CSI SPECIFICATION: *Mini-MOD-CNC*

SECTION: 230913   Instrumentation and Control devices for HVAC

PART 1 GENERAL
1.1   Summary
   A. **Section Includes:**
       1. Multi-Stage modulating and sequencing of hydronic condensing and non-condensing boilers for heating applications.

   B. **Related Sections:**
       1. Conforms to applicable building and local code requirements of all authorities having jurisdiction.

1.2   References
   A. **International Organization for Standardization (ISO)**
       1. Manufacturer shall be ISO 9001:2000 Quality Management Systems Certified.

   B. **National Electrical Manufacturers Association (NEMA)**
       1. Enclosure follows NEMA Standard 250. (NEMA-1)

   C. **Underwriters Laboratories, Inc. (UL):**
       1. The control shall be tested and certified per standard 916 "Energy Management Equipment".

1.3   Quality Assurance
   A. **Manufacturer's Quality System:**
       1. Registered to ISO 9001:2000 Quality Standard, including in-house engineering for product design activities.
       2. The control must be UL tested and certified per standard 916 "Energy Management Equipment".

1.4   Control Operation
   A. **Description:** The control shall operate on 120VAC, with a maximum power of 12 VA. The control shall be pre-engineered and programmed exclusively for the modulation, sequencing, and lead rotation of two groups of boilers, condensing and non-condensing. It shall be capable of switching the lead group between the condensing boiler group and the non-condensing boiler group based on the system or the outdoor switching set point and an adjustable switching delay.

   B. **Stages:** The control shall have four stage outputs that can be used to start and stop each stage without the use of any additional equipment. However, it shall be capable of controlling a total of 16 stages using a maximum of two external compatible extension controls. The control shall have the capability of controlling two types of groups of boilers; modulating and staging. For modulating boilers, the control shall be capable of modulating the boilers using a current and/or voltage modulation signal. For staging boilers, the control shall be capable of staging multiple single-stage, two-stage, three-stage, or four-stage boilers.

C. **Sequence of Operation:**

1. **When heat is required while using the system switching set point to switch the lead group**, the control PID shall activate the system pump output. If the prove input is activated, the control shall check the system temperature. If the system temperature is above the system switching set point, the control shall set the lead group to the non-condensing group and shall start its lead boiler to satisfy the heating load. If the system temperature was at or below system switching set point, the control shall set the lead group to the condensing group and shall start its lead boiler to satisfy the heating load. If during the lead group operation, the system temperature changed to allow for the second group to be the lead, the control shall hold the current lead group for an adjustable switching delay before changing the lead group.

2. **When heat is required while using the outdoor switching set point to switch the lead group**, the control PID shall activate the system pump output. If the prove input is activated, the control shall check the outdoor temperature. If the outdoor temperature is above the outdoor switching set point, the control shall set the lead group to the condensing group and shall start its lead boiler to satisfy the heating load. If the outdoor temperature was at or below outdoor switching set point, the control shall set the lead group to the non-condensing group and shall start its lead boiler to satisfy the heating load. If during the lead group operation, the outdoor temperature changed to allow for the second group to be the lead, the control shall hold the current lead group for an adjustable switching delay before changing the lead group.

3. **Using the lag group as a Backup:** The control shall offer a setting that will allow the lag group boilers to turn on in addition to the lead group boilers when the lead group's full capacity cannot satisfy the heating load.

4. **Modulating boilers sequence of operation:** When heat is required, the control PID shall activate the lead boiler in the lead group and start its purge delay followed by the initiation of modulation at the Ignition Percent. When additional heat is needed, the control shall start to increase modulation until the Modulation Start percent has been reached. That shall be followed by the initiation of the lag boiler purge. The lag boiler shall remain at the Ignition percent and the lead boiler shall resume its modulation until it reaches full fire (100% modulation). Any requirements for additional output shall trigger the control to increase the lag boiler modulation. When the control PID requires reduced output, the control shall reduce the modulation of the lag boiler until it reaches its Ignition percent. That shall be followed by the reduction of modulation of the lead boiler until it reaches 40% percent of the Modulation Start percent at which the lag boiler shall turn off.

5. **Sequencing boilers sequence of operation:** When heat is required, the control PID shall activate the lead boiler in the lead group and start its purge delay and energize its lowest firing stage. When additional heat is needed, the control shall not energize the lag stage except after the lead stage has been on for at least a full Reaction Time. This shall apply to all the stages regardless of the boilers they are part of. When less output is required, the control shall de-energize the last stage turned on only after it has been on for at least the Minimum Runtime. No additional stages shall turn off unless the previous stage has been turned off for at least the full Minimum Runtime.

D. **Features:**

1. **Operate a Condensing and a Non-Condensing Boiler Groups**: The control shall be capable of switching the lead boiler group between a condensing and a non-condensing boiler groups based on either the outdoor temperature or the system/return water temperature to achieve the maximum system operating efficiency.

2. **Modulating and Staging Boiler Groups**: The control shall be capable of operating two groups of boilers. Each group shall be of the modulating or staging type. The control shall have a set of independent settings for each group.

3. **Outdoor Reset**: The control shall provide an integral outdoor reset adjustment that changes the system target set point based on the outdoor temperature. All outdoor reset curve parameters shall be field adjustable.

4. **Modulating Boilers Ignition Percent and Modulation Start Percent:** For each of the modulating boiler groups, the control shall have a Gain setting to adjust the PID rate of modulation change. For each individual modulating boiler, the control shall have an Ignition Percent and a Modulation Start Percent.

5. **Staging Boilers Reaction Time and Minimum Runtime:** For each of the staging boiler groups, the control shall have a separate Reaction Time and Minimum Runtime setting that adjusts the PID delays required to turn on or off a stage. The control shall utilize the Reaction Time when adding boiler stages. The control shall utilize the Minimum Runtime when turning boiler stages off.

6. **Purge Time:** The control shall have an adjustable purge period. This setting shall determine the delay time required for a boiler to start to produce output.

7. **Last Stage Hold:** The control shall have an adjustable Last-Stage-Hold setting. This setting shall keep the last boiler at its lowest firing rate for an additional, field adjustable, number of degrees before de-energizing it to reduce the short cycling of the lead boiler during low heat demand periods.

8. **Rotation:** The control shall be capable of rotating the lead boiler within each group of boilers either based on an adjustable time period (between 1 hour and 60 days), First-On/First-Off, or Manually.

9. **Parallel or Normal Modulation:** The control shall have an option to parallel modulate boilers within the same group where multiple boilers shall increase and decrease their modulation together. The control shall also be capable of modulating boilers normally by increasing or decreasing the modulation of one boiler at a time.

10. **Parallel or Normal Sequencing:** The control shall have an option for group parallel sequencing where the control shall start the lower firing stages on all boilers before energizing the higher firing stages. Also, it shall have a normal sequencing mode where it shall bring on the lowest stage of a unit followed by the next higher stage on the same unit. Then when all stages on that unit are energized, it shall do the same to the next unit inline.

11. **Memory:** The control shall store all configuration and settings on an EE-Prom. In case of power failure, the control shall retrieve all of its latest settings on the next power up.

12. **Display:** The control shall have a graphical display capable of displaying a minimum of five lines by twenty-one characters. The display shall be visible with no ambient light. All control operation information shall be available for display. During times of inactivity, or 5 minutes after the last user entry, the display shall enter default mode. In this mode the control shall display the outdoor temperature, system temperature, and each stage status.

13. **Setback Schedule or Remote Setback:** The control shall have a setback setting where it will reduce the target temperature of the system by the setback setting either based on the programmed schedule or using an external setback signal.

14. **Boost:** The control shall have the capability of increasing the target system temperature by a specified setting for 30 minutes when switching from setback to normal period to preheat the building to the desired temperature.

15. **Domestic Hot Water:** The control shall offer several domestic hot water priority options. It shall have a DHW set point and be capable of accepting a dry-contact DHW call input. During a DHW call, the control shall change the target system temperature to the DHW set point.

E. Inputs:

1. **Outdoor Temperature:** The control shall be capable of accepting a Heat-Timer thermistor type sensor to be used to read the current outdoor temperature. It shall be placed on the north side of the building at least 10 Ft. above the ground.

2. **System Temperature:** The control shall be capable of accepting a Heat-Timer thermistor type sensor to be used to read the current system temperature. It shall be placed on the system water pipe supply or return to measure the circulating water temperature.

3. **Domestic Hot Water dry-contact Call:** The control shall be capable of accepting a dry-contact input to be used as a domestic hot water call. This shall be the input from a domestic hot water tank aquastat connection.

4. **External Shutdown (Opened for normal operation):** The control shall be capable of accepting a dry-contact shutdown input. This shall prevent any heat call from activating the boilers. However, a DHW shall be capable of starting the boilers.

5. **Thermostat Input (Closed for normal operation):** The control shall be capable of accepting a dry-contact Thermostat input. This shall prevent any stage from being activated when the contact is opened.

6. **Setback Input:** The control shall be capable of accepting a dry-contact Setback input that could be used to lower the set point by a specified number of degrees to save energy.

7. **Prove Input:** The control shall be capable of accepting a dry-contact prove input to check on system components before energizing the stages. This shall prevent any stage from being activated until the contact is closed/shorted.

F. **Outputs:**
1. Four Stage relay outputs
2. Four Stage current or voltage modulating outputs
3. System relay output
4. Connection to compatible extension controls.

G. **Sensor History:**
1. **System Sensor History:** This shall be the history of the system sensor readings at 12-minute intervals for the past 24 hours.
2. **Outdoor Sensor History:** This shall be the history of the outdoor sensor readings at 12-minute intervals for the past 24 hours.

1.5 Regulatory Approvals

A. **Underwriters Laboratories, Inc. (UL):**
1. The control shall be tested and certified per standard 916 "Energy Management Equipment".

1.6 Items Included

A. **Outdoor Temperature Sensor** shall be of the Thermistor type capable of measuring temperatures between –30°F to 250°F. It shall have a weather shield.

B. **System Temperature Sensor** shall be of the Thermistor type capable of measuring from –30°F to 250°F. It shall fit in a 3/8" well.

1.7 Security

A. **Control Security:**
1. No changes to control settings shall take place except after the program switch has been toggled to allow for changes. The switch shall be located in a secure location on the control where it can be locked from unauthorized users.