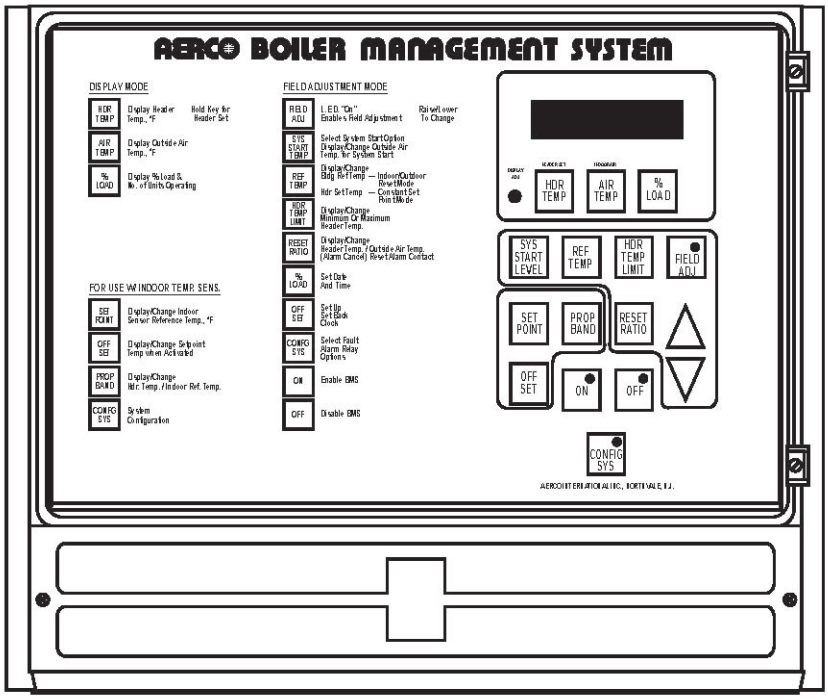
Applicable to Serial Numbers 329985 and above (EPROM Rev. K and above)

BOILER MANAGEMENT SYSTEM



Revised: 06/22/2010

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About Your New Boiler Management System (BMS)

AERCO's Boiler Management System (BMS), stages and modulates AERCO KC Series and Benchmark Boilers, allowing them to operate efficiently as a system. It provides a broad array of operating modes, so that the nuances of specific applications can be easily accommodated. The BMS can control up to 40 boilers; 8 via pulse width modulation (PWM) and up to 32 via Modbus (RS485) communication. For Modbus control, the AERCO Boilers must be equipped with C-More Control Systems.

PRECISE CONTROL

Utilizing PWM or Modbus control, the BMS fully exploits the condensing and modulating ability and efficiency of each boiler and regulates the output of the boiler plant with water supply temperature variation of no more than ±2°F

Staging can be performed sequentially or in parallel. The BMS can sample building reference temperatures to modulate boiler plant output, and will perform water supply temperature night setback automatically referenced to its internal clock.

SIMPLE INSTALLATION AND OPERATION

Installation of the BMS is simple, and low-voltage wiring is employed between the BMS panel and boiler modules. There are no complex design steps to be performed, since a keypad in conjunction with the LCD allows the operator to acquire, change, and program settings through easy-to-use labeled buttons. Each BMS function consists only of selecting the function and toggling values, which generally requires no more than pressing four keys.

The instant a parameter is programmed, it is automatically entered into the BMS memory, avoiding multiple programming steps to store information. In the event of power loss, most factory default settings remain in nonvolatile memory for up to 10 years and need not be reprogrammed. However, date and time remain in memory for about 30 days.

BMS PROGRAMMING VIA RS232 PORT

If desired, the BMS can be programmed by connecting a Laptop Computer, or other type of terminal emulation device, to the RS232 connector on the left side of the BMS. See Appendix J for programming using RS232 communication.

Section 1 - Features of the BMS

APPLICATION FLEXIBILITY

Three different system or control options can be selected at setup to match the needs of any closed-loop system - Indoor/Outdoor Reset, 4-to-20 mA Remote Setpoint, and Constant Setpoint.

CONTINUOUS COMMUNICATIONS

The BMS continually sends information to the boilers and receives information from them, providing total control of boiler plant dynamics.

EXCEPTIONAL ACCURACY

The BMS control system uses a PID (Proportional Integral Derivative) control algorithm to respond dynamically to system changes. Water temperatures are precisely controlled by modulating energy in put. A supply water temperature of ±2°F is assured.

BUILDING INDOOR AIR TEMPERATURE INPUTS

The BMS accepts building indoor air temperatures directly from a thermistor sensor or from a 4-to-20 mA signal. Adjustments can be made to the header setpoint temperature to compensate for varying building temperatures and conditions.

SEQUENTIAL OR PARALLEL OPERATION

Modules can be either sequenced on, or run in parallel, by selection from the front panel. In sequential mode, boilers are brought on one at a time, so turn-down ratio is 14 multiplied by the number of KC Series boilers, or 20 multiplied by the number of Benchmark boilers. This provides higher energy savings and seasonal efficiency. In parallel mode, all of the boilers are modulated together at the same firing rate. The turn-down ratio of the system is fixed at 14:1 for the KC Series boilers and 20:1 for the Benchmark boilers.

BUMPLESS TRANSFER

When in sequential mode, the BMS stages boilers on and off, one at a time, at selectable percentages of firing rate. The result is a seamless transition and undetectable room temperature changes. Sequential mode has several other unique features:

Run-Time Equalization: The BMS se-quences boilers on a first on-first off basis, which automatically equalizes the run time of all boilers in the plant.

Automatic Load Distribution: The BMS continuously monitors the number of modules that are available for operation. In the event of a boiler malfunction or when service is performed, the BMS automatically compensates for a lack of response from any unit and brings on the next available boiler to satisfy demand. This feature operates in both parallel and sequential modes.

Time Delay Between Boiler Starts:

A fixed, 30-second time delay between boiler starts ensures smooth energy input without spikes in electrical, gas, or venting conditions.

AUTOMATIC SYSTEM START

Automatic system start contacts for controlling auxiliary equipment such as pumps and dampers can be selected to close between 32°F and 100°F outside air temperature, eliminating the need for the plant operator to turn auxiliary equipment on and off.

MINIMUM AND MAXIMUM HEADER SET CLAMPING

The supply water temperature can be clamped at a maximum high temperature or minimum low temperature, to ensure that the building temperature is optimal for the greatest comfort.

Two Interlock Circuits (Enable/Disable Contacts)

The BMS contains two normally-open interlock circuits that require only a set of dry contacts to enable or disable the boiler plant. They can be used to monitor pumps, combustion air dampers, or other equip-ment. Out-of-limit conditions trip the interlocks, shutting down the boiler plant, and providing a high level of protection.

ADJUSTABLE OFFSET

The Offset feature can allow the temperature of the supply water to be offset in 1° increments over a range of -50°F below to +50°F above its current temperature. This feature is employed for night setback or morning warmup. The BMS lets you select, over a 7-day period, the time when the offset begins and ends.

CONTROL OF AUXILIARY EQUIPMENT

The auxiliary relay uses a dry set of contacts to operate auxiliary equipment. For example, when the boiler plant is at 100% load, these contacts close and can start an auxiliary boiler, or notify an energy manage-ment system of a full-load condition.

FAULT ALARM SURVEILLANCE

The BMS continually monitors its sensors for opens and shorts and the interlock circuits for opens. However, the BMS fault alarm relay does not close or indicate a fault when a boiler has failed. The fault alarm circuit consists of a dry set of 120 VAC contacts rated at 5 A.

SIMPLE INSTALLATION

The BMS operates from 120 VAC, 50 to 60 Hz, and uses Belden 9841 or equivalent wiring between modules for control and monitoring. The lightweight panel can be mounted up to 200 feet from the boilers when using pulse width modulation communication.

RUGGED AND RELIABLE

The BMS is housed in a NEMA 13-grade enclosure and operates in ambient temperatures as high as 131°F (55°C).

POWER-OFF MEMORY

Most system configuration values are retained in nonvolatile memory for up to 10 years. Date and time remain in memory for approximately 30 days.

MODBUS COMMUNICATION

The BMS can monitor or control C-More Boilers using Modbus communication via its RS485 port. It can also be monitored or controlled by a Building Automation System (BAS) or a PC connected to its RS232 port.

Section 2 - Installing the BMS

Please follow the installation procedure in the order presented. Incorrect wiring may damage the unit and void the AERCO warranty Do not omit steps, and do not substitute other types of wiring for those specified. Figure 1 shows a typical BMS installation.

3.1 MOUNTING THE BMS

Use the mounting plate (Figure 2) supplied with the BMS to securely mount the unit away from moisture, and at an appropriate height for easy reading of the display. To reduce the possibility of electrical noise entering the system, mount the BMS at least 6 feet away from electrical devices such as power panels, high voltage transformers and transmission lines, motors, and fluorescent lights.

All wiring and fusing must be in compliance with the National Electrical Code and with local electrical codes. Control wiring for the sensors and communications links must run in separate conduit and not in the conduit providing line voltage in order to ensure immunity from electrical noise.

All wiring should be installed in conduit leading up to the bottom of the BMS panel. There are five knock-outs in the bottom of the panel by which wiring must enter the BMS.

3.2 GENERAL WIRING

Shielded, twisted-pair cable should be used for sensor and communication wiring. This wiring should be 18 to 24 AWG. Examples of suitable sensor and communication wire are: Belden 9841, 8761, 3105A or equiv-alent. AC power wiring should be 16 to 18 AWG. A BMS wiring diagram is included in Appendix I. Once mounting is complete and the BMS is secured in place, loosen the two captive screws on the wiring cover plate with a Phillips screwdriver. Feed all wiring through the knock-outs provided on the bottom of the panel. All pulse width modulation (PWM) and RS485 control wires should be fed through the two knock-outs furthest to the left.

Shock Hazard!

Extreme caution must be exercised when connecting power wiring to the BMS. The external circuit breaker supplying Line voltage to the the BMS must be turned off to avoid electrical shock

Power wiring should be fed through the right-most knock-out in the bottom of the panel (Figure 3). The remaining knockouts are for control wiring located on the middle terminal block. The terminal blocks can be detached from the BMS headers to simplify field wiring.

Once power wiring is completed, apply line voltage to the BMS, and press the ON key on the BMS keypad to verify proper connection. The display should show **INITIALIZING EPROM REV. n** where **n** is the current EPROM version.

WARNING!

Turn off AC input power to the BMS to avoid electrical shock.

3.3 PULSE WIDTH MODULATION WIRING

Pulse width modulation (PWM) wiring connections are made between the BMS JP2 terminal block and the Relay or I/O Box terminals at each AERCO Boiler. Shielded twisted-pair wire is recommended.

3.3.1 PWM Wiring At BMS

To wire boilers for pulse width modulation (PWM), connect the boiler control wires in ascending order according to the numbers on the BMS (Figure 4). For example, the control wiring for boiler 1 at the BMS would be connected as follows:

- Positive control wire connects to JP 2, terminal 1 (+).
- Negative control wire connects to JP 2, terminal 2 (-).
- Shield wiring connects to the negative (-) control wire at Section BLR 1, terminal 2. The shield is not terminated at the boiler. All shields must be terminated on the BMS end. The wiring terminals labeled SHIELD at terminal block JP3 of the BMS are not internally connected to ground and are only used as a place to terminate the sensor shields. The pulse width modulation shield can be connected to any minus (-) terminal of the PWM terminal strip (JP2).

3.3.2 PWM Wiring At The Boilers

The pulse-width modulation (PWM) control wiring from the BMS to each boiler is connected at each boiler's relay box or input/output (I/O) box, depending on the type of control system used. Modular control systems utilize a relay box as shown in Figure 5 (KC1000) and Figure 7 (Benchmark). The newer C-More control system utilizes an I/O box as shown in Figure 6 and Figure 8.

Regardless of the type of control system used, the PWM wiring is connected to the BMS + and – terminals as shown in the respective illustrations. It is imperative that positive (+) and negative (-) polarity be observed when making these connections. All boilers follow the same control wiring scheme.

When using pulse width modulation, the BMS may be mounted up to 200 feet from the boilers.

3.4 RS485 (MODBUS) WIRING

All Modbus Networks are implemented using a "Master - Slave" technique. The BMS can function as either a "Master" controlling C-More Slaves or a "Slave" controlled by a "Master" Energy Management System (EMS) or Building Automation System (BAS). Therefore, the following paragraphs provide only an over-view of the required wiring connections. Detailed information and setup procedures for RS485 Modbus networks are provided in Modbus Communication Manual GF-114. Refer to GF-114 prior to implementing any RS485 networks using Modbus.

RS485 wiring connections are made using a "Daisy-Chain" configuration. Shielded twisted-pair wire from 18 to 24 AWG is required for all RS485 wiring.

3.4.1 RS485 Wiring At BMS

RS485 wiring connections are made at the BMS at connector JP11 which is labeled RS485 TO BLRS. The location of this RS485 connector is shown in Figure 9. In addition, Figure 9 also shows the locations of the external and internal RS232 connectors which are used to interface the BMS to an EMS Master if required. The pin assignments for the RS485 and RS232 connectors are shown in Figure 10.

Connect the RS485 wiring at the BMS as follows:

- Connect the positive (+) lead to the +(B) terminal of JP11.

- Connect the negative (-) lead to the -(A) terminal of JP11.
- Connect the shield to the SHLD terminal of JP11.

3.4.2 RS485 Wiring At Boilers

RS485 wiring connections are made at the RS485 COMM terminals of each boiler's I/O Box as shown in Figures 6 (KC1000) and Figure 8 (Benchmark). Connect the wiring as follows:

- Connect the positive lead to the + terminal
- Connect the negative lead to the - terminal
- DO NOT terminate the shields to the Ground (G) terminal at the Boiler end of the RS485 loop. Connect the shields of the incoming and outgoing leads together. The RS485 loop should only be terminated at the BMS.

RS485 loops should not exceed 4000 feet.

Detailed wiring diagrams for RS485 Modbus communication networks are provided in the Modbus Communication Manual GF-114.

3.5 SENSOR INSTALLATION AND WIRING

There are two types of sensors that may be installed -- header sensors and outside air sensors. While an outside air sensor is required for Indoor/Outdoor Reset mode, it is not required for Constant Setpoint or 4-to-20-mA modes of operation. However, it is recommended to take full advantage of all BMS features. The header sensor is required for all modes of operation.

Sensor wiring and power wiring should be run separately to reduce the chance of electrical noise entering the sensor wiring.

3.5.1 Header Sensor

The header sensor to be used with the BMS is a sensor that requires a well as shown in Figure 11. When installing the sensor, use a 1/2 inch NPT tapped coupling or a 4 x 4 x 1/2 Tee fitting. Use heat-conductive grease when installing to aid in its response. The sensor probe must be inserted at least 2 inches into the flow of water for proper response. The header sensor must be installed between 2 and 10 feet downstream of the LAST boiler in the plant's supply water header.

The header sensor is a thermistor type sensor. The Resistance vs. Temperature Chart for the sensor is provided in Appendix F. See Figure 11 for installation details.

Shielded pair 18 AWG cable (Belden # 8760 or equiv.) is recommended for header sensor wiring. There is no polarity to be observed. Connect the wires from the sensor to BMS terminals 4 and 5 on JP3. The ground for the shield is at BMS end of the link, not the header sensor. Connect the ground to JP3, terminal 8 (SHIELD). The header sensor can be installed up to 600 feet from the BMS.

3.5.2 Outside Air Sensor

The Outside Air Sensor, AERCO part no. 122662, must be mounted on the North side of the building, shielded from direct sunlight, and away from air intakes or outlets from the building. See Figure 12 for a typical installation. The sensor includes a plate for wall mounting. Shielded

pair 18 AWG cable (Belden # 8760 or equiv.) is recommended for sensor wiring. There is no polarity to be observed. Connect the sensor wires to BMS terminals 1 and 2 on JP3. Connect the shield to JP3, terminal 3 (SHIELD) at the BMS. The shield must not be grounded on the sensor end. The sensor can be mounted up to 600 feet from the BMS.

3.6 INTERLOCK WIRING

The BMS is equipped with two interlocks designated Interlock 1 (INT 1) and Interlock 2 (INT 2). Since both interlocks must be closed for the BMS to operate the boiler plant, the associated wiring terminals are jumpered, prior to shipment. If desired, proving device switches can be connected to either interlock in place of the jumper. If used, interlock wiring connections are made as described in the following paragraphs.

NOTE

If necessary, Interlock 1 can be programmed to operate the boilers only when the outside air temperature falls below the system start temperature. See para. 4.4.2 for details. Interlock 2 cannot be programmed with this feature.

3.6.1 Interlock 1 Wiring

Interlock 1 is often used with auxiliary equipment, such as air dampers or flow switches. If used, connect the end proving switch to INT 1 terminals 11 and 12 as shown in the wiring diagram in Appendix I.

3.6.2 Interlock 2 Wiring

Interlock 2 is a general purpose interlock which can be used with a variety of devices or equipment or conditions that must be proved prior to enabling the boiler plant. If used, connect the end proving switch to INT 2 terminals 13 and 14 as shown in the wiring diagram in Appendix I.

3.7 RELAY WIRING

The BMS contains a System Start Relay, a Fault Alarm Relay and an Auxiliary Relay which can be connected to external monitoring or control devices. The contacts for each of these relays are rated at 120 VAC, 5A and are fused internally at 5A with replaceable fuses. The contact terminals for these relays are shown in the wiring diagram in Appendix I.

3.7 1 System Start Relay

The state of the System Start (SYS START) relay contacts are controlled by the value set for the SYS START TEMP function in the Field Adjust Mode (para. 4.3.5). The contacts are closed only when the outside air temperature is less than the System Start Temperature (SYS START TEMP) which is set in the Field Adjust Mode. The default for this temperature setting is 70°F.

3.7.2 Fault Alarm Relay

The state of the Fault Alarm (FLT ALARM) relay contacts are controlled by the option selected by pressing the CONFIG SYS key when in the Field Adjust mode (para. 4.3.16). Contact closure can be set to ALL FAULTS, INTERLOCK 1, INTERLOCK 2, or NO INTERLOCK.

3.7.3 Auxiliary Relay

The state of the Auxiliary (AUX) relay contacts are controlled by the AUX RELAY CLOSE option selected when in the System Configuration mode (para. 4.4.8). Contact closure can be set to occur either when all available boilers are at the maximum power input or no boilers are available (all boilers faulted or turned off).

NOTE

The SET BACK function is used only if the header supply temperature will be offset manually as described in para. 4.3.13. Disregard para. 3.8 if an automatic header temperature reset schedule is used as described in para. 4.3.12.

3.8 SET BACK

The SET BACK terminals shown in the wiring diagram in Appendix I are used only when implementing a manually-controlled header temperature offset. If used, connect a dry contact switch across SET BACK terminals 15 and 16 on JP3.

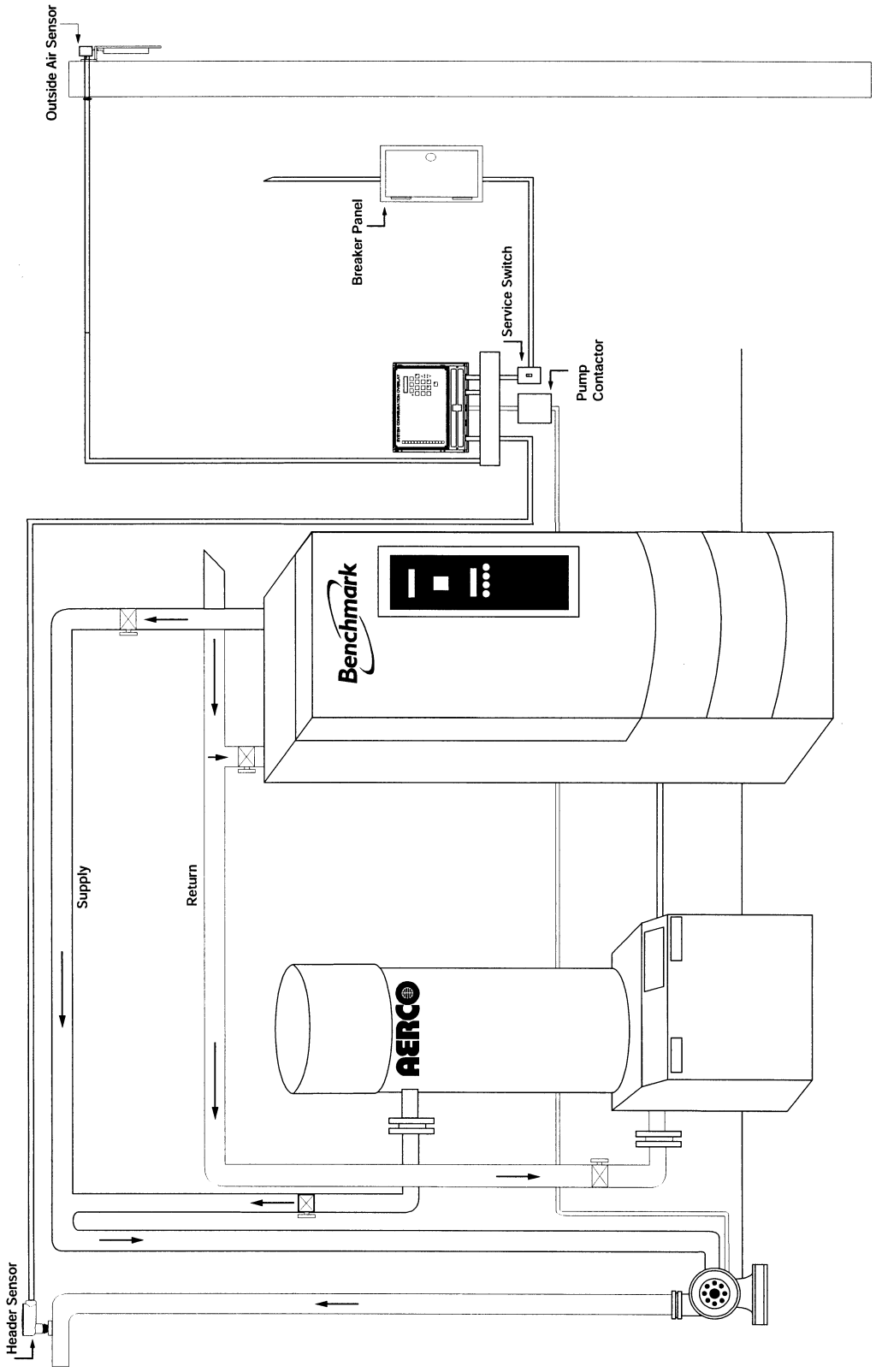


Figure 1
TYPICAL BMS INSTALLATION

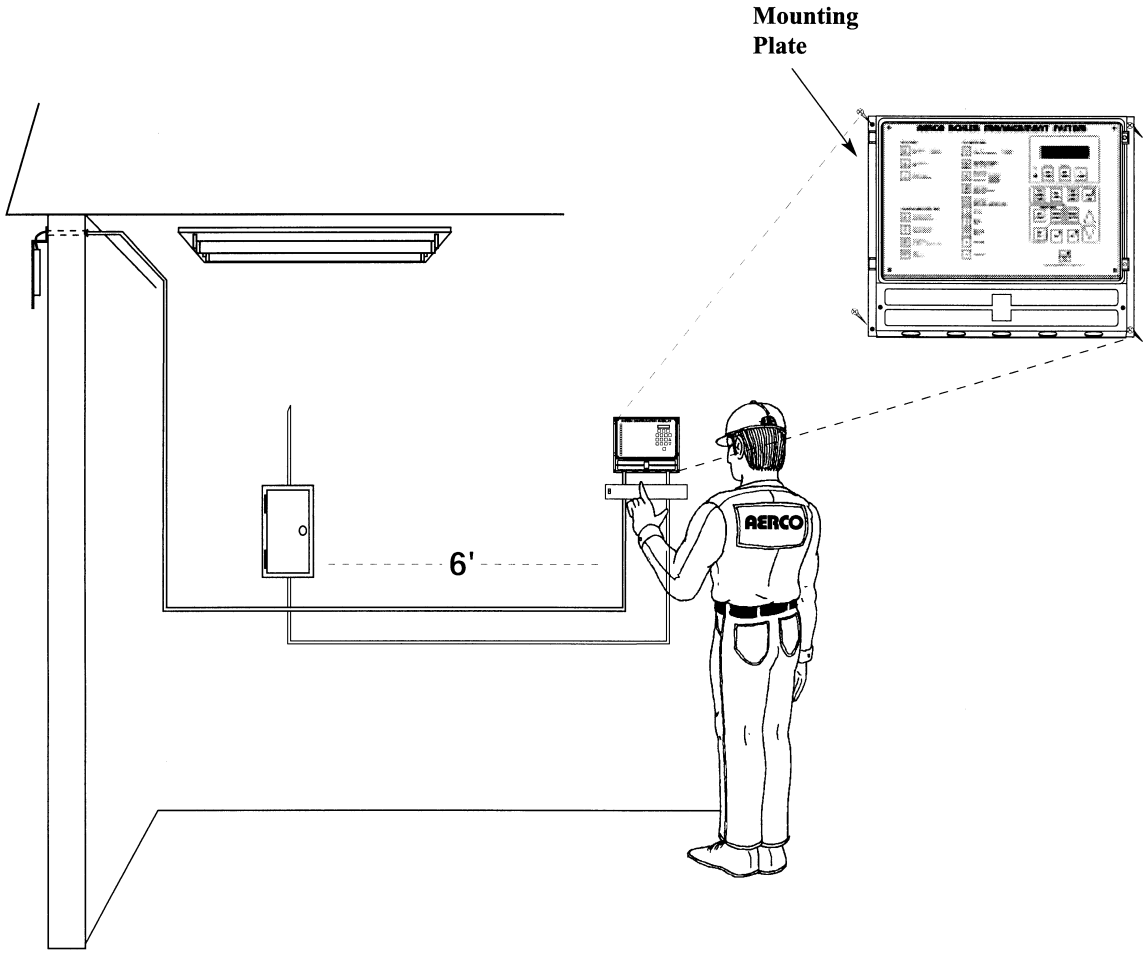


Figure 2
BMS MOUNTING

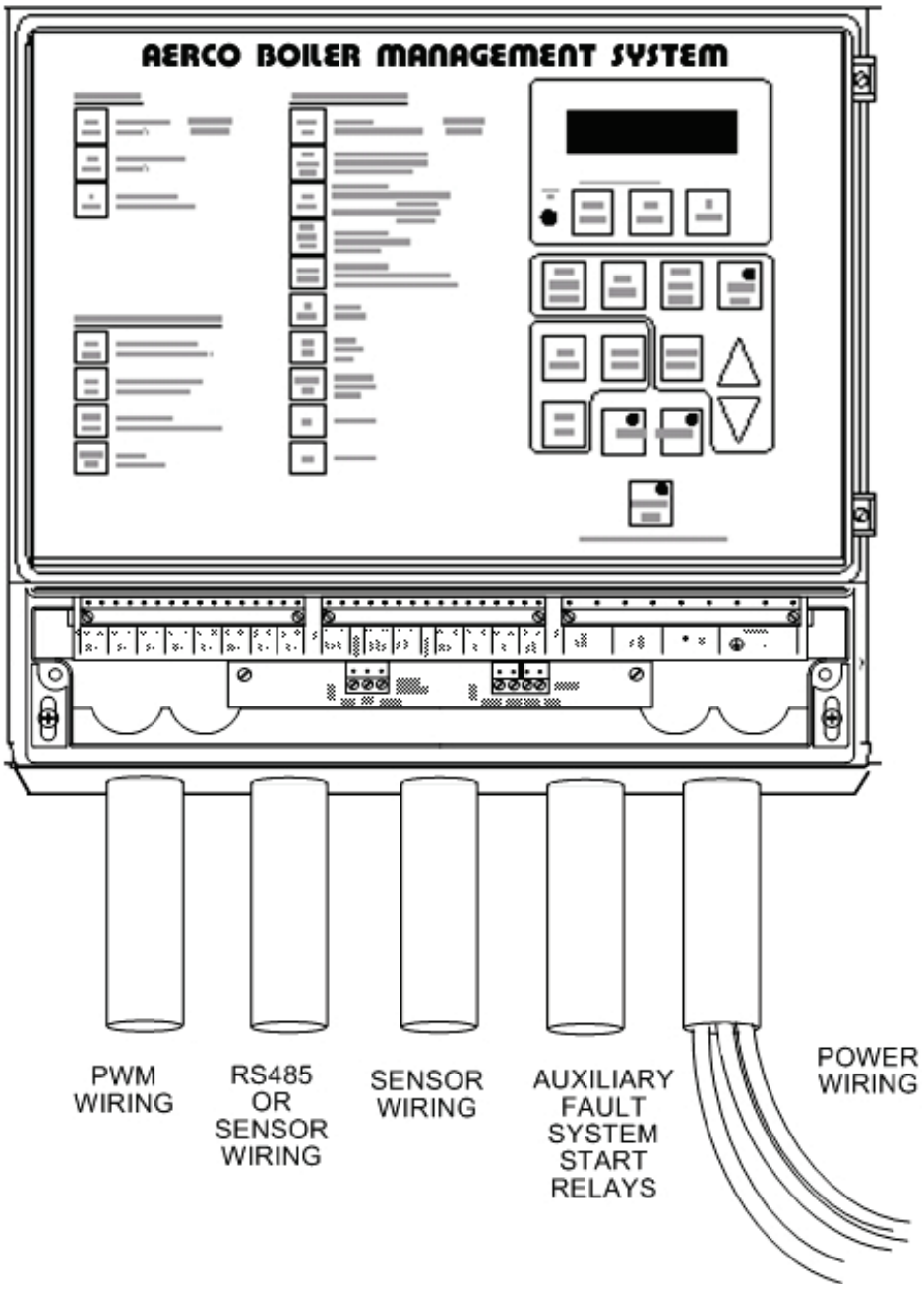


Figure 3
RECOMMENDED WIRE ROUTING LOCATIONS AT THE BMS

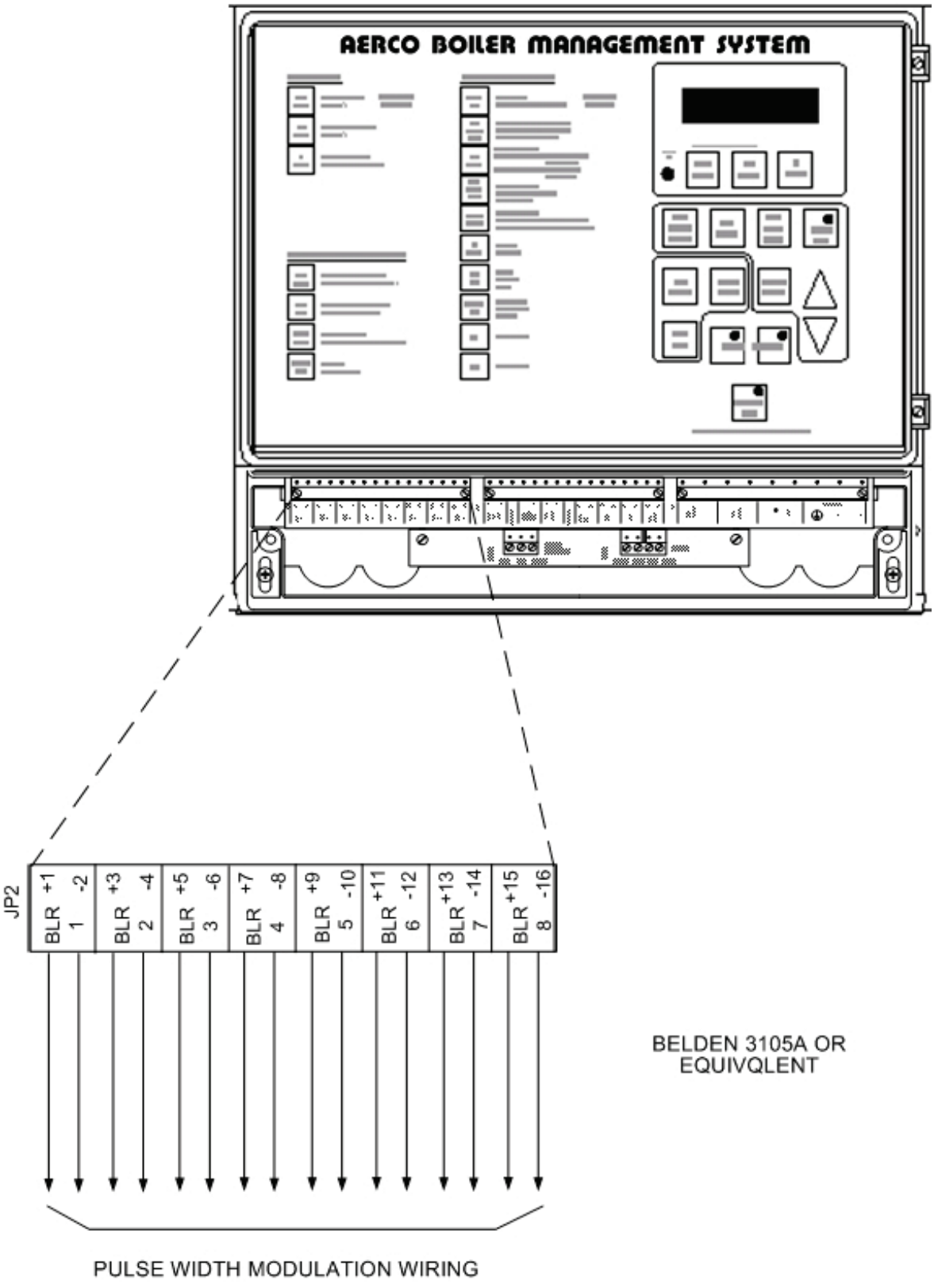


Figure 4
PWM COMMUNICATION OUTPUTS AT THE BMS

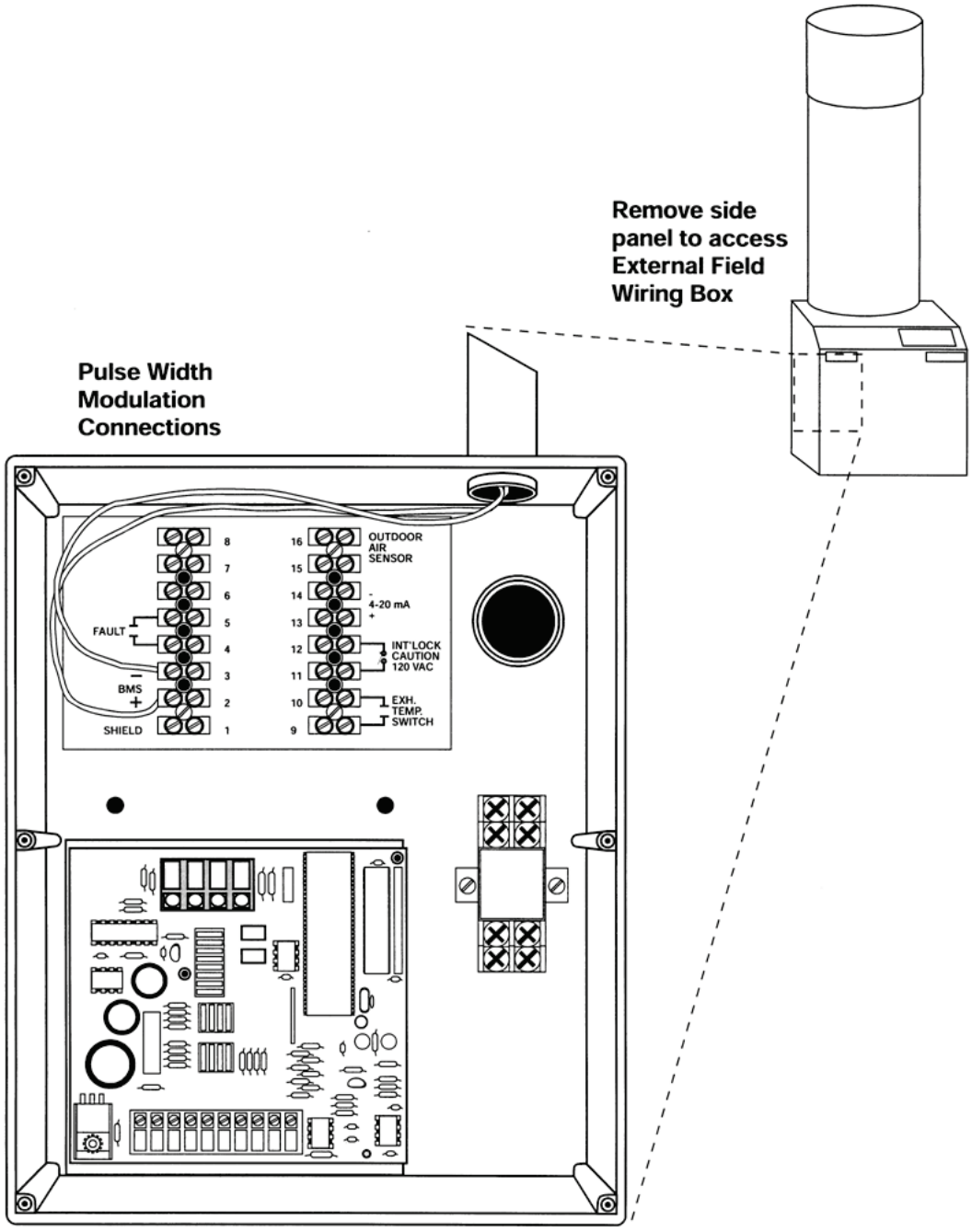


Figure 5
PULSE WIDTH MODULATION CONNECTIONS AT KC SERIES BOILER WITH MODULAR CONTROL BOX

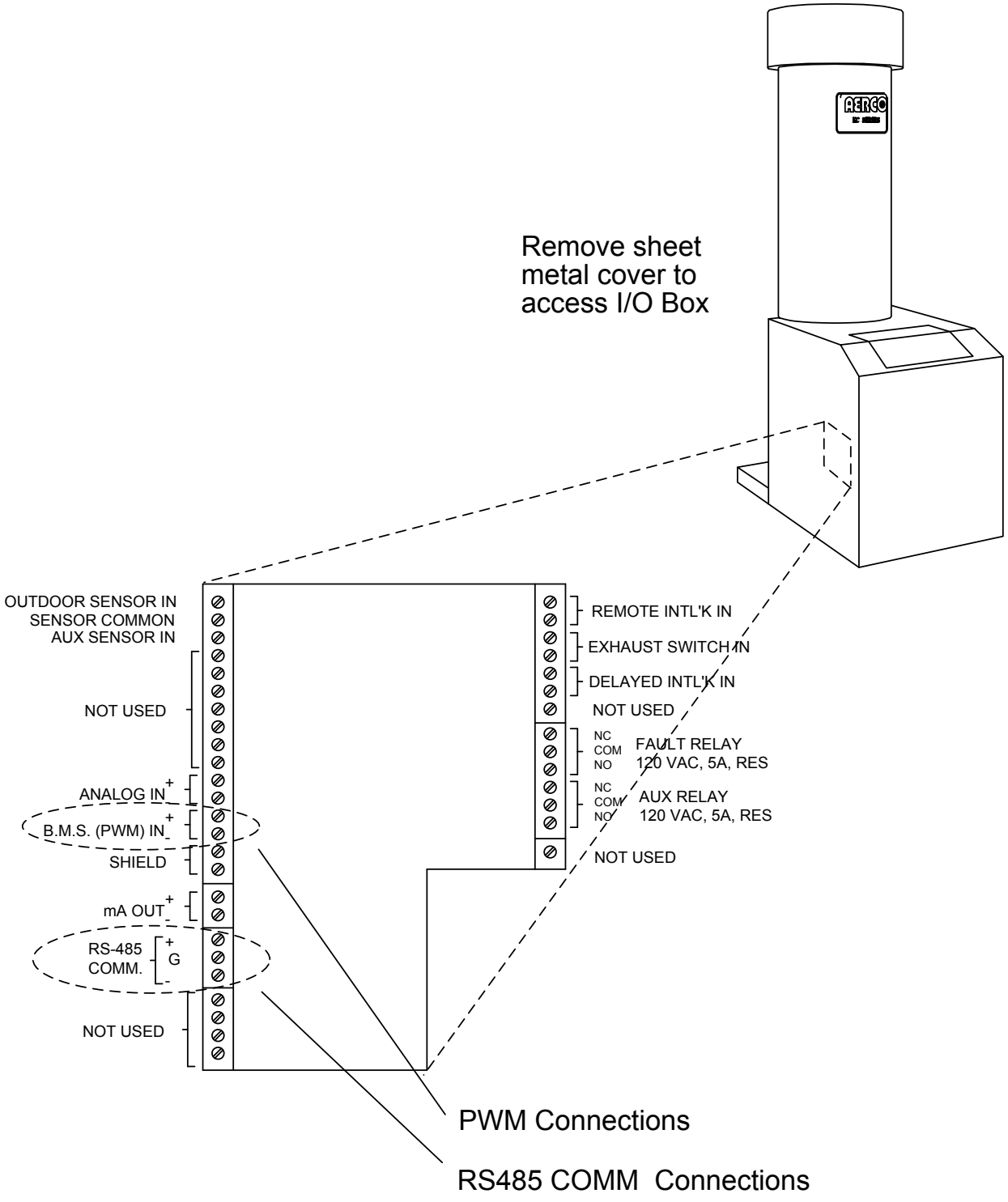


Figure 6
PWM & RS485 CONNECTIONS AT
KC SERIES BOILER WITH C-MORE CONTROL BOX

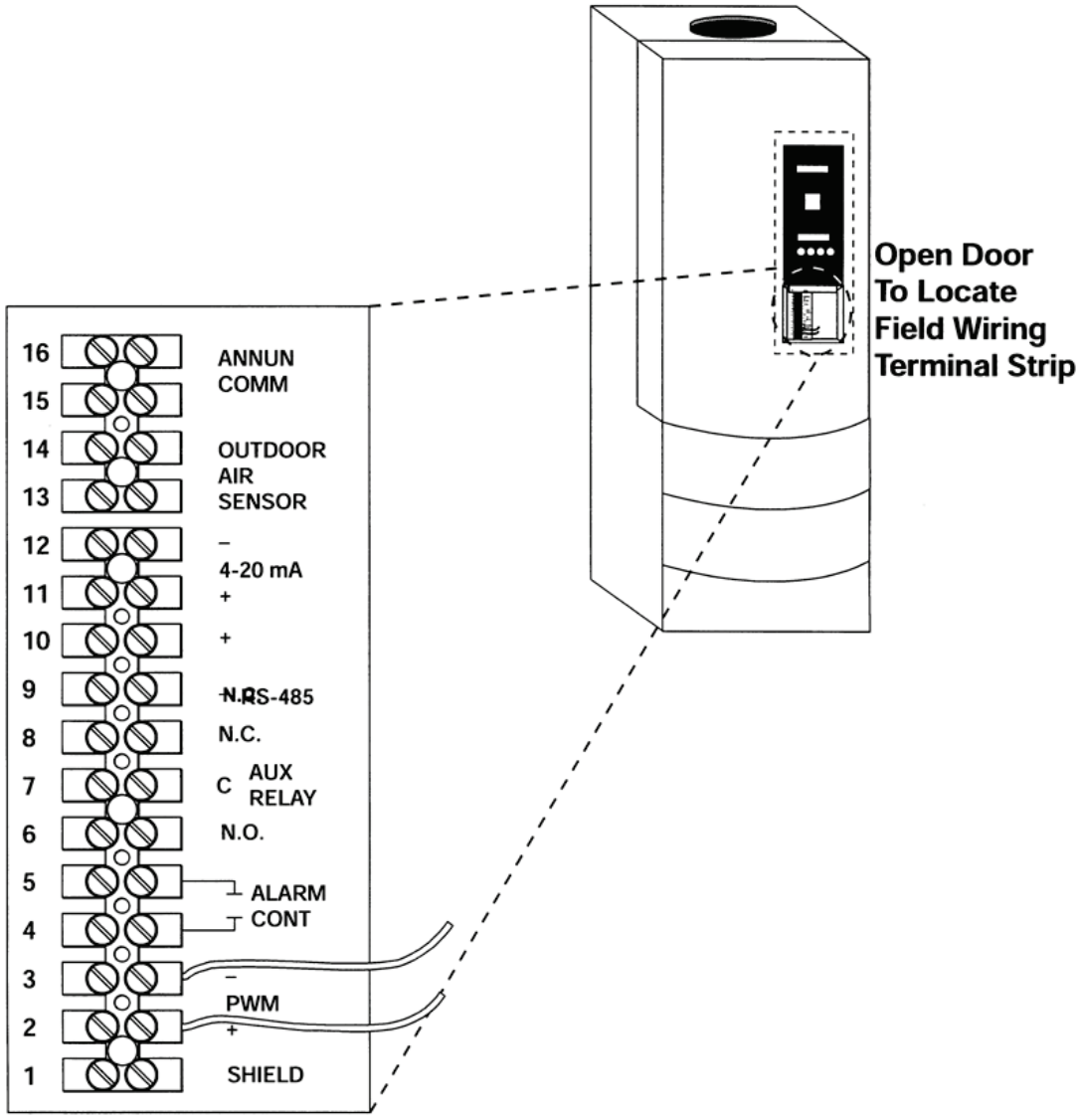


Figure 7
PWM CONNECTIONS AT
BENCHMARK BOILER WITH MODULAR CONTROL BOX

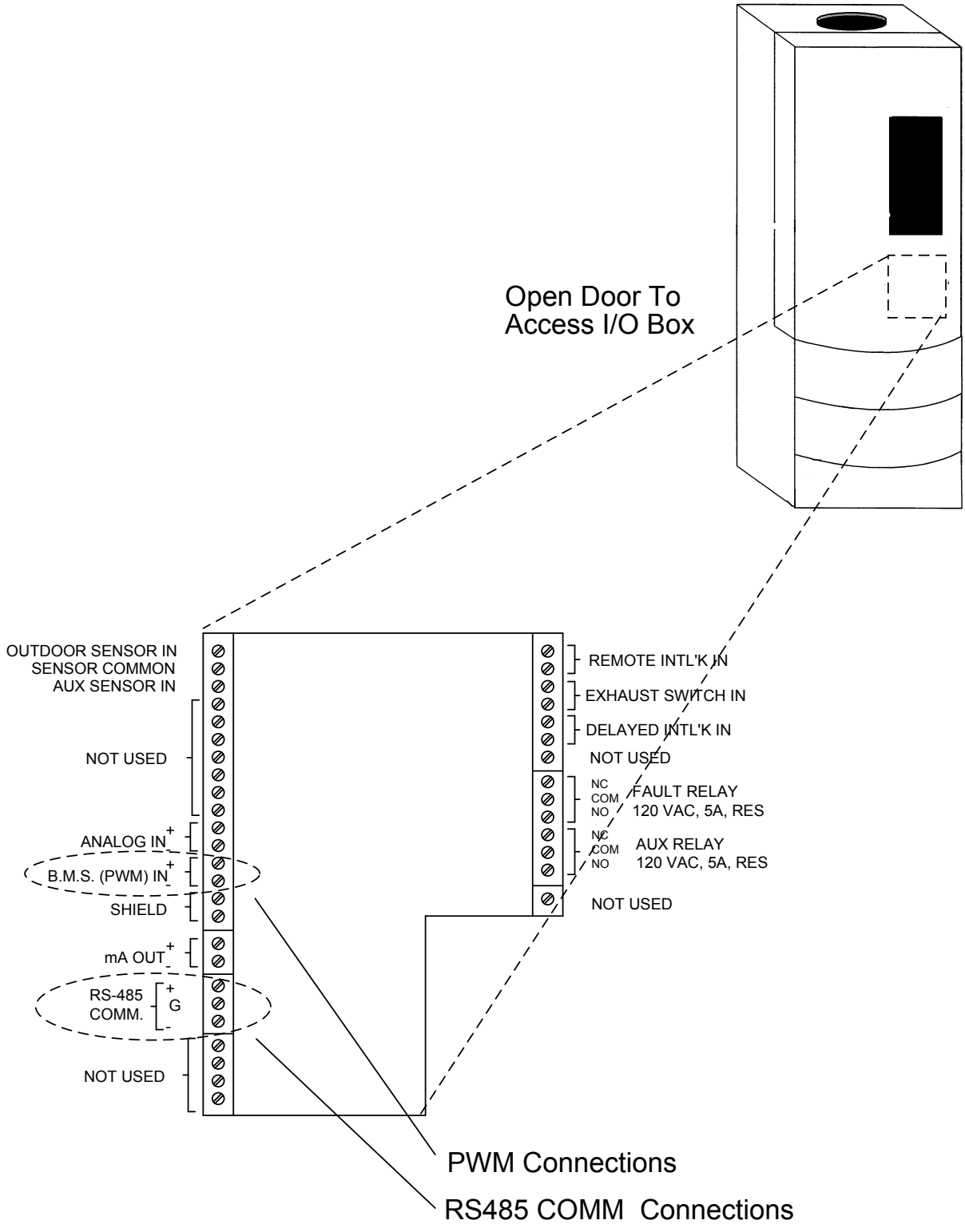
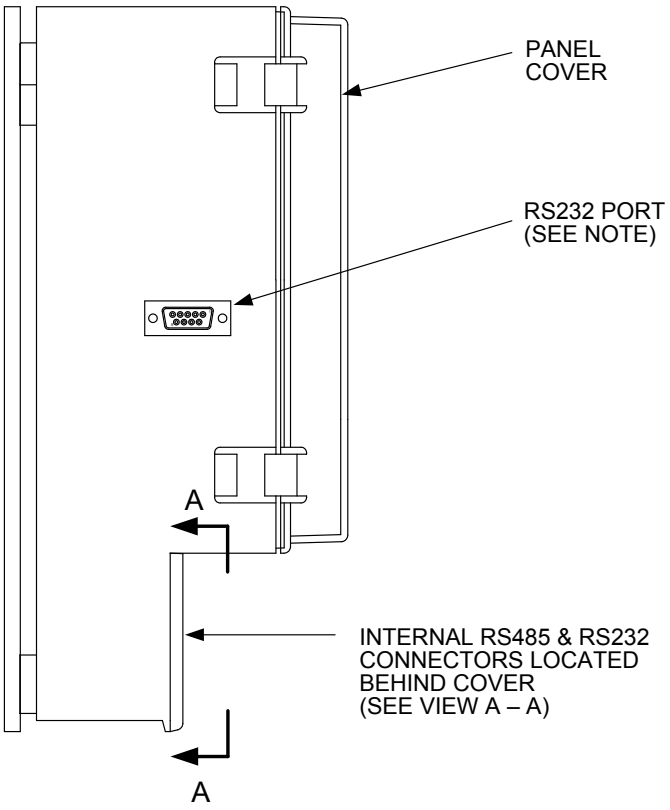
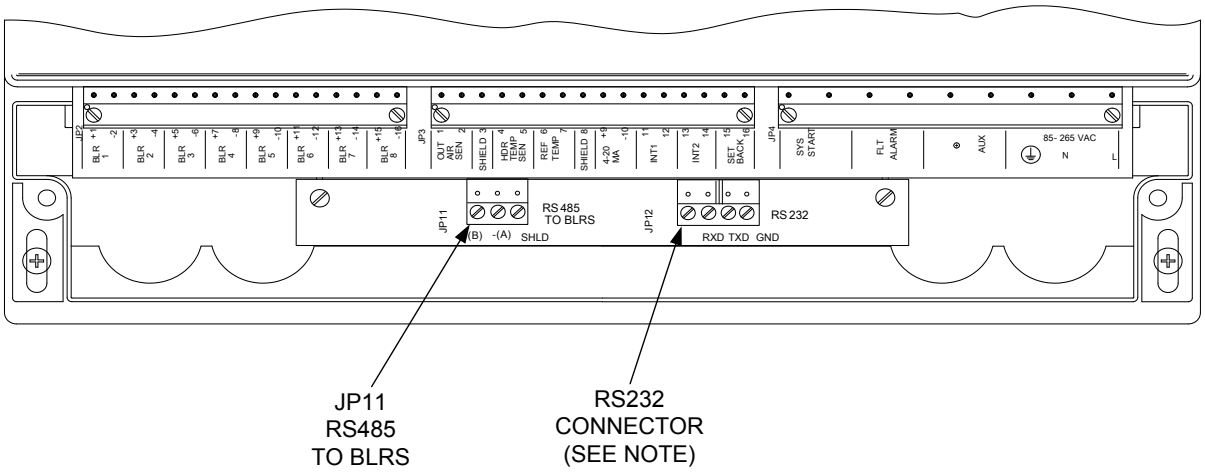


Figure 8
PWM & RS485 CONNECTIONS AT
BENCHMARK BOILER WITH C-MORE CONTROL BOX



BMS LEFT SIDE VIEW

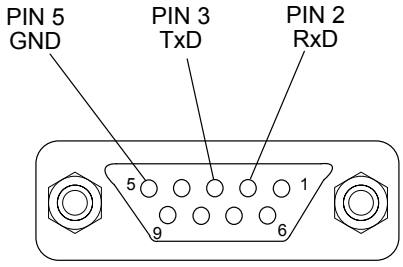
NOTE
ONLY 1 OF THE 2 RS232 CONNECTORS
CAN BE CONNECTED TO AN EXTERNAL
DEVICE AT ANY GIVEN TIME



VIEW A - A

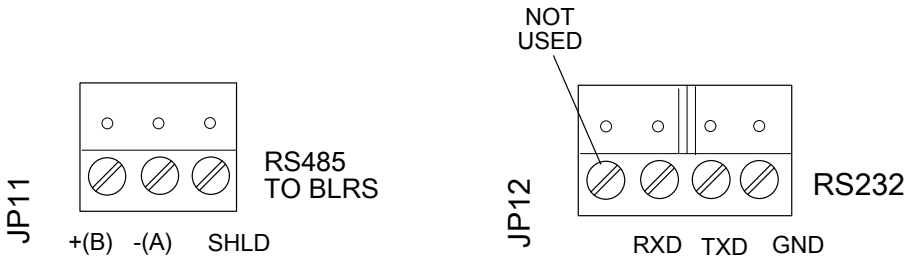
(PARTIAL FRONT VIEW WITH COVER REMOVED)

Figure 9
BMS RS485 & RS232 CONNECTOR LOCATIONS



DB9 (FEMALE)

EXTERNAL RS232 PORT



RS485 PORT

RS232 PORT

INTERNAL RS485 & RS232 PORTS

Figure 10
BMS RS485 & RS232 CONNECTOR PIN ASSIGNMENTS

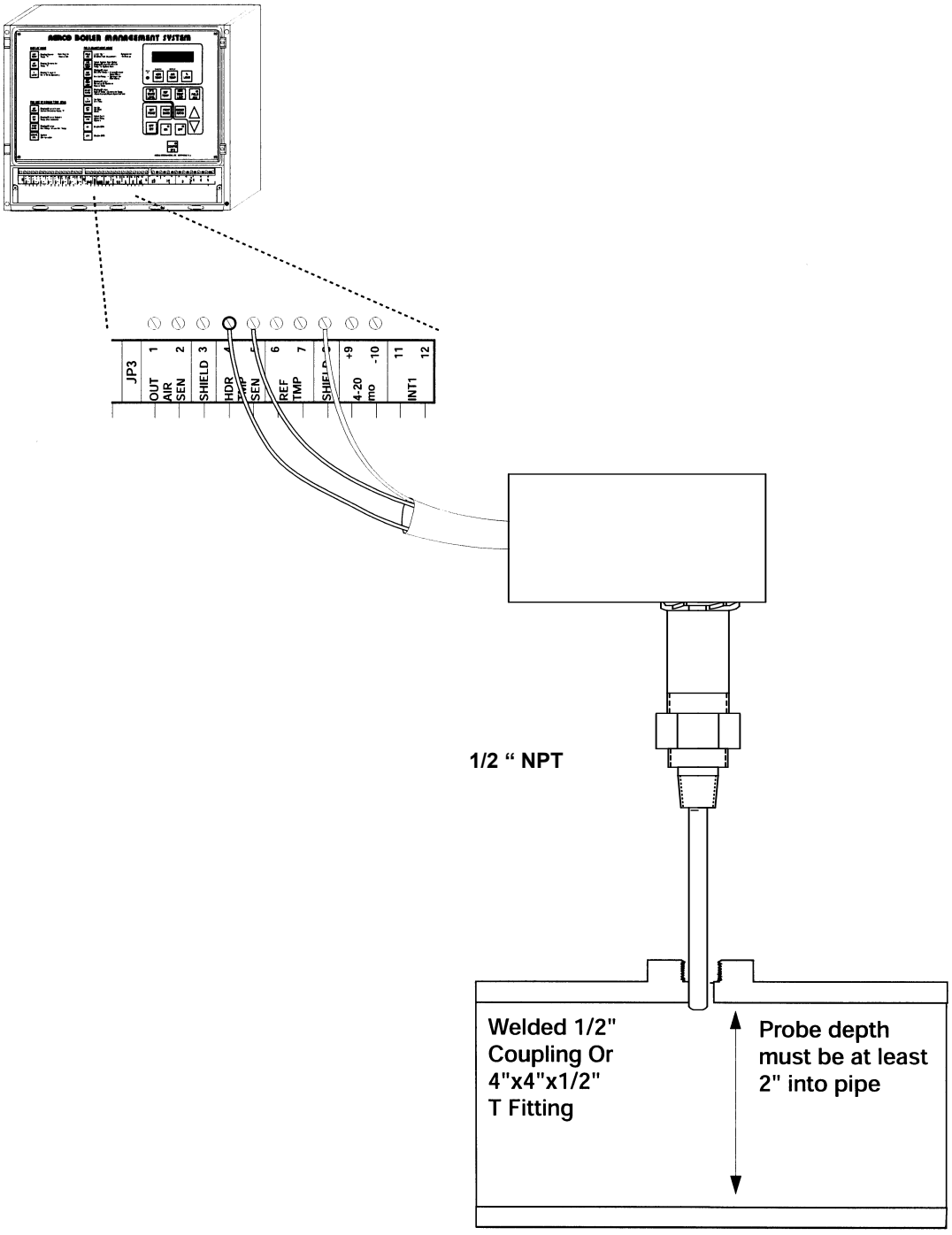


Figure 11
HEADER SENSOR INSTALLATION WITH WELL

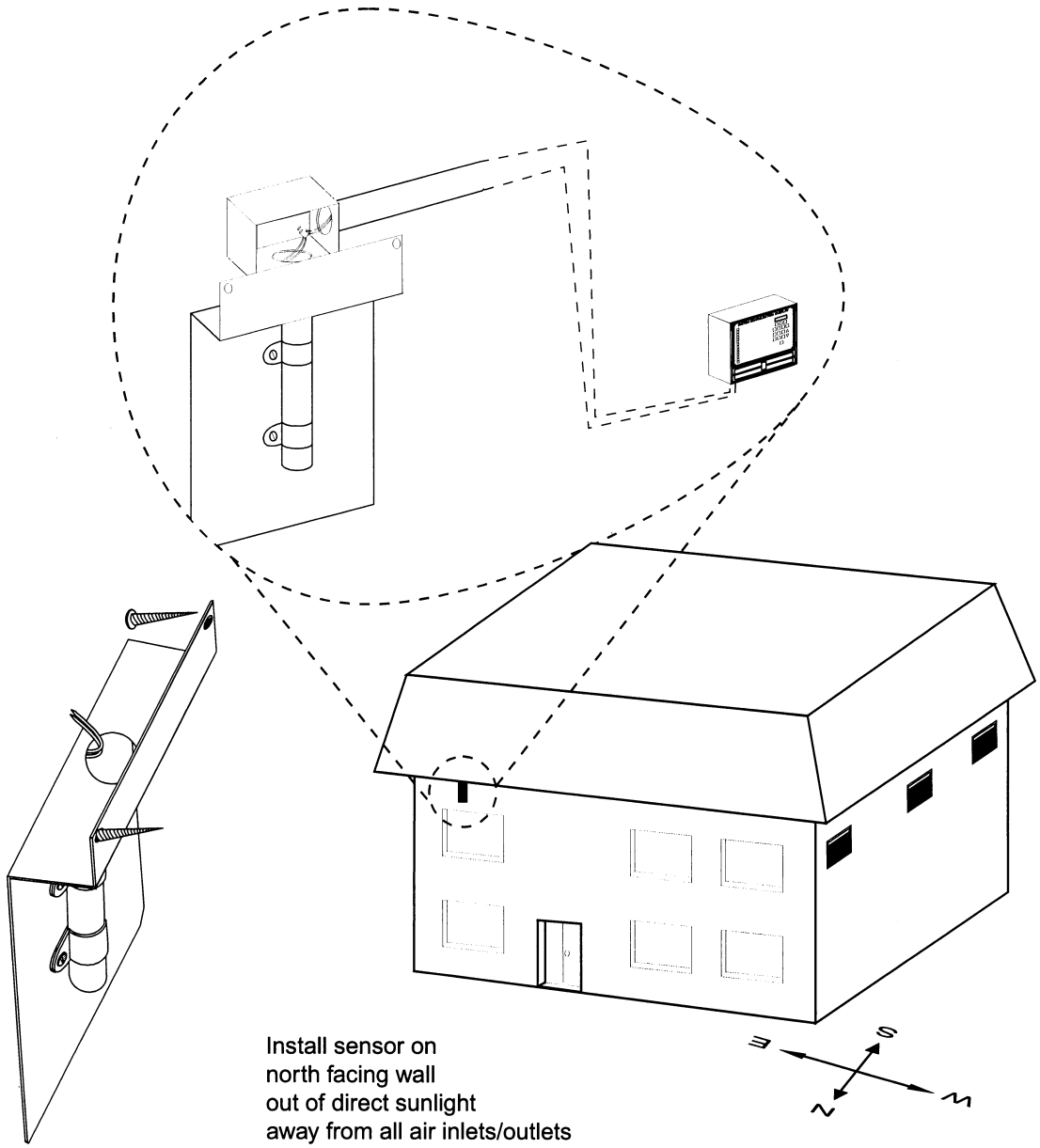


Figure 12
OUTSIDE AIR SENSOR MOUNTING AND CONNECTIONS

Section 4 - Familiarizing Yourself With the BMS

4.1 ABOUT BMS MODES

The BMS has three basic modes: Normal Mode, Field Adjust Mode and Configure System Mode. The Normal Mode is a "Read-Only" mode which only allows you to view system settings. The Field Adjust (**FIELD ADJ**) Mode and System Configuration (**CONFIG SYS**) Mode allow you to view or change BMS settings to customize and tune the system to the specific needs of your site. The BMS keypad normally displays the functions applicable to the Normal and Field Adjust Mode. However, the keys perform slightly different functions for Normal and Field Adjust Modes. When operating in the System Configuration Mode, you must install the **SYSTEM CONFIGURATION OVERLAY** sheet, supplied with the BMS, over the keypad. Figures 13 and 14 show the Normal/Field Adjust layout and the System Configuration keypad layouts respectively.

The following paragraphs describe the operation of the BMS keypad for each mode. In addition, tabular listings summarizing keypad operation for each mode are provided in Appendices C, D and E. Ensure that 120 Vac power is supplied to the BMS and the **ON** key LED is illuminated. If the LED is not illuminated, press the **ON** key.

4.1.1 Selecting and Viewing Functions

As previously mentioned, the Normal mode, is a read-only mode which allows functions to be viewed, but not changed. However, functions associated with the keypad keys can also be viewed in the **FIELD ADJ** and **CONFIG SYS** modes, provided the appropriate mode key (**FIELD ADJ** or **CONFIG SYS**) is first selected. For example, pressing the **HDR TEMP** key displays the supply water temperature. You can view all mode functions by simply pressing its associated key. You must be in the System Configuration mode (**CONFIG SYS**) to view the functions associated with the **SYSTEM CONFIGURATION OVER-LAY**.

4.1.2 Changing Function Settings

To change, rather than simply display settings and functions, the BMS must be in the **FIELD ADJ** or **CONFIG SYS** mode. To change a function value, press the ▲ and ▼ arrow keys until the display shows the desired selection. Once you change the value, associated with one or more function keys they are automatically stored in non-volatile memory. For example, if you change the values for three separate functions in the Field Adjust mode, you don't need to exit and then re-enter the mode for each function change.

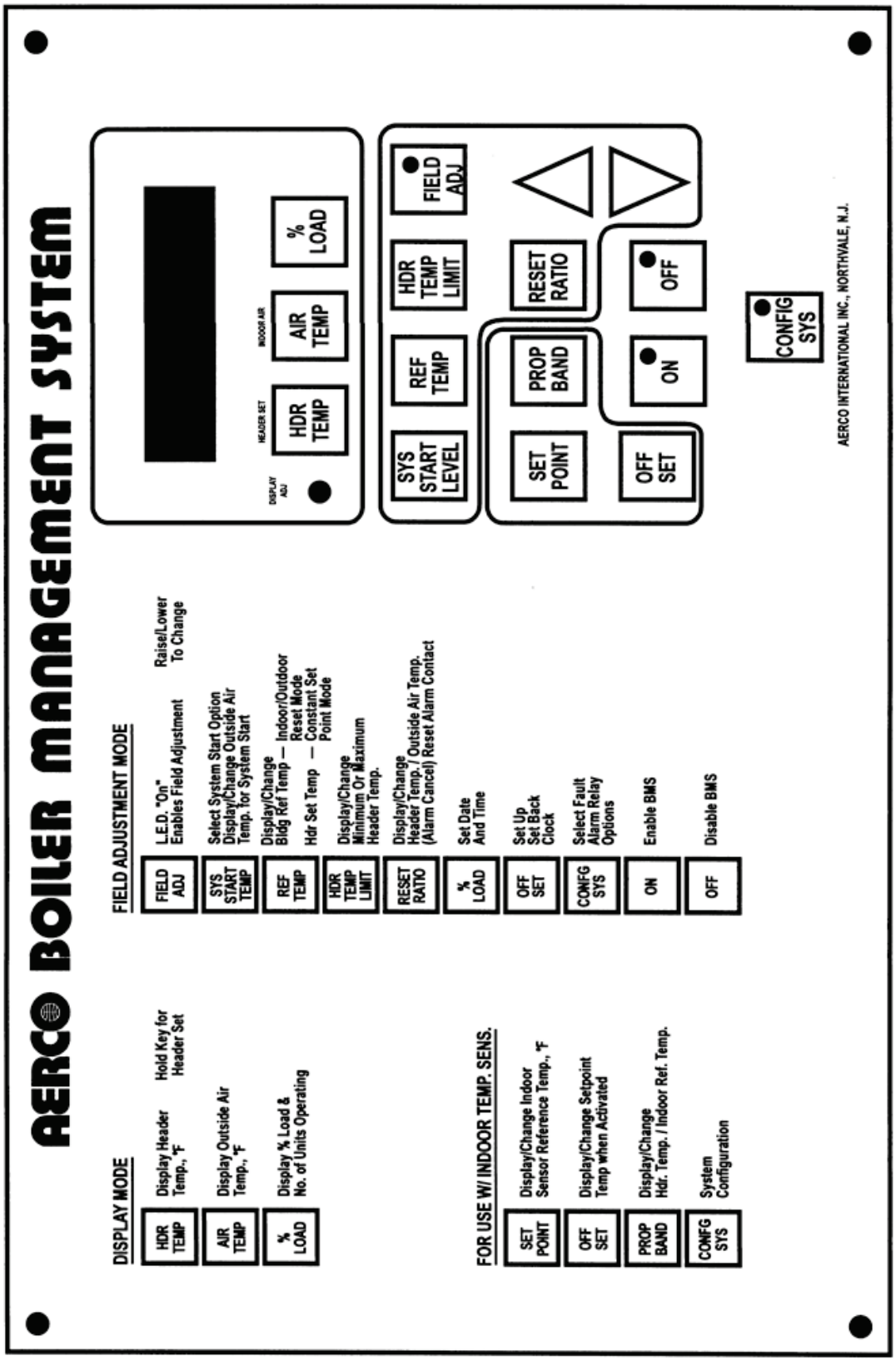


Figure 13
NORMAL & FIELD ADJUST MODE OVERLAY

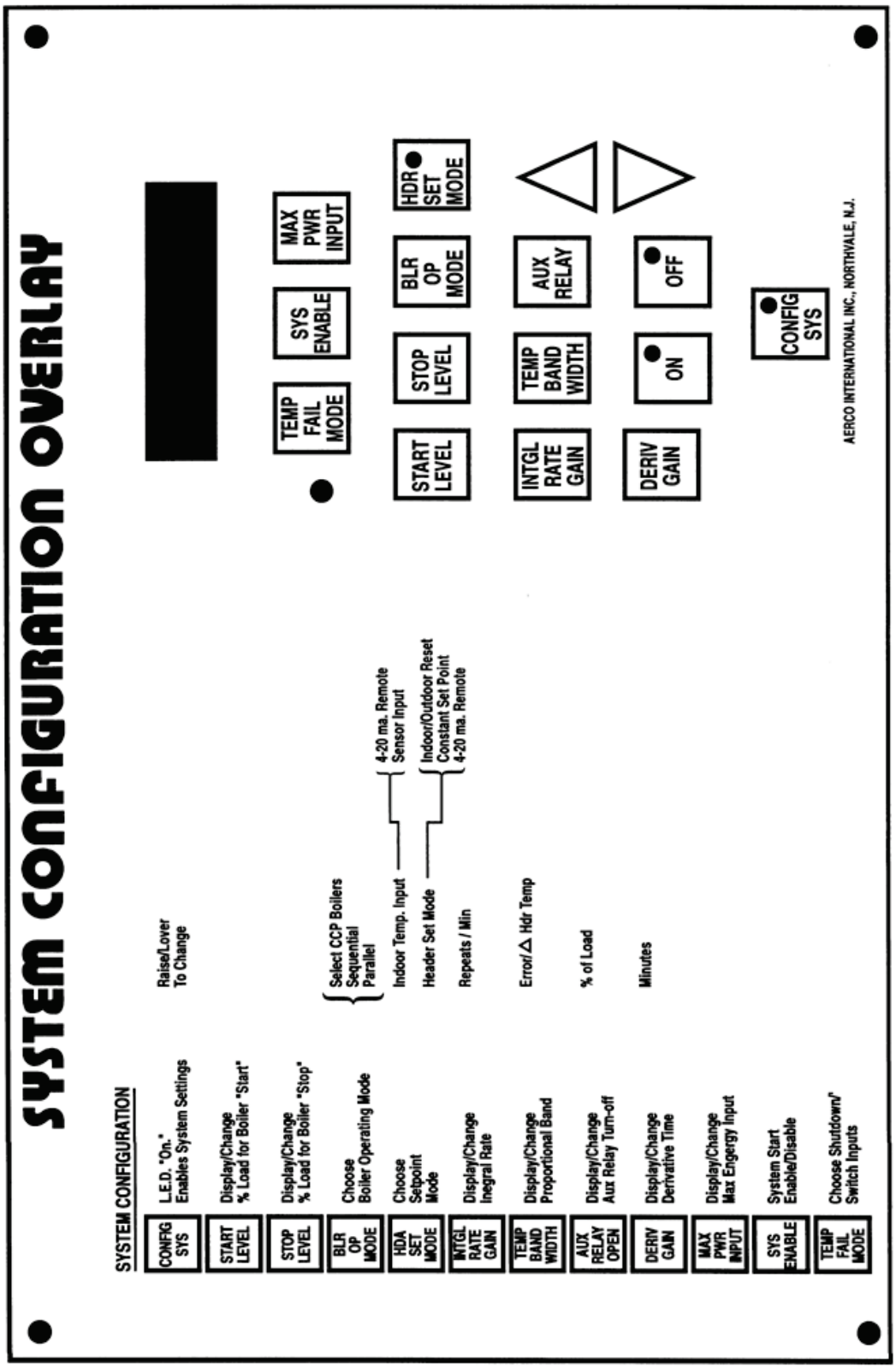


Figure 14
SYSTEM CONFIGURATION MODE OVERLAY

NOTE

Sample Normal Mode displays with their Factory Default values are provided in Appendix C.

4.2 NORMAL MODE DISPLAYS AND FUNCTIONS

When power is applied to the BMS, it is automatically placed in the Normal Mode. It allows you to view the settings currently stored in memory for BMS parameters. In addition, you can enter the Field Adjust or System Configuration Mode by pressing the **FIELD ADJ** or **CONFIG SYS** key. The functions provided by the keypad keys are described in the following paragraphs.

4.2.1 HDR TEMP

Pressing and releasing this key displays the actual header sensor water temperature in °F. Pressing and holding this key displays the header setpoint temperature presently stored in memory.

4.2.2 AIR TEMP

Pressing and releasing this key displays the actual outside air temperature. Pressing and holding this key displays the actual inside air temperature, only if an indoor air temperature sensor is installed. If an indoor air sensor is not installed, *INDOOR AIR TEMP NOT CONNECTED* will be displayed.

4.2.3 % LOAD

Pressing and releasing this key displays the actual firing rate percentage (% Load) for the boiler plant. It also displays the number of boilers presently operating.

4.2.4 SYS START TEMP

Pressing and holding this key displays the System Start Relay temperature setting in °F presently stored in memory. The system will start whenever the outside air temperatures drops below this setting.

4.2.5 REF TEMP

Pressing and holding this key displays the Header Reference Temperature in °F presently stored in memory.

4.2.6 HDR TEMP LIMIT

Pressing and holding this key displays the header high limit temperature setting (°F) stored in memory.

4.2.7 FIELD ADJ

Pressing and releasing this key places the BMS in the Field Adjust Mode and lights the **FIELD ADJ** key LED. When this key is pressed, the display will read *FLD ADJUSTMENT MAKE SELECTION.* Refer to paragraph 4.3 for key functions when in this mode.

4.2.8 SET POINT

Pressing and holding this key displays the indoor setpoint temperature (°F) stored in memory.

4.2.9 PROP BAND

Pressing this key displays the indoor air proportional bandwidth. This bandwidth is a variable used in an equation that solves for the proper offset of supply water temperature based on an

indoor air temperature. Normally the display will read *INDOOR PROP BAND 00.0°F/°F*. See paragraph 4.3.9 for additional information.

4.2.10 OFFSET

Pressing and holding this key displays the Header Temperature Offset (°F) for the present time and day-of-the-week. See paragraph 4.3.10 for additional information on setting up an offset schedule.

4.2.11 RESET RATIO

Pressing and holding this key will display the header reset ratio if a value is currently stored in memory. This function is only used in the Indoor/Outdoor Reset Mode. If this function is not set, or the Constant Setpoint or Remote (4-20 mA) mode is used, the display will show *FUNCTION NOT VALID*.

Also, ALARM CANCEL is printed directly above this key. Pressing and releasing this key will open the Alarm Relay contacts until the Alarm condition reappears.

4.2.12 ▲ and ▼ Arrow Keys

The ▲ and ▼ arrow keys are not active in this mode, since no changes can be made to the displayed settings

4.2.13 ON and OFF Keys

Pressing and releasing the **ON** or **OFF** key enables or disables the BMS. In addition, the corresponding key LED will light when the key is pressed.

4.2.14 CONFIG SYS

Pressing and releasing this key places the BMS in the System Configuration Mode and lights the **CONFIG SYS** key LED. When this key is pressed, the display will read *CONFIG. SYSTEM MAKE SELECTION.* Refer to paragraph 4.4 for key functions when in this mode.

NOTE

Sample Field Adjust Mode displays with their Factory Default values and allowable entry ranges are provided in Appendix D.

4.3 FIELD ADJUST MODE DISPLAYS AND FUNCTIONS

The Field Adjust Mode allows you to view or change settings currently stored in memory for BMS parameters. Many of the settings in this mode have been preset by AERCO to their Factory Defaults. However, you can reset many functions to suit the specific needs of your BMS installation.

The Field Adjust Mode is entered by simply pressing the **FIELD ADJ** key and verifying that the **FIELD ADJ** key LED lights. When this key is pressed, the display will read *FLD. ADJUSTMENTS MAKE SELECTION.* The following paragraphs describe the functions of the keys when in the Field Adjust Mode.

NOTE

When in the Field Adjust Mode, the **HDR TEMP** and **AIR TEMP** keys are used to set multiple functions required for Modbus Network operation. Refer to Modbus Communication Manual GF-114 for additional information on set-up and installation of Modbus (RS485) Networks.

4.3.1 HDR TEMP

The **HDR TEMP** key is used to set multiple Modbus functions when the BMS is configured as the Modbus Master and is directly controlling C-More Boiler Controller Slaves on the RS485 Network. This key is used to set functions as follows:

NOTE

Default values for each function are indicated below. Refer to Modbus Communication Manual GF-114 for required settings. Use the ▲ and ▼ arrow keys to increment or decrement the displayed value.

1. Press key once. *RS485 BAUDRATE* is displayed. Default = 9600.
2. Press key again. *MIN SLAVE ADDR* is displayed. Default = 0.
3. Press key again. *MAX SLAVE ADDR* is displayed. Default = 0.
4. Press key again. *NUMBER OF NETW BLRS* is displayed. Default=0. This key is used to set the maximum number of C-More Boilers that will be controlled on the Modbus Network.
5. Press key again. *MODBUS CNTL TYPE* is displayed. Default = *Round Robin*.
6. Press key again. *NETW BOILER 1 ADDRESS=0* is displayed. Default = 0. This address must be the same as the Comm Address stored in the C-More Boiler Controller.
7. Repeatedly pressing the **HDR TEMP** key allows the *NETW BOILER ADDRESS* to be set for each boiler being controlled on the Modbus Network.

4.3.2 AIR TEMP

The **AIR TEMP** key is used to set multiple Modbus functions when the BMS is configured as a Modbus Slave to an EMS (or BAS) Master. This key is used to set functions as follows:

NOTE

Default values for each function are indicated below. Refer to Modbus Communication Manual GF-114 for required settings. Use the ▲ and ▼ arrow keys to increment or decrement the displayed value.

1. Press key once. *RS232 MODE is displayed.* This function can be set to *NORMAL* or *MODBUS SLAVE.* The Default = *MODBUS SLAVE.*
2. Press key again. *RS232 BAUDRATE* is displayed. Default = 9600.
3. Press key again. *MODBUS ADDRESS* is displayed. Default = 128.
4. Press key again. *NETWORK TIMEOUT* is displayed. Default = 60 sec.
5. Press key again. *REMOTE SIGNAL.* is displayed. This function can be set to 4-20MA or MODBUS. Default = 4-20MA.
6. Press key again. *MODBUS PASS THRU* is displayed. This function can be set to *ENABLED* or *DISABLED.* Default = *DISABLED.*

4.3.3 % LOAD

The **% LOAD** key has two separate and distinct functions in the Field Adjust Mode. Pressing and holding this key displays the actual firing rate (load) percentage and the number of boilers presently operating. Releasing the **% LOAD** key changes its function to Setting the Internal Clock as described in the following paragraph.

4.3.4 Setting the Internal Clock With The % LOAD Key

Pressing and releasing the **% LOAD** key changes the first line of the display to *SET TIME CLOCK.* The second line of the display will show: *MONTH, DATE, YEAR, DAY, HOURS,* or *MINS.* Since these functions wrap around, it is strongly suggested that you repeatedly press the **% LOAD** key until the display shows *MONTH:* in the second line. This will make the following steps easier to follow:

NOTE

When performing the following steps, use the ▲ and ▼ arrow keys to increment or decrement the displayed value. Pressing and holding the ▲ or ▼ key will change the displayed value at a rapid rate.

1. Press key until *MONTH:* is displayed. Set the actual number of the month (1-12).
2. Press key again to display *DATE:.* Set the actual day of the current month (1-31).
3. Press key again to display *YEAR:.* Set the last 2 digits of the year.
4. Press key again to display *DAY:*. Set the day that you want to be the first day of the week. AERCO normally sets Sunday as *DAY 1,* however any day of the week can be set as *DAY 1.*

   For example, if the actual *DATE* (day of month) entered in step 2 is a Monday, and you want Monday to be the first day of the week, set *DAY:* to *1.* Conversely, if you want to retain Sunday as the first day of the week, set *DAY:* to *2* to indicate you are currently in the second day of the week.
5. Press key again to display *HOURS:.* Set the hours using the 24-hour format (0 to 23).
6. Press key again to display *MINS.* Set the minutes (0 to 59).
7. This completes the Internal Clock settings.

4.3.5 SYS START TEMP

When in the Field Adjust Mode, the **SYS START TEMP** key has two functions. First, It lets you select the outdoor temperature at which the system starts. Second, it lets you select the system start option (*TEMP ONLY* or *TEMP AND LOAD*).

For example, with the system start temperature set at 70°F (*SYS. START RELAY 70°F)*, the system start relay will close and enable the boilers when the outside air temperature falls to 69°F (or lower).

To always enable the boilers, regardless of the system start temperature, or if an outside air temperature sensor is not used, see paragraph 4.4.2 in the System Configuration Mode section.

- Pressing and releasing the **SYS START TEMP** key once displays the System Start Relay temperature. (AERCO presets System Start to an outside air temperature of 70°F). To change the displayed start temperature, press the ▲ or ▼ arrow key.

- Pressing and releasing this key a second time displays the System Start Option which can be set to either outside air temperature only (*TEMP ONLY*) or outside air temperature and load (*TEMP AND LOAD).* To change Start Option, press ▲ or ▼ key to toggle the setting.

If *TEMP ONLY* is chosen, the BMS will close the system start relay contacts when the outdoor air temperature drops below the system start temperature setting, without regard to load.

The *TEMP AND LOAD* feature is used when the System Start Relay will control dampers. It keeps dampers closed until it is necessary to open them for combustion. This is designed to ensure that cold air is not always entering the boiler room.

If *TEMP AND LOAD* is chosen, two conditions are necessary for the system start relay contacts to close and enable the boilers. First, the firing rate (displayed as *% LOAD*) must be above 11%. Second the outdoor air temperature must be below the system start temperature. The system start relay contacts will open when the load percentage falls below 7%.

4.3.6 REF TEMP

The **REF TEMP** key has two functions, depending on the operating mode used by the boilers connected to the BMS.

- In the Indoor/Outdoor Reset or Remote Setpoint Mode, pressing and releasing this key displays the Building Reference Temperature (*BLDG REF TEMP*).
- In the Constant Setpoint Mode, pressing this key displays the header supply water temperature setpoint (*HEADER REF. TEMP).*

To change the displayed Reference Temperature, press the ▲ or ▼ arrow key.

4.3.7 HDR TEMP LIMIT

This key allows you to view or change the low and high temperature limits for the header supply water temperature.

In addition, when in the 4-to-20 mA Remote Setpoint Mode, it automatically scales the 4-to-20 mA signal. Accordingly, 4 mA will be equal to the header low limit setting and 20 mA will be equal to the header high limit setting.

- Pressing and releasing this key once displays the header high limit temperature (*HDR HIGH LIMIT*).
- Pressing and releasing this key a second time displays the header low limit temperature (*HDR LOW LIMIT*).
- Pressing and releasing this key a third time displays the header offset temperature (*HEADER OFFSET*).

To change the displayed header high, low or offset temperature limits, press the ▲ or ▼ arrow key.

4.3.8 FIELD ADJ

The **FIELD ADJ** key LED should be lit to indicate that the BMS is already in the Field Adjust Mode. Pressing and releasing this key when already in the Field Adjust Mode will cause the BMS to exit the Field Adjust Mode and switch the BMS to the Normal (Read-Only) Mode.

4.3.9 SET POINT

Pressing and releasing this key allows you to view or change the indoor setpoint temperature. This function is only used when an indoor air temperature sensor is connected to the BMS. If used, the input can be provided by a resistive type sensor, or a 4-to-20 mA input.

4.3.10 PROP BAND

Pressing this key displays the indoor air proportional bandwidth. This bandwidth is a variable used in an equation that solves for the proper offset of supply water temperature based on an indoor air temperature. Normally, the display will read *INDOOR PROP BAND 00.0°F/°F.*

AERCO presets the proportional bandwidth to 00.00°F/°F. It should NOT be readjusted unless your system has an indoor air temperature sensor and is operating in the Indoor Setpoint mode. If the indoor temperature feature is not being used, PROP BAND MUST be set to 00.00°F/°F or the BMS will not run the boiler plant.

4.3.11 OFFSET

The OFFSET key is used to enable and set up an Offset Schedule for the header supply temperature. The schedule can be set up for a 7-day period.

Pressing and releasing this key once will display *OFFSET ENABLE* followed by *OFF* or *ON* (Default is *OFF*). If an Offset Schedule will be used, toggle the display to *ON* using the ▲ or ▼ arrow key.

Normally, if an Offset Schedule is used, it is controlled automatically using the set-up procedures described in paragraph 4.3.12. However, if desired, the header offset can be controlled manually by connecting a switch across the SET BACK wiring terminals (see para. 3.8). If a manual offset is used, refer to paragraph 4.3.13

IMPORTANT

Prior to setting up an automatic Reset Schedule (para. 4.3.12) or manual Set Back (para. 4.3.13), refer to the paragraph 4.3.4 to determine which Day of the Week has been set as Day 1. AERCO presets Day 1 of the week as Sunday. However, any day of the week can be specified as Day 1 by performing the steps outlined in paragraph 4.3.4.

4.3.12 Setting Up A Reset Schedule

The basic steps for setting up an automatic Reset Schedule consist of first selecting the temperature offset and then entering the start and stop times for which the offset will be in effect. Keep in mind that the BMS uses a 24-hour clock (00:00 to 23:59).

In the following example, for Day 1, we want to offset the setpoint temperature by -15°F starting at 12:30 am (00:30) and return it to the normal setpoint at 8:15 am (08:15). Proceed as follows:

1. Press **OFFSET** key once and toggle the display to *OFFSET ENABLE ON.*
2. Press key a second time. *OFFSET TEMP DAY 1→* is displayed prompting entry of the offset temperature. Set the offset temperature to *-15* using the ▲ and ▼ arrow keys.
3. Press key a third time. *OFFSET ON TIME DAY 1 → 0: 0* is displayed prompting Hours to be entered for the start time. Set the Hours to *zero (midnight)* using the ▲ and ▼ arrow keys.
4. Press key a fourth time. *OFFSET ON TIME DAY 1: 0 → 0* is displayed, prompting Minutes to be entered for the start time. Set the Minutes to 30 using the ▲ and ▼ arrow keys.

5. Press key a fifth time. *OFFSET OFF TIME DAY 1 → 0: 0* is displayed prompting Hours to be entered for off time. Since the BMS uses a 24-hour clock format, set the Hours to *8* using the ▲ and ▼ arrow keys.
6. Press key a sixth time. *OFFSET OFF TIME DAY 1: 8→ 0* is displayed prompting Minutes to be entered. Set the Minutes to *15* using the ▲ and ▼ arrow keys.
7. This completes the steps for setting the Offset Temperature, and Start/Stop Times for Day 1.

For a 7-Day Schedule, steps 2 through 7 would be repeated as needed. Offset Schedule entries stored in memory can be reviewed by repeatedly pressing the **OFFSET** key as necessary.

4.3.13 Manual Set Back

If a switch is connected across the SET BACK terminals (para. 3.8), the header offset temperature can be controlled manually by setting all offset times to zero.
Using the **OFFSET** key:

1. Toggle the display to *OFFSET ENABLE ON.*
2. Set the desired *OFFSET TEMP.* A different *OFFSET TEMP* can be entered for each day if desired.
3. Set the *OFFSET ON TIME* and *OFFSET OFF TIME* to zero for each day.

Once programmed as described above, closing the SET BACK switch will enable the programmed *OFFSET TEMP* for that day. Opening the SET BACK switch will disable the *OFFSET*.

4.3.14 RESET RATIO

The Reset Ratio is only used in the Indoor/Outdoor Reset Mode of operation. This ratio the amount that the supply water temperature will rise for each degree drop in outside air temperature. A reset ratio of 2.0 means that the supply water temperature will increase 2°F for every 1°F decrease in outdoor air temperature. For example, if the building reference temperature is set at 70°F, when outside air temperature drops to 69°F, and the reset ratio is 1.8, the water supply temperature will increase to 71.8°F. AERCO presets the Reset Ratio to 1.2°F/°F. See Appendix B for Reset Ratio Charts.

Pressing and releasing this key will display the Header Reset Ratio (*°F/°F)* if a value is currently stored in memory. When operating in the Constant Setpoint or Remote (4-20 mA) mode, the display will show *FUNCTION NOT VALID*.

4.3.15 ▲ and ▼ Arrow Keys

These keys are used to increment (▲) or decrement (▼) the displayed variable, or toggle the display through available options. When these keys are depressed and held the displayed value will increment or decrement at a rapid rate.

4.3.16 ON and OFF Keys

Pressing and releasing the **ON** or **OFF** key enables or disables the BMS. In addition, the corresponding LED will light when the corresponding key is pressed.

4.3.17 CONFIG SYS

When the BMS is in the Field Adjust Mode, this key has two functions. First, it allows you to select the types of faults which will cause an alarm. Second, it allows you to select how alarms are cleared.

- Pressing and releasing the **CONFIG SYS** key once displays the *FAULT ALARM RELAY* status and allows you to select the types of faults which will cause an alarm. The choices are: *ALL FAULTS, NO INTERLOCK, INTERLOCK 2* or *INTERLOCK 1.*

  Selecting ALL FAULTS causes the BMS Fault Relay to close and generate an alarm when either Interlock 1 or 2 opens. It also closes the Fault Relay when any of the fault messages listed in Appendix H, Table H-1 are displayed.

  Selecting *INTERLOCK 2* causes the Fault Relay to close and generate an alarm only when Interlock 2 opens. However, if *INTERLOCK 1* opens, a fault message will be generated but the Fault Relay will not be closed.

  Selecting *INTERLOCK 1* causes the Fault Relay to close and generate an alarm only when Interlock 1 opens. However, if *INTERLOCK 2* opens, a fault message will be generated but the Fault Relay will not be closed.

  Selecting *NO INTERLOCK* causes the Fault Relay to remain open and not generate an alarm when either Interlock 1 or Interlock 2 opens.

  It should be noted that the BMS will <u>always</u> shut down the boilers when Interlock 1 or 2 opens, <u>regardless</u> of the selected Fault Relay option.

  - Select the desired option using the ▲ or ▼ arrow key.

- Pressing and releasing the **CONFIG SYS** key a second time displays *FAULT ALARM CLEAR* and allows you to select how faults are cleared. The available choices are *MANUAL RESET* or *AUTOMATIC.* Toggle to the desired option using the ▲ or ▼ arrow key.

Prior to placing the BMS in the System Configuration Mode, the **FIELD ADJ** key must be pressed to exit the Field Adjust Mode. Pressing and releasing the **CONFIG SYS** key places the BMS in the System Configuration Mode and lights the **CONFIG SYS** key LED. When this key is pressed, the display will read *CONFIG. SYSTEM MAKE SELECTION.* Refer to paragraph 4.4 for key functions when in this mode.

NOTE

Sample System Configuration mode displays with their Factory Default values are provided in Appendix E.

4.4 SYSTEM CONFIGURATION MODE DISPLAYS AND FUNCTIONS

The System Configuration Mode allows you to program and operate the BMS to effectively run and manage the performance of the boiler plant. In order to effectively use this mode, the **SYSTEM CONFIGURATION OVERLAY** provided with the BMS must be placed over the keypad for proper identification of key functions (Figure 12).

The System Configuration Mode is entered by simply pressing the **CONFIG SYS** key and verifying that the **CONFIG SYS** key LED lights.

The keys described in the following paragraphs allow you to view or change settings currently stored in memory. If the desired setting is not displayed for the selected BMS parameter, press the ▲ or ▼ arrow key to increase, decrease or toggle the displayed setting. All changes made will be stored in memory.

4.4.1 TEMP FAIL MODE

Pressing and holding this key displays the actual header sensor water temperature in °F. This is a “Read Only” display and cannot be changed.

Pressing and releasing this key allows you to display and select a Temperature Failure Mode (*TEMP FAIL MODE)* of either *SHUTDOWN* or *SWITCH INPUTS.*

If *SHUTDOWN* is selected, regardless of the operating mode, the BMS will shut down the boiler plant whenever a temperature sensor fails or either interlock opens. If the BMS is operating in the Remote Setpoint mode, the BMS will also shut down the boiler plant if the remote 4-to-20-mA input signal drops below 3 mA. If any of these failures occur, the fault relay will close and the BMS will display the appropriate failure message.

If *SWITCH INPUTS* is selected, the BMS will automatically switch to Constant Setpoint mode if a sensor or remote input error occurs. Once the sensor or remote input error has been cleared, the BMS will automatically switch to the previous mode.

When selecting *SWITCH INPUTS,* the reference temperature for the Constant Setpoint mode must be preset. See Section 5 for programming steps.

Regardless of whether *SHUTDOWN* or *SWITCH INPUTS* is selected, the BMS will shut down and close the fault relay contacts if the header sensor circuit fails.

4.4.2 SYS ENABLE

Pressing and releasing this key allows you to select the *INTERLOCK 1* enable setting of *START ENABLED* or *ALWAYS ENABLED.*

The *START ENABLED* feature will not enable the boiler plant until the outside air temperature falls below the system start temperature. If the boiler plant begins to operate and Interlock 1 is open, the BMS will wait 30 seconds before stopping the boilers and displaying a fault message.

This feature is intended for use with auxiliary equipment having limit switches. For instance, dampers with proving end switches, can be triggered by the BMS system start relay as the boilers start. If the dampers do not open, the end switch wired to Interlock 1 will not make (close) and the BMS will shut down the boilers.

The *ALWAYS ENABLED* feature allows the boilers to run, regardless of the system start and outside air temperature settings. This feature is used when there is a loss of an outside air sensor or one is not installed. It will also function if an outside air temperature sensor is present. It should be noted that if either Interlock 1 or 2 opens, the BMS will shut down the boilers.

The system start relay will close only after the outside air temperature falls below the system start temperature, whether *START ENABLED* or *ALWAYS ENABLED* is selected. AERCO recommends that the system be equipped with a flow switch that is interlocked to the BMS. This is especially important if *ALWAYS ENABLED* is selected and the BMS is controlling the pumps based on outside air temperature, or the BMS is interfaced with an energy management system that is controlling the pumps.

4.4.3 MAX PWR INPUT

This key provides two distinct functions. First, it is used to establish the maximum firing rate percentage for the boilers being controlled by the BMS. Second, it permits adjustment of the pulse width modulation (PWM) signal supplied to the boilers.

- Pressing and releasing the **MAX PWR INPUT** key once displays the maximum allowable firing rate percentage for the boilers (MAX POWER INPUT 100%). If desired, the maximum firing rate of the boilers can be limited to values below 100%. This is useful if there is a problem with gas supply pressure.

  For example, if gas pressure is too low, the boilers can be run at a lower firing rate temporarily until proper gas pressure can be restored. If necessary, adjust the firing rate using the ▲ or ▼ arrow key.

- Pressing and releasing the **MAX PWR INPUT** key a second time displays a *PWM TIMEBASE CAL* message. If necessary, the PWM pulse width ON time can be adjusted using the ▲ and ▼ arrow keys. Pressing the ▲ arrow key increases the pulse width ON time and pressing the ▼ key reduces the ON time. The PWM TIMEBASE CAL is adjustable from -30 to 30 (Default = 0).

  The PWM TIMEBASE CAL should only be adjusted when all boilers are indicating a firing rate above or below the firing rate being supplied by the BMS PWM signal. If necessary, individual boilers can be adjusted via their respective C-More Control Systems.

4.4.4 START LEVEL and STOP LEVEL Keys

These keys allow you to set the energy levels (firing rate percentages) at which additional boilers are staged-in or staged-out of the system during Sequential or Combination mode operation. While the start level can be set at any percentage up to 100%, it is best to keep it below 60%**.** This allows the system to operate at optimum efficiency under low loads. The BMS is preset with 45% start and 18% stop levels, which generally provide the best performance.

When changing the start or stop levels, it is important to remember that load-balancing affects bumpless transfer. A sufficiently wide gap between the start and stop levels must be maintained to prevent cycling between units. For example, in a two-boiler system with a start level of 60% and a stop level of 30%, when the first boiler reaches 60%, the BMS will distribute the load between the two boilers, so that each will have a firing rate of 30%. However, since the stop level is 30%, the BMS will automatically shut down one boiler and allow the firing rate of the second boiler to increase to 60%. The BMS will then repeat this undesirable cycling. To avoid this, the start level could be set to 65%, leaving the stop level at 30%. When the BMS distributes the load after the first boiler reaches a 65% firing rate, the individual load would be 32.5%, sufficiently above the stop level. Conversely, the stop level could be changed to 25%, leaving the start level at 60%. In this case, when the BMS distributes the load, there will be 5% margin between this load (30%) and the stop level (25%).

- Pressing the **START LEVEL** key displays firing rate percentage at which the boilers will start.
- Pressing the **STOP LEVEL** key displays firing rate percentage at which the boilers will stop.

4.4.5 BLR OP MODE

This key is used to select the Boiler Operating Mode. It allows you to make choices concerning the effective and efficient way to fire the boilers based on the building load. The mode choices include: Parallel, Sequential, or Combination Mode.

Pressing the **BLR OP MODE** key displays *BOILER OP MODE* followed by the currently selected mode (*PARALLEL, SEQUENTIAL* or *COMBINATION*). AERCO presets the mode to *SEQUENTIAL*. If necessary, use the ▲ and ▼ arrow keys to toggle between the 3 available modes. The following paragraphs describe the advantages of each mode selection.

4.4.5.1 Sequential Mode

The Sequential Mode provides a greater turn-down ratio than Parallel Mode. This is because the turn-down ratio in Sequential Mode is equal to the number of boilers multiplied by 14 for KC Series boilers and by 15 for Benchmark boilers. In Parallel Mode, the turn-down ratio is fixed at 14:1 for KC Series boilers and 15:1 for Benchmark boilers, and does not consider the number of boilers in the plant.

In Sequential Mode, each boiler is started one at a time based on the load and start/stop levels programmed in the BMS. The BMS will start a single boiler when there is a load demand. Once the first boiler reaches the start level, a second boiler will be started and the load will be distributed evenly between the two boilers.

For instance, if a start level of 50% is chosen, when the first boiler reaches 50% a second boiler will start (after a 30 second delay), and the BMS will distribute the load 25% for each boiler. If the firing rate of both boilers reach the start level, a third boiler is started by the BMS (after a 30 second delay), and the load will be distributed across all three boilers. This sequence will continue base on load demand and the number of boilers connected to the BMS.

As the load drops off, the firing rates decrease. When all boilers reach the stop level, the first boiler turned on will be shut off by the BMS and its load will be evenly distributed to the remaining firing boilers. This off-sequencing continues until only one boiler is left firing. The last boiler will turn off when its stop level is reached.

4.4.5.2 Parallel Mode

When operating in Parallel Mode, the boilers are simultaneously started by the BMS. The start and stop levels have no effect when in Parallel Mode. The turn-down ratio in Parallel Mode is fixed at 14:1 for KC 1000 Series boilers and 15:1 for Benchmark boilers, regardless of the number of boilers in the plant.

4.4.5.3 Combination Mode

Combination mode is used only when the boiler plant will be used to satisfy both space heating and domestic hot water needs. This configuration, known as a Combination System, is used in conjunction with an AERCO Combination Control Panel (CCP). This system uses BMS-mode boilers dedicated to space heating and Combination boilers that are primarily used to satisfy the domestic hot water need. The domestic combination boilers are also available for the space heating load when the domestic hot water load is satisfied. This is accomplished using a motorized valve and storage tank equipped with a heat exchanger. For additional information on the Combination System, see AERCO's CCP-1 literature.

4.4.5.4 Designating the Number of Combination Boilers

A maximum of 4 combination boilers can be connected to the BMS. However, when using the Combination Mode, it is necessary to tell the BMS how many combination boilers there are. This is accomplished as follows:

IMPORTANT

When connecting combination boilers to the BMS, it is important that you start at the BLR 8 terminals on Terminal

Strip JP2 and work towards BLR 5.

1. With the *COMBINATION MODE* selected, press the **BLR OP MODE** key. The display will read: *COMBINATION MODE* X *OF CCP BOILERS*, (where X is the number of combination boilers).

2. Enter the number of combination boilers connected to the BMS using the ▲ and ▼ arrow keys.

4.4.6 HDR SET MODE

This key has two functions. First, it is used to select the Indoor/Outdoor Reset, Constant Setpoint, or Remote Setpoint boiler mode operation. Second, it is used to select the type of indoor temperature sensor used with the BMS, if one is installed. The type of sensor can be either resistive (thermistor) or a constant voltage signal with current varying from 4 to 20 mA.

Pressing the **HDR SET MODE** key once selects the Header Set Mode function. If the desired mode is not displayed, toggle the display to the desired mode (*IN/OUTDOOR RESET, REMOTE SET TEMP* or *CONSTANT SETTEMP)* using the ▲ or ▼ arrow key.

Pressing the **HDR SET MODE** key a second time toggles the display to indicate the type of indoor temperature sensor which will be used with the BMS (THERMISTOR or 4-20 mA). If necessary, toggle the display to the desired sensor type using the ▲ or ▼ arrow key.

If the *REMOTE SET TEMP* mode is selected and the Indoor Temperature Sensor feature is used, the Sensor input type must be *THERMISTOR* (resistive) since the BMS has only one 4-to-20 mA input.

4.4.7 INTGL RATE GAIN, TEMP BANDWIDTH and DERIV GAIN Keys

These three keys provide PID (Proportional Integral Derivative) control functions which govern temperature control and response of the BMS to the boiler system. Since each
system is different, these PID controls can tune the BMS to the characteristics of your specific installation. The factory defaults preset by AERCO work well for most applications. In instances when there is a large error between the setpoint and the actual supply water temperature, the BMS may appear to require PID tuning. However, It is best to observe BMS operation over a period of time prior to making any PID changes. Contact AERCO or an AERCO representative prior to making any PID setting changes.

The functions provided by the PID function keys are described in the following paragraphs.

4.4.7.1 TEMP BANDWIDTH

Header Temperature Bandwidth (*HDR TEMP B.W.)* concerns the system's response to the setpoint error. Setpoint error is the difference between the supply water temperature setpoint and the actual supply water temperature. A constant setpoint error will yield a constant and proportionate correction factor for the duration of the error. If there is a deviation from the constant error, the correction factor will be changed in proportion to the deviation. For instance, a temperature bandwidth of 50°F is chosen. The header temperature setpoint is 180°F and the actual incoming supply water temperature is 130°F. This is a 50° error and the following is true:

$$\frac{\text{Temp. Error}}{\text{Prop Bandwidth}} \times 100 = \text{Firing Rate in \%}$$

Therefore:

$$\frac{50}{50} \times 100\% = \text{Firing Rate}$$

1 X 100 = 100 % Firing Rate

With an error of 30° and a bandwidth of 50, the following would be true:

30/50 X 100 = .6 X 100 = 60% Firing Rate.

4.4.7.2 INTGL RATE GAIN

Integral gain responds to the setpoint error over a period of time. Integral references the proportional bandwidth error signal and sums itself with respect to the period of time that an error exists. Based on the example in the previous paragraph (4.4.7.1), if the integral is 0.15 repeats per minute and the firing rate is 60%, and a temperature error exists for 1 minute, then the following is true:

(0.15 reps/min.) x (60% firing rate) = 9% actual firing rate

60% firing rate +9% firing rate = 69% firing rate

If the error continues and is present for another minute, another 9% correction factor will be added:

69% firing rate +9% firing rate = 78% firing rate

If, after a load change, the supply water temperature stabilizes at a temperature above or below the setpoint, the integral gain should be increased. If, after a load change, the supply water temperature overshoots and oscillates excessively, integral gain should be reduced.

4.4.7.3 DERIV GAIN

Derivative gain is a function of time. It senses and responds to the rate of change of the setpoint error. A slow rate of change will yield a small amount of derivative gain. Conversely, a fast rate of change will yield a large derivative gain. Too high a derivative gain setting will produce a large output for a short time. This can result in overshoot of the setpoint. Too low a derivative gain setting will have the opposite effect, producing a small output for a longer period, and may result in slow system response or the system undershooting the setpoint.

4.4.8 AUX RELAY

This key is used to display or change the firing rate at which the Auxiliary Relay opens and closes. The Auxiliary Relay is typically used with AERCO's Combination Control Panel (CCP) system or to start an auxiliary boiler for use under peak load conditions. If this boiler is of the non-condensing type, the OFF firing rate percentage must be high enough to prevent the boiler from operation in condensing mode.

Pressing the **AUX RELAY** key once displays the firing rate percentage at which the relay opens (*AUX RELAY OPEN*). The default value of 45% is acceptable for a CCP system. However, to run another non-condensing boiler, this percentage may need to be changed to approximately 70%**.** The displayed percentage can be changed in 1% increments from 1 to 99%.

Pressing the **AUX RELAY** key again displays the firing rate percentage at which the relay closes (*AUX RELAY CLOSE).* Two options are available for this function: *100% FIRING RATE, or 100% AND OFF* (default)*.* Pressing the ▲ or ▼ arrow key will toggle the display. If *100% FIRING RATE* is selected, the Auxiliary Relay contacts close when the BMS indicates that all boilers are at a 100% firing rate. If the default setting of 100% *AND OFF* is selected, the Auxiliary contacts close when the BMS indicates that all boilers are at a 100% firing rate**,** or when the BMS determines that all boilers are off. The off-state is when each boiler has either faulted, or someone has pressed the off button on the boilers. This function allows a boiler that is wired to the Auxiliary Relay contacts to fire when all of the other boilers have faulted or have been turned off.

When in Combination Control Panel (CCP) mode, care must be taken to ensure that the *AUX RELAY OPEN* percentage is set so that the system does not oscillate turning boilers on and off. A maximum open percentage of 45% is recommended for Combination Control mode. If using the AUX contacts to fire an auxiliary boiler, the recommended open percentage is 70%.

4.4.9 ▲ and ▼ Arrow Keys

These keys are used to increment (▲) or decrement (▼) the displayed variable, or toggle the display through available options. Pressing and holding these keys will increment or decrement the displayed value at a rapid rate.

4.4.10 ON and OFF Keys

Pressing and releasing the ON or OFF key enables or disables the BMS. In addition, the corresponding LED will light when the corresponding key is pressed.

4.4.11 CONFIG SYS

When the **CONFIG SYS** key LED is lit, pressing this key will exit the System Configuration Mode and place the BMS in the Normal Mode. When this occurs, the display will show *HEADER TEMP (°F)* which is the default Normal Mode display. See paragraph 4.2 for key functions in Normal Mode.

Section 5 - Programming the BMS Mode of Operation

Prior to programming, the BMS must be mounted and all required wiring completed. In addition, all connections should be checked for accuracy. The BMS is now ready to be programmed for the desired mode of operation of the boiler plant. The steps for programming will vary somewhat, depending on whether the Indoor/Outdoor Reset, Remote Setpoint or Constant Setpoint operating mode is selected.

5.1 INDOOR/OUTDOOR RESET MODE

The Indoor/Outdoor Reset mode is based on outside air temperature. The header supply water temperature will vary up or down in accordance with outside air temperature. This mode requires that, as a minimum, a System Start Temperature (*SYS.START RELAY*), Building Reference Temperature (*BLDG REF.* TEMP) and Reset Ratio be programmed into the BMS. This data is based on the degree days for your geographic area. An outdoor air sensor MUST be installed when operating in this mode (refer to paragraph 3.3.2).

5.1.1 Selecting Indoor/Outdoor Reset Mode

To select Indoor/Outdoor Reset mode, perform the following steps:

1. Press the **CONFIG SYS** key to enter the System Configuration mode. The **CONFIG SYS** key LED will illuminate.
2. Place **SYSTEM CONFIGURATION OVERLAY** on the BMS front panel.
3. Press the **HDR SET MODE** key once. *HEADER SET MODE* is displayed with the present mode selection.
4. While observing the display, toggle the *HDR SET MODE* using the ▲ or ▼ key to *IN/OUTDOOR RESET.*
5. Press the **CONFIG SYS** key to exit the System Configuration mode. The key LED will go off.
6. Remove the **SYSTEM CONFIGURA-TION OVERLAY** from the front panel.

5.1.2 Entering System Start Temperature

The system start temperature is the outside temperature at which the boiler plant begins to operate. AERCO presets the system start temperature at 70°F. However, temper-atures from 32 to 120°F can be selected using the ▲ and ▼ arrow keys on the keypad. Proceed as follows to enter the system start temperature:

1. Press **FIELD ADJ** mode key. Verify that the **FIELD ADJ** key LED illuminates.
2. Press the **SYS START TEMP** key.
3. Using the ▲ and ▼arrow keys, select the desired Start Temperature for the boiler plant.

5.1.3 Determining Reset Schedule

There are two possible variables that must be considered when determining reset schedule; reset ratio and building reference temperature. There are two methods for determining reset ratio. The first method uses the charts in Appendix B. This method is suitable for most

installations. However, if a special reset schedule is desired for reheat or other purposes, the calculation method must be used. In this method, both reset ratio and building reference temperature must be calculated. See Appendix B for further instructions concerning both of these methods.

5.1.4 Entering the Building Reference Temperature

To enter the Building Reference Temperature, perform the following steps:

1. Enter Field Adjust mode by pressing the **FIELD ADJ** key. Verify that the key LED illuminates.
2. Press the **REF TEMP** key. The display will show the present *BLDG REF. TEMP.*
3. Using the ▲ and ▼ arrow keys, select the desired Building Reference Temperature.

5.1.5 Entering the Reset Ratio

Enter the Reset Ratio as follows:

1. Ensure that the BMS is in the Field Adjust mode.
2. Press the **RESET RATIO** key. The display will show *RESET RATIO 1.2°F/°F* which is the default setting.
3. Using the ▲ and ▼ arrow keys, select the desired Reset Ratio.
4. Initialize the system as described in paragraph 5.5.

NOTE

For Remote Setpoint control utilizing a RS485 Modbus network, refer to Modbus Communication Manual GF-114.

5.2 SETUP FOR REMOTE SETPOINT MODE

In order to set up the BMS to operate in this mode, a 4-to-20 mA communication line from an Energy Management System with a floating ground is required. In addition, a BMS header sensor is required. This mode may be used with or without an outdoor air temperature sensor installed. Entries in this mode are required for the following items:

- Header Set Mode
- Boiler Operating Mode
- Remote Signal Type
- Header Temperature Limits.

5.2.1 Entering Header Set Mode and Boiler Operating Mode

These selections are made with the BMS in the System Configuration mode. Proceed as follows:

1. Press the **CONFIG SYS** key to enter the System Configuration mode. The **CONFIG SYS** key LED will illuminate.
2. Place **SYSTEM CONFIGURATION OVERLAY** on the BMS front panel.
3. Press the **HDR SET MODE** key once. *HDR SET MODE* is displayed with the present mode selection.

4. While observing the display, toggle the *HDR SET MODE to REMOTE SET TEMP* using the ▲ or ▼ arrow key.
5. Press the **BLR OP MODE** key. *BOILER OP MODE* is displayed with the present mode selection.
6. Select either the *PARALLEL MODE* or *SEQUENTIAL MODE* using the ▲ or ▼ arrow key.
7. Press the **CONFIG SYS** key to exit the System Configuration mode. The **CONFIG SYS** LED will go off.
8. Remove the **SYSTEM CONFIGUR-ATION** overlay from the BMS front panel.

5.2.2 Entering Remote Signal Type and Header Temperature Limits

These selections are made with the BMS in the Field Adjust mode. Proceed as follows:

1. Enter Field Adjust mode by pressing the **FIELD ADJ** key. Verify that the key LED illuminates.
2. Press the **AIR TEMP** key five times until the first line of the display reads *REMOTE SIGNAL.*
3. Using the ▲ or ▼arrow key, toggle the second line of the display to read 4-20MA.
4. Next, press and release the **HDR TEMP LIMIT** key once. *HDR HIGH LIMIT* is displayed with the present high temperature limit setting.

NOTE

Steps 5, 6 and 7 scale the 20 mA Remote Signal to the selected *HDR HIGH LIMIT* and *HDR LOW LIMIT* settings.

5. Select the desired header high temperature limit setting using the ▲ and ▼ arrow keys. The selected temperature will be equal to a 20 mA Remote Signal.
6. Press and release the **HDR TEMP LIMIT** key again. *HDR LOW LIMIT* is displayed with the present low temperature limit setting.
7. Select the desired header low temperature limit setting using the ▲ and ▼ arrow keys. The selected temperature will be equal to a 4 mA Remote Signal.

5.3 SETUP FOR CONSTANT SETPOINT MODE

In this mode of operation, only a header sensor is required. Entries in this mode are required for Header Set Mode, Boiler Operating Mode and Header Reference Temperature.

5.3.1 Entering Header Set and Boiler Operating Modes

These selections are made with the BMS in the System Configuration mode. Proceed as follows:

1. Press the **CONFIG SYS** key to enter the System Configuration mode. The **CONFIG SYS** key LED will illuminate.
2. Place **SYSTEM CONFIGURATION OVERLAY** on the BMS front panel.

3. Press the **HDR SET MODE** key once. *HEADER SET MODE* is displayed with the presently stored mode selection.
4. While observing the display, toggle the *HDR SET MODE to CONSTANT SETTEMP* using the ▲ or ▼ arrow key.
5. Press the **BLR OP MODE** key. *BOILER OP MODE* is displayed with the presently stored mode selection.
6. Select the *PARALLEL, SEQUENTIAL* or *COMBINATION MODE* using the ▲ or ▼ arrow key.
7. Press the **CONFIG SYS** key to exit the System Configuration mode. The **CONFIG SYS** LED will go off.
8. Remove the **SYSTEM CONFIG-URATION** overlay from the BMS front panel.

5.3.2 Entering Header Reference Temperature (Setpoint)

The Header Reference Temperature (Setpoint) is entered as follows:

1. Enter Field Adjust mode by pressing the **FIELD ADJ** key. Verify that the key LED illuminates.
2. Press the **REF TEMP** key. The display will show the present *HEADER REF. TEMP* stored in memory.
3. Set the desired setpoint temperature using the ▲ and ▼arrow keys. The setpoint temperature can be adjusted from 40°F to 220°F.
4. Initialize the BMS using the procedures in paragraph 5.5.

5.4 "TEMP AND LOAD OPTION"

The boiler plant, and the System Start Relay, can be programmed to start based on either, or both, an outdoor temperature and/or load demand criteria. When the *SYS START OPTION* is set to *TEMP ONLY*, the outdoor temperature is the only criteria used

to activate the system. In this case the system, and the System Start Relay, will activate when the outdoor temperature falls below the *SYS START TEMP* setting. If no outdoor sensor is installed, the system (and the System Start Relay) will always be activated in this case. The system will shut down and the System Start Relay deactivated when the outdoor temperature rises above the *SYS START TEMP* setting.

If the SYS START OPTION is set to *TEMP AND LOAD*, the system (and the System Start Relay) will start when the outdoor temperature is below the *SYS START TEMP* setting and the load demand (*PERCENT OF LOAD*) is at or above the *LOAD START PCT* (in Calibration Menu). The *PERCENT OF LOAD* display in the Operating Menu will show 0% until both of these criteria are satisfied. The system will shut down and the System Start Relay deactivated if either the outdoor temperature rises above the *SYS START TEMP* or the *PERCENT OF LOAD* falls below the *LOAD STOP PCT.* If no outdoor sensor is installed, the system (and the System Start Relay) will activate when the *PERCENT OF LOAD* is at or above the *LOAD START PCT.* The system will shut down when the *PERCENT OF LOAD* falls below the *LOAD STOP PCT.*

5.5 CONFIGURING BOILERS FOR PULSE WIDTH MODULATION (PWM)

Configuring each boiler for BMS control using Pulse Width Modulation (PWM) differs, depending on the Control System used by each AERCO boiler. Refer to the appropriate Operation and Maintenance Manuals provided with the boilers being used. If the KC1000 or Benchmark boilers are equipped with the newer C-More Control Systems, proceed to paragraph 5.4.1. However, if the boilers are equipped with the older Modular Control Systems, proceed to paragraph 5.4.2.

5.5.1 C-More Control System PWM Setup

For PWM communication, each boiler's C-More Control System must have the Configuration Menu items properly set up as follows:

1. Boiler Mode – This option must be set for *Direct Drive*.
2. Remote Signal – This option must be set for *BMS (PWM Input).*

Refer to Operation and Maintenance Manual GF-109 (KC1000 Boiler) or GF-110 (Benchmark Boiler) for instructions on changing menu items.

NOTE

AERCO Modular Control Systems are equipped with Honeywell (Blue) or Fire-Eye (Red) Temperature Controllers.

5.5.2 Modular Control System PWM Setup

For proper PWM communication, each boiler's Modular Control System Temp-erature Controller must be properly addressed and configured as follows:

5.5.2.1 Temperature Controller Addressing

For proper PWM communication, each boiler's Temperature Controller must be set to a comm. Address of 32. This is true whether the boilers are space heating or Combination (CCP) types.

If the individual boiler's temperature controller is not correctly addressed, the secure menu of the temperature controller must be entered in order to change the address. Refer to Operation and Maintenance Manual GF-106 (KC1000 Boiler) or GF-107 (Benchmark Boiler) for detailed procedures.

5.5.2.2 Configuring the Temperature Controller

Once addressing has been completed, it is necessary to perform two more configuration steps to each boiler's temperature controller. Each temperature controller must be in the Remote and Auto/Off (Manual) modes for proper communication and operation with the BMS.

Refer to Operation and Maintenance Manual GF-106 (KC1000 Boiler) or GF-107 (Benchmark Boiler) for detailed procedures to set each boiler to the Remote and Auto/Off (Manual) modes.

5.6 SYSTEM INITIALIZATION AND POLLING

In order for the BMS to recognize each boiler, a closed signal loop must exist between the BMS and the boiler. Initialization and polling is accomplished by performing the following simple

steps:

1. Set the **ON/OFF** switch on each boiler control panel to **ON**.
2. Turn on the BMS by pressing the **ON** key. The BMS will automatically poll (recognize) each boiler at prescribed intervals.
3. Check the yellow **REMOTE** (**REM**) LED on each boiler control panel to ensure it is ON. This indicates that the boiler is now being controlled by the BMS.
4. If any of the boiler **REMOTE** LEDs are off, check to ensure that:
   (a) Boiler AC power is not turned off.
   (b) Boiler is not shut down due to a fault.
   (c) The BMS-to-boiler signal loop is not broken.

The BMS will continuously poll the boilers at prescribed intervals. Therefore, if a boiler is placed off-line and then placed back on-line, it will again be recognized by the BMS during the next polling cycle.

5.7 TESTING THE SYSTEM

The following procedure places a load on the system and will begin firing the boilers. At this point it is very important to make sure the system pumps are running.

After system has been initialized as described in paragraph 5.5, proceed as follows:

IMPORTANT

Prior to performing these tests, view and record the PRESENT settings stored in the BMS for **HDR SET MODE** and **REF TEMP.** These settings MUST be restored to these values upon completion of the following tests.

1. Turn off the BMS by pressing the **OFF** key. The **OFF** LED will illuminate..
2. Place the **SYSTEM CONFIGURATION OVERLAY** on the BMS front panel.
3. Press the **CONFIG SYS** key. The **CONFIG SYS LED** will illuminate.
4. Press the **HDR SET MODE** key. *HEADER SET MODE* will be displayed, followed by the mode setting stored in memory (*IN/OUTDOOR RESET, REMOTE (4-20ma.),* or *CONSTANT SETTEMP).*
5. Select *CONSTANT SETTEMP* using the ▲ or ▼ arrow key.
6. Press the **CONFIG SYS** key The LED will turn off.
7. Remove the SYSTEM CONFIG-URATION OVERLAY.
8. Press the **FIELD ADJ** key. The LED will illuminate.
9. Press the **REF TEMP** key.

   Set the *HEADER REF. TEMP* (setpoint) to 220°F using the ▲ and ▼ arrow keys.
10. Press the **FIELD ADJ** key. The LED will turn off.
11. Press the **%LOAD** key and monitor the display for the firing rate (*PERCENT OF LOAD)* and the number of boilers firing (*Units)*.

12. When all boilers have reached at least a 55% firing rate, any boilers that have not started have not been identified by the BMS.
13. Remember that in the Sequential or Combination modes, the BMS turns boilers on in 30-second intervals. Therefore, in a 6-boiler plant, with five boilers operating at 55% capacity, a boiler that has not started after 3 minutes has not been recognized. In parallel mode, all boilers will start at the same time.
14. This completes the System Test. Return the **HDR SET MODE** and **REF TEMP** settings to their previously stored values.
15. If the System Test is not completed successfully, contact AERCO at 1-800-526-0288.

Appendix A

SPECIFICATIONS

INPUTS

POWER

Input voltage	120 VAC, 60Hz, 1 phase, ± 10%, fused at 1 A

OUTSIDE AIR SENSOR (NTC thermistor)

Acceptable types	AERCO GP-122662 (Sensor Only) or GM-122781 (Sensor & Mounting Plate)
Range	-60°F to +80°F
Short sensor protection	Invoked at +200°F

HEADER SENSOR (NTC thermistor)

Acceptable types	AERCO 64038 (Sensor Only) or GM-122790 (Sensor and Thermowell)
Range	40°F to +220°F
Short sensor protection	Invoked at +300°F

INDOOR TEMPERATURE SENSOR (NTC thermistor)

Acceptable types	AERCO GP-122882 (Sensor Only)
Range	40°F to 140°F
Short sensor protection	Invoked at 300°F

Appendix A (cont.)

CURRENT LOOP

Input resistance	250 Ohms
Protection	Isolated from AC line potential, fuse-protected at 62 mA, open loop detected at <1 mA
Operational current range	4 mA to 20 mA

SET BACK

Input	12 VDC at 15 mA. External short activates circuit; Open deactivates it

OUTPUTS

SYSTEM START RELAY

Contact Rating	120 VAC at 5 A, fuse protected at 5 A
Operation	Relay closes when outside air temperature is less than the system start temperature setting

FAULT ALARM RELAY

Contact Rating	120 VAC at 5 A, fuse protected at 5 A
Operation	Relay closes when valid error condition occurs

AUXILIARY RELAY

Contact Rating	120 VAC at 5 A, fuse protected at 5 A
Operation	Relay closes when all available boilers are operating at maximum power input (fire rate). Relay can be programmed to close when all available boilers are at maximum power input or no boilers are available (all boilers faulted or turned off).

Appendix A (cont.)

BOILER DRIVE

Drive Type (PWM) Signal (with 12 msec time base)	Optically-isolated, pulse width modulated
Valve drive	100% fire rate at 95% pulse width, 0% fire rate at 5% pulse width
Current Loop Determination	Optically isolated detection

MEMORY

Non-Volatile Memory	EPROM storage of system input. Variables changed in Field Adjust or Configure System mode. EPROM storage of on/off state. All other variables stored in volatile memory which is not retained after power interruption.

ALARMS

Error Handling	If a valid error condition occurs, the display will show the error condition for 2 seconds, then return to the previous display. If multiple error conditions are present, the display will show all error modes. The alarm relay contacts will close upon detection of the error. The alarm can be canceled by pressing the RESET RATIO key or correcting the error.
Error Messages	Refer to Appendix H for displayed error messages and troubleshooting information.

Appendix A (cont.)

DEFAULT VALUES

System State	Halted (stop mode)
Header Set Mode	Indoor/Outdoor Reset
Indoor Air Input	Thermistor
Boiler Op Mode	Sequential
Start Level	45%
Stop Level	18%
Auxiliary Relay Open	45% Fire Rate
Auxiliary Relay Close	100% and Off
Header Temperature Bandwidth	70°F
Integral Gain	.15 repeats/min.
Derivative Gain	.15
System Start Relay	70°F
Building Reference Temperature	70°F
Header Reference Temperature	160°F
Header High Limit	220°F
Header Low Limit	40°F
Reset Ratio	1.2
Indoor Setpoint	70°F
All Offset Temperatures	0
All Offset Times	0
Indoor Prop Band	0
Maximum Power Input	100%
Interlock 1	Start Enabled
Number of Combo Units	1
Real-Time Clock	Set to Present Date and Time

Appendix B

Methods for Determining Reset Schedule and Indoor/Outdoor Reset Ratio Charts

Using the Charts to Determine Reset Schedule

Each table in this appendix provides data for a specific building reference temperature. On the vertical axis of each table are degree day temperatures. These are the average lowest temperatures likely to be encountered. The engineer of your system should have this number for your area. The reset ratio is shown across the top. The data in the tables is header temperature. To determine the reset ratio for your installation, follow these steps:

- On the vertical axis, find the degree day for your area.
- Select the temperature that should be maintained in the header to maintain the building at the desired temperature. The system engineer should have this information.
- The proper reset ratio is the value found above the two selected points. For example, for a degree day of 15°F and a header temperature of 125°F, the reset ratio is 1.4.

Determining Reset Schedule By Formula

There are two steps required to determine reset schedule with this method. The first is to determine the reset ratio by dividing the range of outside temperatures by the range of header temperatures:

$T_{header}/T_{outside}$ = Reset Ratio.

for example, If $T_{outside}$ varies from -10 to +95°F (105° range), and

T_{header} varies from 125 to 200°F (75° range), then the reset ratio equals

75°/105° = 0.714.

Once the reset ratio is determined, this number and the lowest or highest header temperature and corresponding lowest or highest air temperature, are input to the following equation to yield the building reference temperature:

T_{header} . RR (TR-TO)+TR, where:

RR is the reset ratio
TR is the building reference temperature
TO is the minimum outside temperature, and
T_{header} is the maximum heating system Temperature desired at the minimum outside air temperature.

So in this example:

T_{header} = 200°F
200°F = 0.714 [TR-(-10°F)] +TR
200°F = 1.714TR + 7.14°F

Solving for TR:

TR = (200°F-7.14°F)/1.714
TR = 192.86°F/1.714
TR = 112.5°F

Therefore, use a reset ratio of 0.7 (closest to 0.714) and a building reference temperature of 113 (closest to 112.5).

Appendix B (cont.)

Header Temperature for a Building Reference Temperature of 50°F

	Reset Ratio									
Air Temp (°F)	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0	2.2	2.4
50	50	50	50	50	50	50	50	50	50	50
45	53	54	55	56	57	58	59	60	60	62
40	56	58	60	62	64	66	68	70	72	74
35	59	62	65	68	71	74	77	80	83	86
30	62	66	70	74	78	82	86	90	94	98
25	65	70	75	80	85	90	95	100	105	110
25	65	70	75	80	85	90	95	100	105	110
20	68	74	80	86	92	98	104	110	111	122
15	71	78	85	92	99	106	113	120	127	134
10	74	82	90	98	106	114	122	130	138	146
5	77	86	95	104	113	122	131	140	149	158
0	80	90	100	110	120	130	140	150	160	170
-5	83	94	105	116	127	138	149	160	171	182
-10	86	98	110	122	134	146	158	170	182	194
-15	89	102	116	128	141	154	167	180	193	206
-20	92	106	120	134	148	162	176	190	204	218

Appendix B (cont.)

Header Temperature for a Building Reference Temperature of 65°F

	Reset Ratio									
Air Temp (^{0}F)	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0	2.2	2.4
65	65	65	65	65	65	65	65	65	65	65
60	68	69	70	71	72	73	74	75	76	77
55	71	73	75	77	79	81	83	85	87	89
50	74	77	80	83	86	89	92	95	98	101
45	77	81	85	89	93	97	101	105	109	113
40	80	85	90	95	100	105	110	115	120	125
35	83	89	95	101	107	113	119	125	131	137
30	86	93	100	107	114	121	128	135	142	149
25	89	97	105	113	121	129	137	145	153	161
20	92	101	110	119	128	137	146	155	164	173
15	95	105	115	126	135	145	155	165	175	185
10	98	109	120	131	142	153	164	175	186	197
5	101	113	125	137	149	161	173	185	197	209
0	104	117	130	143	156	169	182	195	208	
-5	107	121	135	149	163	177	191	205	219	
-10	110	125	140	155	170	185	200	215		
-15	113	129	145	161	177	193	209			
-20	116	133	150	167	201	218				

Appendix B (cont.)

Header Temperature for a Building Reference Temperature of 70°F

	Reset Ratio									
Air Temp (^{0}F)	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0	2.2	2.4
70	70	70	70	70	70	70	70	70	70	70
65	73	74	75	76	77	78	79	80	81	82
60	76	78	80	82	64	86	88	90	92	94
55	79	82	85	88	91	94	97	100	103	106
50	82	86	90	94	98	102	106	110	114	118
45	85	90	95	100	105	110	115	120	125	130
40	88	94	100	106	112	118	124	130	136	142
35	91	98	105	112	119	126	133	140	147	154
30	94	102	110	118	126	134	142	150	158	166
25	97	106	115	124	133	142	151	160	169	178
20	100	110	120	130	140	150	160	170	180	190
15	103	114	125	136	147	158	169	180	191	202
10	106	118	130	142	154	166	178	190	202	214
5	109	122	135	148	161	174	187	200	213	
0	112	126	140	154	168	182	196	210		
-5	115	130	145	160	175	190	205			
-10	118	134	150	166	182	198	214			
-15	121	138	155	172	189	206				
-20	124	142	160	178	196	214				

Appendix B (cont.)

Header Temperature for a Building Reference Temperature of 75°F

	Reset Ratio									
Air Temp (°F)	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0	2.2	2.4
75	75	75	75	75	75	75	75	75	75	75
70	78	79	80	81	82	83	84	85	88	75
65	81	83	85	87	89	91	93	95	97	87
60	84	87	90	93	96	99	102	105	108	99
55	87	91	96	99	103	107	111	115	119	111
50	90	95	100	105	110	115	120	125	130	123
45	93	99	105	111	117	123	129	135	141	135
40	96	103	110	117	124	131	138	145	156	147
35	99	107	115	123	131	139	147	155	163	159
30	102	111	120	129	138	147	156	165	174	171
25	105	115	125	135	145	155	165	175	185	183
20	108	119	130	141	152	163	174	185	196	195
15	111	123	135	147	159	171	183	195	207	207
10	114	127	140	153	166	179	192	205	218	219
5	117	131	145	159	173	187	201	215		
0	120	135	150	165	180	195	210			
-5	123	139	155	171	187	203	219			
-10	126	143	160	177	194	211				
-15	129	147	165	183	201	219				

Appendix B (cont.)

Header Temperature for a Building Reference Temperature of 80°F

	Reset Ratio									
Air Temp (˚F)	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0	2.2	2.4
80	80	80	80	80	80	80	80	80	80	80
75	83	84	85	86	87	88	89	90	91	92
70	86	88	90	92	94	96	98	100	102	104
65	89	92	95	98	101	104	107	110	113	116
60	92	96	100	104	108	112	116	120	124	128
55	95	100	105	110	115	120	125	130	135	140
50	98	104	110	116	122	128	134	140	148	152
45	101	108	115	122	129	136	143	150	157	164
40	104	112	120	128	136	144	152	160	168	176
35	107	116	125	134	143	152	161	170	179	188
30	110	120	130	140	150	160	170	180	190	200
25	113	124	135	146	157	168	174	190	201	212
20	116	128	140	152	164	176	188	200	212	
15	119	132	145	158	171	184	197	210		
10	122	136	150	164	178	192	206			
5	125	140	155	170	185	200	215			
0	128	144	160	176	192	208				
-5	131	148	165	187	199	216				
-10	134	152	170	188	206					

Appendix B (cont.)

Header Temperature for a Building Reference Temperature of 90°F

	Reset Ratio									
Air Temp (°F)	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0	2.2	2.4
90	90	90	90	90	90	90	90	90	90	90
85	93	94	95	96	97	98	99	100	101	102
80	96	98	100	102	104	106	108	110	112	114
75	99	102	105	108	111	114	117	120	123	126
70	102	106	110	114	118	122	126	130	134	138
65	105	110	115	120	125	130	135	140	145	150
60	108	114	120	126	132	138	144	150	156	162
55	111	118	125	132	139	146	153	160	167	174
50	114	122	130	138	146	154	162	170	178	186
45	117	126	135	144	153	162	171	180	189	198
40	120	130	140	150	160	170	180	190	200	210
35	123	134	145	156	174	186	198	210		
30	126	138	150	162	174	186	198	210		
25	129	142	155	168	181	194	207			
20	132	146	160	174	188	202	218			
15	135	150	165	180	195	210				
10	138	154	170	186	202	218				
5	141	158	175	192	209					
0	144	162	180	198	216					

Appendix C

Normal (Read-Only) Mode
Display Messages and Defaults

Key	Display Message	Default	Range
HDR TEMP	HEADER TEMP 160°F (Default Display)		
(Press and Hold)	HEADER SET TEMP 160°F	160°F	40 to 220°F
AIR TEMP	OUTSIDE AIR TEMP 70°F		
(Press and Hold)	INDOOR AIR TEMP 70°F (If Connected)		
% LOAD	PERCENT OF LOAD 100% 8 Units	100 %	0 to 100 % 0 to 40 Units
SYS START TEMP (Press and Hold)	SYS. START RELAY 70°F	70°F	32 to 120°F
REF TEMP (Press and Hold)	BLDG REF TEMP (Indoor/Outdoor Reset Mode)	70°F	40 to 220°F
	HEADER REF. TEMP (Constant Setpoint Mode)	120°F	40 to 220°F
	BLDG REF TEMP (Remote Setpoint Mode)	70°F	40 to 220°F
HDR TEMP LIMIT (Press and Hold)	HDR HIGH LIMIT 220°F	220°F	40 to 220°F
SET POINT (Press and Hold)	INDOOR SET POINT 70°F	70°F	50 to 150°F
PROP BAND (Press and Hold)	INDOOR PROP BAND 00.0°F/°F	00.0°F/°F	0 to 20°F/°F in 0.5°F/°F increments
RESET RATIO (Press and Hold)	RESET RATIO 1.2°F/°F (Indoor/Outdoor Reset Mode Only)	1.2°F/°F	0.3 to 3.0°F/°F in 0.1 increments
	FUNCTION NOT VALID (All Other Modes)		
OFF SET (Press and Hold)	OFFSET TEMP 0°F	0°F	-50 to +50°F

Appendix D

Field Adjust Mode
Display Messages and Defaults

Key	Display Message	Default	Range
HDR TEMP (Press Once)	RS485 BAUDRATE 9600	9600	2400, 4800, 9600, 14400, 19200
(Press 2nd Time)	MIN SLAVE ADDR 0	0	0 to 127
(Press 3rd Time)	MAX SLAVE ADDR 0	0	0 to 127
(Press 4th Time)	NUMBER NETW BLRS 0	0	0 to 32
(Press 5th Time)	MODBUS CNTL TYPE Round Robin	Round Robin	Round Robin or Broadcast
(Press 6th Time)	NETW BOILER 1 ADDRESS=0 (Repeat for Each Netw Boiler)	0	0 to 127
AIR TEMP (Press Once)	RS232 MODE MODBUS SLAVE	MODBUS SLAVE	NORMAL or MODBUS SLAVE
(Press 2nd Time)	RS232 BAUDRATE 9600	9600	2400, 4800, 9600, 14400, 19200
(Press 3rd Time)	MODBUS ADDRESS 128	128	0, 128 to 247
(Press 4th Time)	NETWORK TIMEOUT 60	60 sec.	5 to 240 sec.
(Press 5th Time)	REMOTE SIGNAL 4-20MA	4-20MA	4-20MA or MODBUS
(Press 6th Time)	MODBUS PASS THRU DISABLED	DISABLED	ENABLED or DISABLED
% LOAD (Press & Hold)	PERCENTAGE OF LOAD 100% 8 Units	100 %	0 to 100 % 0 to 8 Units
% LOAD (Press & Release)	SET TIME CLOCK MONTH: 06	Present month	01 to 12
(Press 2nd Time)	SET TIME CLOCK DATE: 21	Present day of month	1 to 31
(Press 3rd Time)	SET TIME CLOCK YEAR: 03	Present year	00 to 99
(Press 4th Time)	SET TIME CLOCK DAY: 1	Day one is Sunday	1 to 7
(Press 5th Time)	SET TIME CLOCK HOURS: 14	Present time	00 to 23
(Press 5th Time)	SET TIME CLOCK HOURS: 14	Present time	00 to 23
(Press 6th Time)	SET TIME CLOCK MINS: 30	Present time	00 to 59

Appendix D (cont.)

Field Adjust Mode
Display Messages and Defaults (cont.)

Key	Display Message	Default	Range
SYS START TEMP	SYS START RELAY 70°F	70°F	32 to 120°F
(Press 2nd Time)	SYS START OPTION TEMP ONLY	TEMP ONLY	TEMP ONLY, or TEMP AND LOAD
REF TEMP	BLDG REF TEMP (When in Indoor/Outdoor Reset Mode or Remote Setpoint Mode)	70°F	40 to 220°F
	HEADER REF TEMP (When in Constant Setpoint Mode)	120°F	40 to 220°F
HDR TEMP LIMIT	HDR HIGH LIMIT 220°F	220°F	40 to 220°F
(Press 2nd Time)	HDR LOW LIMIT 40°F	40°F	40 to 220°F
(Press 3rd Time)	HEADER OFFSET 0°F	0°F	-5°F to 5°F
SET POINT	INDOOR SET POINT 70°F	70°F	50 to 150°F
PROP BAND	INDOOR PROP BAND 00.0°F/°F	00.0°F/°F	0 to 20°F/°F in 0.5°F/°F increments
RESET RATIO	RESET RATIO 1.2°F/°F (Indoor/Outdoor Reset Mode Only)	1.2°F/°F	0.3 to 3.0°F/°F in 0.1 increments
	FUNCTION NOT VALID (All Other Modes)		
OFFSET	OFFSET ENABLE OFF	OFF	ON or OFF
	OFFSET TEMP DAY 1:	0	-50 to +50°F
	OFFSET ON TIME DAY 1	00:00	00 to 23 Hours 00 to 59 Mins.
	OFFSET OFF TIME DAY 1	00:00	00 to 23 Hours 00 to 59 Mins.
CONFIG SYS	FAULT ALARM RELAY ALL FAULTS	ALL FAULTS	ALL FAULTS, NO INTERLOCK, INTERLOCK 2 INTERLOCK 1
(Press 2nd Time)	FAULT ALARM CLEAR MANUAL RESET	MANUAL RESET	MANUAL RESET or AUTOMATIC

Appendix E

Config Sys Mode
Display Messages and Defaults

Key	Display Message	Defaults	Range
TEMP FAIL MODE	TEMP FAIL MODE SHUTDOWN	SHUTDOWN	SHUTDOWN or SWITCH INPUTS
SYS ENABLE	INTERLOCK 1 START ENABLED	START ENABLED	START ENABLED or ALWAYS ENABLED
MAX PWR INPUT	MAX POWER INPUT 100%	100%	50 to 100%
(Press 2nd Time)	PWM TIMEBASE CAL 0	0	-30 to 30
START LEVEL	BLR. START LEVEL 45%	45%	25 to 100%
STOP LEVEL	BLR STOP LEVEL 18%	18%	10 to 45%
BLR OP MODE	BOILER OP MODE SEQUENTIAL MODE	SEQUENTIAL	SEQUENTIAL, PARALLEL or COMBINATION
(Press 2nd Time) If COMBINATION MODE is selected	COMBINATION MODE 1 OF CCP BOILERS	1	1 to 4
HDR SET MODE	HEADER SET MODE IN/OUTDOOR RESET	IN/OUTDOOR RESET	IN/OUTDOOR RESET, CONSTANT SETTEMP, REMOTE SET TEMP
(Press 2nd Time)	INDOOR TEMP INP. THERMISTOR INPUT	THERMISTOR	THERMISTOR or 4-20 mA
INTGL RATE GAIN	INTEGRAL GAIN 0.15 REP/MIN	0.15 REP/MIN	0.00 to 9.99 REP/MIN
TEMP BANDWIDTH	HDR TEMP B.W. 70°F	70°F	5 to 100°F
AUX RELAY	AUX RELAY OPEN 45%	45%	0 to 99%
(Press 2nd Time)	AUX RELAY CLOSE 100% AND OFF	100% AND OFF	100% AND OFF or 100% FIRE RATE
DERIV GAIN	DERIVATIVE GAIN 0.15 MIN.	0.15 MIN.	-2.00 to 2.00 MIN.

Appendix F

Temperature Sensor Resistance Data

Temperature (°F)	Resistance (ohms)	Temperature (°F)	Resistance (ohms)
-40	239,571	180	1,362
-30	173,530	190	1,155
-20	127,088	200	984
-10	94,059	210	842
0	70,314	220	723
10	53,068	230	623
20	40,418	240	539
30	31,053	250	468
40	24,057	260	408
50	18,787	270	357
60	14,783	280	313
70	11,717	290	276
80	9,353	300	243
90	7,516	310	
100	6,078	320	
110	4,946	330	
120	4,049	340	
130	3,333	350	
140	2,759	360	
150	2,296	370	
160	1,920	380	
170	1,613	390	

Appendix G

Parts List

Part Number	Description	Comment
GP-122783	Boiler Management System (BMS)	Complete BMS
124376	Electronics	BMS Controls per Spec. 5C5-380
GP-6-217	#10-32 x 3/8 inch Mounting Screws	
GP-6-218	#10-32 x 1/2 inch Mounting Screw	
GP-161228	Mounting Plate	
GP-181108	Field Adjust Overlay	
GP-181109	System Configuration Overlay	
18949	Machined Front Panel	Supplied with Control Panel (122784)
122784	Control Panel	Includes Machined Front Panel (18949)
GP-123042	120 VAC, 1A, 2AG subminiature, fast-acting fuse (Littlefuse 225001)	For BMS Electronics
GP-123043	12 VAC, 5A, 2AG Subminiature, Fast-Acting Fuse (Littlefuse 225005)	For System-Start, Fault Alarm, and Auxiliary Relays
GP-122662	Outside Air Temperature Sensor	
GM-122781	Outside Air Temperature Sensor Kit	Includes Sensor (122662) and Mounting Bracket
64038	Header Temperature Sensor	Sensor Only
GP-122758	Thermowell for Header Temperature Sensor	Thermowell Only
GM-122790	Header Temperature Sensor Kit	Includes 64038 and GP-122758
GM-122791	Outdoor Reset Kit	Includes GM-122781 and GM-122790
GP-122882	Indoor Temperature Sensor	
65020	Low Voltage Terminal Block (16 pin)	
65021	High Voltage Terminal Block (9 pin)	

Appendix H

TROUBLESHOOTING

When a fault occurs in the boiler plant, the BMS flashes error messages at 2-second intervals and the alarm contacts close. To cancel alarms (open contacts but message still displays), press the **RESET RATIO** key The fault messages shown in Table H1 can occur in any mode of operation, Constant Setpoint, Indoor/Outdoor Reset, or Remote Setpoint. Some of the most common problems encountered in BMS operation are contained in Table H2.

Table H1 Error Messages

Fault Message	Description & Possible cause
OUTSIDE AIR TEMP NOT CONNECTED	• Open outside air temp. sensor: resistance greater than 240K ohms (less than -40°F) Shorted outside air temp. sensor: resistance less than 1K ohms (greater than 200°F) No sensor connected Note: Displays only in 4-to-20 mA and Constant Setpoint modes. It does not display as an error message, and will display only after pressing the AIR TEMP key.
OUTSIDE AIR TEMP SENSOR ERROR	When in Indoor/Outdoor Reset Mode, the outside air temperature sensor is either open, shorted, or not connected.
HEADER TEMP SENSOR ERROR	• Open header sensor: resistance greater than 240K ohms (less than -40°F) Shorted header sensor: resistance less than 240 ohms (over 300°F) Sensor not installed
INDOOR AIR TEMP SENSOR ERROR	• Open indoor air temp. sensor: resistance greater than 240K ohms (less than -40°F) . Shorted sensor: resistance less than 240 ohms (over 300°F) No sensor installed and Prop Band is adjusted to > 0°F/°F
SYSTEM ERROR, INTERLOCK 1	Interlock 1 is open

Appendix H

Table H1 Error Messages - Continued

Fault Message	Description & Possible cause
SYSTEM ERROR, INTERLOCK 2 OPEN	Interlock 2 is open
(4-20 MA) INPUT OPEN LOOP ERROR	The 4-to-20-mA remote input signal has dropped below 3 mA, or the signal is not present at the BMS.
FAIL SAFE MODE ACTIVATED	This message can be displayed when the BMS is controlling the boilers via Modbus or PWM communication. It indicates that the BMS is operating in the Fail Safe (Constant Setpoint) mode.
NETWORK COMM FLT TIMEOUT ERROR	Displayed during Modbus Remote Setpoint operation when the BMS is functioning as a Slave to an EMS Master. Error indicates that the Network Timeout has expired.
NETWORK DISABLED MODBUS LISTEN	Displayed during Modbus operation when the “FORCE LISTEN ONLY” Modbus diagnostic command is sent to the BMS Slave by the controlling Master, thereby disabling normal Modbus Network communication. It indicates that the Master is listening for the “RESTART COMMUNICATIONS OPTIONS” diagnostic command required to restart normal Modbus communication. The BMS will operate in the Fail Safe mode during this period.

Appendix H

Table H2 Common Problems

Problem	Possible Causes	Solution
Boiler plant not started by BMS	• Outside air temperature higher than system's start temperature	• Check outside air temperature and system start temperature. System start temperature should be higher than outside air temperature for boilers to run. See para. 4.3.3 and 4.3.5.
	• System must be initialized	Initialize and test system (para. 5.5 and 5.6).
	• Wiring between boilers and BMS not correct	• Check wiring (Section 3)
Boiler not being recognized by BMS with Modular Control Box	• Temperature controller is not in Manual/Remote mode	• Check temperature controller. The REM and MAN lights should be illuminated. If not, shut off AC power to the boiler, wait 30 sec., and reapply power. The boiler will automatically return to remote/manual mode.
	• Temperature controller's secure menu is not locked	• Go to Secure menu in temperature controller. It should display Secure 3. If the display shows Secure 4, relock to Secure 4.
	• Boilers are not correctly addressed	• See para. 5.4
	• Wiring between the BMS and boilers is incorrect Indoor sensor not installed but value has been entered under PROP BAND	• See Section 3 for correct wiring connections • If value has been entered under PROP BAND, change value to 00/00° F
Boiler not being recognized by BMS with C-More Control Box	• C-More Box not configured correctly.	• Ensure that the C-More Boiler is configured for Direct Drive and PWM (see para. 5.5 of GF-109 (KC1000) or GF-110 (Benchmark) for required menu settings.
	• C-More Box not enabled. Front panel switch is off.	• Check ON/OFF switch.
	• Incorrect wiring between BMS and Boiler.	• See Section 3 for correct wiring connections

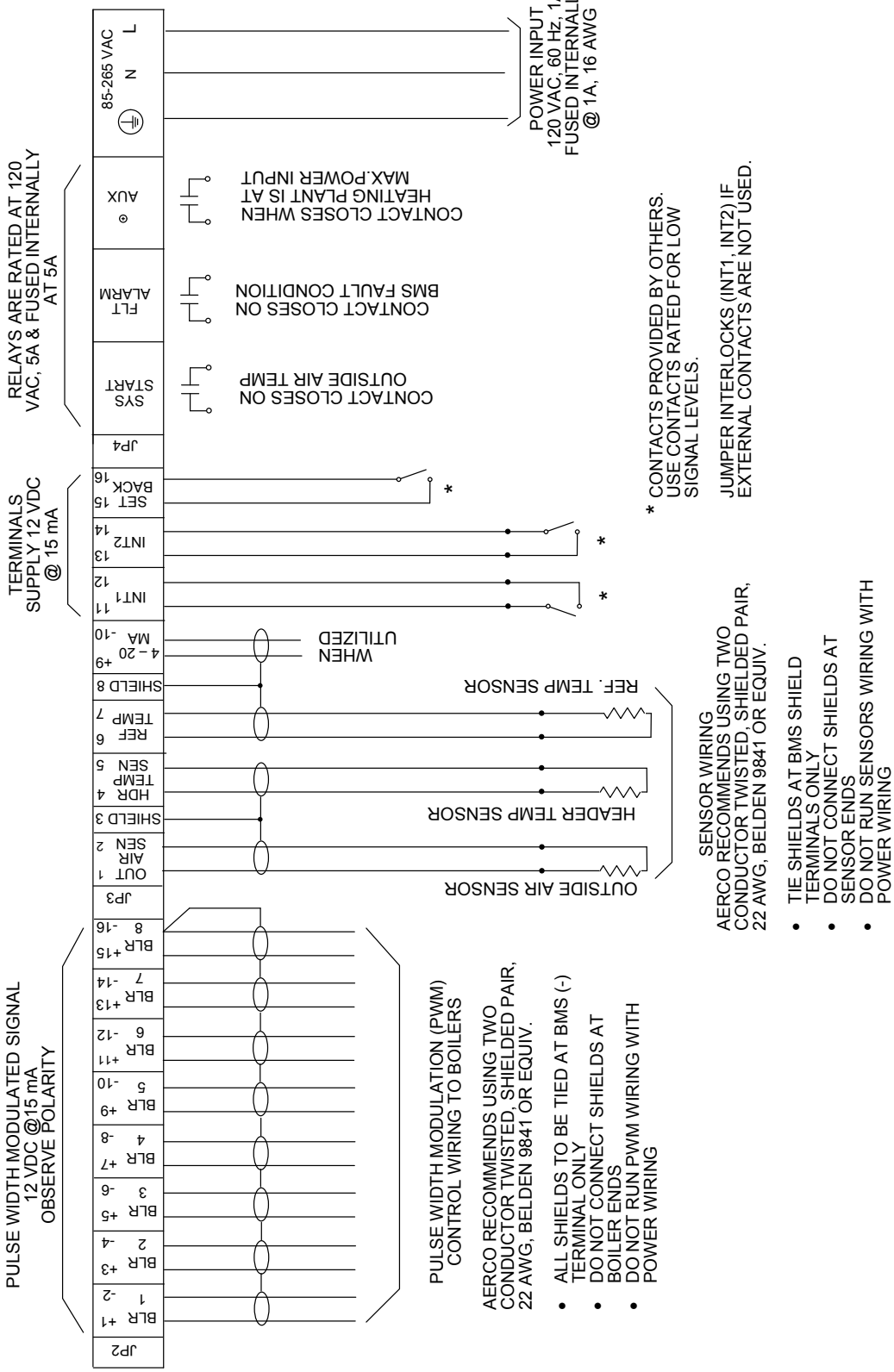
Appendix H

Table H2 Common Problems - Continued

Problem	Possible Causes	Solution
Boilers overshooting setpoint or tripping aquastat	• Header sensor not installed correctly	• Check header sensor connections and installation.
	• PID setting require adjustment	• Adjust PID settings. See para. 4.4.7
	• Adjustable aquastat set too low	• If aquastat is set lower than 200°F, reset it to 220°F.
	• System pumps are shut down and not controlled by or interlocked with the BMS	• If system pumps are shut down, check start and stop temperatures on energy management system. They should correspond to those set in the BMS. In addition, interlock wiring can be run between the BMS and energy management system to disable the BMS pumps when pumps are not running.
	• BMS is set to ALWAYS ENABLE	• If BMS is set to ALWAYS ENABLED, change it to START ENABLED
Modbus Network faults encountered. Boiler plant not operating	• BMS or boilers not properly configured for Modbus communication	• Refer to Modbus Communication Manual GF-114. Check all wiring connections and software menu settings.

Appendix I

GENERAL WIRING



Appendix J

PROGRAMMING THE BMS USING RS-232 COMMUNICATION

Introduction

The RS-232 port on the left side of the BMS can be used to program the BMS using a laptop computer or other suitable terminal. Connection to a laptop or other terminal device is made using a 9-pin RS-232 adapter cable. Communication can be accomplished using any "Dumb Terminal" emulation, such as Hyper Terminal which is included with Microsoft Windows. The RS-232 communication feature allows the BMS to be easily programmed to your installation requirements using a listing of entry commands.

Set-Up

Regardless of the terminal emulation utilized, the following guidelines must be adhered to when interfacing the BMS to the Terminal device:

1. Connect a 9-pin serial cable to the RS-232 connector near the lower left corner of the BMS front panel.
2. Connect the free end of the cable to the COM 1 or COM 2 port on your laptop, or other suitable terminal device.
3. Set up the emulator communication link as follows:
   (a) Set the baud rate to 9600.
   (b) Set the data format to 8 bits, 1 stop bit, no parity and either Xon/Xoff or No Flow Control.
4. Turn on the BMS by pressing the **ON** key. Verify that the **ON** LED lights.
5. Press the **FIELD ADJ** key on the BMS to enter the Field Adjust Mode. Verify that the **FIELD ADJ** LED lights.

IMPORTANT

The *RS232 MODE* setting MUST be set to *NORMAL* to permit the BMS functions to be programmed via the RS232 port.

6. Press the **AIR TEMP** key until *RS232 MODE* is shown in the top line of the display. If necessary, press the ▲ or ▼ arrow key until *NORMAL* appears in the second line of the display.
7. Press the **FIELD ADJ** key to exit the Field Adjust Mode. Verify that the **FIELD ADJ** LED goes off.
8. Start the emulator software program.
9. At the command prompt, enter the password EXACTLY as follows (case-sensitive):

   P=gobms

10. Press Return (<Rtn>) on your terminal.
11. The setup is now complete. You are ready to begin viewing or changing BMS functions.

Appendix J (cont.)

Programming Procedure

BMS functions which can be viewed or changed are listed in Table J-1 along with their corresponding command numbers. Functions which can only be viewed (such as actual sensor readings) are marked “Read Only”. Viewing or changing function values is accomplished as follows:

1. Select the number of the desired command from Table J-1.
2. To view a parameter, type ?, followed by the command number and then press return (<Rtn>). For example, to view command no. 00 (HEADER TEMPERATURE), enter:

   ?00<Rtn>

   The header temperature reading will be displayed. All temperature readings are in °F.
3. To program (set) a BMS parameter, type @, followed by the command number, an equal sign, the parameter value and a trailing zero. For example, to set command 05 (SYSTEM OUTSIDE AIR START TEMPERATURE) to 65°F, enter:

   @05=650<Rtn>

Use the above steps to view and/or program the desired BMS functions listed in Table J-1.

Appendix J (cont.)

Table J-1. BMS COMMANDS

No.	COMMAND	ENTRY RANGE	FACTORY DEFAULT
00	Header Temperature (°F)	40 to 220	Read Only
01	Outside Air Temperature (°F)	-60 to 80	Read Only
02	Indoor Air Temperature (°F)	40 to 160	Read Only
03	Fire Rate (%)	0 to 100	Read Only
04	Header Set Temperature (°F)	40 to 220	Read Only
05	System Outside Air Start Temperature (°F)	32 to 120	70
06	System Start Mode	0 = Temp Only 1 = Temp and Load	0 = Temp Only
07	Manual Header Set Temperature (°F)	40 to 220	160
08	Reference Temperature (°F)	40 to 220	70°F
09	Indoor Prop Band	0.0 to 20.0 (0.1 increments)	0.0
10	Setpoint Temperature(°F)	40 to 220	160
11	Reset Ratio	0.3 to 3.0 (0.1 increments)	1.2
12	Maximum Header Temperature (°F)	40 to 220	220
13	Minimum Header Temperature (°F)	40 to 220	40
14	Boiler Start Percent	25 to 100	45
15	Boiler Stop Percent	10 to 45	18
16	Integral Gain (Rep./Min)	0.00 to 9.99 (0.01 increments)	0.15
17	Header Set Mode	0 = Constant Settemp 1 = Indr/Outdr Reset 2 = Remote Settemp	1 = Indr/Outdr Reset
18	Derivative Gain	-2.00 to 2.00 (0.01 increments)	0.15
19	Header Bandwidth (°F)	5 to 100	70
20	Aux Relay Off Level (%)	0 to 99	45

Appendix J (cont.)

Table J-1. BMS COMMANDS

No.	COMMAND	ENTRY RANGE	FACTORY DEFAULT
21	Aux Relay Mode	0 = 100% Fire Rate 1 = 100% and OFF	1 = 100% AND OFF
22	Temperature Sensor Fail Mode	0 = Shutdown 1 = Switch Inputs	0 = Shutdown
23	Fault Relay Mode	0 = All Faults 1 = No Interlock 2 = Interlock 2 3 = Interlock 1	0 = All Faults
24	Alarm Clear Method	0 = Automatic 1 = Manual	0 = Automatic
25	Boiler Operation Mode	0 = Parallel 1 = Sequential 2 = Combination	1 = Sequential
26	Number Of PWM Combo Units	0 to 4	1
27 28 29	Reserved		
30	Maximum PWM Percent Level	50 to 100	100
31	Interlock 1 Method Of Operation	0 = Always Enabled 1 = Start Enabled	1 = Start Enabled
32	Real Time Clock - Minutes	00 to 59	Present Time
33	Real Time Clock - Hours	00 to 23	Present Time
34	Real Time Clock - Day Of Week	1 to 7	Present Day
35	Real Time Clock - Year	00 to 99	Present Year
36	Real Time Clock - Day Of Month	00 to 31	Present Day
37	Real Time Clock - Month	00 to 12	Present Month
38 Thru 44	(Day 1) Offset Temperatures (Day 1-7) (Day 7)	-50 to +50°F	All Set To 0°F

Appendix J (cont.)

Table J-1. BMS COMMANDS – (Continued)

No.	COMMAND	ENTRY RANGE	FACTORY DEFAULT
45 Thru 51	(Day 1) Offset ON Time – Minutes (Day 1-7) (Day 7)	00 to 59	All Set to Zero
52 Thru 58	(Day 1) Offset ON Time – Hours (Day 1-7) (Day 7)	00 to 23	All Set To Zero
59	Offset Enable	0 = Disabled 1 = Enabled	0 = Disabled
60	Header Offset (°F)	0 to 5	0
61	System Start Relay Contact Operation With Interlocks	0 = No Action 1 = Either Intlk Opens Start Relay 2 = Intlk 1 Opens Start Relay 3 = Intlk 2 Opens Start Relay	0 = No Action
70 Thru 76	(Day 1) Offset OFF Time – Minutes (Day 1-7) (Day 7)	00 to 59	All Set To Zero
77 Thru 83	(Day 1) Offset OFF Time – Hours (Day 1-7) (Day 7)	0 to 23	All Set To Zero
84	(Reserved)		
85	Indoor Air Input	0 or 1 0 = 4 - 20 mA 1 = Thermistor	1 = Thermistor
Command Nos. 86 and Up Apply Only to BMS Units Equipped With Modbus Capability			
86	Remote Signal	0 or 1 0 = 4 - 20 mA 1 = Modbus	0 = 4 - 20 mA

Appendix J (cont.)

Table J-1. BMS COMMANDS – (Continued)

No.	COMMAND	ENTRY RANGE	FACTORY DEFAULT
87	RS232 Mode	0 or 1 0 = Normal 1 = Modbus	1 = Modbus
88	RS232 Baud Rate	2400, 4800, 9600, 14400, 19200	9600
89	Number Of Network Boilers	0 to 32	0
90	Min Slave Address	0 to 127	0
91	Max Slave Address	0 to 127	0
92	Net Boiler 1 Address	Address for Network Boiler 1 (same as Boiler #9)	
93	Net Boiler 2 Address	Address for Network Boiler 2 (same as Boiler #10)	
94	Net Boiler 3 Address	Address for Network Boiler 3 (same as Boiler #11)	
95	Net Boiler 4 Address	Address for Network Boiler 4 (same as Boiler #12)	
96	Net Boiler 5 Address	Address for Network Boiler 5 (same as Boiler #13)	
97	Net Boiler 6 Address	Address for Network Boiler 6 (same as Boiler #14)	
98	Net Boiler 7 Address	Address for Network Boiler 7 (same as Boiler #15)	
99	Net Boiler 8 Address	Address for Network Boiler 8 (same as Boiler #16)	
100	Net Boiler 9 Address	Address for Network Boiler 9 (same as Boiler #17)	

Appendix J (cont.)

Table J-1. BMS COMMANDS – (Continued)

No.	COMMAND	ENTRY RANGE	FACTORY DEFAULT
101	Net Boiler 10 Address	Address for Network Boiler 10 (same as Boiler #18)	
102	Net Boiler 11address	Address for Network Boiler 11 (same as Boiler #19)	
103	Net Boiler 12 Address	Address for Network Boiler 12 (same as Boiler #20)	
104	Net Boiler 13 Address	Address for Network Boiler 13 (same as Boiler #21)	
105	Net Boiler 14 Address	Address for Network Boiler 14 (same as Boiler #22)	
106	Net Boiler 15 Address	Address for Network Boiler 15 (same as Boiler #23)	
107	Net Boiler 16 Address	Address for Network Boiler 16 (same as Boiler #24)	
108	Net Boiler 17 Address	Address for Network Boiler 17 (same as Boiler #25)	
109	Net Boiler 18 Address	Address for Network Boiler 18 (same as Boiler #26)	
110	Net Boiler 19 Address	Address for Network Boiler 19 (same as Boiler #27)	
111	Net Boiler 20 Address	Address for Network Boiler 20 (same as Boiler #28)	
112	Net Boiler 21 Address	Address for Network Boiler 21 (same as Boiler #29)	

Appendix J (cont.)

Table J-1. BMS COMMANDS – (Continued)

No.	COMMAND	ENTRY RANGE	FACTORY DEFAULT
113	Net Boiler 22 Address	Address for Network Boiler 22 same as Boiler #30)	
114	Net Boiler 23 Address	Address for Network Boiler 23 (same as Boiler #31)	
115	Net Boiler 24 Address	Address for Network Boiler 24 (same as Boiler #32)	
116	Net Boiler 25 Address	Address for Network Boiler 25 (same as Boiler #33)	
117	Net Boiler 26 Address	Address for Network Boiler 26 (same as Boiler #34)	
118	Net Boiler 27 Address	Address for Network Boiler 27 (same as Boiler #35)	
119	Net Boiler 28 Address	Address for Network Boiler 28 (same as Boiler #36)	
120	Net Boiler 29 Address	Address for Network Boiler 29 (same as Boiler #37)	
121	Net Boiler 30 Address	Address for Network Boiler 30 (same as Boiler #38)	
122	Net Boiler 31 Address	Address for Network Boiler 31 (same as Boiler #39)	
123	Net Boiler 32 Address	Address for Network Boiler 32 (same as Boiler #40)	

Appendix J (cont.)

Table J-1. BMS COMMANDS – (Continued)

No.	COMMAND	ENTRY RANGE	FACTORY DEFAULT
124	Network Baud	2400, 4800, 9600, 14400, 19200	9600
125	Network Timeout	5 to 240 sec	60 sec.
126	Password Lo	0 to 255	0
127	Password Hi	0 to 255	0
128	Modbus Control Type	0 = Round-Robin 1 = Broadcast	0 = Round Robin
129	Modbus Pass-Thru	0 = Disabled 1 = Enabled	0 = Disabled
130 & Up	(Reserved For Future Expansion)	Undefined	