Thermal Solutions Boiler Control (TSBC)

Consulting Engineer
Suggested Specification

2.4 Boiler Control System

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 burner 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 Energy Management System (EMS) firing rate demand, remote setpoint or remote start/stop commands. In the event a selected sensor fails, the control system shall automatically change to a control mode that will allow continued safe automatic operation of the boiler.

B. Boiler Control

Using PID (proportional-integral-derivative) based control, with the addition of a remote sensor, the remote system water temperature shall establish a target boiler firing rate. Alternately, using parameter menu selections, the control system shall allow the boiler to respond to 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 logic required to ensure that pre-purge, post-purge, light-off, and burner modulate cycles are automated shall be provided.

C. Hot Water Temperature Setpoint

When the controller is in the local control mode, the control system can establish the setpoint based on outside air temperature and a reset function curve or be manually adjusted by the operator. When DHWD is enabled, the domestic setpoint shall be adjusted above a preset central heat setpoint upon sensing a domestic hot water demand contact input on DP. When in remote mode, the control system shall accept a Modbus or 1-9 Vdc remote setpoint or firing rate demand signal from an external Energy Management System (EMS).

D. Multiple Boiler Sequence

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 a programmable 1 to 168 hours. When enabled, warm weather shut down control logic shall prevent boiler operation.

E. User Interface

A panel front-mounted English language, two line, sixteen character LCD message display shall be provided to display numeric data, startup and shutdown sequence status, alarm, system diagnostic, first-out messages and boiler historical information. Historical information shall include the last ten lockout and alarm conditions, number of boiler cycles, boiler hours and last ten low boiler inlet temperature events. When boiler inlet 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. A panel mounted red alarm light shall annunciate alarm messages. Alarm

conditions requiring a manual reset shall be annunciated by a flashing red light. At a minimum, the boiler system shall display the following:

1. 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 (when required by contract drawings)
   e) Firing Rate %
   f) Boiler Temperature Setpoint
   g) Mixing Valve Position % (when required by contract drawings)
   h) Lead Boiler Position
   i) Boiler Cycles
   j) Boiler Operating Hours

2. 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) Low Fire Hold
   j) Boiler Running
   k) Fan Post Purge
   l) Pump Cooldown
   m) Standby

3. Alarm, System Diagnostic, First-Out English language Messages: (numeric code numbersshall not be acceptable):
   a) Low Water Level (when required by contract drawings)
   b) Off Switch
   c) Low Water Flow (when required by contract drawings)
   d) Fuel Limit (low or high gas pressure switch)
   e) High Boiler Supply Temperature Limit
   f) Low Boiler Return Temperature
   g) Low Air Flow
   h) Flame Safeguard Internal Fault
   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)

An industrial duty microprocessor-based FSG shall provide: safety interlocks, flame monitoring protection and timed sequences. Sequences shall include forced draft fan start and stop, furnace purge, burner light-off and shutdown and post-purge. Control components shall be fully integrated for automatic sequencing of light-off and shutdown.

G. Boiler Pump Sequence

Include primary water pump control to allow boiler warm-up to the return water temperature before the boiler start; adjustable water flow delta t 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. System and Standby System Pump (when required by contract drawings)

System pump shall be energized based upon an input from the system, unless when turned off by the Warm Weather Shutdown feature. A Standby System pump, if applicable, shall be energized based on an input signal indicating the primary system pump is not operating. Additional LWCO by customer must be added to flow loop.

I. Flue Gas Condensate Protection

Include alarms and control logic to help prevent corrosion in the boiler due to sustained flue gas condensation. These features become increasingly important as we add energy savings modulation and outdoor air reset functions. Provide a 4-20mAdc, three-way mixing valve control output based on PID control, measured boiler inlet temperature and minimum inlet temperature setpoint and measured boiler inlet and outlet temperature difference and differential setpoint. If the boiler inlet water temperature drops below setpoint or the differential temperature is excessive the valve shall open to allow hot boiler outlet water to blend with cold inlet water temperature. The valve repositions toward 0% recirculation after inlet water temperature increases above setpoint. Low boiler inlet water temperature shall be alarmed using an alarm message, indicating light and an alarm contact output. Excessively low boiler inlet temperature events shall be stored with boiler historical data.

J. Mixing Valve (when required by contract drawings) EVCA model only

In order to prevent low inlet water temperature, provide an electric actuated three-way mixing valve with a 4-20 mAdc input control signal and slow (1 minute) travel time for each boiler. If the boiler inlet water temperature is below 130° F (adjustable) or when boiler differential temperature is above 40° F (adjustable), the valve shall slowly jog closed causing boiler outlet water to blend with the inlet water. When the inlet water temperature and differential temperature return to an acceptable range, the boiler outlet valve shall slowly jog open.

K. Combustion Air Damper and Vent Inducer (when required by contract drawings)

The boiler control system shall have the capability of energizing the combustion air damper and vent inducer upon call for heat.

L. 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 information as required to provide coordinated fully modulating lead/lag functions by wiring RJ11 phones cords between the 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 is readable/writable or boiler firing rate with start/stop command to be readable and writable.

M. Quality Assurance

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