

2.1 GENERAL

- A. All manufacturers to be considered shall be required to meet or exceed scheduled I=B=R capacities and ratings and will be held to strict compliance with these contract specifications. For factory packaged and firetested boilers.
- B. Installing contractor shall include, as part of his contract, all charges and costs for boiler and burner testing, start-up, checkout, adjusting, field and state inspections, including service contracts for systems and equipment as here-in-after specified. Provide signed documentation to the awarding authority for completion of specified procedures.
- C. Contractor shall obtain certificate of boiler inspection after boiler installation has been completed and pay all fees associated with such inspection. After receipt of certificate of inspection, installing contractor shall furnish a suitable glass front frame in which to place said certificate. Frame, with inspection certificate inserted therein, shall then be placed on or posted in a suitable location within the boiler room in which the new boilers have been installed.
- D. Installing contractor shall obtain from the boiler manufacturer pertinent Installation, Operating and Service Instructions for the boilers, burners, controls and safety devices furnished with the Boiler(s).
- E. It shall be the responsibility of the installing contractor to deliver boiler manuals, together with complete wiring and piping diagrams, to the owner/user and to obtain a receipt for the instructions. The receipt shall be filed with the installation report.

2.2 WARRANTY

- A. The manufactured heating units, equipped with a pressed-tubular heat exchanger constructed of stainless steel and a welded stainless steel manifold, shall be warranted by the boiler manufacturer to be free from defects in material and workmanship under normal usage for a period of **ten years** from the date of original installation.
 - 1. All parts and controls shall have a one-year warranty against defects in manufacturing, materials and workmanship.

2.3 PRODUCTS:

A. APEX SERIES – ULTRA-HIGH EFFICIENT CONDENSING BOILER

- 1. Hot water boiler shall be a high efficiency condensing boiler with a pressure vessel, constructed of stainless steel, which shall not require a refractory combustion chamber. The boiler shall be suitable for forced draft firing and capable of achieving a minimum thermal efficiency of 95.8% and minimum combustion efficiency of 95.7%, when fired with natural gas. The boiler a gas valve will be designed with negative pressure regu-

- lation and equipped with a variable speed blower system to precisely control the fuel/air mixture, providing fully modulating firing rates for maximum efficiency.
2. All piping and wiring connections shall be located on the left-side of the boiler. Connections include: 1-1/2 inch supply water connection, 1-1/2 inch return water connection, 3/4 inch relief/drain tapping, 3/4 inch condensate trap drain, and 3/4 inch gas valve inlet connection. Condensate trap shall have a factory supplied compression fitting. A factory supplied drain valve and oversized relief valve shall be provided with the boiler(s).
 3. Installation in elevations up to 7,000 feet above sea level (FASL) shall not require any additional equipment or conversion kits for proper combustion and operation. The only adjustment needed shall be to the throttle, offset and turndown rates. For installations above 2,000 FASL, ratings are to be reduced by four percent (4%) for each 1,000 FASL.
 4. The Apex boiler shall be factory assembled and completely packaged with burner and controls mounted and wired. Burner shall be factory fire tested to ensure proper operation before shipment.
 5. The flue passages and combustion chamber shall be accessible from the front of the boiler for cleaning.
 6. Boiler shall be equipped with an integral pre-mix, metal-mesh type burner. Input, output and combustion efficiency shall be certified to efficiency test procedures specified in *I=B=R/BTS-2000*. ***Boiler efficiencies must meet ASHRAE 90.1 and the National Energy Policy Act of 1992 requirements. Boiler must be certified to ANSI Z21.13 and ETL test standards.***
 7. Boiler shall be constructed for 80 PSI maximum allowable working pressure (MAWP) in accordance with the ASME Section IV Rules for Construction of Heating Boilers. Pressure vessel shall have been subjected to a hydrostatic pressure test of 240 PSIG at the factory before shipment and the boiler shall be stamped with the ASME 'H' symbol.
 8. A polypropylene condensate trap with a float-actuated shut-off switch shall be located within the boiler jacket and beneath the heat exchanger drain pan. The float-actuated shutoff switch must be located upstream from any bends in the condensate trap. Float switches located on the downstream side of the condensate trap shall not be acceptable due to the possibility of blockages occurring the the trap bends.
 - a. The float-actuated switch shall be offset from the condensate drip to prevent mineral build-up from interfering with the switch actuation.
 9. The boiler shall be provided with a heavy duty 20 gauge steel jacket with a rust resis-

tant powder coat finish. Jackets made of plastic or resin material are 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. Furthermore, all electrical and control components shall be mounted on a pullout-tray, providing easy access to wiring terminals, controls and 360 view of all wiring components. Individual lift-off jacket front panel may be installed after system piping and wiring to allow ease of access to the pressure vessel.

- 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.
10. Boiler trim shall include: *(Select all that apply)*
- a. One (1) 3-1/2" inch dia. combination pressure-temperature gauge.
 - b. Safety high limit aquastat; auxiliary safety high limit aquastat with manual reset (must specify on order).
 - c. sensors shall be mounted on the supply and return connections, inside the boiler jacket to monitor supply and return water temperatures. Each sensor shall be accessible through a removable access door on the left side of the boiler. The boiler control shall measure supply and return temperatures and notify the operator if the direction of flow is reversed.
 - 1) *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.*
 - d. ASME Section IV safety relief valve sized to exceed the gross output of the boiler which shall be factory set to relieve pressure at (50) (80) PSI water working pressure.
 - e. One (1) low water cutoff device with manual reset, to comply with CSD-1 requirements. 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 FM approved, suitable for commercial hydronic heating service at 80 PSI.
 - f. One set of high and low gas pressure switches with a range of 4.5 – 13.5 PSIG, wired to put the boiler into a hard lockout, requiring manual reset of the boiler primary safeguard control.

2.4 Boiler Control System (Sage2™) – Standard on all Apex boilers

A Scope of Supply

Supply a boiler control system to 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 boiler 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 building automation system (BAS) firing rate demand, remote setpoint or remote start/stop commands.

B 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. If the secondary loop flow speed is greater than the primary loop flow speed, firing rate is increased in response to the decrease in secondary loop temperature. 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.

C 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 Modbus or 4-20mA remote setpoint or firing rate demand signal from an external BAS.

D Multiple Boiler Sequence

Multiple boilers shall be modulated in "unison" (all at the same firing rate). The control system shall utilize both water temperature and boiler firing rate percent to start and stop the boilers and shall minimize 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. When rotation is enabled the lead boiler shall automatically rotate every 1 to 168 hours. 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.

E User Interface

A touch-screen message display with two-tone backlight shall be provided to display numeric data, startup and shutdown sequence status, alarm, system diagnostic, first-out messages and boiler historical information. The two-tone backlight, shall light red, in the event of an alarm and green in any other condition. Historical information shall include the last ten lockout and alarm conditions, number of boiler cycles, boiler hours and last ten low boiler return temperature events. When boiler return water temperature is below a minimum setpoint a low temperature events shall be stored with time, date, “lowest temperature for event” and “duration below setpoint” data. At a minimum, the boiler system shall display the following:

1. The display must be accessible through the front of the jacket, so that users can read displays, without removal of the boiler jacket.
2. Numeric Display with Engineering Units:
 - a. Boiler Supply Water Temperature
 - b. Boiler Return Water Temperature
 - c. Remote System Temperature (when required by contract drawings)
 - d. Outside Air Temperature
 - (a) A factory supplied outdoor air temperature sensor must be supplied with the boiler.
 - e. Firing Rate %
 - f. Boiler Temperature Setpoint
 - g. Mixing Valve % (when required by contract drawings)
3. Status, Startup And Shutdown Sequence English language Messages:
 - a. Boiler disabled
 - b. Warm Weather Shutdown
 - c. Lockout
 - d. Pump Purge
 - e. Limit Hold
 - f. Purge / Pilot Ignition
 - g. Low Fire / Pilot Ignition
 - h. Main Burner Ignition
 - i. Boiler Running
 - j. Fan Post Purge
 - k. Pump Cooldown
 - l. Standby

4. Alarm, System Diagnostic, First-Out English language Messages: (numeric code numbers shall not be acceptable):
 - a. Low Water Level (when required by contract drawings)
 - b. Low Water Flow (when required by contract drawings)
 - c. Fuel Limit (gas pressure or oil temperature)
 - d. High Boiler Supply Temperature Limit
 - e. Low Return Water Temperature
 - f. Low Air Flow
 - g. Flame Safeguard Internal Fault
 - h. High Supply Temperature
 - i. Supply Temperature Sensor Fault
 - j. Return Temperature Sensor Fault
 - k. Outside Air Temperature Sensor Fault
 - l. Remote System Temperature Sensor Fault
 - m. Remote Input Signal Fault
 - n. Modbus Communication Fault
 - o. Memory Fault

F Flame Safeguard (FSG)

The boiler controller shall also be the primary flame safeguard, overseeing operation of the burner, firing sequence and safe operation of the complete unit. Thus eliminating the need to program and troubleshoot multiple electronic components during installation, setup and service.

G Boiler Pump Sequence

Include primary water pump control to allow boiler warm-up to the return water temperature before the boiler start; continue water flow for an adjustable cool down period after the boiler has stopped; and ensure water is always moving past the remote system temperature sensor even after the last boiler has been stopped. The pump shall immediately stop if any trips occur during pre-purge, pilot, or main flame trial for ignition.

H Communication

Include an RS485 modbus slave or peer-to-peer communications data highway on each boiler control system. When peer-to-peer communication is enabled the data highway 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. When modbus communication is enabled the data highway 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. Provide all equipment capabilities specified in this paragraph, even if a connecting SCADA (Supervisory Control And Data Acquisition system, typically a desk top personal computer) system is not included in this project.

I Quality Assurance

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

2.5 – VENTING

- A. Vent Material - The boiler shall be vented using PVC/CPVC vent material in accordance with local code. A Factory supplied 90° elbow (schedule 80 CPVC) and a 30-inch length of schedule 40 CPVC pipe must be included as a transition from the boiler to traditional solid core schedule 40 PVC vent material. Foam core pipe shall not be an approved vent material for either intake/exhaust piping. Vent connections must be located at the rear of the boiler.

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- B. Concentric Vent Option -