2000] [VTG-3000] [VTG-4000] [VTG-5000] [VTG-6000]** firetube condensing boiler.
				1. Alternate boilers must equal or exceed all aspects of this specification in its entirety throughout. Boilers seeking an approval shall provide documentation that supports this requirement.
		3. The boiler manufacturer shall have the capability to construct an engineered hydronic system, skid mounted, for the above referenced boilers incorporating single point electrical, supply water, return water, fresh water make up, fuel, and drain. The boiler manufacturer shall have the engineering capabilities for all aspects of the mechanical, electrical and control design of the skidded system.
	2. CONSTRUCTION
		1. Description: Factory-fabricated, -assembled, and -pressure tested, stainless steel firetube condensing boiler with heat exchanger sealed pressure tight, built on a steel base; including flue gas vent; combustion air intake, water supply, water return, condensate drain, and controls. The boiler, burner and controls shall be completely factory assembled as a self-contained unit. Each boiler shall be neatly finished, thoroughly tested, and properly packaged for shipping. The boiler shall be suitable for closed-loop water hydronic heating service.
			1. Boilers must be fully factory assembled, wired, and tested as a packaged boiler. Boilers which require assembly by the distributor, manufacturer’s representative or installing contractor do not meet the minimum listed and labeled packaged boiler safety requirements of this specification and will not be accepted. There will be no deviations or exceptions granted.
		2. Heat Exchanger: The heat exchanger is defined as the surfaces of the pressure vessel where combustion gases transfer heat to the hydronic heating fluid.
			1. Material: The combustion chamber furnace shall be minimum 3/8” thick steel SA-53B ERW pipe or SA-516 Grade 70 plate with a fully water-backed rear dished head. Furnace chamber pipes shall be minimum 3” diameter Schedule 40 steel. The heat exchanger tubesheets and tubes where flue gases condense shall be constructed of Duplex stainless steel alloy(s) meeting the following minimum requirements:
				1. For long term durability, heat exchanger material of construction must have a minimum 0.2% Yield Strength of 30 ksi. Weaker materials of construction with reduced yield strength are not accepted. Boilers seeking approval must provide documentation supporting this requirement or will be rejected.
				2. The nickel content in weight percent shall not exceed 6.5%. A nickel content between 7 to 20% is highly susceptible to Stress Corrosion Cracking (SCC), a mode of cracking failure instigated without warning which can be catastrophic in pressurized equipment. Austenitic stainless steels including 316(L) and 304(L) are most prone to this mode of failure and are not accepted.
				3. Heat exchangers constructed of austenitic stainless steels, ferritic stainless steels, cast aluminum, cast iron or copper materials are not accepted.
			2. Dryback combustion chamber furnaces which require rear refractory do not match maintenance and longevity requirements and will not be accepted.
			3. The boiler shall be a three-pass firetube design. Watertube designs will not be accepted.
			4. Heat transfer capability shall be maximized via the use of inspectable and removable flue gas turbulators.
		3. Pressure Vessel: Design and construction shall be in accordance with Section IV of the ASME Code for heating boilers.
			1. The pressure vessel shall be a counter-flow design with internal water-baffling plates.
			2. The boiler return and supply water connections shall be 150# ANSI flanged. The water connections shall not be designed to support an external structural load from the piping system.
			3. The water volume of the boiler shall not be less than 55 gallons per 1,000 MBTU/hr.
			4. The maximum water pressure drop across the boiler inlet and outlet connections shall not exceed **[VTG-2000: 0.9 PSID]** **[VTG-3000: 1.0 PSID]** **[VTG-4000: 2.6 PSID] [VTG-5000: 4.8 PSID] [VTG-6000: 5.6 PSID]** at full rated capacity operating with a 20°F delta-T.
			5. The pressure vessel shall be fully insulated.
		4. Fuel/Air Mixture Combustion System: Linkageless Parallel Positioning.
			1. A parallel positioning electronic combustion control system shall be provided to empower technicians to accurately dial-in positions electronically. Pneumatic (“negative regulation”, “zero governor”) type systems offer far less precision and are not capable of independent air and gas control and are not accepted.
			2. The air and gas tolerance shall be no greater than +/- 0.2° to allow for much more precise control of air-fuel ratio compared to linkages that may slip, or pneumatic gas valves which drift over time and have difficulty handling environmental and installation fluctuations.
				1. Combustion air flow shall be controlled by a servo-motor actuated butterfly valve. Fuel gas flow shall be controlled by a servo-motor actuated butterfly valve.
		5. Burner: Standard Natural Gas, forced draft design.
			1. Turndown: Shall be no less than 5:1 full modulation.
			2. Excess Air: The burner shall be capable of operating at no greater than 8.0% excess O2 over the entire modulation range to maximize seasonal combustion and thermal efficiencies.
			3. Dual Gas: The packaged boiler shall have an optional configuration for dual gas service with combination natural gas and propane.
			4. Alternative Renewable Fuels: The burner shall be hydrogen-ready for blends of up to 20% hydrogen and 80% natural gas, including fossil-free renewable natural gas (RNG). To ensure future-proof service, those seeking an approval shall provide documentation proving successful laboratory tests on Hydrogen blends.
		6. Blower: Centrifugal blower to operate during each burner firing sequence and to pre-purge and post-purge the combustion chamber.
		7. Main Fuel Gas Train: The fuel train shall be fully factory assembled and leak tested, complete with factory mounted and wired high and low gas pressure switches in compliance with CSD-1.
		8. Fuel Gas Ignition: Spark ignited pilot assembly, ignition transformer, pilot safety shut off valve, pilot gas pressure regulator and manual gas shutoff valve.
		9. Boiler Enclosure:
			1. Cabinet: Jacketed steel enclosure with front access door, fully removable access panels, mounted on a steel skid with steel plate decking.
			2. Control Enclosure: Equivalent to NEMA 250, Type 1.
			3. Finish: Cabinet shall be factory powder coated or painted.
		10. Rigging and Placement: The boiler shall include lifting eyes and fork hole accessibility for rigging.
		11. Characteristics and Capacities:
			1. Standard capacities shall be based on 100% water.
			2. Minimum Design Water Pressure Rating: 160 psig.
			3. Minimum Return Water Temperature, Natural Gas or Propane: None.
			4. Maximum Allowable Water Temperature (ASME): 210°F.
			5. Minimum Water Flow Rate: None.
			6. Maximum Delta-T: 100°F.
			7. Maximum Allowable Operating Setpoint: 200°F.
			8. Jacket Losses: External convection and radiation heat losses to the boiler room from the boiler shall not exceed 0.5% of the rated boiler input at maximum capacity.
		12. A zero flow or low flow condition shall not cause any harm to the pressure vessel or heat exchanger of the boiler. Flow switches, dedicated circulator pumps, or primary-secondary arrangements shall not be required to protect the boiler from thermal shock. Boilers requiring the use of flow switches or primary-secondary piping arrangements will not be accepted.
		13. The thermal efficiency must be witnessed and certified by an independent third party and listed on the AHRI directory. The test parameters shall be in accordance with the AHRI-1500 or BTS-2000 test standard. The natural gas thermal efficiency shall not be less than **[VTG-2000: 95.7%] [VTG-3000: 96.3%] [VTG-4000: 96.9%] [VTG-5000: 92.0%] [VTG-6000: 94.0%]**.
		14. The footprint of the boiler from which service clearances are measured shall not exceed 11.5 ft2 per 1,000 MBTU/hr.
		15. The side clearance requirement shall not be exceed **[VTG-2000: 1”] [VTG-3000: 1”] [VTG-4000: 1”] [VTG-5000: 8”] [VTG-6000: 1”]**.
		16. The equipment shall be in strict compliance with the requirements of this specification and shall be the manufacturer’s standard commercial product unless specified otherwise. Additional equipment features, details, accessories, etc. which are not specifically identified but which are a part of the manufacturer’s standard commercial product, shall be included in the equipment being furnished.
	3. TRIM
		1. Manual: Instructions for installation, operation and maintenance of the boiler.
		2. Electrical Schematic: Wiring diagram corresponding to the boiler configuration.
		3. Factory Test Fire Report: Safety and combustion test report.
		4. Safety Relief Valve: ASME rated **[60] [100] [125] [160]** psig.
		5. Pressure and Temperature Gauge: Minimum 3-1/2” diameter, combination pressure and temperature gauge.
		6. Flue Gas Condensate Drain Trap: A flue gas condensate drain trap shall be provided to prevent positive pressure exhaust gases from entering the boiler room.
		7. **[Optional Equipment]** Flue Gas Condensate Neutralization: pH neutralization shall be provided.
	4. CONTROLS
		1. The boiler electrical control panel shall include the following devices and features:
			1. Control display(s) factory mounted at the front of the boiler which shall serve as a user interface for programming parameters, boiler control and monitoring.
			2. Controls Transformer: 120VAC.
			3. Flame safeguard control with 9 combustion fuel/air load profile points.
			4. All standard controls shall be factory mounted and wired according to UL requirements.
		2. Burner Operating Controls: To maintain safe operating conditions, factory mounted and wired burner safety controls limit burner operation:
			1. High Limit: A manual reset mechanical Aquastat device shall stop the burner if operating conditions rise above maximum boiler design temperature.
			2. Low-Water Cut Off: Electronic probe type mounted in the pressure vessel shall prevent burner operation on low water alarm.
			3. Air Safety Switch: Prevent operation unless sufficient combustion air is proven.
		3. Boiler Operating Controls and Features:
			1. Proportional Integral Derivative (PID) temperature load control capability.
			2. Operating temperature sensor for automatic start and stop.
			3. Running history of operating hours and number of cycles.
			4. Alarm history for a minimum 24 most recent alarms.
			5. Administrative password protection.
		4. **[Optional Device:]** Lead/Lag Control of Modular (Multiple) Boiler Plants: Lead/Lag sequencing capabilities shall be provided by the Fulton ModSync. Refer to the full Modular Boiler Plant Sequencing Control specification.
		5. Building Automation System Interface: Hardware and software to enable building automation system (BAS) to monitor, control, and display boiler status and alarms.
			1. Hardwired Contacts:
				1. Monitoring: Boiler Status, Burner Demand, General Alarm.
				2. Control with Factory Installed Jumper: Safety Interlock for External Device, Remote Enable, Emergency Stop (E-Stop).
			2. Communication Protocol: A Modbus communication interface with BAS shall enable BAS operator to remotely enable and monitor the boiler plant from an operator workstation.
				1. **[Optional Device:]** A BACnet MSTP and IP protocol communication gateway shall be provided. The BACnet gateway is field installed on a boiler. Additional boilers in the modular shall not require a dedicated BACnet gateway for the BAS to monitor status. A communication point mapping list shall be provided.
				2. **[Optional Device:]** A LonWorks protocol communication gateway shall be provided. The LonWorks gateway is field installed on a boiler. Additional boilers in the modular system shall not require a dedicated LonWorks gateway for the BAS to monitor status. A communication point mapping list shall be provided.
	5. ELECTRICAL POWER
		1. Single-Point Field Power Connection: Factory-installed and factory-wired switches, transformers, control and safety devices and other devices shall provide a single-point field power connection to the boiler.
		2. Electrical Characteristics:
			1. Voltage: 460 V.
			2. Phase: Three.
			3. Frequency: 60 Hz.
	6. VENTING
		1. The boiler shall be capable of operating with a stack effect of -0.04” W.C. and a combined combustion air intake and exhaust venting pressure drop of +0.35” W.C.
		2. Combustion Air Intake: It shall be acceptable to either use sealed combustion by ducting combustion air in from the outdoors or by drawing air from the mechanical space itself.
			1. Sealed Combustion: Schedule 40 PVC pipe or smooth-walled galvanized steel, vent termination with 1/2” x 1/2” mesh bird screen.
			2. Mechanical Space: Adequate combustion air and ventilation shall be supplied to the boiler room in accordance with boiler manufacturer requirements and local codes.
		3. Flue Gas Exhaust: The flue gas exhaust stack shall be AL 29-4C or acceptable alternative stainless steel, listed and labeled to UL-1738 / C-UL S636 for use with Category II/IV appliances, guaranteed appropriate for the application by the manufacturer and supplier of the venting.
		4. Common Exhaust Vents: The draft system shall be designed to prevent the backflow of exhaust gases through idle boilers. The common boiler vent shall not be combined with any other appliance.
		5. Boilers requiring an intake or exhaust muffler for noise sensitive applications are unacceptable.
		6. Condensate drain piping must be galvanized or stainless steel. Copper, carbon steel, CPVC, or PVC pipe materials are not accepted.
	7. SOURCE QUALITY CONTROL
		1. Test and inspect factory-assembled boilers, before shipping, according to ASME Boiler and Pressure Vessel Code.
		2. Each boiler shall be installed and operated in a functioning hydronic system, inclusive of venting, as part of the manufacturing process. The boiler shall be fully factory test fired on both Natural Gas and No. 2 Fuel Oil. A factory test fire report shall be furnished by the manufacturer with each boiler. Boilers which require test fire by the distributor, manufacturer’s representative, installing contractor or service contractor do not meet the minimum safety and quality requirements of this specification and will not be accepted. There will be no deviations or exceptions granted.
3. EXECUTION
	1. EXAMINATION
		1. 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.
		2. Examine mechanical spaces for suitable conditions where boilers will be installed.
		3. Proceed with installation only after satisfactory conditions have been verified.
	2. BOILER INSTALLATION
		1. Install boilers level on concrete base, minimum 4 inches high. Concrete base is specified in Division 23 Section “Common Work Results for HVAC,” and concrete materials and installation requirements are specified in Division 03.
		2. Install gas-fired boilers according to NFPA 54. Equipment and materials shall be installed in an approved manner and in accordance with the boiler manufacturer’s installation requirements.
		3. Assemble and install boiler trim.
		4. Install electrical devices furnished with the boiler but not specified to be factory mounted.
		5. Install control wiring to field-mounted electrical devices.
	3. CONNECTIONS
		1. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
		2. 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.
		3. Connect gas piping to boiler gas train inlet with isolation valve and union. Piping shall be at least full size of gas train connection. Provide a reducer if required.
		4. Connect hot water supply and return water connections with shutoff valve and union or flange at each connection.
		5. Install piping from safety relief valves to the nearest floor drain or local equivalent approved by local code.
		6. Install piping from flue gas condensate drain connection to the condensate drain trap and to the nearest floor drain.
		7. Boiler Venting:
			1. Install flue venting and combustion air-intake.
			2. Connect to boiler connections, flue size and type as recommended by the manufacturer.
		8. Ground equipment according to Division 26 Section “Grounding and Bonding for Electrical Systems.”
		9. Connect wiring according to Division 26 Section “Low-Voltage Electrical Power Conductors and Cables.”
	4. FIELD QUALITY CONTROL
		1. Perform tests and inspections and prepare test reports.
			1. After boiler installation is completed, the manufacturer shall provide the services of a field representative to inspect components, assemblies, and equipment installations, including connections and provide startup of the boiler and training to the operator.
			2. Arrange with National Board of Boiler and Pressure Vessel Inspectors for inspection of boilers and piping. Obtain certification for completed boiler units, deliver to Owner, and obtain receipt.
		2. Tests and inspections:
			1. Perform installation and startup checks according to manufacturer’s written instructions.
			2. Leak Test: Hydrostatic test. Repair leaks and retest until no leaks exist.
			3. Operational Test: Start units to confirm proper motor rotation and unit operation. Adjust air-fuel ratio and combustion.
				1. Check and adjust initial operating set points and high- and low-limit safety set points of fuel supply, water level and water temperature.
		3. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION 235216