**[NOTE: Amend to the end of “PART 2 – PRODUCTS” of SECTION 235239]**

* 1. MODULAR BOILER PLANT SEQUENCING CONTROL: For multiple boilers installed in a common system, a standalone boiler plant sequencing control system shall be provided to monitor, enable/disable and command the firing rate of each boiler. To ensure accurate pressure control and optimized boiler operating efficiencies, a Fulton ModSync LX or PLC with equivalent functionality shall be used. Integrated boiler controls do not meet the intent of this specification and are not accepted as an alternate.
     1. The control panel shall be listed and labeled to UL508A and include the following hardware:
        1. A microprocessor-based process controller with a real-time clock, assignable I/O, and a graphical user interface (GUI). The display shall be minimum 12.1” 65,536 color touchscreen LCD. Alpha-numeric displays have inherent flexibility limitations and are not accepted.
        2. The enclosure shall be wall mountable, suitable for installation in indoor or outdoor environments and carry a NEMA 4X rating.
        3. Electrical requirement shall be 120/60/1.
        4. A panel mount disconnect switch shall be provided.
        5. **[Optional:]** A panel mount alarm horn shall be provided.
        6. The following I/O shall be provided:
           1. Digital Inputs (24 VDC)

**[Optional:]** E-Stop Status Monitoring

**[Optional:]** Individual Boiler Remote Mode Selected

**[Optional:]** Individual Boiler Main Burner On Status

**[Optional:]** Individual Boiler Alarm Status

**[Optional:]** Primary Low Water

**[Optional:]** Secondary Low Water

**[Optional:]** High Water

* + - * 1. Digital Outputs (24 VDC)

**[Optional:]** Individual Boiler Alarm Output

**[Optional:]** Individual Boiler Status Output

**[Optional:]** General Steam Demand Status Output

**[Optional:]** Individual Boiler Steam Demand Status Output

* + - * 1. Analog Inputs (4-20 mA)

**[Optional:]** Supply Header Pressure

**[Optional:]** Pressure Retransmission

**[Optional:]** Supply Header Steam Flow Monitoring; From a Field-Supplied Meter

**[Optional:]** Remote CO Monitoring; From a Field-Supplied Meter

**[Optional:]** Supply Header Gas Flow Monitoring; From a Field-Supplied Meter

**[Optional:]** Per Boiler Gas Flow Monitoring; From Field-Supplied Meters

**[Optional:]** Flooded LoopSupply and Return No. 2 Fuel Oil Flow Monitoring (2 Inputs); From Field-Supplied Meters

**[Optional:]** Per Boiler Supply and Return No. 2 Fuel Oil Flow Monitoring (2 Inputs Per Boiler); From Field-Supplied Meters

* + - * 1. Analog Outputs (4-20 mA)

**[Optional:]** Individual Boiler Firing Rate

* + 1. Instrumentation: Shall be field installed and wired back to the boiler plant sequencing panel.
       1. A supply header pressure sensor shall measure the common supply steam pressure for use as the process variable.
       2. **[Optional:]** Outdoor air temperature sensor.
    2. **[Optional:]** Custom Engineered Sequence of Operation
       1. The following custom engineered sequence of operation shall be provided to meet the unique needs of the application: **[Define Here]**
       2. The boiler sequencing system shall have the ability for the control logic to be adjusted and reconfigured by the factory to meet system design changes that may arise during commissioning of the system or future expansion.
    3. Pressure Control Features:
       1. Proportional Integral Derivative (PID) load control
          1. A control variable (CV) is calculated using PID settings and the difference between process variable (PV) and setpoint (SP). The CV is used to determine response.
       2. To satisfy flexible control configurations, multiple setpoint modes shall be provided. The mode shall be field configurable through the touchscreen GUI.
          1. 4-20mA Remote Setpoint
          2. BMS Communication
          3. Local Normal or Setback
          4. Outdoor Air Temperature (OAT) Reset

The control shall monitor OAT and calculate a setpoint pressure. As OAT increases, the setpoint shall decrease, thereby significantly reducing fuel costs and emissions while continuing to satisfy building load requirements.

OAT reset parameters shall be user configurable. Minimum and maximum setpoint parameters shall be provided to prevent the reset schedule from operating outside of a configured pressure range.

* + - 1. An Outdoor Temperature Disable warm weather shutdown function shall be provided to disable the boiler plant upon reaching a configurable OAT. A hysteresis variable will prevent the plant from re-enabling until the OAT decreases by a configurable amount.
      2. Setback functionality shall be provided to adjust the pressure setpoint.
         1. A setback schedule shall be provided based on whether the process is in Normal or Setback mode as determined by configurable Time of Day or Day of Week parameters or manual selection.
         2. An Anticipation Mode function shall be provided to automatically switch to Normal Mode a configurable number of hours earlier than scheduled if OAT drops below a configurable temperature during Setback Mode.
      3. **[Optional:]** Warm Standby:
         1. To ensure boilers are prepared to respond to rapid heating demands, the control shall enable any boiler which has remained idle for a configurable amount of time and command the burner to low fire.
    1. Lead/Lag Control of Modular (Multiple) Boiler Plants: Lead/Lag capabilities shall be provided for up to **[Define # Here]** boilers installed in the same process.
       1. The boiler plant sequencing control shall communicate with the boilers through Modbus RTU or hardwire I/O.
       2. Sequence of Operation:
          1. Upon a steam demand, the lead boiler is enabled and the initial firing rate commanded to a configurable Lead Start Firing Rate parameter.
          2. In accordance with PID settings the CV parameter shall determine boiler firing rate.
          3. A configurable Lag Boiler Start Delay timer shall be provided to prevent short cycling.
          4. The control shall enable a lag boiler when the Lag Boiler Start CV value has been reached and the Lag Boiler Start Delay has expired.
          5. Where additional capacity is required, the control shall enable additional lag boiler stages in accordance with configurable settings until all available boilers in the plant are enabled.
          6. Both sequential and parallel staging methods shall be provided through an interface selection. Sequential staging shall allow each boiler to reach a high firing rate before the next stage is enabled. Parallel staging shall command the plant to modulate in parallel at the same firing rate to satisfy demand at the lowest possible firing rate. To meet flexible needs of the system the control must offer both staging methods, controls which offer only one staging method are not accepted.
          7. The boiler plant shall be commanded to modulate to maintain the system load.
          8. As the load is satisfied, the firing rate of all enabled boilers shall decrease to maintain header pressure. As boiler(s) reach low fire and the CV decreases to a configurable parameter, lag boiler stages shall be disabled in reverse order.
          9. The lead boiler shall be disabled when the process variable reaches a configurable stop parameter relative to the setpoint.
       3. **[Optional:]** Hybrid Plant Sequencing: Lead/Lag capabilities shall be provided for combination Fuel-Fired Boiler and Electric Boiler hybrid plants.
          1. To meet facility sustainability goals, operational requirements and satisfy demand response events, the control shall permit the operator to select energy priority:

Priority Exclusive: Run the plant exclusively on fuel or electricity.

Priority Backup: Utilize fuel or electricity as Lead, the other energy source shall be enabled to satisfy peak demand conditions or as a backup.

Priority Off: Standard automatic rotation of all boilers shall be utilized.

* + - * 1. Priority switchover shall offer the following manual and autonomous capabilities:

Manual Operator Selection

Time of Day

Outdoor Temperature

BAS 24VDC Digital Input

BAS Network Input

* + - 1. Automatic Boiler Rotation:
         1. Automatic rotation of the boiler Lead and Lag positions shall be determined using configurable operating history cycle count or run hours. Sequencing systems that rotate the lead position to the next boiler in the sequence are not accepted due to their inability to maintain balanced boiler usage.
      2. **[Optional:]** Forced Rotation:
         1. When enabled, the control shall rotate the boilers at a configurable time or day of the week and shall not wait for the next heat demand to rotate Lead and Lag positions.
      3. **[Optional:]** Transition Delay:
         1. Running transition functionality shall be provided to allow for more seamless transition when a Lead/Lag rotation is triggered. The running boiler(s) shall remain enabled until the next boiler is firing, or the demand is satisfied.
    1. Graphical User Interface:
       1. The following screens or menus shall be provided for intuitive overview and configuration of the multiple boiler system.
          1. Outdoor Reset Configuration
          2. Setback Schedule
          3. Lead/Lag Configuration
          4. Boiler Configuration

Shall include for each boiler: Status, cycles, run hours, cycles per run hour ratio, outlet pressure, automatic modulation, and manual firing rate control.

Functionality shall be provided to enable/disable each boiler through the operator interface. Disabled boilers are excluded from the sequencing logic.

* + - * 1. System Status

Detail current outdoor, system and control variable values. The status screen will also display enable/disable and firing rate information for each of the boilers.

* + - * 1. Alarm Status

Provides a text description of any current alarm conditions. Boiler sequencing systems that use codes or symbols to detail alarm conditions will not be acceptable.

* + - * 1. Alarm History

Records the last 100 alarm conditions. A Date/Time stamp and text description of each alarm condition in the history shall be available.

* + - * 1. Trending Data

Trending of the supply pressure, system setpoint and outdoor temperature will be displayed to provide system operational history for tuning of the PID and lead/lag parameters.

* + - 1. Password requirements will prevent access to any of the screens where parameters may be adjusted, while maintaining the ability of viewing the system status and performance.
    1. Alarm Handling:
       1. The control shall start a timer when each boiler stage is enabled to run. If the main gas valves do not energize within the user-defined timeframe then a local limit is preventing the boiler from operating. The boiler shall be removed from the lead/lag sequence and a local boiler error alarm should be annunciated. An automatic reset option shall allow the boiler to be re-enabled after a configurable timer has elapsed.
       2. The control shall automatically remove the boiler from the sequencing rotation if an alarm occurs and adjust lead/lag positions. The boiler shall be automatically added back into rotation upon detecting the alarm has been cleared.
       3. The control shall monitor the status of all connected instrumentation and boilers. An alarm shall be annunciated for an instrumentation error.
       4. Should an outdoor temperature sensor error occur, the control will automatically switch to manual (static) setpoint mode.
       5. **[Optional:]** The following custom alarm conditions shall be provided to meet the unique needs of the application: **[Define Here]**
    2. Building Automation System Interface: Hardware and software to enable building automation system (BAS) to monitor, control, and display boiler status and alarms.
       1. Fixed Hardwired Contacts:
          1. Monitoring: General Alarm.
          2. Control: Remote Enable, DHW Aquastat.
          3. Remote Setpoint Signal: 4-20 mA.
       2. Communication Protocol: A communication interface with BAS shall enable BAS operator to remotely enable and monitor the boiler plant from an operator workstation.
          1. The boiler plant sequencing control will communicate to the Building Automation System via a daisy chain addressed Modbus RTU network.
          2. The boiler plant sequencing control shall have the ability to receive the header pressure value from the BAS through the communication protocol.
          3. **[Optional:]** A BACnet MSTP and IP protocol communication gateway shall be provided. A communication point mapping list shall be provided.
          4. **[Optional:]** The following custom integration points shall be provided to meet the unique needs of the application: **[Define Here]**