



**Natural Gas Modulating  
& Condensing Hot Water  
Heating Boiler Models:**

- **BMK 1500**
- **BMK 2000**

**THIS MANUAL APPLIES TO  
CHINA LOW PRESSURE  
(0.9 Bar) APPLICATIONS ONLY**

Applicable to Serial Numbers:  
**G-16-0450 and Above**

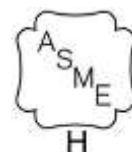
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# **USER MANUAL**

Installation, Operation and Maintenance

## **BENCHMARK 1500 and 2000 Gas-Fired Boilers**



# Benchmark 1500 – 2000 Boilers - INTERNATIONAL

Installation, Operation & Maintenance Manual

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### FOREWORD

The AERCO Benchmark (BMK) 1500 MBH (440 kW) and 2000 MBH (586 kW) boilers are modulating and condensing units. They represent a true industry advance that meets the needs of today's energy and environmental concerns. Designed for application in any closed loop hydronic system, the Benchmark's modulating capability relates energy input directly to fluctuating system loads. The turn down ratios for these boilers is 20:1. These BMK models provide extremely high efficiency operation and are ideally suited for modern low temperature, as well as, conventional heating systems.

The Benchmark Model BMK 1500 and BMK 2000 boilers operate within the following input and output ranges:

| Benchmark Model | Input Range (BTU/hr.) |                    | Output Range (BTU/hr.) |                    |
|-----------------|-----------------------|--------------------|------------------------|--------------------|
|                 | Minimum               | Maximum            | Minimum                | Maximum            |
| BMK 1500        | 75,000 (22 kW)        | 1,500,000 (440 kW) | 64,500 (18.9 kW)       | 1,395,000 (409 kW) |
| BMK 2000        | 100,000 (29.3 kW)     | 2,000,000 (586 kW) | 86,000 (25.2 kW)       | 1,860,000 (545 kW) |

The output of the boiler is a function of the unit's firing rate (valve position) and return water temperature.

When installed and operated in accordance with this Instruction Manual, these boilers comply with the NOx emission standards outlined in:

South Coast Air Quality Management District (SCAQMD), Rule 1146.2

Whether used in singular or modular arrangements, the BMK 1500 and BMK 2000 boilers offer the maximum venting flexibility with minimum installation space requirements. These boilers are Category II and IV, positive pressure appliances. Single and/or multiple breached units are capable of operation in the following vent configurations:

- Conventional, Vertical
- Conventional, Sidewall
- Conventional, Direct Vent, Vertical
- Sealed, Direct Vent, Horizontal

These boilers are capable of being vented utilizing Polypropylene and AL29-4C vent systems.

The Benchmark's advanced electronics are available in several selectable modes of operation offering the most efficient operating methods and energy management system integration.

### IMPORTANT

Unless otherwise specified, all descriptions and procedures provided in this Installation, Operation & Maintenance Manual apply to the Benchmark series of boiler.

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### Phrases, Abbreviations and Acronyms

| Phrase, Abbreviation or Acronym    | Meaning   |
|------------------------------------|---|
| A (Amp)                            | Ampere  |
| ACS                                | AERCO Control System, AERCO's boiler management systems   |
| ADDR                               | Address   |
| AGND                               | Analog Ground   |
| ALRM                               | Alarm   |
| ANSI                               | American National Standards Institute,  |
| ASME                               | American Society of Mechanical Engineers  |
| AUX                                | Auxiliary   |
| BAS                                | Building Automation System, often used interchangeably with EMS (see below)   |
| Baud Rate                          | Symbol rate, or simply the number of distinct symbol changes (signaling events) transmitted per second. It is not equal to bits per second, unless each symbol is 1 bit long. |
| BMK (Benchmark)                    | AERCO's Benchmark series boilers  |
| BMS or BMS II                      | AERCO Boiler Management Systems   |
| BLDG (Bldg)                        | Building  |
| BST                                | AERCO on-board Boiler Sequencing Technology   |
| BTU                                | British Thermal Unit. A unit of energy approximately equal to the heat required to raise 1 pound (0.45 kg) of water 1°F (0.55 °C)   |
| BTU/HR                             | BTUs per Hour (1 BTU/hr = 0.29 W)   |
| CCP                                | Combination Control Panel   |
| C-More Controller (or Control Box) | A control system developed by AERCO and currently used in all Benchmark, Innovation and KC1000 Series product lines.  |
| CFH                                | Cubic Feet per Hour (1 CFH = 0.028 m <sup>3</sup> /hr)  |
| CO                                 | Carbon Monoxide   |
| COMM (Comm)                        | Communication   |
| Cal.                               | Calibration   |
| CNTL                               | Control   |
| CPU                                | Central Processing Unit   |
| DIP                                | Dual In-Line Package, a type of switch  |
| ECU                                | Electronic Control Unit (O <sub>2</sub> sensor)   |
| EMS                                | Energy Management System; often used interchangeably with BAS   |
| FM                                 | Factory Mutual. Used to define boiler gas trains.   |
| GF-xxxx                            | Gas Fired (an AERCO document numbering system)  |
| GND                                | Ground  |
| HDR                                | Header  |



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| Phrase, Abbreviation or Acronym | Meaning   |
|---------------------------------|---|
| Hex                             | Hexadecimal Number (0 – 9, A – F)   |
| HP                              | Horse Power   |
| HX                              | Heat Exchanger  |
| Hz                              | Hertz (Cycles Per Second)   |
| I.D.                            | Inside Diameter   |
| IGN                             | Ignition  |
| IGST Board                      | Ignition/Stepper Board, contained in C-More Control Box                                   |
| INTLK (INTL'K)                  | Interlock   |
| I/O                             | Input/Output  |
| I/O Box                         | Input/Output (I/O) Box currently used on Benchmark, Innovation and KC1000 Series products |
| IP                              | Internet Protocol   |
| ISO                             | International Organization for Standardization  |
| Lbs.                            | Pounds (1 lb = 0.45 kg)   |
| LED                             | Light Emitting Diode  |
| LN                              | Low Nitrogen Oxide  |
| MA (mA)                         | Milliampere (1 thousand <sup>th</sup> of an ampere)                                       |
| MAX (Max)                       | Maximum   |
| MBH                             | 1000 BTUs per Hour (1000 MBH = 293 kW)  |
| MIN (Min)                       | Minimum   |
| Modbus®                         | A serial, half-duplex data transmission protocol developed by AEG Modicon                 |
| NC (N.C.)                       | Normally Closed   |
| NO (N.O.)                       | Normally Open   |
| NOx                             | Nitrogen Oxide  |
| NPT                             | National Pipe Thread  |
| O <sub>2</sub>                  | Oxygen  |
| O.D.                            | Outside Diameter  |
| OMM & O&M                       | Operation and Maintenance Manual  |
| OnAER                           | AERCO's on-line remote monitoring system  |
| PCB                             | Printed Circuit Board   |
| PMC Board                       | Primary Micro-Controller (PMC) board, contained in the C-More                             |
| P/N                             | Part Number   |
| POC                             | Proof of Closure  |
| PPM                             | Parts per Million   |
| PSI                             | Pounds per Square Inch (1 PSI = 6.89 kPa)   |
| PTP                             | Point-to-Point (usually over RS232 networks)  |

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| Phrase, Abbreviation or Acronym | Meaning   |
|---------------------------------|---|
| P&T                             | Pressure and Temperature  |
| ProtoNode                       | Hardware interface between BAS and a boiler or water heater   |
| PVC                             | Poly Vinyl Chloride, a common synthetic plastic   |
| PWM                             | Pulse Width Modulation  |
| REF (Ref)                       | Reference   |
| RES.                            | Resistive   |
| RS232<br>(or EIA-232)           | A standard for serial, full-duplex (FDX) transmission of data based on the RS232 Standard   |
| RS422<br>(or EIA-422)           | A standard for serial, full-duplex (FDX) transmission of data based on the RS422 Standard   |
| RS485<br>(or EIA-485)           | A standard for serial, half-duplex (HDX) transmission of data based on the RS485 Standard   |
| RTN (Rtn)                       | Return  |
| SETPT (Setpt)                   | Setpoint Temperature  |
| SHLD (Shld)                     | Shield  |
| SPDT                            | Single Pole Double Throw, a type of switch  |
| SSOV                            | Safety Shut Off Valve   |
| TEMP (Temp)                     | Temperature   |
| Terminating Resistor            | A resistor placed at each end of a daisy-chain or multi-drop network in order to prevent reflections that may cause invalid data in the communication |
| Tip-N-Tell                      | A device that indicates if a package was tipped during shipping   |
| UL                              | A business that tests and validates products  |
| VAC                             | Volts, Alternating Current  |
| VDC                             | Volts, Direct Current   |
| VFD                             | Vacuum Fluorescent Display, also Variable Frequency Drive   |
| W                               | Watt  |
| W.C.                            | Water Column, a unit of pressure (1 W.C. = 249 Pa)  |
| µA                              | Micro amp (1 million <sup>th</sup> of an ampere)  |

### CHAPTER 1. SAFETY PRECAUTIONS

#### 1.1 WARNINGS & CAUTIONS

Installers and operating personnel MUST, at all times, observe all safety regulations. The following warnings and cautions are general and must be given the same attention as specific precautions included in these instructions. In addition to all the requirements included in this AERCO instruction manual, the installation of units MUST conform with local building codes, or, in the absence of local codes, ANSI Z223.1 (National Fuel Gas Code Publication No. NFPA-54) for gas-fired boilers and ANSI/NFPASB for LP gas-fired boilers. Where applicable, the equipment shall be installed in accordance with the current Installation Code for Gas Burning Appliances and Equipment, CSA B149.1, and applicable Provincial regulations for the class; which should be carefully followed in all cases. Authorities having jurisdiction should be consulted before installations are made.

#### IMPORTANT

This instruction manual is an integral part of the product and must be maintained in legible condition. It must be given to the user by the installer and kept in a safe place for future reference.

#### --WARNING! --

Do not use matches, candles, flames, or other sources of ignition to check for gas leaks.

#### --WARNING! --

Fluids under pressure may cause injury to personnel or damage to equipment when released. Be sure to shut off all incoming and outgoing water shutoff valves. Carefully decrease all trapped pressures to zero before performing maintenance.

#### --WARNING! --

Before attempting to perform any maintenance on the unit, shut off all gas and electrical inputs to the unit.

#### --WARNING! --

The exhaust vent pipe of the unit operates under a positive pressure and therefore must be completely sealed to prevent leakage of combustion products into living spaces.

#### --WARNING! --

Electrical voltages up to 220 VAC may be used in this equipment. Therefore the cover on the unit's power box (located behind the front panel door) must be installed at all times, except during maintenance and servicing.

### --WARNING! --

A switch must be installed on the electrical supply line of the unit. The switch must be installed in an easily accessible position to quickly and safely disconnect electrical service. Do not affix switch to unit sheet metal enclosures.

### --CAUTION --

Many soaps used for gas pipe leak testing are corrosive to metals. The piping must be rinsed thoroughly with clean water after leak checks have been completed.

### --CAUTION --

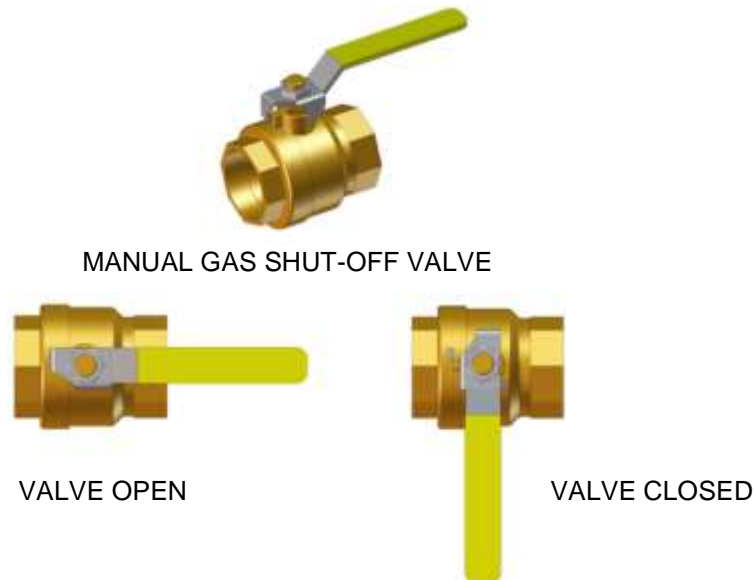
DO NOT use this boiler if any part has been under water. Call a qualified service technician to inspect and replace any part that has been under water.

## 1.2 EMERGENCY SHUTDOWN

If overheating occurs or the gas supply fails to shut off, close the manual gas shutoff valve (Figure 1-1) located external to the unit.

### NOTE

The Installer must identify and indicate the location of the emergency shutdown manual gas valve to operating personnel.



**Figure 1-1: Manual Gas Shutoff Valve**

## 1.3 PROLONGED SHUTDOWN

After prolonged shutdown, it is recommended that the startup procedures in Chapter 4 and the safety device test procedures in Chapter 6 of this manual be performed, to verify all system-operating parameters. If there is an emergency, turn off the electrical power supply to the AERCO boiler and close the manual gas valve located upstream the unit. The installer must identify the emergency shut-off device.

## CHAPTER 2. INSTALLATION

### 2.1 INTRODUCTION

This Chapter provides the descriptions and procedures necessary to unpack, inspect and install the AERCO Benchmark Model BMK 1500 and BMK 2000 Heating Boiler.

### 2.2 RECEIVING THE UNIT

Each Benchmark Heating Boiler System is shipped as a single crated unit. The shipping weight for these BMK models is approximately 1800 pounds (817 kg). The unit must be moved with the proper rigging equipment for safety and to avoid equipment damage. The unit should be completely inspected for evidence of shipping damage and shipment completeness at the time of receipt from the carrier and before the bill of lading is signed.

#### NOTE

AERCO is not responsible for lost or damaged freight. Each unit has a Tip-N-Tell indicator on the outside of the crate. This indicates if the unit has been turned on its side during shipment. If the Tip-N-Tell indicator is tripped, do not sign for the shipment. Note the information on the carrier's paperwork and request a freight claim and inspection by a claims adjuster before proceeding. Any other visual damage to the packaging materials should also be made clear to the delivering carrier.

### 2.3 UNPACKING

Carefully unpack the unit taking care not to damage the unit enclosure when cutting away packaging materials

After unpacking, a close inspection of the unit should be made to ensure that there is no evidence of damage not indicated by the Tip-N-Tell indicator. The freight carrier should be notified immediately if any damage is detected.

The following accessories come standard with each unit and are either packed separately within the unit's shipping container or are factory installed on the unit:

- Pressure/Temperature Gauge
- ASME Pressure Relief Valve
- Condensate Drain Trap (P/N **24441**)
- 2" Natural Gas Supply Shutoff Valve

When optional accessories are ordered, they may be packed within the unit's shipping container, factory installed on the unit, or packed and shipped in a separate container. Any standard or optional accessories shipped loose should be identified and stored in a safe place until ready for installation or use.

### 2.4 SITE PREPARATION

Ensure that the site selected for installation of the Benchmark 1500/2000 Heating Boiler includes:

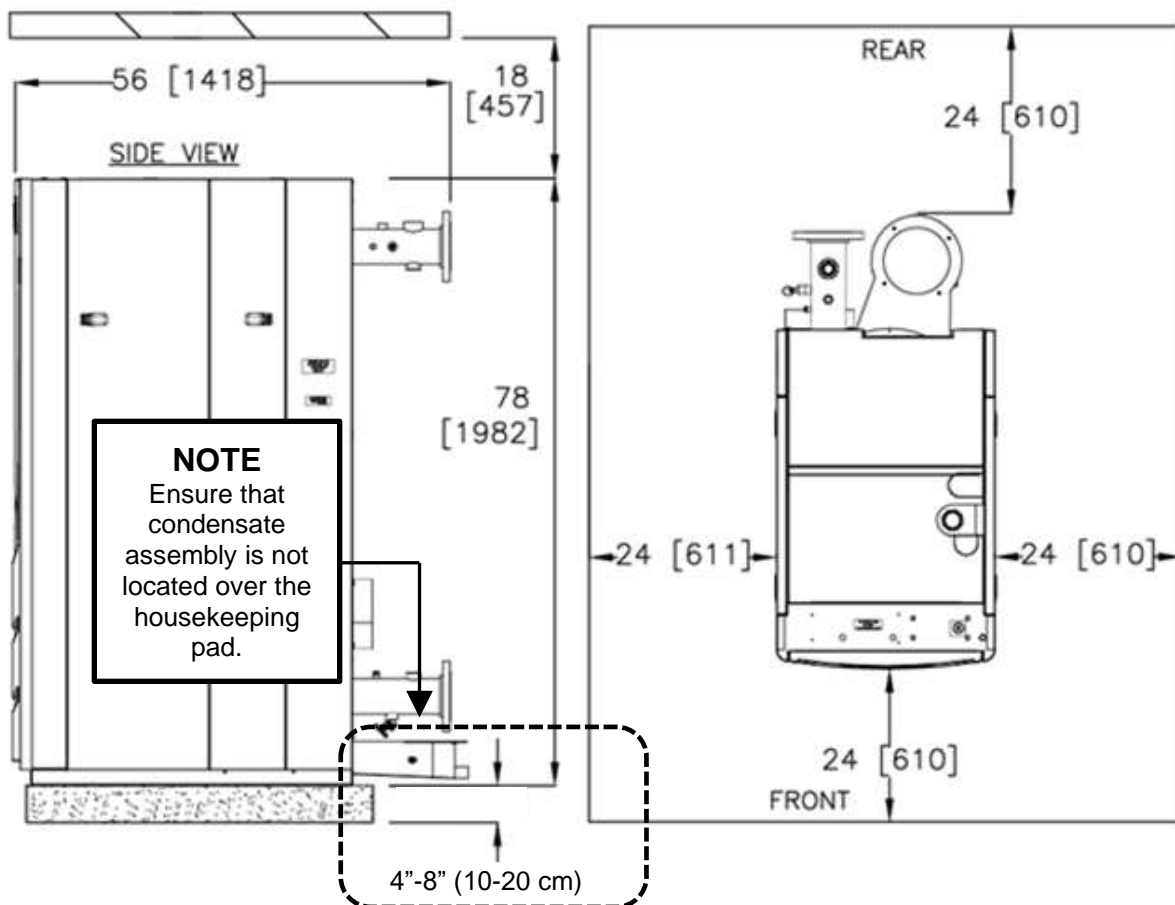
- Access to AC Input Power at 220 VAC, Single-Phase, 50 Hz @ 15 Amps
- Access to a Natural Gas line with a **minimum pressure of 4 inches W.C. (996 Pa) with the unit operating at maximum capacity.**

#### 2.4.1 Installation Clearances

The Benchmark Model 1500 and 2000 are packaged in an enclosure having identical exterior dimensions. The unit must be installed with the prescribed clearances for service as shown in Figure 2-1a. The minimum clearance dimensions, required by AERCO, are listed below. However, if Local Building Codes require additional clearances, these codes shall supersede AERCO's requirements. Minimum acceptable clearances required are as follows:

- Sides: 24 inches (61 cm)
- Front: 24 inches (61 cm)
- Rear: 24 inches (61 cm)
- Top: 18 inches (45.7 cm)

All gas piping, water piping and electrical conduit or cable must be arranged so that they do not interfere with the removal of any panels, or inhibit service or maintenance of the unit.



**Figure 2-1a: Benchmark Heating Boiler Model 1500/2000 Clearances**

### --WARNING! --

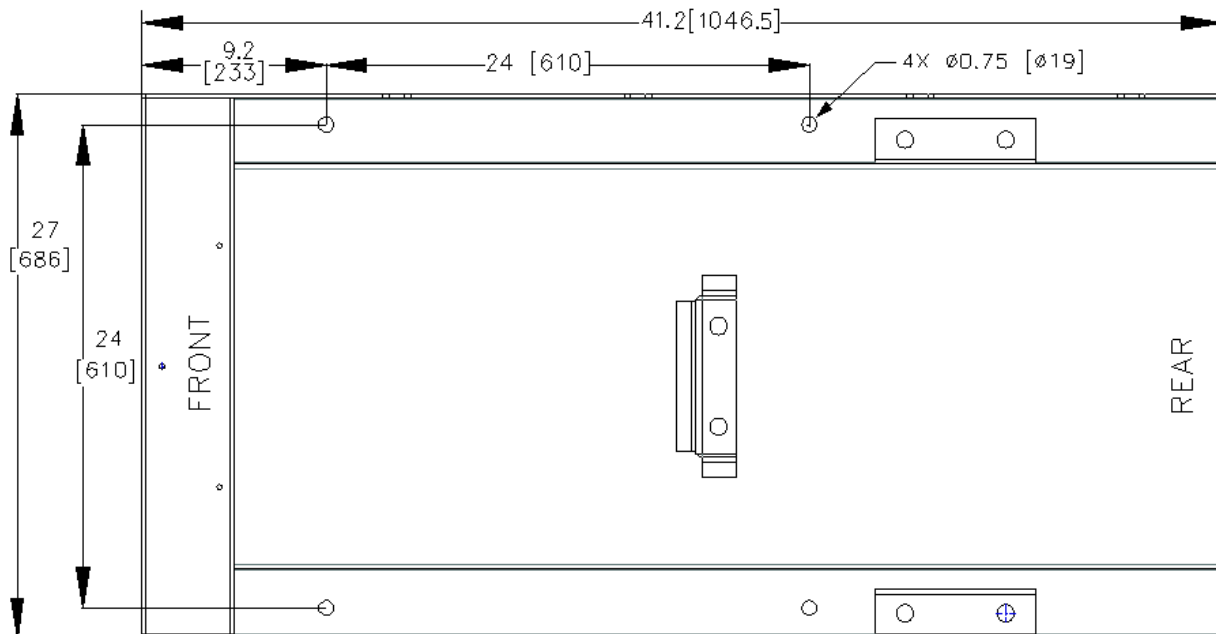
Keep the unit area clear and free from all combustible materials and flammable vapors or liquids.

### --CAUTION --

While packaged in the shipping container, the unit must be moved by pallet jack or forklift from the FRONT ONLY.

### 2.4.2 Setting the Unit

The unit must be installed on a **4 to 8 inch (10 to 20 cm)** thick housekeeping pad to ensure proper condensate drainage. If anchoring the unit, refer to Figure 2-1b for anchor locations.



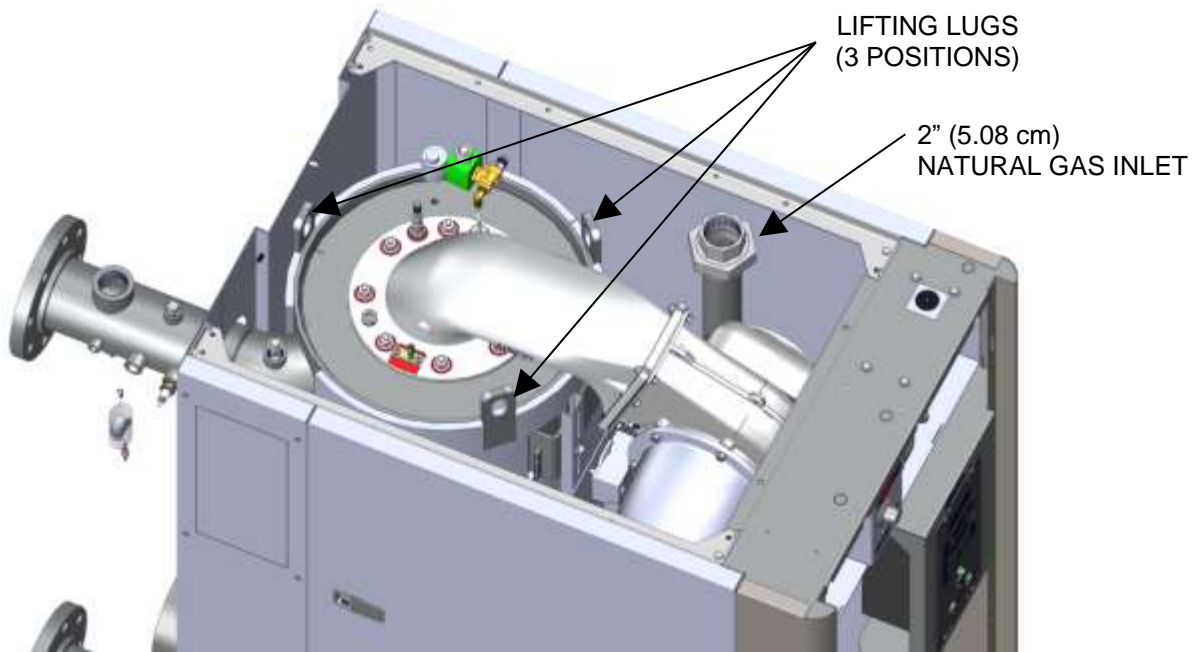
**Figure 2-1b: Benchmark 1500/2000 Anchor Bolt Locations**

A total of 3 lifting lugs are provided at the top of the primary heat exchanger as shown in Figure 2-2. Remove the front top panel from the unit to provide access to the lifting tabs.

Remove the four (4) lag screws securing the unit to the shipping skid. Lift the unit off the shipping skid and position it on the 4 to 8 inch (10 to 20 cm) concrete housekeeping pad (required) in the desired location.

### --WARNING! --

When lifting or moving the Heating Boiler, **DO NOT** attempt to manipulate the Heating Boiler using the gas train or blower.



**Figure 2-2: Heating Boiler Lifting Provisions**

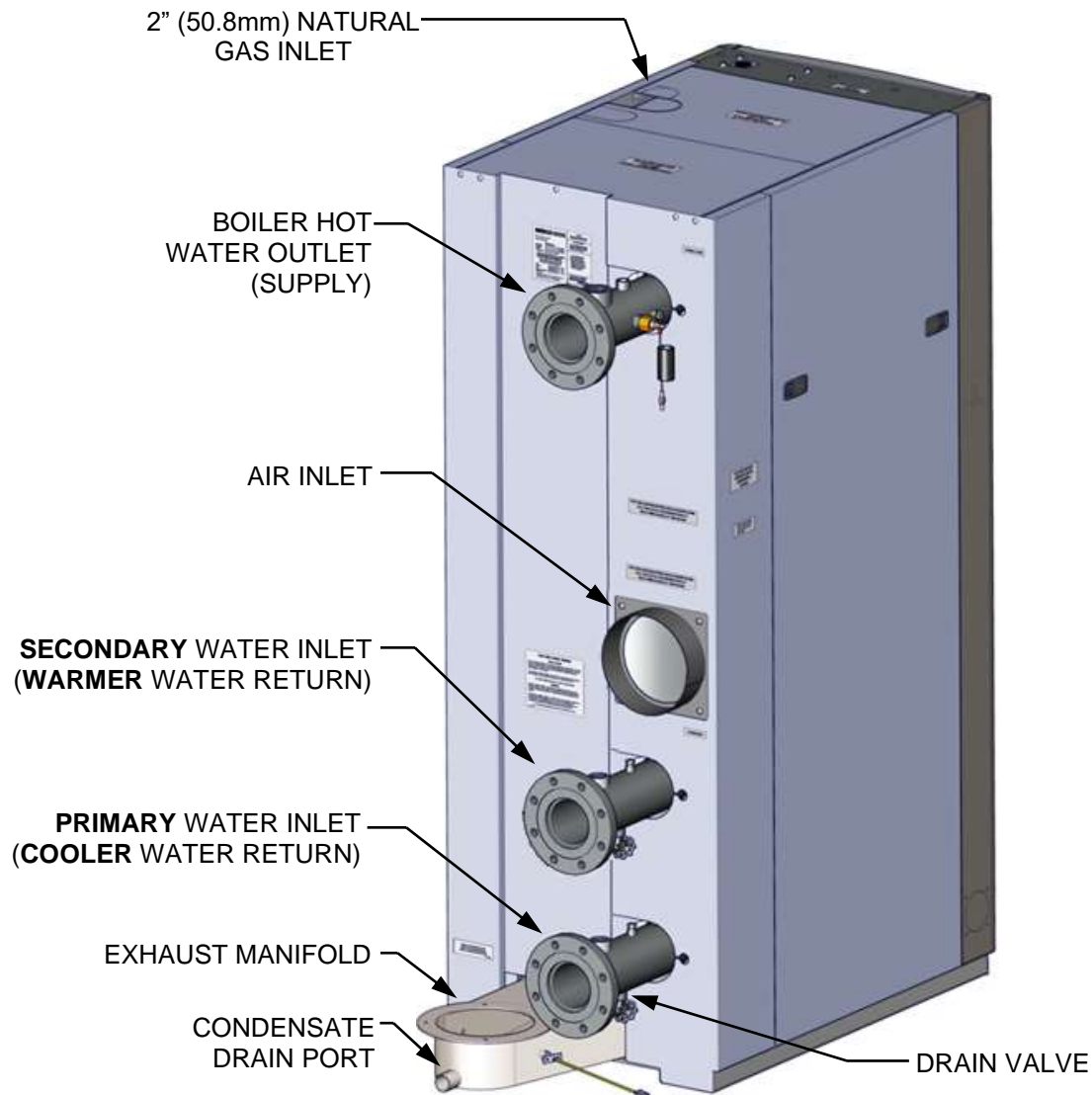
In multiple unit installations, it is important to plan the position of each unit in advance. Sufficient space for piping connections and future service/maintenance requirements must also be taken into consideration. All piping must include ample provisions for expansion.

### 2.5 SUPPLY AND RETURN PIPING

Benchmark 1500 and 2000 Heating Boilers have 4" (102mm) 150# flanges for the water system supply and return piping connections. The physical location of the supply and return piping connections are on the rear of the unit as shown in Figure 2-3. Refer to Appendix F for dimensional data.

When connecting the hot water outlet and cold water inlet to building piping, first make sure the mating surfaces are thoroughly clean. AERCO recommends using Loctite® 7649 to prime the mating surfaces and then Loctite 567 as pipe dope. Do *NOT* use Teflon tape.





**Figure 2-3: Supply and Return Locations**

The dual inlet connections allow these units to be configured with a separate cooler return temperature zone, rather than blending high and low return temperature zones. Utilizing the dual return capability, these Heating Boilers can take further advantage of the condensing capabilities. When configured with a lower return temperature zone or AERCO SmartPlates, thermal efficiency can improve by up to 6% (Based on an 80°F (26.7°C) minimum return water temperature at full fire. Lower return temperatures are possible which would yield even greater efficiency gains. The maximum temperature differential across the Heating Boiler's heat exchanger is 100°F (55°C).

To use the secondary inlet, pipe the **warmer** return water to the secondary (upper) inlet and the **cooler** return water to the **primary** (lower) inlet. . If the flow through both the primary and the secondary return is constant, then the combined minimum flows must equal the specified minimum flow of the Heating Boiler. If the flow through either of the inlet returns is intermittent, then the minimum flow through one of the return connections must always equal the specified minimum flow of the Heating Boiler.

If the secondary inlet is not utilized, it may serve as an inspection port. Contact your AERCO representative for additional information.

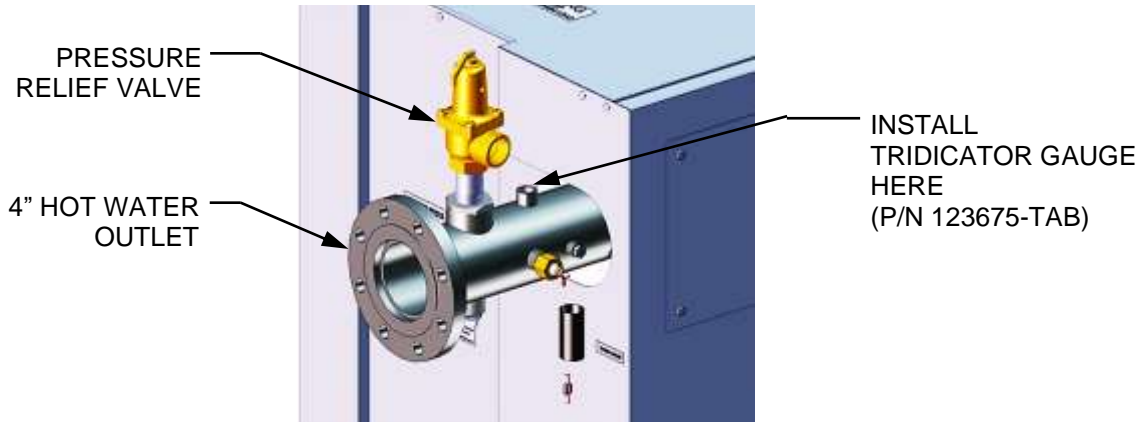
### 2.6 PRESSURE RELIEF VALVE INSTALLATION

#### NOTE

Pressure relief valves are not required for low pressure applications, but we recommend that they be installed as a safety measure to avoid the build-up of pressure inside the device (although this rarely occurs).

An ASME rated 30 PSI (207 kPa) Pressure Relief Valve is supplied with each Benchmark Boiler.

The relief valve is installed on the hot water outlet of the boiler as shown in Figure 2-4. A suitable pipe joint compound should be used on the threaded connections. Any excess should be wiped off to avoid getting any joint compound into the valve body. The relief valve must be piped to **within 12 inches (30.5 cm)** of the floor to prevent injury in the event of a discharge. No valves, restrictions, or other blockages are allowed in the discharge line. In multiple unit installations the discharge lines must ***NOT*** be manifolded together. Each must be individually run to a suitable discharge location.



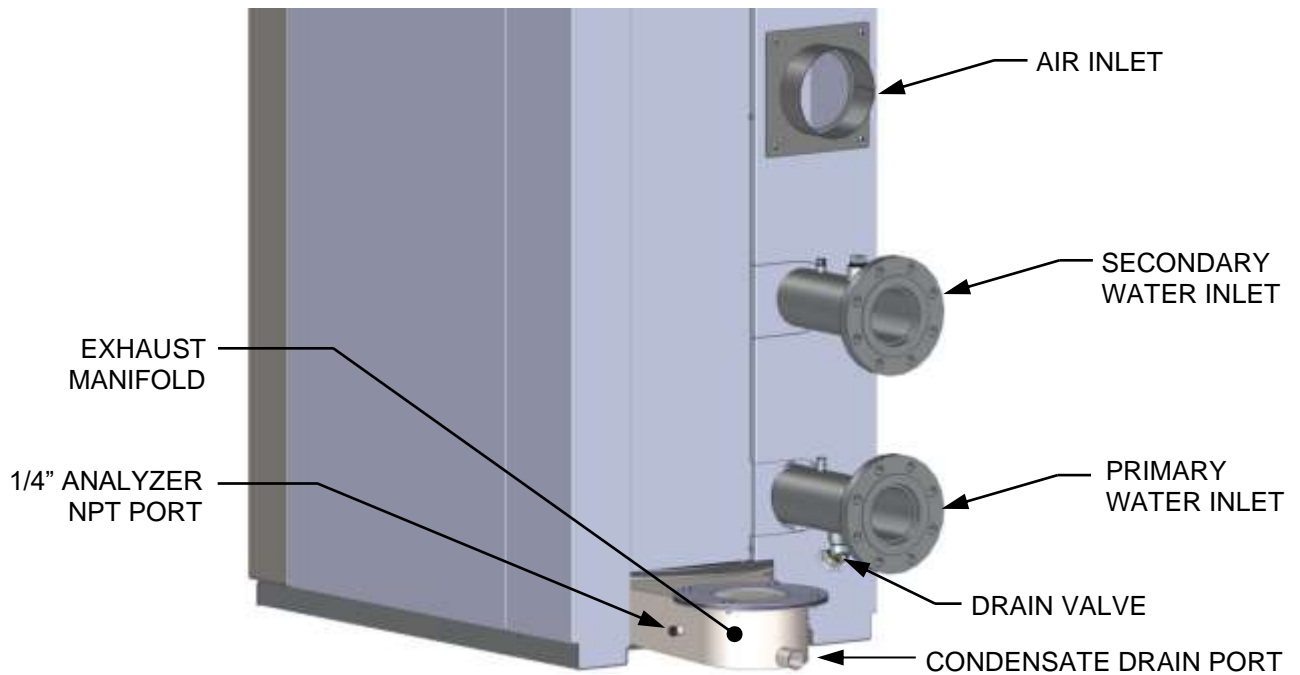
**Figure 2-4: P&T Relief Valve Location**

See Diagram 1 in Appendix I for an example of a low-pressure piping scheme.

### 2.7 CONDENSATE DRAIN & PIPING

The Benchmark Heating Boiler is designed to condense water vapor from the flue products. Therefore, the installation must have provisions for suitable condensate drainage or collection.

The condensate drain port located on the exhaust manifold (Figure 2-5) must be connected to the condensate trap (P/N **24441**) which is packed separately within the unit's shipping container. The condensate trap inlet features two integral O-rings and a thumbscrew to allow direct connection of the drain port into the trap inlet. See the Condensate trap Installation instructions and Figure 2-6.



**Figure 2-5: Condensate Drain Connection Location**

A sample condensate trap installation is shown in Figure 2-6. The following general guidelines must be observed to ensure proper condensate drainage:

- The condensate trap inlet (Figure 2-6) must be level the exhaust manifold drain port.
- The base of the condensate trap must be supported to ensure that it is level (horizontal).
- The trap must be removable for routine maintenance.

While observing the above guidelines, install the condensate trap as follows:

#### **Condensate Trap Installation**

1. Connect the condensate trap inlet to the exhaust manifold drain connection by inserting the drain port directly into the trap adaptor inlet, and then tightening the inlet thumbscrew, as shown in Figure 2-6. The inlet features two integral O-rings to prevent leakage.
2. At the condensate trap outlet, install a 3/4" NPT nipple.
3. Connect a length of 1" (2.54 cm) diameter polypropylene hose to the trap outlet and secure with a hose clamp.
4. Route the hose on the trap outlet to a nearby floor drain.

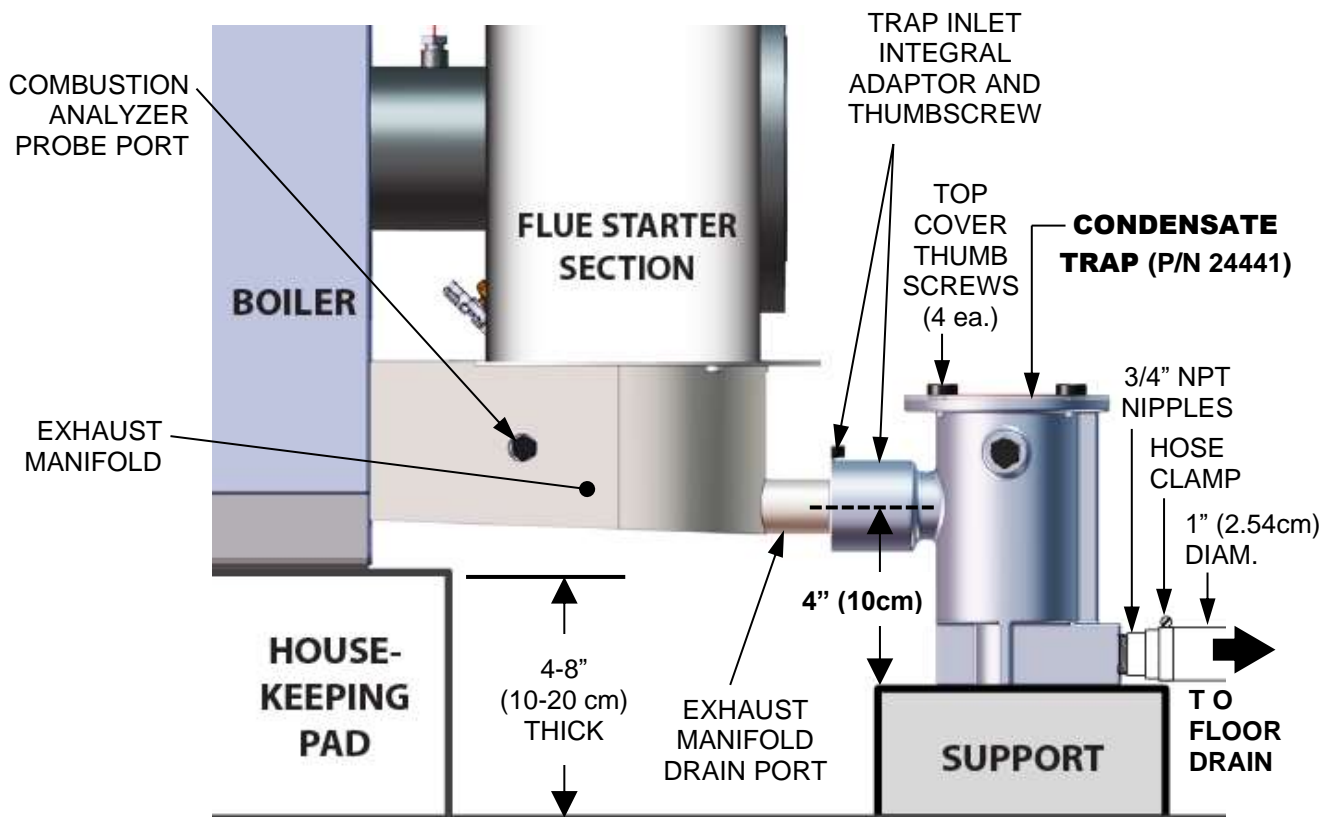
# Benchmark 1500 – 2000 Boiler User Manual - INTERNATIONAL

## CHAPTER 2 – INSTALLATION

If a floor drain is not available, a condensate pump can be used to remove the condensate to drain. **The maximum condensate flow rate is 30 gallons (113 liters) per hour.** The condensate drain trap, associated fittings and drain line must be removable for routine maintenance.

### WARNING!

Use PVC, stainless steel, aluminum or polypropylene for condensate drain piping (Figure 2-6). Do **NOT** use carbon or copper components.



### NOTE

HOUSEKEEPING PAD MUST NOT EXTEND UNDER THE CONDENSATE ASSEMBLY.

**Figure 2-6: Sample Condensate Trap Installation (Right Side View)**

### 2.8 GAS SUPPLY PIPING

The AERCO Benchmark Gas Components and Supply Design Guide, GF-2035 must be consulted prior to designing or installing any gas supply piping.

#### **--WARNING! --**

NEVER USE MATCHES, CANDLES, FLAMES OR OTHER SOURCES OF IGNITION TO CHECK FOR GAS LEAKS.

#### **--CAUTION --**

Many of the soaps used for gas pipe leak testing are corrosive to metals. Therefore, piping must be rinsed thoroughly with clean water after leak checks have been completed.

#### **NOTE**

All gas piping must be arranged so that it does not interfere with removal of any covers, inhibit service/maintenance, or restrict access between the unit and walls, or another unit.

Benchmark 1500 and 2000 units contain a 2 inch (5.08 cm) NATURAL GAS inlet connection on the top of the unit, as shown in Figure 2-2 and 2-3.

Prior to installation, all pipes should be de-burred and internally cleared of any scale, metal chips or other foreign particles. Do *NOT* install any flexible connectors or unapproved gas fittings. Piping must be supported from the floor, ceiling or walls only and must not be supported by the unit.

A suitable piping compound, approved for use with natural gas, should be used. Any excess must be wiped off to prevent clogging of components.

To avoid unit damage when pressure testing gas piping, the unit must be isolated from the gas supply piping. The gas pressure applied to the unit **must never exceed 14" W.C. (3487 Pa)**. A thorough leak test of all external piping must be performed using a soap and water solution or suitable equivalent. The gas piping used must meet all applicable codes.

#### 2.8.1 Gas Supply Specifications

The gas supply input specifications to the unit for Natural Gas are as follows:

- The maximum static pressure to the unit **must not exceed 14" W.C. (3.49 kPa)**
- Supply piping and pressure to the unit must be sufficient to provide **2000 CFH (56.6 m<sup>3</sup>/hr)** volume of gas while maintaining a gas pressure of **4" W.C. (996 Pa)** *while operating at maximum capacity*. However, the BMK 2000 may derate by up to 150,000 BTU's when operated **below 5" W.C. (1.25 kPa)** at full fire.

#### 2.8.2 Manual Gas Shutoff Valve

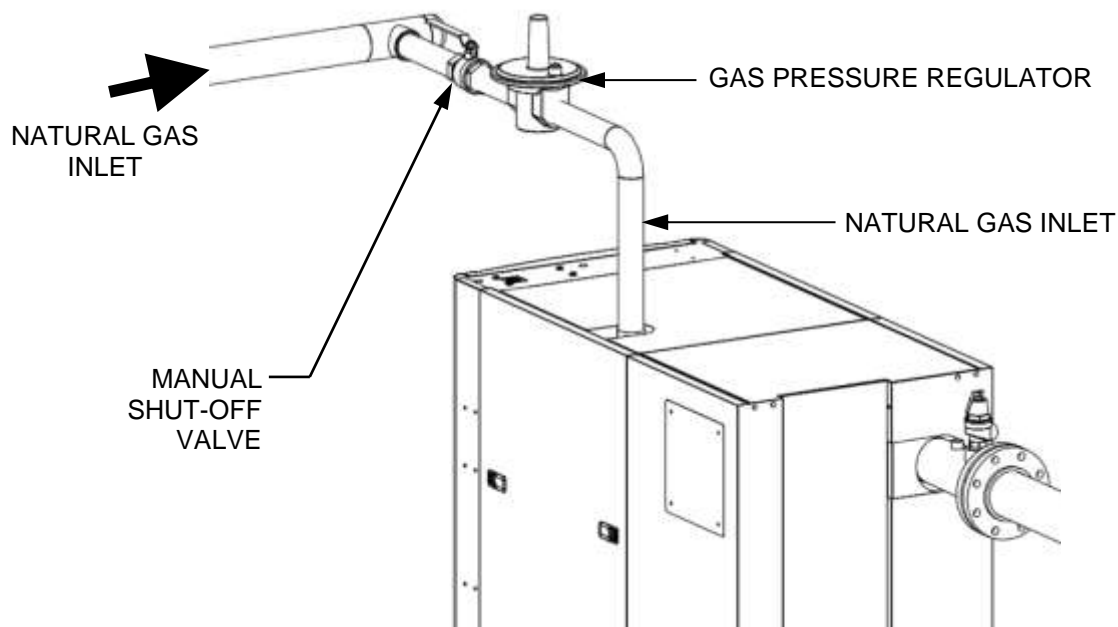
A manual shut-off valve must be installed in the gas supply line upstream of the Heating Boiler as shown in Figure 2-7. **Maximum allowable gas pressure to the Heating Boiler is 14" W.C. (3487 Pa)**.

### 2.8.3 External Gas Supply Regulator

An external gas pressure regulator is required on the gas inlet piping under most conditions. Regulators must conform to the following specifications:

- The external natural gas regulator must be capable of regulating **75,000 – 2,120,000 BTU/HR (22 – 621 kW)** of natural gas while maintaining a gas pressure of **4.0” W.C. (996 Pa)** minimum to the unit.
- A lock-up style regulator **MUST** be used when gas supply pressure will **exceed 14” W.C. (3.49 kPa)**

For installations with 3 or more units that **EXCEED 7” W.C. (1.75 kPa)** gas pressure, an external gas supply regulator, as shown in Figure 2-7, is highly recommended. No regulator is required for gas pressures **below 7” W.C. (1.75 kPa)** of pressure. Consult the local gas utility for detailed requirements concerning venting of the supply gas regulator.



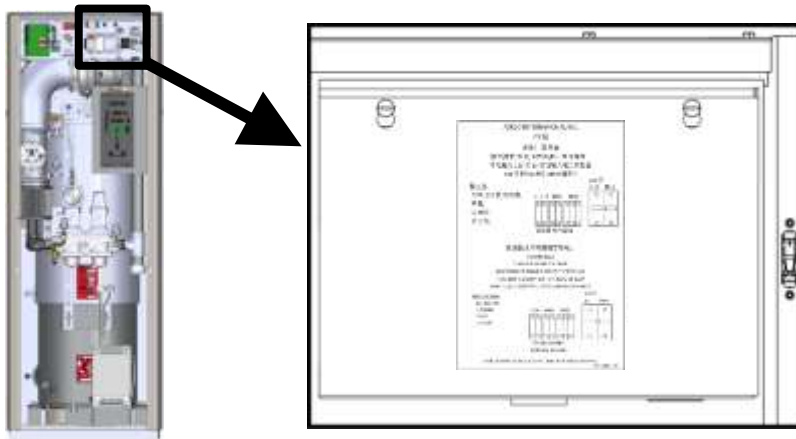
**Figure 2-7: Manual Gas Shut-Off Valve Location**

#### NOTE

It is the responsibility of the customer to source and purchase the appropriate gas regulator as described above. However, AERCO offers for sale an appropriate regulator, which may be ordered at the time of unit purchase or separately. Contact AERCO for more information.

### 2.9 AC ELECTRICAL POWER WIRING

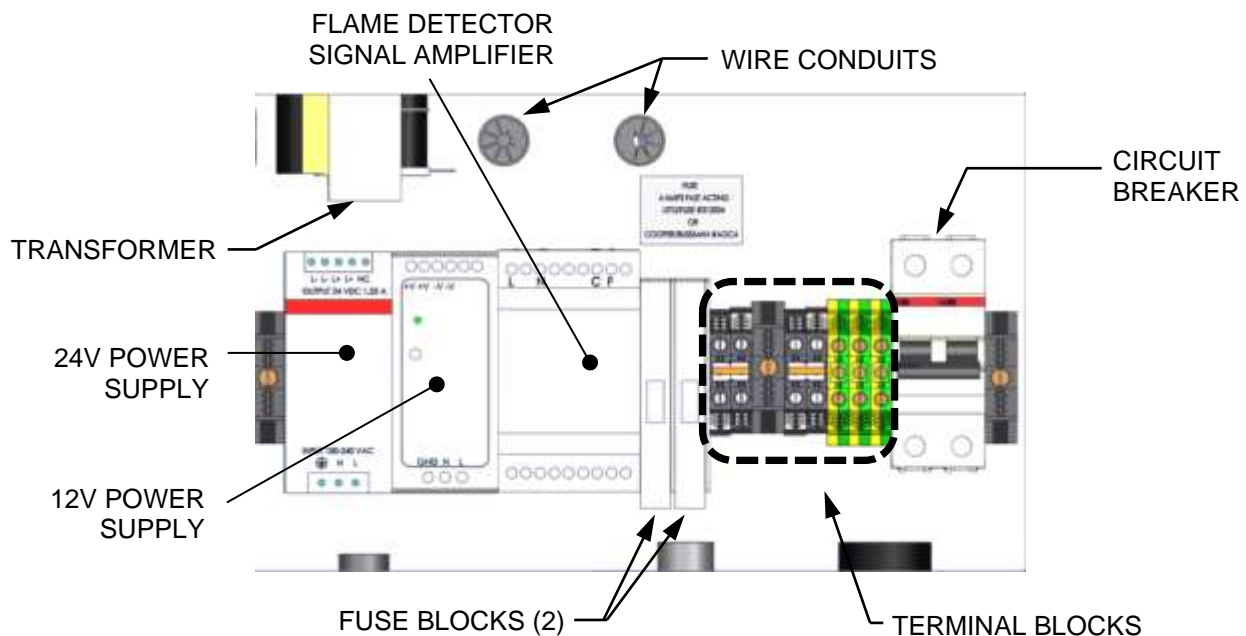
The AERCO Benchmark Electrical Power Wiring Guide, GF-2065, must be consulted prior to connecting any AC power wiring to the unit. External AC power connections are made to the unit inside the Power Box on the front of the unit. Remove the front panel to access the Power Box, which is mounted in the upper right corner of the unit as shown in Figure 2-8. Loosen the two upper screws of the Power Box cover and remove cover to access the internal connections shown in Figure 2-9.



**Figure 2-8: Power Box Location with Cover Closed**

**--WARNING! --**

The power breaker shown in figure 2-9 does **NOT** remove power from the terminal blocks.



**Figure 2-9: Power Box Internal Components**

With the exception of the transformer shown in Figure 2-9, all of the components in the Power Box are mounted on a DIN rail.

**NOTE**

All electrical conduit and hardware must be installed so that it does not interfere with the removal of any unit covers, inhibit service/maintenance, or prevent access between the unit and walls or another unit.

### 2.9.1 Electrical Power Requirements

The Benchmark 1500 and Benchmark 2000 models are available in one voltage configuration:

- 220 VAC, Single-Phase, 50 Hz @ 15 Amps

All Benchmark 1500 and 2000 Heating Boilers include a 220 VAC to 120 VAC Power Transformer (P/N 24468) installed inside the unit on the base. It is pre-wired to the Power Box. 220 VAC input power is converted to 110 VAC. See Appendix L for more information.

The Power Box contains terminal blocks as shown in Figure 2-9. A label showing the required AC power connections is provided on the front cover of the Power Box as shown in Figure 2-10.



**Figure 2-10: Power Box Cover Labels – 220 VAC**

Each unit must be connected to a dedicated electrical circuit. **NO OTHER DEVICES SHOULD BE ON THE SAME ELECTRICAL CIRCUIT AS THE HEATING BOILER.**

A switch must be installed on the electrical supply line in an easily accessible location to quickly and safely disconnect electrical service. DO NOT attach the switch to sheet metal enclosures of the unit.

After placing the unit in service, the ignition safety shutoff device must be tested. If an external electrical power source is used, the installed Heating Boiler must be electrically bonded to ground in accordance with the requirements of the authority having jurisdiction. In the absence of such requirements, the installation shall conform to National Electrical Code (NEC), ANSI/NFPA 70.

For electrical power wiring diagrams, see the AERCO Benchmark Electrical Power Guide, (GF-2065).

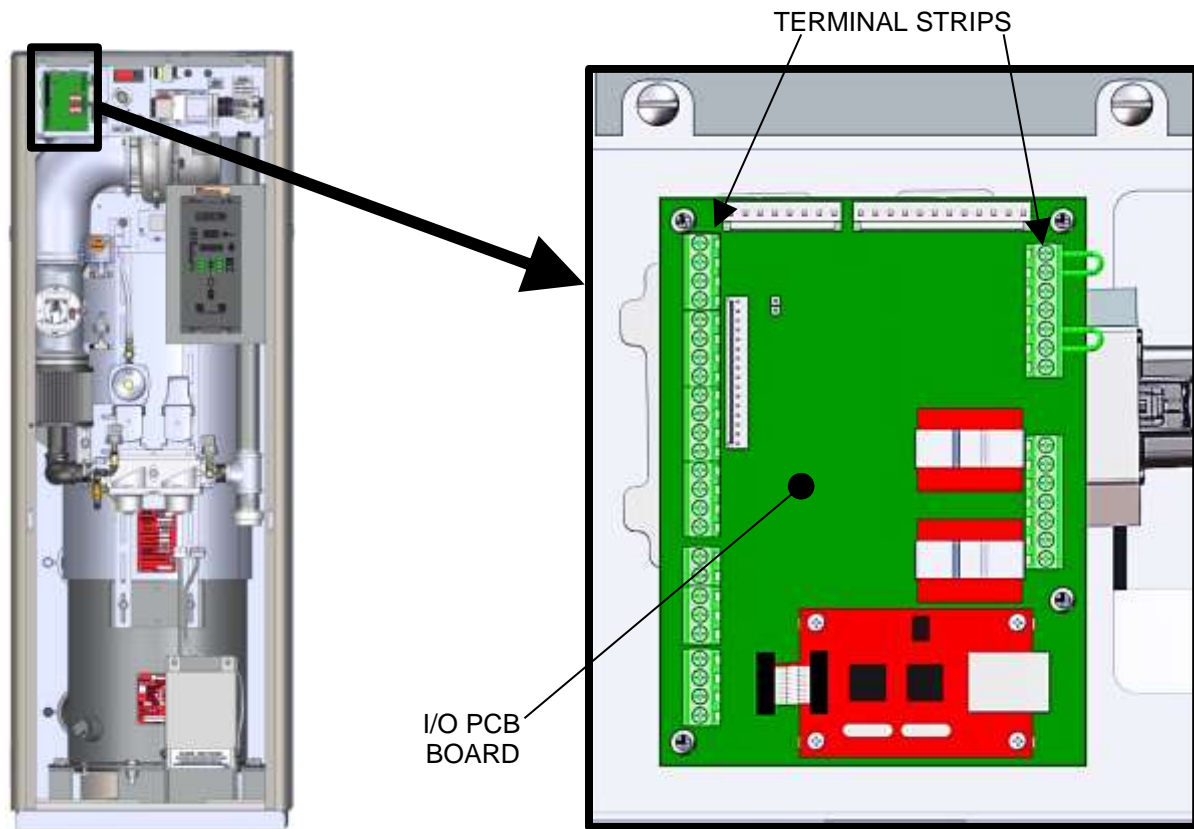
### 2.10 FIELD CONTROL WIRING

Each unit is fully wired from the factory with an internal operating control system. No field control wiring is required for normal operation. However, the C-More Control system used with all Benchmark units does allow for some additional control and monitoring features. Wiring connections for these features are made on the Input/Output (I/O) board located behind the removable front panel assembly of the unit. The I/O board is located in the upper-left portion on the front of the unit as shown in Figure 2-11. The I/O board terminal strip connections are shown



in Figure 2-11. All field wiring is installed from the rear of the panel by routing the wires through one of the four bushings provided on the sides of the I/O board.

Refer to the wiring diagram provided below the I/O Box (Figure 2-12) when making all wiring connections.



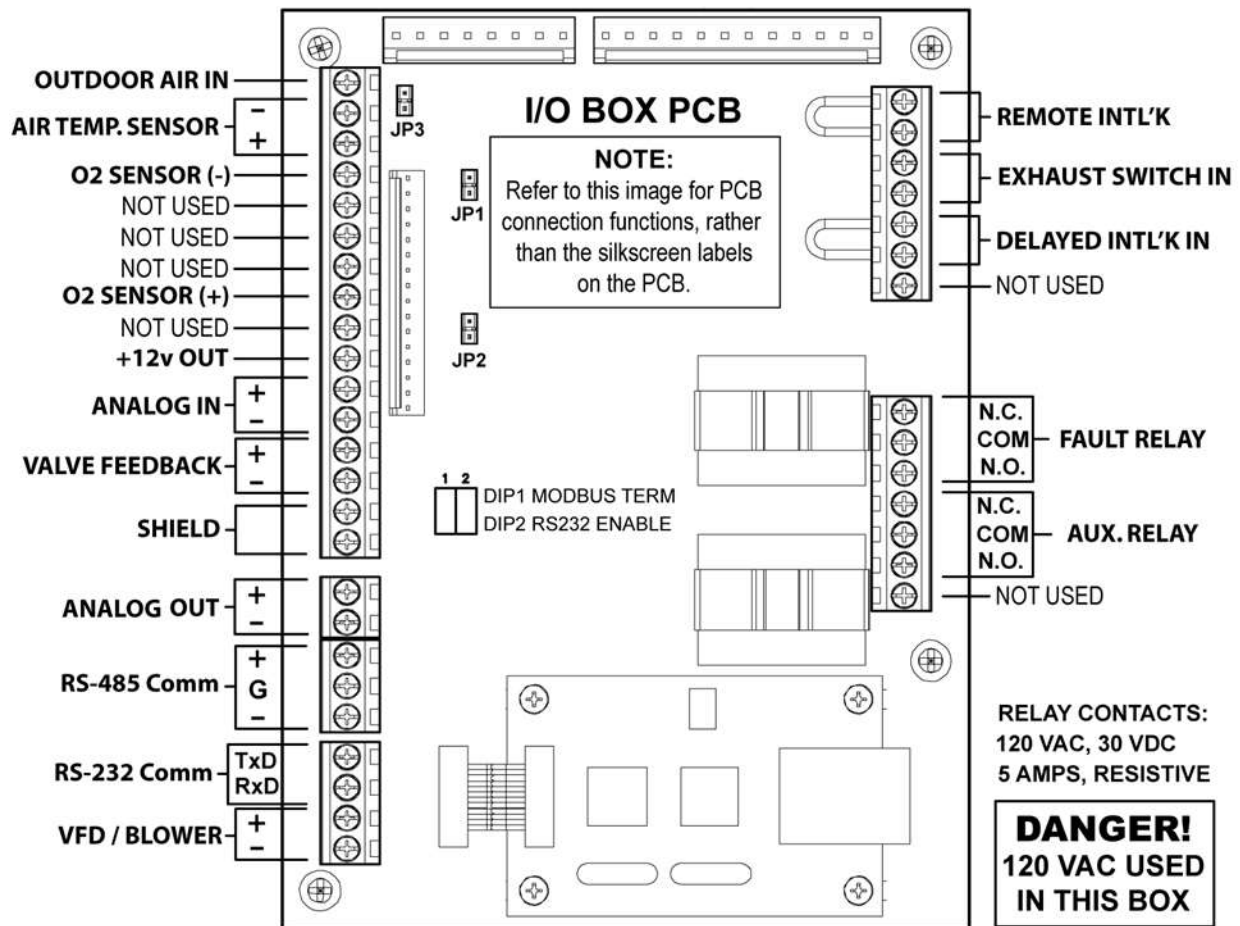
**Figure 2-11: Input/Output (I/O) Box Location**

### NOTE

Use Figure 2-12 to determine the functions of the I/O PCB connections. Do not use the silkscreened labels on the PCB itself, as these may not match the function names. There is a diagram of the connection functions on the cover of the I/O Box as well.

### WARNING!

DO NOT make any connections to the I/O Box terminals labeled "NOT USED". Attempting to do so may cause equipment damage.



**Figure 2-12: I/O Box Terminal Strips**

### 2.10.1 Outdoor Air In (OUT) & Air Sensor Common (COM)

The OUTDOOR AIR IN terminal is used for connecting an outdoor temperature sensor (P/N **GM-123525**) as required primarily for the INDOOR/OUTDOOR RESET mode of operation. It can also be used with another mode if it is desired to use the outdoor sensor enable/disable feature. This feature allows the Heating Boiler to be enabled or disabled based on the outdoor air temperature.

The factory default for the outdoor sensor is DISABLED. To enable the sensor and/or select an enable/disable outdoor temperature, see the *Configuration* menu in Chapter 3.

The outdoor sensor may be wired **up to 200 feet (61m)** from the Heating Boiler. It is connected to the OUTDOOR AIR IN and AIR SENSOR COMMON terminals of the I/O PCB (Figure 2-12). Wire the sensor using a twisted shielded pair wire from 18 to 22 AWG. There is no polarity to observe when terminating these wires. The shield is to be connected only to the terminals labeled *SHIELD* in the I/O Box PCB. The sensor end of the shield must be left free and ungrounded.

When mounting the sensor, it must be located on the North side of the building where an average outside air temperature is expected. The sensor must be shielded from direct sunlight as well as impingement by the elements. If a shield is used, it must allow for free air circulation.

### 2.10.2 AIR TEMP SENSOR Terminals

The AIR TEMP SENSOR terminals are used to monitor the air inlet temperature sensor (P/N **61024**). This input is always enabled and is a “to view only” input that can be seen in the *Operating* menu. A resistance chart for this sensor is provided in APPENDIX C. This sensor is an active part of the combustion control system and must be operational for accurate air/fuel mixing control.

### 2.10.3 O<sub>2</sub> SENSOR Terminals (O<sub>2</sub>+ & O<sub>2</sub>-)

The O<sub>2</sub> SENSOR (+) and O<sub>2</sub> SENSOR (-) terminals are used to connect an integrated oxygen sensor to the I/O Box PCB. The O<sub>2</sub> concentration is displayed in the *Operating* menu of the C-More Control system after a 60 second warm-up period.

### 2.10.4 ANALOG IN Terminals

The two ANALOG IN terminals (+ and –) are used when an external signal is used to change the setpoint (REMOTE SETPOINT mode) of the Heating Boiler.

Either a 4 to 20 mA / 1 to 5 VDC or a 0 to 20 mA / 0 to 5 VDC signal may be used to vary the setpoint or air/fuel valve position. The factory default setting is for 4 to 20 mA / 1 to 5 VDC, however this may be changed to 0 to 20 mA / 0 to 5 VDC using the *Configuration* menu described in Chapter 3.

If voltage rather than current is selected as the drive signal, a DIP switch must be set on the PMC Board located inside the C-More Control Box. Contact the AERCO factory for information on setting DIP switches.

All supplied signals must be floating (ungrounded) signals. Connections between the source and the Heating Boiler's I/O PCB (Figure 2-12) must be made using twisted shielded pair of 18–22 AWG wire such as Belden 9841. Polarity must be maintained and the shield must be connected only at the source end and must be left floating (not connected) at the Heating Boiler's I/O PCB.

Whether using voltage or current for the drive signal, they are linearly mapped to a 40°F to 240°F (4.4 °C to 116 °C) setpoint or a 0% to 100% air/fuel valve position. No scaling for these signals is provided

### 2.10.5 VALVE FEEDBACK Terminals

The Valve Feedback terminals are used when the Sequencing Isolation Valve Feedback option is selected. The Valve Feedback signal is connected to the “Valve Fdbk” terminals and is used to confirm that the valve has properly opened or closed. If the Valve Feedback signal does not match the Valve-Open or Valve-Close command for the time defined in the “Valve Fdbk timer” entry, the controller will proceed as follows:

- (a) If the valve fails with the Valve Stuck Open fault, the “Valve Stuck Open” message will be displayed and the unit will remain active.
- (b) If the valve fails with the Valve Stuck Closed fault, the “Valve Stuck Closed” message will be displayed and the unit will shut down.

#### NOTE

If the Valve Feedback option is used, Shorting Jumper #JP2 on the I/O Board MUST be inserted.

### 2.10.6 SHIELD Terminals (SHLD & SHLD)

The SHIELD terminals are used to terminate any shields used on sensor wires connected to the unit. Shields must only be connected to these terminals.

### 2.10.7 ANALOG OUT Terminals

The ANALOG OUT terminals (+ & -) output from 0 to 20 mA and may be used to monitor Setpoint, Outlet Temperature, Valve Position 4-20 mA, Valve Position 0-10v or be set to OFF. Default setting in the C-More controller is Valve Position 0-10v and settings behave as follows:

1. When 0-10VDC is selected, the voltage output is used by the controller to modulate the combustion blower via the I/O Box terminals labeled **VFD/Blower** (Section 2.9.11).
2. If On Board Boiler Sequencing Technology (BST) is enabled, the Analog Output terminals are used to drive the isolation valve, open and closed. A 0-20 mA signal is used, with 20 mA to close the valve and 0 to open.

#### NOTE

When driving an isolation valve, shorting jumper #JP2 on the I/O Board **MUST** be installed.

3. When the 4-20mA is selected for the Analog Output, the 0-10VDC is disabled at the VFD/Blower terminals, and the selected output is available at the terminals labeled *Analog Output +/-*.

### 2.10.8 RS485 Comm (+, GND, & -)

The RS485 communication terminals are used when the Heating Boiler plant is being controlled by an Energy Management System (EMS) using Modbus (RS485) communication.

### 2.10.9 RS232 Comm (TxD & RxD)

As of Firmware version 4.0 and above, these terminals are used only by factory-trained personnel to monitor OnAER communications via a portable computer.

### 2.10.10 VFD/Blower (0-10 & AGND)

These terminals (0-10 & AGND) send an analog signal to control the blower speed. When any of the 4-20mA options is selected for the Analog Outputs (Section 2.9.8), the output from the VFD/Blower terminals is disabled.

### 2.10.11 Interlocks

The unit offers two interlock circuits for interfacing with Energy Management Systems and auxiliary equipment such as pumps or louvers or other accessories. These interlocks are called the Remote Interlock and Delayed Interlock (REMOTE INTL'K IN and DELAYED INTL'K IN in Figure 2-12). Both interlocks, described below, are factory wired in the closed position (using jumpers).

#### NOTE

Both the Delayed Interlock and Remote Interlock must be in the closed position for the unit to fire.

#### 2.10.11.1 Remote Interlock In (OUT & IN)

The remote interlock circuit is provided to remotely start (enable) and stop (disable) the unit if desired. The circuit is 24 VAC and comes factory pre-wired closed (jumped).

### 2.10.11.2 Delayed Interlock In (OUT & IN)

The Delayed Interlock terminals can be used in one of two ways:

- In conjunction with the optional external sequencing valve (see section 2.14 and Chapter 9 – BST), a component of AERCO's on-board Boiler Sequencing Technology (BST) solution. By default a cable of the unit's wiring harness is connected to these terminals. If BST is implemented, the other end of that cable is connected to the sequencing valve.
- If BST is *NOT* implemented, the second use is typically in conjunction with the AUXILIARY RELAY CONTACTS described in section 2.10.14. This interlock circuit is located in the purge section of the start string. It can be connected to the proving device (end switch, flow switch etc.) of an auxiliary piece of equipment started by the unit's auxiliary relay. If the delayed interlock is connected to a proving device that requires time to close (make), a time delay (AUX START ON DLY) that holds the start sequence of the unit long enough for a proving switch to make (close) can be programmed.

To use this option, you must disconnect the harness from the Delayed Interlock terminals and connect the proving device in its place.

Should the proving switch not prove within the programmed time frame, the unit will shut down. The AUX START ON DLY can be programmed from 0 to 120 seconds. This option is located in the *Configuration* menu (Chapter 3).

### 2.10.12 Fault Relay (NC, COM, & NO)

The fault relay is a single pole double throw (SPDT) relay having a normally open and normally closed set of relay contacts that are rated for 5 amps at 120 VAC and 5 amps at 30 VDC. The relay energizes when any fault condition occurs and remains energized until the fault is cleared and the **CLEAR** button is depressed. The fault relay connections are shown in Figure 2-12.

### 2.10.13 Auxiliary Relay Contacts (NC, COM, & NO)

Each unit is equipped with a single pole double throw (SPDT) relay that is energized when there is a demand for heat and de-energized after the demand for heat is satisfied. The relay is provided for the control of auxiliary equipment, such as pumps and louvers, or can be used as a unit status indicator (firing or not firing). Its contacts are rated for 120 VAC @ 5 amps. Refer to Figure 2-12 to locate the AUXILIARY RELAY terminals for wiring connections.

## 2.11 FLUE GAS VENT INSTALLATION

AERCO Gas Fired Venting and Combustion Air Guide, GF-2055 must be consulted before any flue or combustion air venting is designed or installed. Suitable, U/L approved, positive pressure, watertight vent materials **MUST** be used for safety and UL certification. Because the unit is capable of discharging low temperature exhaust gases, **the flue must be pitched back towards the unit a minimum of 1/4" per foot (0.64 cm per 0.3 m)** to avoid any condensate pooling and to allow for proper drainage.

While there is a positive flue pressure during operation, the combined pressure drop of vent and combustion air systems **must not exceed 140 equivalent feet (42.7m) or 0.8" W.C. (199 Pa)**. Fittings as well as pipe lengths must be calculated as part of the equivalent length. For a natural draft installation **the draft must not exceed -0.25" W.C. (-62 Pa)**. These factors must be planned into the vent installation. If the maximum allowable equivalent lengths of piping are exceeded, the unit will not operate properly or reliably.

## 2.12 COMBUSTION AIR

The AERCO Benchmark Boiler Venting and Combustion Air Guide, GF-2055 **MUST** be consulted before any flue or inlet air venting is designed or installed. Air supply is a direct

requirement of ANSI 223.1, NFPA-54, CSA B149.1 and local codes. These codes should be consulted before a permanent design is determined.

The combustion air must be free of chlorine, halogenated hydrocarbons or other chemicals that can become hazardous when used in gas-fired equipment. Common sources of these compounds are swimming pools, degreasing compounds, plastic processing, and refrigerants. Whenever the environment contains these types of chemicals, combustion air **MUST** be supplied from a clean area outdoors for the protection and longevity of the equipment and warranty validation.

For combustion air supply from ducting, see section 2.12 below and consult the AERCO GF-2055, Gas Fired Venting and Combustion Air Guide.

Air must be supplied to the unit(s) through two permanent openings. These two openings must have a free area of **not less than one square inch (6.5 cm<sup>2</sup>) for each 4000 BTUs (1.17 kW) input for each unit**. The free area must take into account restrictions such as louvers and bird screens.

### 2.13 DUCTED COMBUSTION AIR

For ducted combustion air installations, the air ductwork must then be attached directly to the air inlet connection on the sheet metal enclosure.

In a ducted combustion air application, the combustion air ducting pressure losses must be taken into account when calculating the total maximum allowable venting run. See the AERCO Benchmark Venting and Combustion Air Guide, GF-2055. When using the unit in a ducted combustion air configuration, the minimum diameter connection at the unit is:

- BMK 1500 – 6 inch (15.2 cm) diameter connection
- BMK 2000 – 8 inch (20.3 cm) diameter connection

### 2.14 SEQUENCING ISOLATION VALVE INSTALLATION

All Benchmark units are shipped with a connection for an optional motorized external sequencing isolation valve (P/N **92084-TAB**) included in the shipping container. This valve is an integral component of the AERCO's on-board Boiler Sequencing Technology (BST) solution. BST allows sites with multiple Heating Boilers to have one Heating Boiler, acting as a "master" to manage the other Heating Boilers at the site in such a way that the efficiency of the entire Heating Boiler array is maximized.

When operated with the BST system, the Master controls its own isolation valve and sends signals to the slave units to open or close their isolation valves. After the Heating Boiler load is satisfied, the isolation valve opens for a programmed interval (default = 1 minute) before closing. When the system load is satisfied, the BST system will open the isolation valves for all of the Heating Boilers.

The implementation of BST, and the installation and use of this valve is optional. However, **when BST is implemented, use of this valve is strongly recommended.**

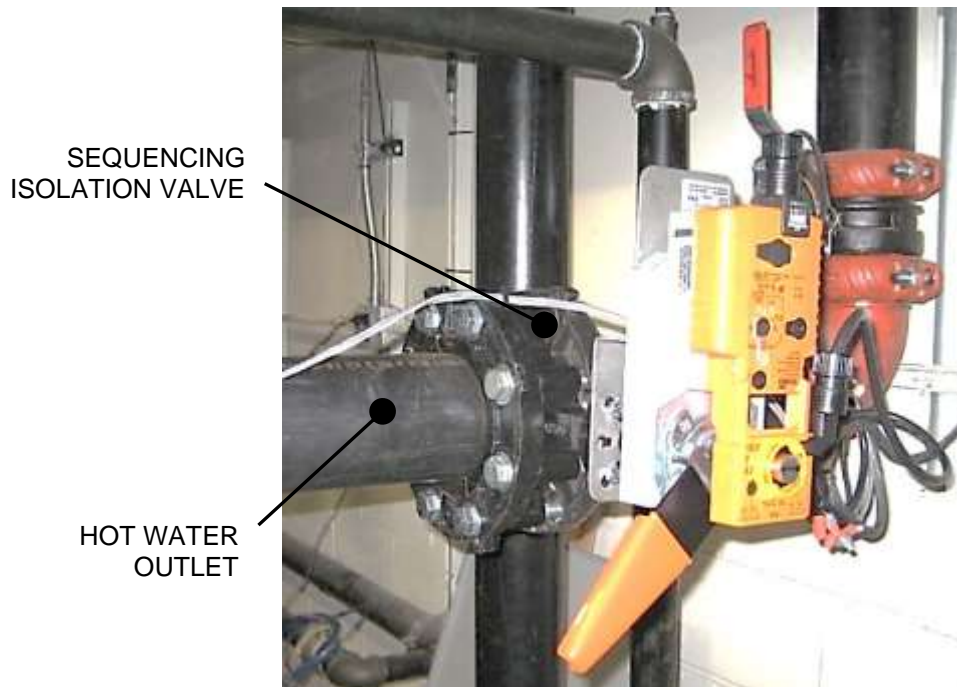
The Heating Boiler is pre-wired to accept the sequencing isolation valve. Installation consists of installing the sequencing isolation valve in the hot water outlet pipe, and then connecting it into the shell harness, as described below.

#### NOTE

When the Sequencing Isolation Valve is used, the AUX START ON DLY in the *Configuration* menu must be set to at least 120 seconds. The Sequencing Isolation Valve control is only available when BST is enabled. Refer to section 2.10.12.2 and Table 3-4 in section 3-6 and Chapter 9.

#### Installing Sequencing Isolation Valve

1. Install the sequencing isolation valve in the Heating Boiler's hot water outlet pipe.



**Figure 2-13: Sequencing Isolation Valve Installed**

### Installing Sequencing Isolation Valve – Continued

2. The Heating Boiler's shell harness has one unused cable. One end of this cable is connected to the DELAYED INTERLOCK IN terminals in the I/O board (see Figure 2-14) while the other end contains a Molex connector with a jumper wire inserted in it (this jumper wire allows units that do not have a sequencing isolation valve to operate normally). Find the free end of this cable inside the unit's enclosure.



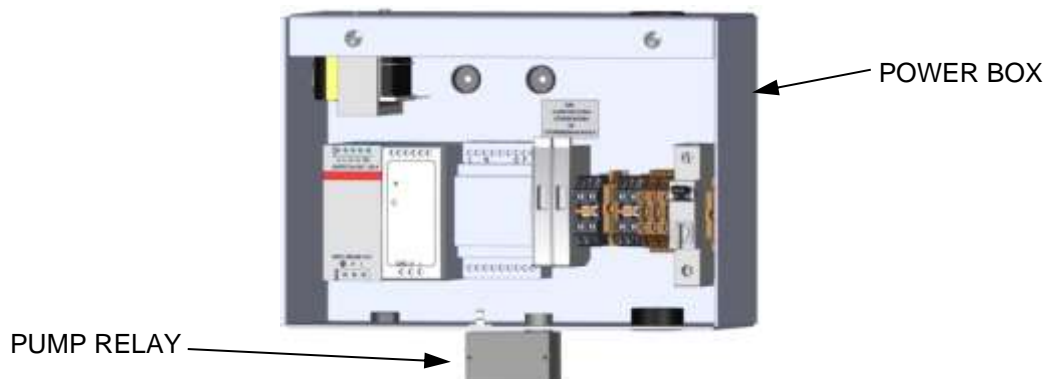
**Figure 2-14: Sequencing Isolation Valve Installed**

3. Remove the jumper wire from the Molex connector and then plug it into the sequencing isolation valve's connector.

### 2.15 BENCHMARK PUMP RELAY

Benchmark 1500 and 2000 models ship with a pump relay (P/N **69102-3**) as standard equipment. The pump relay allows the user to turn a pump on/off and open/close a motorized valve as the boiler cycles on and off on demand. The Pump Delay Timer feature allows the user to keep the pump running and keep the motorized valve open for up to 30 minutes after the boiler has shut down and the demand is satisfied. See Figure 2-15 and 2-16 for wiring details.

The pump relay is attached to the outside of the power box. Older units may or may not include the pump relay. Boilers equipped with the pump relay have a label on the power box cover adjacent to the relay.

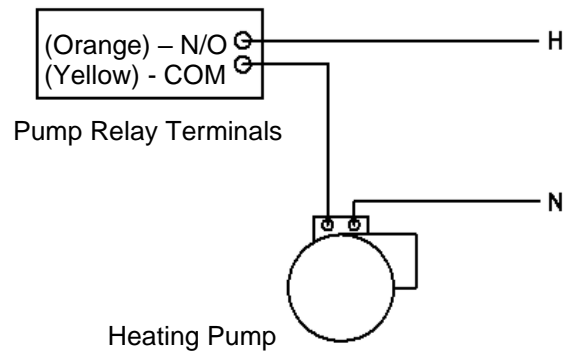


**Figure 2-15: Pump Relay Location**



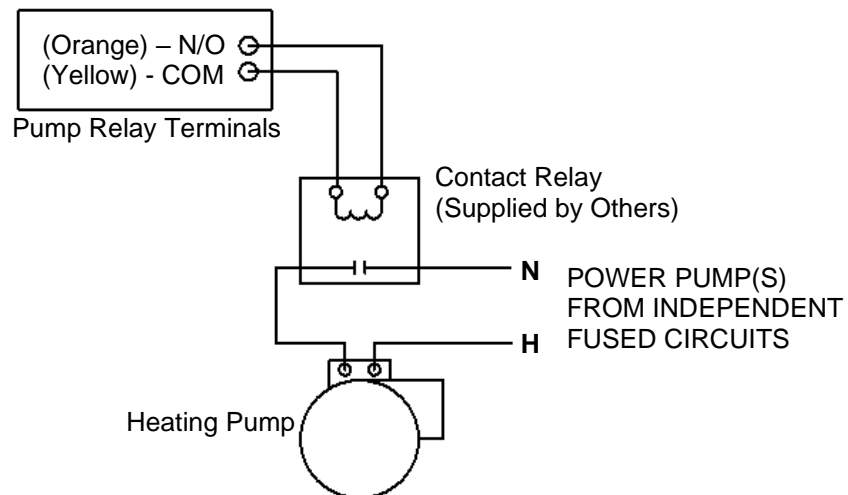
The Benchmark pump relay (SPDT) contact is rated for:

- 10 A Resistive @ 277 VAC or 28 VDC
- 1/3 HP @ 120/240 VAC N/O
- 1/6 HP @ 120/240 VAC N/C
- 480 VA @ 240-277 VAC Pilot Duty



**Figure 2-16: Schematic – System Pump Start using Boiler Pump Relay**

If pump/valve load exceeds the above contact ratings, use a separate contact relay, as shown in Figure 2-17.

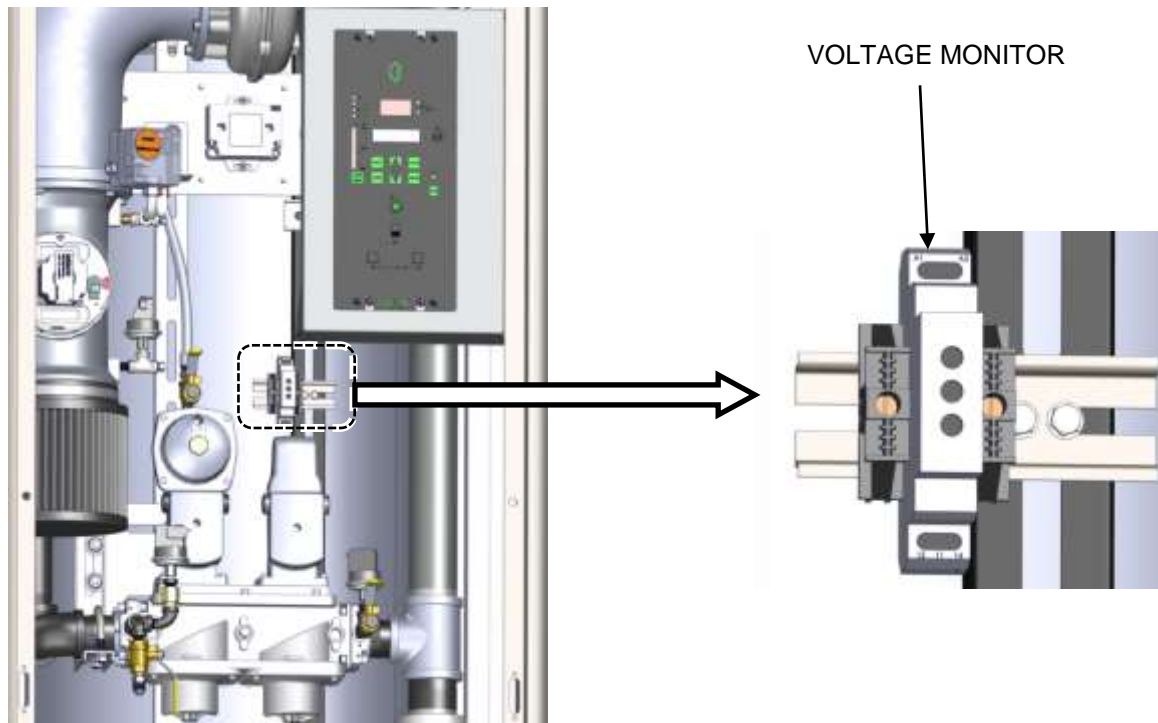


**Figure 2-17: Schematic – System Pump Start using a Separate Contact Relay**

### 2.16 Voltage Monitor and Cutoff

Benchmark 1500 and 2000 Heating Boilers include a voltage monitor (P/N 61054), which will shut down the unit if the voltage leaving the 220 to 110 voltage transformer falls outside the acceptable range of 100 V to 140 V for more than 5 seconds. Once the voltage returns to the acceptable range, the unit will restart automatically.

The voltage monitor is mounted to the heat exchanger shell, just above the gas train. It contains three adjustment screws. Do **NOT** adjust any of the adjustment screws unless directed to do so by AERCO Technical Support.



**Figure 2-18: Voltage Monitor Location**

### CHAPTER 3. OPERATION

#### 3.1 INTRODUCTION

The information in this Chapter provides a guide to the operation of the Benchmark Heating Boiler using the Control Panel mounted on the front of the unit. It is imperative that the initial startup of this unit be performed by factory trained personnel. Operation prior to initial startup by factory trained personnel may void the equipment warranty. In addition, the following WARNINGS and CAUTIONS must be observed at all times.

#### **--WARNING! --**

- ELECTRICAL VOLTAGES IN THIS SYSTEM INCLUDE 220, 120 AND 24 VOLTS AC. IT MUST BE SERVICED ONLY BY FACTORY CERTIFIED SERVICE TECHNICIANS.
- **DO NOT ATTEMPT TO DRY FIRE THE UNIT.** STARTING THE UNIT WITHOUT A FULL WATER LEVEL CAN SERIOUSLY DAMAGE THE UNIT AND MAY RESULT IN INJURY TO PERSONNEL OR PROPERTY DAMAGE. THIS SITUATION WILL VOID ANY WARRANTY.

#### **--CAUTION --**

All of the installation procedures in Chapter 2 must be completed before attempting to start the unit.

#### 3.2 CONTROL PANEL DESCRIPTION

All Benchmark Heating Boilers utilize the C-More Control Panel shown in Figure 3-1. This panel contains all of the controls, indicators and displays necessary to operate, adjust and troubleshoot the Heating Boiler. These operating controls, indicators and displays are listed and described in Table 3-1. Additional information on these items is provided in the individual operating procedures and menu descriptions provided in this Chapter.

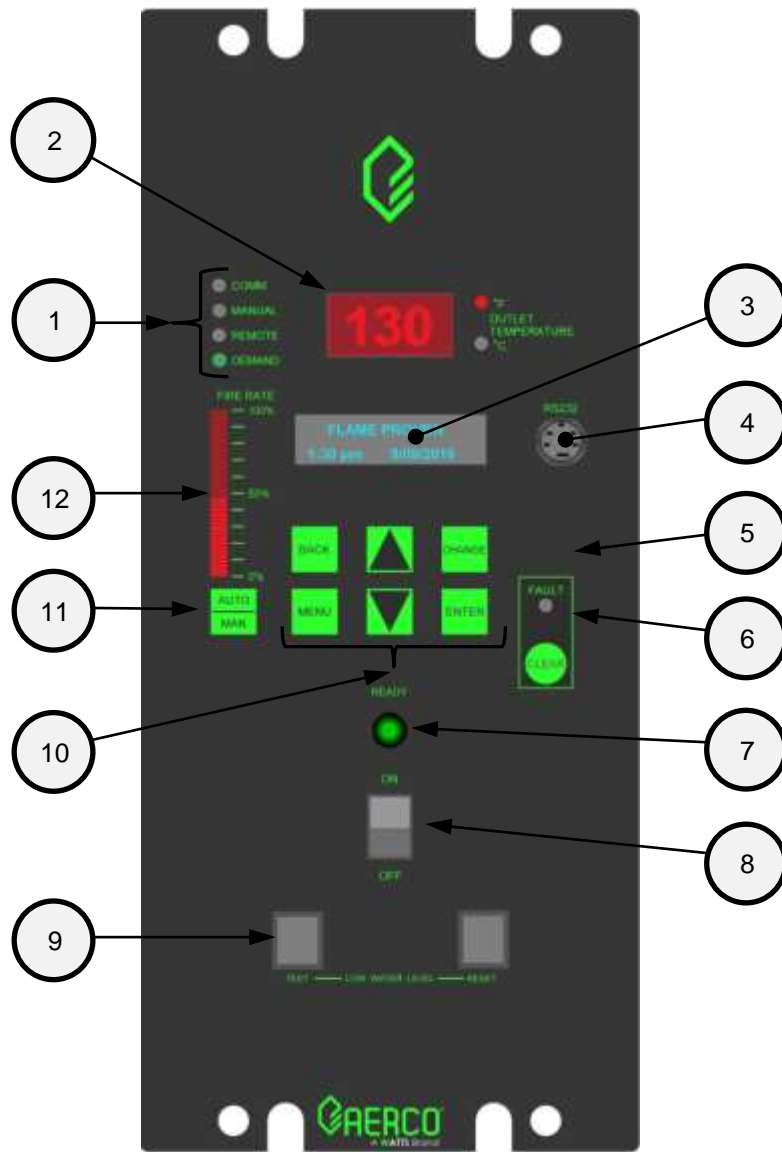


Figure 3-1: Control Panel Front View

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## CHAPTER 3 – OPERATION

**Table 3-1: Operating Controls, Indicators and Displays**

| ITEM  | CONTROL, INDICATOR OR DISPLAY              | FUNCTION  |
|---|--|---|
| <p><b><u>LED Status Indicators</u></b><br/>Four Status LEDs indicate the current operating status as follows:</p> |  |   |
| 1   | <b>COMM</b>                                | Lights when RS232 communication is occurring – see Item 4   |
|   | <b>MANUAL</b>                              | Lights when the valve position (fire rate) is being controlled using the front panel keypad. This mode of operation is for service technician use only.   |
|   | <b>REMOTE</b>                              | Lights when the unit is being controlled by an external signal from an Energy Management System   |
|   | <b>DEMAND</b>                              | Lights when there is a demand for heat.   |
| 2   | <b>OUTLET TEMPERATURE Display</b>          | <p>3–Digit, 7–Segment LED display continuously displays the outlet water temperature. The °F or °C LED next to the display lights to indicate whether the displayed temperature is in degrees Fahrenheit or degrees Celsius. The °F or °C blinks when operating in the DEADBAND mode.</p> <p>On a BST Master, display flashes &amp; shows header temperature.</p> |
| 3   | <b>VFD Display</b>                         | <p>Vacuum Fluorescent Display (VFD) consists of 2 lines each capable of displaying up to 16 alphanumeric characters. The information displayed includes:</p> <ul style="list-style-type: none"> <li>• Startup Messages</li> <li>• Fault Messages</li> <li>• Operating Status Messages</li> <li>• Menu Selection</li> <li>• BST Messages</li> </ul>                |
| 4   | <b>RS232 Port</b>                          | This port is used only by factory-trained personnel to monitor OnAER communications, in combination with the RS232 Adaptor Cable (P/N <b>124675</b> ).  |
| 5   | <b>FAULT Indicator</b>                     | Red <b>FAULT</b> LED indicator lights when a Heating Boiler alarm condition occurs. An alarm message will appear in the VFD.  |
| 6   | <b>CLEAR Key</b>                           | Turns off the <b>FAULT</b> indicator and clears the alarm message if the alarm is no longer valid. Lockout type alarms will be latched and cannot be cleared by simply pressing this key. Troubleshooting may be required to clear these types of alarms.   |
| 7   | <b>READY Indicator</b>                     | Lights ON/OFF switch is set to <b>ON</b> and all Pre-Purge conditions have been satisfied.  |
| 8   | <b>ON/OFF switch</b>                       | Enables and disables Heating Boiler operation.  |
| 9   | <b>LOW WATER LEVEL TEST/RESET switches</b> | <p>Allows operator to test operation of the water level monitor.</p> <p>Pressing <b>TEST</b> opens the water level probe circuit and simulates a Low Water Level alarm.</p> <p>Pressing <b>RESET</b> resets the water level monitor circuit.</p> <p>Pressing the <b>CLEAR</b> key (item 6) resets the display.</p>  |

**Table 3-1: Operating Controls, Indicators and Displays – Continued**

| ITEM  | CONTROL, INDICATOR OR DISPLAY     | FUNCTION  |
|---|-----------------------------------|---|
| <p><b><u>MENU Keypad</u></b></p> <p>Six (6) keys which provide the following functions for the Control Panel menus:</p> |                                   |   |
| <b>10</b>   | <b>MENU</b>                       | Steps through the main menu categories shown in Figure 3-2. The menu categories wrap around in the order shown.   |
|   | <b>BACK</b>                       | Allows you to go back to the previous menu level without changing any information. Continuously pressing this key will bring you back to the default status display in the VFD. Also, this key allows you to go back to the top of a main menu category.  |
|   | <b>▲ (UP) Arrow</b>               | When in one of the main menu categories (Figure 3-2), pressing the ▲ arrow key will select the displayed menu category. If the <b>CHANGE</b> key was pressed and the menu item is flashing, pressing the ▲ arrow key will increment the selected setting.   |
|   | <b>▼ (DOWN) Arrow</b>             | When in one of the main menu categories (Figure 3-2), pressing this key will select the displayed menu category. If the <b>CHANGE</b> key was pressed and the menu item is flashing, pressing the ▼ arrow key will decrement the selected setting.  |
|   | <b>CHANGE</b>                     | Permits a setting to be changed (edited). When the <b>CHANGE</b> key is pressed, the displayed menu item will begin to flash. Pressing the ▲ or ▼ arrow key when the item is flashing will increment or decrement the displayed setting.  |
|   | <b>ENTER</b>                      | Saves the modified menu settings in memory. The display will stop flashing.   |
| <b>11</b>   | <b>AUTO/MAN</b> switch            | <p>This switch toggles the unit between the AUTOMATIC and MANUAL modes of operation. When in the MANUAL (<b>MAN</b>) mode, the front panel controls are enabled and the <b>MANUAL</b> status LED lights. Manual operation is for service only.</p> <p>When in the AUTOMATIC (<b>AUTO</b>) mode, the <b>MANUAL</b> status LED will be off and the front panel controls disabled.</p> |
| <b>12</b>   | <b>VALVE POSITION</b><br>Bargraph | 20 segment red LED bargraph continuously shows the Air/Fuel Valve position in 5% increments from 0 to 100%  |

### 3.3 CONTROL PANEL MENUS

The Control Panel incorporates an extensive menu structure which permits the operator to set up, and configure the unit. The menu structure consists of five major menu categories which are applicable to this manual. These categories are shown in Figure 3-2. Each of the menus shown, contain options which permit operating parameters to be viewed or changed. The menus are protected by password levels to prevent unauthorized use.

Prior to entering the correct password, the options contained in the *Operation*, *Setup*, *Configuration* and *Tuning* menu categories can be viewed. However, with the exception of Internal Setpoint Temperature (*Configuration* menu), none of the viewable menu options can be changed.

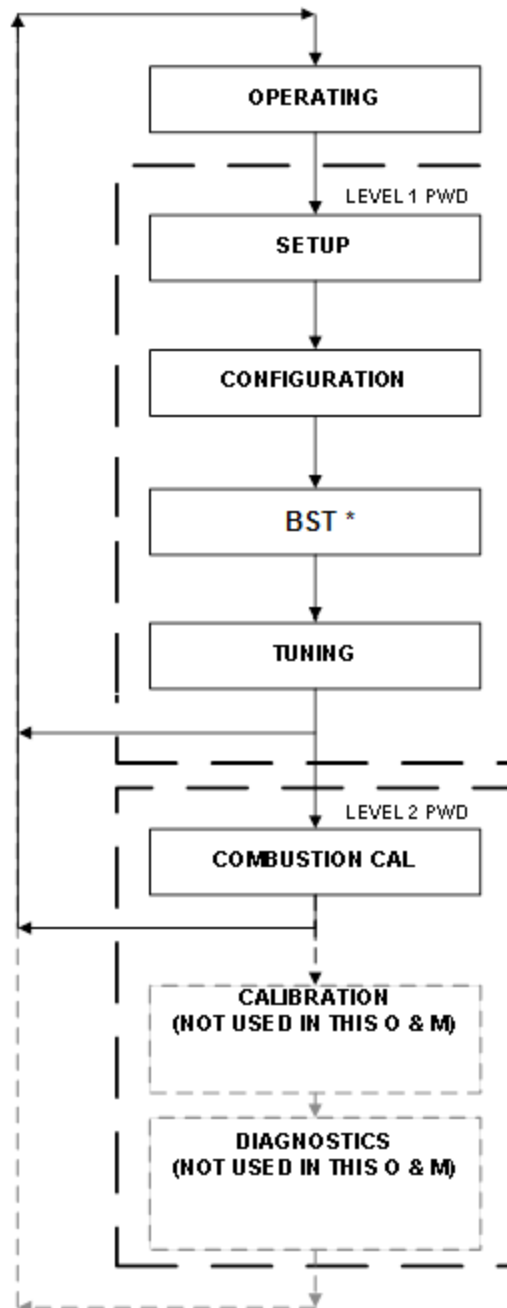
Once the valid **level 1 password (159)** is entered, the options listed in the *Setup*, *Configuration* and *Tuning* menus can be viewed and changed, if desired. The *Combustion Cal* menu is protected by the **level 2 password (6817)**, which is used in Chapter 4 to perform combustion calibration prior to service use.

#### 3.3.1 Menu Processing Procedure

Accessing and initiating each menu and option is accomplished using the menu keys shown in Figure 3-1. Therefore, it is imperative that you be thoroughly familiar with the following basic steps before attempting to perform specific menu procedures:

#### Menu Processing Procedure

1. The Control Panel will normally be in the *Operating* menu and the VFD will display the current unit status. Pressing the ▲ or ▼ arrow key will display the other available data items in the *Operating* menu.
2. Press the **MENU** key. The display will show the *Setup* menu, which is the next menu category shown in Figure 3-2. This menu contains the Password option which must be entered if other menu options will be changed.
3. Continue pressing the **MENU** key until the desired menu is displayed.
4. With the desired menu displayed, press the ▲ or ▼ arrow key. The first option in the selected menu will be displayed.
5. Continue to press the ▲ or ▼ arrow key until the desired menu option is displayed. Pressing the ▲ arrow key will display the available menu options in the Top-Down sequence. Pressing the ▼ arrow key will display the options in the Bottom-Up sequence. The menu options will wrap-around after the first or last available option is reached.
6. To change the value or setting of a displayed menu option, press the **CHANGE** key. The displayed option will begin to flash. Press the ▲ or ▼ arrow key to scroll through the available menu option choices for the option to be changed. The menu option choices do not wrap around.
7. To select and store a changed menu item, press the **ENTER** key.



\* Only if BST is enabled (see Chapter 9)

**Figure 3-2: Menu Structure**

### NOTE

The following sections provide brief descriptions of the options contained in each menu. Refer to Appendix A for detailed descriptions of each menu option. Refer to Appendix B for listings and descriptions of displayed startup, status and error messages.



### 3.4 OPERATING MENU

The *Operating* menu displays a number of key operating parameters for the unit as listed in Table 3-2. This menu is “Read-Only” and does not allow personnel to change or adjust any displayed items. Since this menu is “Read-Only”, it can be viewed at any time without entering a password. Pressing the ▲ arrow key to display the menu items in the order listed (Top-Down). Pressing the ▼ arrow key will display the menu items in reverse order (Bottom-Up).

**Table 3-2: Operating Menu**

| Menu Item Display |                      | Available Choices or Limits    |                |
|-------------------|----------------------|--------------------------------|----------------|
|                   |                      | Minimum                        | Maximum        |
| 1                 | Active Setpoint      | 40°F (4.4°C)                   | 240°F (116°C)  |
| 2                 | Inlet Temp           | 40°F (4.4°C)                   | 140°F (60°C)   |
| 3                 | Air Temp             | -70°F (-56.7°C)                | 245°F (118°C)  |
| 4                 | * Outdoor Temp       | -70°F (-56.7°C)                | 130°F (54.4°C) |
| 5                 | Valve Position In    | 0%                             | 100%           |
| 6                 | * Valve Position Out | 0%                             | 100%           |
| 7                 | Exhaust Temp         | Current Temp, Read Only, in °F |                |
| 8                 | Flame Strength       | 0%                             | 100%           |
| 9                 | Oxygen Level         | 0%                             | 21%            |
| 10                | Ignition Time        | 0.00                           | 10.00          |
| 11                | SSOV Time to OPN     | 0.00                           | 10.00          |
| 12                | Spark Current        | Displays current value         |                |
| 13                | Run Cycles           | 0                              | 999,999,999    |
| 14                | Run Hours            | 0                              | 999,999,999    |
| 15                | Fault Log            | 0                              | 19             |

**\*NOTE**

The Outdoor Temp and Valve Position Out display items shown with an asterisk in Table 3-2 will not be displayed unless the Outdoor Sensor function has been enabled in the *Configuration* menu (Table 3-4).

### 3.5 SETUP MENU

The *Setup* menu (Table 3-3) permits the operator to enter the unit password (159) which is required to change the menu options. To prevent unauthorized use, the password will time-out after 1 hour. Therefore, the correct password must be reentered when required. In addition to permitting password entries, the *Setup* menu is also used to enter date and time, and units of temperature measurements. A view-only software version display is also provided to indicate the current Control Box software version.

**Table 3-3: Setup Menu**

| Menu Item Display |                  | Available Choices or Limits |           | Default                  |
|-------------------|------------------|-----------------------------|-----------|--------------------------|
|                   |                  | Minimum                     | Maximum   |                          |
| 1                 | Password         | 0                           | 9999      | 0                        |
| 2                 | Language         | English                     |           | English                  |
| 3                 | Time             | 12:00 am                    | 11:59 pm  |                          |
| 4                 | Date             | 01/01/00                    | 12/31/99  |                          |
| 5                 | Unit of Temp     | Fahrenheit or Celsius       |           | Fahrenheit               |
| 6                 | Comm Address     | 0                           | 127       | 0                        |
| 7                 | Baud Rate        | 2400, 4800, 9600, 19.2K     |           | 9600                     |
| 8                 | OnAER Mode       | Ethernet or SD Card         |           | Ethernet                 |
| 9                 | Min Upload Timer | 0                           | 9,999 Sec | 0                        |
| 10                | Unit Alpha       | E, G, H, R, N or A          |           | A                        |
| 11                | Unit Year        | 0                           | 99        | 0                        |
| 12                | Unit Serial #    | 0                           | 9999      | 0                        |
| 13                | Software         | Ver 0.00                    | Ver 9.99  | Current software version |

### 3.6 CONFIGURATION MENU

The *Configuration* menu shown in Table 3-4 permits adjustment of the Internal Setpoint (Setpt) temperature regardless of whether the valid password has been entered. Setpt is required for operation in the CONSTANT SETPOINT mode. The remaining options in this menu require the valid password to be entered, prior to changing existing entries. This menu contains a number of other configuration settings which may or may not be displayed, depending on the current operating mode setting.

#### NOTE

The *Configuration* menu settings shown in Table 3-4 are Factory-Set in accordance with the requirements specified for each individual order. Therefore, under normal operating conditions, no changes will be required.

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**Table 3-4: Configuration Menu**

| Menu Item Display |  | Available Choices or Limits  |                   | Default   |
|-------------------|--|--|-------------------|---|
|                   |  | Minimum  | Maximum           |   |
| 1                 | Internal Setpt   | Lo Temp Limit  | Hi Temp Limit     | 130°F (54.4°C)  |
| 2                 | Unit Type  | BMK Blr Std, BMK Blr Std Dual,<br>BMK Blr LN, BMK Blr LN Dual                            |                   | BMK Boiler LN   |
| 3                 | Unit Size<br>(Only the unit sizes available for the Unit Type are displayed) | 1500 MBH (439.6 kW)<br>2000 MBH (586.1 kW)   |                   | 1500 MBH (439.6 kW)<br><u>or</u><br>2000 MBH (586.1 kW) |
| 4                 | Fuel Type  | Natural Gas or Propane   |                   | Natural Gas   |
| 5                 | Heating Boiler Mode  | Constant Setpoint,<br>Remote Setpoint,<br>Direct Drive,<br>Combination,<br>Outdoor Reset |                   | Constant Setpoint                                       |
| 6                 | Remote Signal<br>(If Mode = Remote Setpoint, Direct Drive or Combination)    | 4 – 20 mA/1 – 5V<br>0 -20 mA/0 – 5V<br>PWM Input (Legacy BMS), Network                   |                   | 4 – 20 mA,<br>1-5V                                      |
| 7                 | Outdoor Sensor   | Enabled or Disabled  |                   | Disabled  |
| 8                 | * Bldg Ref Temp<br>(If Mode = Outdoor Reset)                                 | 40°F<br>(4.4°C)  | 230°F<br>(110°C)  | 70°F<br>(21.1°C)  |
| 9                 | * Reset Ratio<br>(If Mode = Outdoor Reset)                                   | 0.1  | 9.9               | 1.2   |
| 10                | * System Start Tmp<br>(If Outdoor Sensor = Enabled)                          | 30°F<br>(-1.1°C)   | 100°F<br>(37.8°C) | 60°F<br>(15.6°C)  |
| 11                | Setpt Lo Limit   | 40°F (4.4°C)   | Setpt Hi Limit    | 60°F (15.6°C)   |
| 12                | Setpt Hi Limit   | Setpt Lo Limit   | 210°F (98.9°C)    | 195°F (90.6°C)  |
| 13                | Temp Hi Limit  | 40°F (4.4°C)   | 210°F (98.9°C)    | 195°F (90.6°C)  |
| 14                | Max Valve Position   | 40%  | 100%              | 100%  |
| 15                | Pump Delay Timer   | 0 min.   | 30 min.           | 0 min.  |
| 16                | Aux Start On Dly   | 0 sec.   | 120 sec.          | 0 sec.  |
| 17                | Failsafe Mode  | Shutdown or Constant Setpt   |                   | Shutdown  |
| 18                | Analog Output  | Off, Setpoint, Outlet Temp, Valve Pos<br>4-20mA, valve Pos 0-10v                         |                   | Valve Pos 0-10v   |
| 19                | Low Fire Timer   | 2 sec.   | 600 sec.          | 2 sec.  |
| 20                | Setpt Limiting   | Enabled or Disabled  |                   | Disabled  |

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**Table 3-4: Configuration Menu**

| Menu Item Display |                    | Available Choices or Limits |                | Default      |
|-------------------|--------------------|-----------------------------|----------------|--------------|
|                   |                    | Minimum                     | Maximum        |              |
| 21                | Setpt Limit Band   | 0°F (0°C)                   | 10°F (5.5°C)   | 5°F (2.75°C) |
| 22                | Network Timeout    | 5 sec.                      | 999 sec.       | 30 sec.      |
| 23                | Shutoff Dly Temp   | 0°F (0°C)                   | 25°F (13.75°C) | 10°F (5.5°C) |
| 24                | Demand Offset      | 0°F (0°C)                   | 25°F (13.75°C) | 0°F (0°C)    |
| 25                | Deadband High      | 0°F (0°C)                   | 25°F (13.75°C) | 5°F (2.75°C) |
| 26                | Deadband Low       | 0°F (0°C)                   | 25°F (13.75°C) | 5°F (2.75°C) |
| 27                | IGST Version       | V2.00 or Lower              |                | V2.02        |
| 28                | IGN Time Setting   | 4 sec.                      | 7 sec.         |              |
| 29                | Slow Shutdown      | Enabled or Disabled         |                | Disabled     |
| 30                | Slow Sht Duration  | 0 sec.                      | 9,999 sec.     | 60 sec.      |
| 31                | Slow Sht Threshold | 40%                         | 100%           | 60%          |
| 32                | BST Menu           | Enabled or Disabled         |                | Disabled     |

**\*NOTE**

The *Bldg Ref Temp* and *Reset Ratio* menu items are only displayed when the *Outdoor Sensor* menu item is set to **Enabled**.

**--CAUTION--**

**DO NOT** change the *Analog Output* menu item from its default setting (Valve Position 0-10V).

### 3.7 TUNING MENU

The *Tuning* menu items in Table 3-5 are Factory set for each individual unit. Do not change these menu entries unless specifically requested to do so by factory-trained personnel.

**Table 3-5: Tuning Menu**

| Menu Item Display |                  | Available Choices or Limits |              | Default       |
|-------------------|------------------|-----------------------------|--------------|---------------|
|                   |                  | Minimum                     | Maximum      |               |
| 1                 | Prop Band        | 1°F (0.55°C)                | 120°F (66°C) | 70°F (38.5°C) |
| 2                 | Integral Gain    | 0.00                        | 2.00         | 1.00          |
| 3                 | Derivative Time  | 0.0 min                     | 2.00 min     | 0.0min        |
| 4                 | Warmup Prop Band | 1°F 0.55°C)                 | 120°F (66°C) | 95 °F (52°C)  |
| 5                 | Warmup Int Gain  | 0.00                        | 2.00         | 0.50          |
| 6                 | Warmup PID timer | 0 sec.                      | 240 sec.     | 20 sec.       |
| 7                 | Reset Defaults?  | Yes, No, Are You Sure?      |              | No            |

### 3.8 COMBUSTION CAL MENU

The *Combustion Cal* (Calibration) menu is protected by the level 2 password (**6817**) which must be entered to view or change the menu items shown in Table 3-6. These menu items are used to vary the speed of the unit's blower motor based on air temperature and air density at prescribed Air/Fuel Valve positions (% open). This is accomplished by providing a DC drive voltage to the motor which then adjusts the rotational speed of the blower to maximize combustion efficiency and ensure the unit conforms to the Nitrogen Oxide (NOx) and Carbon Monoxide (CO) emissions specified in Chapter 4. The valve positions where the default drive voltages are set are listed in Table 3-6.

**Table 3-6: Combustion Cal Menu**

| Menu Item Display |                          | BMK 1500/2000          |         | BMK 1500 | BMK 2000 |
|-------------------|--------------------------|------------------------|---------|----------|----------|
|                   |                          | Minimum                | Maximum | Default  | Default  |
| 1                 | CAL Voltage BMK 1500:16% | 0.25                   | 10.00   | 1.00     | -        |
|                   | CAL Voltage BMK 2000:18% |                        |         | -        | 1.40     |
| 2                 | CAL Voltage 30%          |                        |         | 2.30     | 3.80     |
| 3                 | CAL Voltage 40%          |                        |         | 2.50     | 4.30     |
| 4                 | CAL Voltage 50%          |                        |         | 2.90     | 5.40     |
| 5                 | CAL Voltage 70%          |                        |         | 3.80     | 6.40     |
| 6                 | CAL Voltage 100%         |                        |         | 7.90     | 9.50     |
| 7                 | SET Valve Position       | 0                      | 100     | variable |          |
| 8                 | Blower Output            | Displays current value |         |          |          |
| 9                 | Set Stdby Volt           | 0                      | 10.0    | 2.00     |          |
| 10                | Oxygen Level             | Displays current value |         |          |          |
| 11                | Spark Monitor            | Enable or Disable      |         | Disable  |          |
| 12                | Min Spark Amps           | 0                      | 2.5     | 0.1      |          |
| 13                | Max Spark Amps           | 0                      | 2.5     | 0.4      |          |

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### 3.9 BST (Boiler Sequencing Technology) Menu

The *BST* menu must be enabled in order to be displayed and accessed. The **BST Menu** item, located at the end of the *Configuration* menu (item 32 in Table 3-4), must be set to **Enabled**.

The *BST* menu contains all of the items required to configure, operate and monitor the functionality of the BST System. There are over 50 items in this menu, and selecting any particular item from the list, for inspection or modification, could be time consuming. As a result, the *BST* menu has been segmented into FIVE logical groups based on functionality.

The five Item groups are:

1. **BST Monitor Items**
2. **\*BST SETUP MENU\***
3. **\*OPERATE MENU\***
4. **\*TEMP CTRL MENU\***
5. **\*BST COMM MENU\***

These displayed item groups are displayed in UPPER CASE letters, and are bounded by an asterisk \* in order to readily identify them within the item list.

The Items contained in group 1 (BST Monitor Items) are *always* displayed within the menu, as these items are critical for proper system operation. Therefore, the BST Monitor Items Header itself is *not* displayed.

The Items contained in groups 2-5 are *not displayed* unless that particular item group has been enabled from the C-More keypad.

**Table 3-7: BST Menu**

| Menu Item Display |                         | Available Choices or Limits                   |                 |                    | Default         |
|-------------------|-------------------------|---|-----------------|--------------------|-----------------|
|                   |                         | Minimum                                       | Maximum         |                    |                 |
| 1                 | <b>BST Mode</b>         | Off   | BST Slave       | BST Master         | Off             |
| 2                 | BST Setpoint            | BST Setpt Lo Limit                            |                 | BST Setpt Hi Limit | 130°F (54.4°C)  |
| 3                 | Header Temp             | Read Only – current Header temperature in °F  |                 |                    | N/A             |
| 4                 | BST Fire Rate           | 0   | 100%            |                    | Fire rate %     |
| 5                 | BST Ave Fire Rate       | 0   | 100%            |                    | Avg Fire Rate % |
| 6                 | BST Outdoor Temp        | Read Only – current outdoor temperature in °F |                 |                    | N/A             |
| 7                 | Units Available         | 0   | 8               |                    | Units Present   |
| 8                 | Units Ignited           | 0   | 8               |                    | Units firing    |
| 9                 | BST Valve State         | 0 (CLOSED)                                    | 1 (OPEN)        |                    | 0               |
| 10                | 1 Comm Errors 8         | 0   | 9               |                    | 0               |
| 11                | 1 BST Units 8           | 0 (see table)                                 | 0 (see table)   |                    | 0               |
| 12                | <b>*BST SETUP MENU*</b> | Disabled                                      |                 | Enabled            | Disabled        |
| 13                | BST Setpoint Mode       | Constant Setpoint                             | Remote Setpoint | Outdoor Reset      | Constant Setpt  |
| 14                | Head Temp Source        | Network                                       |                 | FFWD Temp          | FFWD Temp       |
| 15                | Header Temp Addr        | 0   | 255             |                    | 240             |
| 16                | Header Temp Point       | 0   | 255             |                    | 14              |
| 17                | BST Outdoor Sens        | Disabled                                      |                 | Enabled            | Disabled        |

# Benchmark 1500 – 2000 Boiler User Manual - INTERNATIONAL

## CHAPTER 3 – OPERATION

**Table 3-7: BST Menu**

| Menu Item Display |                             | Available Choices or Limits |                  |   | Default         |
|-------------------|-----------------------------|-----------------------------|------------------|---|-----------------|
|                   |                             | Minimum                     | Maximum          |   |                 |
| 18                | Outdr Tmp Source            | Outdoor Temp                |                  | Network   | Outdoor Temp    |
| 19                | Outdoor Tmp Addr            | 0                           |                  | 255   | 240             |
| 20                | Outdoor Tmp Pnt             | 0                           |                  | 255   | 215             |
| 21                | BST Remote Signal           | 4-20 mA/1-5 VDC;            | 0-20 mA/0-5 VDC; | Network   | Network         |
| 22                | BST Auto Mstr               | No                          |                  | Yes<br>NOTE! A Modbus temperature transmitter must be installed in conjunction with this feature. | No              |
| 23                | BST Auto Timer              | 10 sec                      |                  | 120 sec   | 30 sec          |
| 24                | Remote Intlk Use            | Heating Boiler Shutdown     |                  | System Shutdown   | System Shutdown |
| 25                | One Boiler Mode             | Off                         | On-Outlet Temp   | On-Avg Temp   | Off             |
| 26                | 1 Blr Threshold             | 10                          |                  | 35  | 25              |
| 27                | Setpoint Setback            | Disable                     |                  | Enable  | Disable         |
| 28                | Setback Setpoint            | BST Setpt Lo Limit          |                  | BST Setpt HI Limit  | 130°F (54.4°C)  |
| 29                | Setback Start               | 12:00am                     |                  | 11:59pm   | 12.00am         |
| 30                | Setback End                 | 12:00am                     |                  | 11:59pm   | 12.00am         |
| 31                | Rate Threshold              | 1°F (0.55°C)                |                  | 30°F (16.5°C)   | 15°F (8.25°C)   |
| <b>32</b>         | <b>*BST OPERATE MENU*</b>   | Disabled                    |                  | Enabled   | Disabled        |
| 33                | BST Next On VP              | 16%                         |                  | 100%  | 50%             |
| 34                | BST Max Boilers             | 1                           |                  | 8   | 8               |
| 35                | BST On Delay                | 30 sec                      |                  | 300 sec   | 60 sec          |
| 36                | BST On Timeout              | 15 sec                      |                  | 300 sec   | 60 Sec          |
| 37                | Valve Override              | Off                         | Closed           | Open  | Off             |
| 38                | Valve Off Delay             | 0                           |                  | 15 min  | 1 min           |
| 39                | BST Sequencing              | Run Hours                   | Unit Size        | Select Lead   | Run Hours       |
| 40                | Select Lead Unit            | 0                           |                  | 127   | 0               |
| 41                | Select Lag Unit             | 0                           |                  | 127   | 0               |
| 42                | Lead/Lag Hours              | 25 hours                    |                  | 225 hours   | 72 hours        |
| <b>43</b>         | <b>*BST TEMP CTRL MENU*</b> | Disabled                    |                  | Enabled   | Disabled        |
| 44                | BST Temp Hi Limit           | 40°F (4.4°C)                |                  | 210°F (98.9°C)  | 210°F (98.9°C)  |
| 45                | BST Setpt Lo Limit          | 40°F (4.4°C)                |                  | BST Setpt HI Limit  | 60°F (15.5°C)   |
| 46                | BST Setpt HI Limit          | BST Setpt Lo Limit          |                  | 220°F (104.4°C)   | 195°F (90.6°C)  |
| 47                | BST Prop Band               | 1°F (-17.2°C)               |                  | 120°F (48.9°C)  | 100°F (37.8°C)  |
| 48                | BST Intgral Gain            | 0.00                        |                  | 2.00  | 0.50            |
| 49                | BST Deriv Time              | 0.00 Min                    |                  | 2.00 Min  | 0.10 Min        |
| 50                | BST Deadband Hi             | 0                           |                  | 25  | 1               |

**Table 3-7: BST Menu**

| Menu Item Display         |                  | Available Choices or Limits |                | Default       |
|---------------------------|------------------|-----------------------------|----------------|---------------|
|                           |                  | Minimum                     | Maximum        |               |
| 51                        | BST Deadband Lo  | 0                           | 25             | 1             |
| 52                        | Deadband En Time | 0                           | 120 Sec        | 30 Sec        |
| 53                        | BST FR Up Rate   | 1                           | 120            | 20            |
| 54                        | BST Bldg Ref Tmp | 40°F (4.4°C)                | 230°F (110°C)  | 70°F (21.1°C) |
| 55                        | BST Reset Ratio  | 0.1                         | 9.9            | 1.2           |
| 56                        | System Start Tmp | 30°F (-1.1°C)               | 120°F (48.9°C) | 60°F (15.6°C) |
| <b>57 *BST COMM MENU*</b> |                  |                             |                |               |
|                           |                  | Disabled                    | Enabled        | Disabled      |
| 58                        | Comm Address     | 0                           | 127            | 0             |
| 59                        | BST Min Addr     | 1                           | 128            | 1             |
| 60                        | BST Max Addr     | 1                           | 128            | 8             |
| 61                        | SSD Address      | 0                           | 250            | 247           |
| 62                        | SSD Poll Control | 0                           | 1000           | 0             |
| 63                        | Err Threshold    | 1                           | 9              | 5             |
| 64                        | SSD Temp Format  | Degrees                     | Points         | Degrees       |
| 65                        | BST Upld Timer   | 0                           | 9999 sec       | 0             |

### 3.10 START SEQUENCE

When the Control Box ON/OFF switch is set to the **ON** position, it checks all pre-purge safety switches to ensure they are closed. These switches include:

- Safety Shut-Off Valve (SSOV) Proof of Closure (POC) switch
- Low Water Level switch
- High Water Temperature switch
- High Gas Pressure switch
- Low Gas Pressure switch

#### NOTE

The **Blocked Inlet** and downstream **Blower Proof** switches are *not* checked prior to starting the pre-purge.

If all of the above switches are closed, the READY light above the ON/OFF switch will light and the unit will be in the STANDBY mode.

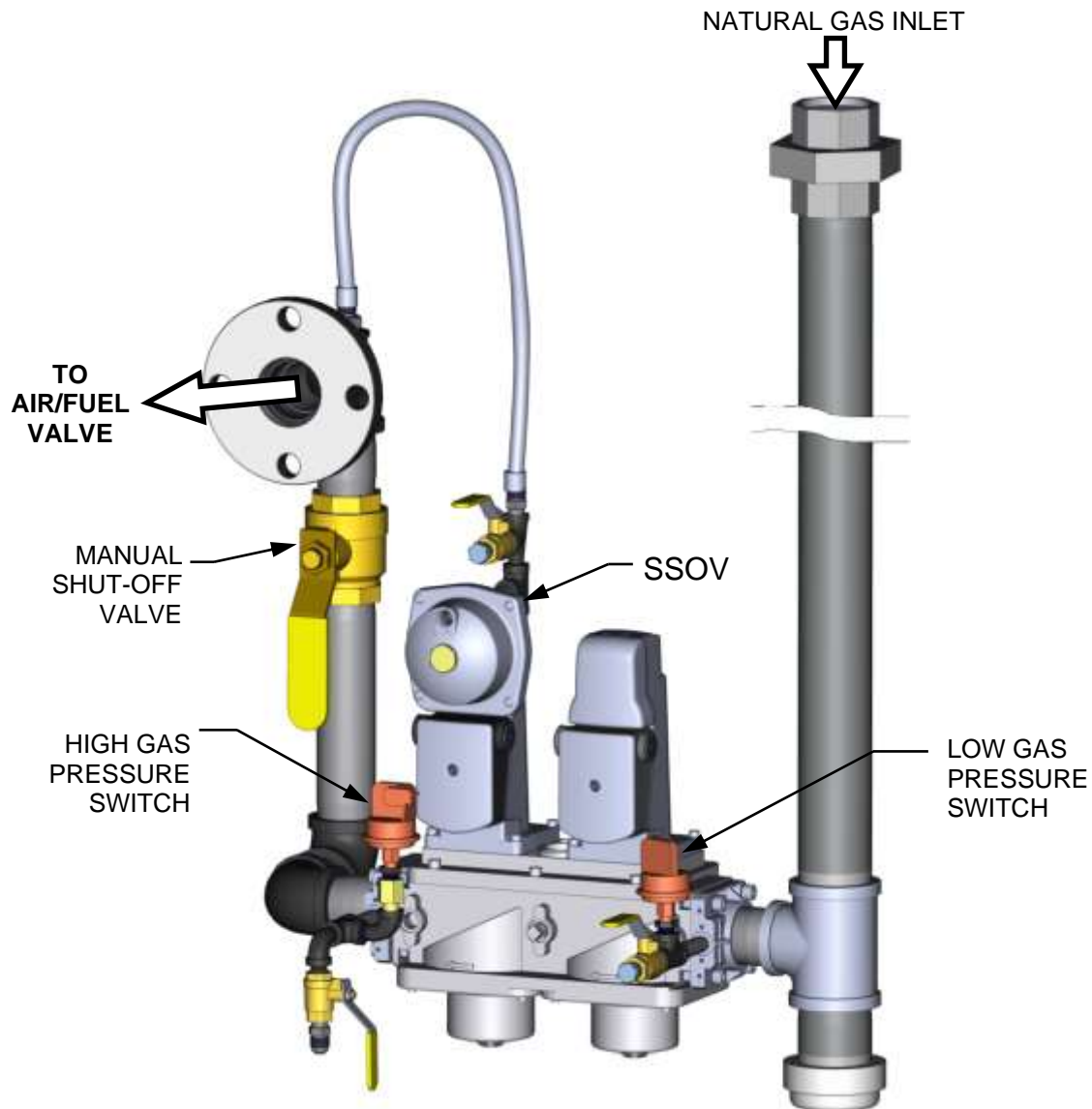
When there is a demand for heat, the following events will occur:

#### NOTE

If any of the Pre-Purge safety device switches are open, the appropriate fault message will be displayed. Also, the appropriate messages will be displayed throughout the start sequence, if the required conditions are not observed.

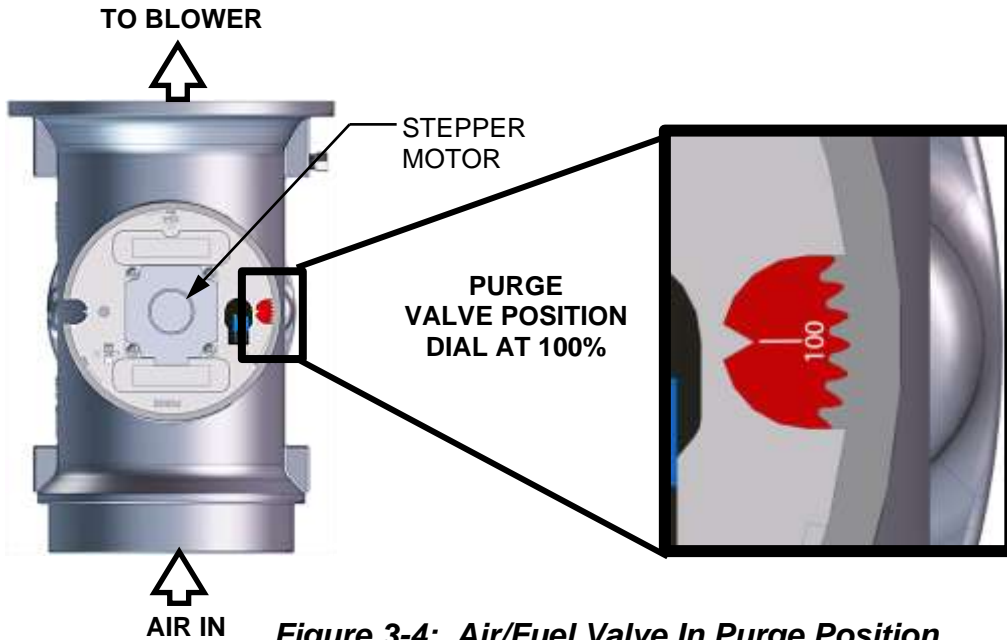


1. The **DEMAND** LED status indicator will light.
2. The unit checks to ensure that the Proof of Closure (POC) switch in the downstream Safety Shut-Off Valve (SSOV) is closed. See Figure 3-3 for SSOV location.



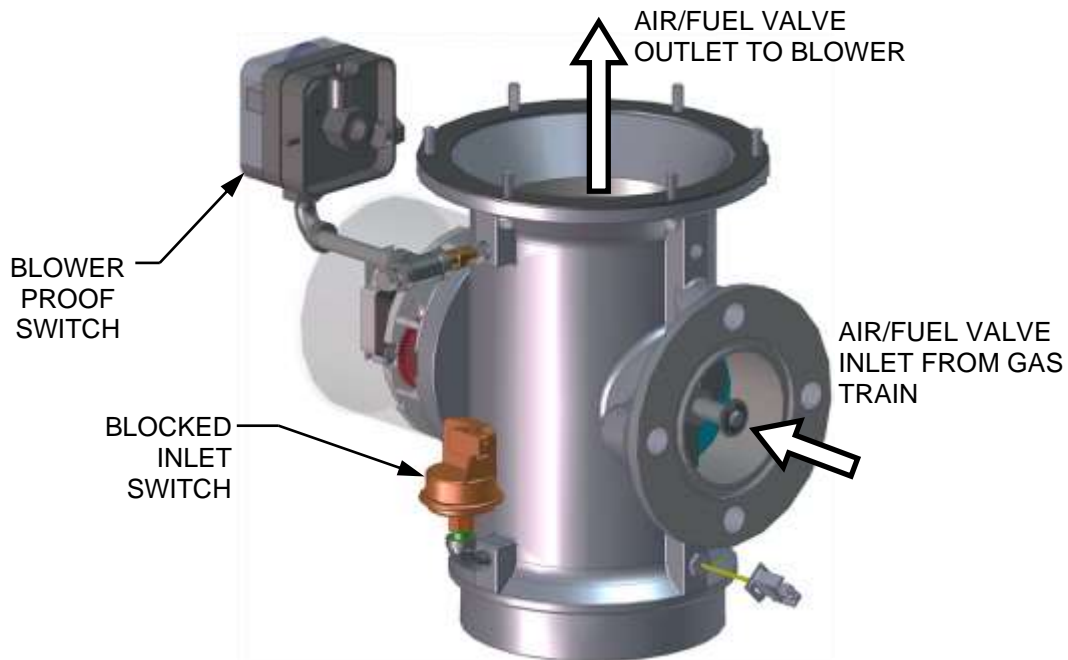
**Figure 3-3: BMK 1500/2000: SSOV Location**

3. With all required safety device switches closed, a purge cycle will be initiated and the following events will occur:
  - a. The Blower relay energizes and turns on the blower.
  - b. The Air/Fuel Valve rotates to the full-open purge position and closes purge position switch. The dial on the Air/Fuel Valve (Figure 3-4) will read **100** to indicate that it is full-open (100%).
  - c. The **VALVE POSITION** bargraph will show 100%.



**Figure 3-4: Air/Fuel Valve In Purge Position**

4. Next, the blower proof switch on the Air/Fuel Valve (Figure 3-5) closes. The display will show **PURGING** and indicate the elapsed time of the purge cycle in seconds.



**Figure 3-5: Blower Proof Switch**

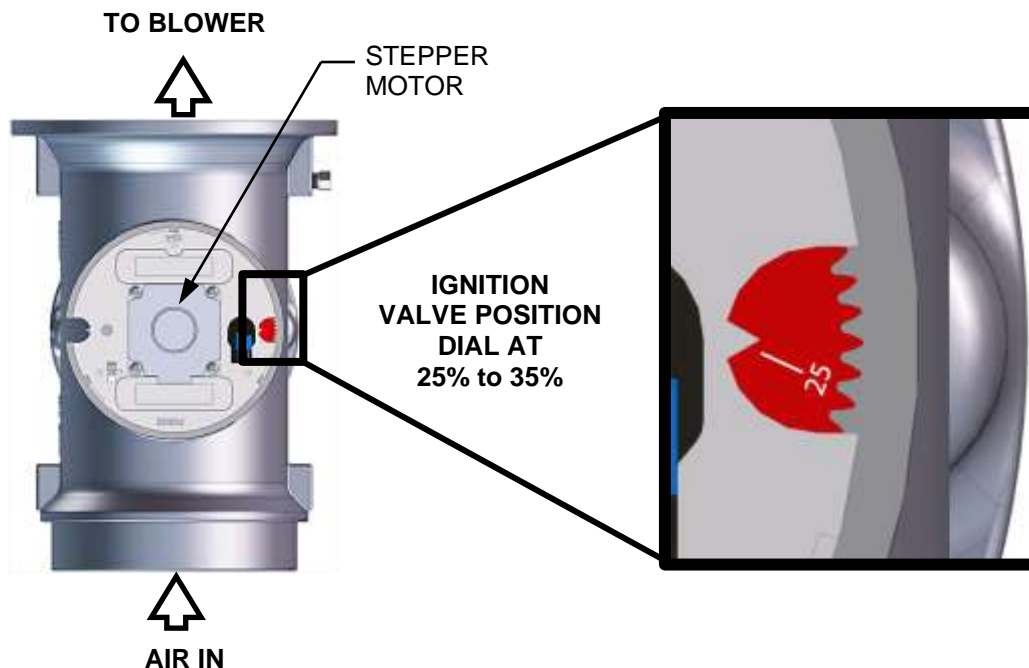
5. Upon completion of the purge cycle, the Control Box initiates an ignition cycle and the following events occur:
  - (a) The Air/Fuel Valve rotates to the low-fire (Ignition Position) position and closes the ignition switch. The Dial on the Air/Fuel Valve (Figure 3-6) will read between **25** and **35** to indicate that the valve is in the low fire position.

- (b) The “Spark Cycle Time” item in the *Factory* menu can be set to either 0 Sec, 2 Sec or 7 Sec to define the duration of the Spark Element Cleaning Cycle. This cycle turns on the spark transformer to produce a spark (with no gas flowing) to clean the spark element of moisture or carbon buildup.

For the duration of this cycle, the C-More will display the **CLEANING IGNITER** message.

- (c) Following the Spark Element Cleaning Cycle, power is applied to the Gas Safety Shut-off Valve (SSOV) and the C-More displays the **PRE IGNITION** message. When the SSOV indicates the Gas Valve is OPEN (POC), the C-More displays the **IGNITION TRIAL** message.

- (d) If no spark is present 3 seconds into the IGNITION TRIAL, the C-More will abort the Ignition Cycle and shut down the Heating Boiler. Refer to **Chapter 8: Troubleshooting** for guidance if this occurs.



**Figure 3-6: Air/Fuel Valve In Ignition Position**

6. Up to 4 seconds will be allowed for ignition to be detected. The igniter relay will be turned off one second after flame is detected.
7. After 2 seconds of continuous flame, **FLAME PROVEN** will be displayed and the flame strength will be indicated. After 5 seconds, the current date and time will be displayed in place of the flame strength.
8. With the unit firing properly, it will be controlled by the temperature controller circuitry. The Heating Boiler's **VALVE POSITION** will be continuously displayed on the front panel bargraph.

Once the demand for heat has been satisfied, the Control Box will turn off the SSOV gas valve. The blower relay will be deactivated and the Air/Fuel Valve will be closed. **STANDBY** will be displayed.

### 3.11 START/STOP LEVELS

The start and stop levels are the Air/Fuel Valve positions (% open) that start and stop the unit, based on load. These levels are Factory preset as follows:

|                     | Natural Gas |          |
|---------------------|-------------|----------|
|                     | BMK 1500    | BMK 2000 |
| <b>Start Level:</b> | 24%         | 24%      |
| <b>Stop Level:</b>  | 16%         | 18%      |

Normally, these settings should not require adjustment.

Note that the energy input of the Heating Boiler is not linearly related to the Air/Fuel Valve position.

The Tables below show the relationship between the energy input and Air/Fuel Valve position.

**Table 3-8a: BMK 1500: Air/Fuel Valve Position and Energy Input Relationship**

| Air/Fuel Valve Position (% Open) | Energy Input (BTU/Hr) | Heating Boiler Energy Input (% of Full Capacity) |
|----------------------------------|-----------------------|--|
| 16% (Stop Level)                 | 76,000 (22.3 kW)      | 5.0%   |
| 20%                              | 127,000 (37.2 kW)     | 8.5%   |
| 30%                              | 366,000 (107.2 kW)    | 24.4%  |
| 40%                              | 629,000 (184.3 kW)    | 41.9%  |
| 50%                              | 822,000 (240.9 kW)    | 54.7%  |
| 60%                              | 977,000 (286.2 kW)    | 65.0%  |
| 70%                              | 1,119,000 (327.9 kW)  | 74.5%  |
| 80%                              | 1,255,000 (367.7 kW)  | 83.5%  |
| 90%                              | 1,396,000 (409.0 kW)  | 92.9%  |
| 100%                             | 1,502,000 (440.1 kW)  | 100%   |

**Table 3-8b: BMK 2000: Air/Fuel Valve Position and Energy Input Relationship**

| Air/Fuel Valve Position (% Open) | Energy Input (BTU/Hr) | Heating Boiler Energy Input (% of Full Capacity) |
|----------------------------------|-----------------------|--|
| 18% (Stop Level)                 | 100,000 (29.3 kW)     | 6.7%   |
| 20%                              | 143,000 (41.9 kW)     | 11%  |
| 30%                              | 388,000 (113.7 kW)    | 23%  |
| 40%                              | 759,000 (222.4 kW)    | 37%  |
| 50%                              | 1,069,000 (313.2 kW)  | 51%  |
| 60%                              | 1,283,000 (375.9 kW)  | 61%  |
| 70%                              | 1,476,000 (432.5 kW)  | 74%  |
| 80%                              | 1,675,000 (490.1 kW)  | 83%  |
| 90%                              | 1,833,000 (537.1 kW)  | 93%  |
| 100%                             | 2,000,000 (586.0 kW)  | 100%   |

### CHAPTER 4. INITIAL START-UP

#### 4.1 INITIAL START-UP REQUIREMENTS

The requirements for the initial start-up of the Benchmark Heating Boiler consist of the following:

- Complete installation (Chapter 2)
- Set proper controls and limits (Chapter 3)
- Perform combustion calibration (Chapter 4)
- Test safety devices (Chapter 6)

All applicable installation procedures in Chapter 2 must be fully completed prior to performing the initial start-up of the unit. The initial start-up must be successfully completed prior to putting the unit into service. Starting a unit without the proper piping, venting, or electrical systems can be dangerous and may void the product warranty. The following start-up instructions should be followed precisely in order to operate the unit safely and at a high thermal efficiency, with low flue gas emissions.

Initial unit start-up must be performed ONLY by AERCO factory trained start-up and service personnel. After performing the start-up procedures in this Chapter, it will be necessary to perform the Safety Device Testing procedures specified in Chapter 6 to complete all initial unit start-up requirements.

An AERCO Gas Fired Startup Sheet, included with each Benchmark unit, must be completed for each unit for warranty validation and a copy must be returned promptly to AERCO via e-mail at: **STARTUP@AERCO.COM**.

#### **--WARNING! --**

**DO NOT ATTEMPT TO DRY FIRE THE UNIT.** Starting the unit without a full water level can seriously damage the unit and may result in injury to personnel or property damage. This situation will void any warranty.

#### **NOTE**

All applicable installation procedures in Chapter 2 must be completed before attempting to start the unit.

#### 4.2 TOOLS AND INSTRUMENTATION FOR COMBUSTION CALIBRATION

To properly perform combustion calibration, the proper instruments and tools must be used and correctly attached to the unit. The following sections outline the necessary tools and instrumentation as well as their installation.

### 4.2.1 Required Tools & Instrumentation

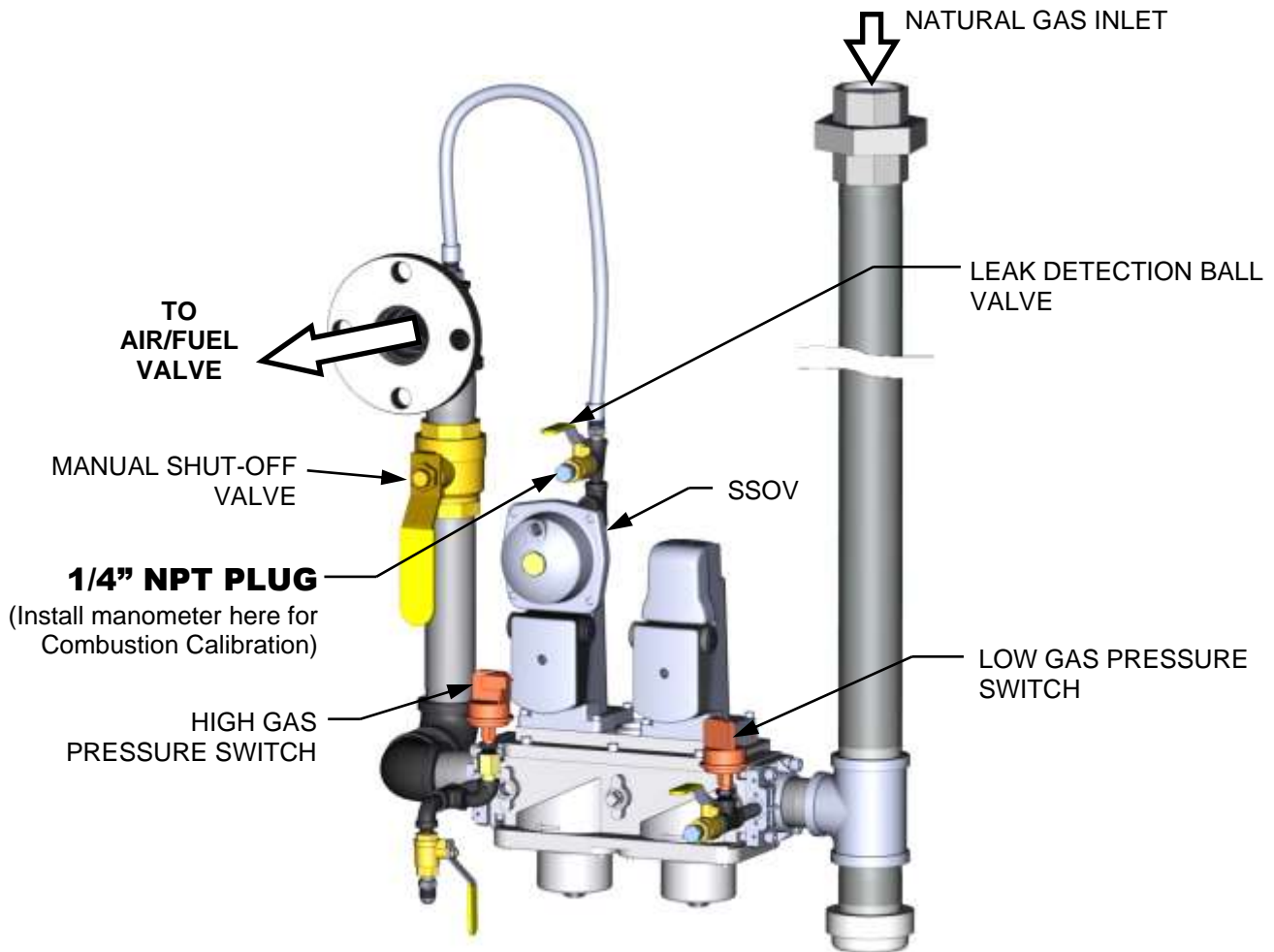
The following tools and instrumentation are necessary to perform combustion calibration of the unit:

- Digital Combustion Analyzer: Oxygen accuracy to  $\pm 0.4\%$ ; Carbon Monoxide (CO) and Nitrogen Oxide (NOx) resolution to 1PPM.
- 0 to 16 inch W.C. (0 to 4000 Pa) manometer or equivalent gauge and plastic tubing.
- 1/4 inch NPT-to-barbed fittings for use with gas supply manometer or gauge.
- Small and large flat blade screwdrivers.
- Tube of silicone adhesive

### 4.2.2 Installing Gas Supply Manometer

The gas supply manometer (or gauge) is used to monitor the gas pressure on the downstream side of the SSOV during the Combustion Calibration procedures described in section 4.3.

The gas supply manometer is installed at the upstream and/or downstream location shown in Figure 4-1.



**Figure 4-1: 1/4 Inch Gas Plug Location for Combustion Calibration**



To monitor the gas pressure on the downstream side of the SSOV during Combustion Calibration (section 4.3), install the 16" W.C. (4000 Pa) manometer(s) as described in the following steps:

### **Installing Gas Supply Manometer**

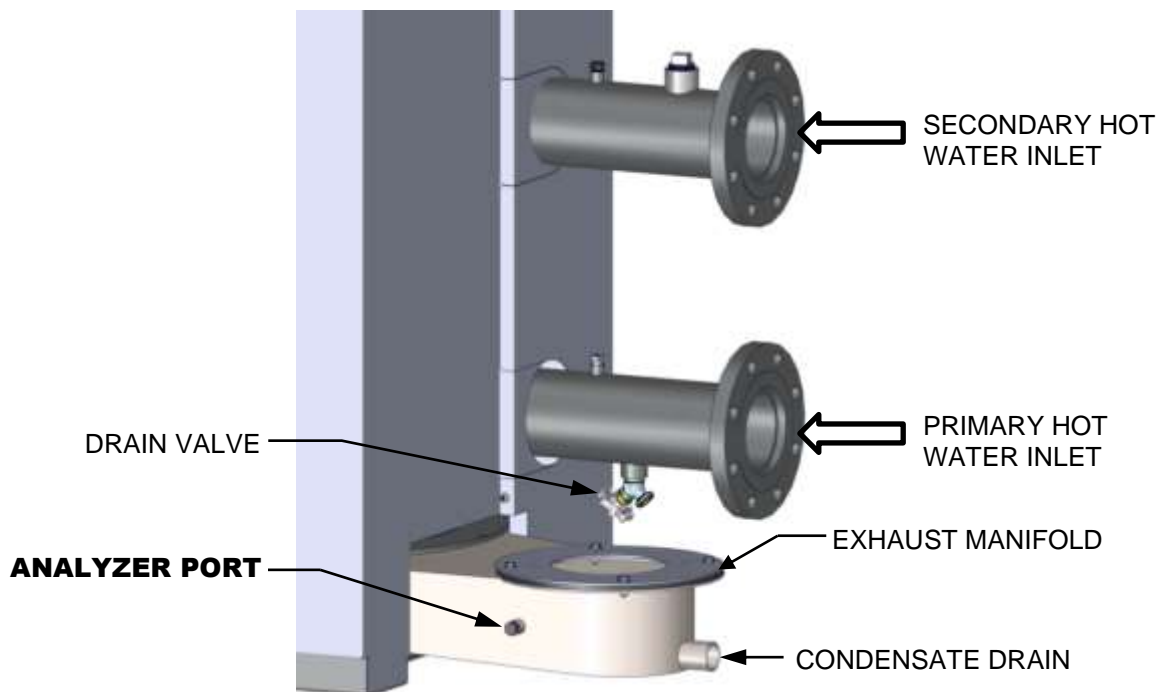
1. Turn off the main gas supply upstream of the unit.
2. Remove the top panel and front panel from the Heating Boiler to access the gas train components.
3. Remove the 1/4" NPT plug from the leak detection ball valve on the downstream side of the SSOV as shown in Figure 4-1.
4. Install a NPT-to-barbed fitting into the tapped plug port.
5. Attach one end of the plastic tubing to the barbed fitting and the other end to the 16" W.C. (4000 Pa) manometer.

### **4.2.3 Accessing the Analyzer Probe Port**

The unit contains a 1/4" NPT port on the side of the exhaust manifold as shown in Figure 4-2. Prepare the port for the combustion analyzer probe as follows:

### **Accessing the Analyzer Probe Port**

1. Refer to Figure 4-2 and remove the 1/4" NPT plug from the exhaust manifold.
2. If necessary, adjust the stop on the combustion analyzer probe so it will extend mid-way into the flue gas flow. **DO NOT install the probe at this time.**



**Figure 4-2: Analyzer Probe Port Location (Right Side Partial View)**

### 4.3 NATURAL GAS COMBUSTION CALIBRATION

The Benchmark Heating Boiler is combustion calibrated at the factory prior to shipping. This gas pressure must be within the following ranges for each model of Heating Boiler **at full fire**:

**Table 4-1: Nominal Gas Pressure**

| BMK Heating Boiler Model | Nominal Gas Pressure                |
|--------------------------|-------------------------------------|
| BMK 1500                 | 3.6" W.C. ± 0.2" W.C. (897 ± 50 Pa) |
| BMK 2000                 | 3.4" W.C. ± 0.2" W.C. (847 ± 50 Pa) |

Recalibration as part of initial start-up is necessary due to changes in the local altitude, gas BTU content, gas supply piping and supply regulators. Combustion Calibration Test Data sheets are shipped with each unit. These sheets must be filled out and returned to AERCO for proper Warranty Validation.

It is important to perform the following procedure as outlined. This will keep readjustments to a minimum and provide optimum performance.

#### 4.3.1 BMK 1500 Natural Gas Combustion Calibration

Complete the following instructions for natural gas combustion calibration of BMK 1500 units.

#### **BMK 1500 Natural Gas Combustion Calibration**

1. Open the water supply and return valves to the unit and ensure that the system pumps are running.
2. Open the natural gas supply valve to the unit.
3. Set the control panel ON/OFF switch to the **OFF** position
4. Turn on external AC power to the unit. The display will show the time and date of the last time the unit was shut down or lost power.
5. Set the unit to the MANUAL mode by pressing the **AUTO/MAN** key. A flashing manual valve position message will be displayed with the present position in %. Also, the **MANUAL** LED will light.
6. Adjust the air/fuel valve position to 0% by pressing the ▼ arrow key.
7. Ensure that the leak detection ball valve downstream of the SSOV is open.
8. Set the ON/OFF switch to the **ON** position.
9. Change the valve position to **30%** using the ▲ arrow key. The unit should begin its start sequence and fire.
10. Next, verify that the gas pressure downstream of the SSOV is set to **3.6 ± 0.2" W.C. (897 ± 50 Pa)**. If gas pressure adjustment is required, remove the brass hex nut on the SSOV actuator to access the gas pressure adjustment screw (Figure 4-3). Make gas pressure adjustments using a flat-tip screwdriver to obtain a gas pressure approximately **3.6" W.C. ± 0.2" W.C. (897 ± 50 Pa)**.
11. Using the ▲ arrow key, increase the valve open position to 100%. Verify that the gas pressure on the downstream side of the SSOV settles within the range of **3.6 ± 0.1" W.C. (897 ± 25 Pa)**. Readjust the gas pressure if necessary.
12. With the valve position at 100%, insert the combustion analyzer probe into the flue probe opening and allow enough time for the combustion analyzer reading to stabilize.



### **BMK 1500 Natural Gas Combustion Calibration – Continued**

13. Compare the oxygen readings on the combustion analyzer to the on-board O<sub>2</sub> sensor value displayed in the *Operating* menu of the C-More Control Panel. If the values differ by more than  $\pm 1.5\%$  and your combustion analyzer is correctly calibrated, the on-board O<sub>2</sub> sensor may be defective and need to be replaced.
14. Compare the measured oxygen level to the oxygen range shown below. Also, ensure that the nitrogen oxide (NO<sub>x</sub>) and carbon monoxide (CO) readings do not exceed the values shown. If you are not in a “NO<sub>x</sub>-limited” area and/or do not have a NO<sub>x</sub> measurement in your analyzer, set the oxygen (O<sub>2</sub>) at **5.5%  $\pm$  0.5%**.

**Table 4-2: Combustion Calibration Readings – 100% Valve Position**

| Valve Position | Oxygen (O <sub>2</sub> ) % | Nitrogen Oxide (NO <sub>x</sub> ) | Carbon Monoxide (CO) |
|----------------|----------------------------|-----------------------------------|----------------------|
| 100%           | 5.0% - 6.0%                | $\leq 20$ ppm                     | <100 ppm             |

15. If the oxygen level is not within the required tolerance, the gas pressure on the downstream side of the SSOV must be adjusted using the gas pressure adjustment screw on the SSOV (Figure 4-3). Slowly rotate the gas pressure adjustment (approximately 1/4-turn increments). Allow the combustion analyzer to stabilize following each adjustment. Clockwise rotation reduces the oxygen level, while counterclockwise rotation increases the oxygen level.
16. Once the oxygen level is within the specified range at 100%, record the O<sub>2</sub>, NO<sub>x</sub> and CO readings on the Combustion Calibration Data Sheets provided with the unit.
17. Lower the valve position to **70%** using the ▼ arrow key.

#### **NOTE**

The remaining combustion calibration steps are performed using the *Combustion Cal* menu included in the C-More Control System. The combustion calibration control functions will be used to adjust the oxygen level (%) at valve positions of 70%, 50%, 40%, 30% and 16% as described in the following steps. These steps assume that the **inlet air temperature is within the range of 50°F to 100°F (10°C – 37.8°C)**. If NO<sub>x</sub> readings exceed the target values shown, increase the O<sub>2</sub> level up to 1% higher than the listed calibration range. Record the increased O<sub>2</sub> value on the Combustion Calibration sheet.

18. Press the **MENU** key on the front panel of the C-More and access the *Setup* menu. Enter password **6817** and then press the **ENTER** key.
19. Press the **MENU** key on the front panel of the C-More until **Combustion Cal Menu** appears on the display.
20. Press the Up ▲ arrow key until the **SET Stdbby V Out (Standby Voltage)** setting appears. Verify that it is set to **2.0 V** (the default). AERCO recommends it be kept at 2.0 volts to prevent flue gas recirculation.
21. Press the ▲ arrow key until **SET Valve Position** appears on the display.
22. Press the **CHANGE** key. **SET Valve Position** will begin to flash.
23. Press the ▲ arrow key until the **SET Valve Position** reads **70%**. Press the **ENTER** key.
24. Next, press the down (▼) arrow key until **CAL Voltage 70%** is displayed.

### **BMK 1500 Natural Gas Combustion Calibration – *Continued***

25. Press the **CHANGE** key and observe that **CAL Voltage 70%** is flashing.
26. The oxygen level at the 70% valve position should be as shown below. Also, ensure that the nitrogen oxide (NOx) and carbon monoxide (CO) readings do not exceed the following values:

**Table 4-3: Combustion Calibration Readings – 70% Valve Position**

| Valve Position | Oxygen (O <sub>2</sub> ) % | Nitrogen Oxide (NOx) | Carbon Monoxide (CO) |
|----------------|----------------------------|----------------------|----------------------|
| 70%            | 5.9% ± 0.5%                | ≤20 ppm              | <100 ppm             |

27. If the oxygen level is not within the specified range, adjust the level using the ▲ and ▼ arrow keys. This will adjust the output voltage to the blower motor as indicated on the display. Pressing the ▲ arrow key increases the oxygen level and pressing the down ▼ arrow key decreases the oxygen level.
28. Once the oxygen level is within the specified range at 70%, press the **ENTER** key to store the selected blower output voltage for the 70% valve position. Record all readings on the Combustion Calibration Sheets provided.
29. Repeat steps 20 through 27 for valve positions of 50%, 40%, 30% and 16%. The oxygen (O<sub>2</sub>), nitrogen oxide (NOx) and carbon monoxide (CO) should remain within the same limits for all valve positions as shown in the following table.

#### **NOTE**

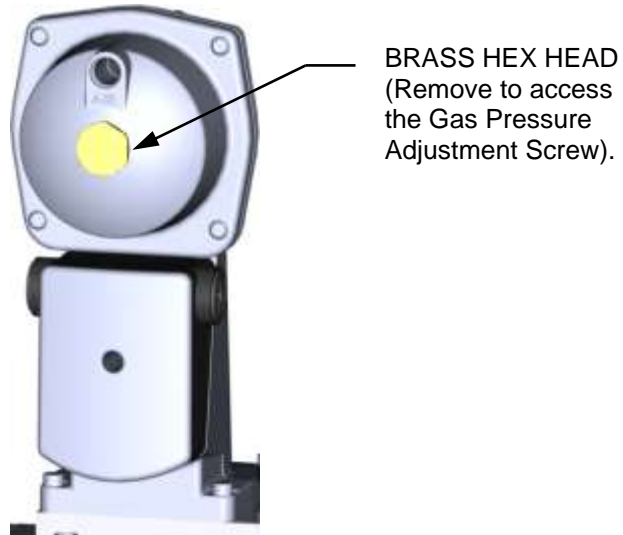
If NOx readings exceed the target values shown (<20 ppm), increase the O<sub>2</sub> level up to 1% higher than the listed calibration range shown in the table. Record the increased O<sub>2</sub> value on the Combustion Calibration sheet.

**Table 4-4: Combustion Calibration Readings**

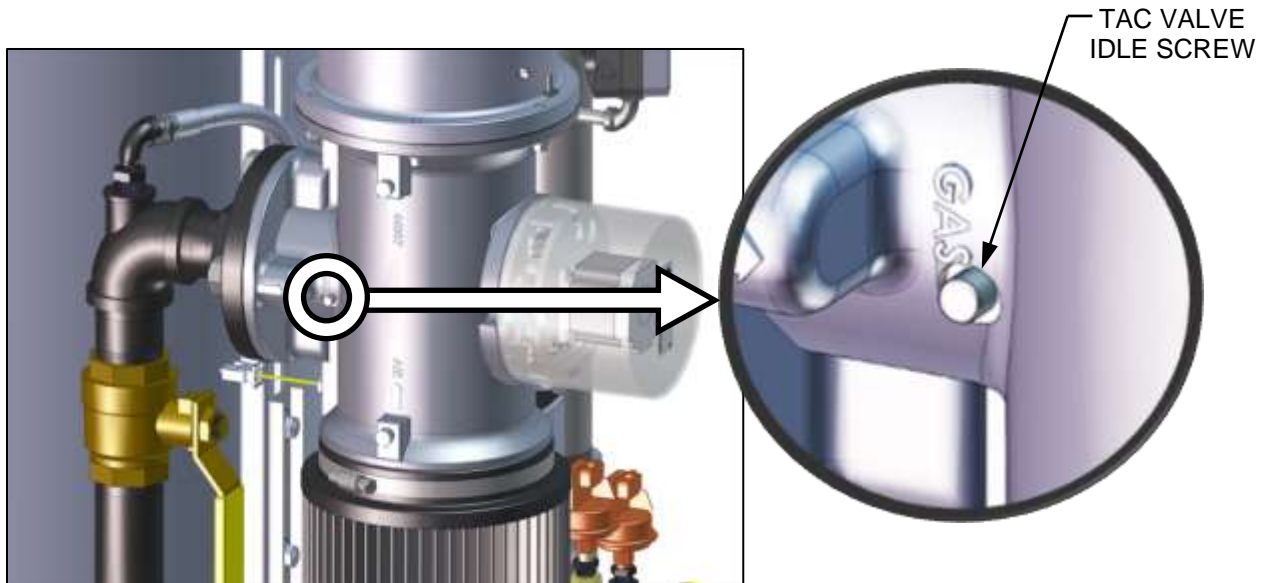
| Valve Position | Oxygen (O <sub>2</sub> ) % | Nitrogen Oxide (NOx) | Carbon Monoxide (CO) |
|----------------|----------------------------|----------------------|----------------------|
| 50%            | 6.0% ± 0.5                 | <20 ppm              | <100 ppm             |
| 40%            | 6.3% ± 0.5                 | <20 ppm              | <100 ppm             |
| 30%            | 6.3% ± 0.5                 | <20 ppm              | <100 ppm             |
| 16%            | 6.0% ± 0.5                 | <20 ppm              | <100 ppm             |

30. If the oxygen level at the 16% valve position is too high and the Blower voltage is at the minimum value, you can adjust the idle screw (TAC valve) which is recessed in the top of the Air/Fuel Valve (see Figure 4-4). Rotate the screw 1/2 turn clockwise (CW) to add fuel and reduce the O<sub>2</sub> to the specified level. Recalibration **MUST** be performed again from 60% down to 16% after making a change to the idle screw (TAC valve).

**This completes the BMK 1500 Natural Gas combustion calibration procedures.**



**Figure 4-3: Gas Pressure Adjustment Screw Location**



**Figure 4-4: TAC Valve Adjust (Idle Screw)**

### 4.3.2 BMK 2000 Natural Gas Combustion Calibration

Complete the following instructions for natural gas combustion calibration of BMK 2000 units.

#### BMK 2000 Natural Gas Combustion Calibration

1. Open the water supply and return valves to the unit and ensure that the system pumps are running.
2. Open the natural gas supply valve to the unit.
3. Set the control panel ON/OFF switch to the **OFF** position
4. Turn on external AC power to the unit. The display will show loss of power and the time and date.
5. Set the unit to the MANUAL mode by pressing the **AUTO/MAN** key. A flashing manual valve position message will be displayed with the present position in %. Also, the **MANUAL** LED will light.
6. Adjust the air/fuel valve position to 0% by pressing the ▼ arrow key.
7. Ensure that the leak detection ball valve downstream of the SSOV is open.
8. Set the ON/OFF switch to the **ON** position.
9. Change the valve position to **30%** using the ▲ arrow key. The unit should begin its start sequence and fire.
10. Next, verify that the gas pressure downstream of the SSOV is set to **3.4 ± 0.2” W.C. (850 ± 50 Pa)**. If gas pressure adjustment is required, remove the brass hex nut on the SSOV actuator to access the gas pressure adjustment screw (Figure 4-3). Make gas pressure adjustments using a flat-tip screwdriver to obtain a gas pressure within the range of **3.4” W.C. ± 0.2” W.C. (850 ± 50 Pa)**.
11. Using the ▲ arrow key, increase the valve open position to 100%. Verify that the gas pressure on the downstream side of the SSOV settles within the range of **3.4 ± 0.2” W.C. (850 ± 50 Pa)**. Readjust the gas pressure if necessary.
12. With the valve position at 100%, insert the combustion analyzer probe into the flue probe opening and allow enough time for the combustion analyzer reading to stabilize.
13. Compare the oxygen readings on the combustion analyzer to the on-board O<sub>2</sub> sensor value displayed in the *Operating* menu of the C-More Control Panel. If the values differ by more than ±1.5% and your combustion analyzer is correctly calibrated, the on-board O<sub>2</sub> sensor may be defective and need to be replaced.
14. Compare the measured oxygen level to the oxygen range shown below. Also, ensure that the nitrogen oxide (NO<sub>x</sub>) and carbon monoxide (CO) readings do not exceed the values shown. If you are not in a “NO<sub>x</sub>-limited” area and/or do not have a NO<sub>x</sub> measurement in your analyzer, set the oxygen (O<sub>2</sub>) at **5.5% ± 0.5%**.

**Table 4-5: Combustion Calibration Readings – 100% Valve Position**

| Valve Position | Oxygen (O <sub>2</sub> ) % | Nitrogen Oxide (NO <sub>x</sub> ) | Carbon Monoxide (CO) |
|----------------|----------------------------|-----------------------------------|----------------------|
| 100%           | 5.0% - 6.0%                | ≤20 ppm                           | <100 ppm             |

### **BMK 2000 Natural Gas Combustion Calibration – Continued**

15. If the oxygen level is not within the required tolerance, the gas pressure on the downstream side of the SSOV must be adjusted using the gas pressure adjustment screw on the SSOV (Figure 4-3). Slowly rotate the gas pressure adjustment (approximately 1/4-turn increments). Allow the combustion analyzer to stabilize following each adjustment. Clockwise rotation reduces the oxygen level, while counterclockwise rotation increases the oxygen level.
16. Once the oxygen level is within the specified range at 100%, record the O<sub>2</sub>, NO<sub>x</sub> and CO readings on the Combustion Calibration Data Sheets provided with the unit.
17. Lower the valve position to **70%** using the ▼ arrow key.

#### **NOTE**

The remaining combustion calibration steps are performed using the *Combustion Cal* menu included in the C-More Control System. The combustion calibration control functions will be used to adjust the oxygen level (%) at valve positions of 70%, 50%, 40%, 30% and 18% as described in the following steps. These steps assume that the **inlet air temperature is within the range of 50°F to 100°F (10°C – 37.8°C)**. If NO<sub>x</sub> readings exceed the target values shown, increase the O<sub>2</sub> level up to 1% higher than the listed calibration range. Record the increased O<sub>2</sub> value on the Combustion Calibration sheet.

18. Press the **MENU** key on the front panel of the C-MORE and access the *Setup* menu. Enter password **6817** and then press the **ENTER** key.
19. Press the **MENU** key on the front panel of the C-MORE until **Combustion Cal Menu** appears on the display.
20. Press the Up ▲ arrow key until the **SET Stdby V Out** (*Standby Voltage*) setting appears. Verify that it is set to **2.0 V** (the default). AERCO recommends it be kept at 2.0 volts to prevent flue gas recirculation.
21. Press the ▲ arrow key until **SET Valve Position** appears on the display.
22. Press the **CHANGE** key. **SET Valve Position** will begin to flash.
23. Press the ▲ arrow key until the **SET Valve Position** reads **70%**. Press the **ENTER** key.
24. Next, press the down (▼) arrow key until **CAL Voltage 70%** is displayed.
25. Press the **CHANGE** key and observe that **CAL Voltage 70%** is flashing.
26. The oxygen level at the 70% valve position should be as shown below. Also, ensure that the nitrogen oxide (NO<sub>x</sub>) and carbon monoxide (CO) readings do not exceed the following values:

**Table 4-6: Combustion Calibration Readings – 70% Valve Position**

| Valve Position | Oxygen (O <sub>2</sub> ) % | Nitrogen Oxide (NO <sub>x</sub> ) | Carbon Monoxide (CO) |
|----------------|----------------------------|-----------------------------------|----------------------|
| 70%            | 5.9% ± 0.5%                | ≤20 ppm                           | <100 ppm             |



### **BMK 2000 Natural Gas Combustion Calibration – Continued**

27. If the oxygen level is not within the specified range, adjust the level using the ▲ and ▼ arrow keys. This will adjust the output voltage to the blower motor as indicated on the display. Pressing the ▲ arrow key increases the oxygen level and pressing the down ▼ arrow key decreases the oxygen level.
28. Once the oxygen level is within the specified range at 70%, press the **ENTER** key to store the selected blower output voltage for the 70% valve position. Record all readings on the Combustion Calibration Sheets provided.
29. Repeat steps 20 through 27 for valve positions of 50%, 40%, 30% and 18%. The oxygen (O<sub>2</sub>), nitrogen oxide (NO<sub>x</sub>) and carbon monoxide (CO) should remain within the same limits for all valve positions as shown in the following table.

#### **NOTE**

If NO<sub>x</sub> readings exceed the target values shown (<20 ppm), increase the O<sub>2</sub> level up to 1% higher than the listed calibration range shown in the table. Record the increased O<sub>2</sub> value on the Combustion Calibration sheet.

**Table 4-7: Combustion Calibration Readings**

| Valve Position | Oxygen (O <sub>2</sub> ) % | Nitrogen Oxide (NO <sub>x</sub> ) | Carbon Monoxide (CO) |
|----------------|----------------------------|-----------------------------------|----------------------|
| 50%            | 6.0% ± 0.5                 | <20 ppm                           | <100 ppm             |
| 40%            | 6.3% ± 0.5                 | <20 ppm                           | <100 ppm             |
| 30%            | 6.3% ± 0.5                 | <20 ppm                           | <100 ppm             |
| 18%            | 6.0% ± 0.5                 | <20 ppm                           | <100 ppm             |

30. If the oxygen level at the 18% valve position is too high and the Blower voltage is at the minimum value, you can adjust the idle screw (TAC valve) which is recessed in the top of the Air/Fuel Valve (see Figure 4-4). Rotate the screw 1/2 turn clockwise (CW) to add fuel and reduce the O<sub>2</sub> to the specified level. Recalibration **MUST** be performed again from 50% down to 18% after making a change to the idle screw (TAC valve).

**This completes the BMK 2000 Natural Gas combustion calibration procedures.**

#### **4.4 REASSEMBLY**

Once the combustion calibration adjustments are properly set, the unit can be reassembled for service operation.

#### **Reassembly**

1. Set the ON/OFF switch in the **OFF** position.
2. Disconnect AC power from the unit.
3. Shut off the gas supply to the unit.
4. Remove the manometer and barbed fittings and reinstall the NPT plug using a suitable pipe thread compound.
5. Remove the combustion analyzer probe from the 1/4" vent hole in the exhaust manifold. Replace the 1/4" NPT plug in the manifold.
6. Replace all previously removed sheet metal enclosures on the unit.

**This concludes reassembly of the unit after combustion calibration.**

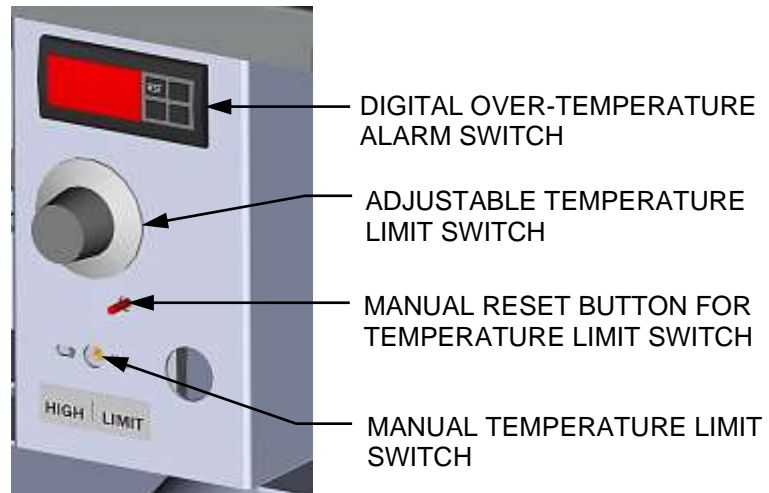
### 4.5 OVER-TEMPERATURE LIMIT SWITCHES

The unit contains three (3) types of over-temperature limit controls. These controls consist of a Manual Reset button, a rotary adjustable Temperature Limit switch and a digital Over-Temperature Alarm button. These controls are mounted on a plate as shown in Figure 4-5. They can be accessed by opening the front panel door of the unit.

The Manual Reset button is not adjustable and is permanently fixed at 210°F (98.9°C). This button will shut down and lock out the Heating Boiler if the water temperature **exceeds 210°F (98.9°C)**. Following an over-temperature condition, it must be manually reset by pressing the **Manual Reset** button shown in Figure 4-5 before the Heating Boiler can be restarted.

The adjustable Temperature Limit switch is manually adjustable from 32°F - 212°F (0°C – 100°C). This switch allows the Heating Boiler to restart, once the temperature drops below the selected temperature setting on the dial. Set the dial on this switch to the desired setting.

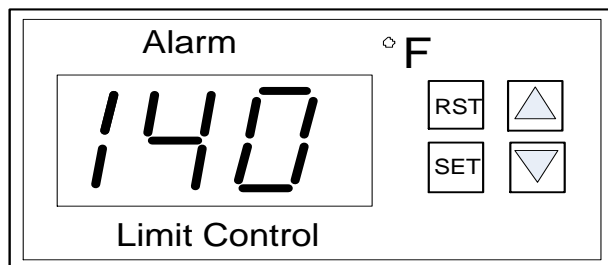
The digital Over-Temperature Alarm switch shown in Figures 4-5 and 4-6 is preset at the factory to 210°F (98.9°C) and should not be changed. If an over-temperature condition is detected, this switch automatically shuts down the Heating Boiler and sounds an audible alarm. If desired, the Over-Temperature Alarm can be checked or adjusted using the procedure in section 4.5.1.



**Figure 4-5: Over-Temperature Limit Switch Locations**

#### 4.5.1 Digital Alarm Switch Checks and Adjustments

The Over-Temperature Alarm switch settings can be checked or adjusted using the controls and display on the front panel of the switch illustrated and described in Figure 4-6 and Table 4-8.



**Figure 4-6: Digital Over-Temperature Alarm Switch Front Panel**

**Table 4-8: Over-Temperature Alarm Switch Controls and Display**

| CONTROL OR DISPLAY | MEANING      | FUNCTION   |
|--------------------|--------------|--|
| LED Display        | TEMP status  | Displays current water temperature or setpoint.  |
| RST                | RESET Button | Resets the unit after an alarm condition.        |
| ▲                  | UP Button    | Increases the displayed temperature.             |
| ▼                  | DOWN Button  | Decreases the displayed temperature.             |
| SET                | SET Button   | Used to access and store parameters in the unit. |

Perform the following steps to check or adjust the **Over-Temperature Alarm** switch settings:

### Switch Check or Adjustment

1. Set the ON/OFF switch to the **ON** position.
2. Press the **SET** button on the **Over-Temperature Alarm** switch. **SP** will appear in the display.
3. Press the **SET** button again. The current over-temperature limit value stored in memory will be displayed. (Default = 210°F, 98.9°C).
4. If the display does not show the required over-temperature alarm setting, press the ▲ or ▼ arrow button to change the display to the desired temperature setting.
5. Once the desired over-temperature alarm setting (210°F) is displayed, press the **SET** button to store the setting in memory.
6. To calibrate the offset (P1), press and hold the **SET** button for 8 seconds on the Over-Temperature Alarm switch. Access code value **0** should appear in the display. The switch comes from the factory with the code set at 0. AERCO recommends that you do not change this code.
7. Press the **SET** button again to enter the code. The first parameter label, **SP**, will appear in the display.
8. Using the ▲ and ▼ arrow keys, select parameter P1.
9. Press **SET** to view the value stored in memory.
10. If the desired value is not displayed, modify the setting using the ▲ and ▼ arrow keys. The value can be changed from -10° to +10° (-5.5°C to + 5.5°C) offset. Press **SET** to enter the value and exit to the text parameter.
11. To exit the programming mode, press the **SET** and ▼ buttons simultaneously or simply wait one minute and the display will automatically exit the programming mode.
12. Once the programming mode has been exited, the display will show the current outlet water temperature of the Heating Boiler.



### CHAPTER 5. MODE OF OPERATION

#### 5.1 INTRODUCTION

The Heating Boiler is capable of being operated in any one of six different modes. The following sections in this Chapter provide descriptions of each of these operating modes. Each Heating Boiler is shipped from the factory tested and configured for the ordered mode of operation. All temperature related parameters are at their factory default values which work well in most applications. However, it may be necessary to change certain parameters to customize the unit to the system environment. A complete listing and descriptions of the temperature related parameters are included in Appendix A. Factory defaults are listed in Chapter 3. After reading this chapter, parameters can be customized to suit the needs of the specific application.

#### 5.2 INDOOR/OUTDOOR RESET MODE

This mode of operation is based on outside air temperatures. As the outside air temperature decreases, the supply header temperature will increase and vice versa. For this mode, it is necessary to install an outside air sensor as well as select a building reference temperature and a reset ratio.

##### 5.2.1 Reset Ratio

Reset ratio is an adjustable number from 0.1 to 9.9. Once adjusted, the supply header temperature will increase by that number for each degree that the outside air temperature decreases. For instance, if a reset ratio of 1.6 is used, for each degree that outside air temperature decreases the supply header temperature will increase by 1.6 degrees.

##### 5.2.2 Building Reference Temperature

This is a temperature from 40°F to 230°F (4.4°C to 110°C). Once selected, it is the temperature that the system references to begin increasing its temperature. For instance, if a reset ratio of 1.6 is used, and we select a building reference temperature of 70°F (21.1°C), then at an outside temperature of 69°F (20.6°C), the supply header temperature will increase by 1.6° to 71.6°F (0.9°C to 22°C).

##### 5.2.3 Outdoor Air Temperature Sensor Installation

The outdoor air temperature sensor must be mounted on the North side of the building in an area where the average outside air temperature is expected. The sensor must be shielded from the sun's direct rays, as well as shielded from rain and snow. If a cover or shield is used, it must allow free air circulation. The sensor may be mounted **up to 200 feet (61m)** from the unit. Sensor connections are made at the Input/Output (I/O) Box on the front of the Heating Boiler. Connections are made at the terminals labeled *OUTDOOR AIR IN* and *AIR SENSOR COM* inside the I/O Box. Use shielded 18 to 22 AWG wire for connections. A wiring diagram is provided on the cover of the I/O Box. Refer to Chapter 2, section 2.8.1 for additional wiring information.

### 5.2.4 Indoor/Outdoor Startup

Startup in the INDOOR/OUTDOOR RESET mode is accomplished as follows:

#### NOTE

A design engineer typically provides design outdoor air temperature and supply header temperature data

#### **Indoor/Outdoor Startup**

1. Refer to the Indoor/Outdoor reset ratio charts in Appendix E.
2. Choose the chart corresponding to the desired Building Reference Temperature.
3. Go down the left column of the chart to the coldest design outdoor air temperature expected in your area.
4. Once the design outdoor air temperature is chosen, go across the chart to the desired supply header temperature for the design temperature chosen in step 3.
5. Next, go up that column to the RESET RATIO row to find the corresponding reset ratio.
6. Access the *Configuration* menu and scroll through it until the display shows **BLDG REF TEMP** (Building Reference Temperature). If necessary, refer to section 3.3 for detailed instructions on menu changing.
7. Press the **CHANGE** key. The display will begin to flash.
8. Use the ▲ and ▼ arrow keys to select the desired Building Reference Temperature.
9. Press **ENTER** to save any changes.
10. Next, scroll through the *Configuration* menu until the display shows **RESET RATIO**.
11. Press the **CHANGE** key. The display will begin to flash.
12. Use the ▲ and ▼ arrow keys to select the Reset Ratio determined in step 5.
13. Press **ENTER** to save the change.

### 5.3 CONSTANT SETPOINT MODE

The CONSTANT SETPOINT mode is used when a fixed header temperature is desired. Common uses of this mode of operation include water source heat pump loops, and indirect heat exchangers for potable hot water systems or processes.

No external sensors are required to operate in this mode. While it is necessary to set the desired setpoint temperature, it is not necessary to change any other temperature-related functions. The unit is factory preset with settings that work well in most applications. Prior to changing any temperature-related parameters, other than the setpoint, it is suggested that an AERCO representative be contacted. For descriptions of temperature-related functions, see Appendix A; their factory defaults are included in Chapter 3, sections 3.4 – 3.8.

### 5.3.1 Setting the Setpoint

The setpoint temperature of the unit is adjustable from 40°F to 240°F (4.4°C to 115.6°C). To set the unit for operation in the CONSTANT SETPOINT mode, the following menu settings must be made in the *Configuration* menu:

**Table 5-1: Constant Setpoint Mode Settings**

| Menu Option    | Setting  |
|----------------|--|
| Boiler Mode    | Constant Setpoint  |
| Internal Setpt | Select desired setpoint using ▲ and ▼ arrow keys (40°F to 240°F, 4.4°C to 115.6°C) |

Refer to section 3.3 for detailed instructions on changing menu options.

### 5.4 REMOTE SETPOINT MODES

The unit's setpoint can be remotely controlled by an Energy Management System (EMS) or Building Automation System (BAS). The Remote Setpoint can be driven by a current or voltage signal within the following ranges:

- 4-20 mA/1-5 VDC
- 0-20 mA/0-5 VDC

The factory default setting for the REMOTE SETPOINT mode is 4 - 20 mA/1 - 5 VDC. With this setting, a 4 to 20 mA/1 to 5 VDC signal, sent by an EMS or BAS, is used to change the unit's setpoint. The 4 mA/1V signal is equal to a 40°F (4.4°C) setpoint while a 20 mA /5V signal is equal to a 240°F (115.6°C) setpoint. When a 0 to 20 mA/0 to 5 VDC signal is used, 0 mA is equal to a 40°F (4.4°C) setpoint.

In addition to the current and voltage signals described above, the REMOTE SETPOINT mode can also driven by a RS-485 Modbus Network signal from an EMS or BAS.

The REMOTE SETPOINT modes of operation can be used to drive single as well as multiple units.

#### NOTE

If a voltage, rather than current signal is used to control the remote setpoint, a DIP switch adjustment must be made on the PMC Board located in the Control Panel Assembly. Contact your local AERCO representative for details.

In order to enable the REMOTE SETPOINT mode, the following menu setting must be made in the *Configuration* menu:

**Table 5-2: Remote Setpoint Mode Settings**

| Menu Option   | Setting                              |
|---------------|--------------------------------------|
| Boiler Mode   | Remote Setpoint                      |
| Remote Signal | 4-20mA/1-5V, 0-20mA/0-5V, or Network |

Refer to section 3.3 for detailed instructions on changing menu options.

If the Network setting is selected for RS-485 Modbus operation, a valid Comm Address must be entered in the *Setup* menu.

While it is possible to change the settings of temperature related functions, the unit is factory preset with settings that work well in most applications. It is suggested that an AERCO representative be contacted, prior to changing any temperature related function settings. For descriptions of temperature-related functions, see Appendix A; their factory defaults are included in Chapter 3, sections 3.4 – 3.8.

### 5.4.1 Remote Setpoint Field Wiring

The only wiring connections necessary for the REMOTE SETPOINT mode are connection of the remote signal leads from the source to the unit's I/O Box. The I/O Box is located on the front panel of the Heating Boiler. For either a 4-20mA/0-5V or a 0-20mA/0-5V setting, the connections are made at the ANALOG IN terminals in the I/O Box. For a Network setting, the connections are made at the RS-485 COMM terminals in the I/O Box. The signal must be floating, (ungrounded) at the I/O Box and the wire used must be a two wire shielded pair from 18 to 22 AWG. Polarity must be observed. The source end of the shield must be connected at the source. When driving multiple units, each unit's wiring must conform to the above.

### 5.4.2 Remote Setpoint Startup

Since this mode of operation is factory preset and the setpoint is being externally controlled, no startup instructions are necessary. In this mode, the REMOTE LED will light when the external signal is present.

To operate the unit in the MANUAL mode, press the **AUTO/MAN** switch. The REMOTE LED will go off and the MANUAL LED will light.

To change back to the REMOTE SETPOINT mode, simply press the **AUTO/MAN** switch. The REMOTE LED will again light and the MANUAL LED will go off.

## 5.5 DIRECT DRIVE MODES

The unit's air/fuel valve position (% open) can be changed by a remote signal which is typically sent from an Energy Management System (EMS) or from a Building Automation System (BAS). The Direct Drive mode can be driven by a current or voltage signal within the following ranges:

- 4-20 mA/1-5 VDC
- 0-20 mA/0-5 VDC

The factory default setting for the DIRECT DRIVE mode is 4-20 mA/1-5 VDC. With this setting, a 4 to 20 mA signal, sent by an EMS or BAS is used to change the unit's valve position from 0% to 100%. A 4 mA/1V signal is equal to a 0% valve position, while a 20 mA /5V signal is equal to a 100% valve position. When a 0-20 mA/0-5 VDC signal is used, zero is equal to a 0% valve position.

In addition to the current and voltage signals described above, the DIRECT DRIVE mode can also driven by a RS-485 Modbus Network signal from an EMS or BAS.

When in a DIRECT DRIVE mode, the unit is a slave to the EMS or BAS and does not have a role in temperature control. DIRECT DRIVE can be used to drive single, or multiple units.

### NOTE

If a voltage, rather than current signal is used to control the remote setpoint, a DIP switch adjustment must be made on the CPU Board located in the Control Box Assembly. Contact your local AERCO representative for details.

To enable the DIRECT DRIVE mode, the following menu setting must be made in the *Configuration* menu:

**Table 5-3: Direct Drive Mode Settings**

| Menu Option   | Setting                              |
|---------------|--------------------------------------|
| Boiler Mode   | Direct Drive                         |
| Remote Signal | 4-20mA/1-5V, 0-20mA/0-5V, or Network |

Refer to section 3.3 for instructions on changing menu options.

If the Network setting is selected for RS-485 Modbus operation, a valid Comm Address must be entered in the *Setup* menu.

### 5.5.1 Direct Drive Field Wiring

The only wiring connections necessary for DIRECT DRIVE mode are connection of the remote signal leads from the source to the unit's I/O Box. For either a 4-20mA/0-5V or a 0-20mA/0-5V setting, the connections are made at the ANALOG IN terminals in the I/O Box. For a Network setting, the connections are made at the RS-485 COMM terminals in the I/O Box. The signal must be floating, (ungrounded) at the I/O Box and the wire used must be a two wire shielded pair from 18 to 22 AWG. Polarity must be observed. The source end of the shield must be connected at the source. When driving multiple units, each unit's wiring must conform to the above.

### 5.5.2 Direct Drive Startup

Since this mode of operation is factory preset and the valve position is being externally controlled, no startup instructions are necessary. In this mode, the REMOTE LED will light when the signal is present.

To operate the unit in MANUAL mode, press the **AUTO/MAN** switch. The REMOTE LED will go off and the MANUAL LED will light.

To change back to the Direct Drive mode, simply press the **AUTO/MAN** switch. The REMOTE LED will again light and the MANUAL LED will go off.

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### CHAPTER 6. SAFETY DEVICE TESTING

#### 6.1 TESTING OF SAFETY DEVICES

Periodic safety device testing is required to ensure that the control system and safety devices are operating properly. The Heating Boiler control system comprehensively monitors all combustion-related safety devices before, during and after the start sequence. The following tests check to ensure that the system is operating as designed.

Operating controls and safety devices should be tested on a regular basis or following service or replacement. All testing must conform to local codes such as ASME CSD-1.

#### NOTES

MANUAL and AUTO modes of operation are required to perform the following tests. For a complete explanation of these modes, see Chapter 3.

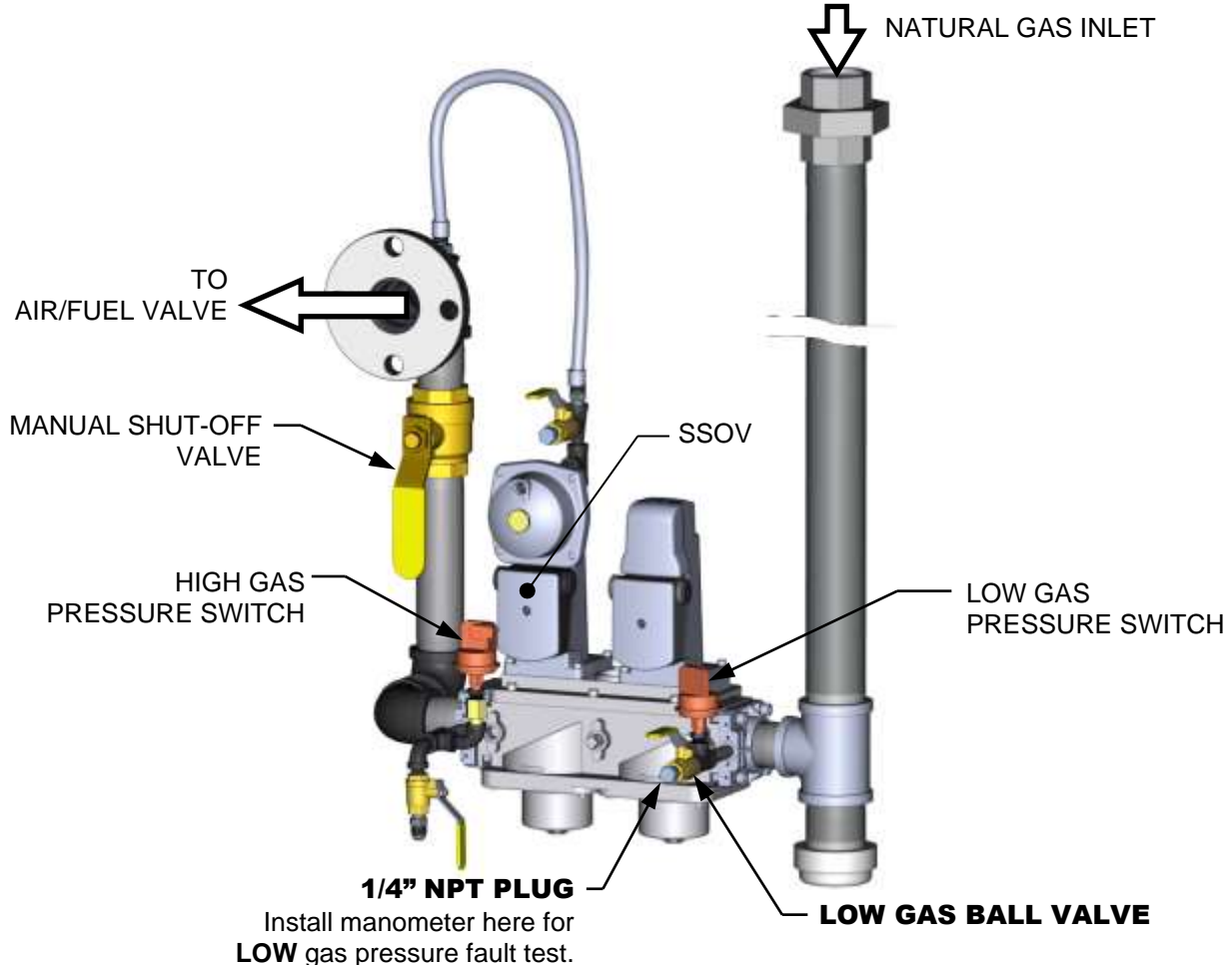
Also, it will be necessary to remove the front door and side panels from the unit to perform the following tests.

#### **--WARNING! --**

Electrical voltages in this system may include 220, 120 and 24 volts AC. Power must be removed prior to performing wire removal or other test procedures that can result in electrical shock.

### 6.2 LOW GAS PRESSURE TEST

To simulate a **low gas pressure fault**, refer to Figure 6-1a and perform the following steps:



**Figure 6-1a: BMK 1500/2000: Low Gas Pressure Test**

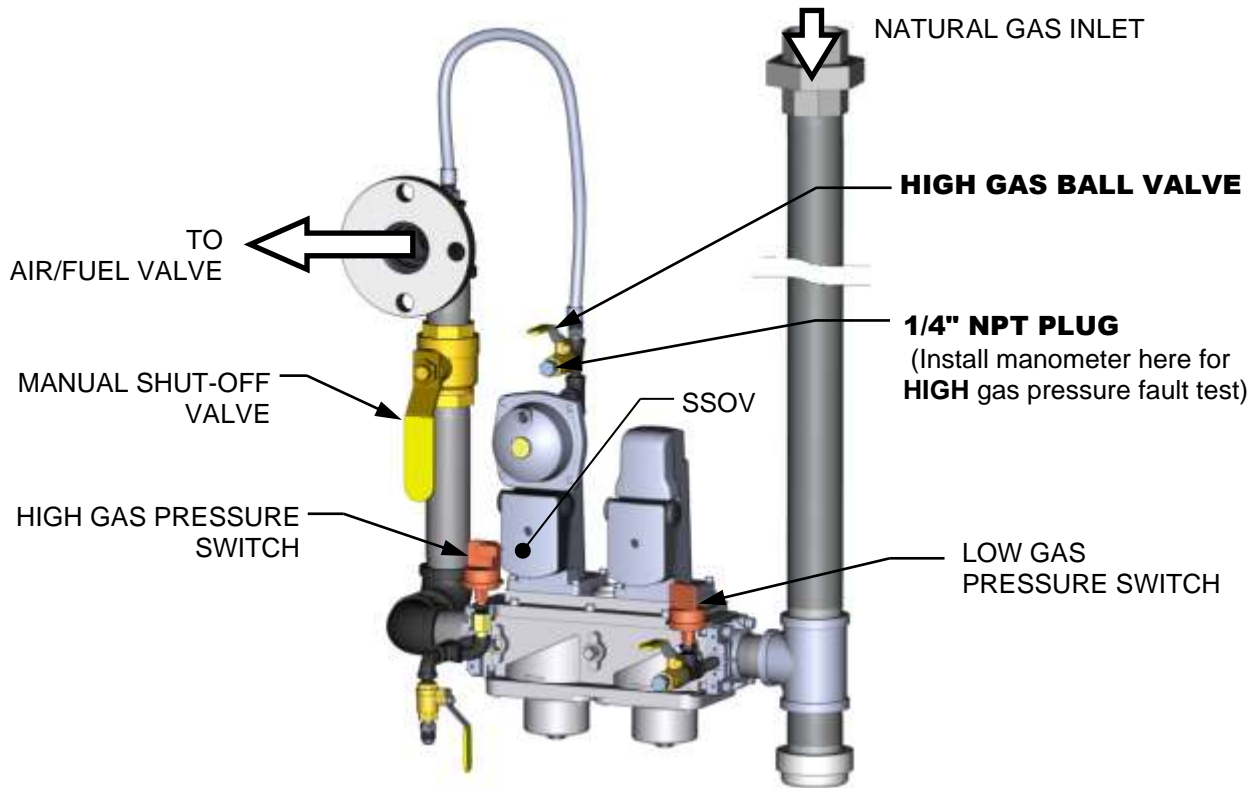
#### **Low Gas Pressure Fault Test**

1. Close the leak detection ball valve located at the Low Gas Pressure switch.
2. Remove the 1/4" NPT plug from the ball valve at the Low Gas Pressure switch.
3. Install a **0 - 16" W.C. (0 – 4.0 kPa)** manometer or gauge where the 1/4" plug was removed.
4. Slowly open the ball valve near the Low Gas Pressure switch.
5. Place the unit in MANUAL mode and adjust the Air/Fuel Valve position (% open) **between 25% and 30%**.
6. While the unit is firing, slowly close the external manual gas shut-off valve.
7. The unit should shut down and display a **GAS PRESSURE** fault message at approximately **2.6" W.C. (648 Pa)** for both 1500 & 2000 units.
8. Fully open the external manual gas shut-off valve and press the **CLEAR** button on the Control Box.
9. The fault message should clear and the **FAULT** indicator should go off. The unit should restart.
10. Upon test completion, close the ball valve and remove the manometer. Replace the 1/4" NPT plug removed in step 2.



### 6.3 HIGH GAS PRESSURE TEST

To simulate a **high gas pressure** fault, refer to Figure 6-1b and perform the following steps:



**Figure 6-1b: BMK 1500/2000: High Gas Pressure Fault Test**

#### High Gas Pressure Test

1. Close the leak detection ball valve located at the **High Gas Pressure** switch.
2. Remove the 1/4" NPT plug from the High Gas pressure leak detection ball valve shown in Figure 6-1b.
3. Install a **0 - 16" W.C. (0 - 4.0 kPa)** manometer or gauge where the 1/4" plug was removed.
4. Slowly open the leak detection ball valve.
5. Start the unit in MANUAL mode at a valve position (firing rate) **between 25% and 30%**.
6. With the unit running, monitor the gas pressure on the manometer installed in step 2 and record the gas pressure reading.
7. Slowly increase the gas pressure using the adjustment screw on the SSOV.
8. The **FAULT** indicator should start flashing and the unit should shut down and display a **GAS PRESSURE** fault message at approximately **4.7" W.C. (1170 Pa)**.
9. Reduce the gas pressure back to the value recorded in step 6. This pressure should be within the following ranges:
  - **BMK 1500 = 3.6" ± 0.2" W.C. (897 ± 50 Pa)**
  - **BMK 2000 = 3.4" ± 0.2" W.C. (847 ± 50 Pa)**
10. Press the **CLEAR** button on the Control Box to clear the fault.
11. The fault message should clear and the **FAULT** indicator should go off. The unit should restart.

12. Upon test completion, close the ball valve and remove the manometer. Replace the 1/4" NPT plug removed in step 2.

### 6.4 LOW WATER LEVEL FAULT TEST

To simulate a low water level fault, proceed as follows:

#### **Low Water Level Fault**

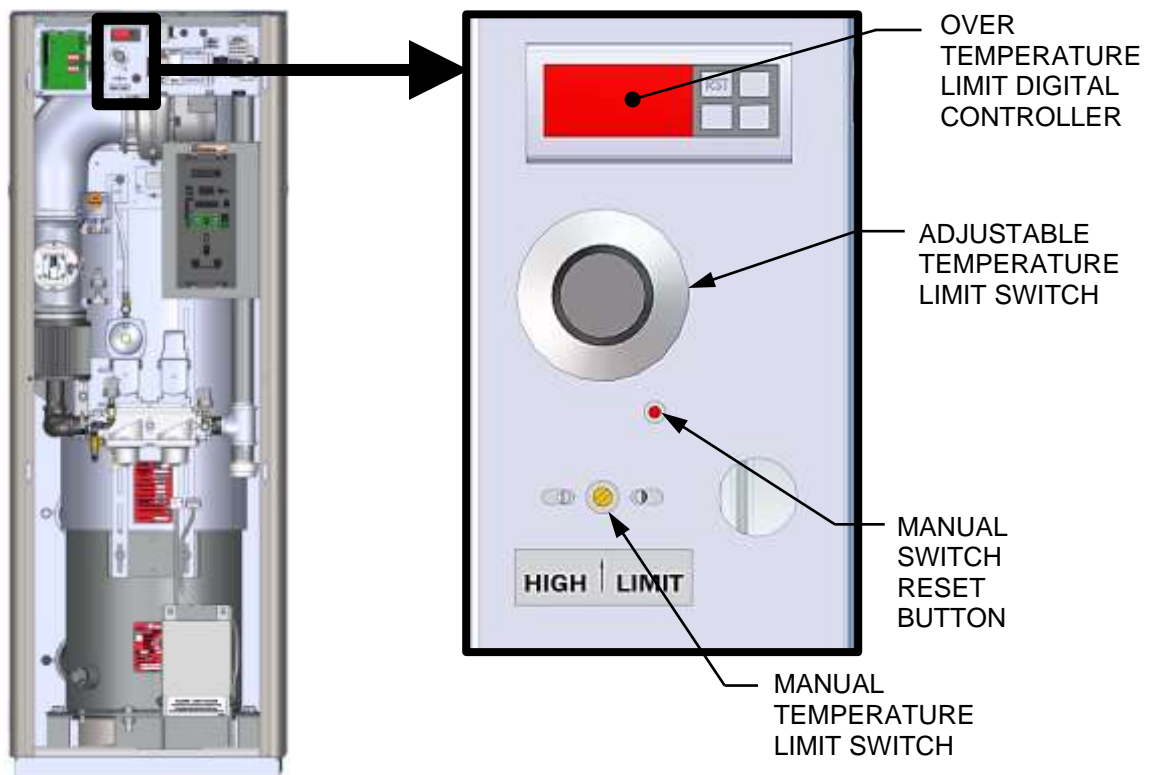
1. Set the ON/OFF switch to the **OFF** position
2. Close the water shut-off valves in the supply and return piping to the unit.
3. Slowly open the drain valve on the rear of the unit. If necessary the unit's relief valve may be opened to aid in draining.
4. Continue draining the unit until a **LOW WATER LEVEL** fault message is displayed and the FAULT indicator flashes.
5. Place the unit in the MANUAL mode and raise the valve position **above 30%**.
6. Set the ON/OFF switch to the **ON** position. The READY light should remain off and the unit should not start. If the unit does start, shut the unit off immediately and refer fault to qualified service personnel.
7. Close the drain used in draining the unit.
8. Open the water shut-off valve in the return piping to the unit.
9. Open the water supply shut-off valve to the unit to refill.
10. After the shell is full, press the **LOW WATER LEVEL RESET** button to reset the low water cutoff.
11. Press the **CLEAR** button to reset the **FAULT** LED and clear the displayed error message.
12. Set the ON/OFF switch to the **ON** position. The unit is now ready for operation.

### 6.5 WATER TEMPERATURE FAULT TEST

A high water temperature fault is simulated by adjusting the automatic **Over-Temperature** switch. This switch is accessible from the front of the unit as shown in Figure 6-2.

#### **Water Temperature Fault Test**

1. Start the unit in the normal operating mode. Allow the unit to stabilize at its setpoint.
2. Lower the adjustable Over-Temperature switch setting to match the displayed **OUTLET TEMPERATURE**.
3. Once the adjustable Over-Temperature switch setting is approximately at, or just below, the actual outlet water temperature, the unit should shut down. The FAULT indicator should start flashing and a **HIGH WATER TEMP SWITCH OPEN** fault message should be displayed. It should not be possible to restart the unit.
4. Reset the adjustable Over-Temperature switch to its original setting.
5. The unit should start once the adjustable Temperature Limit switch setting is above the actual outlet water temperature.



**Figure 6-2: Temperature Limit Switch Location**

### 6.6 INTERLOCK TESTS

The unit is equipped with two interlock circuits called the Remote Interlock and Delayed Interlock. Terminal connections for these circuits are located in the I/O Box (Figure 2-12) and are labeled *REMOTE INTL'K IN* and *DELAYED INTL'K IN*. These circuits can shut down the unit in the event that an interlock is opened. These interlocks are shipped from the factory jumpered (closed). However, each of these interlocks may be utilized in the field as a remote stop and start, an emergency cut-off, or to prove that a device such as a pump, gas booster, or louver is operational.

#### 6.6.1 Remote Interlock Test

##### **Remote Interlock Test**

1. Remove the cover from the I/O Box and locate the REMOTE INTL'K IN terminals.
2. Start the unit in the MANUAL mode and set the valve position **between 25% and 30%**.
3. If there is a jumper across the REMOTE INTL'K IN terminals, remove one side of the jumper. If the interlock is being controlled by an external device, either open the interlock via the external device or disconnect one of the wires leading to the external device.
4. The unit should shut down and display **INTERLOCK OPEN**.
5. Once the interlock connection is reconnected, the **INTERLOCK OPEN** message should automatically clear and the unit should restart.

#### 6.6.2 Delayed Interlock Test

##### **Delayed Interlock Test**

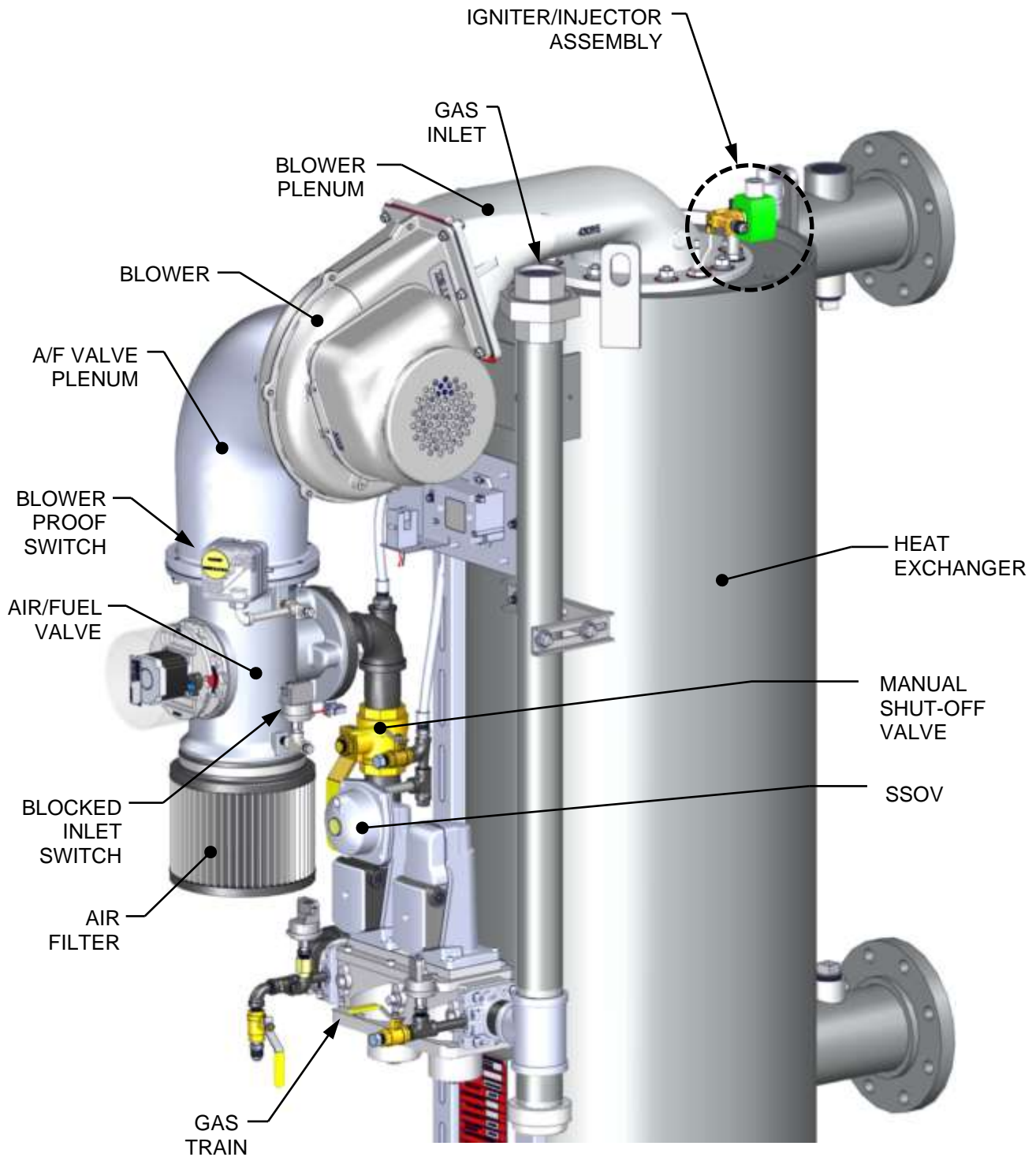
1. Remove the cover from the I/O Box and locate the DELAYED INTL'K IN terminals.
2. Start the unit in the MANUAL mode at a valve position **between 25% and 30%**.
3. If there is a jumper across the DELAYED INTL'K IN terminals, remove one side of the jumper. If the interlock is connected to a proving switch of an external device, disconnect one of the wires leading to the proving switch.
4. The unit should shut down and display a **DELAYED INTERLOCK OPEN** fault message. The FAULT LED should be flashing.
5. Reconnect the wire or jumper removed in step 3 to restore the interlock.
6. Press the **CLEAR** button to reset the fault
7. The unit should start.

### 6.7 FLAME FAULT TESTS

Flame faults can occur during ignition or while the unit is already running. To simulate each of these fault conditions, proceed as follows:

#### **Flame Fault Tests**

1. Set the ON/OFF switch to the **OFF** position.
2. Place the unit in the **MANUAL** mode and set the valve position **between 25% and 30%**.
3. Close the manual gas shutoff valve located between the Safety Shut-Off Valve (SSOV) and the Air/Fuel Valve (see Figure 6-3).
4. Set the ON/OFF switch to the **ON** position to start the unit.
5. The unit should purge and light the Pilot Flame, then it should shut down after reaching the main burner ignition cycle and display **FLAME LOSS DURING IGN.**
6. Open the valve previously closed in step 3 and press the **CLEAR** button.
7. Restart the unit and allow it to prove flame.
8. Once flame is proven, close the manual gas valve located between the SSOV (Figure 6-3) and the Air/Fuel Valve.
9. The unit should shut down and execute an *IGNITION RETRY* cycle by performing the following steps:
  - a) The unit will execute a shutdown purge cycle for a period of 15 seconds and display **WAIT FAULT PURGE.**
  - b) The unit will execute a 30 second re-ignition delay and display **WAIT RETRY PAUSE.**
  - c) The unit will then execute a standard ignition sequence and display **WAIT IGNITION RETRY.**
10. Since the manual gas shutoff valve is still closed, the unit will fail the ignition retry sequence. Therefore, it will shut down and display **FLAME LOSS DURING IGNITION** following the failed *IGNITION RETRY* cycle.
11. Open the valve previously closed in step 8.
12. Press the **CLEAR** button. The unit should restart and fire.



**Figure 6-3: Bare Heating Boiler – Partial View**

### 6.8 AIR FLOW FAULT TESTS

These tests check the operation of the Blower Proof switch and Blocked Inlet switch shown in Figure 6-3.

#### 6.8.1 Blower Proof Switch Test

##### **Blower Proof Switch Test**

1. Disable the blower output drive voltage as follows:
  - (a) Press the **MENU** key until **CONFIGURATION MENU** is displayed.
  - (b) Press the **▲** arrow key until the **ANALOG OUTPUT** function is displayed, then press the **CHANGE** key.
  - (c) Press the **▼** arrow key until **OFF** is displayed, then press the **ENTER** key.
2. Start the unit in the MANUAL mode at a valve position **between 25% and 30%**.
3. The unit should shut down and lockout, showing **AIRFLOW FAULT DURING PURGE** in the display.
4. The unit should perform one IGNITION RETRY cycle and then shut down, since the blower is disabled. The unit will then display **AIRFLOW FAULT DURING PURGE**.
5. Re-enable the blower output drive voltage by performing the following steps:
  - (a) Press the **MENU** key until **CONFIGURATION MENU** is displayed.
  - (b) Press the **▲** arrow key until the **ANALOG OUTPUT** function is displayed, then press the **CHANGE** key.
  - (c) Press the **▲** arrow key until **VALVE POSITION 0-10V** is displayed, then press the **ENTER** key.
  - (d) Press the **CLEAR** button to clear the airflow fault.
6. Once the unit has proved flame, turn off the blower again by going to the *Configuration* menu, *Analog Output* menu item and select **OFF**.
7. The Blower Proof switch will open and the blower should stop. The unit should shut down and display **AIRFLOW FAULT DURING RUN**.
8. Go to the *Configuration* menu, *Analog Output* item and select **VALVE POSITION 0-10v**.

#### 6.8.2 Blocked Inlet Switch Test

This test will be run in simulated fire mode, with the Blocked Inlet switch isolated from the rest of the control circuitry.

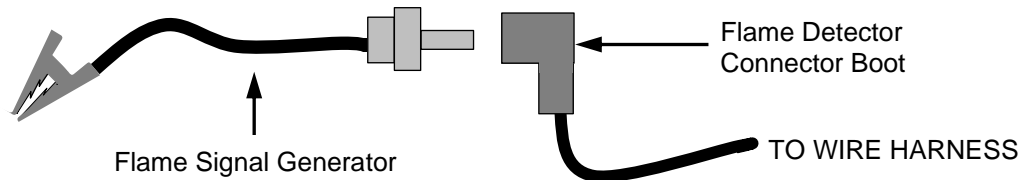
##### **Blocked Inlet Switch Test**

1. Turn the main ON/OFF switch on the front of the Control Panel to the **OFF** position.
2. Remove the air filter (see Figure 6-3, above).



### **Blocked Inlet Switch Test – Continued**

3. Turn off the gas supply ball valve to the Heating Boiler and then complete the following steps:
  - (a) Use jumper wires to jump out the Low Gas Pressure switch and the Blower Proof switch.
  - (b) Remove the black connector boot from the Flame Detector.
  - (c) Connect the Flame Signal Generator to the black connector boot.



**Figure 6-4: Connecting the Flame Signal Generator**

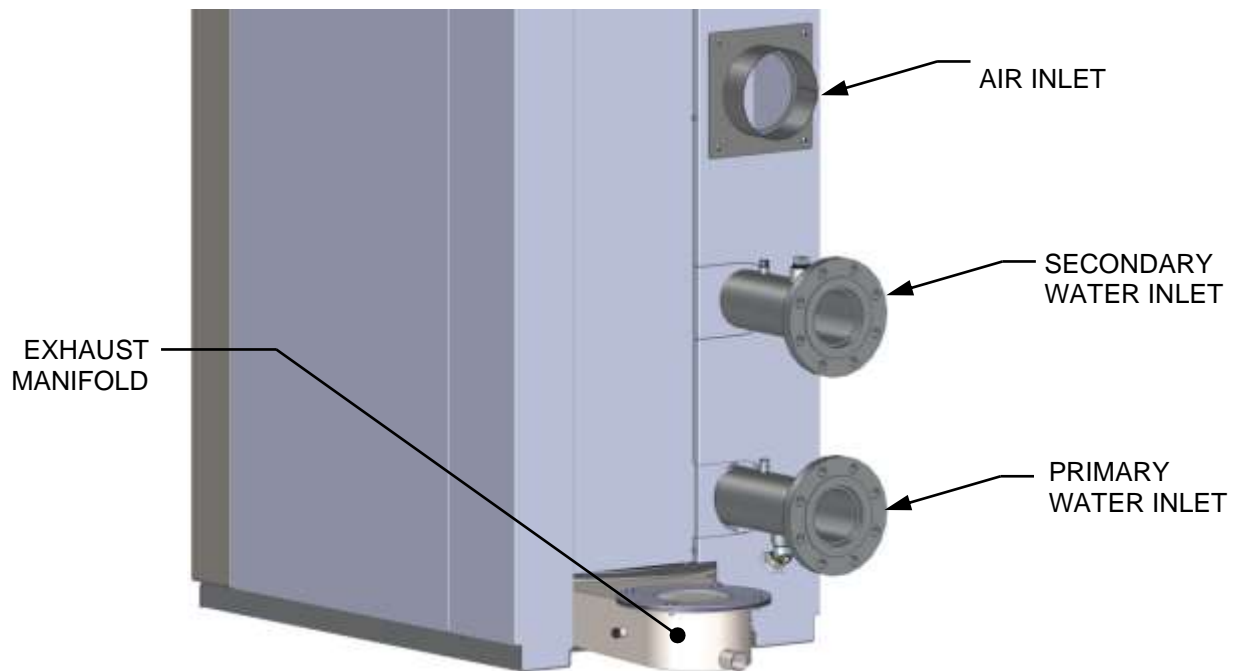
- (d) Keep the alligator clip away from bare metal parts until step 4c.
4. Complete the following with the Heating Boiler operating in MANUAL mode:
  - (a) Ramp the Heating Boiler up to 100% fire rate and then turn the main ON/OFF switch on the front of the Control Panel to the **ON** position.
  - (b) Push the **BACK** button three (3) times to return to the upper level menu.
  - (c) When the Controller gets into the ignition phase, the Control Panel will show **IGNITION TRIAL**. At that point attach the alligator clip (see Figure 6-4) to any bare metal surface or ground. The C-More display should now show **FLAME PROVEN** and begin to ramp up to 100% fire rate. Note that no gas or flame is present in the Heating Boiler at this time.
5. Wait for the Heating Boiler to ramp up to at least 90% before continuing.
6. Cover the opening to the Air/Fuel valve, where the air filter was removed (see Figure 6-3) with a solid, flat object, such as a piece of thick plywood or a thick metal plate.

#### **--WARNING! --**

The blower suction is very strong and can pull nearby objects into the blower's fan blades. **Do NOT allow anything to be pulled into the blower!** Do not wear anything that could get caught and pull you into the blower.

7. The unit should shut down and display **AIRFLOW FAULT DURING RUN**. This step confirms proper operation of the **Blocked Inlet** switch.
8. Remove the cover from the air inlet opening and reinstall the air filter.
9. Remove the jumper wires installed in step 3 and replace the black connector boot on the Flame Detector.
10. Press the **CLEAR** button. The unit should restart.





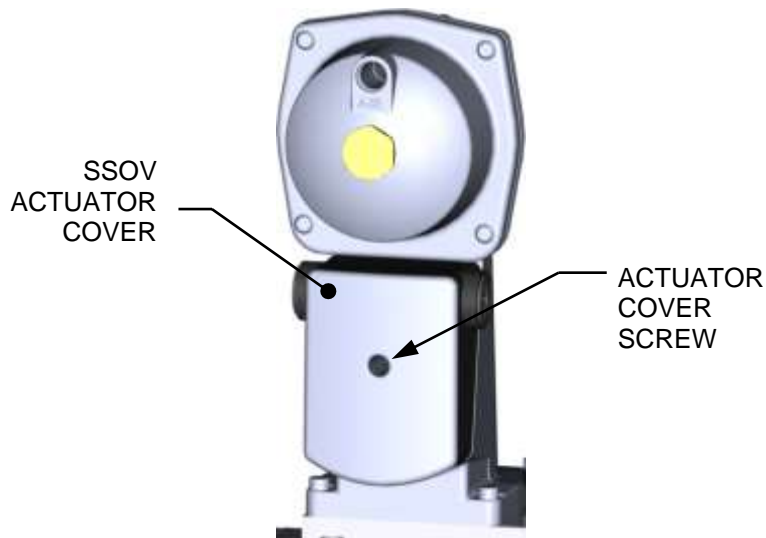
**Figure 6-5: Heating Boiler Rear View Showing Air Inlet Location**

### 6.9 SSOV PROOF OF CLOSURE SWITCH

The SSOV shown in Figure 6-1 contains the **Proof Of Closure** switch. The **Proof Of Closure** switch circuit is checked as follows:

#### **SSOV Proof of Closure Switch**

1. Set the unit's ON/OFF switch to the **OFF** position.
2. Place the unit in **MANUAL** mode and set the valve position **between 25% and 30%**.
3. Refer to Figure 6-1 and locate the SSOV.
4. Remove the cover from the SSOV by loosening the screw shown in Figure 6-6. Lift off the cover to access the terminal wiring connections.
5. Disconnect wire #148 from the SSOV to "open" the **Proof Of Closure** switch circuit.
6. The unit should fault and display **SSOV SWITCH OPEN**.
7. Replace wire #148 and press the **CLEAR** button.
8. Set the ON/OFF switch to the **ON** position to start the unit.
9. Remove the wire again when the unit reaches the purge cycle and **PURGING** is displayed.
10. The unit should shut down and display **SSOV FAULT DURING PURGE**.
11. Replace the wire on the SSOV and press the **CLEAR** button. The unit should restart.



**Figure 6-6: SSOV Actuator Cover Location**

### 6.10 PURGE SWITCH OPEN DURING PURGE

The **Purge** switch (and **Ignition** switch) is located on the Air/Fuel Valve. To check the switch, proceed as follows:

#### **Purge Switch Open During Purge**

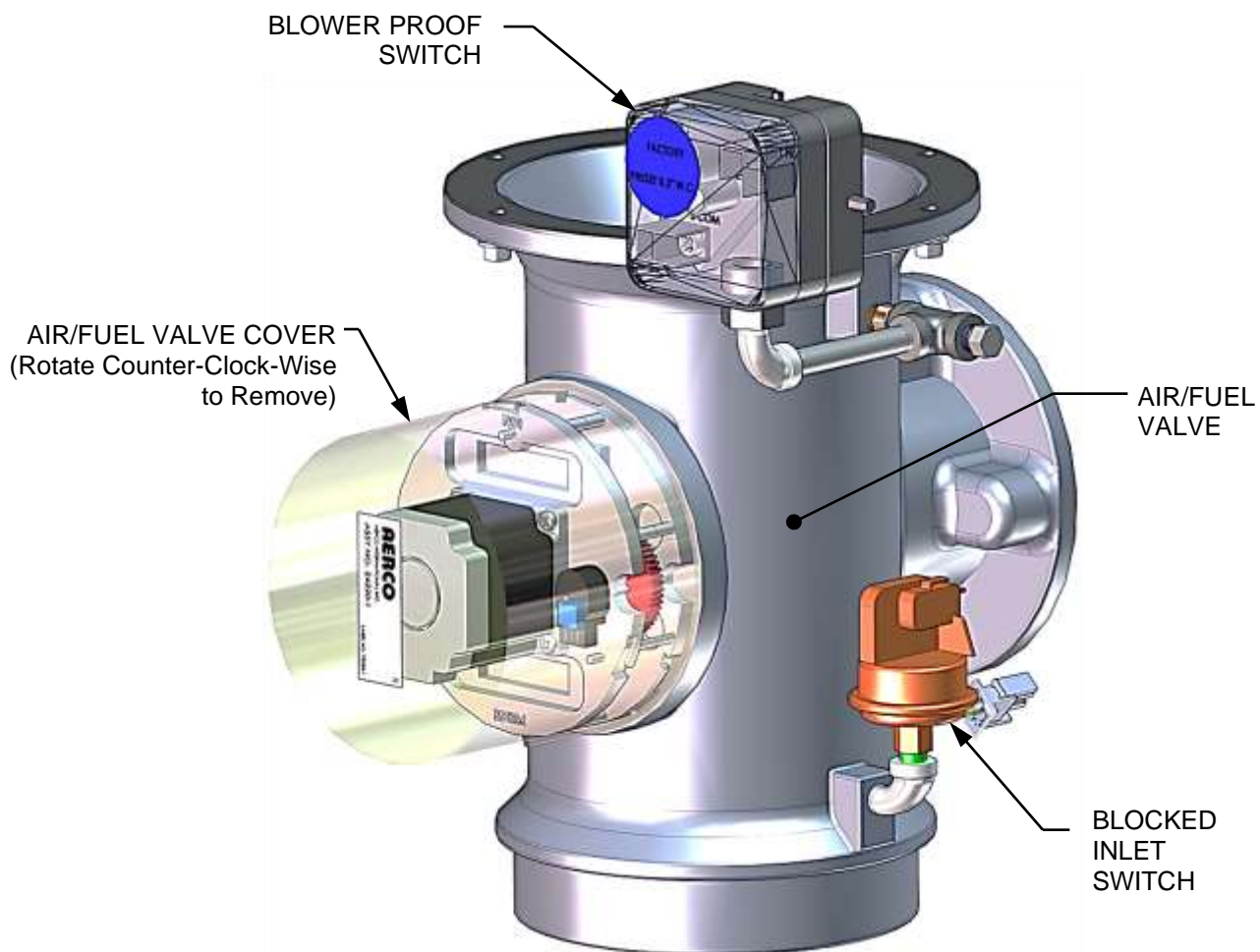
1. Set the unit's ON/OFF switch to the **OFF** position.
2. Place the unit in MANUAL mode and set the valve position **between 25% and 30%**.
3. Remove the Air/Fuel Valve cover by rotating the cover counterclockwise to unlock it (see Figure 6-7).
4. Remove one of the two wires (#171 or #172) from the Purge switch (Figure 6-8).
5. Initiate a unit start sequence.
6. The unit should begin its start sequence, then shut down and display **PRG SWITCH OPEN DURING PURGE**.
7. Replace the wire on the **Purge** switch and depress the **CLEAR** button. The unit should restart.

### 6.11 IGNITION SWITCH OPEN DURING IGNITION

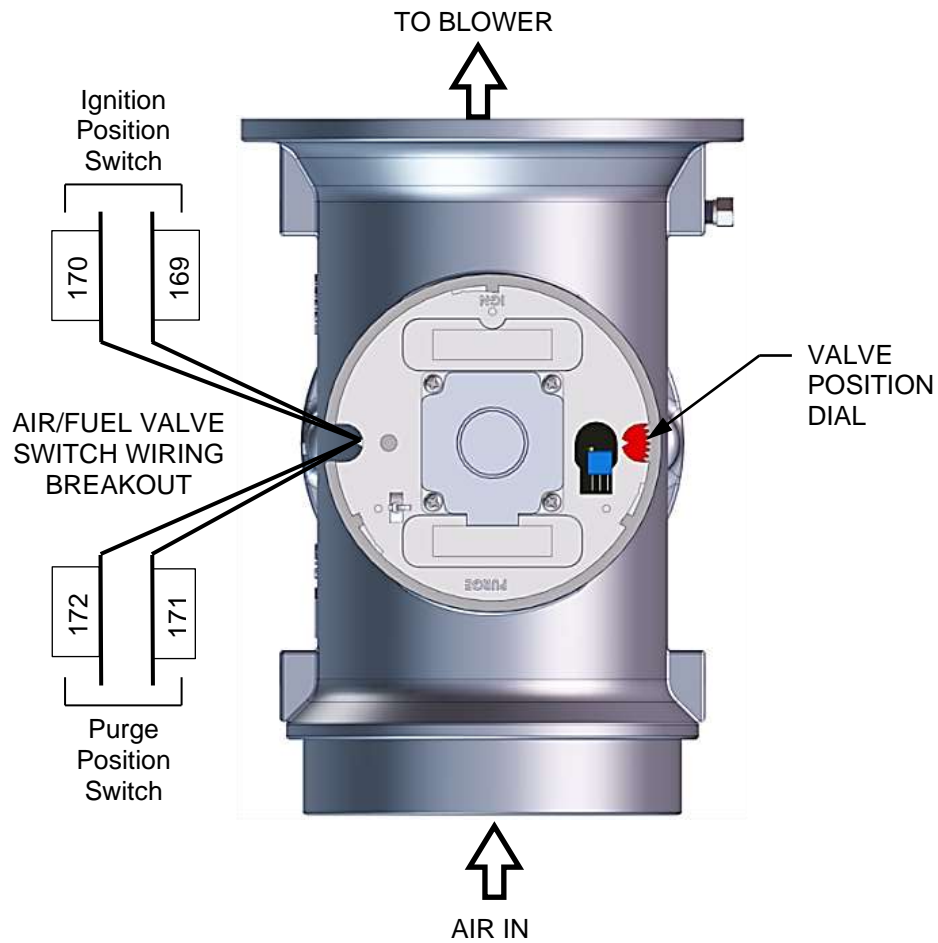
The **Ignition** switch (and the **Purge** switch) is located on the Air/Fuel Valve. To check the switch, proceed as follows:

#### **Ignition Switch Open During Ignition**

1. Set the unit's ON/OFF switch to the **OFF** position.
2. Place the unit in MANUAL mode and set the valve position **between 25% and 30%**.
3. Remove the Air/Fuel Valve cover (Figure 6-7) by rotating the cover counterclockwise to unlock and lift up to remove.
4. Remove one of the two wires (#169 or #170) from the Ignition switch (see Figure 6-8).
5. Initiate a unit start sequence.
6. The unit should begin its start sequence and then shut down and display **IGN SWITCH OPEN DURING IGNITION**.
7. Replace the wire on the **Ignition** switch and press the **CLEAR** button. The unit should restart.



**Figure 6-7: Air/Fuel Valve Cover Location**



**Figure 6-8: Air/Fuel Valve Purge and Ignition Switch Locations**

## CHAPTER 7. MAINTENANCE

### 7.1 MAINTENANCE SCHEDULE

The unit requires regular routine maintenance to keep up efficiency and reliability. For best operation and life of the unit, the following routine maintenance procedures should be performed in the time periods specified in Table 7-1. For a complete inspection check list see ASME CSD-1 chart.

In order to perform the maintenance tasks specified in Table 7-1, the following maintenance kits are available through your local AERCO Sales Representative:

- 12 Month Maintenance Kit, P/N **58025-01**
- 24-Month Waterside/Fireside Inspection Kit, P/N **58025-13** (See NOTE below)

**NOTE**

The 24-Month Waterside/Fireside Inspection Kit also includes the items contained in the Annual Maintenance Kit (P/N **58025-01**). Therefore, only Kit P/N **58025-13** is required when performing the waterside/fireside inspections. Refer to Appendix K for recommended spare parts.

**--WARNING! --**

To avoid personal injury, prior to servicing ensure that the following guidelines are strictly observed:

- Disconnect the AC power supply by turning off the service switch and ac supply circuit breaker.
- Shut off the gas supply at the manual shut-off valve provided with the unit
- Allow the unit to cool to a safe water temperature to prevent burning or scalding

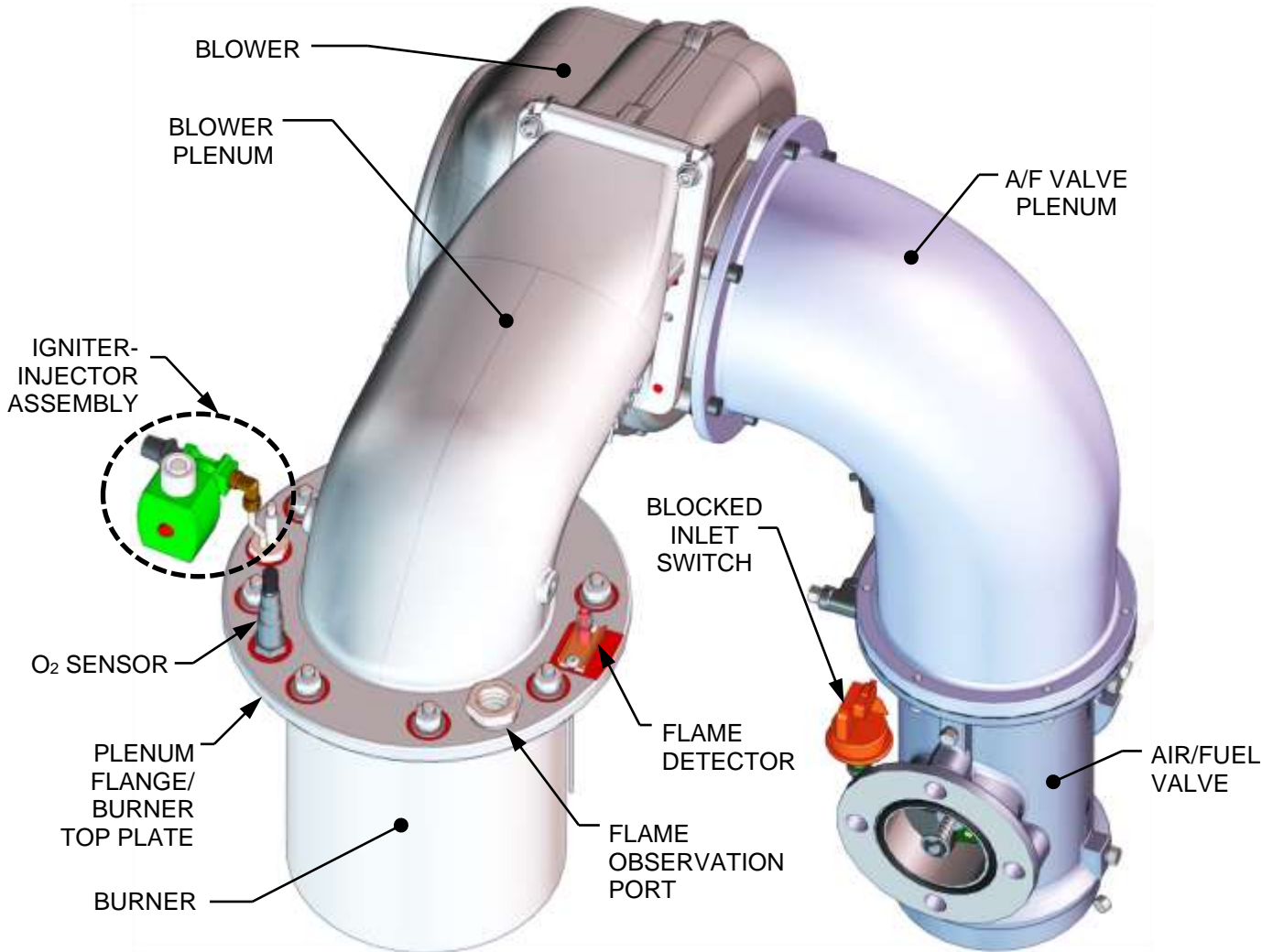
**Table 7-1: Maintenance Schedule**

| Section | Item   | 6 Mos.   | 12 Mos.                          | 24 Mos.                          | Labor Time |
|---------|--|----------|----------------------------------|----------------------------------|------------|
| 7.2     | Igniter-Injector Kit (P/N <b>58023</b> )       | *Inspect | Inspect                          | Replace                          | 15 mins.   |
| 7.3     | Flame Detector Kit (P/N <b>24356-1</b> )       | *Inspect | Inspect                          | Replace                          | 15 mins.   |
| 7.4     | Lean O <sub>2</sub> Sensor (P/N <b>61026</b> ) | *Inspect | Inspect                          |                                  | 15 mins.   |
| 4.3     | Combustion Calibration                         | *Check   | Check                            |                                  | 1 hr.      |
| 7.5     | Testing of Safety Devices                      |          | See ASME CSD-1 Chart             |                                  | 45 mins.   |
| 7.6     | Burner   |          |                                  | Inspect                          | 2 hrs.     |
| 7.7     | Condensate Drain Trap                          | *Inspect | Inspect, Clean & Replace Gaskets | Inspect, Clean & Replace Gaskets | 30 mins.   |
| 7.8     | Air Filter (P/N <b>59138</b> )                 |          | Clean                            | Replace                          | 15 mins.   |

\* Only performed after initial 6 month period after initial startup.

### 7.2 IGNITER-INJECTOR

The igniter-injector (Kit P/N **58023**) is located on the burner plate at the top of the Heating Boiler. In addition to providing the ignition spark required to light the burner, the igniter-injector also contains a gas injector tube which connects to the staged ignition assembly. Figure 7-1 shows the complete burner assembly removed from the Heating Boiler and indicates the location of the igniter-injector flame detector and other related components.



**Figure 7-1: Benchmark 1500/2000 Burner Assembly (Removed from Unit)**

The igniter-injector may be hot, therefore, care should be exercised to avoid burns. It is easier to remove the igniter-injector from the unit after the unit has cooled to room temperature. To inspect/replace the Igniter:

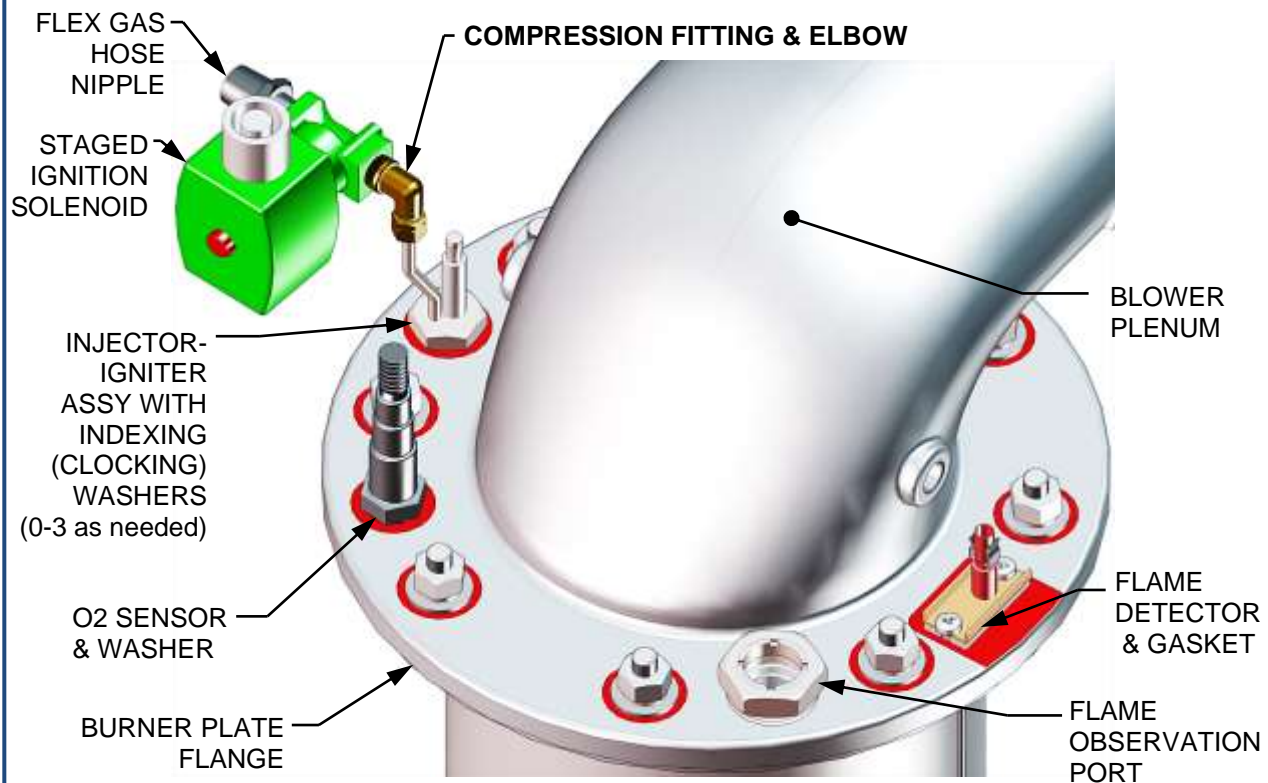
#### **Igniter-Injector Maintenance Procedures**

1. Set the ON/OFF switch on the control panel to the **OFF** position. Disconnect AC power from the unit
2. Remove the top shroud from the unit by grasping the top handle and lifting straight up. This will disengage the shroud from the four (4) pins in the side panels.
3. Disconnect the cable from the igniter-injector (Figure 7-1).



### **Igniter-Injector Maintenance Procedures – Continued**

4. Refer to the partial exploded view in Figure 7-2. Using a 7/16" open-end wrench, disconnect the compression nut securing the gas injector tube of the igniter-injector to the elbow of the staged ignition assembly. Disconnect the staged ignition assembly from the igniter-injector.
5. Next, loosen and remove the igniter-injector from the burner plate using a 1" open-end wrench.
6. Check the igniter-injector for evidence of erosion or carbon build-up. If there is evidence of substantial erosion or carbon build-up, the igniter-injector should be replaced. If carbon build-up is present, clean the component using fine emery cloth. Repeated carbon build-up is an indication that the combustion settings of the unit should be checked. Refer to Chapter 4 for combustion calibration procedures.

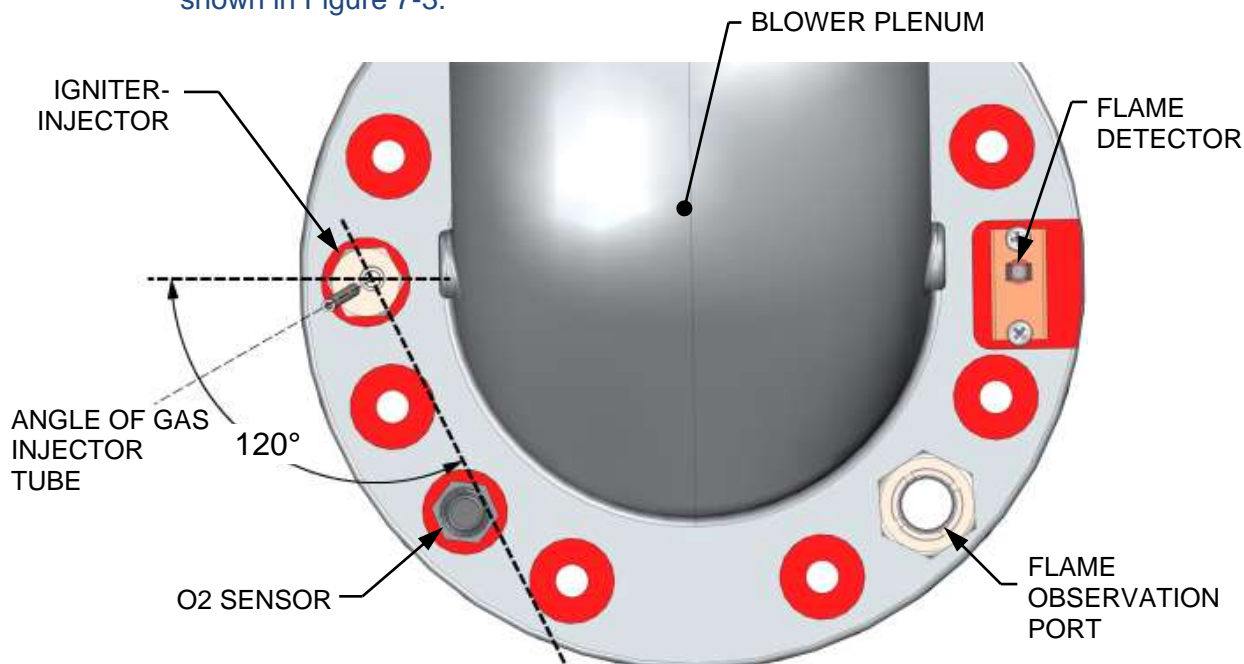


**Figure 7-2: Igniter-Injector & Flame Detector Mounting Details**

7. Prior to reinstalling the igniter-injector, a high temperature, conductive, anti-seize compound must be applied to the threads.

**IGNITER-INJECTOR MAINTENANCE PROCEDURES – Continued****NOTE**

If a replacement igniter-injector (Kit P/N **58023**) is being installed, a compression nut containing a built-in ferrule will be included with the replacement part. If needed, 3 indexing washers are also included. These washers may be needed to properly position the gas injector tube of the igniter-injector within the 120° angle range shown in Figure 7-3.



**Figure 7-3: Igniter-Injector Orientation (Viewed Looking Down from Above)**

8. Reinstall the igniter-injector in the burner plate. **Torque to 170 - 180 in-lbs (19.2 – 20.3 Nm). DO NOT over tighten.**
9. Connect the staged ignition assembly to the gas injector tube of the igniter-injector by securing the compression nut to the elbow of the staged ignition assembly.
10. Reconnect the igniter-injector cable.
11. Reinstall the shroud on the unit.

### 7.3 FLAME DETECTOR

The flame detector (kit P/N **24356-1**) is located on the burner plate at the top of the unit (see Figures 7-1 and 7-2). The flame detector may be hot. Allow the unit to cool sufficiently before removing the flame detector. Inspect or replace the flame detector as follows:

#### **Flame Detector Maintenance**

1. Set the control panel ON/OFF switch to the **OFF** position. Disconnect AC power from the unit.
2. Remove the top shroud from the unit by grasping the top handle and lifting straight up. This will disengage the shroud from the four (4) pins in the side panels.



### **Flame Detector Maintenance – Continued**

3. Disconnect the flame detector lead wire.
4. Remove the two (2) screws securing the flame detector to the plate (Figure 7-2). The flame detector is secured to the burner plate with one #10-32 screw and one #8-32 screw.
5. Remove the flame detector and gasket from the burner plate.
6. Thoroughly inspect the flame detector. If eroded, the detector should be replaced. Otherwise clean the detector with a fine emery cloth.
7. Reinstall the flame detector and flame detector gasket.
8. Reconnect the flame detector lead wire.
9. Reinstall the shroud on the unit.

### **7.4 O<sub>2</sub> SENSOR**

The Lean Oxygen Sensor (P/N **61026**) is located on the burner plate at the top of the unit (see Figures 7-1 and 7-2). The sensor may be hot. Allow the unit to cool sufficiently before removing or replacing the O<sub>2</sub> sensor.

### **O<sub>2</sub> Sensor Maintenance Procedures**

1. Set the ON/OFF switch on the control panel, to the **OFF** position. Disconnect AC power from the unit.
2. Remove the top shroud from the unit by grasping the top handle and lifting straight up. This will disengage the shroud from the four (4) pins in the side panels.
3. Disconnect the O<sub>2</sub> sensor lead wire by pushing in on the release tab and pulling apart the connector.
4. Next, loosen and remove the O<sub>2</sub> sensor and crush washer from the burner plate using a 15/16" open-end wrench.
5. Thoroughly inspect the O<sub>2</sub> sensor. If eroded, the sensor should be replaced. Otherwise clean the sensor with a fine emery cloth.
6. Reinstall the O<sub>2</sub> sensor and crush washer on the burner plate.
7. Reconnect the sensor lead wire.
8. Reinstall the shroud on the unit.

### **7.5 SAFETY DEVICE TESTING**

Systematic and thorough tests of the operating and safety devices should be performed to ensure that they are operating as designed. Certain code requirements, such as ASME CSD-1, require that these tests be performed on a scheduled basis. Test schedules must conform to local jurisdictions. The results of the tests should be recorded in a log book. See Chapter 6- Safety Device Testing Procedures.

### 7.6 BURNER ASSEMBLY INSPECTION

The burner assembly is located at the top of the unit's heat exchanger. The burner assembly may be hot. Therefore, allow the unit to cool sufficiently before removing the burner assembly.

The following parts will be required for reassembly after burner inspection:

| Part No. | Description                           |
|----------|---------------------------------------|
| 88183    | Burner Gasket: Upper Release (1 each) |
| 81166    | Burner Gasket (1 each)                |
| 81186    | Burner Gasket: Lower Release (1 each) |
| 81048    | Flame Detector Gasket (1 each)        |

To inspect or replace the burner assembly, proceed as follows:

#### **Burner Assembly Inspection and Maintenance Procedures**

1. Set the ON/OFF switch on the control panel to the **OFF** position. Disconnect AC power from the unit and turn off the gas supply.
2. Remove the top shroud from the unit by grasping the top handle and lifting straight up. This will disengage the shroud from the four (4) pins in the side panels.
3. Disconnect the lead wire from the flame detector installed on the burner plate. See Figure 7-2.
4. Remove the two (2) screws securing the flame detector to the plate. The flame detector is secured to the burner plate with one (1) #10-32 screw and one (1) #8-32 screw.
5. Remove the flame detector and gasket from the burner plate.
6. Disconnect the cable from the igniter-injector.
7. Using a 7/16" open-end wrench, disconnect the compression nut securing the gas injector tube of the igniter-injector to the elbow of the staged ignition assembly (see Figure 7-2). Disconnect the staged ignition assembly from the igniter-injector.
8. Next, loosen and remove the igniter-injector from the burner plate using a 1" open-end wrench.
9. Loosen and remove the four 5/16x1-3/4" bolts, washers, and nuts from the blower plenum where it is attached to the blower (see Figure 7-4a & 7-4b).
10. You must either rig a support for the blower to hold it in place or remove the blower from the unit and set it aside for later reassembly.
11. Remove the eight (8) 3/8-16 nuts, using a 9/16" wrench, attaching the blower plenum to the burner (see Figure 7-4a & 7-4b).
12. Remove the blower plenum from between the blower and the burner and set it aside for later reassembly. The O<sub>2</sub> sensor and flame observation port remain assembled to the plenum flange.
13. Remove the burner by pulling straight up.
14. Remove and replace the burner gasket(s) (see Figure 7-5).

#### **NOTE**

The burner assembly weighs approximately 65 lbs (29.5 kg).

### **Burner Assembly Inspection and Maintenance Procedure – Continued**

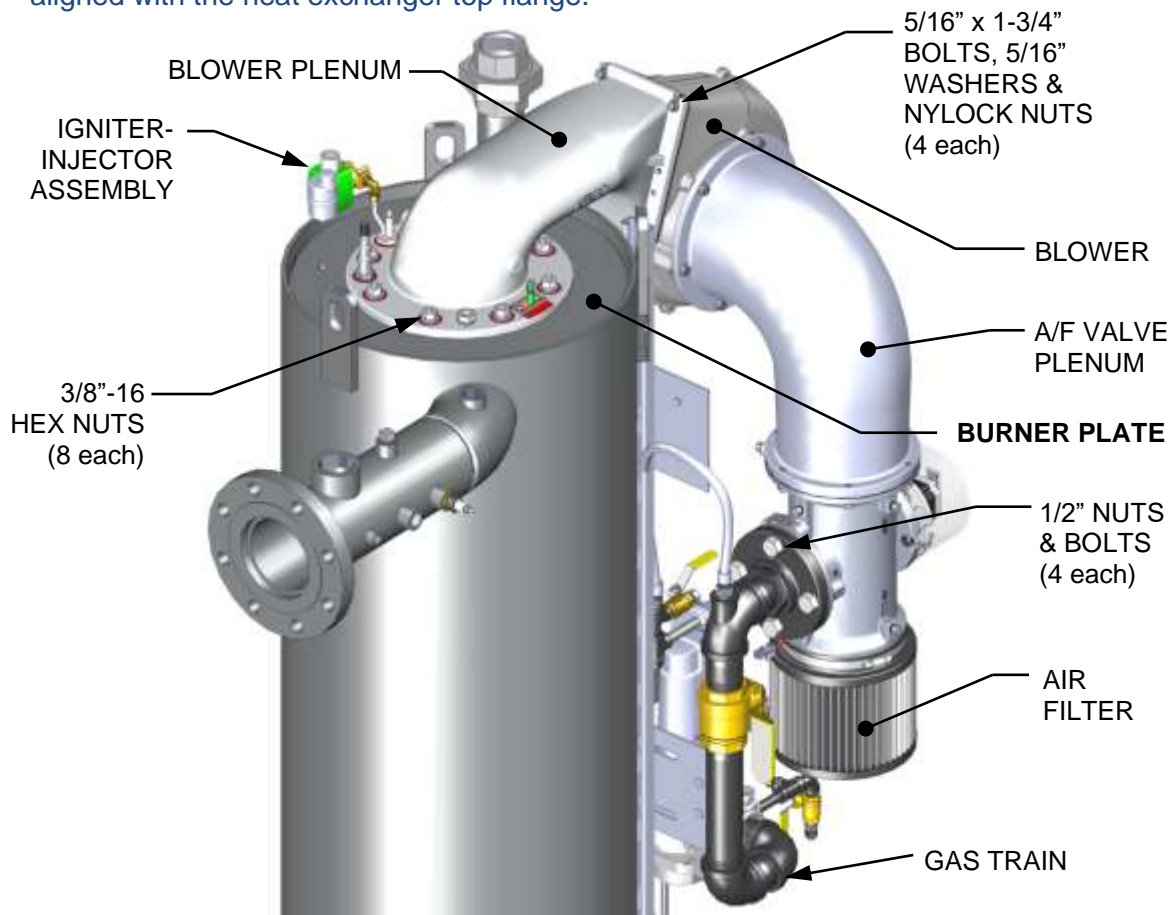
#### **IMPORTANT!**

ALL THREE gaskets provided for maintenance **MUST** be installed during this procedure, as shown in Figure 7-5, even if there is only one existing gasket being replaced. Note that the **LOWER RELEASE GASKET** has tabs, which the others do not.

#### **NOTE**

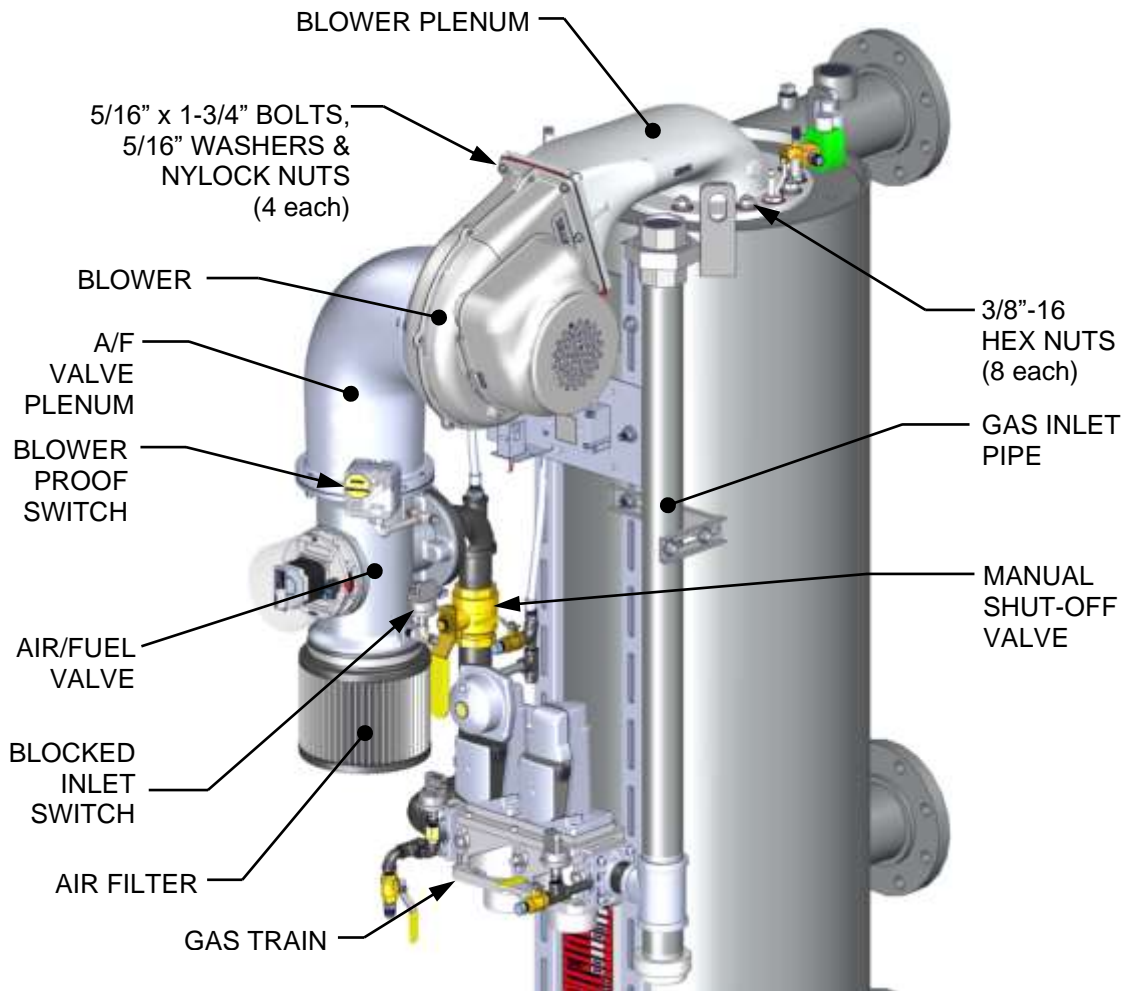
During reassembly, apply a light coating of high-temperature, anti-seize lubricant to the threads of the igniter-injector and grounding screw. Also, ensure that the igniter-injector is properly positioned as indicated in Figure 7-3. **Torque the igniter-injector to 170 - 180 in-lbs. (19.2 - 20.3 Nm).**

15. Beginning with the burner assembly, reinstall all the components in the reverse order that they were removed. When reinstalling the blower plenum (removed in step 11), tighten the 3/8-16 nuts using a typical torque pattern (for example, loosely tighten one nut, then loosely tighten a second nut on the opposite side, a third at 90 degrees to the first two, and a fourth opposite the third, and then repeat this pattern with the remaining four nuts. Repeat the entire pattern a second time to partially tighten all eight nuts, and then repeat a third time until all eight nuts are **fully torqued to 35 ft. lbs. (47.5 Nm)**.
16. Ensure that the igniter-injector and flame detector cutouts in the burner plate are properly aligned with the heat exchanger top flange.



**Figure 7-4a: Burner Assembly Mounting Details**

### Burner Assembly Inspection and Maintenance Procedure – *Continued*



**Figure 7-4b: Burner Assembly Mounting Details**

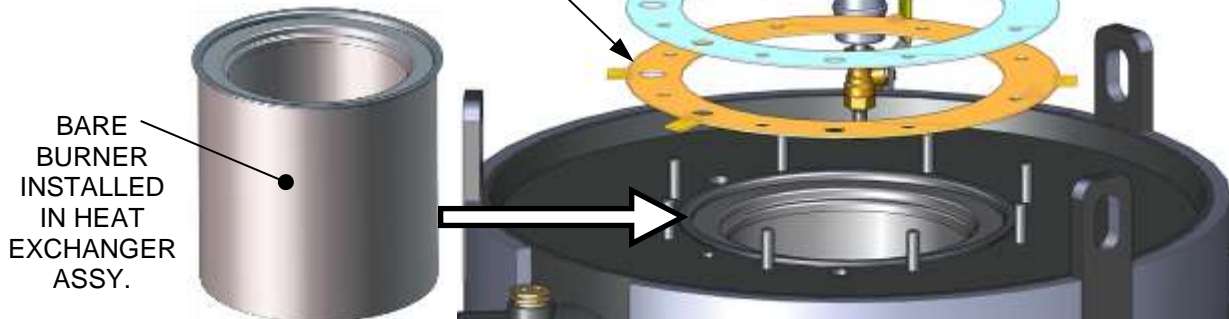
**NOTE**

The LOWER RELEASE GASKET (P/N 81186) features four tabs around its periphery.

**IMPORTANT!**

Use ALL THREE gaskets provided, even if there is only one existing gasket being replaced.

- 81183 – Burner Gasket: Upper Release
- 81166 – Burner Gasket (Middle)
- 81186 – Burner Gasket: Lower Release



**Figure 7-5: Bare Burner and Replacement Gaskets Location**





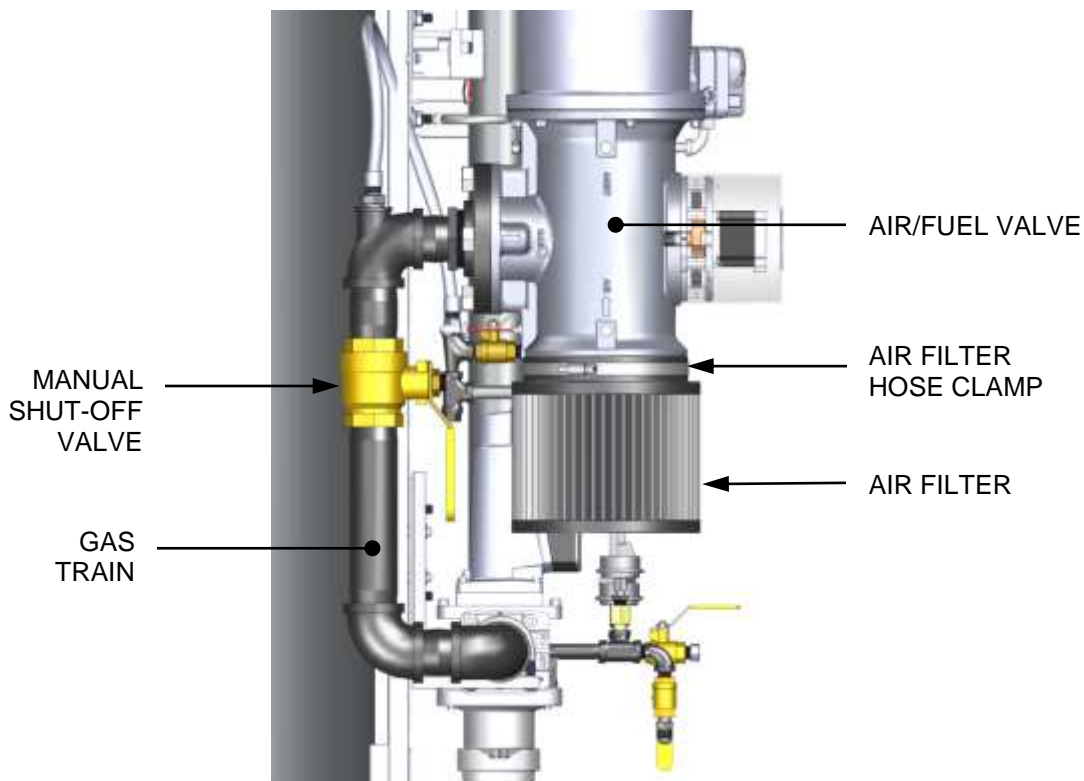
### 7.8 AIR FILTER CLEANING & REPLACEMENT

The Benchmark Heating Boiler is equipped with an air filter (P/N **59138**) which should be cleaned and re-oiled every 12 months and replaced every 24 months. The air filter is located at the air fuel valve inlet, as shown in Figure 7-7.

To inspect/replace the air filter, proceed as follows:

#### **Air Filter Cleaning & Replacement Procedures**

1. Set the ON/OFF switch on the control panel, to the **OFF** position. Disconnect AC power from the unit.
2. Remove the top shroud from the unit by grasping the top handle and lifting straight up. This will disengage the shroud from the four (4) pins in the side panels.
3. Refer to Figure 7-7 and locate the air filter attached to the air/fuel valve inlet.
4. Using a flat-tip screwdriver or 5/16" nut driver, loosen the clamp securing the filter to the inlet flange of the air/fuel valve. Remove the filter and clamp.
5. The filter may be cleaned in hot soapy water to remove oil and dirt. It should then be thoroughly dried and then sprayed with a light coating of K&N® Air Filter Oil (or equivalent specifically formulated for air filters) prior to reinstallation. Do NOT use WD-40.
6. Each replacement air filter is equipped with its own clamp. Therefore, simply install the replacement air filter on inlet flange of the air fuel valve and tighten the clamp with a flat-tip screwdriver or 5/16" nut driver.
7. Replace the top shroud on the unit and return unit to service use.

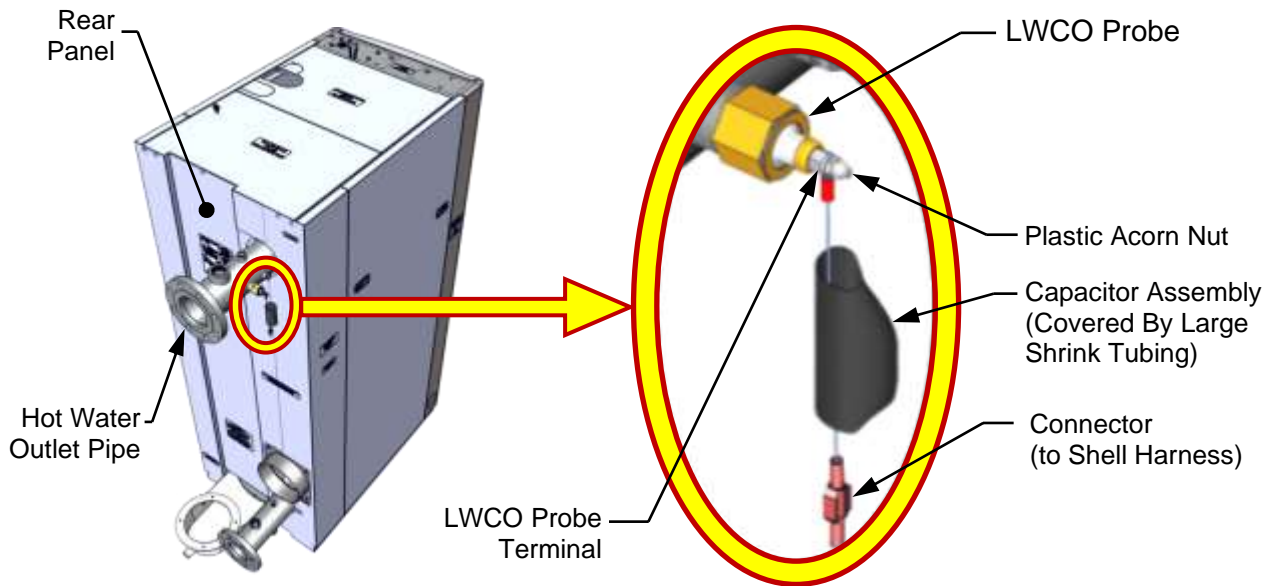


**Figure 7-7: Air Filter Location**

### 7.9 WATER CUTOFF (LWCO) CAPACITOR INTEGRITY TEST

The LWCO capacitor should be tested for electrical shorts every 12 months and replaced, then tested, every 24 months. The LWCO capacitor integrity test consists of two parts as described in the next two sections. The first procedure explains how to test for electrical shorting of the LWCO probe capacitor, while the second procedure instructs how to perform the standard Low Water Cutoff test using the C-More controls.

Refer to Figure 7-8 for an illustration of the LWCO probe assembly and its typical installation.



**Figure 7-8: LWCO Probe Location (BMK1500 Shown)**

#### 7.9.1 Low Water Cutoff (LWCO) - Capacitor Electrical Short Test

This test determines if there is an electrical short between the LWCO capacitor and the heat exchanger. Perform the capacitor electrical short test as described below.

#### **LWCO Capacitor Electrical Short Test**

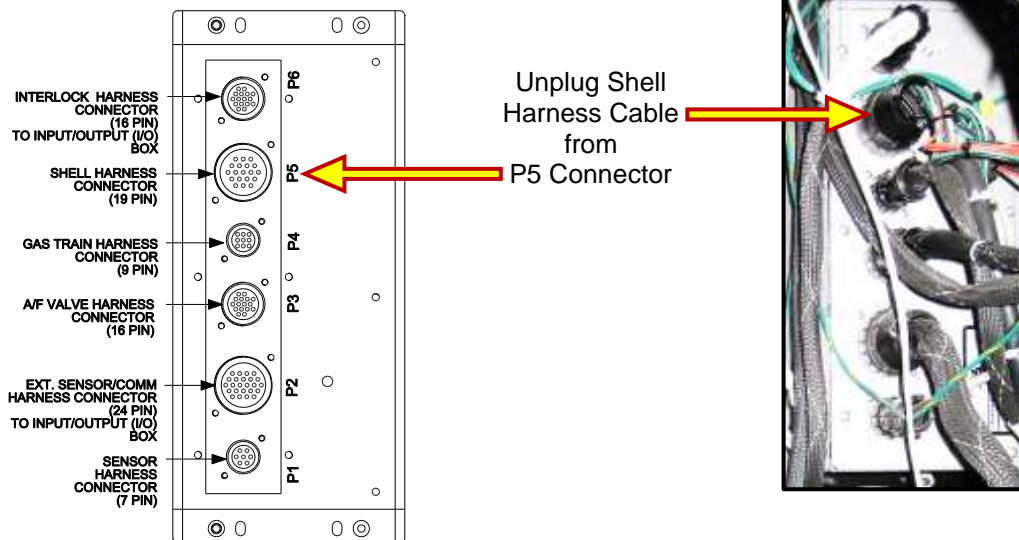
1. Turn the AC power to the unit to **OFF**.

#### **--WARNING! --**

High voltages are used to power these units and so it is required that power applied to these units is removed first before performing the procedure described in this instruction. Serious personal injury or death may occur if this warning is not observed.

### LWCO Capacitor Electrical Short Test – Continued

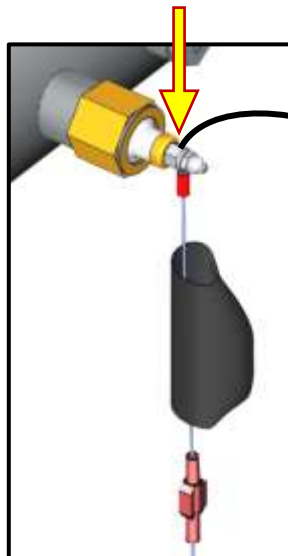
- Remove the Shell Harness Cable (male) connector from the P-5 (female) connector on the rear panel of the C-More controller (see Figure 7-9).



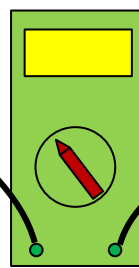
**Figure 7-9: Removing Shell Harness Cable from P5 Conn. on C-More Rear Panel**

- Using an ohmmeter, connect one ohmmeter probe to the LWCO capacitor terminal on the unit shell as shown on left in Figure 7-10.
- Connect the second ohmmeter probe to Pin #6 of Shell Harness Connector (removed from the C-More controller) as shown on right in Figure 7-10.

Connect 1<sup>st</sup> Lead to LWCO Terminal

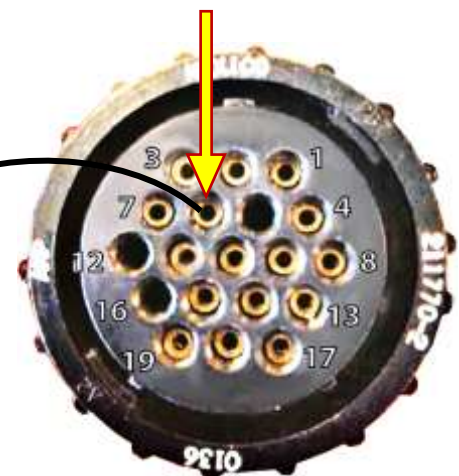


**LWCO Probe Assembly Connector**



**Ohmmeter**

Connect 2<sup>nd</sup> Lead to PIN #6



**19-Pin Shell Harness Cable Connector**

**Figure 7-10: Connecting Ohmmeter between LWCO Probe & Shell Harness Cable**



### **LWCO Capacitor Integrity Test – Continued**

5. Confirm that the ohmmeter does NOT read a short.

#### **NOTE**

If the ohmmeter reads a short, the capacitor assembly needs to be replaced.

6. Remove both ohmmeter probes and reconnect the Shell Harness connector to the P5 connector on the rear of the C-More controller.

### **7.9.2 Low Water Cutoff (LWCO) - Standard C-More Test**

Perform the standard Low Water Cutoff test using the C-More controls as described below.

#### **Standard Low Water Cutoff C-More Test**

1. Turn the AC power to the unit to the **ON** position.
2. Press the **TEST** switch on the C-More controller and confirm that the blinking **LOW WATER LEVEL** message appears on the C-More display within 4 seconds.
3. Press the **RESET** key, followed by the **Clear** button, and confirm that the **LOW WATER LEVEL** message is cleared.

### **7.10 SHUTTING THE HEATING BOILER DOWN FOR AN EXTENDED PERIOD OF TIME**

If the Heating Boiler is to be taken out of service for an extended period of time (one year or more), the following instructions must be followed.

#### **Shutting Heating Boiler Down for Extended Period**

1. Set ON/OFF switch on the front panel to the **OFF** position to shut down the Heating Boiler's operating controls.
2. Disconnect AC power from the unit.
3. Close the water supply and return valves to isolate Heating Boiler.
4. Close external gas supply valve.
5. Open relief valve to vent water pressure.
6. Open the drain valve to drain water from the unit.

### 7.11 PLACING THE HEATING BOILER BACK IN SERVICE AFTER A PROLONGED SHUTDOWN

After a prolonged shutdown (one year or more), the following procedures must be followed:

#### **Placing Heating Boiler in Service After Long Shutdown**

1. Review installation requirements included in Chapter 2.
2. Inspect all piping and connections to the unit.
3. Inspect exhaust vent and air inlet duct work (if applicable).
4. Perform initial startup per Chapter 4.
5. Perform safety device testing and scheduled maintenance procedures per Chapters 6 and 7 of this manual.

### CHAPTER 8. TROUBLESHOOTING GUIDE

#### 8.1 INTRODUCTION

This troubleshooting guide is intended to aid service/maintenance personnel in isolating the cause of a fault in Benchmark 1500 and 2000 Heating Boilers. The troubleshooting procedures contained herein are presented in tabular form on the following pages. These tables are comprised of three columns labeled: Fault Indication, Probable Cause and Corrective Action. The numbered items in the Probable Cause and Corrective Action columns correspond to each other. For example, Probable Cause No. 1 corresponds to Corrective Action No. 1, etc.

When a fault occurs in the unit, proceed as follows to isolate and correct the fault:

#### **Fault Correction**

1. Observe the fault messages displayed in the Control Box display.
2. Refer to the Fault Indication column in Troubleshooting Table 8-1 which follows and locate the Fault that best describes the existing conditions.
3. Proceed to the Probable Cause column and start with the first item (1) listed for the Fault Indication.
4. Perform the checks and procedures listed in the Corrective Action column for the first Probable Cause candidate.
5. Continue checking each additional Probable Cause for the existing fault until the fault is corrected.
6. Section 8.2 and Table 8-2 contain additional troubleshooting information which may apply when a no fault message is displayed.

If the fault cannot be corrected using the information provided in the Troubleshooting Tables, contact your local AERCO Representative.

#### **NOTE**

The front panel of the C-More Control Box contains an RS232 port. This port is used only by factory-trained personnel to monitor OnAER communications via a portable computer.

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## CHAPTER 8 – TROUBLESHOOTING GUIDE

**TABLE 8-1: HEATING BOILER TROUBLESHOOTING**

| FAULT INDICATION              | PROBABLE CAUSES  | CORRECTIVE ACTION   |
|-------------------------------|--|---|
| AIRFLOW FAULT DURING IGNITION | <ol style="list-style-type: none"> <li>1. Blower stopped running due to thermal or current overload.</li> <li>2. Blocked Blower inlet or inlet air filter.</li> <li>3. Blockage in Blower Proof switch.</li> <li>4. Blockage in Blocked Inlet switch.</li> <li>5. Defective Blower Proof switch.</li> <li>6. Defective Blocked Inlet switch.</li> <li>7. Loose temperature to AUX connection in I/O Box.</li> <li>8. Defective temperature sensor.</li> <li>9. Loose wire connection between the 0-10V signal from I/O box to the Blower input.</li> <li>10. Defective I/O Box.</li> <li>11. Wrong 0-10V output selection on the control box.</li> <li>12. Defective Air-Fuel Valve potentiometer.</li> <li>13. Hard light.</li> </ol> | <ol style="list-style-type: none"> <li>1. Check combustion blower for signs of excessive heat or high current drain that may trip thermal or current overload devices.</li> <li>2. Inspect the inlet to the combustion blower including the air filter at the air/fuel valve for signs of blockage.</li> <li>3. Remove the Blower Proof switch and inspect for signs of blockage, clean or replace as necessary.</li> <li>4. Remove the Blocked Inlet switch and inspect for signs of blockage, clean or replace as necessary.</li> <li>5. Check the continuity of the Blower Proof switch with the combustion blower running. If there is an erratic resistance reading or the resistance reading is greater than zero ohms, replace the switch.</li> <li>6. Turn off unit and check the continuity of the Blocked Inlet switch. If there is an erratic resistance reading or the resistance reading is greater than zero ohms, replace the switch.</li> <li>7. Check the actual inlet air temperature and measure voltage at AUX input in the I/O Box. Verify that the voltage conforms to the values shown in the tabular listing provided in Appendix C.</li> <li>8. Refer to CORRECTIVE ACTION 7 and verify that the voltage conforms to the values shown in Appendix C.</li> <li>9. Check wire connection from I/O Box 0-10V signal to the Blower Motor.</li> <li>10. Measure voltage at the I/O box 0-10V output. A voltage of 10V equates to a 100% open valve position.</li> <li>11. Check the <i>Analog Out</i> option on the <i>C-More Configuration</i> menu. <b>Valve Position 0-10V</b> should be selected.</li> <li>12. Check Air/Fuel Valve position at 0%, 50% and 100% open positions. The positions on the VALVE POSITION bargraph should match the readings on the Air/Fuel Valve dial.</li> <li>13. Check igniter-injector for soot or erosion of electrode. Check injector solenoid valve to insure proper open/close operation.</li> </ol> |

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## CHAPTER 8 – TROUBLESHOOTING GUIDE

**TABLE 8-1: HEATING BOILER TROUBLESHOOTING – Continued**

| FAULT INDICATION           | PROBABLE CAUSES   | CORRECTIVE ACTION  |
|----------------------------|---|--|
| AIRFLOW FAULT DURING PURGE | <ol style="list-style-type: none"> <li>1. Blower not running or running too slow.</li> <li>2. Defective Blocked Inlet switch.</li> <li>3. Blockage in air filter or Blocked Inlet switch.</li> <li>4. Blocked blower inlet or inlet ductwork.</li> <li>5. No voltage to Blocked Inlet switch from C-More Control Box.</li> <li>6. PROBABLE CAUSES from 3 to 12 for AIRFLOW FAULT DURING IGNITION apply for this fault.</li> </ol> | <ol style="list-style-type: none"> <li>1. Start the unit. If the blower does not run check the blower solid state relay for input and output voltage. If the relay is OK, check the blower.</li> <li>2. Start the unit. If the blower runs, turn off unit and check the Blocked Inlet switch for continuity. Replace the switch if continuity does not exist.</li> <li>3. Remove the air filter and Blocked Inlet switch and inspect for signs of blockage. Clean or replace as necessary.</li> <li>4. Inspect the inlet to the combustion blower including any ductwork leading up to the combustion blower for signs of blockage.</li> <li>5. During the start sequence, verify that 24 VAC is present between each side of the switch and ground. If 24 VAC is not present, refer fault to qualified service personnel.</li> <li>6. See CORRECTIVE ACTIONS from 3 to 12 for AIRFLOW FAULT DURING IGNITION.</li> </ol> |
| AIRFLOW FAULT DURING RUN   | <ol style="list-style-type: none"> <li>1. Blower stopped running due to thermal or current overload.</li> <li>2. Blocked Blower inlet or inlet ductwork.</li> <li>3. Blockage in air filter or Blocked Inlet switch.</li> <li>4. Defective Blocked Inlet switch.</li> <li>5. Combustion oscillations.</li> <li>6. Probable causes from 3 to 16 for AIRFLOW FAULT DURING IGNITION applies for this fault.</li> </ol>               | <ol style="list-style-type: none"> <li>1. Check combustion blower for signs of excessive heat or high current draw that may trip thermal or current overload devices.</li> <li>2. Inspect the inlet to the combustion blower, including any ductwork leading up to the combustion blower, for signs of blockage.</li> <li>3. Remove the air filter and Blocked Inlet switch and inspect for signs of blockage, clean or replace as necessary.</li> <li>4. Verify that 24 VAC is present between each side of the switch and ground. If 24 VAC is not present at both sides, replace switch.</li> <li>5. Run unit to full fire. If the unit rumbles or runs rough, perform combustion calibration.</li> <li>6. See CORRECTIVE ACTIONS from 3 to 12 for AIRFLOW FAULT DURING IGNITION.</li> </ol>  |

# Benchmark 1500 – 2000 Boiler User Manual - INTERNATIONAL

## CHAPTER 8 – TROUBLESHOOTING GUIDE

**TABLE 8-1: HEATING BOILER TROUBLESHOOTING – Continued**

| FAULT INDICATION                 | PROBABLE CAUSES   | CORRECTIVE ACTION  |
|----------------------------------|---|--|
| <p>DELAYED INTERLOCK OPEN</p>    | <ol style="list-style-type: none"> <li>1. Delayed Interlock Jumper not properly installed or missing.</li> <li>2. Device proving switch hooked to interlocks is not closed.</li> </ol>  | <ol style="list-style-type: none"> <li>1. Check to insure jumper is properly installed across the delayed interlock terminals in the I/O Box.</li> <li>2. If there are 2 external wires on these terminals, check to see if an end switch for a proving device (such as a pump, louver, etc.) is tied these interlocks. Ensure that the device and/or its end switch is functional. A jumper may be temporarily installed to test the interlock.</li> </ol>  |
| <p>DIRECT DRIVE SIGNAL FAULT</p> | <ol style="list-style-type: none"> <li>1. Direct drive signal is not present:                             <ul style="list-style-type: none"> <li>--Not yet installed.</li> <li>--Wrong polarity.</li> <li>--Signal defective at source.</li> <li>--Broken or loose wiring.</li> </ul> </li> <li>2. Signal is not isolated (floating).</li> <li>3. Control Box signal type selection switches not set for correct signal type (voltage or current).</li> </ol> | <ol style="list-style-type: none"> <li>1. Check I/O Box to ensure signal is hooked up.                             <ul style="list-style-type: none"> <li>--Hook up if not installed.</li> <li>--If installed, check polarity.</li> <li>--Measure signal level.</li> <li>--Check wiring continuity between source and unit.</li> </ul> </li> <li>2. Check signal at source to ensure it is isolated.</li> <li>3. Check DIP switch on PMC board to ensure it is set correctly for the type of signal being sent. Check control signal type set in <i>Configuration</i> menu.</li> </ol>   |
| <p>FLAME LOSS DURING IGN</p>     | <ol style="list-style-type: none"> <li>1. Worn Flame Detector.</li> <li>2. No spark from Spark Igniter.</li> <li>3. Defective Ignition Transformer.</li> <li>4. Defective Ignition/Stepper (IGST) Board.</li> <li>5. Defective SSOV.</li> </ol>   | <ol style="list-style-type: none"> <li>1. Remove and inspect the Flame Detector for signs of wear. Replace if necessary.</li> <li>2. Close the internal gas valve in the unit. Install and arc a spark igniter outside the unit.</li> <li>3. If there is no spark, check for 120VAC at the primary side to the ignition transformer during the ignition cycle.</li> <li>4. If 120VAC is not present, the IGST Board in the Control Box may be defective. Refer fault to qualified service personnel.</li> <li>5. While externally arcing the spark igniter, observe the open/close indicator in the Safety Shut-Off Valve to ensure it is opening. If the valve does not open, check for 120VAC at the valve input terminals. If 120VAC is not present, the IGST board in the Control Box may be defective. Refer fault to qualified service personnel.</li> </ol> |

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## CHAPTER 8 – TROUBLESHOOTING GUIDE

**TABLE 8-1: HEATING BOILER TROUBLESHOOTING – Continued**

| FAULT INDICATION                             | PROBABLE CAUSES   | CORRECTIVE ACTION  |
|--|---|--|
| <p>FLAME LOSS DURING IGN<br/>(continued)</p> | <p>6. Carbon or other debris on Burner.</p> <p>7. Staged ignition solenoid valve doesn't open.</p> <p>8. Clogged staged ignition piece.</p>   | <p>6. Remove View-Port and inspect Burner with Boroscope. If it is fouled or black with soot, remove the Burner and inspect for any carbon build-up or debris. Clean and reinstall.</p> <p>7. When unit goes to ignition, listen for a clicking sound at the staged ignition solenoid valve to ensure it is opening.</p> <p>8. Remove and inspect staged ignition piece for blockage.</p>  |
| <p>FLAME LOSS DURING RUN</p>                 | <p>1. Worn Flame Detector or cracked ceramic.</p> <p>2. Defective Regulator.</p> <p>3. Poor combustion calibration.</p> <p>4. Debris on burner.</p> <p>5. Blocked condensate drain.</p> | <p>1. Remove and inspect the Flame Detector for signs of wear or cracked ceramic. Replace if necessary.</p> <p>2. Check gas pressure readings using a gauge or manometer into and out of the Air/Fuel Valve to ensure that the gas pressure into and out of the valve is correct.</p> <p>3. Check combustion calibration using procedures in Chapter 4.</p> <p>4. Remove the burner and inspect for any carbon build-up or debris. Clean and reinstall.</p> <p>5. Remove blockage in condensate drain.</p> |
| <p>HEAT DEMAND FAILURE</p>                   | <p>1. The Heat Demand Relays on the Ignition/Stepper (IGST) board failed to activate when commanded.</p> <p>2. Relay is activated when not in Demand.</p>                               | <p>1. Press <b>CLEAR</b> button and restart the unit. If the fault persists, replace Ignition/Stepper (IGST) Board.</p> <p>2. Defective relay. Replace IGST Board.</p>   |
| <p>HIGH EXHAUST TEMPERATURE</p>              | <p>1. Poor combustion calibration.</p> <p>2. Carboned heat exchanger due to incorrect combustion calibration.</p>   | <p>1. Check combustion calibration using procedures in Chapter 4.</p> <p>2. If exhaust temperature is greater than 200° F (93.3°C), check combustion calibration. Calibrate or repair as necessary.</p>  |



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## CHAPTER 8 – TROUBLESHOOTING GUIDE

**TABLE 8-1: HEATING BOILER TROUBLESHOOTING – Continued**

| FAULT INDICATION            | PROBABLE CAUSES   | CORRECTIVE ACTION  |
|-----------------------------|---|--|
| HIGH GAS PRESSURE           | <ol style="list-style-type: none"> <li>1. Incorrect supply gas pressure.</li> <li>2. Defective SSOV Actuator.</li> <li>3. Defective <b>High Gas Pressure</b> switch.</li> </ol>   | <ol style="list-style-type: none"> <li>1. Check to ensure gas pressure at inlet of SSOV does not <b>exceed 14” W.C. (3.49 kPa)</b></li> <li>2. If NATURAL GAS supply pressure downstream of SSOV Actuator cannot be lowered to the range of <b>3.6” ± 0.2” W.C. (897 ± 50 Pa) for BMK1500 or 3.4” ± 0.2” W.C. (847 ± 50 Pa) for BMK2000</b> using the gas pressure adjustment screw (see section 4.3, step 10), the SSOV Actuator may be defective.</li> <li>3. Remove the leads from the High Gas Pressure switch. Measure continuity across the common (C) and normally closed (NC) terminals with the unit not firing. Replace the switch if continuity does not exist.</li> </ol>  |
| HIGH WATER TEMP SWITCH OPEN | <ol style="list-style-type: none"> <li>1. Faulty Water temperature switch.</li> <li>2. Incorrect PID settings.</li> <li>3. Faulty shell temperature sensor.</li> <li>4. Unit in MANUAL mode.</li> <li>5. Unit setpoint is greater than Over Temperature switch setpoint.</li> <li>6. System flow rate changes are occurring faster than units can respond.</li> </ol> | <ol style="list-style-type: none"> <li>1. Test the temperature switch to insure it trips at its actual water temperature setting.</li> <li>2. Check PID settings against menu default settings in Chapter 3. If the settings have been changed, record the current readings then reset them to the default values.</li> <li>3. Using the resistance charts in the Appendix C, Measure the resistance of Shell sensor and BTU sensor at a known water temperature.</li> <li>4. If unit is in MANUAL mode, switch to AUTO mode.</li> <li>5. Check setpoint of unit and setpoint of Temperature switch; Ensure that the temperature switch is set higher than the unit's setpoint.</li> <li>6. If the system is a variable flow system, monitor system flow changes to ensure that the rate of flow change is not faster than what the units can respond to.</li> </ol> |
| HIGH WATER TEMPERATURE      | <ol style="list-style-type: none"> <li>1. See HIGH WATER TEMPERATURE SWITCH OPEN.</li> <li>2. Temp HI Limit setting is too low.</li> </ol>  | <ol style="list-style-type: none"> <li>1. See HIGH WATER TEMPERATURE SWITCH OPEN.</li> <li>2. Check Temp HI Limit setting.</li> </ol>  |
| IGN BOARD COMM FAULT        | <ol style="list-style-type: none"> <li>1. Communication fault has occurred between the PMC board and Ignition/Stepper (IGST) board.</li> </ol>  | <ol style="list-style-type: none"> <li>1. Press <b>CLEAR</b> button and restart unit. If fault persists, contact qualified Service Personnel.</li> </ol>   |

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## CHAPTER 8 – TROUBLESHOOTING GUIDE

**TABLE 8-1: HEATING BOILER TROUBLESHOOTING – Continued**

| FAULT INDICATION               | PROBABLE CAUSES  | CORRECTIVE ACTION  |
|--------------------------------|--|--|
| IGN SWTCH CLOSED DURING PURGE  | <ol style="list-style-type: none"> <li>1. Air/Fuel Valve not rotating.</li> <li>2. Defective or shorted switch.</li> <li>3. Switch wired incorrectly.</li> <li>4. Defective Power Supply Board or fuse.</li> <li>5. Defective IGST Board.</li> </ol> | <ol style="list-style-type: none"> <li>1. Start the unit. The Air/Fuel Valve should rotate to the purge (open) position. If the valve does not rotate at all or does not rotate fully open, check the Air/Fuel Valve calibration. If calibration is okay, the problem may be in the Air-Fuel Valve or the Control Box. Refer to qualified service personnel.</li> <li>2. If the Air/Fuel Valve does rotate to purge, check the ignition switch for continuity between the N.O. and COM terminals. If the switch shows continuity when not in contact with the cam replace the switch.</li> <li>3. Check to ensure that the switch is wired correctly (correct wire numbers on the normally open terminals). If the switch is wired correctly, replace the switch.</li> <li>4. Check DS1 &amp; DS2 LEDs on Power Supply Board. If they are not steady ON, replace Power Supply Board.</li> <li>5. Check “Heartbeat” LED DS1 and verify it is blinking ON &amp; OFF every second. If not, replace IGST Board.</li> </ol> |
| IGN SWTCH OPEN DURING IGNITION | <ol style="list-style-type: none"> <li>1. Air/Fuel Valve not rotating to ignition position.</li> <li>2. Defective Ignition switch.</li> <li>3. Defective Power Supply Board or fuse.</li> <li>4. Defective IGST Board.</li> </ol>                    | <ol style="list-style-type: none"> <li>1. Start the unit. The Air/Fuel Valve should rotate to the purge (open) position, then back to ignition position (towards closed) during the ignition cycle. If the valve does not rotate back to the ignition position, check the Air/Fuel Valve calibration. If calibration is okay, the problem may be in the Air/Fuel Valve or the Control Box. Refer fault to qualified service personnel.</li> <li>2. If the Air/Fuel Valve does rotate to the ignition position, check the ignition position switch for continuity between the N.O. and COM terminals when in contact with the cam.</li> <li>3. Check DS1 &amp; DS2 LEDs on Power Supply Board. If they are not steady ON, replace Power Supply Board.</li> <li>4. Check “Heartbeat” LED DS1 and verify it is blinking ON &amp; OFF every second. If not, replace IGST Board.</li> </ol>   |

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## CHAPTER 8 – TROUBLESHOOTING GUIDE

**TABLE 8-1: HEATING BOILER TROUBLESHOOTING – Continued**

| FAULT INDICATION                  | PROBABLE CAUSES  | CORRECTIVE ACTION  |
|-----------------------------------|--|--|
| INTERLOCK OPEN                    | <ol style="list-style-type: none"> <li>1. Interlock jumper not installed or removed.</li> <li>2. Energy Management System does not have unit enabled.</li> <li>3. Device proving switch hooked to interlocks is not closed.</li> </ol> | <ol style="list-style-type: none"> <li>1. Check for a jumper properly installed across the interlock terminals in the I/O box.</li> <li>2. If there are two external wires on these terminals check any Energy Management system to see if they have the units disabled (a jumper may be temporarily installed to see if the interlock circuit is functioning).</li> <li>3. Check that proving switch for any device hooked to the interlock circuit is closing and that the device is operational.</li> </ol> |
| LINE VOLTAGE OUT OF PHASE         | <ol style="list-style-type: none"> <li>1. Line and Neutral switched in AC Power Box.</li> <li>2. Incorrect power supply transformer wiring.</li> </ol>   | <ol style="list-style-type: none"> <li>1. Check hot and neutral in AC Power Box to ensure they are not reversed.</li> <li>2. Check transformer wiring, in AC Power Box, against the power box transformer wiring diagram to ensure it is wired correctly.</li> </ol>   |
| LOW GAS PRESSURE                  | <ol style="list-style-type: none"> <li>1. Incorrect supply gas pressure.</li> <li>2. Defective Low Gas Pressure switch.</li> </ol>   | <ol style="list-style-type: none"> <li>1. Measure gas pressure upstream of the SSOV Actuator(s) with the unit firing. For FM gas trains, ensure it is <b>between 6.0” W.C. and 14” W.C. (1.49 and 3.49 kPa)</b>. Measure NATURAL GAS pressure at the Low Gas Pressure switch. If it is <b>greater than 4.7” W.C. (1.17 kPa)</b> for both BMK 1500 and BMK 2000, measure continuity across the switch and replace if necessary.</li> </ol>  |
| LOW WATER LEVEL                   | <ol style="list-style-type: none"> <li>1. Insufficient water level in system.</li> <li>2. Defective water level circuitry.</li> <li>3. Defective water level probe.</li> </ol>   | <ol style="list-style-type: none"> <li>1. Check system for sufficient water level.</li> <li>2. Test water level circuitry using the Control Box front panel LOW WATER TEST and RESET buttons. Replace water level circuitry if it does not respond.</li> <li>3. Check continuity of probe end to the shell, change probe if there is no continuity.</li> </ol>   |
| MODBUS COMMFAULT                  | Unit not seeing information from Modbus network.   | Check network connections. If fault persists, contact qualified Service Personnel.   |
| PRG SWITCH CLOSED DURING IGNITION | <ol style="list-style-type: none"> <li>1. A/F Valve rotated open to purge and did not rotate to ignition position.</li> </ol>  | <ol style="list-style-type: none"> <li>1. Start the unit. The Air/Fuel Valve should rotate to the purge (open) position, then back to ignition position (towards closed) during the ignition cycle. If the valve does not rotate back to the ignition position, check the Air/Fuel Valve calibration. If calibration is okay, the problem may be in the Air/Fuel Valve or the Control Box. Refer fault to qualified service personnel.</li> </ol>  |

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## CHAPTER 8 – TROUBLESHOOTING GUIDE

**TABLE 8-1: HEATING BOILER TROUBLESHOOTING – Continued**

| FAULT INDICATION            | PROBABLE CAUSES   | CORRECTIVE ACTION  |
|-----------------------------|---|--|
| (continued)                 | <ol style="list-style-type: none"> <li>2. Defective or shorted switch.</li> <li>3. Switch wired incorrectly.</li> <li>4. Defective Power Supply Board or fuse.</li> <li>5. Defective IGST Board.</li> </ol>                                     | <ol style="list-style-type: none"> <li>2. If the Air/Fuel Valve does rotate to the ignition position, check the purge switch for continuity between the N.O. and COM terminals. If the switch shows continuity when not in contact with the cam, check to ensure that the switch is wired correctly (correct wire numbers on the normally open terminals).</li> <li>3. If the switch is wired correctly, replace the switch.</li> <li>4. Check DS1 &amp; DS2 LEDs on Power Supply Board. If they are not steady ON, replace Power Supply Board.</li> <li>5. Check “Heartbeat” LED DS1 and verify it is blinking ON &amp; OFF every second. If not, replace IGST Board.</li> </ol>                |
| PRG SWTCH OPEN DURING PURGE | <ol style="list-style-type: none"> <li>1. Defective Purge switch.</li> <li>2. No voltage present at switch.</li> <li>3. Switch wired incorrectly.</li> <li>4. Defective Power Supply Board or fuse</li> <li>5. Defective IGST Board.</li> </ol> | <ol style="list-style-type: none"> <li>1. If the air-fuel valve does rotate, check Purge switch for continuity when closing. Replace switch if continuity does not exist.</li> <li>2. Measure for 24 VAC from each side of the switch to ground. If 24VAC is not present, refer fault to qualified service personnel.</li> <li>3. Check to ensure that the switch is wired correctly (correct wire numbers on the normally open terminals).</li> <li>4. Check DS1 &amp; DS2 LEDs on Power Supply Board. If they are not steady ON, replace Power Supply Board.</li> <li>5. Check “Heartbeat” LED DS1 and verify it is blinking ON &amp; OFF every second. If not, replace IGST Board.</li> </ol> |
| OUTDOOR TEMP SENSOR FAULT   | <ol style="list-style-type: none"> <li>1. Loose or broken wiring.</li> <li>2. Defective Sensor.</li> <li>3. Incorrect Sensor.</li> </ol>  | <ol style="list-style-type: none"> <li>1. Inspect Outdoor Temperature sensor for loose or broken wiring.</li> <li>2. Check resistance of sensor to determine if it is within specification.</li> <li>3. Ensure that the correct sensor is installed.</li> </ol>  |
| O2 % OUT OF RANGE           | <ol style="list-style-type: none"> <li>1. Combustion Calibration incorrect.</li> <li>2. Blocked inlet air duct or louver.</li> </ol>  | <ol style="list-style-type: none"> <li>1. Check Combustion Analyzer and recalibrate the Heating Boiler.</li> <li>2. Unblock air inlet and measure open area for combustion air to the room.</li> </ol>   |

# Benchmark 1500 – 2000 Boiler User Manual - INTERNATIONAL

## CHAPTER 8 – TROUBLESHOOTING GUIDE

**TABLE 8-1: HEATING BOILER TROUBLESHOOTING – Continued**

| FAULT INDICATION          | PROBABLE CAUSES   | CORRECTIVE ACTION   |
|---------------------------|---|---|
| RECIRC PUMP FAILURE       | 1. Internal recirculation pump failed.  | 1. Replace recirculation pump.  |
| REMOTE SETPT SIGNAL FAULT | 1. Remote setpoint signal not present:<br>Not yet installed.<br>Wrong polarity.<br>Signal defective at source.<br>Broken or loose wiring.<br>2. Signal is not isolated (floating) if 4 to 20 mA.<br>3. Control Box signal type selection switches not set for correct signal type (voltage or current). | 1. Check I/O Box to ensure signal is hooked up.<br>Hook up if not installed.<br>If installed, check polarity.<br>Measure signal level.<br>Check continuity of wiring between source and unit.<br>2. Check signal at source to ensure it is isolated.<br>3. Check DIP switch on PMC board to ensure it is set correctly for the type of signal being sent. Check control signal type set in <i>Configuration</i> menu.                                   |
| RESIDUAL FLAME            | 1. Defective Flame Detector.<br>2. SSOV not fully closed.   | 1. Replace Flame Detector.<br>2. Check open/close indicator window of Safety Shut-Off Valve (SSOV) and ensure that the SSOV is fully closed. If not fully closed, replace the valve and or actuator.<br>Close the 2" Gas Shut-Off Valve downstream of SSOV (Figure 2-7). Install a manometer or gauge at the leak detection port between the SSOV and Gas Shut Off Valve. If a gas pressure reading is observed replace the SSOV Valve and/or Actuator. |
| SSOV FAULT DURING PURGE   | See SSOV SWITCH OPEN  |   |
| SSOV FAULT DURING RUN     | SSOV switch closed for 15 seconds during run.   | 1. Replace or adjust micro-switch in SSOV actuator. If fault persists, replace actuator.  |
| SSOV RELAY FAILURE        | 1. SSOV relay failed on IGST board.<br>2. Floating Neutral.<br>3. Hot and Neutral reversed at SSOV.   | 1. Press <b>CLEAR</b> button and restart unit. If fault persists, replace Ignition/Stepper (IGST) Board.<br>2. The Neutral and Earth Ground are not connected at the source and therefore there is a voltage measured between the two. Normally this measurement should be near zero or no more than a few millivolts.<br>3. Check SSOV power wiring.   |

# Benchmark 1500 – 2000 Boiler User Manual - INTERNATIONAL

## CHAPTER 8 – TROUBLESHOOTING GUIDE

**TABLE 8-1: HEATING BOILER TROUBLESHOOTING – Continued**

| FAULT INDICATION      | PROBABLE CAUSES   | CORRECTIVE ACTION  |
|-----------------------|---|--|
| SSOV SWITCH OPEN      | <ol style="list-style-type: none"> <li>1. Actuator not allowing for full closure of gas valve.</li> <li>2. SSOV powered when it should not be.</li> <li>3. Defective switch or Actuator.</li> <li>4. Incorrectly wired switch.</li> </ol>   | <ol style="list-style-type: none"> <li>1. Observe operation of the Safety Shut-Off Valve (SSOV) through indicator on the Valve actuator and ensure that the valve is fully and not partially closing.</li> <li>2. If the SSOV never closes, it may be powered continuously. Close the gas supply and remove power from the unit. Refer fault to qualified service personnel.</li> <li>3. Remove the electrical cover from the SSOV and check switch continuity. If the switch does not show continuity with the gas valve closed, either adjust or replace the switch or actuator.</li> <li>4. Ensure that the SSOV Proof of Closure switch is correctly wired.</li> </ol> |
| STEPPER MOTOR FAILURE | <ol style="list-style-type: none"> <li>1. Air/Fuel Valve out of calibration.</li> <li>2. Air/Fuel Valve unplugged.</li> <li>3. Loose wiring connection to the stepper motor.</li> <li>4. Defective Air/Fuel Valve stepper motor.</li> <li>5. Defective Power Supply Board or fuse.</li> <li>6. Defective IGST Board.</li> </ol> | <ol style="list-style-type: none"> <li>1. Perform the Stepper Feedback Calibration procedure.</li> <li>2. Check that the Air/Fuel Valve is connected to the Control Box.</li> <li>3. .Inspect for loose connections between the Air/Fuel Valve motor and the wiring harness.</li> <li>4. Replace stepper motor.</li> <li>5. Check DS1 &amp; DS2 LEDs on Power Supply Board. If they are not steady ON, replace Power Supply Board.</li> <li>6. Check “Heartbeat” LED DS1 and verify it is blinking ON &amp; OFF every second. If not, replace IGST Board.</li> </ol>   |

# Benchmark 1500 – 2000 Boiler User Manual - INTERNATIONAL

## CHAPTER 8 – TROUBLESHOOTING GUIDE

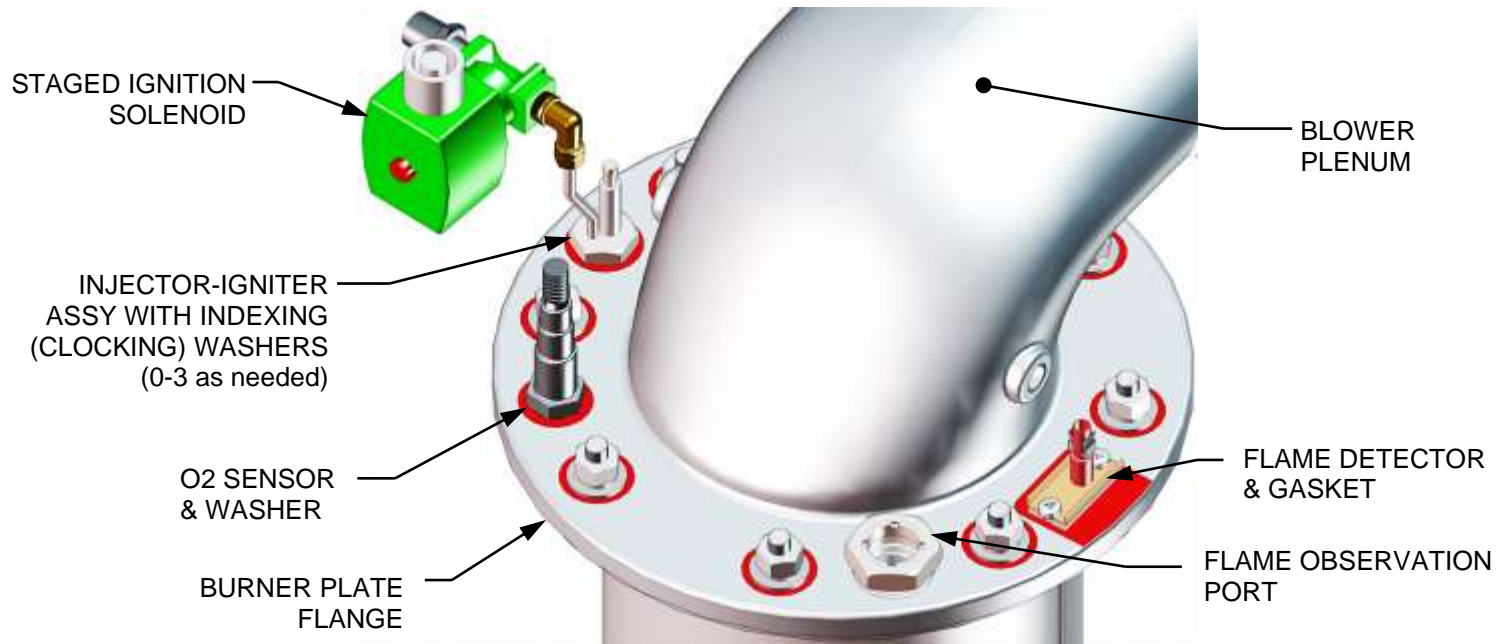
### 8.2 ADDITIONAL FAULTS WITHOUT SPECIFIC FAULT MESSAGES

Refer to Table 8-2 to troubleshoot faults which may occur without a specific fault message being displayed.

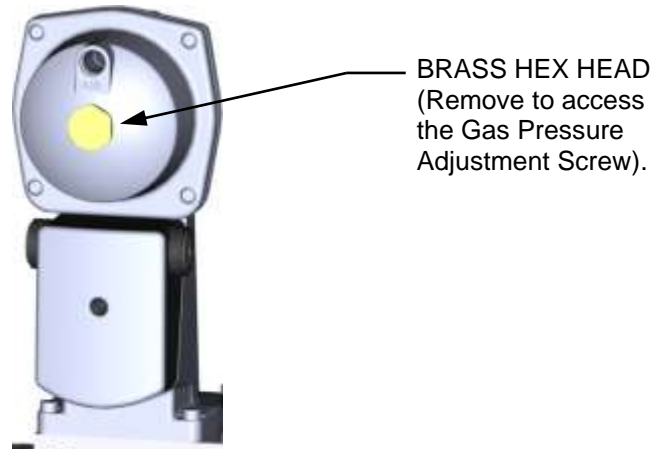
**TABLE 8-2: HEATING BOILER TROUBLESHOOTING WITH NO FAULT MESSAGE DISPLAYED**

| OBSERVED INCIDENT                                  | PROBABLE CAUSES   | CORRECTIVE ACTION   |
|--|---|---|
| Hard Light-Off                                     | <ol style="list-style-type: none"><li>1. Clogged/damaged Gas Injector on Igniter-Injector (Figure 8-1).</li><li>2. Defective Staged Ignition Solenoid (Figure 8-1).</li></ol> | <ol style="list-style-type: none"><li>1. Disconnect the Staged Ignition Assembly solenoid from the Gas injector Tube of the Igniter-Injector (Figure 8-1) and inspect Gas Injector to ensure it is not clogged or damaged.</li><li>2. Close the 2" Manual Shutoff Valve. Attempt to start the unit and listen for a "clicking" sound that the Staged Ignition Solenoid makes during Ignition Trial. If "clicking" sound is not heard after 2 or 3 attempts, replace the Staged Ignition Solenoid.</li></ol> |
| Fluctuating Gas Pressure                           | <ol style="list-style-type: none"><li>1. Gas pressure going into unit is fluctuating.</li></ol>   | <ol style="list-style-type: none"><li>1. Stabilize gas pressure going into unit. If necessary, troubleshoot Building Supply Regulator.</li></ol>  |
| Air/Fuel Valve "hunting" at the 70% Valve Position | <ol style="list-style-type: none"><li>1. IGST and Power Supply Boards in Control Box are outdated.</li></ol>  | <ol style="list-style-type: none"><li>1. Check to ensure that the IGST and Power Supply Boards are Rev. E or higher.</li></ol>  |





**Figure 8-1: Igniter-Injector & Flame Detector Mounting Details**



**Figure 8-2: SSOV Actuator with Gas Pressure Adjustment**

## CHAPTER 9. BOILER SEQUENCING TECHNOLOGY

### 9.1 INTRODUCTION

The C-More on-board Boiler Sequencing Technology system (BST) is an integrated 8 Heating Boiler control system designed into the C-More controller. The BST has its own sophisticated PID control system designed to simultaneously control the light off and modulation of up to 8 Heating Boilers while achieving maximum operational efficiency.

BST is designed to ensure that all Heating Boilers in the system operate at maximum efficiency. This is accomplished by lighting off Heating Boilers only if all ignited Heating Boilers reach or exceed a defined Valve Position (Fire Rate). Operating all Heating Boilers below the defined Fire Rate “Next on VP” (for Next Turn on Valve Position) insures that they are firing at their most efficient Fire Rate. One C-More unit is defined as the MASTER unit and all other C-More units on the BST Modbus Network are defined as SLAVE units. The Master unit will monitor the system Header Temperature, monitor all Slave units’ status information and efficiently control all units in order to achieve and maintain the required BST Setpoint Temperature.

When there is a demand, the Master unit will light off one of the Heating Boilers based on the BST Sequencing selection in the BST menu. As system load increases and the valve position of the ignited units reach the Next On VP (% valve position), the BST master will light off the next available unit. A simplified block diagram of multiple Heating Boilers connected to a BST is shown in Figure 9-1 below.

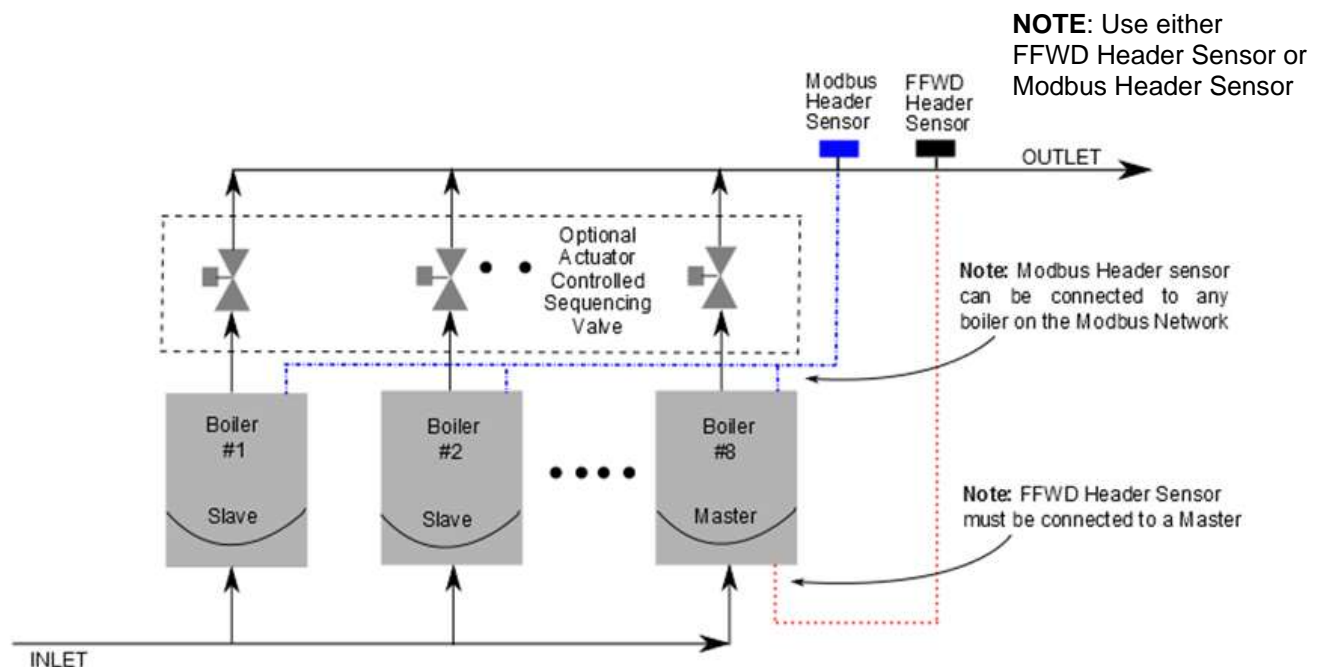


Figure 9-1. Simplified BST Block Diagram

### 9.1.1 Installation Notes

If you are installing a BST system that also includes a ProtoNode SSD (Slave-Slave Device), you **must** adhere to the procedure listed below. Failure to complete these steps can result in the failure of the BST system.

- a) Do **NOT** install the ProtoNode Device at the outset of the installation. If the ProtoNode Device is already installed, you must physically disconnect it from the Modbus network in I/O board.
- b) Make sure that the Modbus load and bias resistors are properly configured for the system to operate without the ProtoNode installed.
- c) Temporarily set the BST system for CONSTANT SETPOINT mode of operation (see below).
- d) Turn on and completely test the installation to verify that it is operating proper.
- e) Once the installation is working properly as a BST system, install the ProtoNode Device.
- f) Make sure that the Modbus load and bias resistors are properly configured for the system to operate with the ProtoNode installed.
- g) Set the BST system for desired mode of operation (SETPOINT mode).
- h) Test the system completely with the ProtoNode installed.

### 9.2 AERCO BST Quick Start Chart

Select the single option that suites your installation and then complete the instructions in the corresponding sub-sections of section 9.3 BST Implementation Instructions.

#### Constant Setpoint (choose option 1 or 2)

**Option 1** – Direct Wired Header      Complete section 9.3.1

**OR**

**Option 2** – Modbus Header              Complete section 9.3.2

#### Outdoor Reset (choose option 3 or 4)

**Option 3** – Direct Wired Header AND Direct Wired Outdoor Air      Complete section 9.3.3

**OR**

**Option 4** – Modbus Header AND Modbus Outdoor Air      Complete section 9.3.4

#### Remote Setpoint (choose option 5 through 8)

**Option 5** – 4-20ma Drive AND Direct Wired Header      Complete section 9.3.5

**OR**

**Option 6** – Modbus Drive AND Direct Wired Header      Complete section 9.3.6

**OR**

**Option 7** – 4-20ma Drive AND Modbus Header      Complete section 9.3.7

**OR**

**Option 8** – Modbus Drive AND Modbus Header      Complete section 9.3.8

### 9.3 BST Implementation Instruction

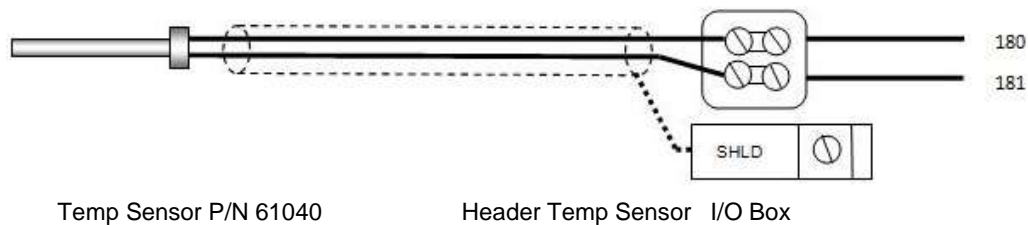
#### 9.3.1 Option 1 - Constant Setpoint with DIRECT Wired Header Sensor

##### Step 1: Direct Wired Header Sensor Wiring

1. On the MASTER Unit, Connect the Header Temperature Sensor (P/N **61040**) to the Feed Forward (FFWD) terminals on the P-1 Harness Via the terminal block labeled **Header Temp sensor** in the I/O Box.

##### NOTES:

- The header sensor must be installed between 2 and 10 feet (0.61 and 3.1m) downstream of the LAST Heating Boiler in the plant's supply water header.
- Shielded pair 18 - 22 AWG cable is recommended for header sensor wiring. There is no polarity to be observed. The ground for the shield is at the "SHLD" terminal in the I/O the Box. The sensor end of the shield must be left free and ungrounded.



##### Step 2: Configure ALL C-More Units

###### On ALL Heating Boilers:

1. Go to the **Configuration** menu item and set the **BST Menu** item to **Enabled**.
2. Go to the **Boiler Sequencing Menu** item and set the **BST Mode** item to **BST Slave** (for now).

###### On MASTER only:

3. Go to the **BST Setpoint** item and enter the desired Setpoint.
4. Go to the **BST Setup** menu item and set to **Enabled**.
5. Go to the **BST Setpoint Mode** item and select **Constant Setpoint**.
6. Go to the **Head Temp Source** item and select **FFWD Temp**.

###### When ALL C-More units have been configured:

7. Go to the **Boiler Sequencing Menu** item of the desired Master unit and set the **BST Mode** item to **BST MASTER**.

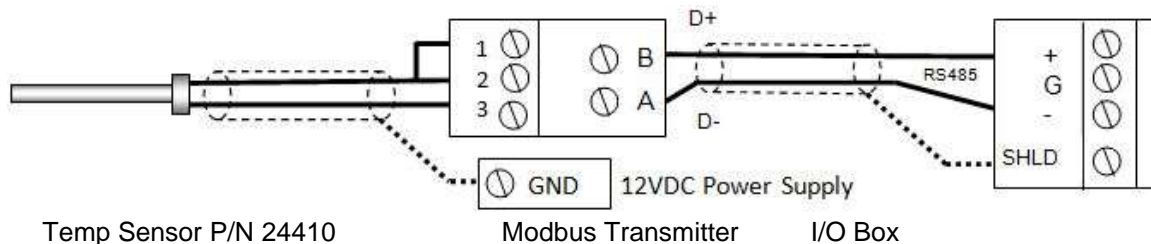
### 9.3.2 Option 2 - Constant Setpoint with MODBUS Wired Header Sensor

#### Step 1: MODbus Header Sensor Wiring

1. Using Shielded pair 18 - 22 AWG cable, connect the Temperature Transmitter (P/N **65169**) terminal Pin B to the RS485+ terminal on the I/O Box of any of the units, and Pin A of the Temperature Transmitter to the RS485- terminal on the I/O Box of any of the units.
2. Using Shielded pair 18 - 22 AWG cable, connect the Modbus Header Temperature Sensor (P/N **24410**) to pins 2 and 3 of the Temperature Transmitter.
3. Install a jumper wire between pins 1 and 2 of the Temperature Transmitter.

#### NOTES:

- Polarity must be observed for the RS485 connections.
- The ground for the shield is at the “SHLD” terminal in the I/O the Box.
- The header sensor must be installed between 2 and 10 feet (0.61 and 3.1m) downstream of the LAST Heating Boiler in the plant’s supply water header.
- There is no polarity to be observed. The ground for the shield is at the power supply ground. The sensor end of the shield must be left free and ungrounded.



#### Step 2: Configure ALL C-More Units

##### On ALL Heating Boilers:

1. Go to the **Configuration** menu item and set the **BST Menu** item to **Enabled**.
2. Go to the **Boiler Sequencing Menu** item and set the **BST Mode** item to **BST Slave** (for now).

##### On MASTER only:

3. Go to the **BST Setpoint** item and enter the desired Setpoint.
4. Go to the **BST Setup Menu** item and set to **Enabled**.
5. Go to the **BST Setpoint Mode** item and select Constant **Setpoint**.
6. Go to the **Head Temp Source** item and select **Network**.
7. Go to the **Header Temp Addr** item and enter the Modbus Address (240).
8. Go to the **Header Temp Point** item and enter the Modbus Point (14).

##### When ALL C-More units have been configured:

9. Go to the **Boiler Sequencing Menu** item of the desired Master unit and set the **BST Mode** item to **BST MASTER**.

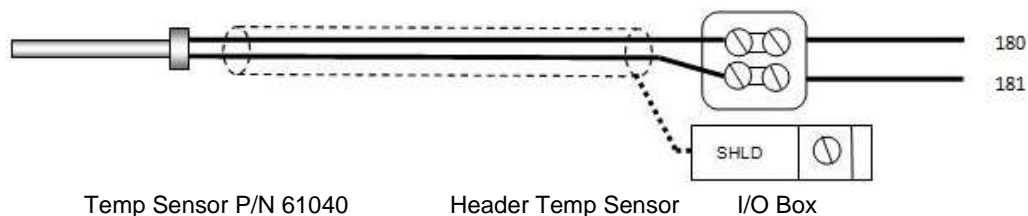
### 9.3.3 Option 3 - Outdoor Reset with DIRECT WIRED Header Sensor AND DIRECT WIRED Outdoor Sensor

**NOTE:** Both Header Sensor AND Outdoor Sensor must be wired.

#### Step 1 - Direct Wired Header Sensor Wiring

1. On the MASTER Unit, connect the Header Temperature Sensor (P/N **61040**) to the Feed Forward (FFWD) terminals on the P-1 Harness Via the terminal block labeled **Header Temp sensor** in the I/O Box.

**NOTES:** The header sensor must be installed between 2 and 10 (0.61 and 3.1m) feet downstream of the LAST Heating Boiler in the plant's supply water header. Shielded pair 18 - 22 AWG cable is recommended for header sensor wiring. There is no polarity to be observed. The ground for the shield is at the "SHLD" terminal in the I/O the Box. The sensor end of the shield must be left free and ungrounded.

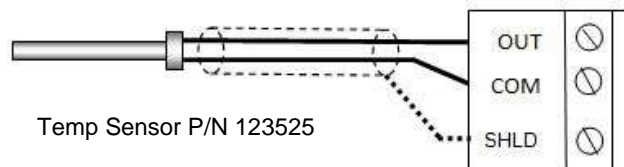


#### Step 2 - Direct Wired Outdoor Sensor

1. On the MASTER Unit, Connect the Outdoor Temperature Sensor (P/N **123525**) to the "OUT" and "COM" terminals in the I/O Box.

#### **NOTES:**

- Twisted shielded pair 18 - 22 AWG cable is recommended for header sensor wiring. There is no polarity to be observed. The ground for the shield is at the "SHLD" terminal in the I/O the Box. The sensor end of the shield must be left free and ungrounded.
- When mounting the Outdoor sensor, it must be located on the North side of the building where an average outside air temperature is expected. The sensor must be shielded from direct sunlight as well as rain and snow. The outdoor sensor may be wired up to 200 feet (61m) from the Heating Boiler.





### Option 3 – Continued

#### Step 3 - Configure ALL C-More Units

##### **On ALL Heating Boilers:**

1. Go to the **Configuration** menu item and set the **BST Menu** item to **Enabled**.
2. Go to the **Boiler Sequencing Menu** item and set the **BST Mode** item to **BST Slave** (for now).

##### **On MASTER only:**

3. Go to the **BST Setpoint** item and enter the Failsafe Setpoint.
4. Go to the **BST Setup Menu** item and set to **Enabled**.
5. Go to the **BST Setpoint Mode** item and select **Outdoor Reset**.
6. Go to the **Head Temp Source** item and select **FFWD Temp**.
7. Go to the **BST Outdoor Sens** item and select **Enabled**.
8. Go to the **Outdoor Temp Source** item and select **Outdoor Temp**.

##### **When ALL C-More units have been configured:**

9. Go to the **Boiler Sequencing Menu** item of the desired Master unit and set the **BST Mode** item to **BST MASTER**.

### 9.3.4 Option 4 - Outdoor Reset with MODBUS Header Sensor AND MODBUS Outdoor Sensor

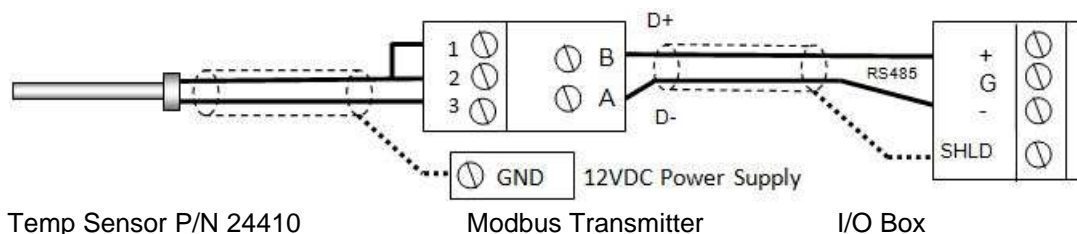
**NOTE:** Both Header Sensor AND Outdoor Sensor must be wired.

#### **Step 1 - Modbus Header Sensor Wiring**

1. Using Shielded pair 18 - 22 AWG cable, connect the Temperature Transmitter (P/N **65169**) terminal Pin B to the RS485+ terminal on the I/O Box of any of the units, and Pin A of the Temperature Transmitter to the RS485- terminal on the I/O Box of any of the units.
2. Using Shielded pair 18 - 22 AWG cable, connect the Modbus Header Temperature Sensor (P/N **24410**) to pins 2 and 3 of the Temperature Transmitter.
3. Install a jumper wire between pins 1 and 2 of the Temperature Transmitter.

#### **NOTES:**

- Polarity must be observed for the RS485 connections. The ground for the shield is at the “SHLD” terminal in the I/O the Box.
- The header sensor must be installed between 2 and 10 feet (0.61 and 3.1m) downstream of the LAST Heating Boiler in the plant’s supply water header.
- There is no polarity to be observed. The ground for the shield is at the power supply ground. The sensor end of the shield must be left free and ungrounded.



#### **Step 2 - Modbus Outdoor Sensor Wiring**

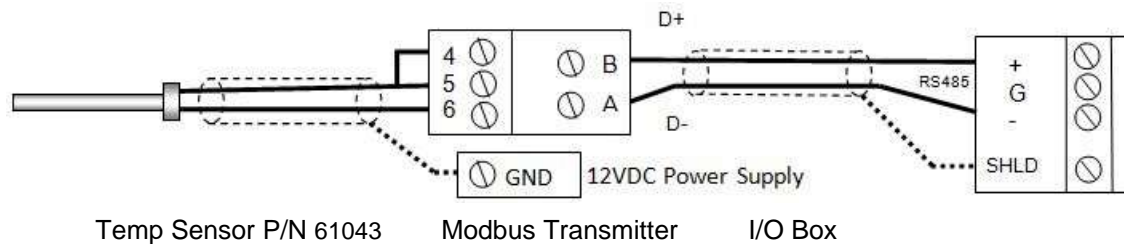
1. If you have not already done so when installing the Modbus Header Sensor, use Shielded pair 18 - 22 AWG cable to connect the Temperature Transmitter terminal Pin B to the RS485+ terminal on the I/O Box of any of the Heating Boiler units, and Pin A of the Temperature Transmitter to the RS485- terminal on the I/O Box of any of the units.
2. Using Shielded pair 18 - 22 AWG cable, connect the Modbus Header Temperature Sensor (P/N **24410**) to pins 2 and 3 of the Temperature Transmitter.
3. Install a jumper wire between pins 1 and 2 of the Temperature Transmitter.

#### **NOTES:**

- Polarity must be observed for the RS485 connections. The ground for the shield is at the “SHLD” terminal in the I/O the Box.
- When mounting the Outdoor sensor, it must be located on the North side of the building where an average outside air temperature is expected. The sensor must be shielded from direct sunlight as well as rain and snow. The outdoor sensor may be wired up to 200 feet (61m) from the Heating Boiler.

### Option 4 – Continued

- There is no polarity to be observed. The ground for the shield is at the power supply ground. The sensor end of the shield must be left free and ungrounded.



### Step 3 - Configure ALL C-More Units

#### **On ALL Heating Boilers:**

1. Go to the **Configuration** menu item and set the **BST Menu item to Enabled**.
2. Go to the **Boiler Sequencing Menu** item and set the **BST Mode** item to **BST Slave** (for now).

#### **On MASTER only:**

3. Go to the **BST Setpoint** item and enter the Failsafe Setpoint.
4. Go to the **BST Setup Menu** item and set to **Enabled**.
5. Go to the **BST Setpoint Mode** item and select **Outdoor Reset**.
6. Go to the **Head Temp Source** item and select **Network**.
7. Go to the **Header Temp Addr** item and enter the Modbus Address (240).
8. Go to the **Header Temp Point** item and enter the Modbus Point (14).
9. Go to the **BST Outdoor Sens** item and select **Enabled**.
10. Go to the **Outdoor Temp Source** item and select **Network**.
11. Go to the **Outdoor Temp Addr** item and enter the Modbus Address (240).
12. Go to the **Outdoor Temp Point** item and enter the Modbus Point (15).

#### **When ALL C-More units have been configured:**

13. Go to the **Boiler Sequencing Menu** item of the desired Master unit and set the **BST Mode** item to **BST MASTER**.

### 9.3.5 Option 5 - Remote Setpoint with DIRECT WIRED Header Sensor AND 4-20ma Setpoint Drive

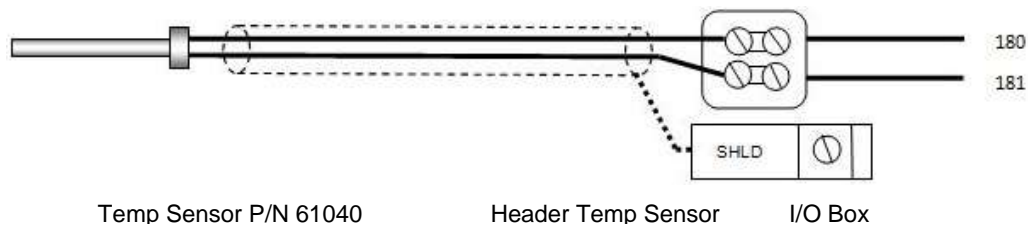
**NOTE:** Both Header Sensor AND 4-20ma Direct Drive must be wired.

#### **Step 1: Direct Wired Header Sensor Wiring**

1. On the MASTER Unit, Connect the Header Temperature Sensor (P/N **61040**) to the Feed Forward (FFWD) terminals on the P-1 Harness Via the terminal block labeled **Header Temp sensor** in the I/O Box.

#### **NOTES:**

- The header sensor must be installed between 2 and 10 feet (0.61 and 3.1m) downstream of the LAST Heating Boiler in the plant's supply water header.
- Shielded pair 18 - 22 AWG cable is recommended for header sensor wiring.
- There is no polarity to be observed.
- The ground for the shield is at the "SHLD" terminal in the I/O the Box.
- The sensor end of the shield must be left free and ungrounded.

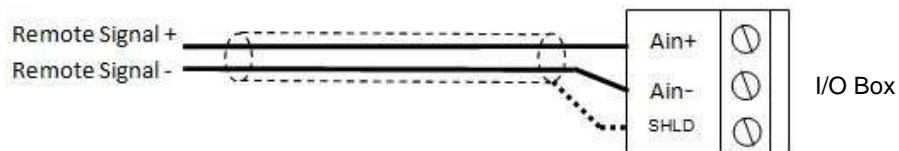


#### **Step 2: Direct Wired 0-20ma or 4-20ma Wiring**

1. Connect the 4-20ma or 0-20ma terminals from the Direct Drive source to the Ain+ and Ain- terminals on the Master Unit's I/O Box.

#### **NOTE:**

- Shielded pair 18 - 22 AWG cable is recommended for this connection. Polarity must be observed.
- The ground for the shield is at the driver signal source.



### Option 5 – Continued

#### Step 3: Configure ALL C-More Units

##### **On ALL Heating Boilers:**

1. Go to the **Configuration** menu item and set the **BST Menu** item to **Enabled**.
2. Go to the **Boiler Sequencing Menu** item and set the **BST Mode** item to **BST Slave** (for now).

##### **On MASTER only:**

3. Go to the **BST Setpoint** item and enter the Failsafe Setpoint.
4. Go to the **BST Setup Menu** item and set to **Enabled**.
5. Go to the **BST Setpoint Mode** item and select **Remote Setpoint**.
6. Go to the **Head Temp Source** item and select **FFWD Temp**.
7. Go to the **BST Remote Signal** and select either **4-20ma** or **0-20ma**.

##### **When ALL C-More units have been configured:**

8. Go to the **Boiler Sequencing Menu** item of the desired Master unit and set the **BST Mode** item to **BST MASTER**.

### 9.3.6 Option 6 - Remote Setpoint with DIRECT WIRED Header Sensor AND MODBUS Setpoint Drive

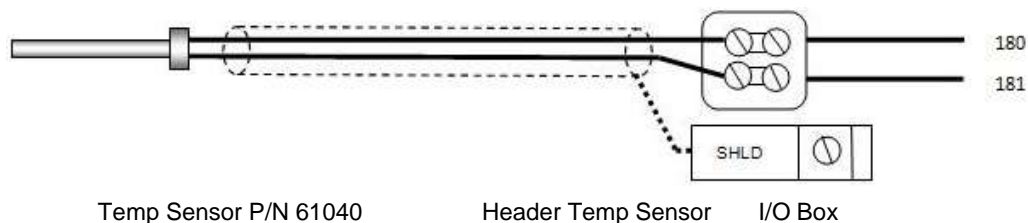
**NOTE:** Both Header Sensor AND the ProtoNode SSD Device must be wired.

#### Step 1: Direct Wired Header Sensor Wiring

1. On the MASTER Unit, Connect the Header Temperature Sensor (P/N **61040**) to the Feed Forward (FFWD) terminals on the P-1 Harness Via the terminal block labeled **Header Temp sensor** in the I/O Box.

#### **NOTES:**

- The header sensor must be installed between 2 and 10 feet (0.61 and 3.1m) downstream of the LAST Heating Boiler in the plant's supply water header.
- Shielded pair 18 - 22 AWG cable is recommended for header sensor wiring. There is no polarity to be observed. The ground for the shield is at the "SHLD" terminal in the I/O the Box. The sensor end of the shield must be left free and ungrounded.



#### Step 2: Remote Setpoint with Network

1. Configure and Connect the SSD Device (ProtoNode) per the AERCO Manual (GF129).

#### Step 3: Configure ALL C-More Units

##### **On ALL Heating Boilers:**

1. Go to the **Configuration** menu item and set the **BST Menu** item to **Enabled**.
2. Go to the **Boiler Sequencing Menu** item and set the **BST Mode** item to **BST Slave** (for now).

##### **On Master only:**

3. Go to the **BST Setpoint** item and enter the Failsafe Setpoint.
4. Go to the **BST Setup Menu** item and set to **Enabled**.
5. Go to the **BST Setpoint Mode** item and select **Remote Setpoint**.
6. Go to the **Head Temp Source** item and select **FFWD Temp**.
7. Go to the **BST Remote Signal** item and select **Network**.

##### **When ALL C-More units have been configured:**

8. Go to the **Boiler Sequencing Menu** item of the desired Master unit and set the **BST Mode** item to **BST MASTER**.

### 9.3.7 Option 7 - Remote Setpoint with MODBUS Header Sensor AND 4-20ma Setpoint Drive

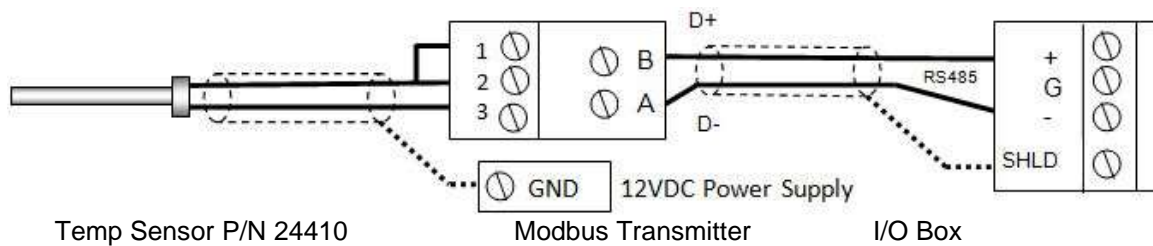
**NOTE:** Both Header Sensor AND 4-20ma Direct Drive must be wired.

#### Step 1: MODbus Header Sensor

1. Using Shielded pair 18 - 22 AWG cable, Connect the Temperature Transmitter (P/N **65169**) terminal Pin B to the RS485+ terminal on the I/O Box of any of the units, and Pin A of the Temperature Transmitter to the RS485- terminal on the I/O Box of any of the units.
2. Using Shielded pair 18 - 22 AWG cable, connect the Modbus Header Temperature Sensor (P/N **24410**) to pins 2 and 3 of the Temperature Transmitter.
3. Install a jumper wire between pins 1 and 2 of the Temperature Transmitter.

#### **NOTES:**

- Polarity must be observed for the RS485 connections. The ground for the shield is at the “SHLD” terminal in the I/O the Box.
- The header sensor must be installed between 2 and 10 feet (0.61 and 3.1m) downstream of the LAST Heating Boiler in the plant’s supply water header.
- There is no polarity to be observed. The ground for the shield is at the power supply ground. The sensor end of the shield must be left free and ungrounded.

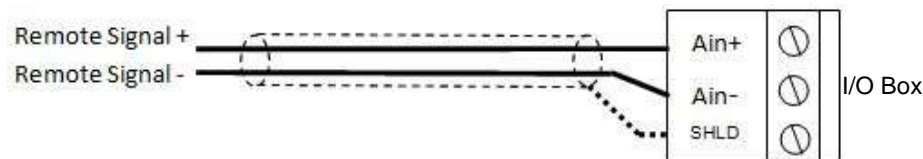


#### Step 2: Direct Wired 0-20ma or 4-20ma Wiring

1. Connect the 4-20ma or 0-20ma terminals from the Direct Drive source to the Ain+ and Ain- terminals on the Master.

#### **NOTES:**

- Unit’s I/O Box. Shielded pair 18 - 22 AWG cable is recommended for this connection. Polarity must be observed.
- The ground for the shield is at the driver signal source.





### Option 7 – Continued

#### Step 3: Configure ALL C-More Units

##### **On ALL Heating Boilers:**

1. Go to the **Configuration** menu item and set the **BST Menu** item to **Enabled**.
2. Go to the **Boiler Sequencing Menu** item and set the **BST Mode** item to **BST Slave** (for now).

##### **On MASTER only:**

3. Go to the **BST Setpoint** item and enter the Failsafe Setpoint.
4. Go to the **BST Setup Menu** item and set to **Enabled**.
5. Go to the **BST Setpoint Mode** item and select Remote **Setpoint**.
6. Go to the **BST Remote Signal** and select either **4-20ma** or **0-20ma**.
7. Go to the **Head Temp Source** item and select **Network**.
8. Go to the **Header Temp Addr** item and enter the Modbus Address (240).
9. Go to the **Header Temp Point** item and enter the Modbus Point (14).

##### **When ALL C-More units have been configured:**

10. Go to the **Boiler Sequencing Menu** item of the desired Master unit and set the **BST Mode** item to **BST MASTER**.

### 9.3.8 Option 8 - Remote Setpoint with MODBUS Header Sensor AND MODBUS Setpoint Drive

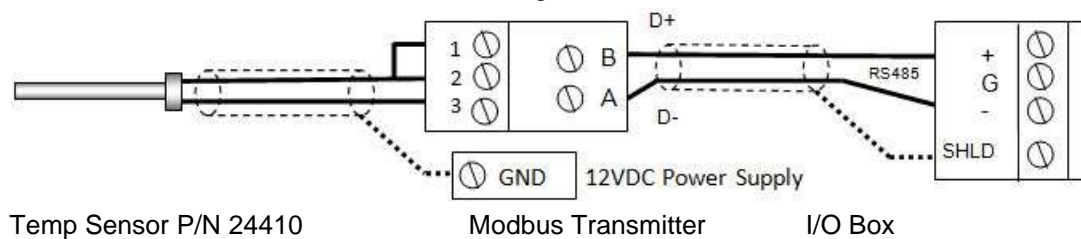
**NOTE!** Both Header Sensor AND ProtoNode SSD Device must be wired.

#### **Step 1: MODbus Header Sensor**

1. Using Shielded pair 18 - 22 AWG cable, Connect the Temperature Transmitter (P/N **65169**) terminal Pin B to the RS485+ terminal on the I/O Box of any of the units, and Pin A of the Temperature Transmitter to the RS485- terminal on the I/O Box of any of the units.
2. Using Shielded pair 18 - 22 AWG cable, connect the Modbus Header Temperature Sensor (P/N **24410**) to pins 2 and 3 of the Temperature Transmitter.
3. Install a jumper wire between pins 1 and 2 of the Temperature Transmitter.

#### **NOTES:**

- Polarity must be observed for the RS485 connections. The ground for the shield is at the “SHLD” terminal in the I/O the Box.
- The header sensor must be installed between 2 and 10 feet (0.61 and 3.1m) downstream of the LAST Heating Boiler in the plant’s supply water header.
- There is no polarity to be observed. The ground for the shield is at the power supply ground. The sensor end of the shield must be left free and ungrounded.



#### **Step 2: Remote Setpoint with Network**

1. Configure and Connect the SSD Device (ProtoNode) per the AERCO Manual (GF129).

### Option 8 – Continued

#### Step 3: Configure ALL C-More Units

##### **On ALL Heating Boilers:**

1. Go to the **Configuration** menu item and set the **BST Menu** item to **Enabled**.
2. Go to the **Boiler Sequencing Menu** item and set the **BST Mode** item to **BST Slave** (for now).

##### **On MASTER only:**

3. Go to the **BST Setpoint** item and enter the failsafe Setpoint.
4. Go to the **BST Setup Menu** item and set to **Enabled**.
5. Go to the **BST Setpoint Mode** item and select Remote **Setpoint**.
6. Go to the **BST Remote Signal** and select either **Network**.
7. Go to the **Head Temp Source** item and select **Network**.
8. Go to the **Header Temp Addr** item and enter the Modbus Address (240).
9. Go to the **Header Temp Point** item and enter the Modbus Point (14).

When ALL C-More units have been configured:

10. Go to the **Boiler Sequencing Menu** item of the desired Master unit and set the **BST Mode** item to **BST MASTER**.

## **Appendix A: HEATING BOILER MENU ITEM DESCRIPTIONS**

**Table A-1: Operating Menu Item Descriptions**

See section 3-4 for a range of choices and the default values.

| <b>Table A-1: OPERATING MENU ITEM DESCRIPTIONS</b> |                    |   |
|--|--------------------|---|
| <b>MENU OPTIONS</b>                                |                    | <b>DESCRIPTION</b>  |
| 1  | Active Setpoint    | This is the setpoint temperature to which the control is set when operating in the Constant Setpoint, Remote Setpoint or Outdoor Reset Mode. When in the Constant Setpoint Mode, this value is equal to the Internal Setpoint setting in the Configuration Menu. When in the Remote Setpoint Mode, this value is the setpoint equivalent to the remote analog signal supplied to the unit. When in the Outdoor Reset Mode, this is the derived value from the charts in Appendix E. |
| 2  | Inlet Temp         | Displays the inlet water temperature.   |
| 3  | Air Temp           | Air Temp is the air temperature at the input to the Air/Fuel Valve. This reading is one of the parameters used to control the Blower Motor speed.   |
| 4  | Outdoor Temp       | Outdoor temperature is displayed in °F or °C, only if outdoor temperature sensor is installed and enabled.  |
| 5  | Valve Position In  | Desired input valve position. This would normally be the same as the fire valve position shown on the bar graph (valve position out) when the Heating Boiler is operating.  |
| 6  | Valve Position Out | Displays actual real time Valve Position.   |
| 7  | Exhaust Temp       | Displays the exhaust temperature in °F (default) or °C.   |
| 8  | Flame Strength     | Displays flame strength from 0% to 100%.  |
| 9  | Oxygen Level       | Displays the real-time combustion oxygen (O <sub>2</sub> ) level (%) measured by the O <sub>2</sub> sensor.   |
| 10   | Ignition Time      | Displays the elapsed time between confirmation of gas valve opening (POC) until a stable flame is detected.   |
| 11   | SSOV Time to OPN   | Displays the elapsed time between 120VAC being applied to the Gas Valve and confirmation of gas valve opening (POC).  |
| 12   | Spark Current      | Displays the current going to the ignition transformer.   |
| 13   | Run Cycles         | Displays the total number of run cycles.  |
| 14   | Run Hours          | Displays total run time of unit in hours.   |
| 15   | Fault Log          | Displays information on the last 20 faults.   |

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## APPENDIX A: BOILER MENU DESCRIPTIONS

**Table A-2: Setup Menu Item Descriptions**

See section 3-5 for a range of choices and the default values.

| SETUP MENU   |                  |   |
|--------------|------------------|---|
| MENU OPTIONS |                  | DESCRIPTION   |
| 1            | Password         | Allows Level 1 or Level 2 password to be entered.<br>Entering the Level 1 Password (159) allows options in the <i>Setup</i> , <i>Configuration</i> and <i>Tuning</i> menus to be modified.<br>Entering the Level 2 Password (6817) allows options in the Calibration and Diagnostics Menus to be changed or activated, in addition to all Level 1 Menu options. |
| 2            | Language         | Permits selection of English, Spanish or French for displayed messages.   |
| 3            | Time             | Displays time from 12:00 am to 11:59 pm.  |
| 4            | Date             | Displays dates from 01/01/00 to 12/31/99  |
| 5            | Unit of Temp     | Permits selection of temperature displays in degrees Fahrenheit (°F) or degrees Celsius (°C).   |
| 6            | Comm Address     | For RS-485 communications (0 to 127). RS232 should have its own (programmable) password.  |
| 7            | Baud Rate        | Allows communications Baud Rate to be set (2400 to 19.2K). Default is 9600.   |
| 8            | OnAER Mode       | Allows selection of either Ethernet or SD Card  |
| 9            | Min Upload Timer | Mandatory for AERCO OnAER Remote Data Collection (ORDC). This parameter enables ORDC and defines the minimum amount of time between heartbeat data uploads in seconds. The COMM LED will light during the upload.   |
| 10           | Unit Alpha       | Mandatory for AERCO OnAER Remote Data Collection. This value must match the first alpha digit on the Code Plate, e.g., <b>G</b> -12-1234.   |
| 11           | Unit Year        | Mandatory for AERCO OnAER Remote Data Collection. This value must match the 2-digit year on the Code Plate, e.g., G- <b>12</b> -1234.   |
| 12           | Unit Serial #    | Mandatory for AERCO OnAER. Remote Data Collection. This value must match the 4-digit serial # on the Code Plate, e.g., G-12- <b>1234</b> .  |
| 13           | Software Version | Identifies the current software version of the control box.   |

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## APPENDIX A: BOILER MENU DESCRIPTIONS

**Table A-3: Configuration Menu Item Descriptions**

See section 3-6 for a range of choices and the default values.

The *Configuration* menu settings are Factory-Set in accordance with the requirements specified with each individual order. No changes will be required under normal operating conditions.

| CONFIGURATION MENU |                    |   |
|--------------------|--------------------|---|
| MENU OPTIONS       |                    | DESCRIPTION   |
| 1                  | Internal Setpoint  | Allows internal setpoint to be set from 40°F to 240°F (4.4°C to 115.6°C)  |
| 2                  | Unit Type          | Can be one of the following: BMK Blr Std, BMK Blr Std Dual, BMK Blr LN, BMK Blr LN Dual.  |
| 3                  | Unit Size          | Sets unit size, depending on the Unit Type:<br>Benchmark 1500 – 1500 MBH (440 kW)<br>Benchmark 2000 – 2000 MBH (586 kW)   |
| 4                  | Fuel Type          | Allows selection of Natural Gas or Propane.   |
| 5                  | Boiler Mode        | Only if Unit Type = Boiler. Allows selection of: Constant Setpoint, Remote Setpoint, Direct Drive, Combination, or Outdoor Reset Mode.  |
| 6                  | Remote Signal      | Only available if Mode = Remote Setpoint, Direct Drive or Combination. Used to set the type of external signal which will be used when operating in the Remote Setpoint, Direct Drive or Combination Mode.                  |
| 7                  | Outdoor Sensor     | Allows outdoor sensor function to be set to Enabled or Disabled.  |
| 8                  | Bldg Ref Temp      | Only available if Boiler Mode = <b>Outdoor Reset</b> . Allows the building reference temperature to be set when operating a Heating Boiler in the Outdoor Reset Mode.   |
| 9                  | Reset Ratio        | Only available if Boiler Mode = <b>Outdoor Reset</b> . Permits setting of Reset Ratio when operating Heating Boiler in the Outdoor Reset Mode.  |
| 10                 | System Start Tmp   | Only if Outdoor Sensor = <b>Enabled</b> . This menu item allows the system start temperature to be set.   |
| 11                 | Setpt Lo Limit     | Used to set the <i>minimum</i> allowable setpoint, from 40°F (4.4°C) up to the Setpt Hi Limit.  |
| 12                 | Setpt Hi Limit     | Used to set the <i>maximum</i> allowable setpoint, from the Setpt Lo Limit up to 210°F (98.9°C).  |
| 13                 | Temp Hi Limit      | This is the maximum allowable outlet temperature, up to 210°F (98.9°C). Any temperature above this setting will turn off the unit. The temperature must then drop 5°F (2.75°C) below this setting to allow the unit to run. |
| 14                 | Max Valve Position | Sets the maximum allowable valve position for the unit.   |
| 15                 | Pump Delay Timer   | Specifies the amount of time, up to 30 minutes, to keep the pump running after the unit turns off.  |

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## APPENDIX A: BOILER MENU DESCRIPTIONS

| CONFIGURATION MENU |                  |  |
|--------------------|------------------|--|
| MENU OPTIONS       |                  | DESCRIPTION  |
| 16                 | Aux Start On Dly | Specifies the amount of time to wait, up to 120 seconds, between activating the Aux Relay (due to a demand) and checking the pre-purge string to start the Heating Boiler.   |
| 17                 | Failsafe Mode    | Allows the Failsafe mode to be set to either Constant Setpoint or Shutdown.  |
| 18                 | Analog Output    | Must be set to <b>Valve Pos 0-10V</b> for both BMK 1500 and BMK 2000. <b>DO NOT CHANGE from its default value.</b>   |
| 19                 | Lo Fire Timer    | Specifies how long, from 2 to 600 seconds, to remain in the low fire position after ignition, before going to the desired output.  |
| 20                 | Setpt Limiting   | Setpoint Limiting can be Enabled or Disabled.  |
| 21                 | Setpt Limit Band | The Setpoint Limit Band can be set from <b>0°F to 10°F (0°C to 5.5°C)</b> .  |
| 22                 | Network Timeout  | Specifies the timeout value in seconds before a Modbus fault is declared, up to 999 seconds  |
| 23                 | Shutoff Dly Temp | This feature delays the shutdown of a Heating Boiler in order to reduce excessive cycling. This specifies the temperature value the Outlet Temperature is permitted to rise above setpoint before being shut down.   |
| 24                 | Demand Offset    | This entry will reduce excessive ON/OFF cycling in AUTO mode. When this entry is a non-zero value, the unit will not turn on again until <i>Valve Position In</i> reaches the Start Level value AND the Outlet Temperature goes below the <i>Active Setpoint – Demand Offset</i> . In addition, the Heating Boiler will fire at the 29% Valve Position level or below for a period of one minute.<br><br>When this entry is set to zero, the unit will turn on again as soon as the <i>Valve Position in</i> reaches the <i>Start Level</i> value. There will not be a one minute delay when firing at the 29% Valve Position level. |



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## APPENDIX A: BOILER MENU DESCRIPTIONS

| CONFIGURATION MENU |                    |  |
|--------------------|--------------------|--|
| MENU OPTIONS       |                    | DESCRIPTION  |
| 25                 | Deadband High      | <p>Deadband High and Deadband Low settings create an “Outlet Temperature” Zone in which no Valve Position corrections will be attempted.</p> <p>The Deadband ZONE is defined as operating with an Outlet Temperature between Active Setpoint + Deadband High and Active Setpoint – Deadband Low.</p> <p>When the Outlet Temperature reaches Active Setpoint and remains there for a period of 15 seconds, the unit will go into a DEADBAND MODE at which point no Valve Position corrections will be attempted while the Outlet Temperature remains anywhere within the Deadband ZONE. When the unit is in the DEADBAND MODE, the °F or °C LED will flash on and off. When the Outlet Temperature drifts out of the Deadband ZONE, the DEADBAND MODE will be terminated and the PID LOOP will again attempt Valve Position corrections.</p> <p>Setting range is 0°F (0°C) to 25°F (13.75°C). Default is 5°F (2.75°C) for both Deadband High and Deadband Low).</p> |
| 26                 | Deadband Low       |  |
| 27                 | IGST Version       | Displays the version of the IGST Board installed.  |
| 28                 | IGN Time Setting   | Displays the MAX Ignition time of 4 Seconds or 7 Seconds as set in the Safety String Harness.  |
| 29                 | Slow Shutdown      | Set the Slow Shutdown feature to Enabled or Disabled.  |
| 30                 | Slow Sht Duration  | If Slow Shutdown = <b>Enabled</b> , sets the time a Heating Boiler will continue to run at the Stop Level after running above the Slow Sht Threshold level, up to 9,999 seconds.   |
| 31                 | Slow Sht Threshold | Sets the Fire Rate above which a Heating Boiler will trigger the Slow Shutdown feature.  |
| 32                 | BST Menu           | When set to Enabled, the BST menu options appears.   |

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## APPENDIX A: BOILER MENU DESCRIPTIONS

**Table A-4: Tuning Menu Item Descriptions**

See section 3-7 for a range of choices and the default values.

| <b>TUNING MENU</b>  |                  |   |                      |
|---|------------------|---|----------------------|
| <b>MENU OPTIONS</b>   |                  | <b>DESCRIPTION</b>  |                      |
| 1   | Prop Band        | Generates a fire rate based on the error that exists between the setpoint temperature and the actual outlet temperature. If the actual error is less than the proportional band setting (1°F to 120°F, 0.55°C to 66°C), the fire rate will be less than 100%. If the error is equal to or greater than the proportional band setting, the fire rate will be 100%. |                      |
| 2   | Integral Gain    | This sets the fraction of the output, due to setpoint error, to add or subtract from the output each minute to move towards the setpoint. Gain is adjustable from 0.00 to 1.00 (Default is 1.0).  |                      |
| 3   | Derivative Time  | This value (0.0 to 2.0 min.) responds to the rate of change of the setpoint error. This is the time that this action advances the output.   |                      |
| <p><b>Warmup</b> – The feature embodied in menu items 4, 5 and 6 eliminates Temperature Overshoots during the “Warmup” period of a cold ignition cycle on all Heating Boilers by temporarily modifying the PID Gain parameter during warmup and for a period defined in the <i>Tuning</i> menu.</p> |                  |   |                      |
| 4   | Warmup Prop Band | Range = 1 – 120°F (0.55°C to 66°C)  | Default = 95 (52°C)  |
| 5   | Warmup Int Gain  | Range = 0.00 – 2.00   | Default = .50        |
| 6   | Warmup PID Timer | Range = 0 - 240 seconds   | Default = 20 seconds |
| 7   | Reset Defaults?  | Allows <i>Tuning</i> menu options to be reset to their Factory Default values.  |                      |

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## APPENDIX A: BOILER MENU DESCRIPTIONS

**Table A-5: Combustion Calibration Menu Item Descriptions**

See section 3-8 for a range of choices and the default values.

### NOTE

The Level 2 Password must be entered to view the options in the *Combustion Cal* menu. This Menu is used during the Combustion Calibration procedures described in Chapter 4 of this Manual.

| <b>COMBUSTION CAL MENU</b> |  |   |
|----------------------------|--|---|
|                            | <b>MENU OPTION</b>                                       | <b>DESCRIPTION</b>  |
| 1                          | CAL Voltage BMK 1500 = 16%<br>CAL Voltage BMK 2000 = 18% | Displays the default DC drive voltage provided to the blower at each of the Air/Fuel Valve positions show in the left-hand column. This drive voltage adjusts the rotational speed of the blower to maximize combustion efficiency. |
| 2                          | CAL Voltage 30%  |   |
| 3                          | CAL Voltage 40%  |   |
| 4                          | CAL Voltage 50%  |   |
| 5                          | CAL Voltage 70%  |   |
| 6                          | CAL Voltage 100%   |   |
| 7                          | Set Valve Position                                       | Permits selection of the Air/Fuel Valve position (% open) to be set from 0 to 100%.   |
| 8                          | Blower Output  | Permits the DC drive voltage to the blower to be monitored.   |
| 9                          | Set Stby V out   | Permits the Standby Voltage to be set from 0 to 4.00 Volts.   |
| 10                         | Oxygen Level   | Permits the combustion oxygen level to be displayed (0% to 25%)   |
| 11                         | Spark Monitor  | Enables or Disables the Spark Monitor   |
| 12                         | Min Spark Amps   | Permits changing the Minimum Spark Amp setting  |
| 13                         | Max Spark Amps   | Permits changing the Maximum Spark Amp setting  |

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### Appendix B: STARTUP, STATUS & DISPLAY MESSAGES

*Table B-1: Startup And Status Messages*

| MESSAGE                              | DESCRIPTION  |
|--------------------------------------|--|
| DEMAND DELAY<br>XX sec               | Displayed if Demand Delay is active.   |
| DISABLED<br>HH:MM pm, pm<br>MM/DD/YY | Displayed if ON/OFF switch is set to <b>OFF</b> . The display also shows the time (am or pm) and date that the unit was disabled.  |
| FLAME PROVEN                         | Displayed after flame has been detected for a period of 2 seconds. Initially, the flame strength is shown in %. After 5 seconds has elapsed, the time and date are shown in place of flame strength. |
| IGNITION TRIAL<br>XX sec             | Displayed during ignition trial of startup sequence. The duration of cycle counts up in seconds.   |
| PURGING<br>XX sec                    | Displayed during the purge cycle during startup. The duration of the purge cycle counts up in seconds.   |
| STANDBY                              | Displayed when ON/OFF switch is in the <b>ON</b> position, but there is no demand for heat. The time and date are also displayed.  |
| WAIT                                 | Prompts the operator to wait.  |
| WARMUP<br>XX sec                     | Displayed for 2 minutes during the initial warm-up only.   |

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## APPENDIX B – STARTUP, STATUS & DISPLAY MESSAGES

**Table B-2: Fault Messages**

| FAULT MESSAGE                  | FAULT DESCRIPTION  |
|--------------------------------|--|
| AIRFLOW FAULT DURING PURGE     | The Blower Proof switch opened during purge, or air inlet is blocked.                    |
| AIRFLOW FAULT DURING IGN       | The Blower Proof switch opened during ignition.  |
| AIRFLOW FAULT DURING RUN       | The Blower Proof switch opened during run.   |
| DELAYED INTERLOCK OPEN         | The Delayed Interlock is open.   |
| DIRECT DRIVE SIGNAL FAULT      | The direct drive signal is not present or is out of range.                               |
| FFWD TEMP SENSOR FAULT         | The temperature measured by the Feed Forward (FFWD) Sensor is out of range.              |
| FLAME LOSS DURING IGN          | The Flame signal was not seen during ignition or lost within 5 seconds after ignition.   |
| FLAME LOSS DURING RUN          | The Flame signal was lost during run.  |
| HEAT DEMAND FAILURE            | The Heat Demand Relays on the Ignition board failed to activate when commanded.          |
| HIGH EXHAUST TEMPERATURE       | The Exhaust Temperature has exceeded 200°F (93.3°C).                                     |
| GAS PRESSURE FAULT             | The High Gas Pressure Limit switch is open or the Low Gas Pressure Limit switch is open. |
| HIGH WATER TEMPERATURE         | The temperature measured by the Outlet Sensor exceeded the Temp Hi Limit setting.        |
| HIGH WATER TEMP SWITCH OPEN    | The High Water Temperature Limit switch is open.   |
| IGN BOARD COMM FAULT           | A communication fault has occurred between the PMC board and Ignition board.             |
| IGN SWTCH CLOSED DURING PURGE  | The Ignition Position Limit switch on the Air/Fuel Valve closed during purge.            |
| IGN SWTCH OPEN DURING IGNITION | The Ignition Position Limit switch on the Air/Fuel Valve opened during ignition.         |
| INTERLOCK OPEN                 | The Remote Interlock is open.  |
| LINE VOLTAGE OUT OF PHASE      | The Line (Hot) and Neutral wires are reversed.   |

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## APPENDIX B – STARTUP, STATUS & DISPLAY MESSAGES

**Table B-2: Fault Messages – Continued**

| FAULT MESSAGE                    | FAULT DESCRIPTION   |
|----------------------------------|---|
| LOW WATER LEVEL                  | The Low Water Cutoff board is indicating low water level.   |
| NETWORK COMM FAULT               | The RS-485 network information is not present or is corrupted.  |
| O <sub>2</sub> % OUT OF RANGE    | The O <sub>2</sub> % has gone below 3% or above 8%.   |
| OUTDOOR TEMP SENSOR FAULT        | The temperature measured by the Outdoor Air Sensor is out of range.   |
| OUTLET TEMP SENSOR FAULT         | The temperature measured by the Outlet Sensor is out of range: <ul style="list-style-type: none"><li>• OUTLET TEMPERATURE display = SHt Indicates sensor is shorted</li><li>• OUTLET TEMPERATURE display = Opn indicates sensor is open-circuited</li></ul> |
| PRG SWTCH CLOSED DURING IGNITION | The Purge Position Limit switch on the Air/Fuel Valve closed during ignition.   |
| PRG SWTCH OPEN DURING PURGE      | The Purge Position Limit switch on the Air/Fuel Valve opened during purge.  |
| REMOTE SETPT SIGNAL FAULT        | The Remote Setpoint signal is not present or is out of range.   |
| RESIDUAL FLAME                   | The Flame signal was seen for more than 60 seconds during standby.  |
| SSOV SWITCH OPEN                 | The SSOV switch opened during standby.  |
| SSOV FAULT DURING PURGE          | The SSOV switch opened during purge.  |
| SSOV FAULT DURING IGN            | The SSOV switch closed or failed to open during ignition.   |
| SSOV FAULT DURING RUN            | The SSOV switch closed for more than 15 seconds during run.   |
| SSOV RELAY FAILURE               | A failure has been detected in one of the relays that control the SSOV.   |
| STEPPER MOTOR FAILURE            | The Stepper Motor failed to move the Air/Fuel Valve to the desired position.  |

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**Appendix C: SENSOR RESISTANCE/VOLTAGE CHART**

*Temperature Sensor Resistance Voltage Chart  
(Balco)*

| TEMPERATURE |       | RES (OHMS) | VOLTS* |
|-------------|-------|------------|--------|
| °F          | °C    |            |        |
| -40         | -40   | 779.0      | 1.93   |
| -30         | -34.4 | 797.5      | 1.96   |
| -20         | -28.9 | 816.3      | 1.99   |
| -10         | -23.3 | 835.4      | 2.02   |
| 0           | -17.2 | 854.8      | 2.05   |
| 10          | -12.2 | 874.6      | 2.07   |
| 20          | -6.7  | 894.7      | 2.10   |
| 30          | -1.1  | 915.1      | 2.12   |
| 40          | 4.4   | 935.9      | 2.15   |
| 50          | 10    | 956.9      | 2.17   |
| 60          | 15.5  | 978.3      | 2.20   |
| 70          | 21.1  | 1000.0     | 2.23   |
| 80          | 26.7  | 1022.0     | 2.25   |
| 90          | 32.2  | 1044.4     | 2.27   |
| 100         | 37.8  | 1067.0     | 2.30   |
| 110         | 43.3  | 1090.0     | 2.32   |
| 120         | 48.9  | 1113.3     | 2.34   |
| 130         | 54.4  | 1137.0     | 2.36   |
| 140         | 60    | 1160.9     | 2.39   |
| 150         | 65.6  | 1185.2     | 2.41   |
| 160         | 71.1  | 1209.5     | 2.43   |
| 170         | 76.7  | 1234.7     | 2.45   |
| 180         | 82.2  | 1260.0     | 2.47   |
| 190         | 87.8  | 1285.6     | 2.50   |
| 200         | 93.3  | 1311.4     | 2.52   |
| 210         | 98.9  | 1337.7     | 2.54   |
| 220         | 104.4 | 1364.2     | 2.56   |
| 230         | 110   | 1391.0     | 2.58   |
| 240         | 115.6 | 1418.2     |        |
| 250         | 121.1 | 1445.7     |        |

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## APPENDIX C – SENSOR RESISTANCE/VOLTAGE CHART

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### Appendix D: RECOMMENDED PERIODIC TESTING

#### --WARNING! --

Periodic testing of all Heating Boiler controls and safety devices is required to determine that they are operating as designed. Precautions shall be taken while tests are being performed to protect against bodily injury and property damage. The owner or user of an automatic Heating Boiler system should set up a formal system of periodic preventive maintenance and testing. Tests should be conducted on a regular basis and the results recorded in a log-book.

| Item  | Frequency     | Accomplished By    | Remarks  |
|---|---------------|--------------------|--|
| <b>Refer to indicated sections of this manual for detailed procedures</b> |               |                    |  |
| Gauges, monitors and indicators   | Daily         | Operator           | Visual inspection and record readings in operator log  |
| Instrument and equipment settings   | Daily         | Operator           | Visual check against factory recommended specifications  |
|   | Weekly        | Operator           | Verify factory settings  |
| Firing Rate Control   | Semi-Annually | Service Technician | Verify factory settings  |
|   | Annually      | Service Technician | Check with combustion calibration test equipment. See sections 4.3 and 7.4.                    |
| Flue, vent, stack or intake air duct                                      | Monthly       | Operator           | Visually inspection condition and check for obstructions                                       |
| Spark Igniter-Injector  | Weekly        | Operator           | See section 7.2  |
| Air/Fuel Valve position   | Weekly        | Operator           | Check position indicator dial (section 3.10)   |
| SSOV Leakage test   | Annually      | Service Technician | Check for leakage in accordance with the SSOV manufacturer's (Siemens) recommendations.        |
| Flame failure   | Weekly        | Operator           | Close manual gas shutoff valve and check safety shutdown. See section 6.7                      |
| Flame signal strength   | Weekly        | Operator           | Check flame strength using the Control Panel <i>Operating</i> menu. See section 3.4.           |
| Low water level cut off and alarm   | Weekly        | Operator           | See section 6.4  |
| Slow drain test   | Semi-Annually | Operator           | Perform a slow drain test in accordance with ASME Boiler and Pressure Vessel Code, Section IV. |
| High water temperature safety control test                                | Annually      | Service Technician | See section 6.5  |
| Operating controls  | Annually      | Operator           | See section 3.2  |
| Low air flow  | Monthly       | Operator           | See section 6.8  |
| High and low gas pressure interlocks                                      | Monthly       | Operator           | See sections 6.2 and 6.3   |
| Air/Fuel Valve purge position switch                                      | Annually      | Service Technician | See section 6.10   |
| Air/Fuel Valve ignition position switch                                   | Annually      | Service Technician | See section 6.11   |
| Safety valves   | As required   | Operator           | Check per A.S.M.E. Boiler and Pressure Vessel Code, Section IV                                 |
| Inspect burner components   | Semi-Annually | Service Technician | See section 7.6  |
| Condensate Trap   | Semi-Annually | Operator           | See section 7.7  |
| Oxygen (O <sub>2</sub> ) Level  | Monthly       | Operator           | Verify oxygen level is between 3% and 8% during Heating Boiler operation                       |

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**Appendix E: INDOOR/OUTDOOR RESET RATIO CHARTS**

**Table E-1. Header Temperature for a Building Reference Temperature = 50°F (10.0°C)**

| Air Temp |       | RESET RATIO |     |     |     |     |     |     |     |     |     |
|----------|-------|-------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|
|          |       | 0.6         | 0.8 | 1.0 | 1.2 | 1.4 | 1.6 | 1.8 | 2.0 | 2.2 | 2.4 |
| °F       | °C    |             |     |     |     |     |     |     |     |     |     |
| 50       | 10.0  | 50          | 50  | 50  | 50  | 50  | 50  | 50  | 50  | 50  | 50  |
| 45       | 7.2   | 53          | 54  | 55  | 56  | 57  | 58  | 59  | 60  | 60  | 62  |
| 40       | 4.4   | 56          | 58  | 60  | 62  | 64  | 66  | 68  | 70  | 72  | 74  |
| 35       | 1.7   | 59          | 62  | 65  | 68  | 71  | 74  | 77  | 80  | 83  | 86  |
| 30       | -1.1  | 62          | 66  | 70  | 74  | 78  | 82  | 86  | 90  | 94  | 98  |
| 25       | -3.9  | 65          | 70  | 75  | 80  | 85  | 90  | 95  | 100 | 105 | 110 |
| 20       | -6.7  | 68          | 74  | 80  | 86  | 92  | 98  | 104 | 110 | 116 | 122 |
| 15       | -9.4  | 71          | 78  | 85  | 92  | 99  | 106 | 113 | 120 | 127 | 134 |
| 10       | -12.2 | 74          | 82  | 90  | 98  | 106 | 114 | 122 | 130 | 138 | 146 |
| 5        | -15.0 | 77          | 86  | 95  | 104 | 113 | 122 | 131 | 140 | 149 | 158 |
| 0        | -17.8 | 80          | 90  | 100 | 110 | 120 | 130 | 140 | 150 | 160 | 170 |
| -5       | -20.6 | 83          | 94  | 105 | 116 | 127 | 138 | 149 | 160 | 171 | 182 |
| -10      | -23.3 | 86          | 98  | 110 | 122 | 134 | 146 | 158 | 170 | 182 | 194 |
| -15      | -26.1 | 89          | 102 | 115 | 128 | 141 | 154 | 167 | 180 | 193 | 206 |
| -20      | -28.9 | 92          | 106 | 120 | 134 | 148 | 162 | 176 | 190 | 204 | 218 |

**Table E-2. Header Temperature for a Building Reference Temperature = 60°F (15.6°C)**

| Air Temp |       | RESET RATIO |     |     |     |     |     |     |     |     |     |
|----------|-------|-------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|
|          |       | 0.6         | 0.8 | 1.0 | 1.2 | 1.4 | 1.6 | 1.8 | 2.0 | 2.2 | 2.4 |
| °F       | °C    |             |     |     |     |     |     |     |     |     |     |
| 60       | 15.6  | 60          | 60  | 60  | 60  | 60  | 60  | 60  | 60  | 60  | 60  |
| 55       | 12.8  | 63          | 64  | 65  | 66  | 67  | 68  | 69  | 70  | 71  | 72  |
| 50       | 10.0  | 66          | 68  | 70  | 72  | 74  | 76  | 78  | 80  | 82  | 84  |
| 45       | 7.2   | 69          | 72  | 75  | 78  | 81  | 84  | 87  | 90  | 93  | 96  |
| 40       | 4.4   | 72          | 76  | 80  | 84  | 88  | 92  | 96  | 100 | 104 | 108 |
| 35       | 1.7   | 75          | 80  | 85  | 90  | 95  | 100 | 105 | 110 | 115 | 120 |
| 30       | -1.1  | 78          | 84  | 90  | 96  | 102 | 108 | 114 | 120 | 126 | 132 |
| 25       | -3.9  | 81          | 88  | 95  | 102 | 109 | 116 | 123 | 130 | 137 | 144 |
| 20       | -6.7  | 84          | 92  | 100 | 108 | 116 | 124 | 132 | 140 | 148 | 156 |
| 15       | -9.4  | 87          | 96  | 105 | 114 | 123 | 132 | 141 | 150 | 159 | 168 |
| 10       | -12.2 | 90          | 100 | 110 | 120 | 130 | 140 | 150 | 160 | 170 | 180 |
| 5        | -15.0 | 93          | 104 | 115 | 126 | 137 | 148 | 159 | 170 | 181 | 192 |
| 0        | -17.8 | 96          | 108 | 120 | 132 | 144 | 156 | 168 | 180 | 192 | 204 |
| -5       | -20.6 | 99          | 112 | 125 | 138 | 151 | 164 | 177 | 190 | 203 | 216 |
| -10      | -23.3 | 102         | 116 | 130 | 144 | 158 | 172 | 186 | 200 | 214 |     |
| -15      | -26.1 | 105         | 120 | 135 | 150 | 165 | 180 | 195 | 210 |     |     |
| -20      | -28.9 | 108         | 124 | 140 | 156 | 172 | 188 | 204 |     |     |     |

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## APPENDIX E – INDOOR/OUTDOOR RESET RATIO CHARTS

**Table E-3. Header Temperature for a Building Reference Temperature = 65°F (18.3°C)**

| Air Temp |       | RESET RATIO |     |     |     |     |     |     |     |     |     |
|----------|-------|-------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|
|          |       | 0.6         | 0.8 | 1.0 | 1.2 | 1.4 | 1.6 | 1.8 | 2.0 | 2.2 | 2.4 |
| °F       | °C    |             |     |     |     |     |     |     |     |     |     |
| 65       | 18.3  | 65          | 65  | 65  | 65  | 65  | 65  | 65  | 65  | 65  | 65  |
| 60       | 15.6  | 68          | 69  | 70  | 71  | 72  | 73  | 74  | 75  | 76  | 77  |
| 55       | 12.8  | 71          | 73  | 75  | 77  | 79  | 81  | 83  | 85  | 87  | 89  |
| 50       | 10.0  | 74          | 77  | 80  | 83  | 86  | 89  | 92  | 95  | 98  | 101 |
| 45       | 7.2   | 77          | 81  | 85  | 89  | 93  | 97  | 101 | 105 | 109 | 113 |
| 40       | 4.4   | 80          | 85  | 90  | 95  | 100 | 105 | 110 | 115 | 120 | 125 |
| 35       | 1.7   | 83          | 89  | 95  | 101 | 107 | 113 | 119 | 125 | 131 | 137 |
| 30       | -1.1  | 86          | 93  | 100 | 107 | 114 | 121 | 128 | 135 | 142 | 149 |
| 25       | -3.9  | 89          | 97  | 105 | 113 | 121 | 129 | 137 | 145 | 153 | 161 |
| 20       | -6.7  | 92          | 101 | 110 | 119 | 128 | 137 | 146 | 155 | 164 | 173 |
| 15       | -9.4  | 95          | 105 | 115 | 125 | 135 | 145 | 155 | 165 | 175 | 185 |
| 10       | -12.2 | 98          | 109 | 120 | 131 | 142 | 153 | 164 | 175 | 186 | 197 |
| 5        | -15.0 | 101         | 113 | 125 | 137 | 149 | 161 | 173 | 185 | 197 | 209 |
| 0        | -17.8 | 104         | 117 | 130 | 143 | 156 | 169 | 182 | 195 | 208 |     |
| -5       | -20.6 | 107         | 121 | 135 | 149 | 163 | 177 | 191 | 205 | 219 |     |
| -10      | -23.3 | 110         | 125 | 140 | 155 | 170 | 185 | 200 | 215 |     |     |
| -15      | -26.1 | 113         | 129 | 145 | 161 | 177 | 193 | 209 |     |     |     |
| -20      | -28.9 | 116         | 133 | 150 | 167 | 201 | 218 |     |     |     |     |

**Table E-4. Header Temperature for a Building Reference Temperature = 70°F (21.1°C)**

| Air Temp |       | RESET RATIO |     |     |     |     |     |     |     |     |     |
|----------|-------|-------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|
|          |       | 0.6         | 0.8 | 1.0 | 1.2 | 1.4 | 1.6 | 1.8 | 2.0 | 2.2 | 2.4 |
| °F       | °C    |             |     |     |     |     |     |     |     |     |     |
| 70       | 21.1  | 70          | 70  | 70  | 70  | 70  | 70  | 70  | 70  | 70  | 70  |
| 65       | 18.3  | 73          | 74  | 75  | 76  | 77  | 78  | 79  | 80  | 81  | 82  |
| 60       | 15.6  | 76          | 78  | 80  | 82  | 84  | 86  | 88  | 90  | 92  | 94  |
| 55       | 12.8  | 79          | 82  | 85  | 88  | 91  | 94  | 97  | 100 | 103 | 106 |
| 50       | 10.0  | 82          | 86  | 90  | 94  | 98  | 102 | 106 | 110 | 114 | 118 |
| 45       | 7.2   | 85          | 90  | 95  | 100 | 105 | 110 | 115 | 120 | 125 | 130 |
| 40       | 4.4   | 88          | 94  | 100 | 106 | 112 | 118 | 124 | 130 | 136 | 142 |
| 35       | 1.7   | 91          | 98  | 105 | 112 | 119 | 126 | 133 | 140 | 147 | 154 |
| 30       | -1.1  | 94          | 102 | 110 | 118 | 126 | 134 | 142 | 150 | 158 | 166 |
| 25       | -3.9  | 97          | 106 | 115 | 124 | 133 | 142 | 151 | 160 | 169 | 178 |
| 20       | -6.7  | 100         | 110 | 120 | 130 | 140 | 150 | 160 | 170 | 180 | 190 |
| 15       | -9.4  | 103         | 114 | 125 | 136 | 147 | 158 | 169 | 180 | 191 | 202 |
| 10       | -12.2 | 106         | 118 | 130 | 142 | 154 | 166 | 178 | 190 | 202 | 214 |
| 5        | -15.0 | 109         | 122 | 135 | 148 | 161 | 174 | 187 | 200 | 213 |     |
| 0        | -17.8 | 112         | 126 | 140 | 154 | 168 | 182 | 196 | 210 |     |     |
| -5       | -20.6 | 115         | 130 | 145 | 160 | 175 | 190 | 205 |     |     |     |
| -10      | -23.3 | 118         | 134 | 150 | 166 | 182 | 198 | 214 |     |     |     |
| -15      | -26.1 | 121         | 138 | 155 | 172 | 189 | 206 |     |     |     |     |
| -20      | -28.9 | 124         | 142 | 160 | 178 | 196 | 214 |     |     |     |     |

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## APPENDIX E – INDOOR/OUTDOOR RESET RATIO CHARTS

**Table E-5. Header Temperature for a Building Reference Temperature = 75°F (23.9°C)**

| Air Temp |       | RESET RATIO |     |     |     |     |     |     |     |     |     |
|----------|-------|-------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|
|          |       | 0.6         | 0.8 | 1.0 | 1.2 | 1.4 | 1.6 | 1.8 | 2.0 | 2.2 | 2.4 |
| °F       | °C    |             |     |     |     |     |     |     |     |     |     |
| 75       | 23.9  | 75          | 75  | 75  | 75  | 75  | 75  | 75  | 75  | 75  | 75  |
| 70       | 21.1  | 78          | 79  | 80  | 81  | 82  | 83  | 84  | 85  | 86  | 87  |
| 65       | 18.3  | 81          | 83  | 85  | 87  | 89  | 91  | 93  | 95  | 97  | 99  |
| 60       | 15.6  | 84          | 87  | 90  | 93  | 96  | 99  | 102 | 105 | 108 | 111 |
| 55       | 12.8  | 87          | 91  | 95  | 99  | 103 | 107 | 111 | 115 | 119 | 123 |
| 50       | 10.0  | 90          | 95  | 100 | 105 | 110 | 115 | 120 | 125 | 130 | 135 |
| 45       | 7.2   | 93          | 99  | 105 | 111 | 117 | 123 | 129 | 135 | 141 | 147 |
| 40       | 4.4   | 96          | 103 | 110 | 117 | 124 | 131 | 138 | 145 | 152 | 159 |
| 35       | 1.7   | 99          | 107 | 115 | 123 | 131 | 139 | 147 | 155 | 163 | 171 |
| 30       | -1.1  | 102         | 111 | 120 | 129 | 138 | 147 | 156 | 165 | 174 | 183 |
| 25       | -3.9  | 105         | 115 | 125 | 135 | 145 | 155 | 165 | 175 | 185 | 195 |
| 20       | -6.7  | 108         | 119 | 130 | 141 | 152 | 163 | 174 | 185 | 196 | 207 |
| 15       | -9.4  | 111         | 123 | 135 | 147 | 159 | 171 | 183 | 195 | 207 | 219 |
| 10       | -12.2 | 114         | 127 | 140 | 153 | 166 | 179 | 192 | 205 | 218 |     |
| 5        | -15.0 | 117         | 131 | 145 | 159 | 173 | 187 | 201 | 215 |     |     |
| 0        | -17.8 | 120         | 135 | 150 | 165 | 180 | 195 | 210 |     |     |     |
| -5       | -20.6 | 123         | 139 | 155 | 171 | 187 | 203 | 219 |     |     |     |
| -10      | -23.3 | 126         | 143 | 160 | 177 | 194 | 211 |     |     |     |     |
| -15      | -26.1 | 129         | 147 | 165 | 183 | 201 | 219 |     |     |     |     |

**Table E-6. Header Temperature for a Building Reference Temperature = 80°F (26.7°C)**

| Air Temp |       | RESET RATIO |     |     |     |     |     |     |     |     |     |
|----------|-------|-------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|
|          |       | 0.6         | 0.8 | 1.0 | 1.2 | 1.4 | 1.6 | 1.8 | 2.0 | 2.2 | 2.4 |
| °F       | °C    |             |     |     |     |     |     |     |     |     |     |
| 80       | 26.7  | 80          | 80  | 80  | 80  | 80  | 80  | 80  | 80  | 80  | 80  |
| 75       | 23.9  | 83          | 84  | 85  | 86  | 87  | 88  | 89  | 90  | 91  | 92  |
| 70       | 21.1  | 86          | 88  | 90  | 92  | 94  | 96  | 98  | 100 | 102 | 104 |
| 65       | 18.3  | 89          | 92  | 95  | 98  | 101 | 104 | 107 | 110 | 113 | 116 |
| 60       | 15.6  | 92          | 96  | 100 | 104 | 108 | 112 | 116 | 120 | 124 | 128 |
| 55       | 12.8  | 95          | 100 | 105 | 110 | 115 | 120 | 125 | 130 | 135 | 140 |
| 50       | 10.0  | 98          | 104 | 110 | 116 | 122 | 128 | 134 | 140 | 146 | 152 |
| 45       | 7.2   | 101         | 108 | 115 | 122 | 129 | 136 | 143 | 150 | 157 | 164 |
| 40       | 4.4   | 104         | 112 | 120 | 128 | 136 | 144 | 152 | 160 | 168 | 176 |
| 35       | 1.7   | 107         | 116 | 125 | 134 | 143 | 152 | 161 | 170 | 179 | 188 |
| 30       | -1.1  | 110         | 120 | 130 | 140 | 150 | 160 | 170 | 180 | 190 | 200 |
| 25       | -3.9  | 113         | 124 | 135 | 146 | 157 | 168 | 174 | 190 | 201 | 212 |
| 20       | -6.7  | 116         | 128 | 140 | 152 | 164 | 176 | 188 | 200 | 212 |     |
| 15       | -9.4  | 119         | 132 | 145 | 158 | 171 | 184 | 197 | 210 |     |     |
| 10       | -12.2 | 122         | 136 | 150 | 164 | 178 | 192 | 206 |     |     |     |
| 5        | -15.0 | 125         | 140 | 155 | 170 | 185 | 200 | 215 |     |     |     |
| 0        | -17.8 | 128         | 144 | 160 | 176 | 192 | 208 |     |     |     |     |
| -5       | -20.6 | 131         | 148 | 165 | 182 | 199 | 216 |     |     |     |     |
| -10      | -23.3 | 134         | 152 | 170 | 188 | 206 |     |     |     |     |     |

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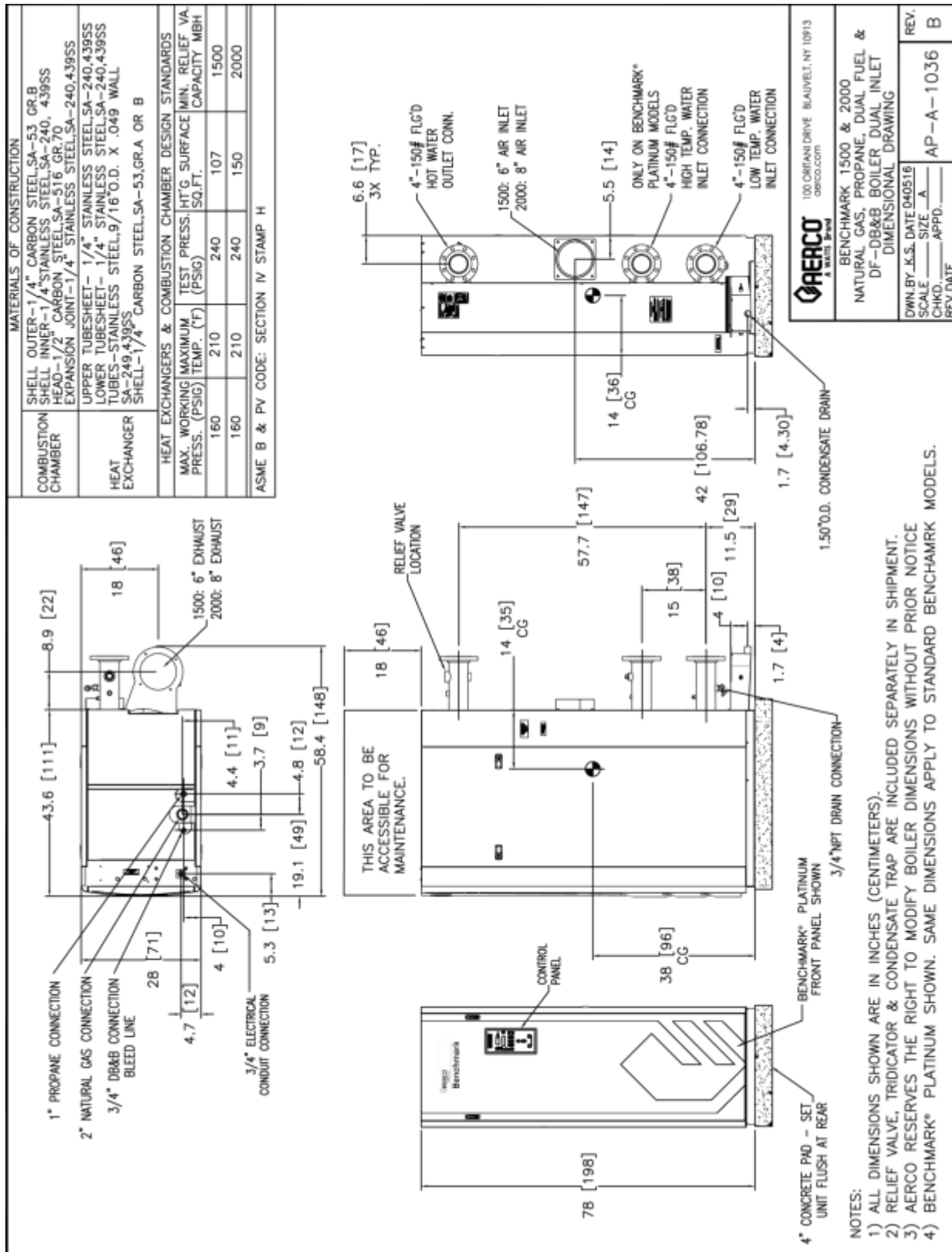
## APPENDIX E – INDOOR/OUTDOOR RESET RATIO CHARTS

**Table E-7. Header Temperature for a Building Reference Temperature = 90°F (32.2°C)**

| Air Temp |       | RESET RATIO |     |     |     |     |     |     |     |     |     |
|----------|-------|-------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|
|          |       | 0.6         | 0.8 | 1.0 | 1.2 | 1.4 | 1.6 | 1.8 | 2.0 | 2.2 | 2.4 |
| °F       | °C    |             |     |     |     |     |     |     |     |     |     |
| 90       | 32.2  | 90          | 90  | 90  | 90  | 90  | 90  | 90  | 90  | 90  | 90  |
| 85       | 29.4  | 93          | 94  | 95  | 96  | 97  | 98  | 99  | 100 | 101 | 102 |
| 80       | 26.7  | 96          | 98  | 100 | 102 | 104 | 106 | 108 | 110 | 112 | 114 |
| 75       | 23.9  | 99          | 102 | 105 | 108 | 111 | 114 | 117 | 120 | 123 | 126 |
| 70       | 21.1  | 102         | 106 | 110 | 114 | 118 | 122 | 126 | 130 | 134 | 138 |
| 65       | 18.3  | 105         | 110 | 115 | 120 | 125 | 130 | 135 | 140 | 145 | 150 |
| 60       | 15.6  | 108         | 114 | 120 | 126 | 132 | 138 | 144 | 150 | 156 | 162 |
| 55       | 12.8  | 111         | 118 | 125 | 132 | 139 | 146 | 153 | 160 | 167 | 174 |
| 50       | 10.0  | 114         | 122 | 130 | 138 | 146 | 154 | 162 | 170 | 178 | 186 |
| 45       | 7.2   | 117         | 126 | 135 | 144 | 153 | 162 | 171 | 180 | 189 | 198 |
| 40       | 4.4   | 120         | 130 | 140 | 150 | 160 | 170 | 180 | 190 | 200 | 210 |
| 35       | 1.7   | 123         | 134 | 145 | 156 | 167 | 178 | 189 | 200 |     |     |
| 30       | -1.1  | 126         | 138 | 150 | 162 | 174 | 186 | 198 | 210 |     |     |
| 25       | -3.9  | 129         | 142 | 155 | 168 | 181 | 194 | 207 |     |     |     |
| 20       | -6.7  | 132         | 146 | 160 | 174 | 188 | 202 | 216 |     |     |     |
| 15       | -9.4  | 135         | 150 | 165 | 180 | 195 | 210 |     |     |     |     |
| 10       | -12.2 | 138         | 154 | 170 | 186 | 202 | 218 |     |     |     |     |
| 5        | -15.0 | 141         | 158 | 175 | 192 | 209 |     |     |     |     |     |
| 0        | -17.8 | 144         | 162 | 180 | 198 | 216 |     |     |     |     |     |



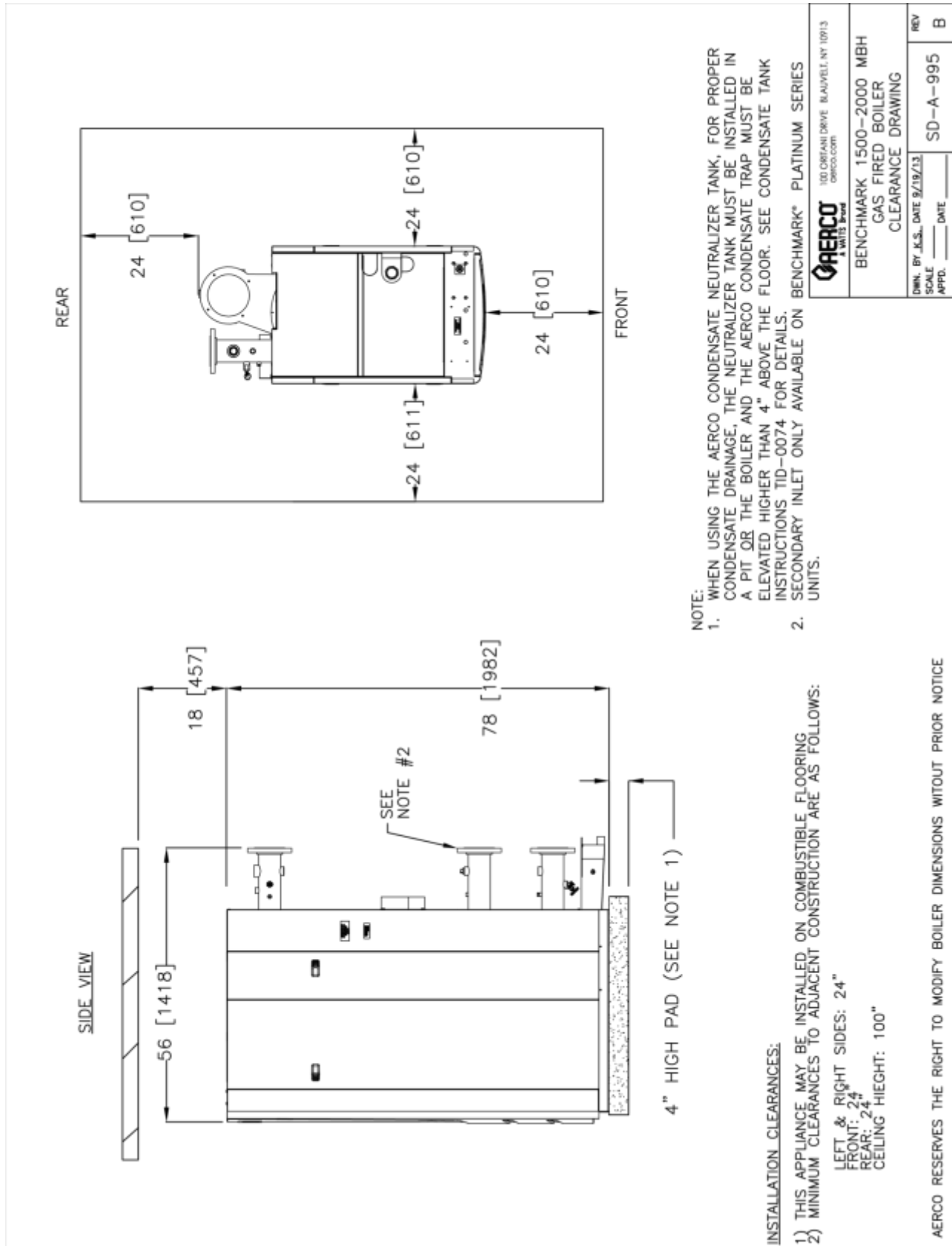
### Appendix F: DIMENSIONAL AND CLEARANCE DRAWINGS



Drawing Number: AP-A-1036 rev B

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## APPENDIX F – DIMENSIONAL AND CLEARANCE DRAWINGS



Drawing Number: SD-A-995 rev B

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## APPENDIX G – PART LIST DRAWINGS

### Appendix G: PART LIST DRAWINGS

#### Benchmark 1500 - 2000 Part List

| Item #                        | Qty | Part #   | Description                      | Item #                      | Qty | Part # | Description                                   |
|-------------------------------|-----|----------|----------------------------------|-----------------------------|-----|--------|---|
| <b>EXHAUST MANIFOLD</b>       |     |          |                                  | <b>CONTROLS (Continued)</b> |     |        |   |
| 1                             | 1   | 39187    | MANIFOLD: EXHAUST                | 35                          | 1   | 64081  | ECU, O <sub>2</sub> SENSOR                    |
| 2                             | 1   | 81165    | MANIFOLD: SEAL                   | 36                          | 1   | 65011  | TRANSFORMER 115V/24V 100VA                    |
| 3                             | 6   | 9-22     | PIPE PLUG: 1/4" NPT: STEEL       | 37                          | 1   | 65109  | 12V POWER SUPPLY                              |
| <b>GAS TRAIN</b>              |     |          |                                  | 38                          | 3   | 69141  | DIN RAIL MOUNT END STOP                       |
|                               |     |          |                                  | 39                          | 2   | 65120  | TERMINAL BLOCK: DIN MOUNTED: BLK              |
| 4                             | 1   | 22283    | BMK 1500 /2000 GAS TRAIN ASSY    | 40                          | 2   | 65121  | TERMINAL BLOCK: DIN MOUNTED: WHT              |
| 5                             | 1   | 63109    | GAS TRAIN HARNESS                | 41                          | 3   | 65122  | TERMINAL GROUND BLOCK: DIN MOUNTED            |
| <b>BURNER, AIR/FUEL VALVE</b> |     |          |                                  | 42                          | 2   | 65118  | FUSE TERMINAL: DIN MOUNTED                    |
|                               |     |          |                                  | 43                          | 1   | 64088  | LIMIT CONTROL TEMPERATURE, DIGITAL CONTROLLER |
| 8                             | 1   | 81186    | LOWER RELEASE GASKET             | 44                          | 1   | 60026  | CIRCUIT BREAKER, 2 POLE 20A                   |
| 10                            | 1   | 46042    | BURNER, BMK 1500                 | 45                          | 1   | 65156  | FLAME DETECTOR SIGNAL AMPLIFIER               |
|                               | 1   | 46044    | BURNER, BMK 2000                 | 46                          | 1   | 65162  | 24V POWER SUPPLY (SEQUENCING ISOLATION VALVE) |
| 11                            | 1   | 24277    | STAGED IGNITION ASSY             | 47                          | 2   | 124512 | FUSE: 4 AMP                                   |
| 12                            | 1   | 81166    | BURNER GASKET                    | 48                          | 1   | 123449 | SENSOR: TEMPERATURE                           |
| 13                            | 2   | 81183    | BURNER RELEASE GASKET            | 49                          | 1   | 58132  | THERMOWELL                                    |
| 14                            | 1   | 43090    | AIR FUEL VALVE PLENUM            | 50                          | 1   | 63105  | I/O SENSOR/COMM HARNESS                       |
| 15                            | 1   | 24311-3  | AIR FUEL VALVE ASSY, BMK 1500    | 51                          | 1   | 63104  | I/O INTERLOCK HARNESS                         |
|                               | 1   | 24311-10 | AIR FUEL VALVE ASSY, BMK 2000    | 52                          | 1   | 63090  | HARNESS ASSY: TEMP LIM CONT PWR               |
| <b>HOSES &amp; INSULATION</b> |     |          |                                  | 53                          | 1   | 63150  | FLAME DETECTOR HARNESS                        |
|                               |     |          |                                  | 54                          | 1   | 33170  | MOUNTING PANEL                                |
| 16                            | 1   | 97005-9  | FLEX GAS TUBE 48" (1.2 m)        | 55                          | 1   | 124324 | GROUND BAR                                    |
| 17                            | 1   | 80089    | SHELL INSULATION                 | 56                          | 1   | 63156  | POWER CABLE, 24V SEQUENCE VALVE               |
| <b>BLOWER</b>                 |     |          |                                  | 57                          | 1   | 63103  | SHELL HARNESS                                 |
|                               |     |          |                                  | 58                          | 1   | 63109  | GAS TRAIN HARNESS                             |
| 18                            | 1   | 58038    | BLOWER ASSEMBLY REPLACEMENT KIT  | 59                          | 1   | 61024  | AIR INLET TEMPERATURE SENSOR                  |
| 19                            | 1   | 81184    | BLOWER OUTLET GASKET             | 60                          | 1   | 123449 | SENSOR: TEMPERATURE                           |
| 20                            | 1   | 81100    | GASKET, BLOWER MOTOR             | 61                          | 1   | 61030  | SENSOR: OUTLET TEMPERATURE                    |
| 21                            | 1   | 24356-1  | FLAME DETECTOR KIT (with gasket) | 62                          | 1   | 69151  | PCB ASSY                                      |
| 22                            | 1   | 61026    | LEAN OXYGEN SENSOR               | 63                          | 1   | 24468  | 220V TO 110V POWER TRANSFORMER                |
| 23                            | 1   | 59104    | OBSERVATION PORT                 | 64                          | 1   | 65104  | CABLE, H.V. IGNITION                          |
| 24                            | 1   | 58023    | IGNITER-INJECTOR REPLACEMENT KIT | 65                          | 1   | 63058  | HARNESS: BLOWER SIGNAL                        |
| 25                            | 1   | 59138    | AIR FILTER, 6"                   | 66                          | 1   | 63083  | HARNESS: O <sub>2</sub> SENSOR                |
| 26                            | 1   | 43095    | BLOWER PLENUM, BMK 1500-2000     | 67                          | 1   | 63111  | HARNESS: CONTROL                              |
| <b>CONTROLS</b>               |     |          |                                  | 69                          | 1   | 63063  | PUMP RELAY                                    |
|                               |     |          |                                  | 70                          | 1   | 38035  | I/O PANEL COVER                               |
| 27                            | 1   | 123966   | SWITCH: OVER TEMP-AUTO RESET     | 71                          | 1   | 38036  | POWER PANEL COVER                             |
| 28                            | 1   | 123552   | SWITCH: OVER TEMP-MANUAL RESET   |                             |     |        |   |
| 29                            | 1   | 60011-4  | BMK 1500 BLOWER PROOF SWITCH     |                             |     |        |   |
|                               |     | 60011-2  | BMK 2000 BLOWER PROOF SWITCH     |                             |     |        |   |
| 30                            | 1   | 61002-5  | BLOCKED INLET SWITCH -4.5" W.C.  |                             |     |        |   |
| 31                            | 1   | 69186-1  | CONTROL BOX: C-MORE              |                             |     |        |   |
| 32                            | 1   | 65085    | IGNITION TRANSFORMER             |                             |     |        |   |
| 33                            | 1   | 63108    | SSOV/RELAY JUMPER                |                             |     |        |   |
| 34                            | 1   | 93230    | SNUBBER, BLOWER PROOF SWITCH     |                             |     |        |   |

① Not shown on drawing

|  |   |              |
|--|---|--------------|
| AERCO<br>International, Inc.<br>Blauvelt, NY 10913 | <b>Benchmark 1500-2000 Part List</b>                              | 03/11/2016   |
|  | <b>Whole Boiler 29313-CHI (BMK 1500)<br/>29337-CHI (BMK 2000)</b> | Sheet 1 of 6 |

# Benchmark 1500 – 2000 Boiler User Manual - INTERNATIONAL

## APPENDIX G – PART LIST DRAWINGS

### Benchmark 1500 - 2000 Part List – Continued

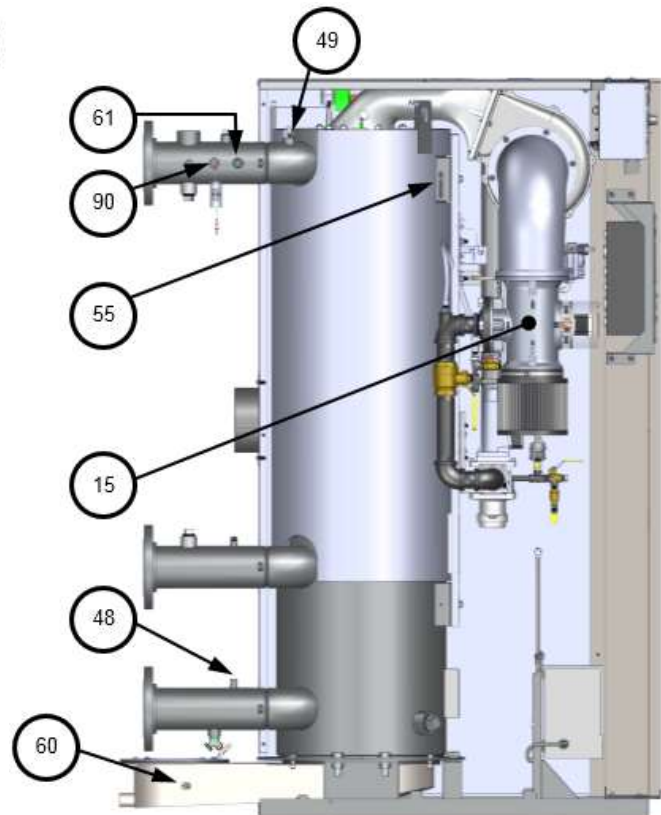
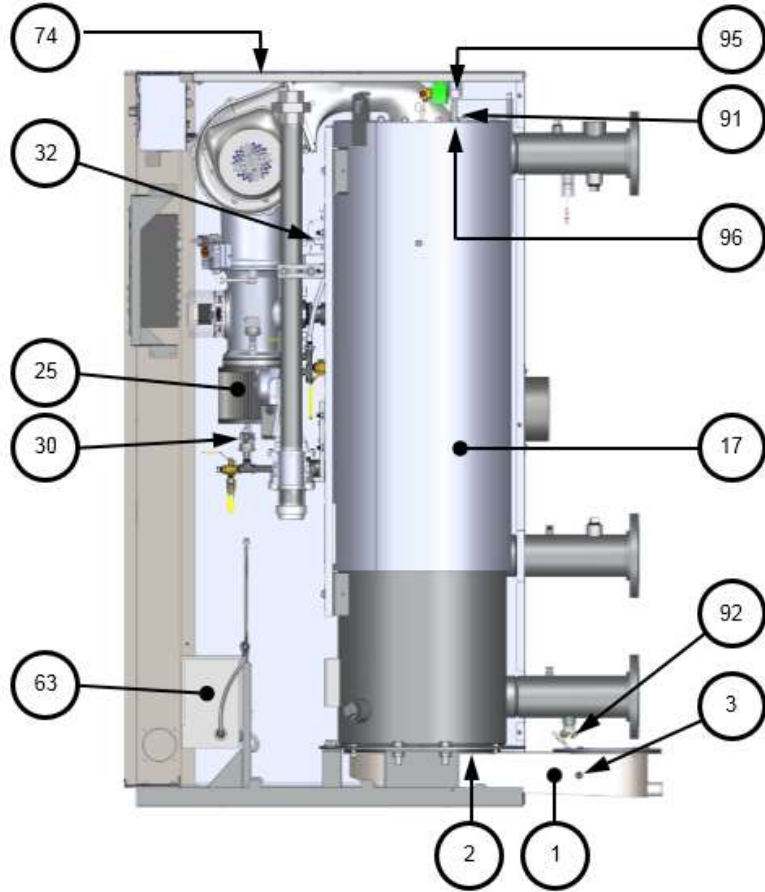
| Item #                            | Qty | Part # | Description                    | Item #                               | Qty | Part #   | Description                                     |
|-----------------------------------|-----|--------|--------------------------------|--------------------------------------|-----|----------|---|
| <b>SHEET METAL/PANEL ASSEMBLY</b> |     |        |                                | <b>OTHER ACCESSORIES &amp; PARTS</b> |     |          |   |
| 72                                | 1   | 37135  | BACK PANEL, RIGHT              | 87 ❶                                 | 1   | 123675-5 | BMK 1500 PRESSURE/TEMP GAUGE                    |
| 73                                | 1   | 37136  | BACK PANEL, LEFT               |                                      |     | 123675-5 | BMK 2000 PRESSURE/TEMP GAUGE                    |
| 74                                | 2   | 35029  | TOP RAIL                       | 88 ❶                                 | 1   | 92023-8  | PRESSURE RELIEF VALVE                           |
| 75                                | 1   | 25068  | FRONT FRAME ASSEMBLY           | 89 ❶                                 | 1   | 123540   | EXTERNAL MANUAL SHUT-OFF VALVE                  |
| 76                                | 1   | 25078  | FRONT PANEL ASSEMBLY           | 90                                   | 1   | 69126    | LOW WATER CUTOFF/CAPACITOR ASSY                 |
| 77                                | 1   | 74042  | DOME LABEL                     | 91                                   | 1   | 123863   | 1/8" NTP BALL VALVE                             |
| 78                                | 2   | 59179  | HANDLE, CONCEALED              | 92                                   | 1   | 92094    | 3/4" DRAIN VALVE                                |
| 79                                | 4   | 59133  | LATCH                          | 93 ❶                                 | 1   | 59043    | CONDENSATE FLOAT                                |
| 80                                | 1   | 37119  | FRONT TOP PANEL                | 94 ❶                                 | 1   | 24441    | COND. TRAP ASSY                                 |
| 81                                | 1   | 37120  | BACK TOP PANEL                 | 95                                   | 1   | 59178    | 1/8" AIR VENT                                   |
| 82                                | 2   | 30117  | SIDE PANEL                     | 96                                   | 1   | 90052    | NIPPLE 1/8" X 1.5" (3.8 mm) LG                  |
| 83                                | 1   | 74039  | BENCHMARK LOGO LABEL           |                                      |     |          |   |
|                                   |     |        |                                | 100 ❶                                | 1   | 92084-6  | MOTORIZED SEQUENCING ISOLATION VALVE (OPTIONAL) |
| 84                                | 1   | 39164  | 8" AIR INLET ADAPTER, BMK 2000 | 101                                  | 1   | 61054    | VOLTAGE MONITOR                                 |
|                                   | 1   | 39200  | 6" AIR INLET ADAPTER, BMK 1500 |                                      |     |          |   |

❶ Not shown on drawing

|  |   |              |
|--|---|--------------|
| AERCO<br>International, Inc.<br>Blauvelt, NY 10913 | <b>Benchmark 1500-2000 Part List</b>                              | 03/11/2016   |
|  | <b>Whole Boiler 29313-CHI (BMK 1500)<br/>29337-CHI (BMK 2000)</b> | Sheet 2 of 6 |

# Benchmark 1500 – 2000 Boiler User Manual - INTERNATIONAL

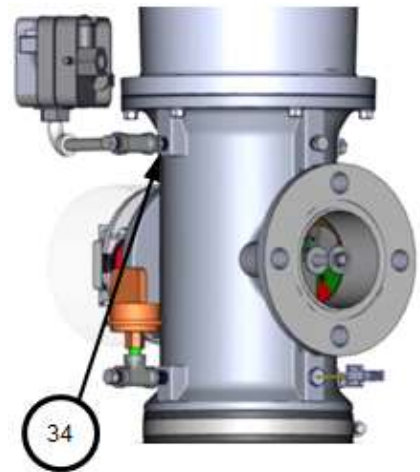
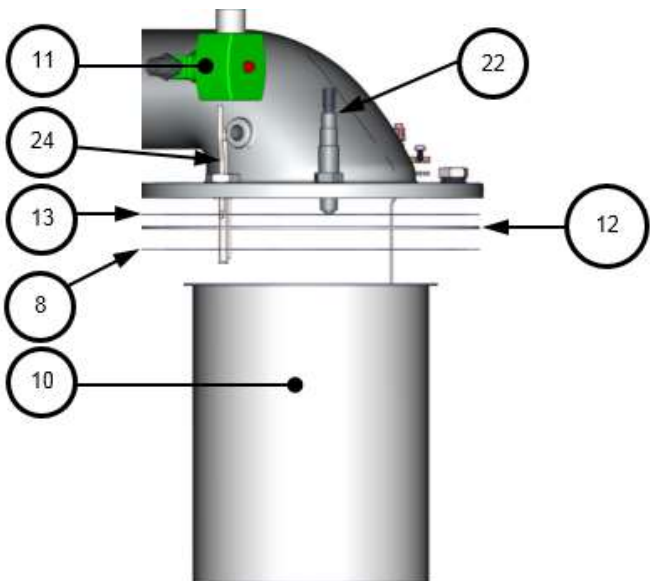
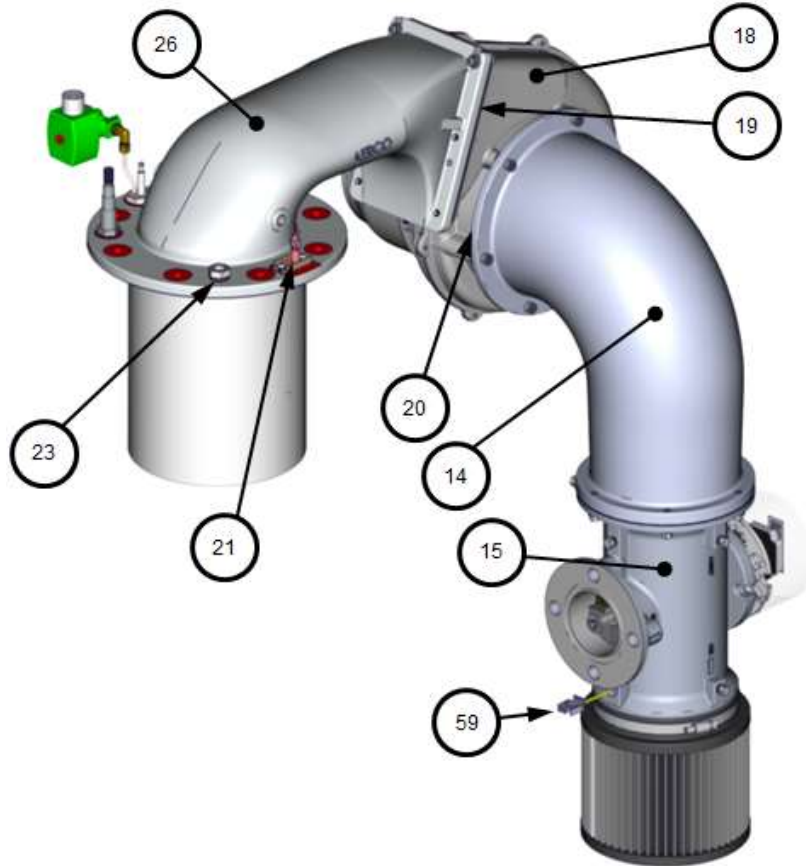
## APPENDIX G – PART LIST DRAWINGS



|  |  |              |
|--|--|--------------|
| AERCO<br>International, Inc.<br>Blauvelt, NY 10913 | <b>Benchmark 1500-2000 Part List</b>   | 03/11/2016   |
|  | <b>Whole Boiler 29313-CHI (BMK 1500)<br/>                 29337-CHI (BMK 2000)</b> | Sheet 3 of 6 |

# Benchmark 1500 – 2000 Boiler User Manual - INTERNATIONAL

## APPENDIX G – PART LIST DRAWINGS



Benchmark 1500 Burner-Air/Fuel Valve Assembly P/N 24378  
 Benchmark 2000 Burner-Air/Fuel Valve Assembly P/N 24378-1

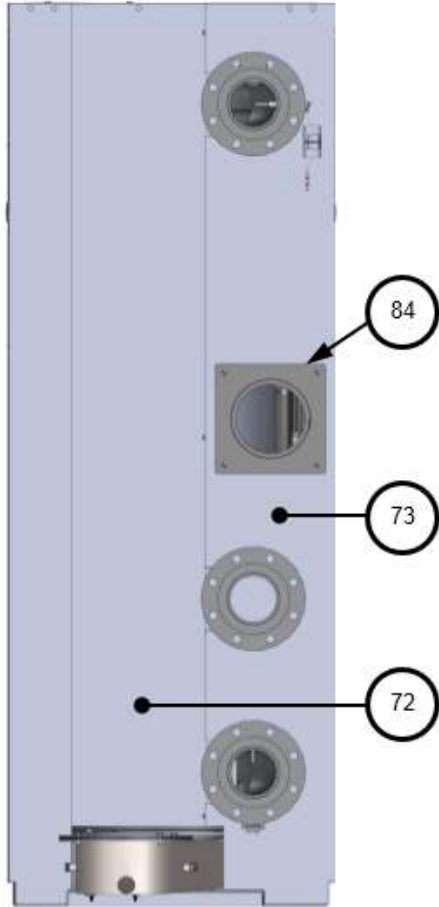
See full part lists below

|  |   |              |
|--|---|--------------|
| AERCO<br>International, Inc.<br>Blauvelt, NY 10913 | <b>Benchmark 1500-2000 Part List</b>                              | 03/11/2016   |
|  | <b>Whole Boiler 29313-CHI (BMK 1500)<br/>29337-CHI (BMK 2000)</b> | Sheet 4 of 6 |

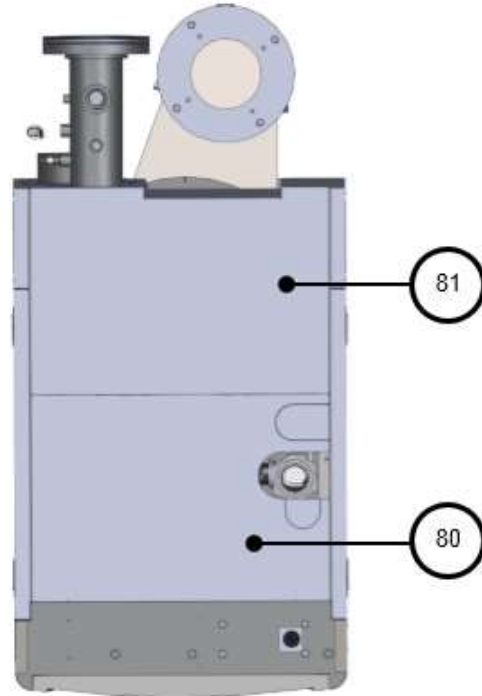


# Benchmark 1500 – 2000 Boiler User Manual - INTERNATIONAL

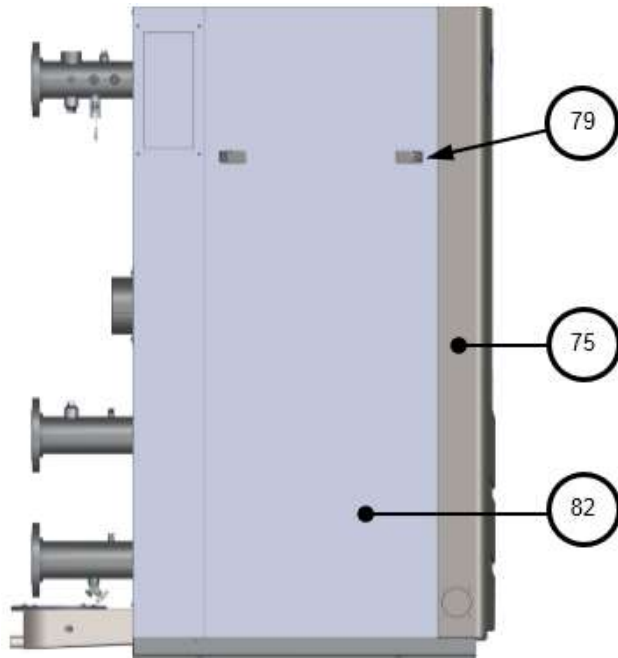
## APPENDIX G – PART LIST DRAWINGS



REAR VIEW



TOP VIEW



LEFT SIDE VIEW

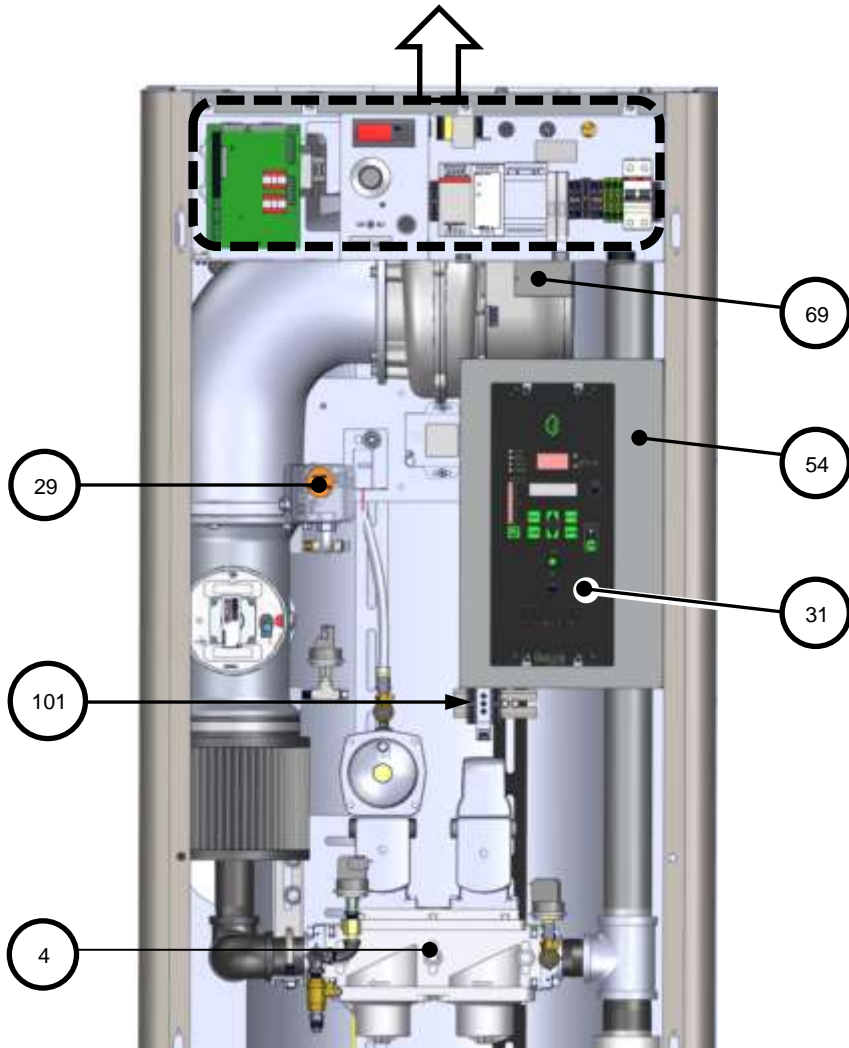
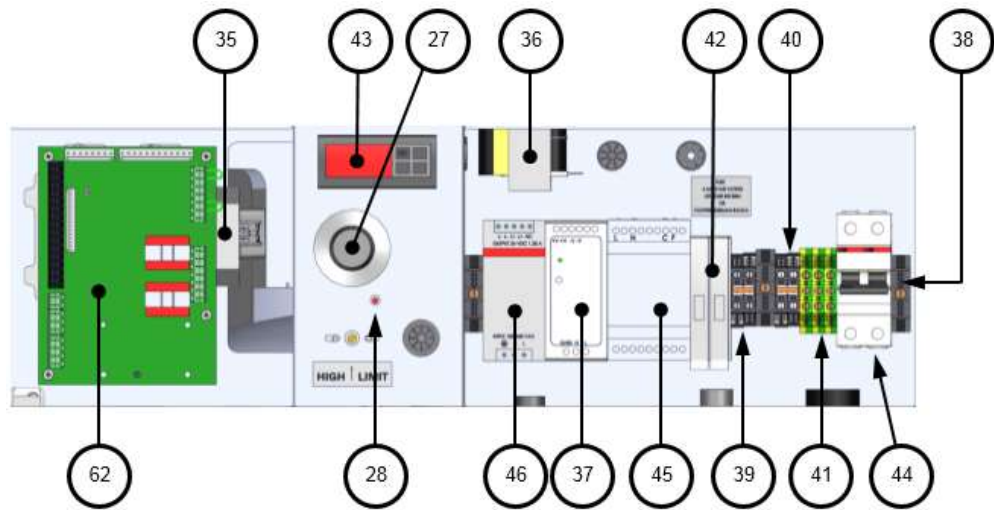


FRONT VIEW

|  |  |              |
|--|--|--------------|
| AERCO<br>International, Inc.<br>Blauvelt, NY 10913 | <b>Benchmark 1500-2000 Part List</b>   | 03/11/2016   |
|  | <b>Whole Boiler 29313-CHI (BMK 1500)<br/>                 29337-CHI (BMK 2000)</b> | Sheet 5 of 6 |

# Benchmark 1500 – 2000 Boiler User Manual - INTERNATIONAL

## APPENDIX G – PART LIST DRAWINGS



PARTIAL FRONT VIEW

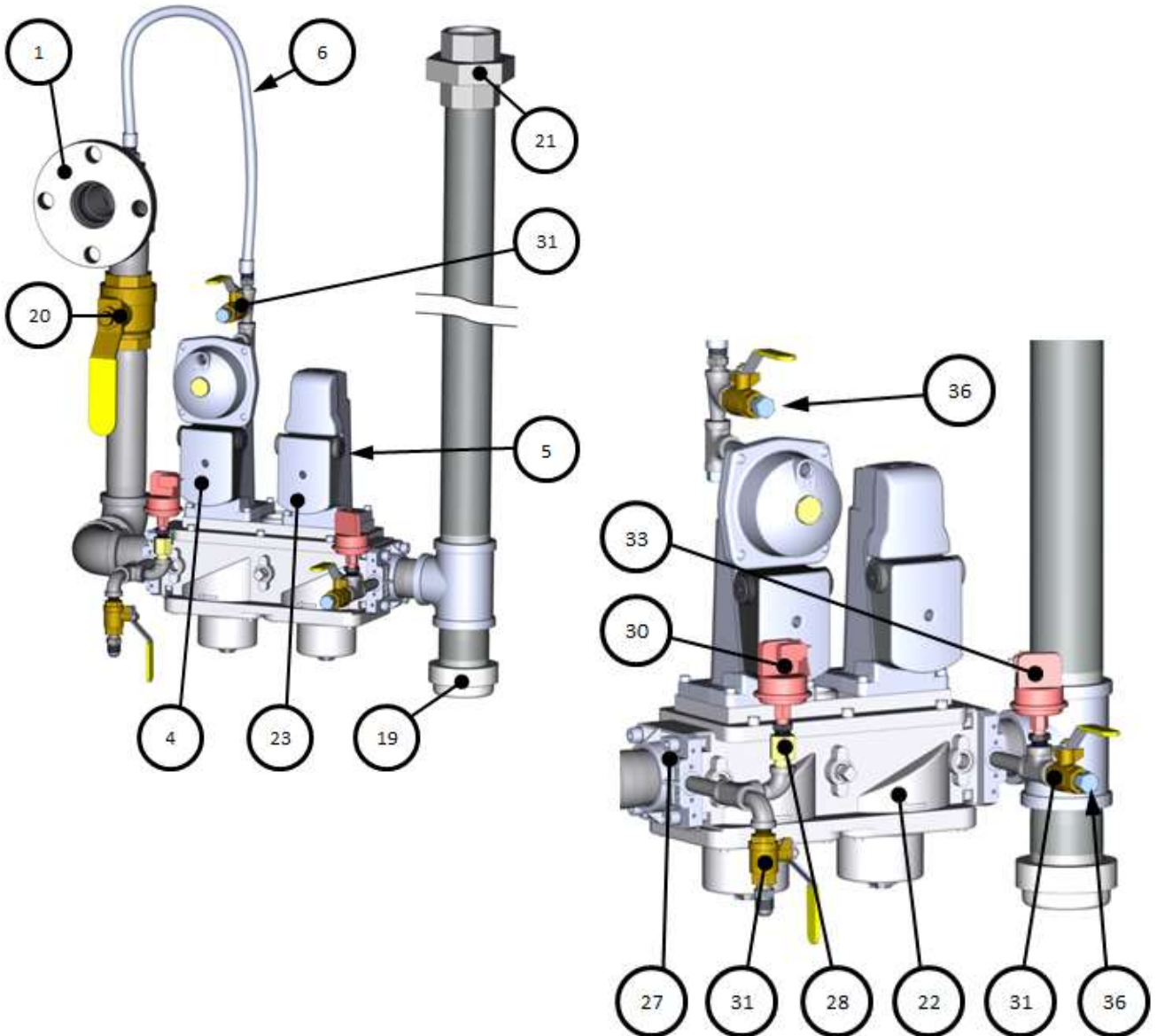
|  |  |              |
|--|--|--------------|
| AERCO<br>International, Inc.<br>Blauvelt, NY 10913 | <b>Benchmark 1500-2000 Part List</b>   | 03/11/2016   |
|  | <b>Whole Boiler 29313-CHI (BMK 1500)<br/>                 29337-CHI (BMK 2000)</b> | Sheet 6 of 6 |



# Benchmark 1500 – 2000 Boiler User Manual - INTERNATIONAL

## APPENDIX G – PART LIST DRAWINGS

| Benchmark 1500-2000 Natural Gas Gas Train – CHINA – 22283 rev A |     |          |                                  |      |     |          |                                    |
|---|-----|----------|----------------------------------|------|-----|----------|------------------------------------|
| Item  | Qty | Part No  | Description                      | Item | Qty | Part No  | Description                        |
| 1   | 1   | 123542   | FLANGE 2" 125# 2"NPT             | 23   | 1   | 69038    | ACTUATOR: SSOV W/O P.O.C. SWITCH   |
| 4   | 1   | 64048    | ACTUATOR: SSOV W/ REGULATOR      | 27   | 2   | 95029    | FLANGE: SSOV 1 1/2" NPT            |
| 5   | 4   | 12951-2  | BUSHING: CONTROL BOX             | 28   | 1   | 99017    | SNUBBER: PRESSURE: 1/4"            |
| 6   | 1   | 97087-20 | TUBING: FLEXIBLE 12"             | 30   | 1   | 61002-12 | HIGH GAS PRESSURE SWITCH 4.7" W.C. |
| 19  | 1   | 93382    | 2" NPT CAP                       | 31   | 3   | 92077    | 1/4" NPT MXF BRASS BALL VALVE      |
| 20  | 1   | 92006-7  | VALVE: BALL BRASS 1-1/2" NPT     | 33   | 1   | 61002-11 | LOW GAS PRESSURE SWITCH 3.6" W.C.  |
| 21  | 1   | 9-294    | UNION: 2" NPT 300#               | 36   | 3   | 9-22     | PIPE PLUG: 1/4" NPT: STEEL         |
| 22  | 1   | 124142   | VALVE: SSOV: DOUBLE BODY: 2" NPT |      |     |          |                                    |

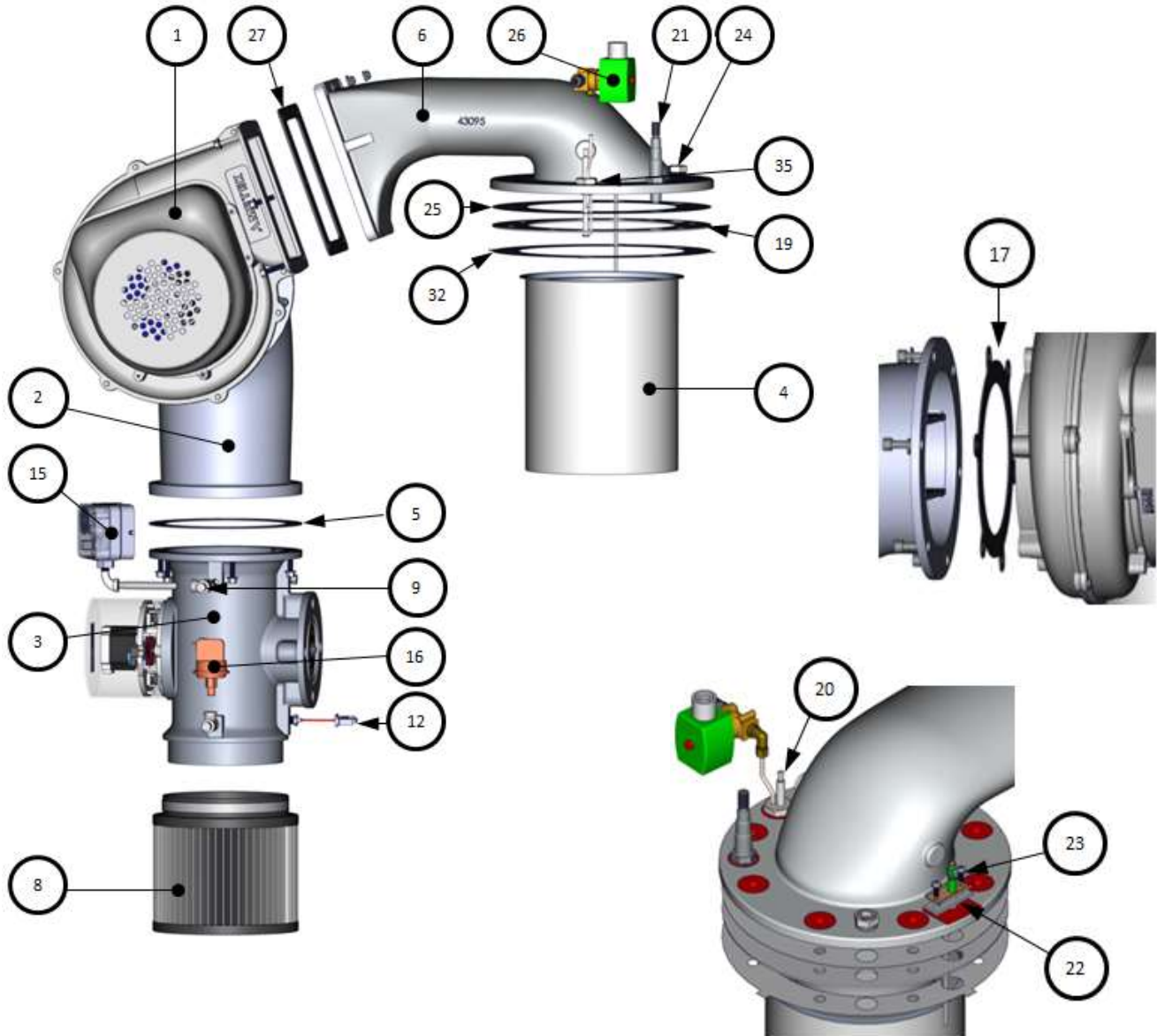


|   |  |              |
|---|--|--------------|
| AERCO International,<br>Inc. Blauvelt, NY 10913 | <b>Benchmark 1500-2000 – CHINA – Gas Train</b> | 01/26/2016   |
|   | <b>22283 rev A</b>                             | Sheet 1 of 1 |

# Benchmark 1500 – 2000 Boiler User Manual - INTERNATIONAL

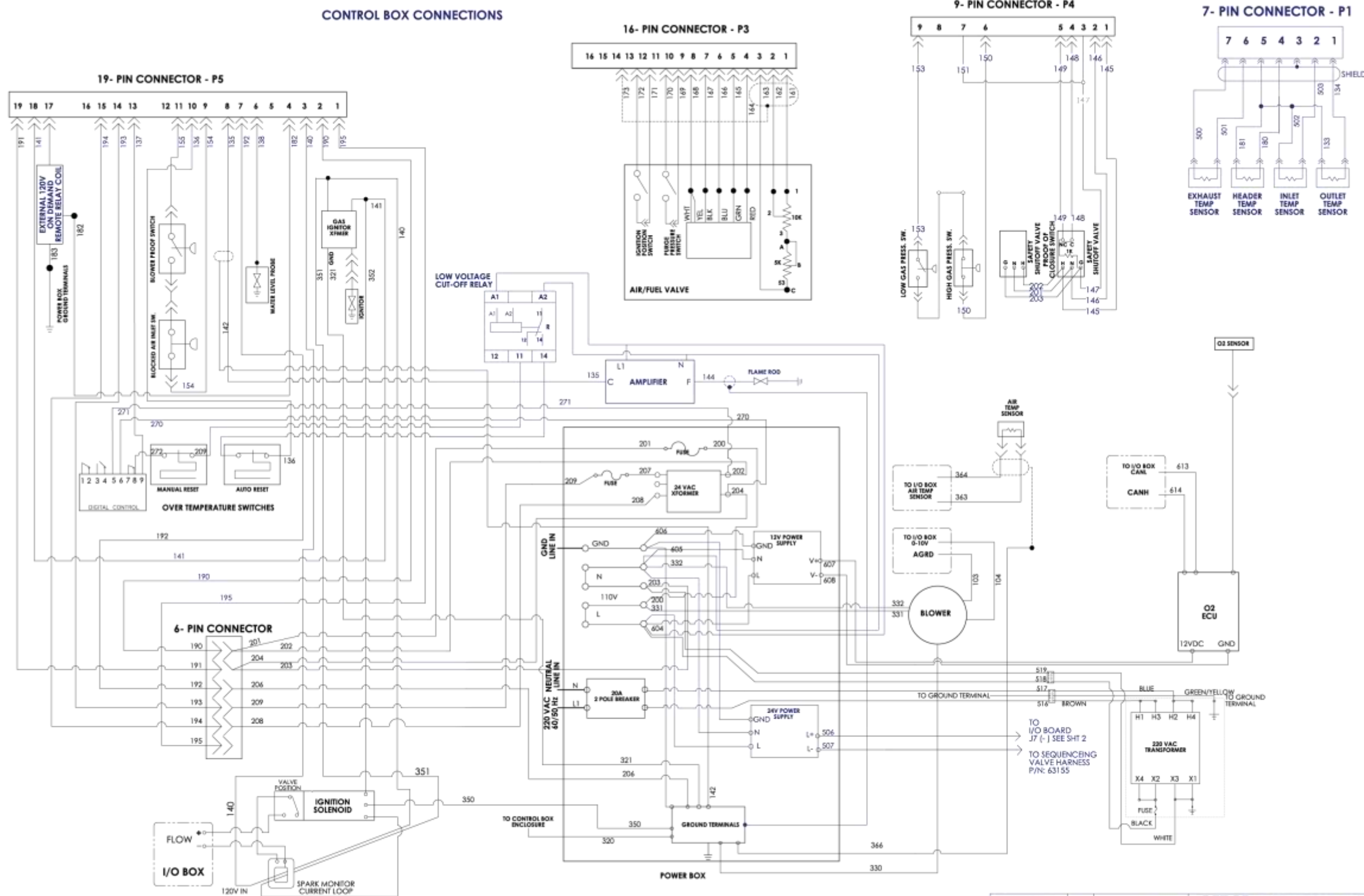
## APPENDIX G – PART LIST DRAWINGS

| Benchmark 1500 – 2000 Burner Assembly – P/N 24378-TAB rev F |     |          |                                     |      |     |         |                                 |
|---|-----|----------|-------------------------------------|------|-----|---------|---------------------------------|
| Item  | Qty | Part #   | Description                         | Item | Qty | Part #  | Description                     |
| 1   | 1   | 69078    | BLOWER: AMETEK 12.3"                | 16   | 1   | 61002-5 | BLOCKED INLET SWITCH -8.0" W.C. |
| 2   | 1   | 43090    | AIR FUEL VALVE PLENUM               | 17   | 1   | 81100   | GASKET: BLOWER 12.3"            |
| 3   | 1   | 24220-3  | A/F VALVE ASSY: BMK 1500            | 19   | 1   | 81166   | GASKET: BURNER                  |
|   |     | 24220-10 | A/F VALVE ASSY: BMK 2000            | 20   | 1   | 66026   | IGNITOR-INJECTOR                |
| 4   | 1   | 46042    | BURNER: BMK 1500                    | 21   | 1   | 61026   | O <sub>2</sub> SENSOR           |
|   |     | 46044    | BURNER: BMK 2000                    | 22   | 1   | 81048   | GASKET: FLAME ROD LOW NOX       |
| 5   | 1   | 81057    | GASKET: BLOWER                      | 23   | 1   | 66034   | FLAME ROD                       |
| 6   | 1   | 43095    | BLOWER PLENUM                       | 24   | 1   | 59104   | OBSERVATION PORT                |
| 8   | 1   | 59138    | FILTER: AIR 6"                      | 25   | 1   | 81183   | GASKET: RELEASE                 |
| 9   | 5   | 9-21     | PLUG: HEX HD 1/8 NPT                | 26   | 1   | 24277   | STAGED IGNITION ASSY            |
| 12  | 1   | 61024    | AIR INLET TEMPERATURE SENSOR        | 27   | 1   | 81184   | GASKET: BLOWER                  |
| 15  | 1   | 60011-4  | SWITCH ASSY: BLOWER PROOF: BMK 1500 | 32   | 1   | 81186   | GASKET: RELEASE: LOWER          |
|   |     | 60011-2  | SWITCH ASSY: BLOWER PROOF: BMK 2000 | 35   | 1   | 53033   | WASHER: CLOCKING                |



|  |  |              |
|--|--|--------------|
| AERCO<br>International, Inc.<br>Blauvelt, NY 10913 | <b>Benchmark 1500 - 2000 Burner Assembly</b> | 10/28/2015   |
|  | <b>24378-TAB rev F</b>                       | Sheet 1 of 1 |

Appendix H: WIRING DIAGRAMS



| REV | NO   | DESCRIPTION                     | DATE    | BY  | CHKD |
|-----|------|---------------------------------|---------|-----|------|
| B   | 1342 | ADDED LOW VOLTAGE CUT-OFF RELAY | 9/30/16 | JLR |      |
| A   | 1228 | RELEASED FOR SELO REVIEW        | 1/28/16 | JC  |      |
| 1   | 1228 | RELEASED FOR PROTOTYPE          | 1/12/14 | JC  |      |

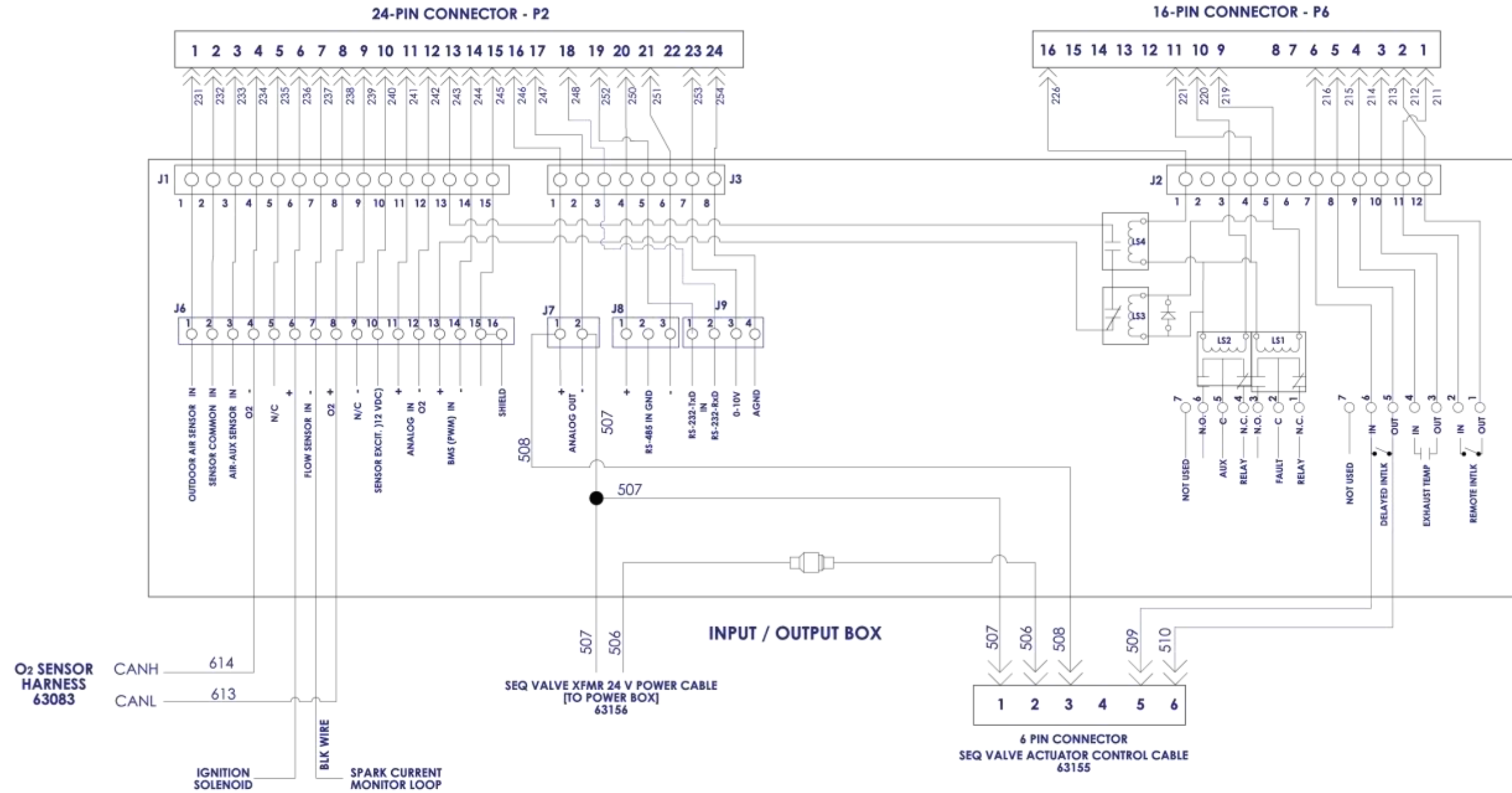
  

|   |   |  |
|---|---|--|
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|---|---|--|

Drawing Number 68088 rev B page 1 of 2

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CONTROL BOX CONNECTORS



| REV   | ECO | REVISIONS | DATE | BY | CHKD |
|---|-----|-----------|------|----|------|
| SEE SH1 FOR REVISIONS   |     |           |      |    |      |
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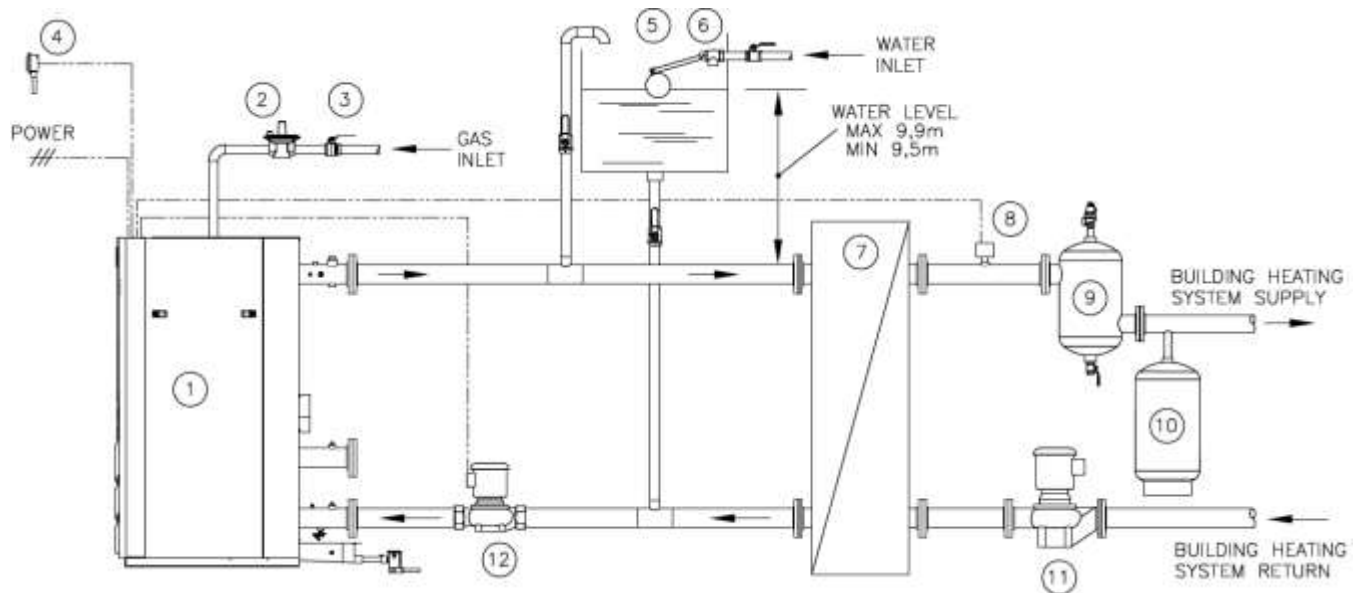
|  |   |  |
|--|---|--|
| THIRD ANGLE PROJECTION<br>   | DRAWING NO. D<br>DRAWN BY: jct<br>DATE: 1/12/16 | AERCO INTERNATIONAL INC.<br>100 OREANI DR. BLAUVELT, N.Y.<br><b>WIRING SCHEMATIC</b><br><b>BMK 1500/2000 CHINA</b> |
| ALL DIMENSIONS ARE IN INCHES AND ALL TOLERANCES ARE AS FOLLOWS (UNLESS OTHERWISE SPECIFIED):<br>XX.XXX XXX.X XXX.FRACTIONS 1/32 ANGLES 11°<br>DIMENSIONS ON A COMMON AXIS Ø IS TOTAL<br>CRITICAL DIMENSION |   | TITLE: 68088<br>SHEET 2 OF 2   |

Drawing Number 68088 rev B page 2 of 2

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**Appendix I: PIPING DRAWINGS**

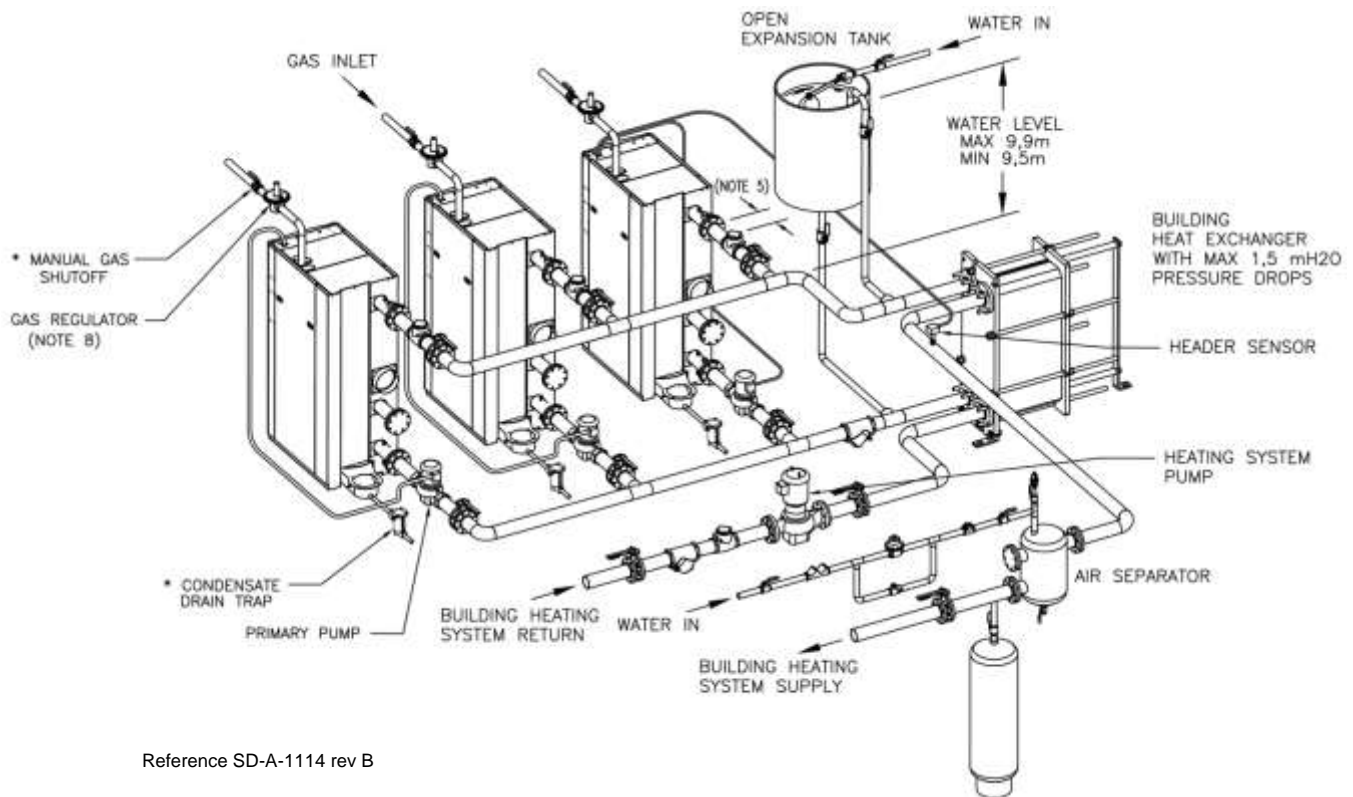


- |                              |                           |
|------------------------------|---------------------------|
| 1 BENCHMARK BOILER           | 7 BUILDING HEAT EXCHANGER |
| 2 GAS REGULATOR              | 8 HEADER SENSOR           |
| 3 MANUAL GAS SHUTOFF         | 9 AIR SEPARATOR           |
| 4 OUTSIDE TEMPERATURE SENSOR | 10 EXPANSION TANK         |
| 5 OPEN EXPANSION TANK        | 11 HEATING SYSTEM PUMP    |
| 6 WATER FILLING DEVICE       | 12 PRIMARY PUMP           |

**Diagram 1: Single Boiler Low Pressure (0.9 Bar) Piping Arrangement**

# Benchmark 1500 – 2000 Boiler User Manual - INTERNATIONAL

## APPENDIX I – PIPING DRAWINGS



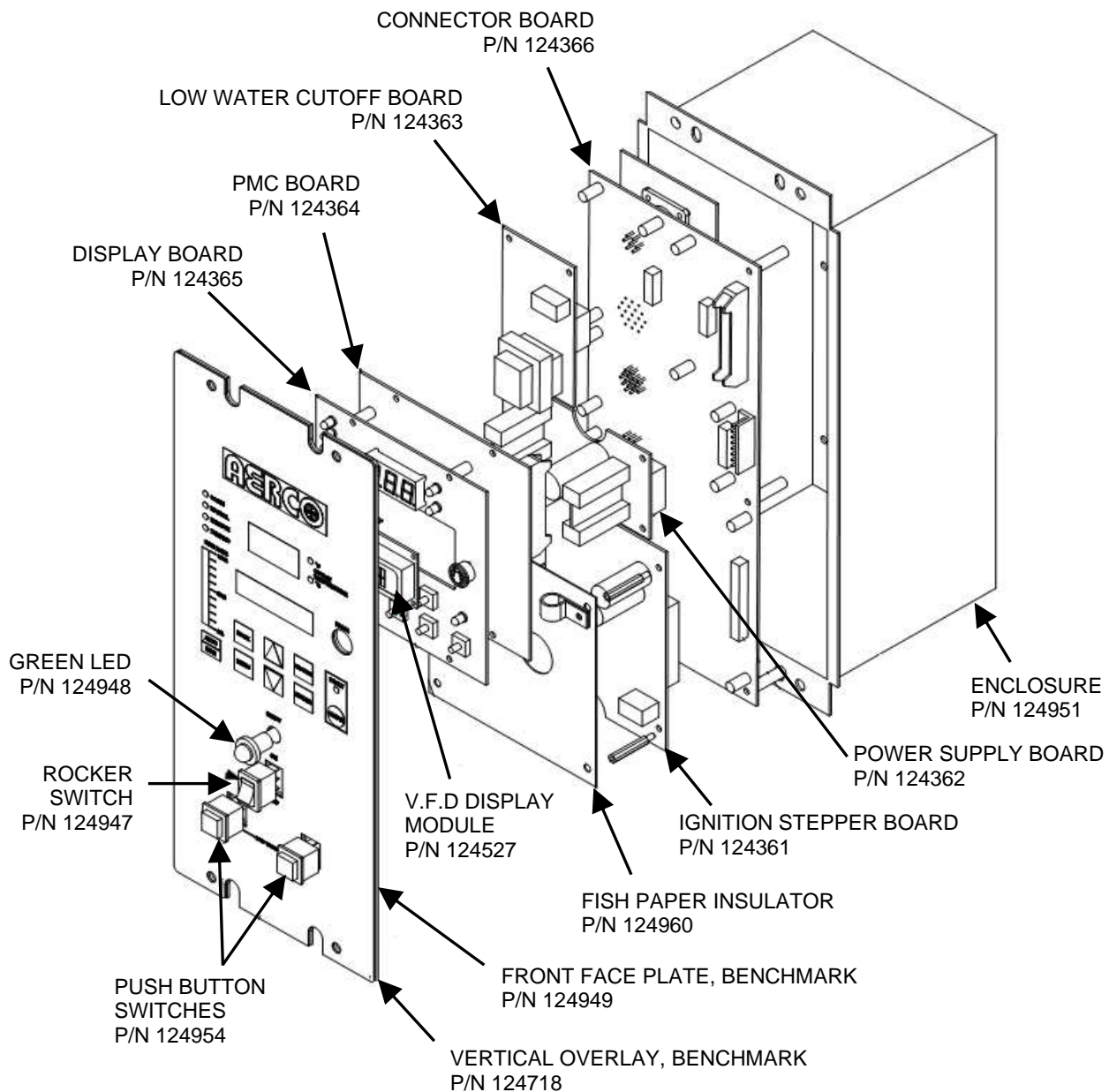
### NOTES:

1. For actual sizes and locations of piping and other connections to the heating boiler, see dimensional drawing.
2. Shell drain valve and condensate hose should be arranged to permit the fluids to drain freely, by gravity, to a floor drain. Relief valve discharge should be piped to the nearest floor drain. When no floor drain is available, the relief valve discharge should be piped vertically to a height 0.5 m above the floor.
3. All (\*) items are included separately in shipment.
4. This is a typical installation drawing. Local codes and authorities should be consulted.
5. Locate water inlet and outlet fittings (i.e. unions, elbows, etc.) a minimum of 0.2 m from heating boiler fittings, to prevent interference with removal of heater panels.
6. When available gas pressure is greater than 3.49 kPa, a lock-up style regulator must be installed downstream of the manual shutoff valve to bring the gas pressure down to 3.49 kPa or less.
7. When using the AERCO condensate neutralizer tank, for proper condensate drainage, the neutralizer tank must be installed in a pit or the boiler and the AERCO condensate trap must be elevated higher than 10 cm above the floor.
8. At 3.49 kPa or below, a gas regulator is optional unless required by local code.

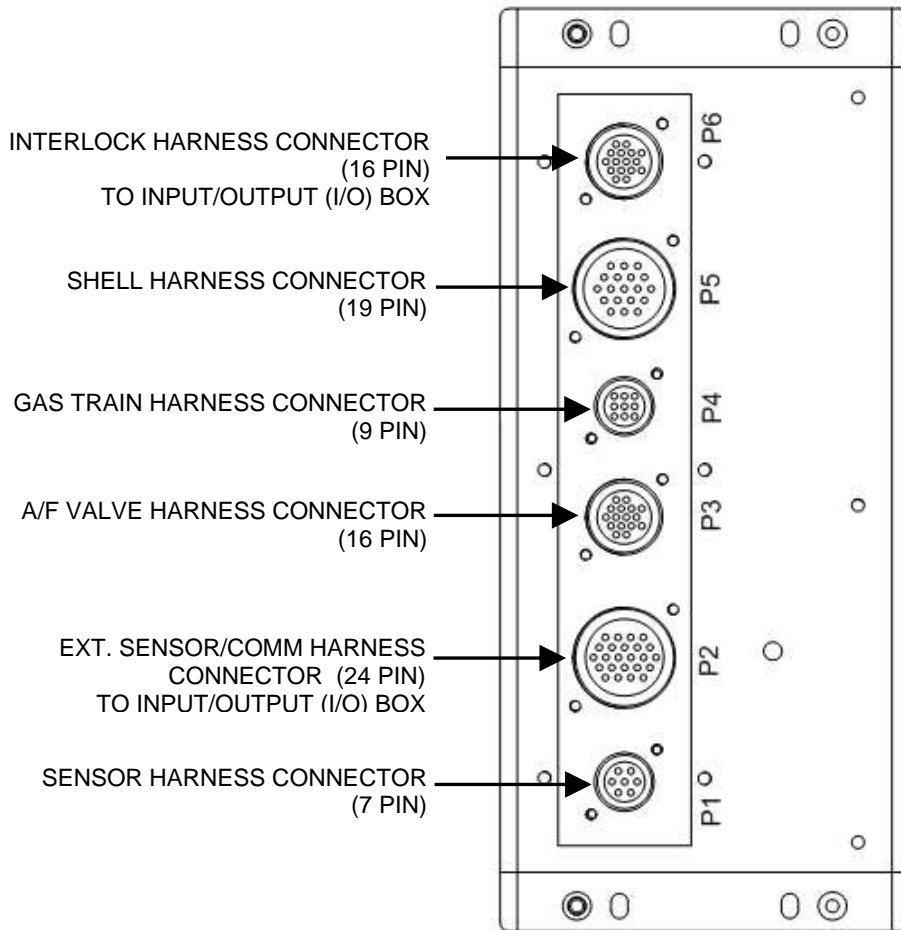
### **Diagram 2: Multiple Boiler Low Pressure (0.9 Bar) Piping Schematic with Boiler Sequencing Technology**



**Appendix J: C-MORE CONTROL PANEL VIEWS**



**Figure J-1 – Benchmark Series Control Panel - Exploded View**



**Figure J-2: Benchmark Control Panel Rear View**

### Appendix K: RECOMMENDED SPARES

#### NOTE

Refer to the Parts List Illustrations in Appendix G for the locations of the recommended and optional spare parts listed in the following Tables.

**Table K-1: Recommended Emergency Spare Parts**

| DESCRIPTION   | PART NUMBER |
|---|-------------|
| 120 VAC Blower  | 69078       |
| SSOV Actuator/Regulator Combo - Used on: <ul style="list-style-type: none"> <li>• ALL gas train models</li> <li>• <b>Downstream</b> SSOV of gas train models</li> </ul> | 64048       |
| SSOV Actuator <u>Without</u> Proof of Closure Switch - Used on: <ul style="list-style-type: none"> <li>• <b>Upstream</b> SSOV of gas train models</li> </ul>            | 69038       |
| Temperature Switch - Manual Reset   | 123552      |

**Table K-2: Spare Parts Recommended for Maintenance**

| DESCRIPTION                                | PART NUMBER |
|--|-------------|
| Annual Maintenance Kit                     | 58025-01    |
| 24-month Waterside/Fireside Inspection Kit | 58025-13    |

NOTE: Kits ending in **-xx** were not available at the time this guide was printed. Contact AERCO for availability.

**Table K-3: Optional Spare Parts**

| DESCRIPTION        | PART NUMBER            |
|--------------------|------------------------|
| C-More Control Box | 181197                 |
| Burner             | <b>BMK 1500:</b> 46042 |
|                    | <b>BMK 2000:</b> 46044 |
| Lean Oxygen Sensor | 61026                  |

**Benchmark 1500 - 2000 Boilers**  
APPENDIX K – RECOMMENDED SPARES

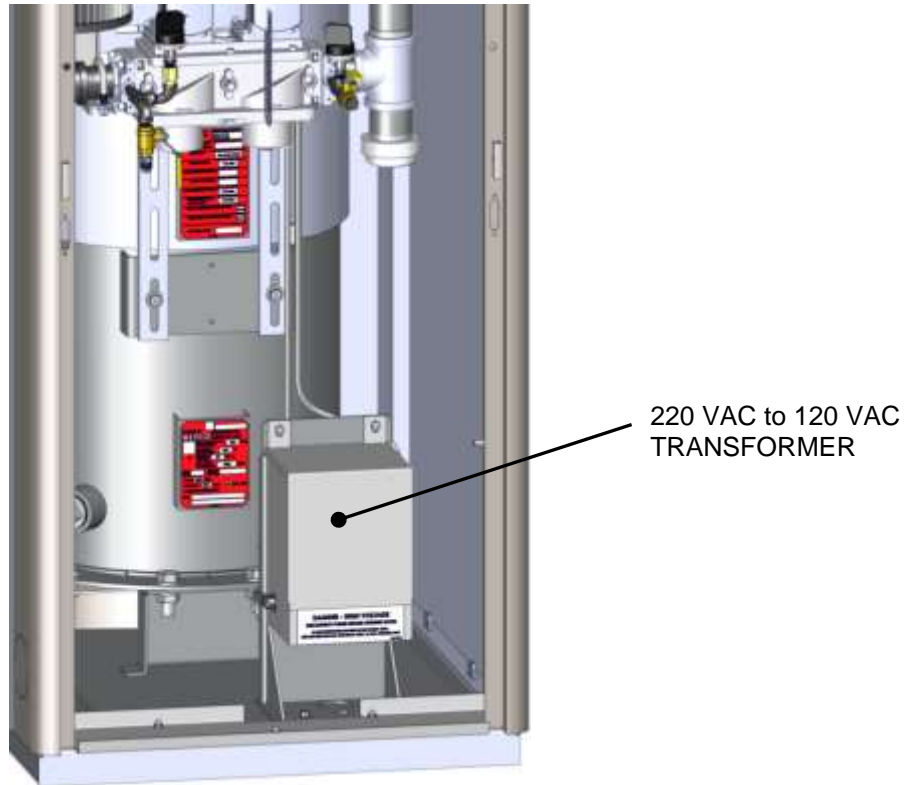
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### Appendix L: 220V to 110V Transformer

Benchmark 1500 and 2000 units that connect to a 220 VAC power source include a pre-installed 220 VAC to 120 VAC transformer. This transformer (P/N **24468**) is installed inside the unit, as shown in Figure L1. The 220 VAC electrical connection is pre-wired in the Power Box (shown in Figure 2-9).

A 250V 15 A time-delay fuse (P/N **65190**) is installed inside the transformer housing.



**Figure L1. 220V Transformer – Front Panel Removed**

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NOTES:



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