USER MANUAL

Installation, Operation and Maintenance

BENCHMARK Series
Gas-Fired Boilers

Natural Gas & Propane
Modulating & Condensing
Hot Water Boiler Models:

- **BMK 750**
- **BMK 1000**

Applicable to Serial Numbers:

G-16-0450 and above

Latest Update: 03/11/2016

Technical Support
(Mon-Fri, 8am-5pm EST)

1-800-526-0288

www.aerco.com

DISCLAIMER

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FOREWORD

The AERCO Benchmark (BMK) 750 MBH (220 kW) and 1000 MBH (293 kW) Boilers are modulating and condensing units. They are a true industry advancement 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 maximum turn down ratios for the BMK 1000 and BMK 750 are 20:1 and 15:1, respectively. Both BMK models provide extremely high efficiencies and make them ideally suited for modern low temperature, as well as, conventional heating systems.

The Benchmark Models BMK 750 and BMK 1000 operate within the following input and output ranges:

Benchmark Model	Input Range (BTU/hr.)		Output Range (BTU/hr.)	
	Minimum	Maximum	Minimum	Maximum
BMK 750	50,000 (14.6 kW)	750,000 (220 kW)	47,750 (14 kW)	716,250 (210 kW)
BMK 1000	50,000 (14.6 kW)	1,000,000 (293 kW)	48,300 (14.15 kW)	968,000 (284 kW)

The output of each boiler model 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, the BMK 750 and BMK 1000 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 750 and BMK 1000 offer the maximum venting flexibility with minimum installation space requirements. These Boilers are Category II, III and IV, positive pressure appliances. Single and/or multiple breeched 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 PVC, CPVC, 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 both Benchmark 750 and Benchmark 1000 boilers.

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
CCS	Combination Control System
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^3/hr)
CO	Carbon Monoxide
COMM (Comm)	Communication
Cal.	Calibration
CNTL	Control
CPU	Central Processing Unit
DBB	Double Block and Bleed, a gas trains containing 2 Safety Shutoff Valves (SSOVs) and a solenoid operated vent valve.
DIP	Dual In-Line Package, a type of switch
ECU	Electronic Control Unit (O_2 sensor)
EMS	Energy Management System; often used interchangeably with BAS

Phrase, Abbreviation or Acronym	Meaning
FM	Factory Mutual. Used to define boiler gas trains.
GF-xxxx	Gas Fired (an AERCO document numbering system)
GND	Ground
HDR	Header
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 thousandth of an ampere)
MAX (Max)	Maximum
MBH	1000 BTUs per Hour
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_2	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

Phrase, Abbreviation or Acronym	Meaning
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)
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 (or EIA-232)	A standard for serial, full-duplex (FDX) transmission of data based on the RS232 Standard
RS422 (or EIA-422)	A standard for serial, full-duplex (FDX) transmission of data based on the RS422 Standard
RS485 (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 millionth 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.

See pages 13 and 14 for important information regarding installation of units within the Commonwealth of Massachusetts.

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 120 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 three-pole 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.

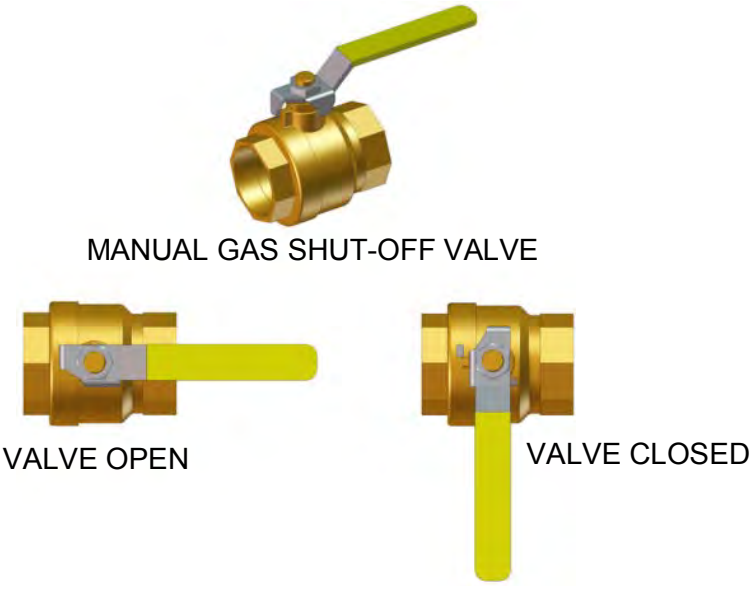


Figure 1-1: Manual Gas Shutoff Valve

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 of the unit. The installer must identify the emergency shut-off device.

IMPORTANT – FOR MASSACHUSETTS INSTALLATIONS

Boiler installations within the Commonwealth of Massachusetts must conform to the following requirements:

- Boiler must be installed by a plumber or a gas fitter who is licensed within the Commonwealth of Massachusetts.
- Prior to unit operation, the complete gas train and all connections must be leak tested using a non-corrosive soap.
- The vent termination must be located a minimum of 4 feet above grade level. If side-wall venting is used, the installation must conform to the following requirements **extracted from 248 CMR 5.08 (2):**

(a) For all side wall horizontally vented gas fueled equipment installed in every dwelling, building or structure used in whole or in part for residential purposes, including those owned or operated by the Commonwealth and where the side wall exhaust vent termination is less than seven (7) feet above finished grade in the area of the venting, including but not limited to decks and porches, the following requirements shall be satisfied:

1. INSTALLATION OF CARBON MONOXIDE DETECTORS. At the time of installation of the side wall horizontal vented gas fueled equipment, the installing plumber or gasfitter shall observe that a hard wired carbon monoxide detector with an alarm and battery back-up is installed on the floor level where the gas equipment is to be installed. In addition, the installing plumber or gasfitter shall observe that a battery operated or hard wired carbon monoxide detector with an alarm is installed on each additional level of the dwelling, building or structure served by the side wall horizontal vented gas fueled equipment. It shall be the responsibility of the property owner to secure the services of qualified licensed professionals for the installation of hard wired carbon monoxide detectors.

   a. In the event that the side wall horizontally vented gas fueled equipment is installed in a crawl space or an attic, the hard wired carbon monoxide detector with alarm and battery back-up may be installed on the next adjacent floor level.

   b. In the event that the requirements of this subdivision cannot be met at the time of completion of installation, the owner shall have a period of thirty (30) days to comply with the above requirements; provided, however, that during said thirty (30) day period, a battery operated carbon monoxide detector with an alarm shall be installed.

2. APPROVED CARBON MONOXIDE DETECTORS. Each carbon monoxide detector as required in accordance with the above provisions shall comply with NFPA 720 and be ANSI/UL 2034 listed and IAS certified.

3. SIGNAGE. A metal or plastic identification plate shall be permanently mounted to the exterior of the building at a minimum height of eight (8) feet above grade directly in line with the exhaust vent terminal for the horizontally vented gas fueled heating appliance or equipment. The sign shall read, in print size no less than one-half (1/2) inch in size, **"GAS VENT DIRECTLY BELOW. KEEP CLEAR OF ALL OBSTRUCTIONS".**

4. INSPECTION. The state or local gas inspector of the side wall horizontally vented gas fueled equipment shall not approve the installation unless, upon inspection, the inspector observes carbon monoxide detectors and signage installed in accordance with the provisions of 248 CMR 5.08(2)(a)1 through 4.

(b) EXEMPTIONS: The following equipment is exempt from 248 CMR 5.08(2)(a)1 through 4:

1. The equipment listed in Chapter 10 entitled "Equipment Not Required To Be Vented" in the most current edition of NFPA 54 as adopted by the Board; and

2. Product Approved side wall horizontally vented gas fueled equipment installed in a room or structure separate from the dwelling, building or structure used in whole or in part for residential purposes.

(c) MANUFACTURER REQUIREMENTS - GAS EQUIPMENT VENTING SYSTEM PROVIDED. When the manufacturer of Product Approved side wall horizontally vented gas equipment provides a venting system design or venting system components with the equipment, the instructions provided by the manufacturer for installation of the equipment and the venting system shall include:

1. Detailed instructions for the installation of the venting system design or the venting system components; and

2. A complete parts list for the venting system design or venting system.

(d) MANUFACTURER REQUIREMENTS - GAS EQUIPMENT VENTING SYSTEM NOT PROVIDED. When the manufacturer of a Product Approved side wall horizontally vented gas fueled equipment does not provide the parts for venting the flue gases, but identifies "special venting systems", the following requirements shall be satisfied by the manufacturer:

1. The referenced "special venting system" instructions shall be included with the appliance or equipment installation instructions; and

2. The "special venting systems" shall be Product Approved by the Board, and the instructions for that system shall include a parts list and detailed installation instructions.

(e) A copy of all installation instructions for all Product Approved side wall horizontally vented gas fueled equipment, all venting instructions, all parts lists for venting instructions, and/or all venting design instructions shall remain with the appliance or equipment at the completion of the installation.

[End of Extracted Information From 248 CMR 5.08 (2)]

CHAPTER 2. INSTALLATION

2.1 INTRODUCTION

This Chapter provides the descriptions and procedures necessary to unpack, inspect and install AERCO Benchmark Boiler Models BMK 750 and BMK 1000.

2.2 RECEIVING THE UNIT

Each Benchmark unit is shipped as a single crated unit. The shipping weights for the BMK 750 and BMK 1000 Models are approximately 1100 (499 kg) and 1200 pounds (544 kg), respectively. 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, closely inspect the unit to make sure there is no evidence of damage not indicated by the Tip-N-Tell indicator. Notify the freight carrier 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**)
- 1" Gas Supply Shutoff Valve
- Lifting Bar (with attaching hardware)

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

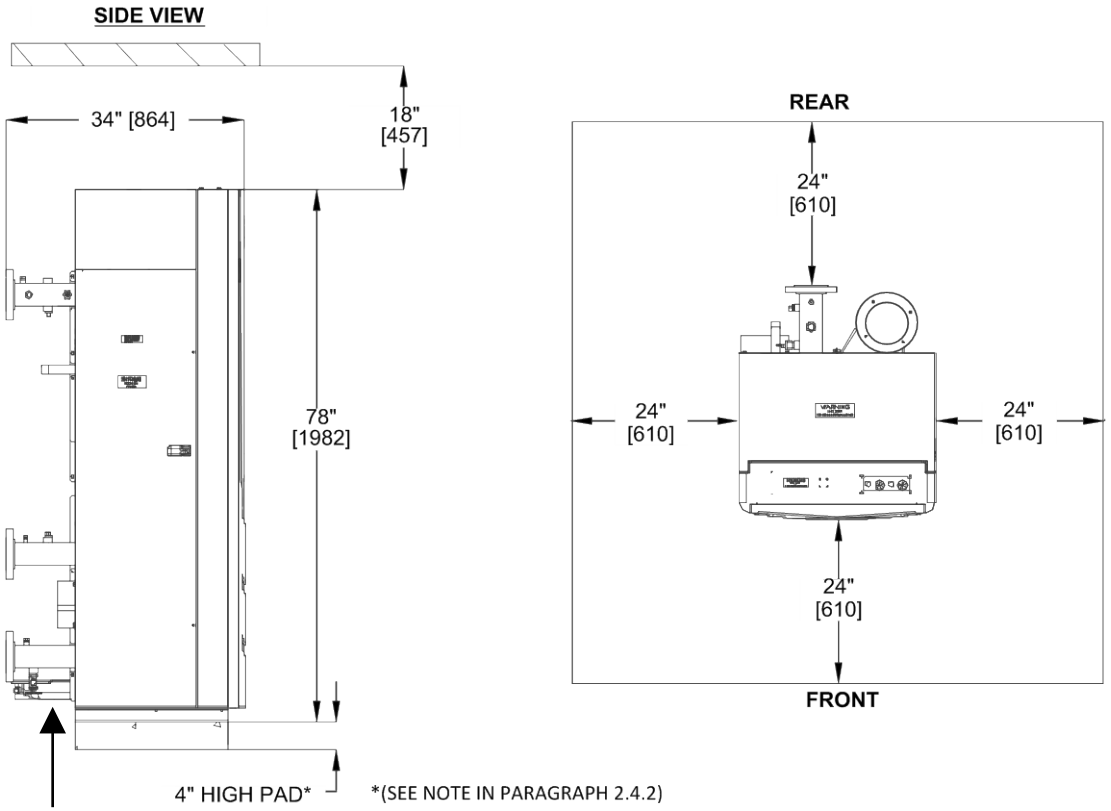
Ensure that the site selected for installation of the Benchmark Boiler includes:

- Access to AC Input Power at 120 VAC, Single-Phase, 60 Hz @ 20 Amps.
- Access to one of the following ***with the unit operating at maximum capacity***:
  - For Benchmark 750 & 1000, a NATURAL GAS line at a minimum pressure of **4" W.C. (996 Pa)**
  - For Benchmark 750, a PROPANE gas line at a minimum pressure of **7" W.C. (1744 Pa)**
  - For Benchmark 1000, a PROPANE gas line at a minimum pressure of **11" W.C. (2740 Pa)**

2.4.1 Installation Clearances

Benchmark Models 750 and 1000 are packaged in enclosures 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)



Housekeeping pad should not extend under the condensate assembly

Figure 2-1a: BMK 750 & 1000 Clearances

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.

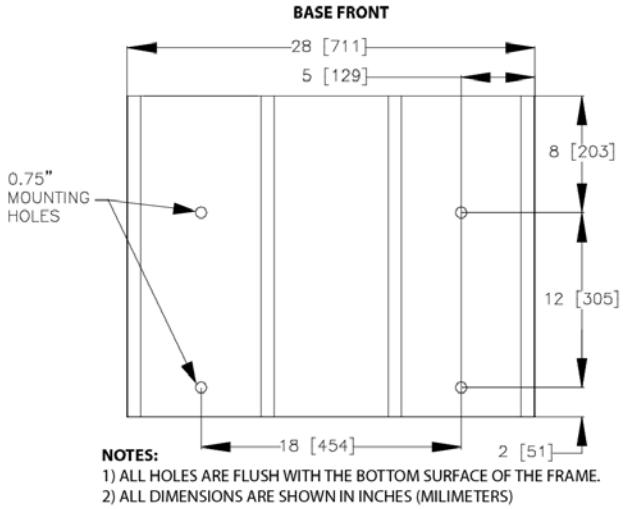


Figure 2-1b: BMK 750 & 1000 Anchor Bolt Locations

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.

FOR MASSACHUSSETTS ONLY:

For Massachusetts installations, the unit must be installed by a plumber or gas-fitter licensed within the Commonwealth of Massachusetts. In addition, the installation must comply with all requirements specified in Chapter 1 (Safety Precautions), pages 11 and 12.

2.4.2 Setting the Unit

The unit must be installed on a **4 inch to 6 inch (10.1cm to 15.24 cm)** concrete housekeeping pad to ensure proper condensate drainage (see NOTE below). If anchoring the unit, refer to the dimensional drawings in Figure 2-1b for anchor locations.

NOTE

When using the AERCO Condensate Neutralizer Tank for proper condensate drainage, the Neutralizer Tank must be stored in a pit, OR the boiler and AERCO Condensate Trap must be elevated **higher than 4" (10.2 cm)** above the floor. See Condensate Tank instructions in TID-0074 for details.

After unpacking and inspecting the boiler, remove the four (4) lag screws securing the boiler to the shipping pallet. The boiler can be lifted and moved by inserting forklift tines in the front slots provided in the base of the unit, or it can be lifted by attaching a lifting bar to the unit's heat exchanger. A lifting bar (P/N **59174**), with attaching hardware, is supplied with each unit. When shipped, this bar is attached to the rear of the unit as shown in Figure 2-2, View A. One (1) lifting tab is provided at the top of the unit's heat exchanger as shown. This tab is used to attach the lifting bar to the unit as follows:

WARNING!

- When lifting or moving the boiler, ***DO NOT*** attempt to manipulate the boiler using the gas train or blower.
- When using the lifting tab and bar, ensure there is no load placed on the gas train or blower.

Attachment of Lifting Bar

1. Remove the lifting bar from its shipping location at the rear of the unit (Figure 2-2, View A). Retain the attaching hardware consisting of two (2) hex head cap screws, hex nuts and flat washers.
2. Remove the top shroud from the boiler by grasping the handle on the top of the unit and lifting straight up. Locate the lifting tab at the top-rear of the heat exchanger.
3. Refer to Figure 2-2, View B and attach the lifting bar to the heat exchanger lifting tab using the hardware removed in step 1. The upper end of the lifting bar containing the oval cutout should be positioned over the top of the heat exchanger as shown.
4. Using proper rigging equipment, capable of supporting **1000 to 1200 lbs. (435 – 544 kg)**, lift the boiler and position it on the housekeeping pad.
5. After the boiler is properly set on the pad, detach the lifting bar and replace the shroud on the top of the unit.
6. Retain the lifting bar for possible reuse at the installation site.

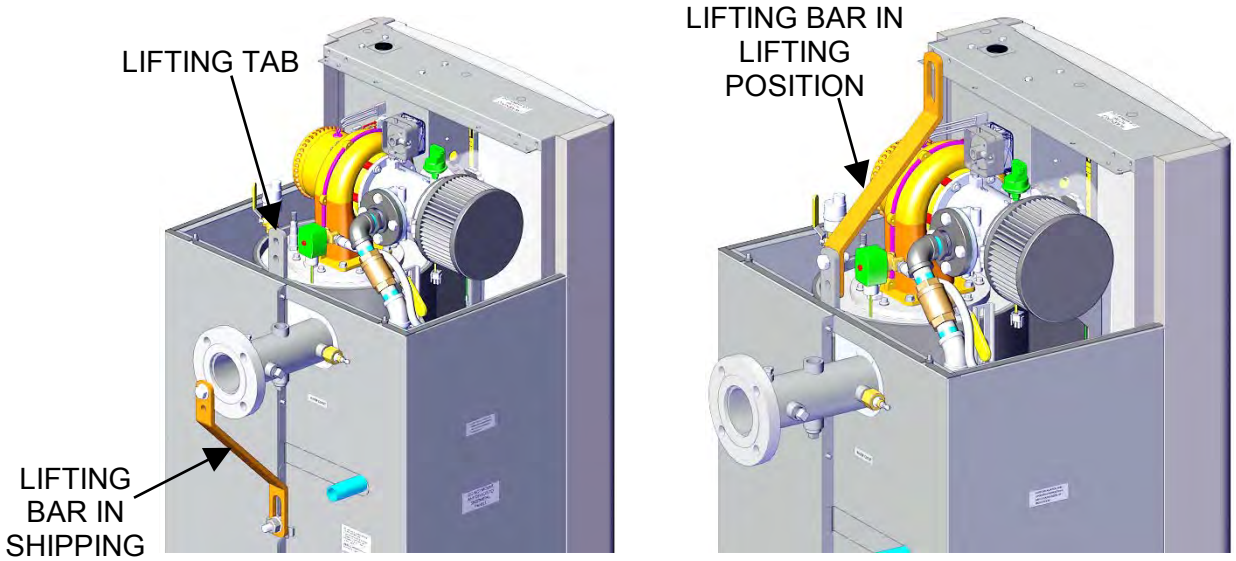


Figure 2-2: Boiler Lifting Provisions

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**.**

If installing a Combination Control Panel (CCP) system, it is important to identify the Combination Mode Boilers in advance and place them in the proper physical location. Refer to Chapter 5 for information on Combination Mode Boilers.

2.5 SUPPLY AND RETURN PIPING

Benchmark 750 and 1000 Boiler utilizes 3" (7.62cm) 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 E 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.

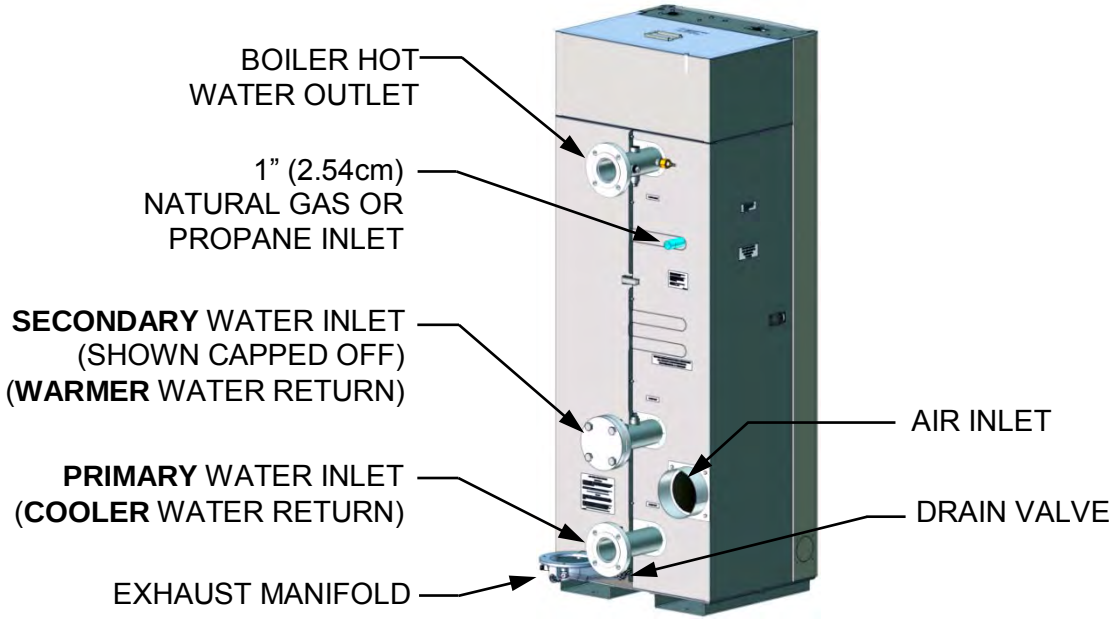


Figure 2-3: Supply and Return Locations – Two Inlet Option Shown

The optional 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 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 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 boiler heat exchanger is 100°F.)

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 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 boiler. Contact your AERCO representative for additional information.

2.6 PRESSURE RELIEF VALVE INSTALLATION

An ASME rated Pressure Relief Valve is supplied with each Benchmark Boiler. The pressure rating for the relief valve must be specified on the sales order. Available pressure ratings range from 30 psi to 160 psi (207 to 1103 kPa). 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. The relief piping must be full size, without reduction. 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.

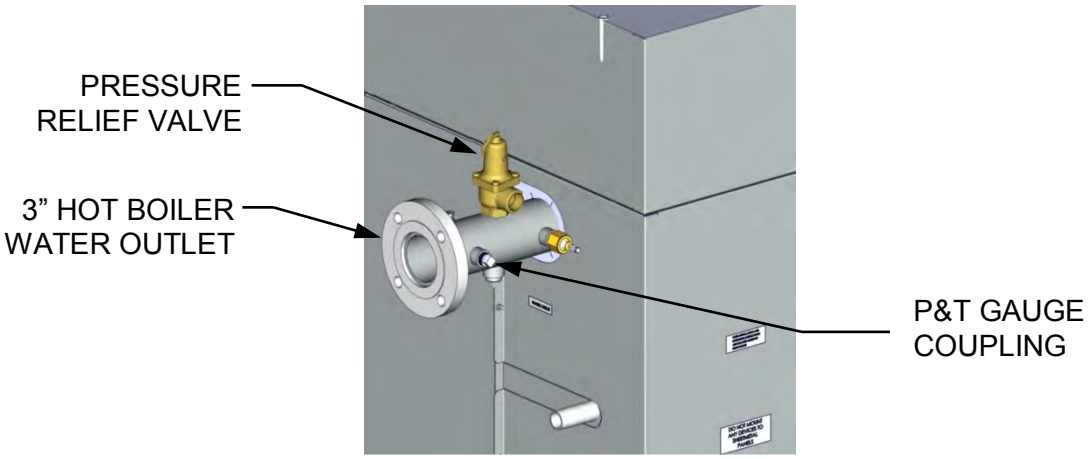


Figure2-4: Pressure Relief Valve Location

2.7 CONDENSATE DRAIN & PIPING

The Benchmark 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 and outlet connections contain tapped 3/4" NPT ports.

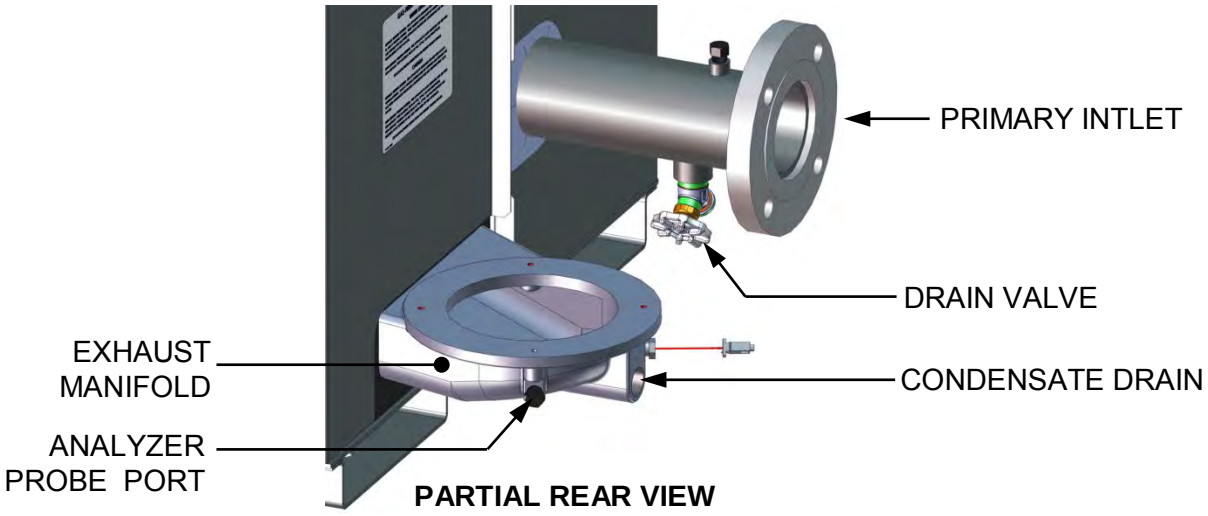


Figure2-5: Condensate Drain Connection Location

A sample condensate trap installation is shown in Figure 2-6. However, the actual installation details for the trap will vary depending on the available clearances, housekeeping pad height/ dimensions and other prevailing conditions at the site. The following general guidelines must be observed to ensure proper condensate drainage:

- The condensate trap inlet (Figure 2-6) must be level with, or lower than 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. AERCO recommends that a union be utilized between the exhaust manifold condensate drain port and the trap inlet port.

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 using the appropriate piping components (nipples, reducers, elbows, etc.) for the boiler installation site.
2. At the condensate trap outlet, install a 3/4" NPT nipple.
3. Connect a length of 1" (2.54 cm) I.D. 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.

If a floor drain is not available, a condensate pump can be used to remove the condensate to an appropriate drain. **The maximum condensate flow rate is 10 gallons (37.8 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.

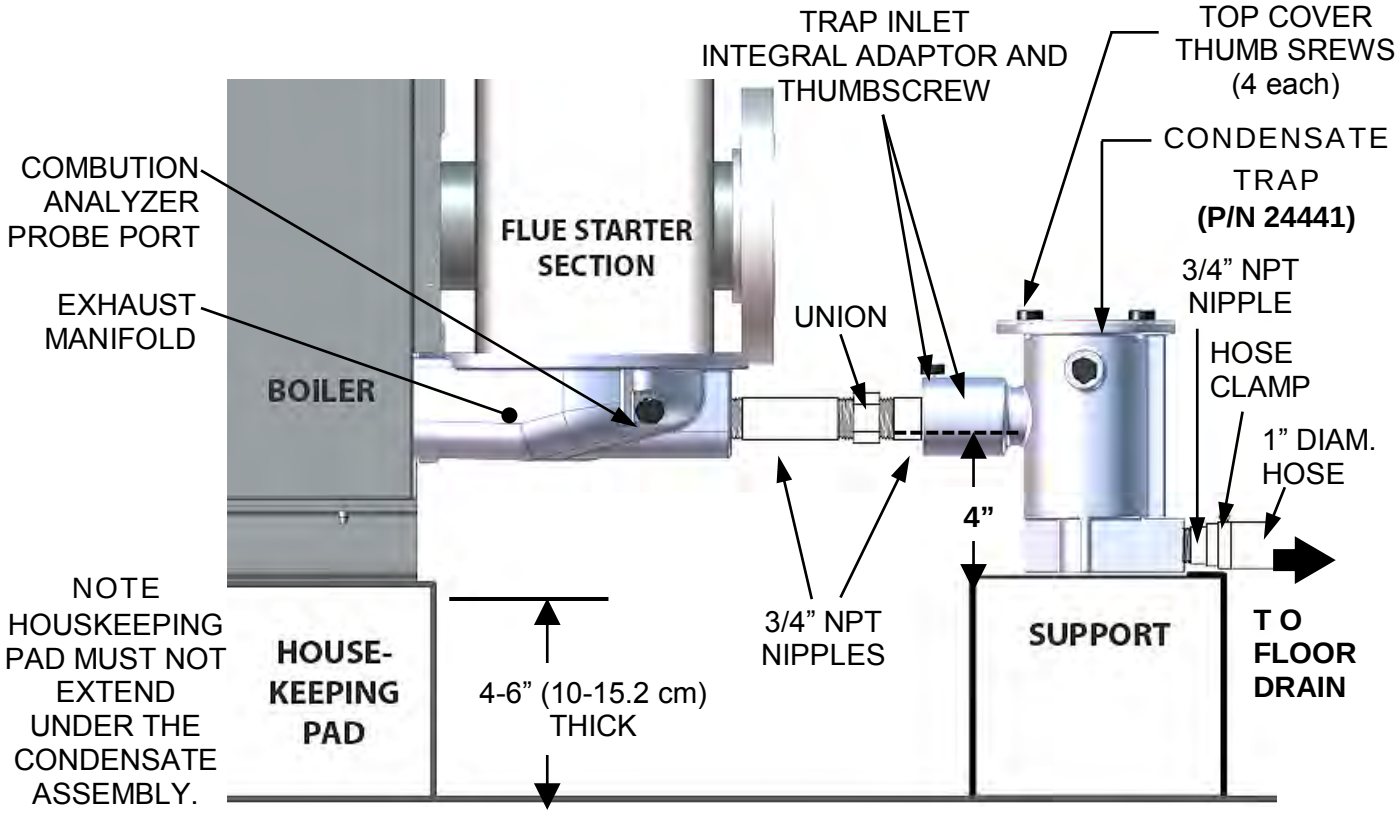


Figure2-6: Sample Condensate Trap Installation

2.8 GAS SUPPLY PIPING

The AERCO Benchmark Gas Components and Supply Design Guide, GF-2030 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 750 and 1000 units contain either a 1 inch (2.54 cm) NATURAL GAS or a 1 inch (2.54 cm) PROPANE gas inlet connection on the rear of the unit, as shown in Figure 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, isolate the unit from the gas supply piping. The gas pressure applied to the unit **must *NOT* exceed 14" W.C. (3487 Pa)** at any time. Leak test all external piping thoroughly 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 are as follows:

- The maximum static pressure to the unit must not exceed the following:

	Natural Gas	Propane
Benchmark 750	14" W.C. (3487 Pa)	14" W.C. (3487 Pa)
Benchmark 1000	14" W.C. (3487 Pa)	16" W.C. (3985 Pa)

- Supply piping and pressure to the unit must be sufficient to provide the volume of gas while maintaining gas pressure listed below while ***operating at maximum capacity***:

	Natural Gas	Propane
BMK 750	**728** CFH (20.6 m^3/hr) while maintaining **4" W.C. (996 Pa)**	**300** CFH (8.5 m^3/hr) while maintaining **7" W.C. (1744 Pa)**
BMK1000	**976** CFH (27.6 m^3/hr) while maintaining **4" W.C. (996 Pa)**	**400** CFH (11.3 m^3/hr) while maintaining **11" W.C. (2740 Pa)**

2.8.2 Manual Gas Shutoff Valve

A manual shut-off valve must be installed in the gas supply line upstream of the boiler as shown in Figure 2-7. **Maximum allowable gas pressure to the 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 (see sections 2.8.3.1 and 2.8.3.2, below). Regulators must conform to the following specifications:

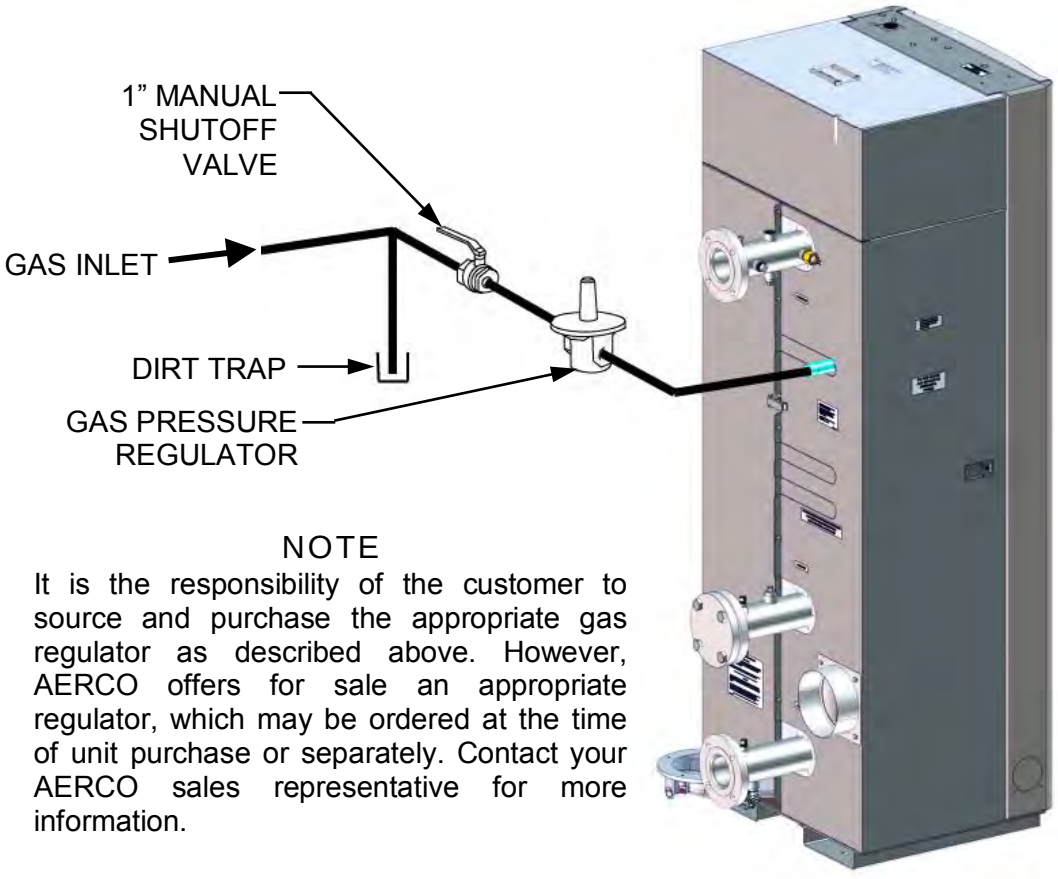
- **NATURAL GAS:** The external natural gas regulator must be capable of regulating **49,000 – 1,020,000 BTU/HR (14.3 kW – 299 kW)** while maintaining a minimum gas pressure of **4.0" W.C. (996 Pa)** to the unit.
- **PROPANE:** The external natural gas regulator must be capable of regulating **49,000 – 1,020,000 BTU/HR (14.3 kW – 299 kW)** while maintaining a minimum gas pressure of **11.0" W.C. (2740 Pa)** to the unit.
- A lock-up style regulator ***MUST*** be used when gas supply pressure will ***exceed* 14" W.C. (3487 Pa)**.

2.8.3.1 Massachusetts Installations Only

For Massachusetts installations, a mandatory external gas supply regulator must be positioned as shown in Figure 2-7. The gas supply regulator must be properly vented to outdoors. Consult the local gas utility for detailed requirements concerning venting of the supply gas regulator.

2.8.3.2 All Installations (Except Massachusetts)

For installations with 3 or more units (other than Massachusetts) that ***EXCEED* 7" W.C. (1744 Pa)** gas pressure, a separate external gas supply regulator, as shown in Figure 2-7, is highly recommended. No regulator is required for gas pressures ***below* 7" W.C. (1744 Pa)** of pressure. Consult the local gas utility for detailed requirements concerning venting of the supply gas regulator.



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 your AERCO sales representative for more information.

Figure2-7: Manual Gas Shut-Off Valve and Gas Regulator Locations

2.9 AC ELECTRICAL POWER WIRING

The AERCO Benchmark Electrical Power Wiring Guide, GF-2060, 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. 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. Open the hinged cover of the Power Box to access the AC terminal block connections and other internal components, as shown in Figure 2-9.

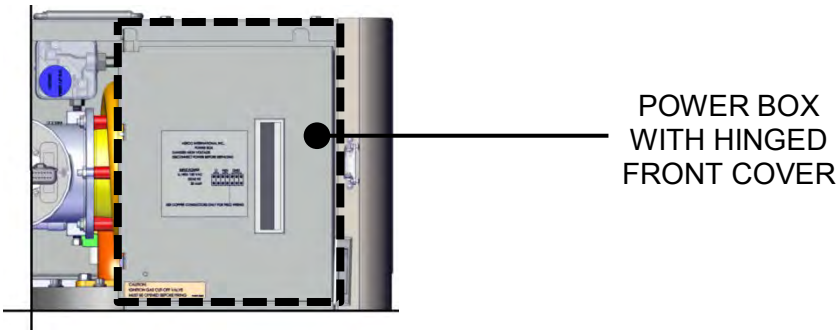


Figure2-8: Power Box With Closed Cover

WARNING!

THE AC POWER OUTLETS SHOWN IN FIGURE 2-9 ARE LIMITED TO 600 WATTS (5 AMP) SERVICE. DO NOT OVER-LOAD THESE OUTLETS. ALSO, THE FUSIBLE LINK SHOWN IN FIGURE 2-9 DOES NOT REMOVE POWER FROM THE TERMINAL BLOCKS OR AC OUTLETS.

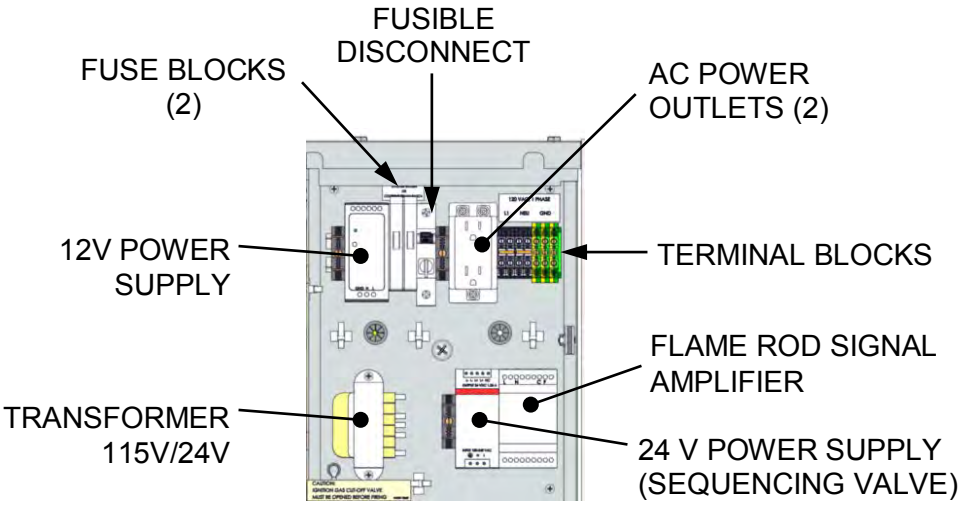


Figure2-9: Power Box Internal Components

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 750 and Benchmark 1000 models are available in one voltage configuration:

- 120 VAC, Single-Phase, 60 Hz @ 20 Amps

The Power Box contains terminal blocks as shown in Figure 2-10. In addition, a label showing the required AC power connections is provided on the front cover of the Power Box as shown in Figure 2-8.

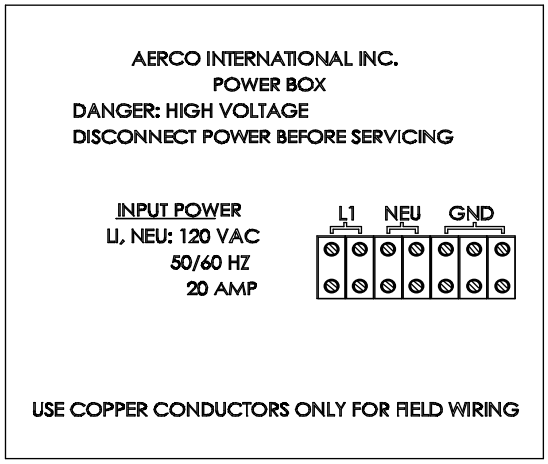


Figure 2-10: Power Box Cover Label

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

A double-pole 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 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 and/or the Canadian Electrical Code (CEC) Part I, CSA C22.1 Electrical Code.

For electrical power wiring diagrams, see the AERCO Benchmark Electrical Power Guide, (GF-2060).

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 center-right portion on the front of the unit directly below the C-More Control Panel as shown in Figure 2-11.

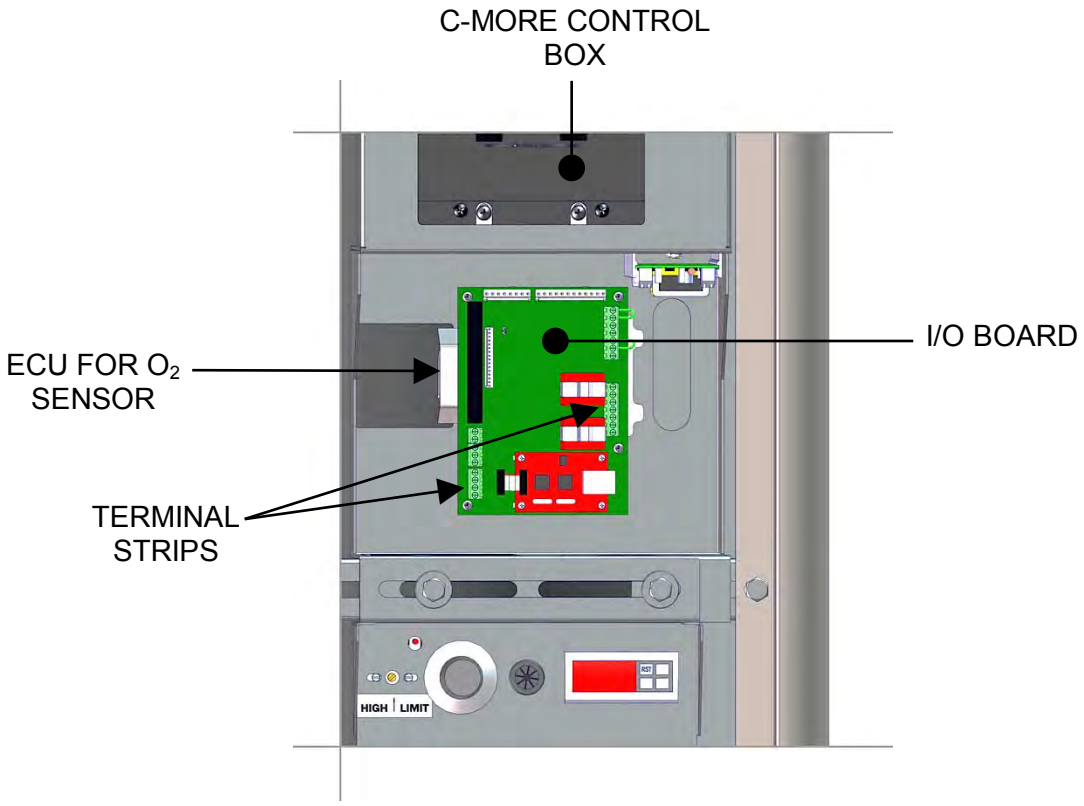


Figure2-11: Input/Output (I/O) Box Location

The I/O board terminal strip connections are shown in Figure 2-12. 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.

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.

WARNING!

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

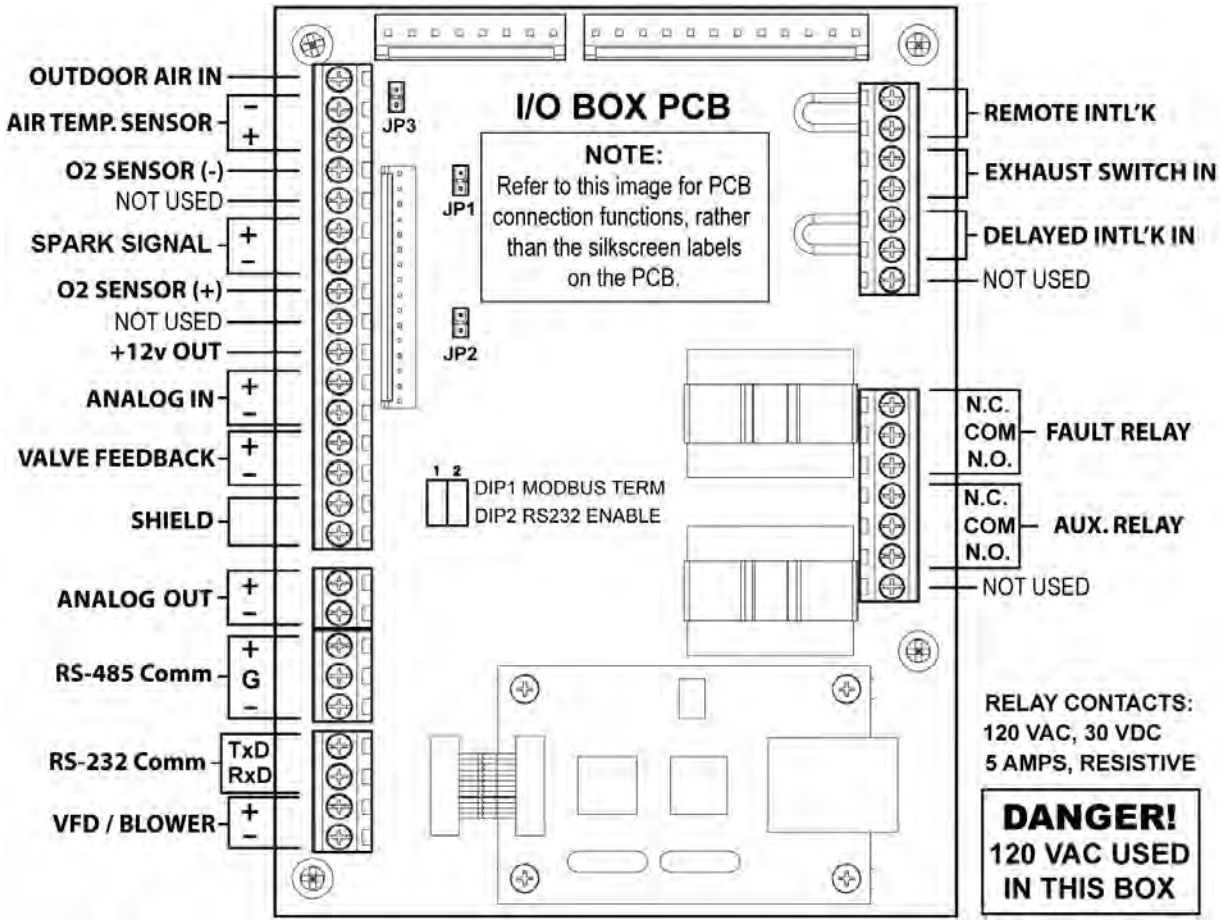


Figure2-12: I/O Box Terminal Strips

2.10.1 OUTDOOR AIR IN Terminals

The OUTDOOR AIR IN terminal is used for connecting an outdoor temperature sensor (P/N **61047**), 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 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 AIR IN terminal is also used for connecting an outdoor temperature sensor if utilized with the BST system. See chapter 9 for additional information.

The outdoor sensor may be wired **up to 200 feet (61 m)** from the boiler. It is connected to the OUTDOOR AIR IN and AIR SENSOR COMMON terminals in the I/O Box (see 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. 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_2 SENSOR Terminals

The O_2 SENSOR (+) and O_2 SENSOR (–) terminals are used to connect an external oxygen sensor to the I/O Box. The O_2 concentration is displayed in the *Operating* menu of the C-More Control system after a 60 second warm-up period.

2.10.4 SPARK SIGNAL Terminals

The SPARK SIGNAL terminals (+ & -) connect to the spark monitor (p/n 61034, also called "AC Current transducer"), which monitors the current going to the ignition transformer (p/n 65085, see Section 7.13). If the current is insufficient (too high or low) during the ignition sequence, the controller will abort the ignition cycle. The controller will attempt up to three ignition cycles. If the current is insufficient by the third try, the controller will shut down and display a fault message.

2.10.5 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 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 set-point 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 boiler’s I/O Box (see 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 Boiler’s I/O Box.

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

2.10.6 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.

2.10.7 SHIELD Terminals

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

2.10.8 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:

- 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 2.10.11).
- 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.

- 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 +/-.*

2.10.9 RS485 Comm Terminals

The RS485 communication terminals (+, GND, & -) are used when the boiler plant is being controlled by an Energy Management System (EMS) or AERCO Control System (ACS) using Modbus (RS-485) communication.

2.10.10 RS232 Comm Terminals

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.

2.10.11 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 2.10.8), the output from the VFD/Blower terminals is disabled.

2.10.12 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.

2.10.12.1 REMOTE INTL'K Terminals

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

2.10.12.2 DELAYED INTL'K Terminals (OUT & IN)

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.

2.10.12.2.1 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).

2.10.12.2.2 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 boiler'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 (see section 3.6 in Chapter 3).

2.10.13 FAULT RELAY (NC, COM, & NO) Terminals

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.

2.10.14 AUX RELAY CONTACTS (NC, COM, & NO) Terminals

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 indictor (firing or not firing). Its contacts are rated for 120 VAC @ 5 amps. Refer to Figure 2-12 to locate the AUX RELAY terminals for wiring connections.

2.11 FLUE GAS VENT INSTALLATION

AERCO Gas Fired Venting and Combustion Air Guide, GF-2050 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 1.9" W.C. (473 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.

For Massachusetts installations, the following companies provide vent systems that conform to all applicable requirements for installations within the Commonwealth of Massachusetts. Contact information is as follows:

Selkirk Corporation - Heatfab Division
130 Industrial Blvd.
Turners Falls, MA 01376
Phone: 1-800-772-0739
www.heat-fab.com

Watertown Supply
33Grove St.
Watertown, MA 02472
Phone: (617) 924-2840
http://www.watertownsupply.com/

M. A. Peacard
1250 Massachusetts Ave.
Boston MA 02125-1689
Phone: (617) 288-0629
www.mapeacard.com

Glover Sheet Metal, Inc.
44 Riverdale Ave.
Newton, MA 02485
Phone: (617) 527-8178
www.gloversheetmetal.com

2.12 COMBUSTION AIR

The AERCO Benchmark Boiler Venting and Combustion Air Guide, GF-2050 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 2.13, below, and consult the AERCO GF-2050, 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^2) 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. For Canada installations, refer to the requirements specified in CSA B149.1-10, sections 8.4.1 and 8.4.3.

2.13 DUCTED COMBUSTION AIR

The AERCO Benchmark 750 & 1000 Boilers are UL listed for 100%-ducted combustion. For ducted combustion air installations, the screen inlet air ductwork must then be attached directly to the unit's air inlet.

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-2050. When using the heater in a ducted combustion air configuration, **each unit must have a minimum 6 inch (15.24 cm) diameter connection** at the unit.

2.14 BENCHMARK PUMP RELAY OPTION

An optional Benchmark 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.

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

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

If pump/valve load exceeds the above contact ratings, use a separate contact relay.

See Figures 2-13 and 2-14 for wiring details.

To identify if the boiler is equipped with the BMK Pump Relay Option (P/N. **69102**), look for the label and relay as shown in Figure 2-15.

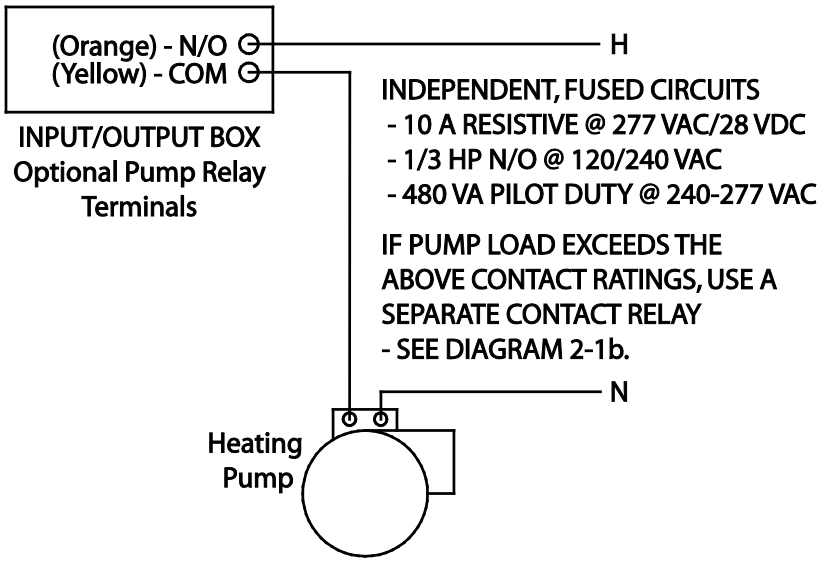


Figure2-13: Schematic – System Pump Start using Boiler Pump Relay

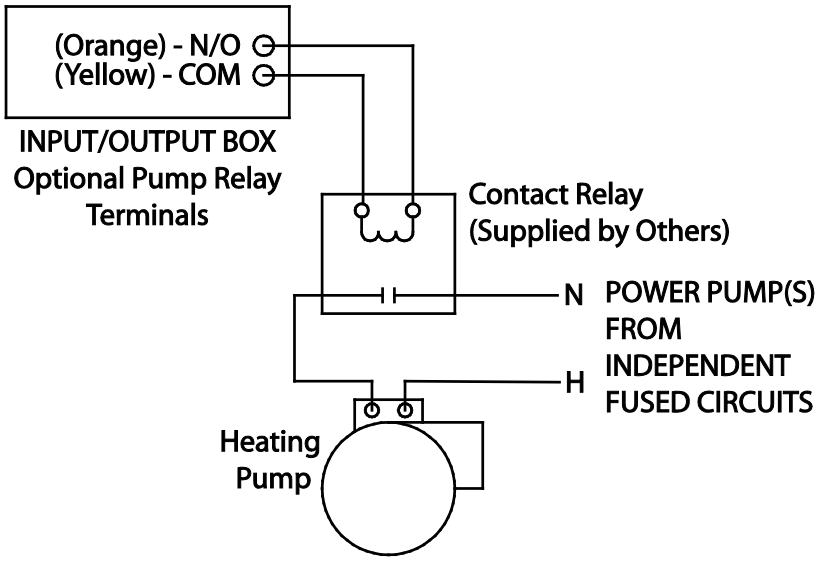


Figure2-14: Schematic – System Pump Start using a Separate Contact Relay

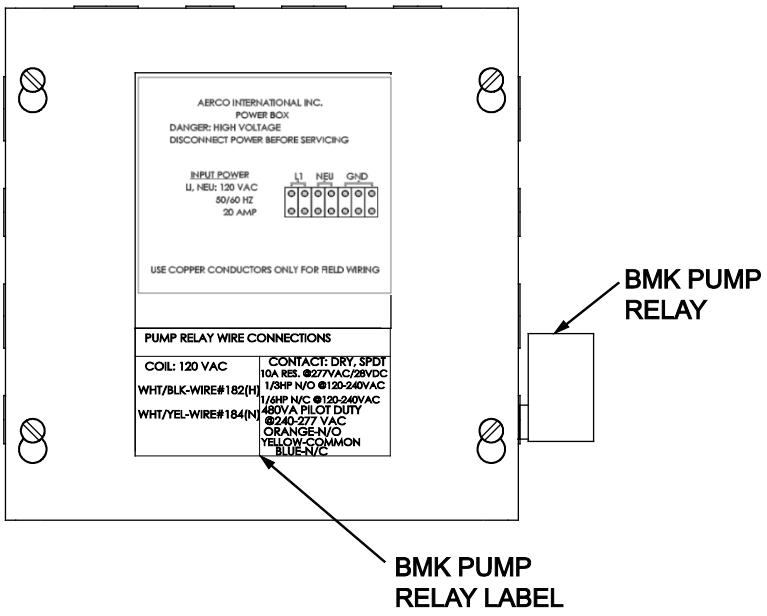


Figure 2-15: Identifying the Presence of BMK Pump Relay Option 69102

2.15 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 boilers to have one boiler, acting as a "master" to manage the other boilers at the site in such a way that the efficiency of the entire 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 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 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 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 boiler's hot water outlet pipe.

Installing Sequencing Isolation Valve – *Continued*

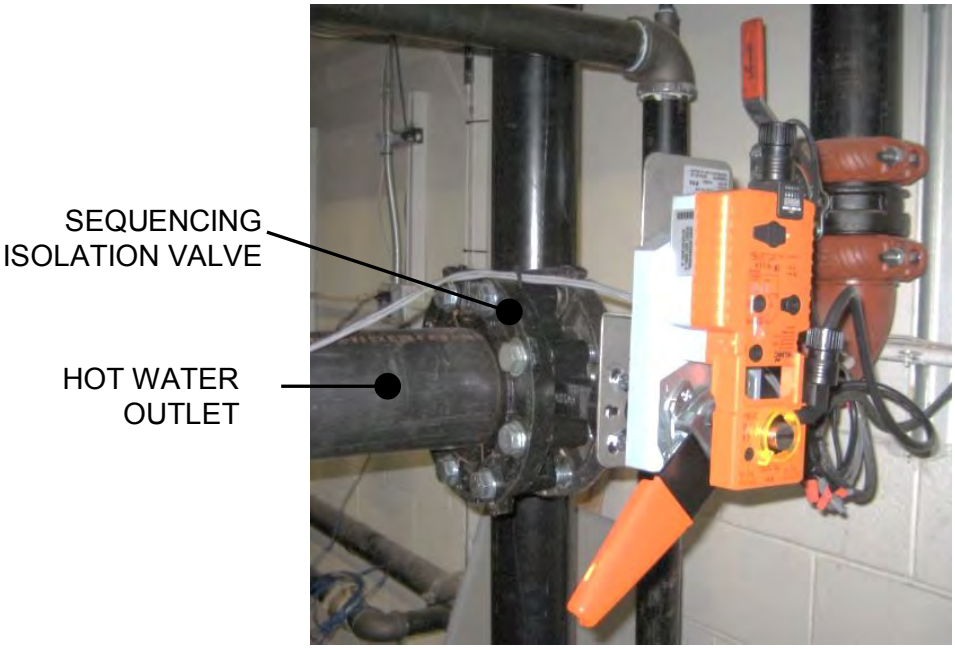


Figure 2-16: Sequencing Isolation Valve Installed

2. The 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 2-12) 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.

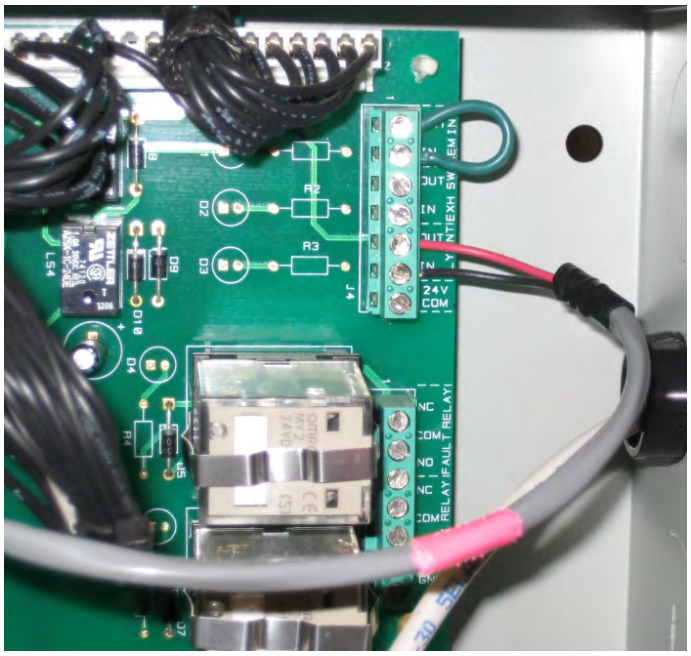


Figure 2-17: Sequencing Isolation Valve Installed

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

CHAPTER 3. OPERATION

3.1 INTRODUCTION

The information in this Chapter provides a guide to the operation of the Benchmark 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 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 Series 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 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.

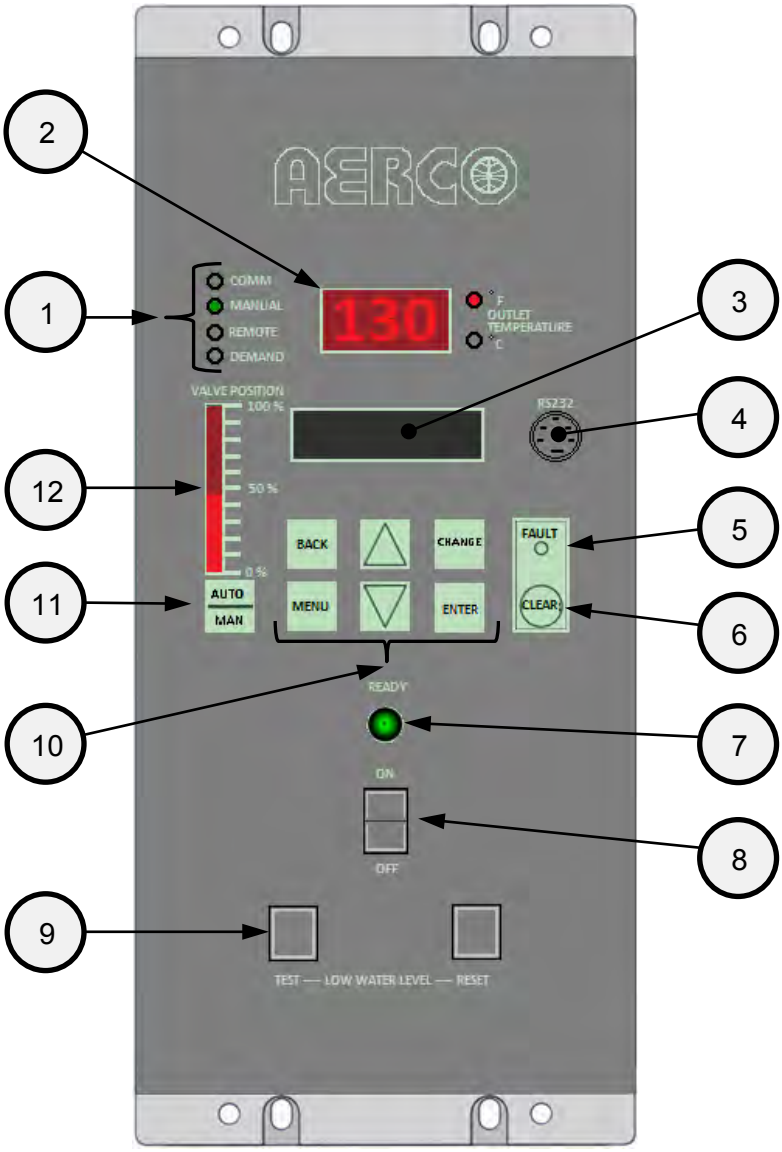


Figure 3-1: Control Panel Front View

Table 3-1: Operating Controls, Indicators and Displays

ITEM	FEATURE	FUNCTION
1	**LED Status Indicators** Four (4) Status LEDs indicate the current operating status as follows:	
	COMM	Lights when RS232 communication is occurring – see Item 4
	MANUAL	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.
	REMOTE	Lights when the unit is being controlled by an external signal from an Energy Management System
	DEMAND	Lights when there is a demand for heat.
2	**OUTLET TEMPERATURE** Display	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. On a BST Master, display flashes & shows header temperature.
3	**VFD** Display	Vacuum Fluorescent Display (VFD) consists of 2 lines each capable of displaying up to 16 alphanumeric characters. The information displayed includes: • Startup Messages • Fault Messages • Operating Status Messages • Menu Selection • BST Messages
4	**RS232** Port	This port is used only factory-trained personnel to monitor OnAER communications, in combination with the RS232 Adaptor Cable (P/N 124675).
5	**FAULT** Indicator	Red **FAULT** LED indicator lights when a boiler alarm condition occurs. An alarm message will appear in the VFD.
6	**CLEAR** Key	Turns off the **FAULT** 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	**READY** Indicator	Lights ON/OFF switch is set to **ON** and all Pre-Purge conditions have been satisfied.
8	**ON/OFF** switch	Enables and disables boiler operation.
9	**LOW WATER LEVEL TEST/RESET** switches	Allows operator to test operation of the water level monitor. Pressing **TEST** opens the water level probe circuit and simulates a Low Water Level alarm. Pressing **RESET** resets the water level monitor circuit. Pressing the **CLEAR** key (item 6) resets the display.

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

ITEM	FEATURE	FUNCTION
10	**MENU Keypad** Six (6) keys provide the following functions for the Control Panel Menus:	
	MENU	Steps through the main menu categories shown in Figure 3-2. The Menu categories wrap around in the order shown.
	BACK	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.
	▲ (UP) Arrow	When in one of the main menu categories (Figure 3-2), pressing the ▲ arrow key will select the displayed menu category. If the **CHANGE** key was pressed and the menu item is flashing, pressing the ▲ arrow key will increment the selected setting.
	▼ (DOWN) Arrow	When in one of the main menu categories (Figure 3-2), pressing this key will select the displayed menu category. If the **CHANGE** key was pressed and the menu item is flashing, pressing the ▼ arrow key will decrement the selected setting.
	CHANGE	Permits a setting to be changed (edited). When the **CHANGE** 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.
	ENTER	Saves the modified menu settings in memory. The display will stop flashing.
11	**AUTO/MAN** switch	This switch toggles the boiler between the Automatic and Manual modes of operation. When in the Manual (**MAN)** mode, the front panel controls are enabled and the **MANUAL** status LED lights. Manual operation is for service only. When in the Automatic (**AUTO)** mode, the **MANUAL** status LED will be off and the front panel controls disabled.
12	**VALVE POSITION** 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.

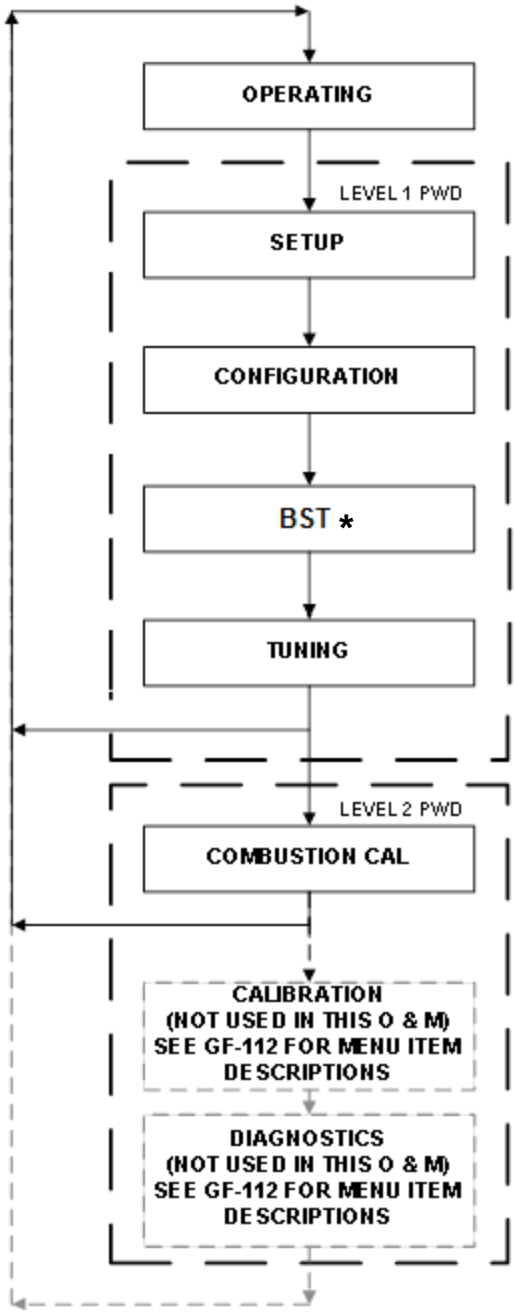
Once the valid level 1 password (159) is entered, the options listed in the Setup, Configuration and *Tuning* menus can be viewed and changed, if desired. The *Combustion Cal* menu is protected by the level 2 password (6817), which is used in Chapter 4 to perform combustion calibration prior to service 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 important 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	Run Cycles	0	999,999,999
11	Ignition Time	0.00	10.00
12	SSOV Time to OPN	0.00	10.00
13	Run Hours	0	999,999,999
14	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.

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	KC Boiler, KC Boiler LN, BMK Blr Std, BMK Blr Std Dual, BMK Blr LN, BMK Blr LN Dual KC Water Heater, KC Water Heater LN, RECON Wtr Heater, Innovation WH		BMK Boiler LN
3	Unit Size (Only the unit sizes available for the Unit Type will be displayed)	750 MBH (219 Pa) 1000 MBH (293 Pa)		750 MBH (219 Pa) or 1000 MBH (293 Pa)
4	Fuel Type	Natural Gas or Propane		Natural Gas
5	Boiler Mode	Constant Setpoint, Remote Setpoint, Direct Drive, Combination, Outdoor Reset		Constant Setpoint
6	Remote Signal (If Mode = Remote Setpoint, Direct Drive or Combination)	4 – 20 mA/1 – 5V 0 -20 mA/0 – 5V PWM Input (Legacy BMS), Network		4 – 20 mA, 1-5V
7	* Bldg Ref Temp (If Mode = Outdoor Reset)	40°F (4.4°C)	230°F (110°C)	70°F (21.1°C)
8	* Reset Ratio (If Mode = Outdoor Reset)	0.1	9.9	1.2
9	Outdoor Sensor	0.1		9.9
10	* System Start Tmp (If Outdoor Sensor = Enabled)	30°F (-1.1°C)	100°F (37.8°C)	60°F (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

Table 3-4: Configuration Menu

Menu Item Display		Available Choices or Limits		Default
		Minimum	Maximum	
18	Analog Output	Off, Setpoint, Outlet Temp, Valve Pos 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
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 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 shown 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 (-17.2°C)	120°F (48.9°C)	70°F (21.1°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 (-17.2°C)	120°F (48.9°C)	95 °F (35°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 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 (%) and default drive voltages are listed in Table 3-6.

Table 3-6: Combustion Cal Menu

Menu Item Display		Acceptable Range For Benchmark 750/1000 *		Default
		Minimum	Maximum	
1	CAL Voltage 16%	1.70	2.20	1.80
2	CAL Voltage 30%	1.90	3.50	3.20
3	CAL Voltage 45%	2.60	4.40	3.70
4	CAL Voltage 60%	2.70	4.50	3.80
5	CAL Voltage 80%	3.60	4.40	4.60
6	CAL Voltage 100%	4.80	6.20	6.00
7	SET Valve Position	0%	100%	Variable
8	Blower Output	Monitor Blower Output Voltage		
9	Set Stdby Volt	0	4.00 V	0/2.00 V
10	Oxygen Level	0%	25%	Variable

* If values fall outside this range, contact the AERCO factory.

3.9 BST (BOILER SEQUENCING TECHNOLOGY) MENU

The BST Menu must be Enabled in order to be displayed and accessed. The BST Enable item is located at the end of the *Configuration* menu.

The Boiler Sequencing Technology (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	**BST Mode**	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	NA			Header Temp (°F)
4	BST Fire Rate	0		100%	Fire rate %
5	BST Ave Fire Rate	0		100%	Avg Fire Rate %
6	BST Outdoor Temp	NA			Outdoor Temp (°F)
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	***BST SETUP MENU***	Disabled		Enabled	Disabled
13	BST Setpoint Mode	Constant Setpoint	Remote Setpoint	Outdoor Reset	Constant Setpt

Table 3-7: BST Menu

Menu Item Display		Available Choices or Limits			Default
		Minimum		Maximum	
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
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 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	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)
32	***BST OPERATE MENU***	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
43	***BST TEMP CTRL MENU***	Disabled		Enabled	Disabled
44	BST Temp Hi Limit	40°F (4.4°C)		210°F (98.9°C)	210°F (98.9°C)

Table 3-7: BST Menu

Menu Item Display		Available Choices or Limits		Default
		Minimum	Maximum	
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
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)
57	***BST COMM MENU***	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
- Blower Proof switch
- Blocked Inlet switch

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.

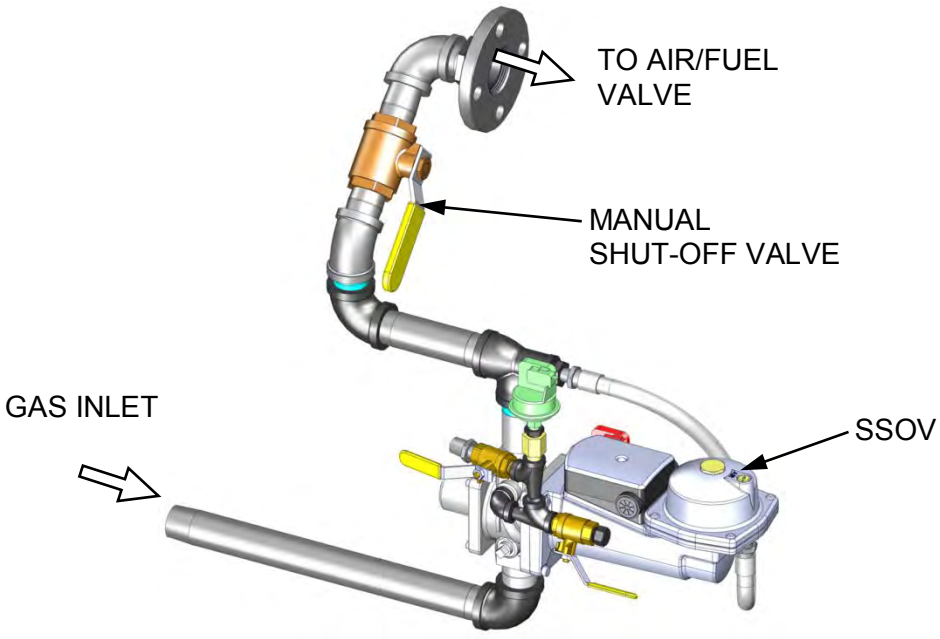


Figure 3-3: SSOV Location

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%.

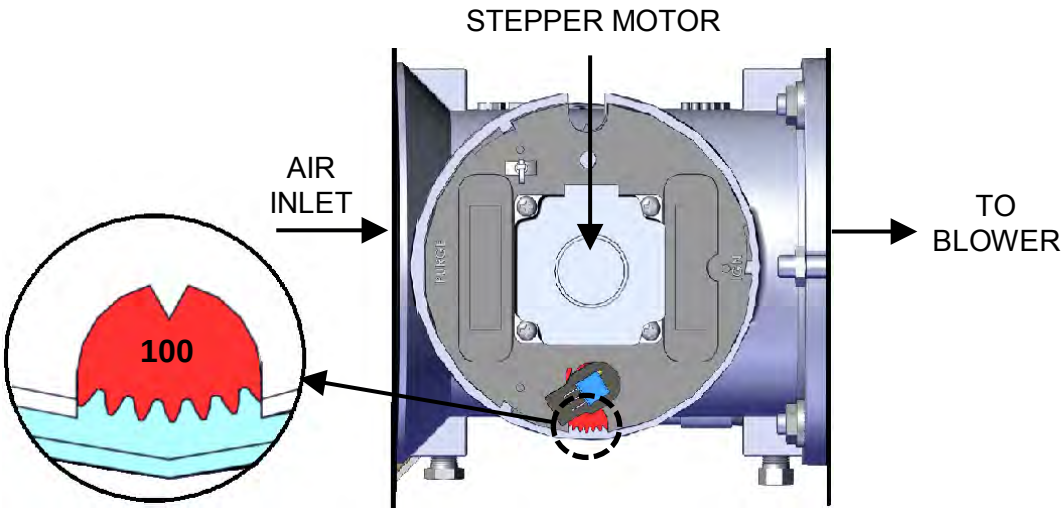


Figure 3-4: Air/Fuel Valve In Purge Position

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.

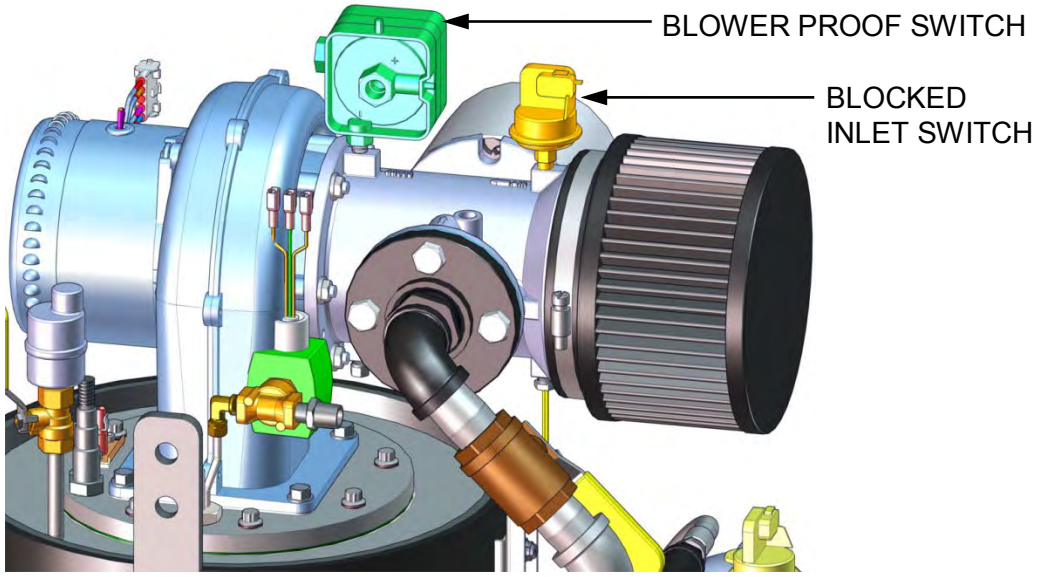


Figure 3-5: Blower Proof Switch

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 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 igniter relay is activated and provides ignition spark. Current to the ignition transformer (P/N **65085**) is monitored by the spark monitor (P/N **61034**), which is mounted to the gas train support bracket. If the current is too high or low, the Controller will stop the ignition process at 3 seconds and shut down the boiler. Refer to Chapter 8 – Troubleshooting for guidance if this occurs.

(c) The gas Safety Shut-Off Valve (SSOV) is energized (opened) allowing gas to flow into the Air/Fuel Valve.

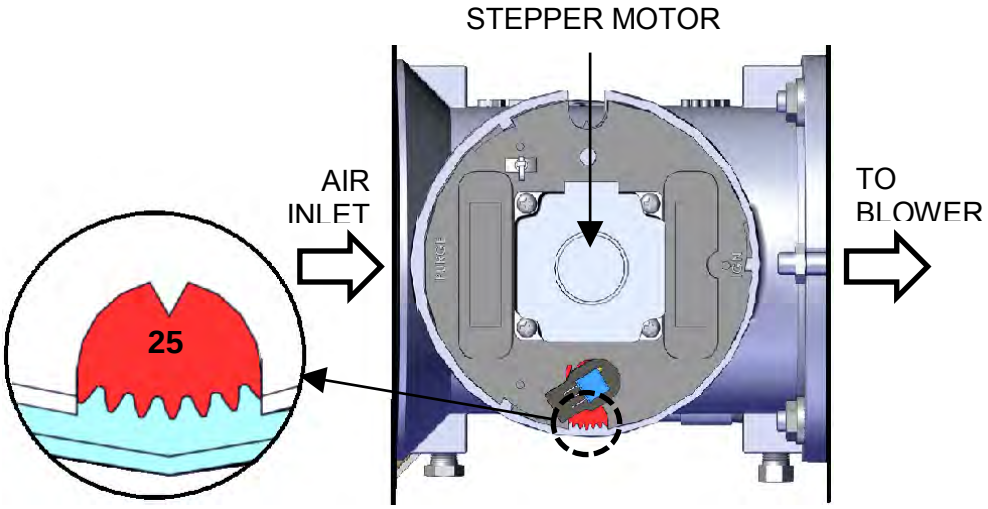


Figure 3-6: Air/Fuel Valve In Ignition Position

6. Up to 7 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 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:

Start Level: 22%

Stop Level: 18%

Normally, these settings should not require adjustment.

Note that the energy input of the boiler is not linearly related to the Air/Fuel Valve position. Refer to Table 3-8 for the relationship between the energy input and Air/Fuel Valve position for a BMK 750 or BMK 1000 boiler running on natural gas.

Table 3-8: Relationship Between Air/Fuel Valve Position and Energy Input For BMK 750 & BMK 1000 Units Running On NATURAL GAS

Air/Fuel Valve Position (% Open)	Energy Input (BTU/Hr)		Boiler Energy Input (% of Full Capacity)	
	BMK 750	BMK 1000	BMK 750	BMK 1000
0%	0	0	0	0
10%	0	0	0	0
18% (Stop Level)	50,000 (14.7 kW)	50,000 (14.7 kW)	6.7%	5%
20%	52,000 (15.2 kW)	54,000 (15.8 kW)	6.9%	5.4%
30%	108,000 (31.7 kW)	140,000 (41.0 kW)	14%	14%
40%	246,000 (72.1 kW)	297,000 (87.0 kW)	33%	30%
50%	369,000 (108.1 kW)	443,000 (126.9 kW)	49%	44%
60%	465,000 (136.3 kW)	564,000 (165.3 kW)	62%	56%
70%	554,000 (162.4 kW)	660,000 (193.4 kW)	74%	66%
80%	637,000 (186.7 kW)	789,000 (231.2 kW)	85%	79%
90%	733,000 (214.8 kW)	933,000 (273.4 kW)	98%	93%
100%	750,000 (219.8 kW)	1,000,000 (293.1 kW)	100%	100%

Table 3-9: Relationship Between Air/Fuel Valve Position and Energy Input For BMK 750 & BMK 1000 Units Running On PROPANE

Air/Fuel Valve Position (% Open)	Energy Input (BTU/Hr)		Boiler Energy Input (% of Full Capacity)	
	BMK 750	BMK 1000	BMK 750	BMK 1000
0%	0	0	0	0
10%	0	0	0	0
18% (Stop Level)	50,000 (14.7 kW	50,000 (14.7 kW	6.7%	5.0%
20%	71,000 (20.8 kW)	71,000 (20.8 kW)	9.5%	7.1%
30%	128,000 (37.5 kW)	181,000 (53.0 kW)	17%	18%
40%	373,000 (109.3 kW)	400,000 (117.2 kW)	50%	40%
50%	508,000 (148.9 kW)	562,000 (164.7 kW)	68%	56%
60%	565,000 (165.6 kW)	703,000 (206.0 kW)	75%	70%
70%	621,000 (182.0 kW)	791,000 (231.8 kW)	83%	79%
80%	660,000 (193.4 kW)	865,000 (253.5 kW)	88%	87%
90%	723,000 (211.9 kW)	963,000 (282.2 kW)	96%	96%
100%	750,000 (219.8 kW)	1,000,000 (293.1 kW)	100%	100%

CHAPTER 4. INITIAL START-UP

4.1 INITIAL START-UP REQUIREMENTS

The requirements for the initial start-up of the Benchmark 750 or 1000 boiler consists 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 ± 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.

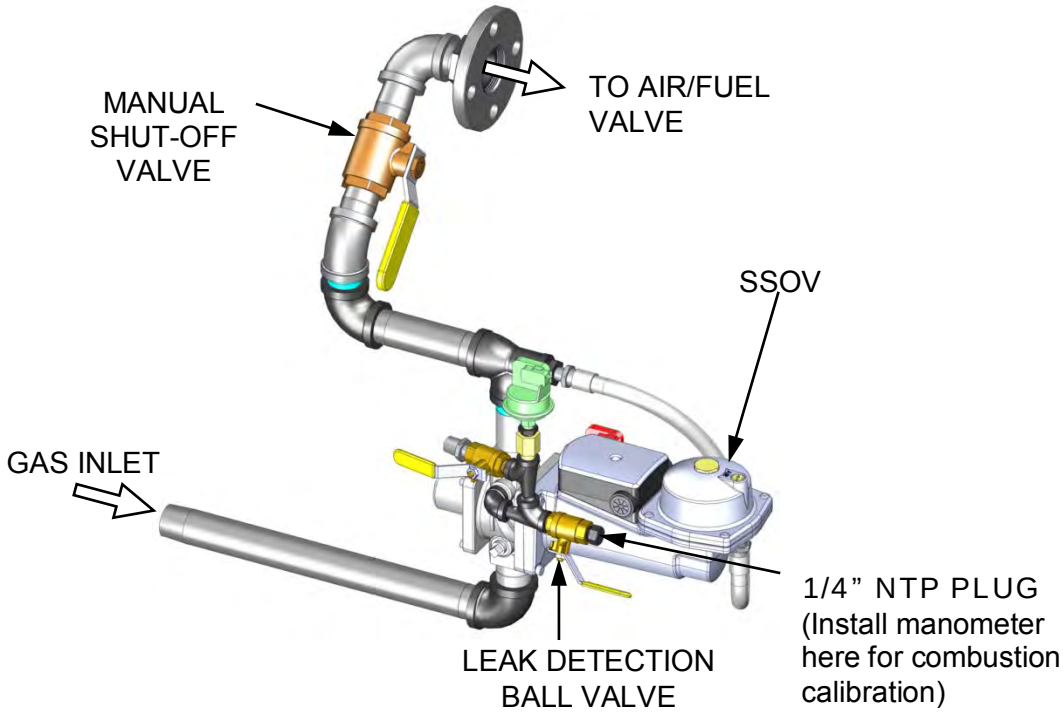


Figure 4-1: 1/4 Inch Gas Plug Location

Install the 0-16" W.C. (0 to 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 boiler to access the gas train components.
3. To monitor the gas pressure on the downstream side of the SSOV during Combustion Calibration (section 4.3), 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 0-16" W.C. (0 to 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 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.**

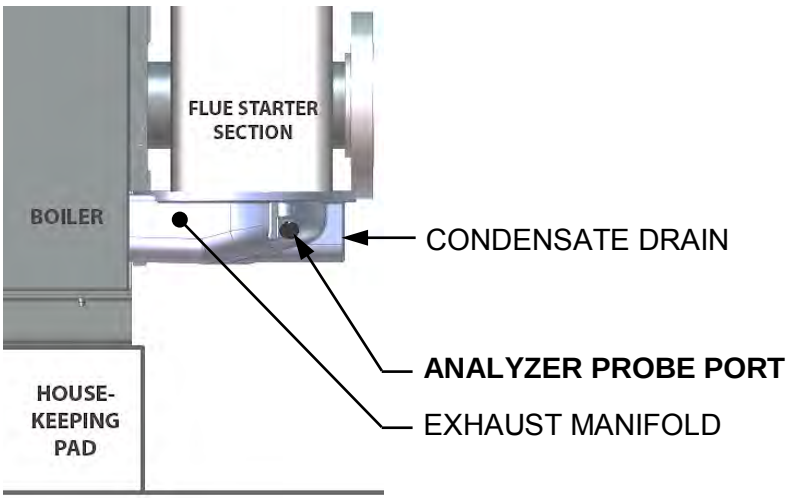


Figure 4-2: Analyzer Probe Port Location

4.3 NATURAL GAS COMBUSTION CALIBRATION

Complete the instructions below if the unit will run on Natural Gas rather than PROPANE gas.

NOTE

When installed and operated in accordance with the requirements specified in this section, this Benchmark boiler delivers low NOx emissions of **<20 ppm** at all firing rates. Alternatively, these boilers can be combustion calibrated to provide ultra-low NOx emissions of **<9 ppm**.

To combustion calibrate the boiler to produce ***low NOx*** emissions of **<20 ppm**, complete the instructions in this section. To combustion calibrate the boiler to produce ***ultra-low NOx*** emissions of **<9 ppm**, first complete the instructions in this section and then, *in addition*, complete the instructions in Appendix L.

The Benchmark 750/1000 boiler is combustion calibrated at the factory prior to shipping. However, recalibration is necessary as part of initial start-up 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.

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 **2.0 ± 0.4" W.C. (498 ± 100 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 **of 2.0" W.C. ± 0.4" W.C. (498 ± 100 Pa)**.

NATURAL GAS Combustion Calibration – *Continued*

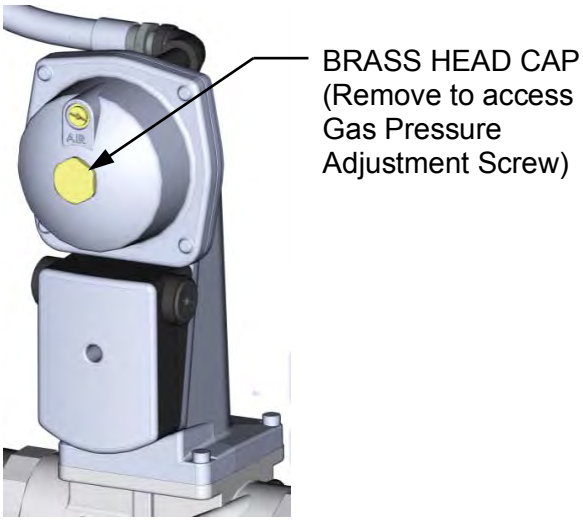


Figure 4-3: Gas Pressure Adjustment Screw Location

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 **2.0" W.C. ± 0.4" W.C. (498 ± 100 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_2 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_2 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 (NOx) and carbon monoxide (CO) readings do not exceed the values shown. If you are not in a "NOx-limited" area and/or do not have a NOx measurement in your analyzer, set the oxygen (O_2) at **5.5% ± 0.5%.**

Combustion Calibration Readings

Valve Position	Oxygen (O_2) %	Nitrogen Oxide (NOx)	Carbon Monoxide (CO)
100%	5% - 6%	<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_2, NOx and CO readings on the Combustion Calibration Data Sheets provided with the unit.
17. Lower the valve position to **80%** using the ▼arrow key.

NATURAL GAS Combustion Calibration – *Continued*

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 80%, 60%, 45%, 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 to 37.8°C). If NOx readings exceed the target values shown, increase the O_2 level up to 1% higher than the listed calibration range. Record the increased O_2 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 until ***Combustion Cal Menu*** appears on the display.
20. Press the ▲ arrow key until ***SET Valve Position*** appears on the display.
21. Press the **CHANGE** key. ***SET Valve Position*** will begin to flash.
22. Press the ▲ arrow key until ***SET Valve Position*** reads ***80%***. Press the **ENTER** key.
23. Next, press the down (▼) arrow key until ***CAL Voltage 80%*** is displayed.
24. Press the **CHANGE** key and observe that ***CAL Voltage 80%*** is flashing.
25. The oxygen level at the 80% 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:

Natural Gas Combustion Calibration Readings

Valve Position	Oxygen (O_2) %	Nitrogen Oxide (NOx)	Carbon Monoxide (CO)
80%	5% - 6%	<20 ppm	<100 ppm

26. 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.
27. Once the oxygen level is within the specified range at 80%, press the **ENTER** key to store the selected blower output voltage for the 80% valve position. Record all readings on the Combustion Calibration Sheets provided.
28. Repeat steps 20 through 27 for valve positions of 60%, 45%, 30% and 18%* (see *NOTE below). The oxygen (O_2), nitrogen oxide (NOx) and carbon monoxide (CO) should remain within the same limits for all valve positions as shown in the following table.

NATURAL GAS Combustion Calibration – *Continued*

*NOTE

Set the Valve Position at 18% but make adjustments to the Combustion Calibration value designated as 16%.

NOTE

If NOx readings exceed the target values shown (<20 ppm), increase the O_2 level up to 1% higher than the listed calibration range shown in the table. Record the increased O_2 value on the Combustion Calibration sheet.

Natural Gas Combustion Calibration Readings

Valve Position	Oxygen (O_2) %	Nitrogen Oxide (NOx)	Carbon Monoxide (CO)
60%	5% - 6%	<20 ppm	<100 ppm
45%	5% - 6%	<20 ppm	<100 ppm
30%	5% - 6%	<20 ppm	<100 ppm
18%	5% - 6%	<20 ppm	<100 ppm

29. 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 Appendix F). Rotate the screw 1/2 turn clockwise (CW) to add fuel and reduce the O_2 to the specified level. Recalibration MUST be performed again from 60% down to 18% after making a change to the idle screw (TAC valve).
30. **This completes the NATURAL GAS combustion calibration procedures.**

4.4 PROPANE COMBUSTION CALIBRATION

Complete the instructions below if the unit will run on PROPANE gas rather than Natural Gas.

NOTE

When installed and operated in accordance with the requirements specified in this section, this Benchmark boiler delivers low NOx emissions of **<30 ppm** at all firing rates. Unlike units running on Natural Gas, there is no ultra-low NOx emissions option.

The Benchmark 750/1000 boiler is combustion calibrated at the factory prior to shipping. However, recalibration is necessary as part of initial start-up 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.

PROPANE 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:
    - Benchmark 750 units: **3.9" ± 0.2" W.C. (971 ± 50 Pa)**
    - Benchmark 1000 units: **7.4" ± 0.2" W.C. (1843 ± 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, above). Make gas pressure adjustments using a flat-tip screwdriver to obtain the gas pressure listed above.
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 listed in step 10. 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_2 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_2 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 (NOx) and carbon monoxide (CO) readings do not exceed the values shown. If you are not in a "NOx-limited" area and/or do not have a NOx measurement in your analyzer, set the oxygen (O_2) at **5.5% ± 0.5%.**

Propane Combustion Calibration Readings

Valve Position	Oxygen (O_2) %	Nitrogen Oxide (NOx)	Carbon Monoxide (CO)
100%	5% - 6%	<30 ppm	<100 ppm

PROPANE 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, above). 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_2, NOx and CO readings on the Combustion Calibration Data Sheets provided with the unit.
17. Lower the valve position to **80%** 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 80%, 60%, 45%, 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 to 37.8°C). If NOx readings exceed the target values shown, increase the O_2 level up to 1% higher than the listed calibration range. Record the increased O_2 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 until ***Combustion Cal Menu*** appears on the display.
20. Press the ▲ arrow key until ***SET Valve Position*** appears on the display.
21. Press the **CHANGE** key. ***SET Valve Position*** will begin to flash.
22. Press the ▲ arrow key until ***SET Valve Position*** reads ***80%***. Press the **ENTER** key.
23. Next, press the down (▼) arrow key until ***CAL Voltage 80%*** is displayed.
24. Press the **CHANGE** key and observe that ***CAL Voltage 80%*** is flashing.
25. The oxygen level at the 80% 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:

Propane Combustion Calibration Readings

Valve Position	Oxygen (O_2) %	Nitrogen Oxide (NOx)	Carbon Monoxide (CO)
80%	5% - 6%	<30 ppm	<100 ppm

26. 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.

PROPANE Combustion Calibration – *Continued*

27. Once the oxygen level is within the specified range at 80%, press the **ENTER** key to store the selected blower output voltage for the 80% valve position. Record all readings on the Combustion Calibration Sheets provided.
28. Repeat steps 20 through 27 for valve positions of 60%, 45%, 30% and 18%* (see *NOTE below). The oxygen (O_2), nitrogen oxide (NOx) and carbon monoxide (CO) should remain within the same limits for all valve positions as shown in the following table.

*NOTE

Set the Valve Position at 18% but make adjustments to the Combustion Calibration value designated as 16%.

NOTE

If NOx readings exceed the target values shown (<30 ppm), increase the O_2 level up to 1% higher than the listed calibration range shown in the table. Record the increased O_2 value on the Combustion Calibration sheet.

Propane Combustion Calibration Readings

Valve Position	Oxygen (O_2) %	Nitrogen Oxide (NOx)	Carbon Monoxide (CO)
60%	5% - 6%	<30 ppm	<100 ppm
45%	5% - 6%	<30 ppm	<100 ppm
30%	5.8% - 6.8%	<30 ppm	<100 ppm
18%	5% - 6%	<30 ppm	<100 ppm

29. 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 Appendix F). Rotate the screw 1/2 turn clockwise (CW) to add fuel and reduce the O_2 to the specified level. Recalibration MUST be performed again from 60% down to 18% after making a change to the idle screw (TAC valve).
30. **This completes the PROPANE combustion calibration procedures.**

4.5 REASSEMBLY AFTER COMBUSTION CALIBRATION

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

Reassembly After Combustion Calibration

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.

Reassembly After Combustion Calibration – *Continued*

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.

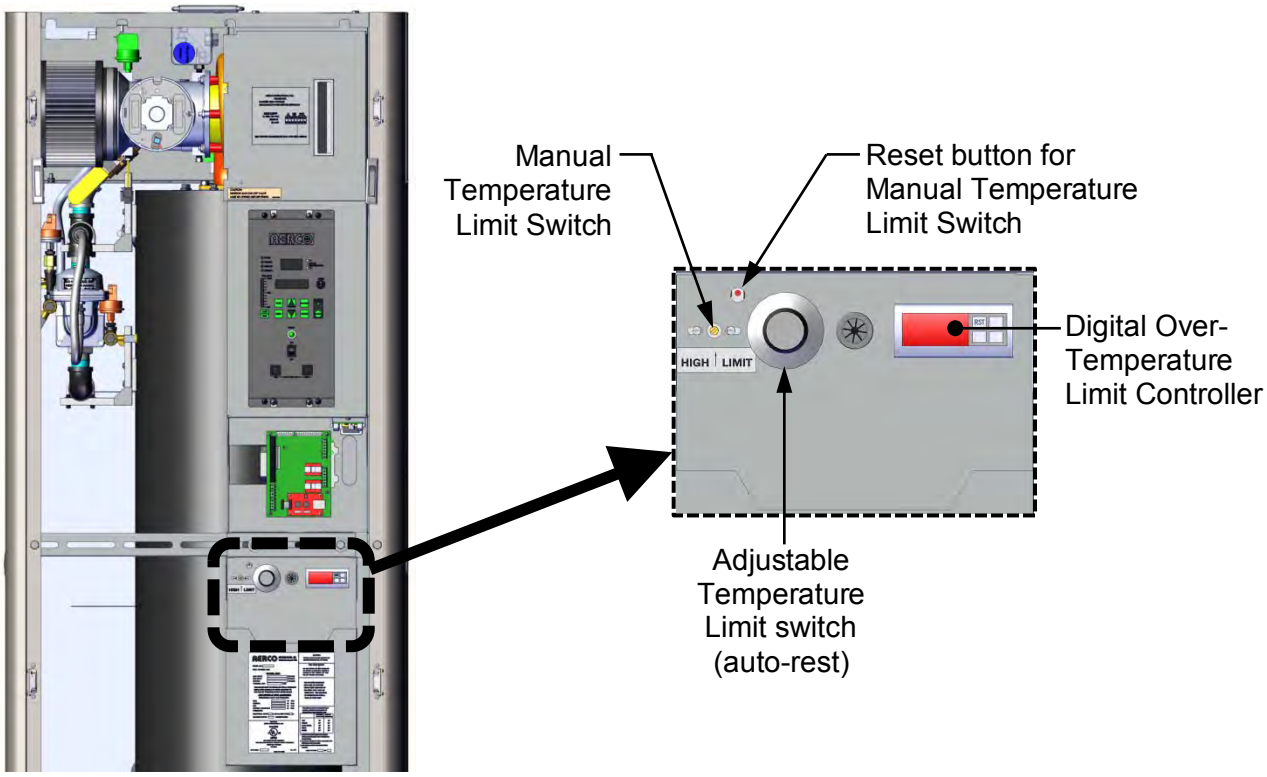
4.6 OVER-TEMPERATURE LIMIT SWITCHES

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** switch. These controls are mounted on a plate as shown in Figure 4-4. They can be accessed by removing the unit front panel from 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 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 Figurer 4-4 before the boiler can be restarted.

The rotary adjustable **Over- Temperature Limit** switch is manually adjustable from 32ºF - 212ºF (0ºC – 100ºC). This switch allows the 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 210ºF (98.9°C) and should not be changed. If an over-temperature condition is detected, this switch automatically shuts down the 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.



PARTIAL FRONT VIEW WITH PANEL REMOVED

Figure 4-4: Over Temperature Limit Switch Locations

4.6.1 Over-Temperature Alarm Switch Checks and Adjustments

The digital **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 4-5.

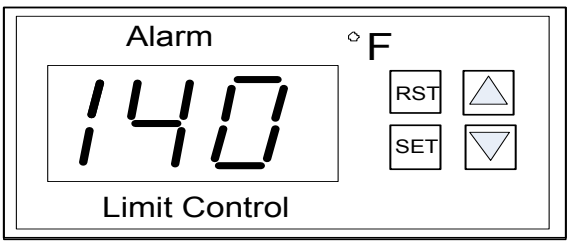


Figure 4-5: Digital Over-Temperature Alarm Switch Front Panel

Table 4-1: 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** 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 (210ºF) 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 boiler.

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CHAPTER 5. MODE OF OPERATION

5.1 INTRODUCTION

The 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 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°F (0.9°C)

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°F 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 direct impingement by the elements. If a cover or shield is used, it must allow free air circulation. The sensor may be mounted up to two hundred feet from the unit. Sensor connections are made at the Input/Output (I/O) Box on the front of the 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 2.10.1 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 D.
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 and their factory defaults, see Appendix A.

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 range:

- 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. Refer to Modbus Communication Manual GF-114 for additional information.

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 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 be 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. Refer to Modbus Communication Manual GF-114 for additional information.

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.

5.6 AERCO CONTROL SYSTEM (ACS)

NOTE

ACS is for installations with 9 or more boilers. It utilizes only RS-485 signaling to the boiler. Installations with 1 to 8 boilers can use BST (see Chapter 9).

The ACS mode of operation is used in conjunction with the AERCO Control System. The ACS mode is used when it is desired to operate multiple units in the most efficient manner possible. For this mode of operation, an ACS Header Sensor must be installed **between 2 and 10 feet (0.61 and 3m)** downstream of the ***LAST*** boiler in the boiler plant's supply water header. The ACS can control up to 40 boilers; up to 32 via Modbus (RS-485) network communication. For ACS programming, operation, and Header Sensor installation details, see ACS Operations Guide, GF-131. For operation via an RS-485 Modbus network, refer to Modbus Communication Manual GF-114.

To enable the ACS mode, the following menu settings must be made in the *Configuration* menu:

Table 5-4: ACS Mode Settings

Menu Option	Setting
Boiler Mode	Direct Drive
Remote Signal	Network (RS-485)

Refer to section 3.3 for instructions on changing menu options.

5.6.1 ACS External Field Wiring

Wiring connections for RS-485 Modbus control are made between the 485 A- and 485 B+ terminals on the ACS (boilers 9 through 40), and the RS-485 COMM terminals in the I/O Box on the front of the boilers.

Wire the units using shielded twisted pair wire between 18 and 22 AWG. Observe the proper polarity for the ACS RS-485 COMM wiring connections. Shields should be terminated only at the ACS and the boiler end must be left floating. Each unit's wiring must conform to the above.

5.6.2 ACS Setup and Startup

This mode of operation is factory preset and the ACS controls the firing rate (air/fuel valve % open position). There are no setup instructions for each individual unit.

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 ACS mode, simply press the **AUTO/MAN** switch. The REMOTE LED will again light and the MANUAL LED will go off.

5.7 COMBINATION CONTROL SYSTEM (CCS)

NOTE
Only ACS can be utilized for the Combination Control System.

A Combination Control System (CCS) is one that uses multiple boilers to cover both space-heating and domestic hot water needs. An AERCO Control System (ACS) and An optional ACS Relay Box are necessary to configure this system. Typically, an adequate number of boilers are installed to cover the space-heating load on the design day, however one or more units are used for the domestic hot water load.

The theory behind this type of system is that the maximum space-heating load and the maximum domestic hot water load do not occur simultaneously. Therefore, boilers used for domestic hot water are capable of switching between constant setpoint and ACS control.

For a typical CCS, an adequate number of boilers are installed to cover the space-heating load on the design-day. However, one or more units are used for the domestic hot water load as well. These boilers are the combination units and are referred to as the combo boilers. The combo boilers heat water to a constant setpoint temperature. That water is then circulated through a heat exchanger in a domestic hot water storage tank.

Only the AERCO Control System (ACS) is necessary to configure this system if only a single valve is used to switch from space heating to domestic hot water. However, the ACS Relay Panel is required in combination with the ACS when there are up to two isolation valves, boiler interlocks, and/or a Domestic Hot Water (DHW) pump in a Combination heating plant where AERCO boilers are being used for both Building Heat and Domestic Hot Water heating.

The following two options are available for using a combination system; one that uses only the ACS, and one that requires the optional ACS Relay Box:

- **OPTION 1** - This option is selected when the ACS controls a boiler plant containing up to eight combination boilers that are Domestic Hot Water Priority (DHW PRIORITY) boilers, along with building heat (BLDG HEAT) boilers, and *one* hydronic isolation valve in the main header between the BLDG HEAT boilers and the DHW PRIORITY boilers.
- **OPTION 2** – When this option is selected, the ACS Relay Panel must be used in conjunction with the ACS. For this option, the ACS controls a boiler plant containing up to eight combination boilers that are divided up into Building Priority (BLDG PRIORITY) boilers and Domestic Hot Water Priority (DHW PRIORITY) boilers, along with building heat (BLDG HEAT) boilers, and using *two* hydronic isolation valves in the main header, one between the BLDG HEAT and BLDG PRIORITY boilers, and the other between the BLDG PRIORITY and the DHW PRIORITY boilers.

In Option 2, when the space-heating load is such that when all the space-heating boilers are at the 100% valve position, the ACS will then ask the ACS Relay Box for the domestic boilers to become space-heating boilers. Provided the domestic hot water load is satisfied, the combo (hot water) boilers will then become space-heating boilers. If the domestic hot water load is not satisfied, the combo boiler(s) remain on the domestic hot water load. If the combo boilers switch over to space heating, but there is a call for domestic hot water, the ACS Relay Box switches the combo units back to the domestic load. The ACS in combination with the ACS Relay Box will ask the BLDG PRIORITY boilers to help with domestic hot water heating if the DHW PRIORITY boilers are not able to satisfy the domestic hot water demand.

When the combo units are satisfying the domestic load, they are in the constant setpoint mode of operation. When the combo units switch over to space heating, their mode of operation

changes to follow the ACS command. For more information concerning the operation of the ACS, consult the ACS Operations Guide, GF-131. For more information on the ACS Relay Box, see section 2.14 in the same manual.

5.7.1 Combination Control System Field Wiring

Wiring for this system is between the ACS, the ACS Relay Box and the terminals in the I/O Box. Wire the units using a shielded twisted pair of 18 to 22 AWG wire. When wiring multiple units, each unit's wiring must conform to the above.

5.7.2 Combination Control System Setup and Startup

Setup for the Combination mode requires entries to be made in the *Configuration* menu for Boiler mode, remote signal type and setpoint. The setpoint is adjustable from 40°F to 190°F (4.4°C to 87.8°C).

Enter the following settings in the *Configuration* menu:

Table 5-5: Combination Mode Settings

Menu Option	Setting
Boiler Mode	Combination
Remote Signal	Network
Internal Setpt	40°F to 190°F (4.4°C to 87.8°C)

Refer to section 3.3 for instructions on changing menu options.

While it is possible to change other temperature-related functions for combination mode, these functions are preset to their factory default values. These default settings work well in most applications. It is suggested that AERCO be contacted prior to changing settings other than the unit's setpoint. For a complete listing of temperature related function defaults, see Chapter 3.

To set the unit to the Manual mode, press the **AUTO/MAN** switch. The MANUAL LED will light.

To set the unit back to the Auto mode, press the **AUTO/MAN** switch. The MANUAL LED will go off and the REMOTE LED will light.

When the boiler is switched to ACS control, the ACS controls the valve position. There are no setup requirements to the boiler(s) in this mode.

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 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.

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 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 FAULT TEST

Refer to Figure 6-1A and ensure that the leak detection ball valve located at the **Low Gas Pressure** switch is closed on both the Natural Gas and Propane gas trains.

Low Gas Pressure Fault Test

1. Remove the 1/4" plug from the leak detection ball valve at the **Low Gas Pressure** switch, shown in Figure 6-1A.
2. Install a **0 – 16“ W.C. (0 - 4000 Pa)** manometer or a W.C. gauge where the plug was removed.
3. Slowly open the ball valve near the **Low Gas Pressure** switch.
4. Place the unit in MANUAL mode and adjust the Air/Fuel Valve position (% open) between **25** and **30**%.
5. While the unit is firing, slowly close the external manual gas shut-off valve.
6. The unit should shut down and display a ***GAS PRESSURE FAULT*** message, and the **FAULT** indicator should also start flashing at the following approximate pressures:
   - **BMK 750 & 1000 –** NATURAL GAS gas trains: **2.6” W.C. (648 Pa)**
   - **BMK 750 –** PROPANE gas train: **4.4” W.C. (1096 Pa)**
   - **BMK 1000 –** PROPANE gas train: **7.5” W.C. (1868 Pa)**
7. Fully open the external manual gas shut-off valve and press the **CLEAR** button on the Control Box.
8. The fault message should clear, the **FAULT** indicator should go off and the unit should restart.
9. Upon test completion, close the ball valve and remove the manometer. Replace the 1/4" plug removed in step 1.

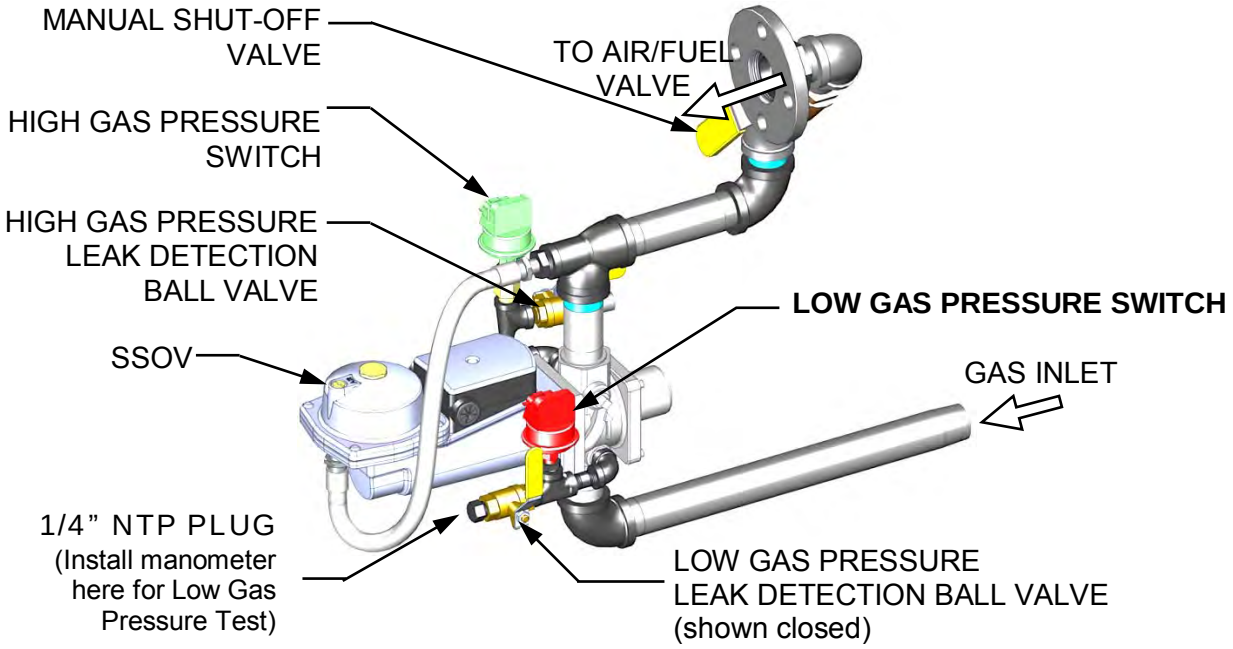

Figure 6-1A: Low Gas Pressure Fault Test – NATURAL GAS Gas Train Shown

6.3 HIGH GAS PRESSURE TEST

The instructions below apply to both the Natural Gas and Propane gas trains.

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

High Gas Pressure Test

1. Remove the 1/4" plug from the leak detection ball valve at the **High Gas Pressure** switch, shown in Figure 6-1B.
2. Install a **0 – 16" W.C. (0 - 4000 Pa)** manometer (or W.C. gauge) where the plug was removed.
3. Slowly open the leak detection ball valve near the **High Gas Pressure** switch.
4. Start the unit in MANUAL mode at a valve position (firing rate) between **25** and **30**%.
5. With the unit running, monitor the gas pressure on the manometer installed in step 2 and record the gas pressure reading.
6. Slowly increase the gas pressure using the adjustment screw on the SSOV (see Figure 4-3 in Chapter 4).
7. The unit should shut down and display a ***GAS PRESSURE*** fault message, and the FAULT indicator should also start flashing at the following approximate pressures:
   - **BMK 750 & 1000** – NATURAL GAS gas trains: **4.7" W.C. (1170 Pa)**
   - **BMK 750** – PROPANE gas train: **4.7" W.C. (1170 Pa)**
   - **BMK 1000** – PROPANE gas train: **10.5" W.C. (2615 Pa)**
8. Reduce the gas pressure back to the value recorded in step 5. This pressure should be within the range of
   - **BMK 750 & 1000 –** NATURAL GAS gas trains: **2.0" W.C. ± 0.4" W.C. (498 ± 100 Pa)**
   - **BMK 750 –** PROPANE gas train: **3.9" W.C. ± 0.2" W.C. (971 ± 50 Pa)**
   - **BMK 1000 – PROPANE gas train: 7.4" W.C. ± 0.2" W.C. (1843 ± 50 Pa)**
9. Press the **CLEAR** button on the Control Box to clear the fault.
10. The fault message should clear and the **FAULT** indicator should go off. The unit should restart.
11. Upon test completion, close the ball valve and remove the manometer. Replace the 1/4" plug removed in step 1.

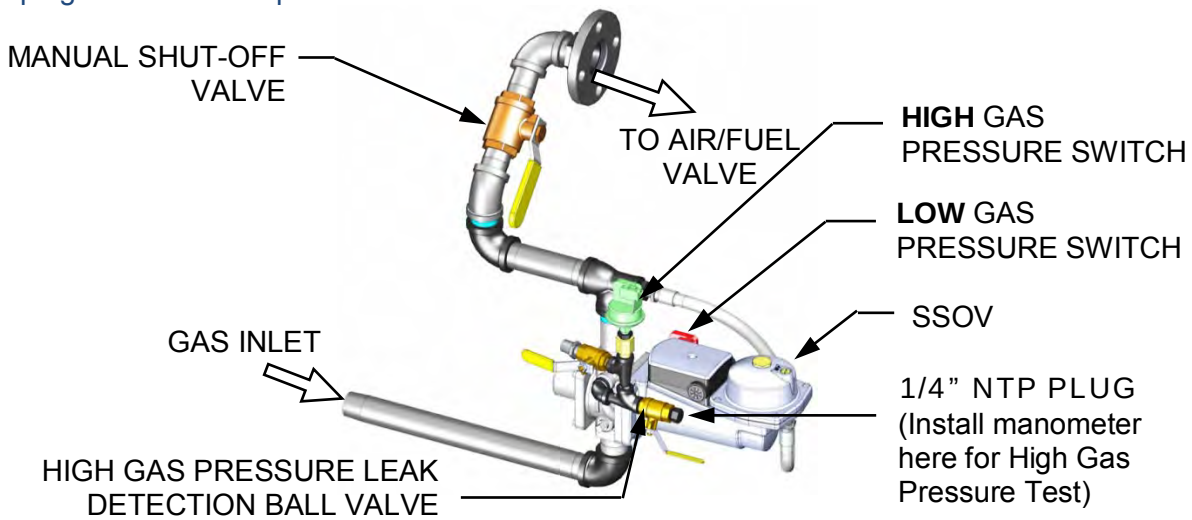

Figure 6–1B: High Gas Pressure Test – NATURAL GAS Gas Train Shown

6.4 LOW WATER LEVEL FAULT TEST

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

Low Water Level Fault Test

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 and pressure relief valve 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.

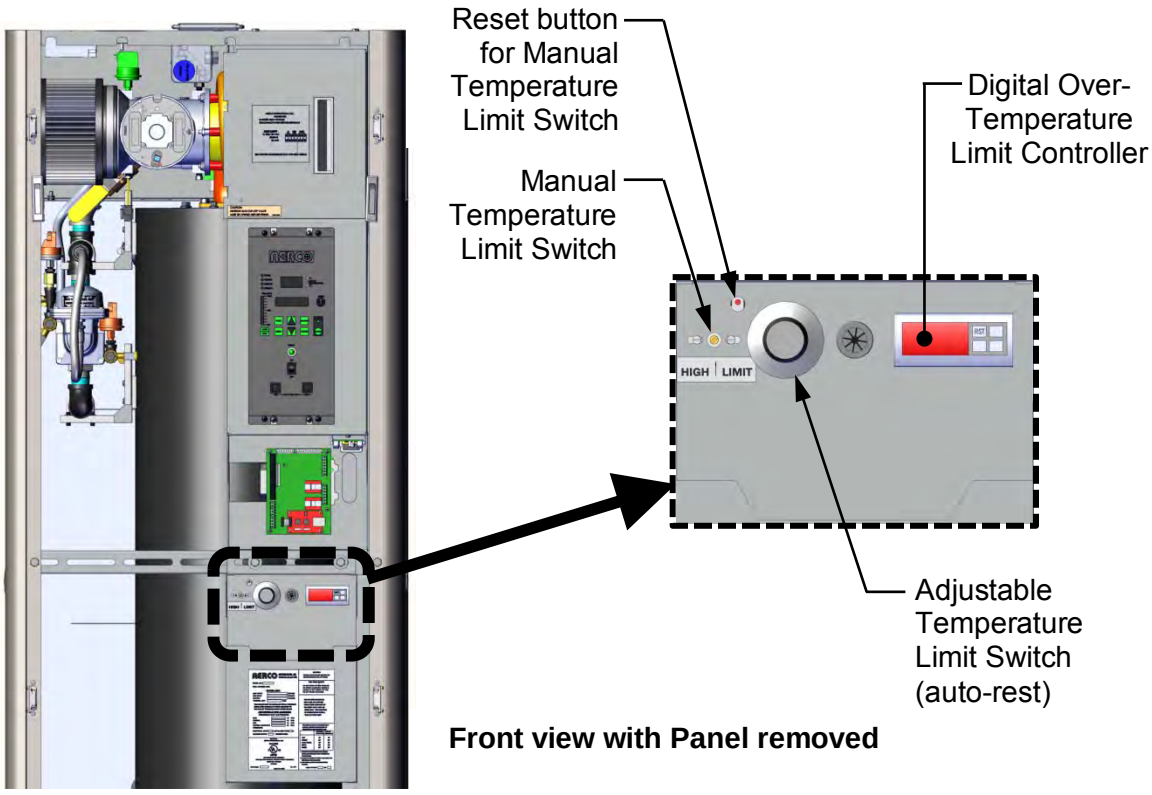

Figure 6-2: Temperature Limit Switch Location and Setting

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 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 TEST

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 shut down after reaching the 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.

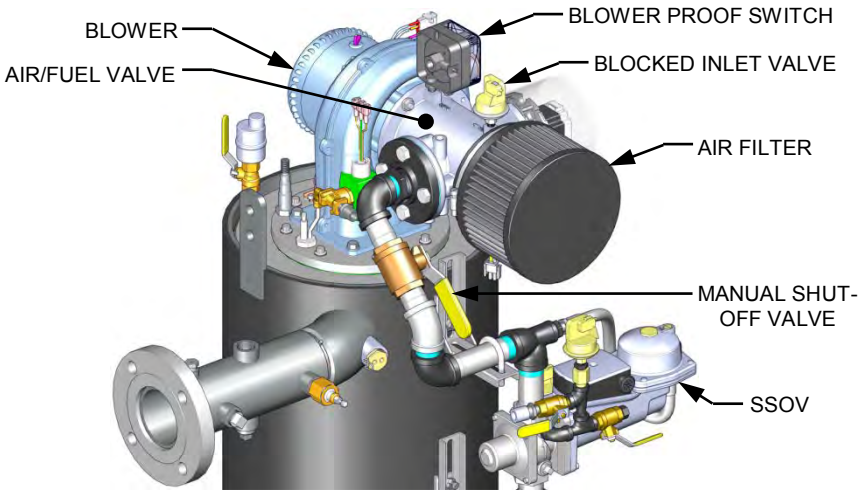

Figure 6-3: Bare Boiler – Partial View

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. For units that get combustion air from a Combustion Air Duct, remove that duct, located on the rear panel of the boiler (see Figure 6-5, below). For units that have an air filter in place of a Combustion Air Duct (not shown), remove the air filter.

Blocked Inlet Switch Test – *Continued*

WARNING

THE BLOWER SUCTION IS VERY STRONG AND CAN PULL NEARBY OBJECTS INTO THE BLOWER'S FAN BLADES. DO ALLOW ANYTHING TO BE PULLED INTO THE BLOWER. DO NOT WEAR ANYTHING THAT COULD GET CAUGHT AND PULL YOU INTO THE BLOWER.

3. Turn off the gas supply ball valve to the 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 (see Figure 6-4).
   c) Connect the Flame Signal Generator to the black connector boot.

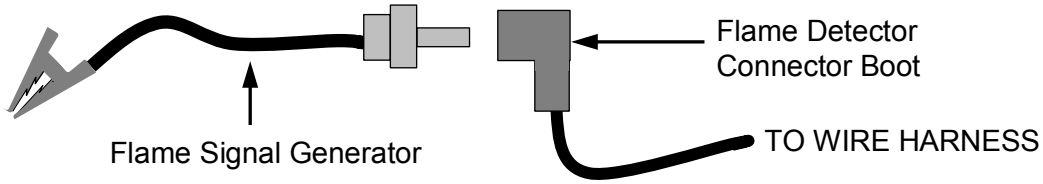

Figure 6-4: Connecting the Flame Signal Generator

   (d) Keep the alligator clip away from bare metal parts until step 4c.

4. Complete the following with the boiler operating in MANUAL mode:
   a) Ramp the boiler up to 100% fire rate and then turn on the main ON/OFF switch on the front of the Control Panel.
   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 boiler at this time.
5. Wait for the boiler to ramp up to at least 90% before continuing.
6. Cover the combustion air inlet opening with a solid, flat object, such as a piece of thick plywood or a thick metal plate.
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 Combustion Air Duct or 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.

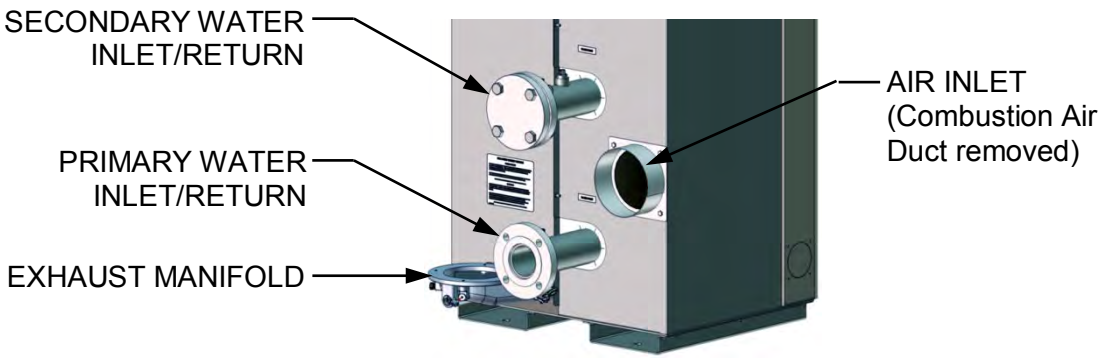

Figure 6-5: Boiler Rear View Showing Air Inlet Location

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 6-3 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.

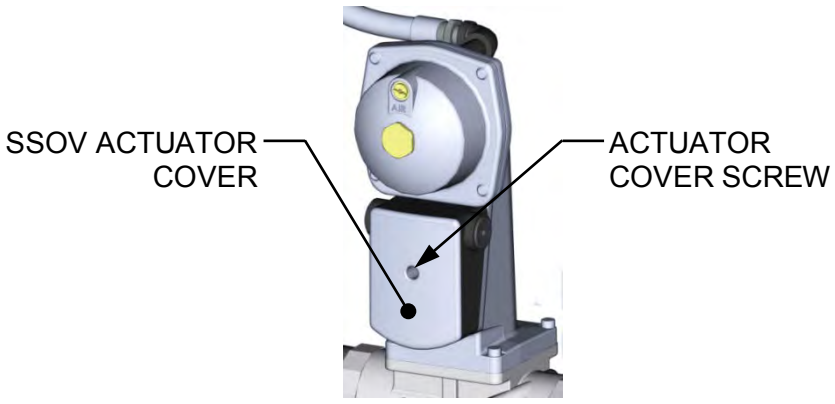

Figure 6-6: SSOV Actuator Cover Location

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.

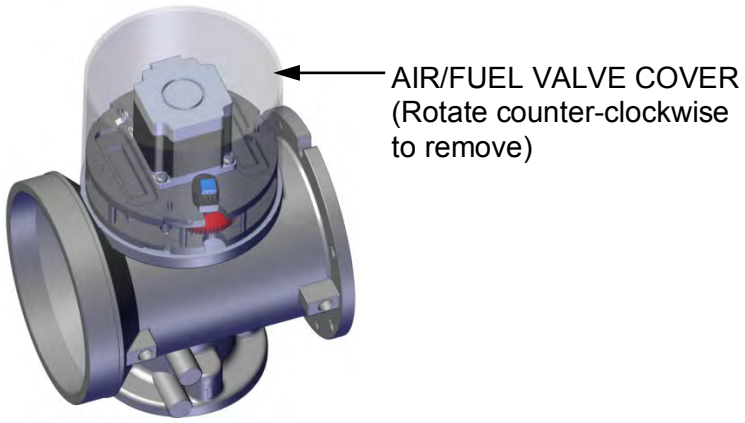

Figure 6-7: Air/Fuel Valve Cover Location

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, above) 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 (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.

Ignition Switch Open During Ignition – *Continued*

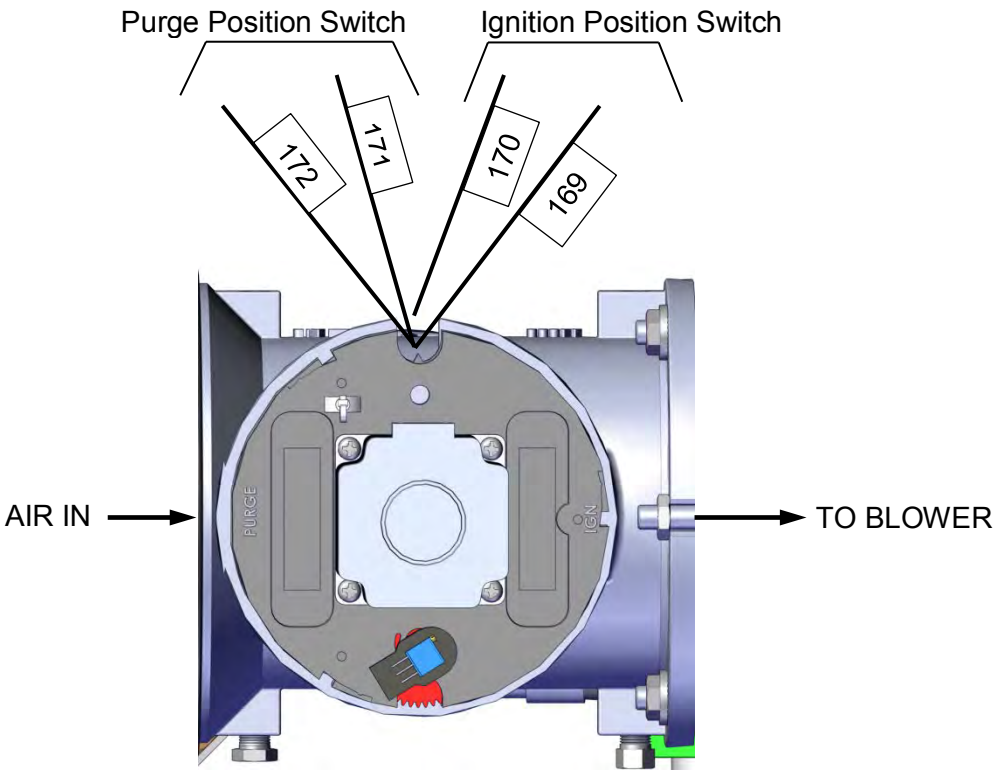

Figure 6-8: Air/Fuel Valve Purge and Ignition Switch Locations

6.12 SAFETY PRESSURE RELIEF VALVE TEST

Test the safety Pressure Relief Valve in accordance with ASME Boiler and Pressure Vessel Code, Section VI.

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:

- Annual Maintenance Kit, P/N. **58025-01**
- 24-Month Waterside/Fireside Inspection Kit, P/N. **58025-08** (See NOTE below)

NOTE

The 24-Month Waterside/Fireside Inspection Kit also includes the items contained in the Annual Maintenance Kit (**58025-01**). Therefore, only Kit P/N **58025-08** 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 **58023**)	*Inspect	Inspect	Replace	15 mins.
7.3	Flame Detector Kit (P/N **24356-1**)	*Inspect	Inspect	Replace	15 mins.
7.4	Lean O_2 Sensor (P/N **61026**)	*Inspect	Inspect		15 mins.
4.3	Combustion Calibration	*Check	Check		1 hr.
7.6	Testing of Safety Devices		See ASME CSD-1 Chart		45 mins.
7.7	Burner			Inspect	2 hrs.
7.8	Condensate Drain Trap	*Inspect	Inspect, Clean & Replace Gaskets	Inspect, Clean & Replace Gaskets	30 mins.
7.9	Air Filter (P/N **59139**)		Clean	Replace	15 mins.

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

7.2 IGNITER-INJECTOR REPLACEMENT

The igniter-injector (kit P/N **58023**) is located on the burner plate at the top of the boiler. In addition to providing the spark required to ignite 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 boiler and indicates the location of the igniter-injector flame detector and other related components.

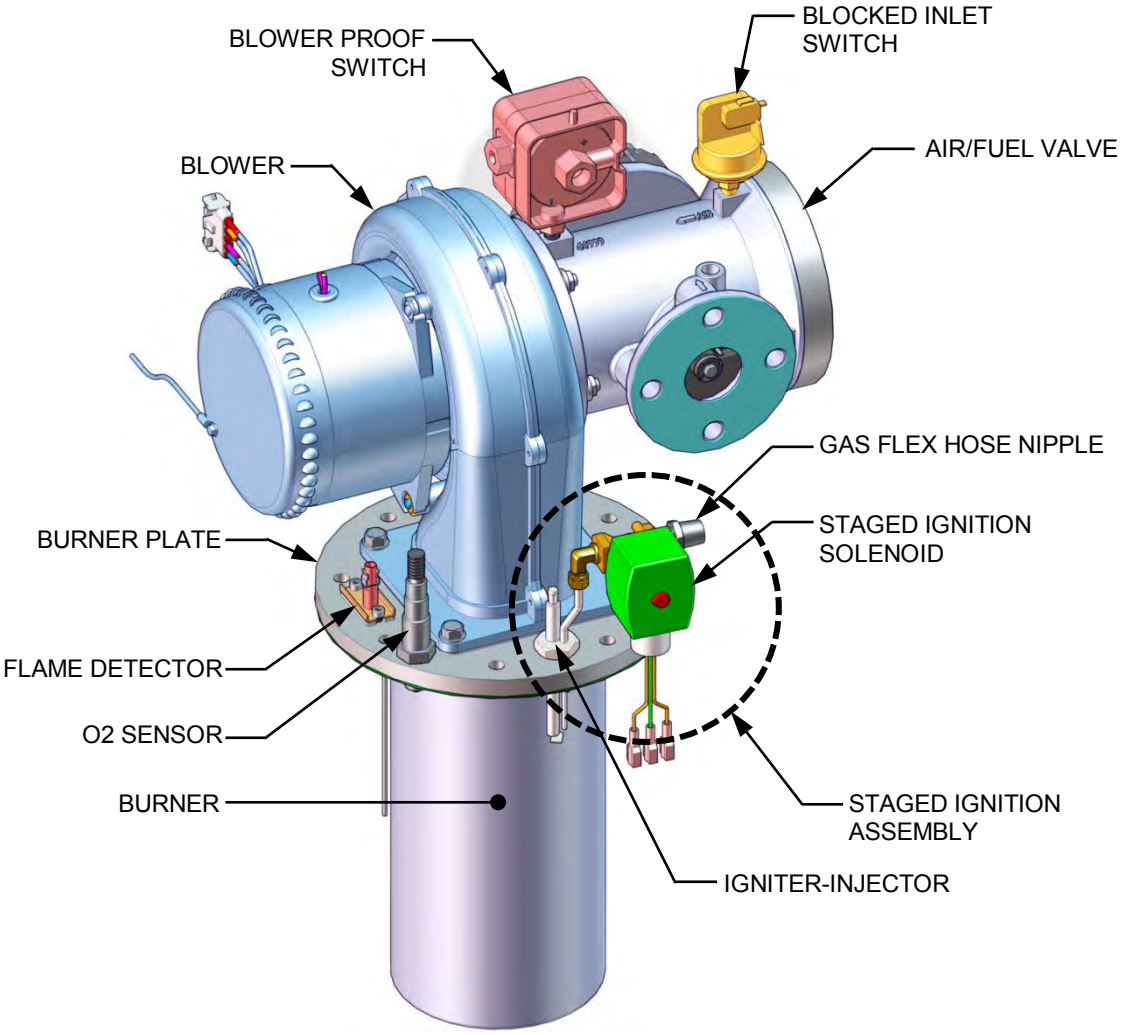

Figure 7-1: Benchmark Burner Assembly (Removed from Boiler)

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 Replacement

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.

Igniter-Injector Replacement – *Continued*

3. Disconnect the cable from the igniter-injector (Figure 7-1).
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.

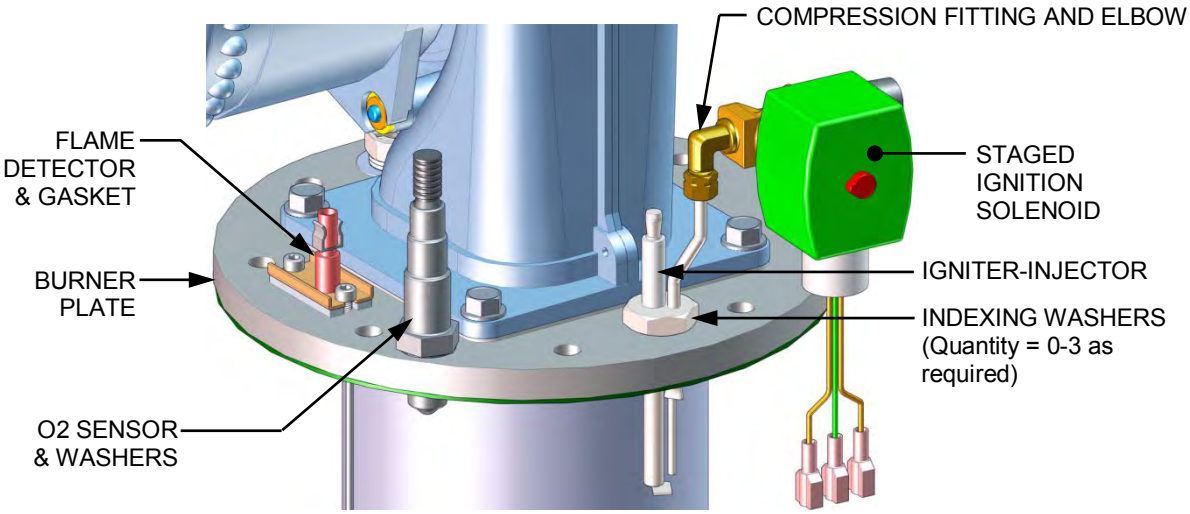

Figure 7-2: Igniter-Injector & Flame Detector Mounting Details

7. Next, loosen and remove the igniter-injector from the burner plate using a 1" open-end wrench.
8. 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.
9. Prior to reinstalling the igniter-injector, a high temperature, conductive, anti-seize compound must be applied to the threads.

NOTE

If a replacement igniter-injector (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.

Igniter-Injector Replacement – *Continued*

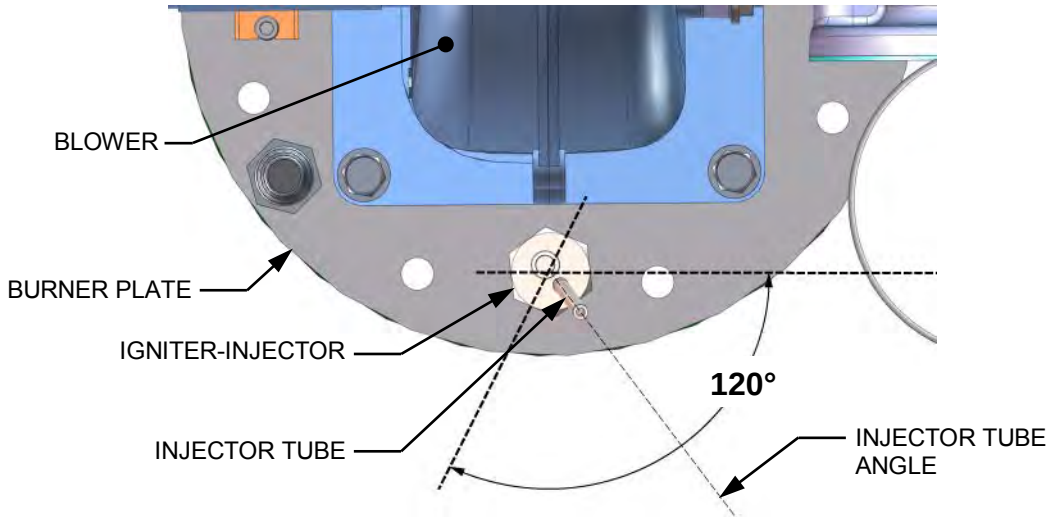

Figure 7-3: Igniter-Injector Orientation (Looking Down from Above)

10. Reinstall the igniter-injector in the burner plate. Torque to **170 - 180 in-lbs**. **(19.2 – 20.3 Nm)**. **DO NOT over tighten**.
11. 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.
12. Reconnect the igniter-injector cable.
13. Reinstall the shroud on the unit.

7.3 FLAME DETECTOR REPLACEMENT

The flame detector (P/N 24356-1) is located on the burner plate at the top of the unit (see Figure 7-1 and Figure 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 Replacement

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.
3. Disconnect the flame detector lead wire.
4. Remove the two (2) screws securing the flame detector to the plate (Figure 7-2 on previous page). 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_2 SENSOR REPLACEMENT

The Lean Oxygen Sensor (P/N **61026**) is located on the burner plate at the top of the unit (see Figure 7-1 and Figure 7-2). The sensor and burner plate may be hot. Allow the unit to cool sufficiently before removing or replacing the O_2 sensor.

O_2 Sensor Replacement

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_2 sensor lead wire by pushing in on the release tab and pulling apart the connector.
4. Next, loosen and remove the O_2 sensor and crush washer from the burner plate using a 15/16" open-end wrench.
5. Thoroughly inspect the O_2 sensor. If eroded, the sensor should be replaced. Otherwise clean the sensor with a fine emery cloth.
6. Reinstall the O_2 sensor and crush washer on the burner plate.
7. Reconnect the sensor lead wire.
8. Reinstall the shroud on the unit.

7.5 COMBUSTION CALIBRATION

Combustion settings must be checked at the intervals shown in Table 7-1 as part of the maintenance requirements. Refer to Chapter 4, section 4.3 for combustion calibration instructions.

7.6 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.

7.7 BURNER ASSEMBLY INSPECTION

The burner assembly (P/N **24276**) 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. It should be noted that the complete burner assembly also includes the blower and air/fuel valve assemblies for the unit.

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

Part No.	Description
81143	Burner Gasket
81048	Flame Detector Gasket
81064	Blower Gasket

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

Burner Assembly Inspection

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. Disconnect the unit wiring harness connectors from the air/fuel valve and blower motor.
10. Disconnect the wire leads connected to the Blower Proof switch and Blocked Inlet switch (Figure 7-4 and Figure 7-5).
11. Disconnect the gas train from the air/fuel valve by removing the four (4) 1/2” bolts and nuts (Figure 7-4).
12. Disconnect the flex hose from the air/fuel valve by loosening the hose clamp.
13. Remove the four 5/16-18 hex head screws securing the blower to the burner plate (Figure 7-5).
14. Remove the blower and air/fuel valve from the burner plate by lifting straight up. Also, remove the blower gasket.
15. Remove the eight (8) 3/8-16 nuts from the burner flange (Figure 7-4) using a 9/16” wrench.

Burner Assembly Inspection – *Continued*

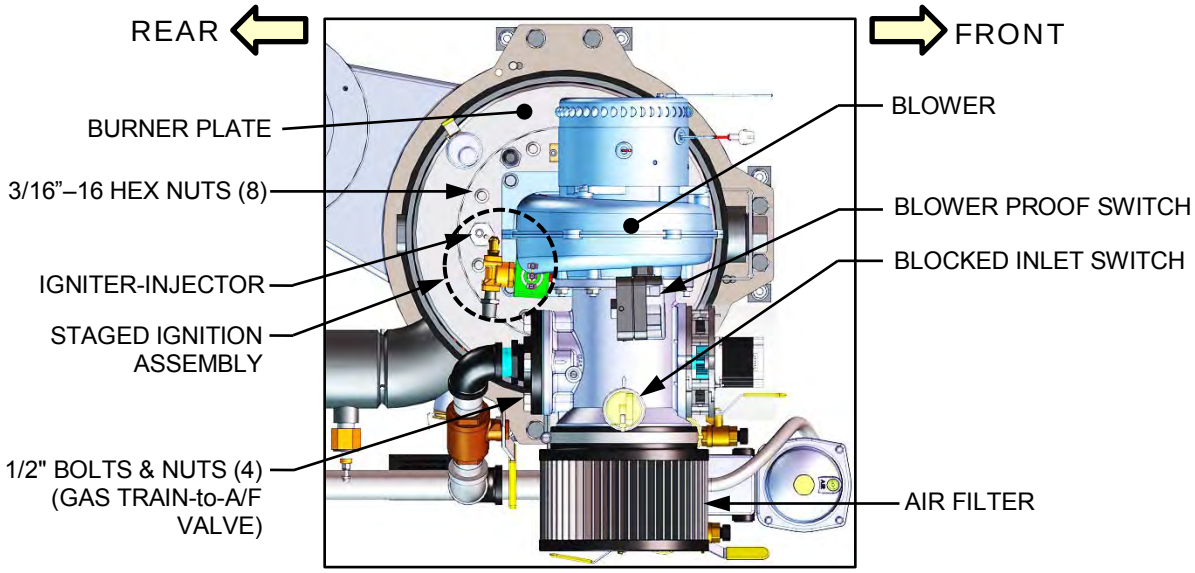

Figure 7-4: Burner Assembly Mounting Details – Overhead View

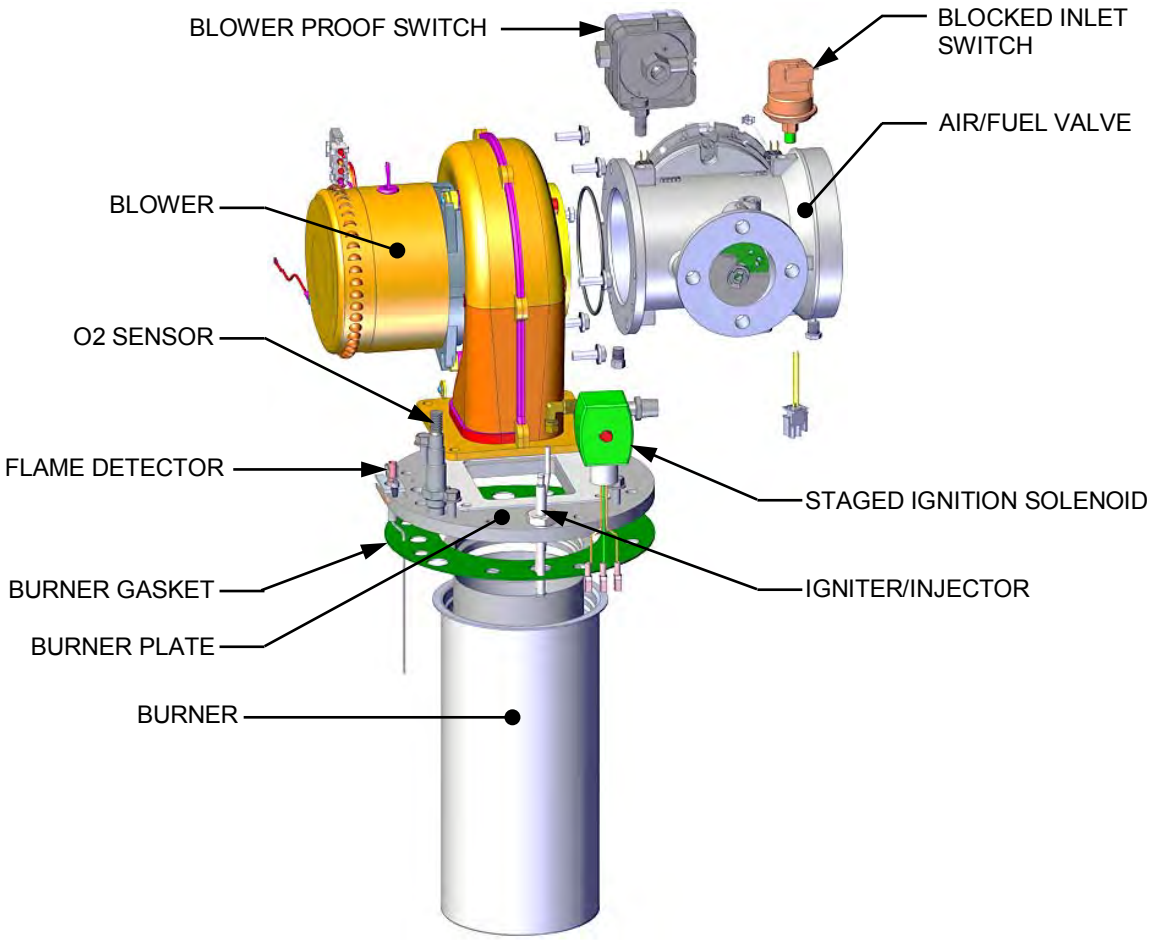

Figure 7-5: Burner Assembly – Exploded View

Burner Assembly Inspection – *Continued*

NOTE

The burner assembly weighs approximately 25 pounds (11.3 kg).

16. Remove the burner assembly from burner flange by pulling straight up.
17. Remove and replace the burner gasket.

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)**.

18. Beginning with the burner assembly removed in step 16, reinstall all the components in the reverse order that they were removed. When reinstalling the burner flange (removed in step 15), 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 30 ft. lbs. (40.7 Nm)**.
19. Ensure that the igniter-injector and flame detector cutouts in the burner plate are properly aligned with the heat exchanger top flange.

7.8 CONDENSATE DRAIN TRAP MAINTENANCE

Benchmark boilers contain a condensate trap, located external to the unit and attached to the drain connection from the exhaust manifold. The location on the unit is shown in Chapter 2, Figure 2-6. This trap should be inspected and cleaned in accordance with the maintenance schedule shown in Table 7-1 to ensure proper operation.

To inspect and clean the trap, proceed as follows:

Condensate Trap Inspection and Cleaning

1. Disconnect the external condensate trap by loosening and then removing connections on the inlet and outlet sides of the condensate trap (see Figure 7-6).
2. Loosen the four (4) thumbscrews securing the trap's cover and then remove the cover and the O-ring from under the cover.
3. Remove the float and then thoroughly clean the trap and float. Also inspect the drain piping for blockage. If the trap cannot be thoroughly cleaned, replace the entire trap (P/N **24441**).
4. Replace the float, install the O-ring (P/N **84017**), and then replace the trap cover.
5. Reassemble all piping and hose connections to the condensate trap inlet and outlet.

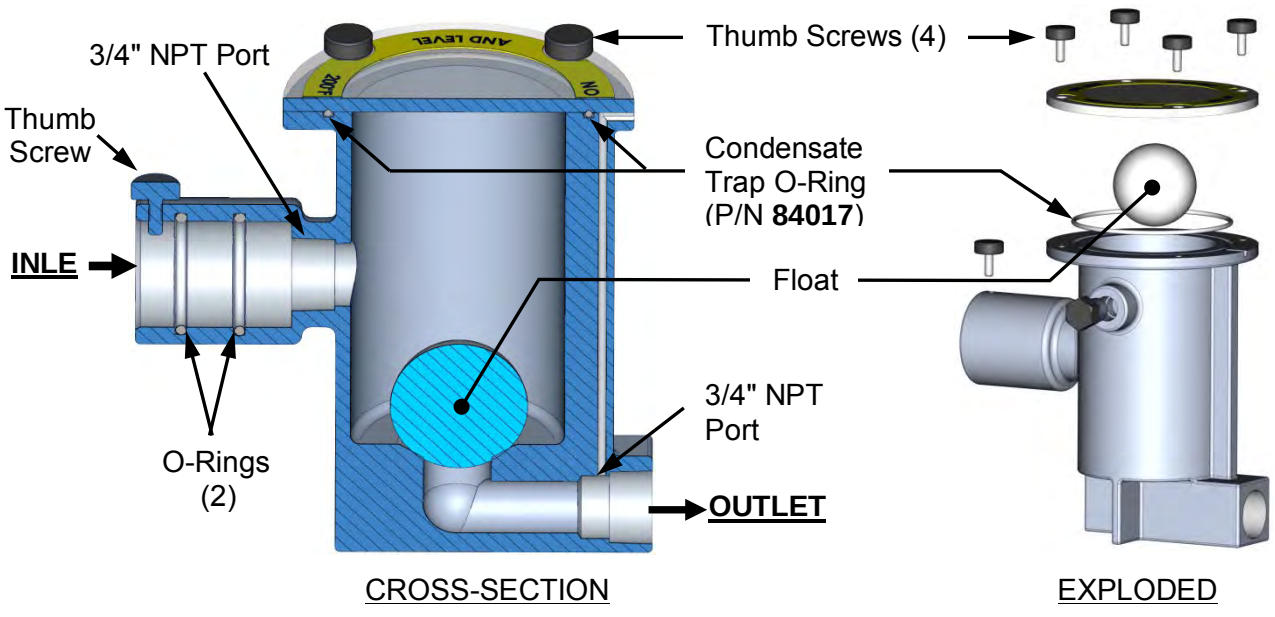

Figure 7-6: External Condensate Trap – Cross-Section & Exploded View

7.9 AIR FILTER CLEANING & REPLACEMENT

The Benchmark boiler is equipped with an air filter (P/N 59139) which should be cleaned and re-oiled every 12 months and replaced every 24 months. The air filter is located at the inlet of the air fuel valve at the top of the boiler as shown in Figure 7-.

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

Air Filter Cleaning & Replacement

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 boiler to service use.

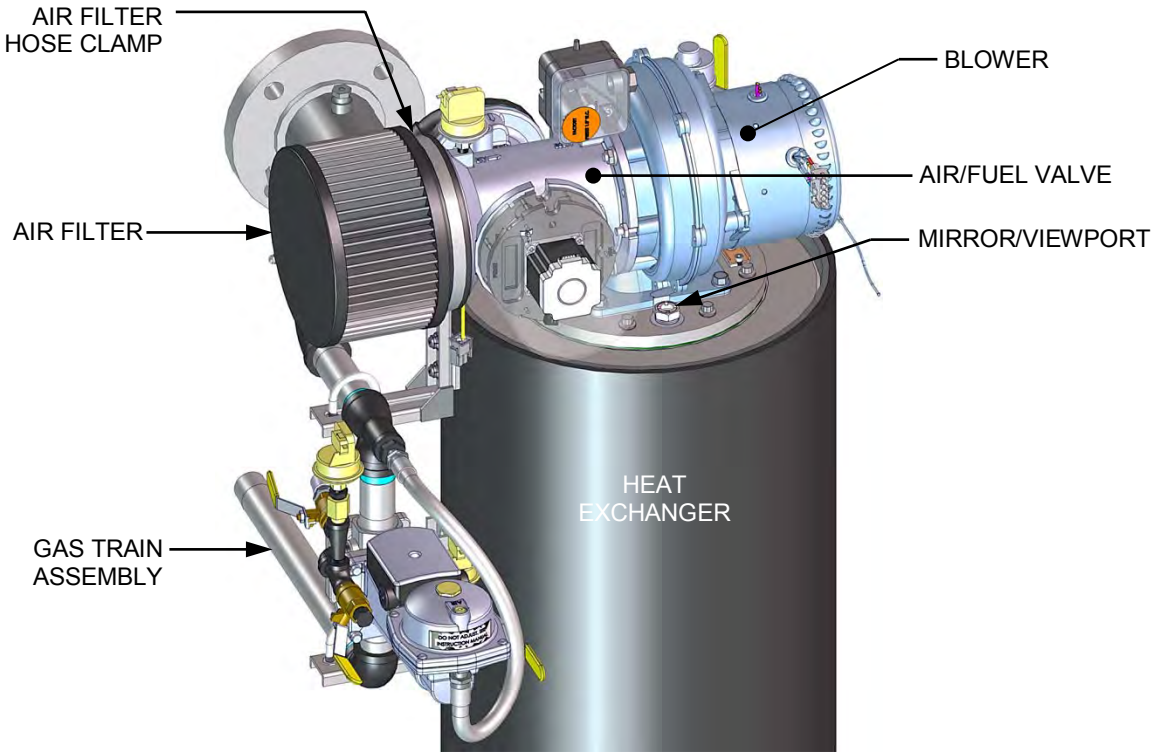

Figure 7-7: Air Filter Replacement

7.10 LOW 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 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.

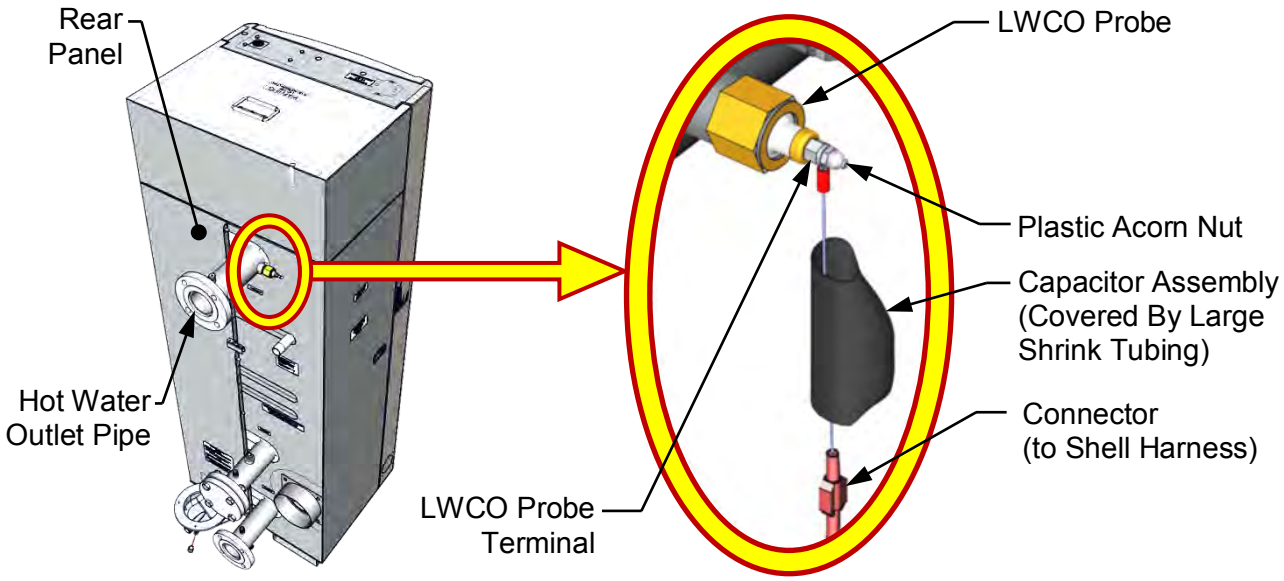

Figure 7-8: LWCO Probe Location for BMK750/1000 (BMK750 Shown)

7.10.1 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 OFF AC power to the unit.

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*

2. 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).

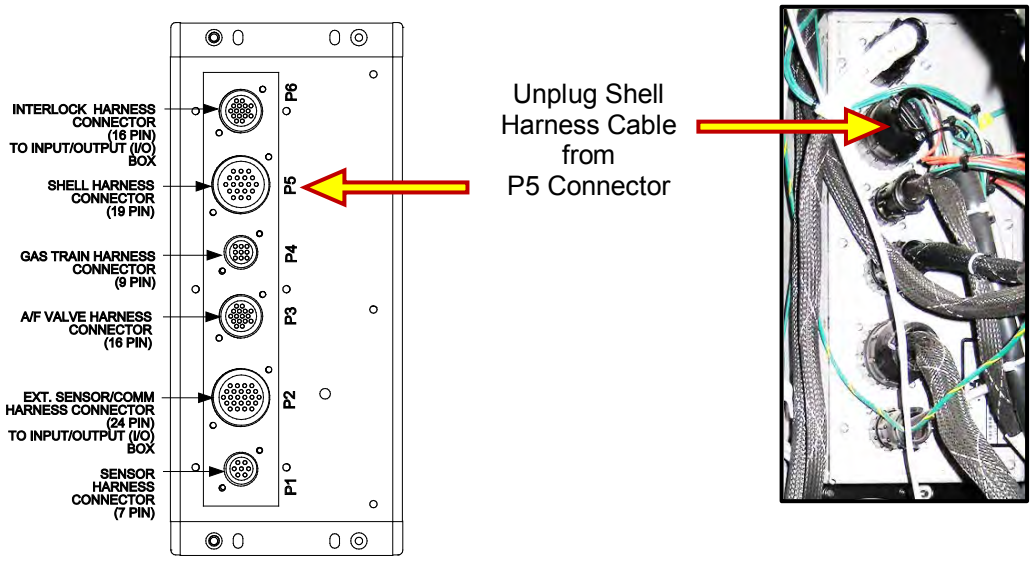

Figure 7-9: Removing Shell Harness Cable from P5 Conn. on C-More Rear Panel

3. Using an ohmmeter, connect one ohmmeter probe to the LWCO capacitor terminal on the unit shell as shown on left in Figure 7-10.
4. 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.

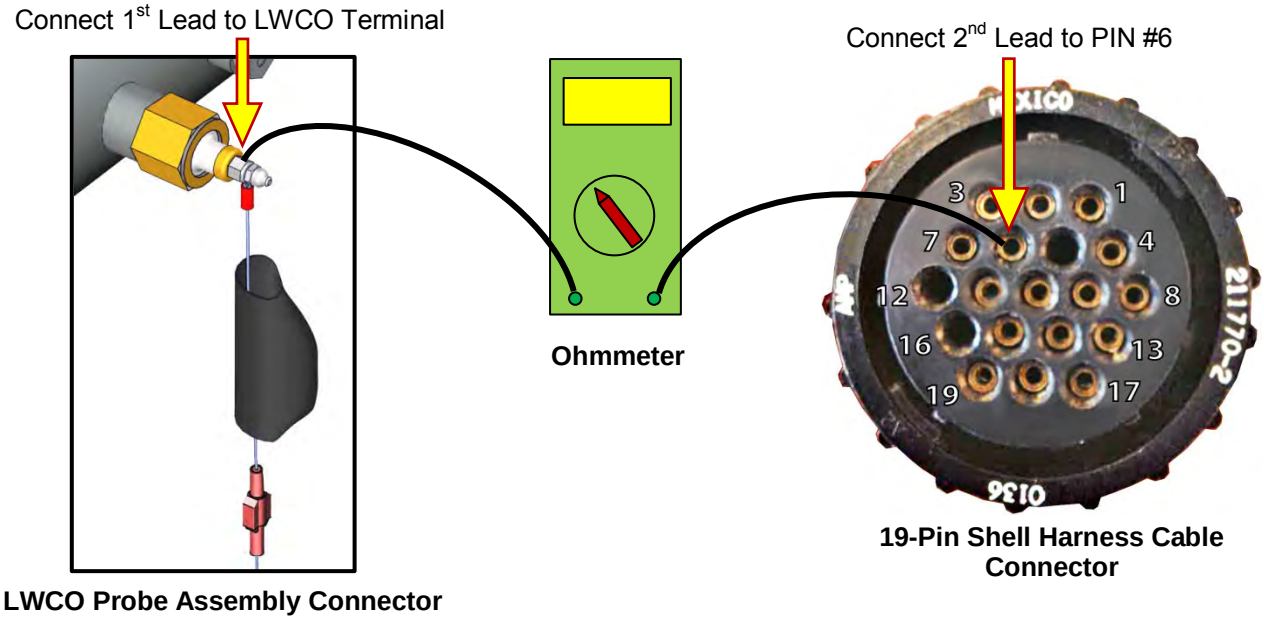

Figure 7-10: Connecting Ohmmeter between LWCO Probe & Shell Harness Cable

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. Refer to document TID-0100, provided with the 24-month maintence kit, for LWCO replacement instructions.

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

7.10.2 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 on the AC power to the unit.
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.

7.11 SHUTTING THE BOILER DOWN FOR AN EXTENDED PERIOD OF TIME

If the 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 the Boiler Down for an Extended Period

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

7.12 PLACING THE BOILER BACK IN SERVICE AFTER A PROLONGED SHUTDOWN

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

Placing Boiler Back In Service After a Prolonged 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.

7.13 SPARK MONITOR (AC CURRENT TRANSDUCER)

The spark monitor (P/N 61034) evaluates the strength of the current between the ignition transformer and igniter-injector. Wire# 140, connected to the ignition transformer (see Figure 7-11), passes through the monitor's orifice. If an adequate AC current is not detected in the wire during ignition, the unit automatically shuts down. The monitor's wires are connected to the I/O board's Spark Signal terminals (see section 2.10.4).

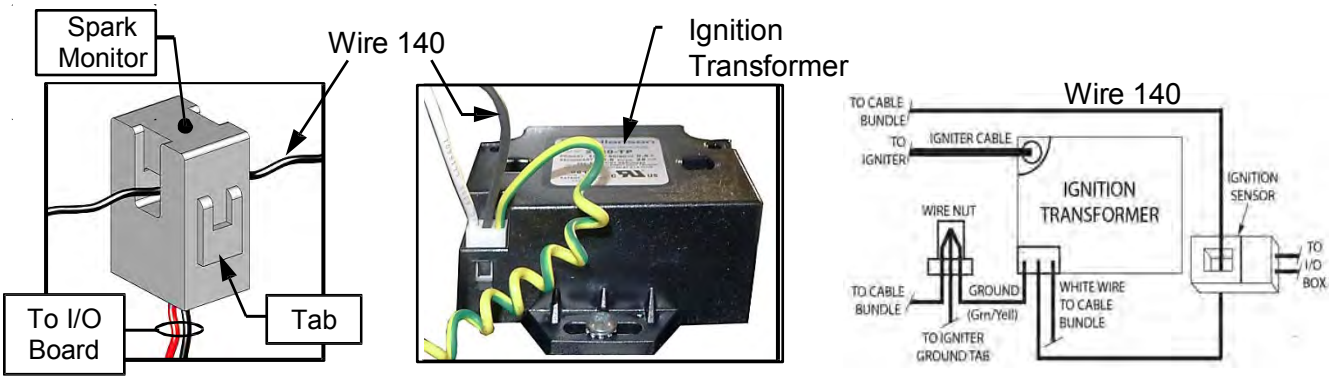

Figure 7-11: Spark Detector Sensor (AC Current Transducer) P/N 61034

If the spark monitor needs to be replaced, open the monitor's orifice by pulling on the tab at the side, remove Wire# 140, disconnect the monitor's wires are from the I/O board, remove the old monitor from its position, install a new monitor in its place, route wire# 140 through the new sensor orifice, and connect the wires to the I/O board's Spark Signal terminals, red wire to the positive (+) terminal and black to negative (-).

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 a Benchmark 750 or 1000 boiler. 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:

Troubleshooting Instructions

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 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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Table 8-1 BOILER TROUBLESHOOTING

FAULT INDICATION	PROBABLE CAUSES	CORRECTIVE ACTION
AIRFLOW FAULT DURING IGNITION	1. Blower stopped running due to thermal or current overload. 2. Blocked Blower inlet or inlet air filter. 3. Blockage in Blower Proof switch. 4. Blockage in Blocked Inlet switch. 5. Defective Blower Proof switch. 6. Defective Blocked Inlet switch. 7. Loose temperature to AUX connection in I/O Box. 8. Defective temperature sensor. 9. Loose wire connection between the 0-10V signal from I/O box to the Blower input. 10. Defective I/O Box. 11. Wrong 0-10V output selection on the control box. 12. Defective Air-Fuel Valve potentiometer. 13. Hard light.	1. Check combustion blower for signs of excessive heat or high current drain that may trip thermal or current overload devices. 2. Inspect the inlet to the combustion blower including the air filter at the air/fuel valve for signs of blockage. 3. Remove the Blower Proof switch and inspect for signs of blockage, clean or replace as necessary. 4. Remove the Blocked Inlet switch and inspect for signs of blockage, clean or replace as necessary. 5. Check the continuity of the Blower Proof switch with the blower running. If the resistance reading is erratic or is greater than zero ohms, replace the switch. 6. Turn off unit and check the continuity of the Blocked Inlet switch. If the resistance reading is erratic or is greater than zero ohms, replace the switch. 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. 8. Refer to CORRECTIVE ACTION 7 and verify that the voltage conforms to the values shown in Appendix C. 9. Check wire connection from I/O Box 0-10V signal to the Blower Motor. 10. Measure voltage at the I/O box 0-10V output. A voltage of 8.2V equates to a 100% open valve position. 11. Check the *Analog Out* option on the C-More *Configuration* menu. ***Valve Position 0-10V*** should be selected. 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. 13. Check igniter-injector for soot or erosion of electrode. Check injector solenoid valve to insure proper open/close operation.

TABLE 8-1. BOILER TROUBLESHOOTING – *Continued*

FAULT INDICATION	PROBABLE CAUSES	CORRECTIVE ACTION
AIRFLOW FAULT DURING PURGE	1. Blower not running or running too slow.	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.
	2. Defective Blocked Inlet switch.	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.
	3. Blockage in air filter or Blocked Inlet switch.	3. Remove the air filter and Blocked Inlet switch and inspect for signs of blockage. Clean or replace as necessary.
	4. Blocked blower inlet or inlet ductwork.	4. Inspect the inlet to the combustion blower including any ductwork leading up to the combustion blower for signs of blockage.
	5. No voltage to Blocked Inlet switch from C-More Control Box.	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.
	6. PROBABLE CAUSES from 3 to 12 for AIRFLOW FAULT DURING IGNITION apply for this fault.	6. See CORRECTIVE ACTIONS from 3 to 12 for AIRFLOW FAULT DURING IGNITION.
AIRFLOW FAULT DURING RUN	1. Blower stopped running due to thermal or current overload.	1. Check combustion blower for signs of excessive heat or high current draw that may trip thermal or current overload devices.
	2. Blocked Blower inlet or inlet ductwork.	2. Inspect the inlet to the combustion blower, including any ductwork leading up to the combustion blower, for signs of blockage.
	3. Blockage in air filter or Blocked Inlet switch.	3. Remove the air filter and Blocked Inlet switch and inspect for signs of blockage, clean or replace as necessary.
	4. Defective Blocked Inlet switch.	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,
	5. Combustion oscillations.	5. Run unit to full fire. If the unit rumbles or runs rough, perform combustion calibration.
	6. PROBABLE CAUSES from 3 to 16 for AIRFLOW FAULT DURING IGNITION applies for this fault.	6. See CORRECTIVE ACTIONS from 3 to 12 for AIRFLOW FAULT DURING IGNITION.

TABLE 8-1. BOILER TROUBLESHOOTING – *Continued*

FAULT INDICATION	PROBABLE CAUSES	CORRECTIVE ACTION
DELAYED INTERLOCK OPEN	1. Delayed Interlock Jumper not properly installed or missing. 2. Device proving switch hooked to interlocks is not closed	1. Check to insure jumper is properly installed across the delayed interlock terminals in the I/O Box. 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.
DIRECT DRIVE SIGNAL FAULT	1. Direct drive signal is not present: --Not yet installed. --Wrong polarity. --Signal defective at source. --Broken or loose wiring. 2. Signal is not isolated (floating). 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. --Hook up if not installed. --If installed, check polarity. --Measure signal level. --Check wiring continuity between source and unit. 2. Check signal at source to ensure it is isolated. 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 *Configuration* menu.
FLAME LOSS DURING IGN	1. Worn Flame Detector. 2. No spark from Spark Igniter. 3. Defective Ignition Transformer. 4. Defective Ignition/Stepper (IGST) Board. 5. Defective SSOV.	1. Remove and inspect the Flame Detector for signs of wear. Replace if necessary. 2. Close the internal gas valve in the unit. Install and arc a spark igniter outside the unit. 3. If there is no spark, check for 120VAC at the primary side to the ignition transformer during the ignition cycle. 4. If 120VAC is not present, the IGST Board in the Control Box may be defective. Refer fault to qualified service personnel. 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.

TABLE 8-1. BOILER TROUBLESHOOTING – *Continued*

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

TABLE 8-1. BOILER TROUBLESHOOTING – *Continued*

FAULT INDICATION	PROBABLE CAUSES	CORRECTIVE ACTION
HIGH GAS PRESSURE	1. Incorrect supply gas pressure. 2. Defective SSOV Actuator. 3. Defective High Gas Pressure switch.	1. Check to ensure gas pressure at inlet of SSOV **does not exceed 14" W.C. (3487 Pa)** 2. If gas supply pressure downstream of SSOV Actuator cannot be lowered to the range of **2.0" ± 0.4" W.C. (498 ± 100 Pa)** using the gas pressure adjustment screw (see section 4.3, step 10), the SSOV Actuator may be defective. 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.
HIGH WATER TEMP SWITCH OPEN	1. Faulty Water temperature switch. 2. Incorrect PID settings. 3. Faulty shell temperature sensor. 4. Unit in Manual mode 5. Unit setpoint is greater than Over Temperature switch setpoint. 6. System flow rate changes are occurring faster than units can respond.	1. Test the temperature switch to insure it trips at its actual water temperature setting. 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. 3. Using the resistance charts in the Appendix C, Measure the resistance of Shell sensor and BTU sensor at a known water temperature. 4. If unit is in Manual mode, switch to Auto mode. 5. Check setpoint of unit and setpoint of Temperature switch; Ensure that the temperature switch is set higher than the unit's setpoint. 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.
HIGH WATER TEMPERATURE	1. See HIGH WATER TEMPERATURE SWITCH OPEN. 2. Temp HI Limit setting is too low.	1. See HIGH WATER TEMPERATURE SWITCH OPEN. 2. Check Temp HI Limit setting.
IGN BOARD COMM FAULT	1. Communication fault has occurred between the PMC board and Ignition/Stepper (IGST) board	1. Press **CLEAR** button and restart unit. If fault persists, contact qualified Service Personnel.

TABLE 8-1. BOILER TROUBLESHOOTING – *Continued*

FAULT INDICATION	PROBABLE CAUSES	CORRECTIVE ACTION
IGN SWTCH CLOSED DURING PURGE	1. Air/Fuel Valve not rotating 2. Defective or shorted switch 3. Switch wired incorrectly 4. Defective Power Supply Board or fuse 5. Defective IGST Board	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 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. 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 4. Check **DS1** & **DS2** LEDs on Power Supply Board. If they are not steady ON, replace Power Supply Board. 5. Check "Heartbeat" LED **DS1** and verify it is blinking ON & OFF every second. If not, replace IGST Board
IGN SWTCH OPEN DURING IGNITION	1. Air/Fuel Valve not rotating to ignition position. 2. Defective **Ignition** switch 3. Defective Power Supply Board or fuse 4. Defective IGST Board	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. 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. 3. Check **DS1** & **DS2** LEDs on Power Supply Board. If they are not steady ON, replace Power Supply Board. 4. Check "Heartbeat" LED **DS1** and verify it is blinking ON & OFF every second. If not, replace IGST Board.

TABLE 8-1. BOILER TROUBLESHOOTING – *Continued*

FAULT INDICATION	PROBABLE CAUSES	CORRECTIVE ACTION
INTERLOCK OPEN	1. Interlock jumper not installed or removed 2. Energy Management System does not have unit enabled. 3. Device proving switch hooked to interlocks is not closed.	1. Check for a jumper properly installed across the interlock terminals in the I/O box. 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). 3. Check that proving switch for any device hooked to the interlock circuit is closing and that the device is operational.
LINE VOLTAGE OUT OF PHASE	1. Line and Neutral switched in AC Power Box. 2. Incorrect power supply transformer wiring.	1. Check hot and neutral in AC Power Box to ensure they are not reversed 2. Check transformer wiring, in AC Power Box, against the power box transformer wiring diagram to ensure it is wired correctly
LOW GAS PRESSURE	1. Incorrect supply gas pressure. 2. Defective **Low Gas Pressure** switch	1. Measure gas pressure upstream of the SSOV Actuator(s) with the unit firing. For FM gas trains, ensure it is **between 4.0" W.C. and 14" W.C. (996 and 3487 Pa)**. For DBB gas trains, ensure it is **between 4.2" W.C. and 14" W.C. (1046 and 3487 Pa)** (see section. 2.8.1). 2. Measure gas pressure at the **Low Gas Pressure** switch. If it is **greater than 2.6" W.C. (648 Pa)**, measure continuity across the switch and replace if necessary.
LOW WATER LEVEL	1. Insufficient water level in system 2. Defective water level circuitry. 3. Defective water level probe.	1. Check system for sufficient water level. 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. 3. Check continuity of probe end to the shell, change probe if there is no continuity.
MODBUS COMMFAULT	Unit not seeing information from Modbus network	Check network connections. If fault persists, contact qualified Service Personnel.
PRG SWTCH CLOSED DURING IGNITION	1. A/F Valve rotated open to purge and did not rotate to ignition position.	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.

TABLE 8-1. BOILER TROUBLESHOOTING – *Continued*

FAULT INDICATION	PROBABLE CAUSES	CORRECTIVE ACTION
PRG SWTCH CLOSED DURING IGNITION (continued)	2. Defective or shorted switch. 3. Switch wired incorrectly. 4. Defective Power Supply Board or fuse 5. Defective IGST Board	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). 3. If the switch is wired correctly, replace the switch. 4. Check **DS1** & **DS2** LEDs on Power Supply Board. If they are not steady ON, replace Power Supply Board. 5. Check "Heartbeat" LED **DS1** and verify it is blinking ON & OFF every second. If not, replace IGST Board.
PRG SWTCH OPEN DURING PURGE	1. Defective **Purge** switch. 2. No voltage present at switch. 3. Switch wired incorrectly. 4. Defective Power Supply Board or fuse 5. Defective IGST Board	1. If the air-fuel valve does rotate, check **Purge** switch for continuity when closing. Replace switch if continuity does not exist. 2. Measure for 24 VAC from each side of the switch to ground. If 24VAC is not present, refer fault to qualified service personnel. 3. Check to ensure that the switch is wired correctly (correct wire numbers on the normally open terminals). 4. Check **DS1** & **DS2** LEDs on Power Supply Board. If they are not steady ON, replace Power Supply Board. 5. Check "Heartbeat" LED **DS1** and verify it is blinking ON & OFF every second. If not, replace IGST Board.
OUTDOOR TEMP SENSOR FAULT	1. Loose or broken wiring. 2. Defective Sensor. 3. Incorrect Sensor.	1. Inspect Outdoor Temperature sensor for loose or broken wiring. 2. Check resistance of sensor to determine if it is within specification. 3. Ensure that the correct sensor is installed.
O2 % OUT OF RANGE	1. Combustion Calibration incorrect. 2. Blocked inlet air duct or louver.	1. Check Combustion Analyzer and recalibrate Boiler. 2. Unblock air inlet and measure open area for combustion air to the room.

TABLE 8-1. 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: Not yet installed. Wrong polarity. Signal defective at source. Broken or loose wiring. 2. Signal is not isolated (floating) if 4 to 20 mA. 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. Hook up if not installed. If installed, check polarity. Measure signal level. Check continuity of wiring between source and unit. 2. Check signal at source to ensure it is isolated. 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 *Configuration* menu.
RESIDUAL FLAME	1. Defective Flame Detector. 2. SSOV not fully closed.	1. Replace Flame Detector. 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. Close the 1" Gas Shut-Off Valve downstream of SSOV (Figure 6-1). 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. 2. Floating Neutral. 3. Hot and Neutral reversed at SSOV.	1. Press **CLEAR** button and restart unit. If fault persists, replace Ignition/Stepper (IGST) Board. 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. 3. Check SSOV power wiring.

TABLE 8-1. BOILER TROUBLESHOOTING – *Continued*

FAULT INDICATION	PROBABLE CAUSES	CORRECTIVE ACTION
SSOV SWITCH OPEN	1. Actuator not allowing for full closure of gas valve	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.
	2. **SSOV** powered when it should not be	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.
	3. Defective switch or Actuator	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.
	4. Incorrectly wired switch.	4. Ensure that the SSOV Proof of Closure switch is correctly wired.
STEPPER MOTOR FAILURE	1. Air/Fuel Valve out of calibration.	1. Refer to GF-112 (C-More O & M) and perform the Stepper Feedback Calibration procedure in Section 6, section 6.2.1.
	2. Air/Fuel Valve unplugged.	2. Check that the Air/Fuel Valve is connected to the Control Box.
	3. Loose wiring connection to the stepper motor.	3. Inspect for loose connections between the Air/Fuel Valve motor and the wiring harness.
	4. Defective Air/Fuel Valve stepper motor.	4. Replace stepper motor.
	5. Defective Power Supply Board or fuse	5. Check **DS1** & **DS2** LEDs on Power Supply Board. If they are not steady ON, replace Power Supply Board.
	6. Defective IGST Board	6. Check “Heartbeat” LED **DS1** and verify it is blinking ON & OFF every second. If not, replace IGST Board.

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 WATER HEATER TROUBLESHOOTING WITH NO FAULT MESSAGE DISPLAYED

OBSERVED INCIDENT	PROBABLE CAUSES	CORRECTIVE ACTION
Hard Light-Off	1. Staged Ignition Ball Valve closed. 2. Clogged/damaged Gas Injector on Igniter-Injector (Figure 8-2). 3. Defective Staged Ignition Solenoid (Figure 8-1).	1. Open the Staged Ignition Ball Valve on the upstream side of the SSOV (Figure 8-1). 2. Disconnect the Staged Ignition Assembly solenoid from the Gas injector Tube of the Igniter-Injector (Figure 8-2) and inspect Gas Injector to ensure it is not clogged or damaged. 3. Close the Manual Shutoff Valve (Figure 8-1, below). 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.
Fluctuating Gas Pressure	1. Gas pressure going into unit is fluctuating. 2. Damping Orifice not installed.	1. Stabilize gas pressure going into unit. If necessary, troubleshoot Building Supply Regulator. 2. Check to ensure that the Damping Orifice is installed in the SSOV Actuator shown in Figure 8-3. (For DBB Gas Trains, the Damping Orifice is installed in the downstream SSOV Actuator).
Air/Fuel Valve “hunting” at the 80% Valve Position	1. IGST and Power Supply Boards in Control Box are outdated.	1. Check to ensure that the IGST and Power Supply Boards are Rev. E or higher.

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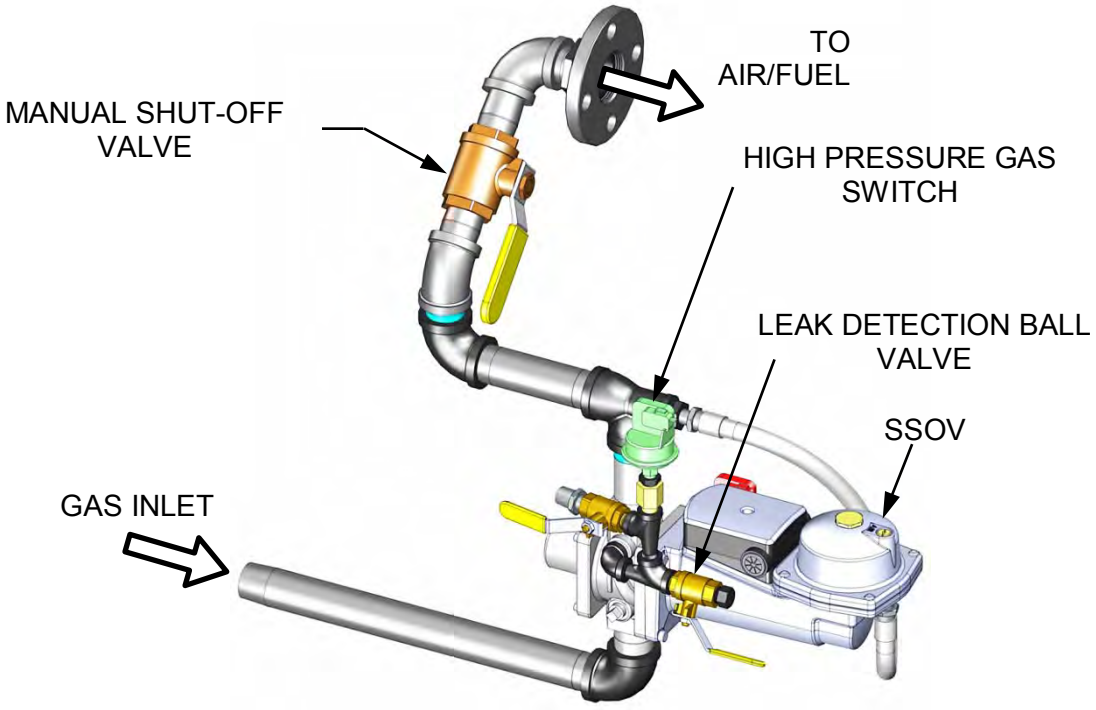


Figure 8-1: Gas Train Component Locations

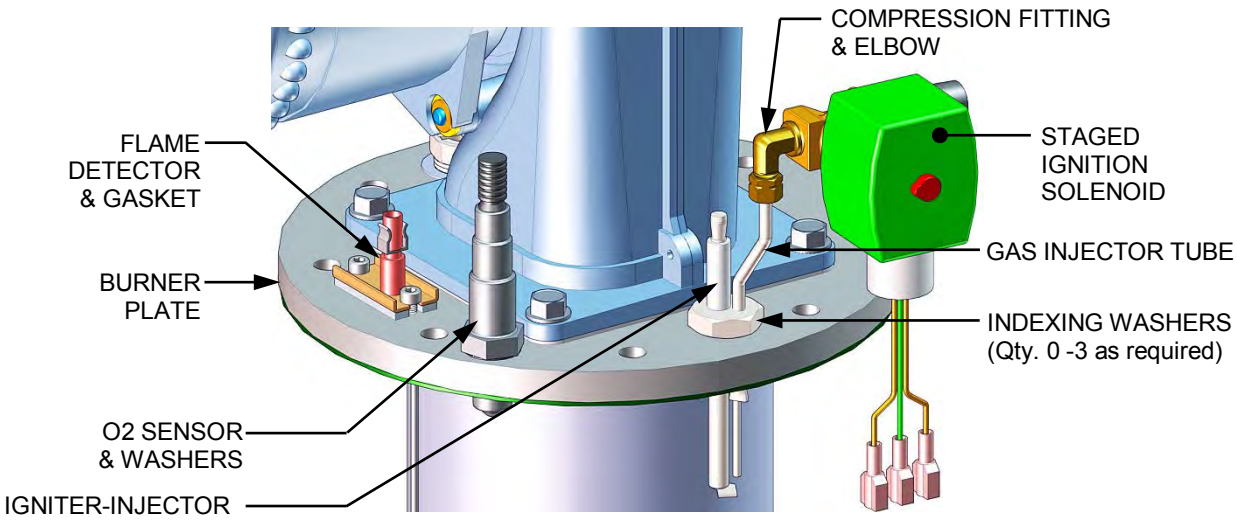


Figure 8-2: Staged Ignition Connection to Gas Injector Tube

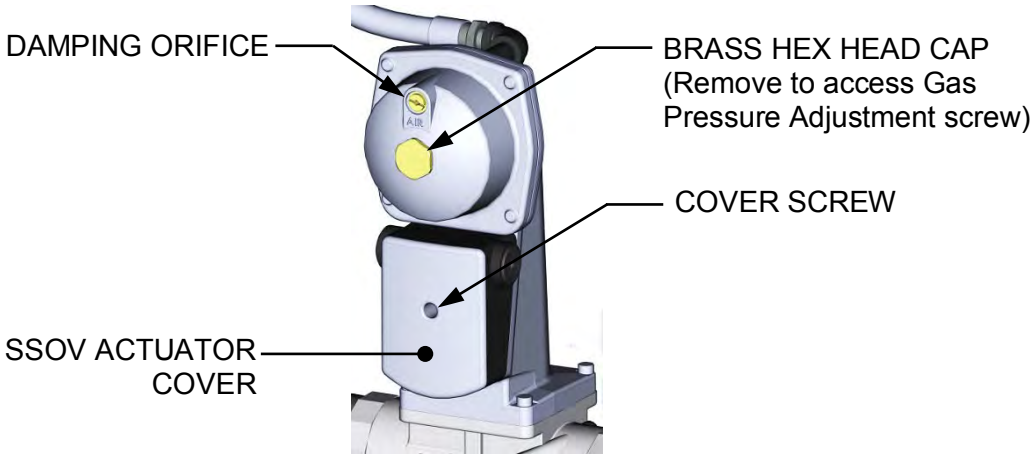


Figure 8-3: SSOV Actuator With Gas Pressure Adjustment & Damping Orifice

CHAPTER 9. BOILER SEQUENCING TECHNOLOGY

9.1 INTRODUCTION

The C-More on-board Boiler Sequencing Technology system (BST) is an integrated 8 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 boilers while achieving maximum operational efficiency.

BST is designed to ensure that all Boilers in the system operate at maximum efficiency. This is accomplished by lighting off boilers only if all ignited boilers reach or exceed a defined Valve Position (Fire Rate). Operating all 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 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 Boilers connected to a BST is shown in Figure 9-1 below.

NOTE: Use either FFWD Header Sensor or Modbus Header

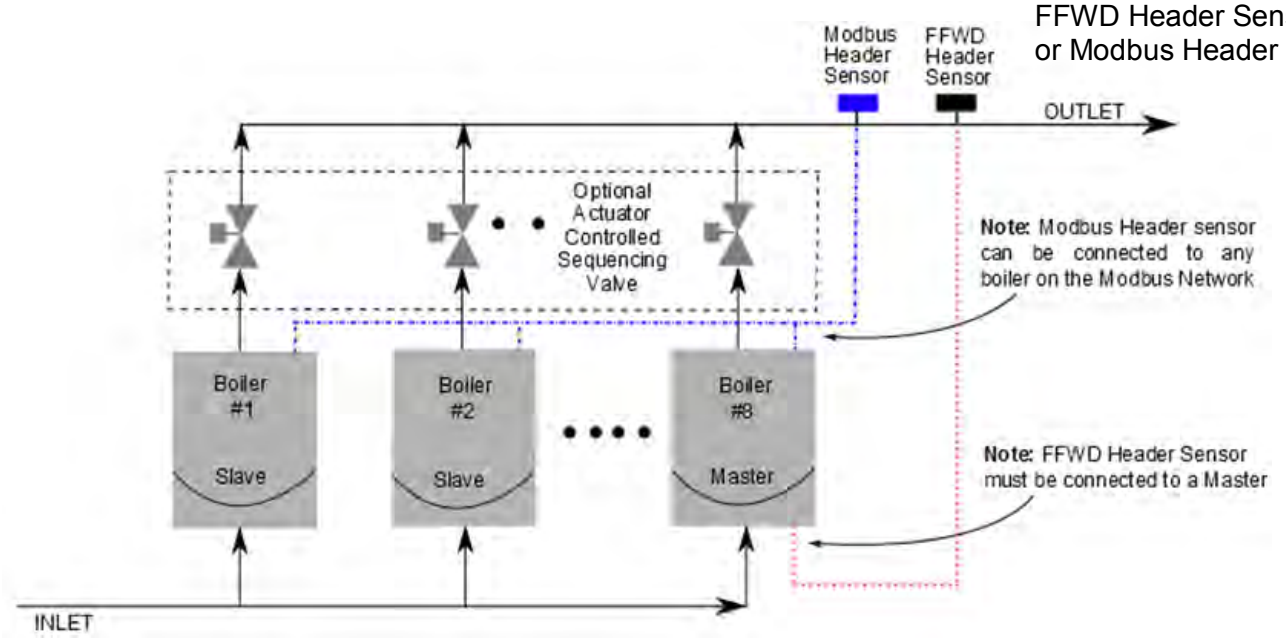


Figure 9-1. Simplified BST Block Diagram

NOTE

After the boiler load is satisfied, the isolation valve remains open for a programmed interval (default = 2 minutes) before closing. When the *system load* is satisfied, the panel will open the isolation valves for all of the boilers. The BST controls the valves via a 0-20 mA signal (See section 2.10.5)

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

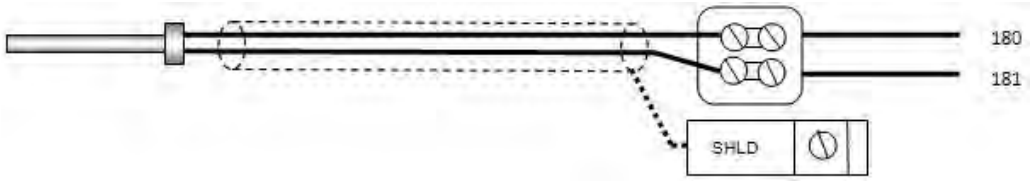
9.3.1 Option 1 - Constant Setpoint with DIRECT Wired Header Sensor

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 downstream of the LAST 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.



Temp Sensor PN 61040 Header Temp Sensor I/O Box

Step 2: Configure ALL C-More Units

On ALL 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**.

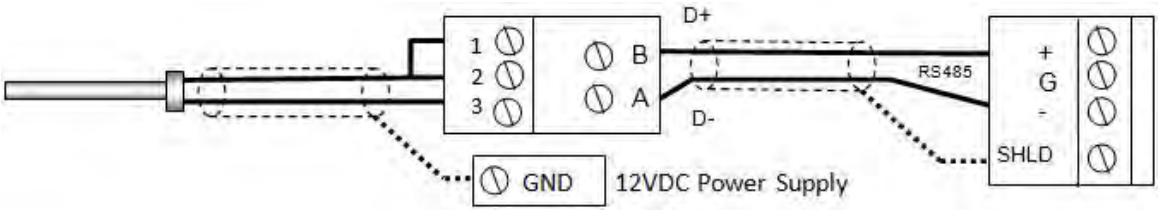
9.3.2 Option 2 - Constant Setpoint with MODBUS Wired Header Sensor

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 Boiler units, and Pin A of the Temperature Transmitter to the RS485- terminal on the I/O Box of any of the Boiler 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 downstream of the LAST 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.



Temp Sensor PN 24410 Modbus Transmitter I/O Box

Step 2: Configure ALL C-More Units

On ALL 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**.

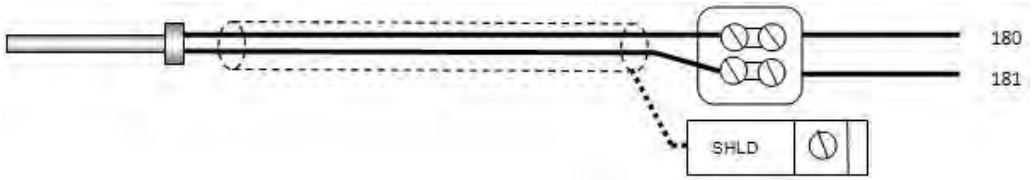
9.3.3 Option 3 - Outdoor Reset with DIRECT WIRED Header Sensor AND DIRECT WIRED Outdoor Sensor

NOTE: Both Header Sensor AND Outdoor Sensor must be wired. See the C-More Controller User Manual, OMM-0032, GF-112 and ProtoNode User Manual, OMM-0080, GF-129 for more information.

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 downstream of the LAST 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.

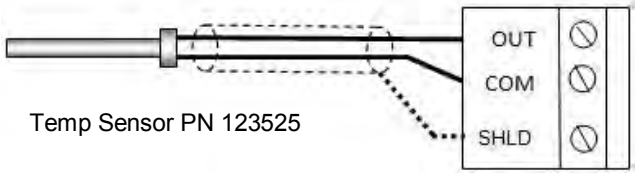


Step 2 - Direct Wired Outdoor Sensor

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 impingement by the elements. The outdoor sensor may be wired up to 200 feet from the boiler.



Option 3 – *Continued*

Step 3 - Configure ALL C-More Units

On ALL 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

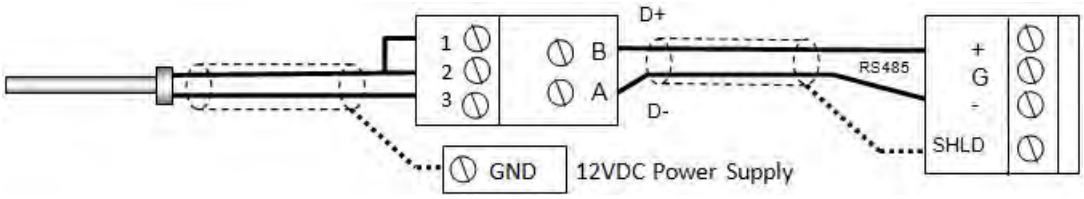
NOTE: Both Header Sensor AND Outdoor Sensor must be wired. See the C-More Controller User Manual, OMM-0032, GF-112 and ProtoNode User Manual, OMM-0080, GF-129 for more information.

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 Boiler units, and Pin A of the Temperature Transmitter to the RS485- terminal on the I/O Box of any of the Boiler 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 downstream of the LAST 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.



Temp Sensor PN 24410 Modbus Transmitter I/O Box

Step 2 - Modbus Outdoor Sensor Wiring

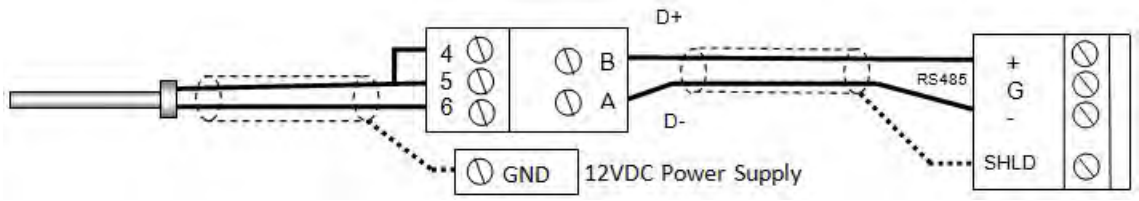
1. If you have not already done so when installing the Modbus Header Sensor, use Shielded pair 18 - 22 AWG cable to connect the Temperature Transmitter terminal Pin B to the RS485+ terminal on the I/O Box of any of the Boiler units, and Pin A of the Temperature Transmitter to the RS485- terminal on the I/O Box of any of the Boiler 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 impingement by the elements. The outdoor sensor may be wired up to 200 feet from the 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.



Temp Sensor PN 61043 Modbus Transmitter I/O Box

Step 3 - Configure ALL C-More Units

On ALL 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

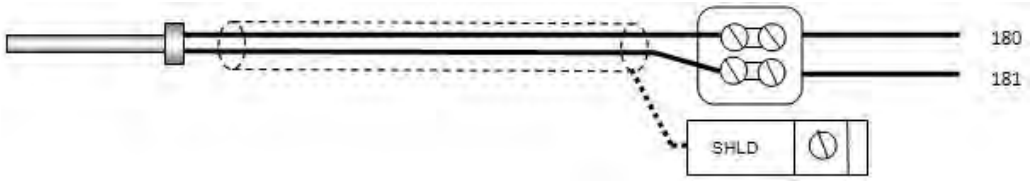
NOTE: Both Header Sensor AND 4-20ma Direct Drive must be wired. See the C-More Controller User Manual, OMM-0032, GF-112 and ProtoNode User Manual, OMM-0080, GF-129 for more information.

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 downstream of the LAST 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.



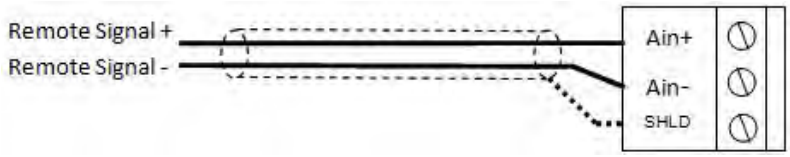
Temp Sensor PN 61040 Header Temp Sensor I/O Box

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.



I/O Box

Option 5 – *Continued*

Step 3: Configure ALL C-More Units

On ALL 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

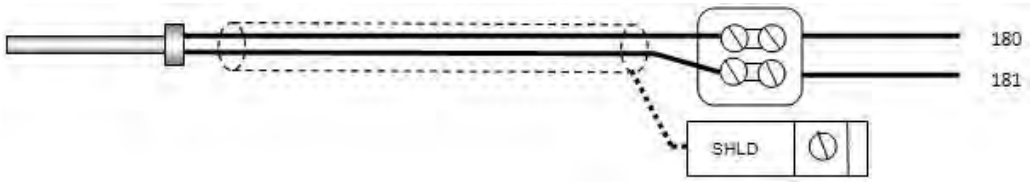
NOTE: Both Header Sensor AND the ProtoNode SSD Device must be wired. See the C-More Controller User Manual, OMM-0032, GF-112 and ProtoNode User Manual, OMM-0080, GF-129 for more information.

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 downstream of the LAST 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.



Temp Sensor PN 61040 Header Temp Sensor I/O Box

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 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

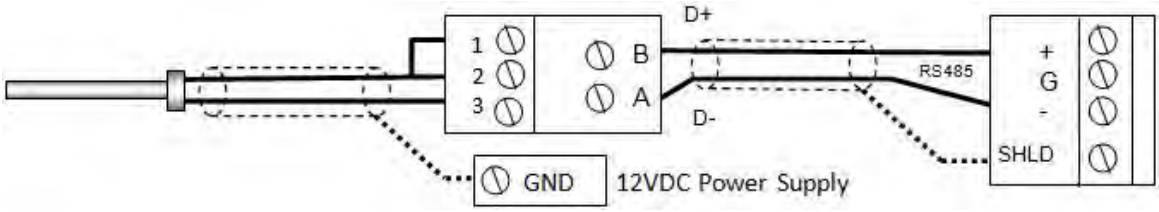
NOTE: Both Header Sensor AND 4-20ma Direct Drive must be wired. See the C-More Controller User Manual, OMM-0032, GF-112 and ProtoNode User Manual, OMM-0080, GF-129 for more information.

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 Boiler units, and Pin A of the Temperature Transmitter to the RS485- terminal on the I/O Box of any of the Boiler 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 downstream of the LAST 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.



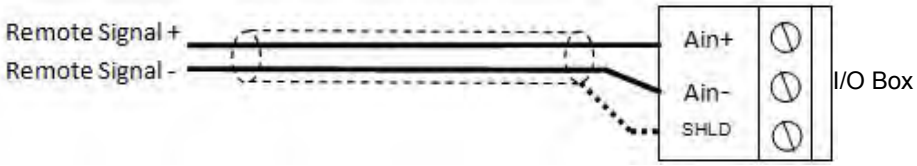
Temp Sensor PN 24410 Modbus Transmitter I/O Box

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 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

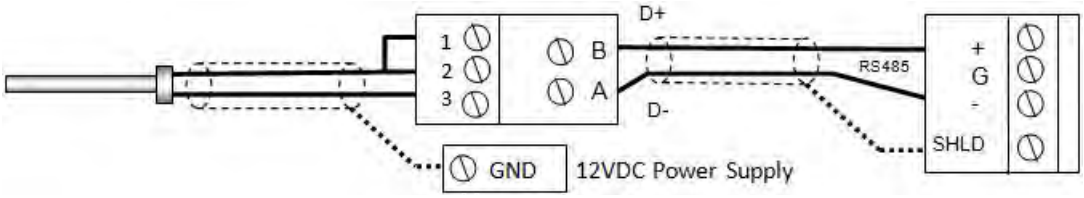
NOTE! Both Header Sensor AND ProtoNode SSD Device must be wired. See the C-More Controller User Manual, OMM-0032, GF-112 and ProtoNode User Manual, OMM-0080, GF-129 for more information.

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 Boiler units, and Pin A of the Temperature Transmitter to the RS485- terminal on the I/O Box of any of the Boiler 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 downstream of the LAST 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.



Temp Sensor PN 24410 Modbus Transmitter I/O Box

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 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: BOILER MENU ITEM DESCRIPTIONS

TABLE A-1: OPERATING MENU ITEM DESCRIPTIONS

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

Table A-1: OPERATING MENU ITEM DESCRIPTIONS		
MENU OPTIONS		**DESCRIPTION**
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 D.
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 ºF or ºC, 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 boiler is operating.
6	Valve Position Out	Displays actual real time Valve Position.
7	Exhaust Temp	Displays the exhaust temperature in °F (default) or ºC.
8	Flame Strength	Displays flame strength from 0% to 100%.
9	Oxygen Level	Displays the real-time combustion oxygen (O_2) level (%) measured by the O_2 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.

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. Entering the Level 1 Password (159) allows options in the Setup, Configuration and *Tuning* menus to be modified. 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., **G**-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-**12**-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-**1234**.
13	Software Version	Identifies the current software version of the control box.

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: Benchmark 750 – 750 MBH (220 kW) Benchmark 1000 – 1000 MBH (293 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 = **Outdoor Reset**. Allows the building reference temperature to be set when operating a boiler in the Outdoor Reset Mode.
9	Reset Ratio	Only available if Boiler Mode = **Outdoor Reset**. Permits setting of Reset Ratio when operating boiler in the Outdoor Reset Mode.
10	System Start Tmp	Only if Outdoor Sensor = **Enabled**. This menu item allows the system start temperature to be set.
11	Setpt Lo Limit	Used to set the *minimum* allowable setpoint, from 40°F (4.4°C) up to the Setpt Hi Limit.
12	Setpt Hi Limit	Used to set the *maximum* 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.

CONFIGURATION MENU		
MENU OPTIONS		**DESCRIPTION**
15	Pump Delay Timer	Specifies the amount of time, up to 30 minutes, to keep the pump running after the unit turns off.
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 boiler.
17	Failsafe Mode	Allows the Failsafe mode to be set to either Constant Setpoint or Shutdown.
18	Analog Output	Must be set to **Valve Pos 0-10V** for both BMK 750 and BMK 1000. **DO NOT CHANGE from its default value.**
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 **0°F** to **10°F (0°C to 5.5°C)**.
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 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 *Valve Position In* reaches the Start Level value AND the Outlet Temperature goes below the *Active Setpoint – Demand Offset.* In addition, the boiler will fire at the 29% Valve Position level or below for a period of one minute. When this entry is set to zero, the unit will turn on again as soon as the *Valve Position in* reaches the *Start Level* value. There will not be a one minute delay when firing at the 29% Valve Position level.

CONFIGURATION MENU		
MENU OPTIONS		**DESCRIPTION**
25 26	Deadband High Deadband Low	Deadband High and Deadband Low settings create an "Outlet Temperature" Zone in which no Valve Position corrections will be attempted. The Deadband ZONE is defined as operating with an Outlet Temperature between Active Setpoint + Deadband High and Active Setpoint – Deadband Low. 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. 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)
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 = **Enabled**, sets the time a 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 boiler will trigger the Slow Shutdown feature.
31	Spark Monitor	Disabled on Benchmark 750 and 1000.
32	Spark Current	Disabled on Benchmark 750 and 1000.
33	BST Menu	When set to Enabled, the BST menu options appears.

TABLE A-4: TUNING MENU ITEM DESCRIPTIONS

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

TUNING MENU			
MENU OPTIONS		**DESCRIPTION**	
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, -17.2°C to 48.9°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.	
Warmup – The feature embodied in menu items 4, 5 and 6 eliminates Temperature Overshoots during the "Warmup" period of a cold ignition cycle on all boilers by temporarily modifying the PID Gain parameter during warmup and for a period defined in the *Tuning* menu.			
4	Warmup Prop Band	Range = 1 – 120°F (-17.2°C to 48.9°C)	Default = 95°F (35°C)
5	Warmup Int Gain	Range = 0.00 – 2.00	Default = 0.50
6	Warmup PID Timer	Range = 0 - 240 seconds	Default = 20 seconds
7	Reset Defaults?	Allows *Tuning* menu options to be reset to their Factory Default values.	

APPENDIX B: STARTUP, STATUS & DISPLAY MESSAGES

Table B-1: Startup and Status Messages

MESSAGE	DESCRIPTION
DEMAND DELAY XX sec	Displayed if Demand Delay is active.
DISABLED HH:MM pm, pm MM/DD/YY	Displayed if ON/OFF switch is set to **OFF**. 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 XX sec	Displayed during ignition trial of startup sequence. The duration of cycle counts up in seconds.
PURGING 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 **ON** position, but there is no demand for heat. The time and date are also displayed.
WAIT	Prompts the operator to wait.
WARMUP XX sec	Displayed for 2 minutes during the initial warm-up only.

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 switch OR Low Gas Pressure 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.
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_2 % OUT OF RANGE	The O_2 % has gone below 3% or above 8%.

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

FAULT MESSAGE	FAULT DESCRIPTION
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: • OUTLET TEMPERATURE display = SHt Indicates sensor is shorted • OUTLET TEMPERATURE display = Opn indicates sensor is open-circuited
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			
°F	**°C**	**RES (OHMS)**	**VOLTS***
-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 D – INDOOR/OUTDOOR RESET RATIO CHARTS

Table D-1. Header Temperature for a Building Reference Temperature = 50°F

		RESET RATIO									
Air Temp		**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 D-2. Header Temperature for a Building Reference Temperature = 60°F

		RESET RATIO									
Air Temp		**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			

Table D-3. Header Temperature for a Building Reference Temperature = 65°F

Air Temp		RESET RATIO									
°F	°C	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0	2.2	2.4
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 D-4. Header Temperature for a Building Reference Temperature = 70°F

Air Temp		RESET RATIO									
°F	°C	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0	2.2	2.4
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				

Table D-5. Header Temperature for a Building Reference Temperature = 75°F

Air Temp		RESET RATIO									
°F	°C	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0	2.2	2.4
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	17
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				

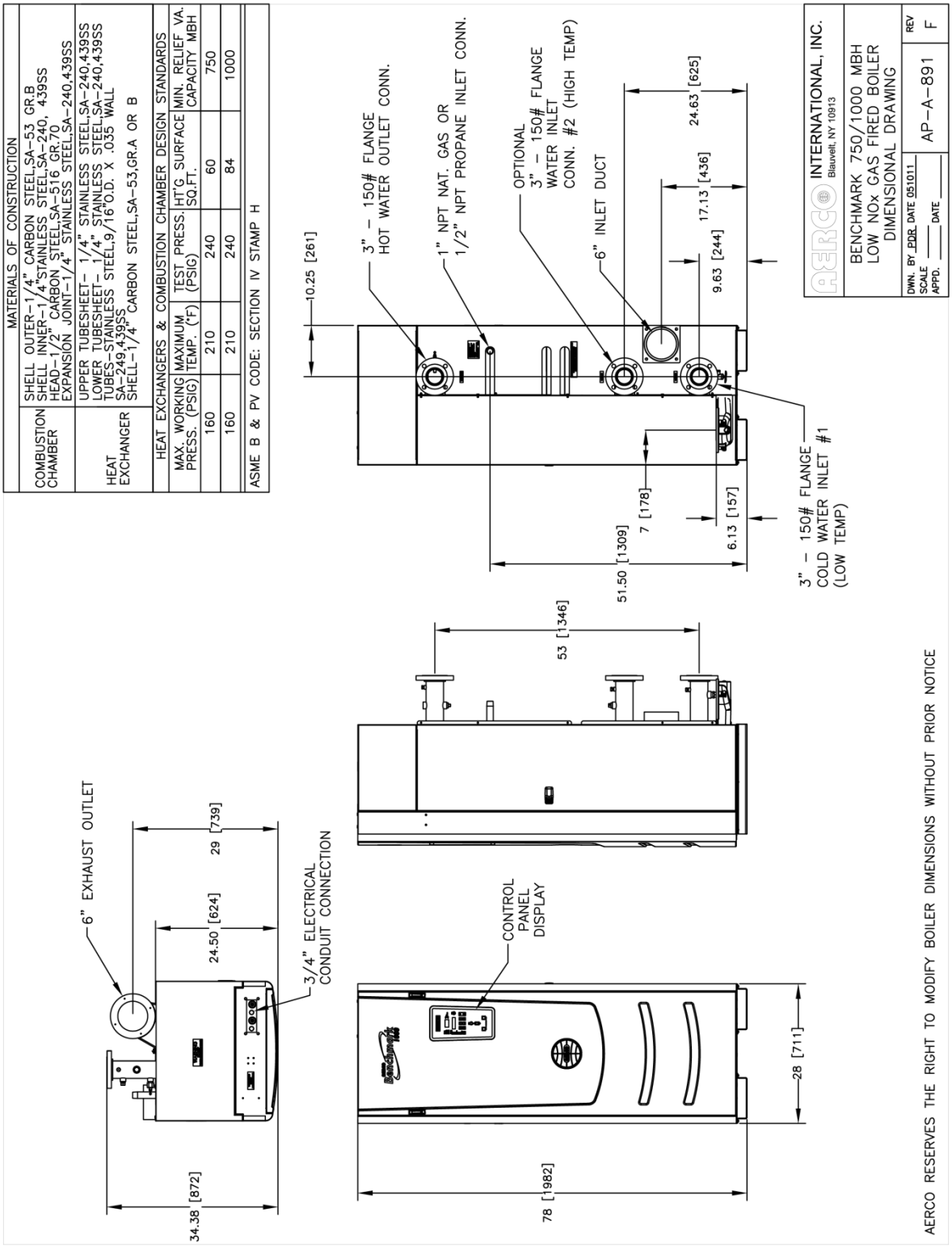
Table D-6. Header Temperature for a Building Reference Temperature = 80°F

Air Temp		RESET RATIO									
°F	°C	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0	2.2	2.4
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					

Table D-7. Header Temperature for a Building Reference Temperature = 90°F

		RESET RATIO									
Air Temp		**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 E – DIMENSIONAL DRAWINGS



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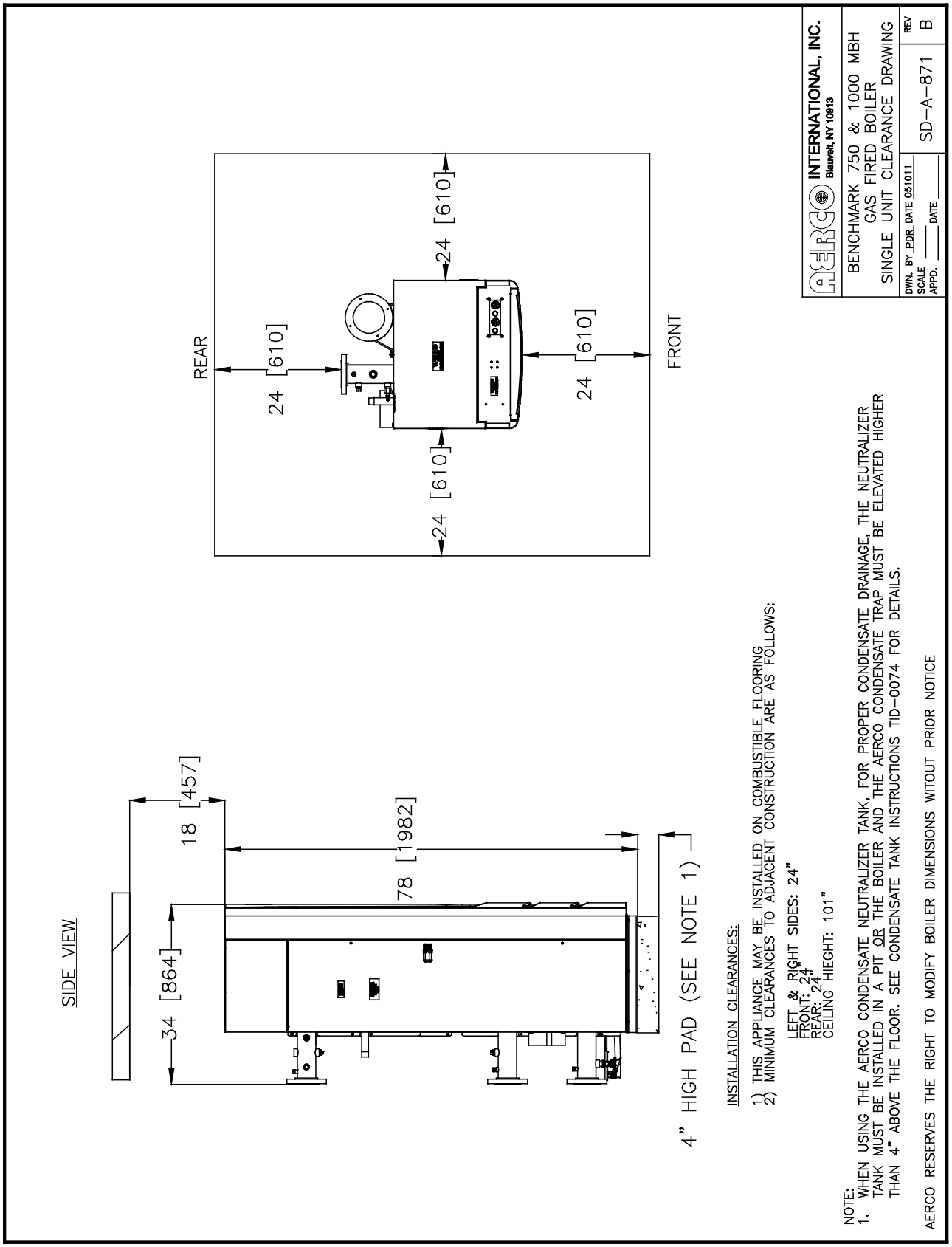

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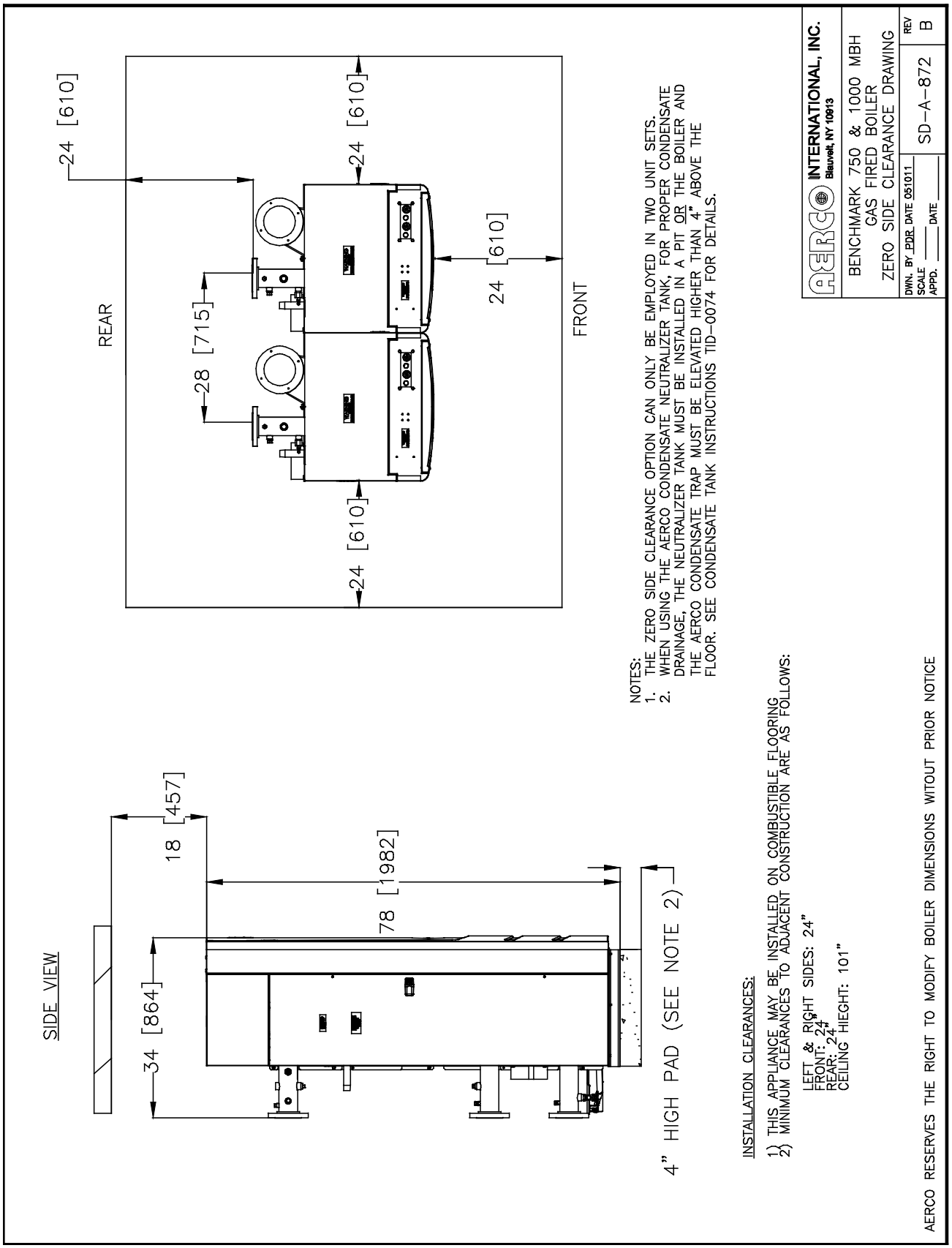

Drawing Number: SD-A-872 rev B

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APPENDIX F – PART LIST DRAWINGS

Benchmark 750 - 1000 Parts List

Item #	Qty	Part #	Description
EXHAUST MANIFOLD			
1	1	43086	MANIFOLD: EXHAUST
2	1	84045	SEAL: EXHAUST MANIFOLD
3	1	9-22	PIPE PLUG: 1/4" NPT: STEEL
GAS TRAIN ASSEMBLY			
4	1	22140-1	STD FM GAS TRAIN ASSY
	1	22140-2	DBB GAS TRAIN ASSY
	1	22140-3	PROPANE GAS TRAIN ASSY
5	1	99017	SNUBBER: PRESSURE: 1/4"
6	1	81155	GASKET: 1 1/4" PIPE FLANGE
7	1	61002-1	PRESSURE SWITCH: 2.6" W.C. FALL N.O.
9	1	61002-12	HIGH GAS PRESSURE SWITCH 4.7" W.C.
10	1	92077	1/4" NPT MXF BRASS BALL VALVE
BURNER, AIR/FUEL VALVE, HEAT EXCHANGER			
11	1	46026	BURNER: BMK 1.0
12	1	24367-1	BMK 1000 A/F Valve FRU kit
	1	24367-2	BMK 750 A/F Valve FRU kit
13	1	24277	STAGED IGNITION ASSY
14	1	81143	GASKET: BURNER
15	1	59171	REFLECTOR: SIGHT GLASS
16	1	59104	OBSERVATION PORT
17	1	28317	BMK 750 HEAT EXCHANGER
	1	28249	BMK 1000 HEAT EXCHANGER
HOSES & INSULATION			
18	1	97005-5	TUBE: FLEXIBLE GAS 18" (45.7 cm)
18a ❶	1	97005-6	TUBE: FLEXIBLE GAS 24" (61 cm)
19	1	80080	INSULATION: SHELL
BLOWER			
20	1	58061	BMK BLOWER REPLACEMENT KIT
22	1	81064	GASKET: BLOWER
23	1	88004	O-RING #2-244 BUNA-N
24	1	24356-1	FLAME DETECTOR KIT
25	1	61026	LEAN OXYGEN SENSOR
26		58023	IGNITER-INJECTOR REPLACEMENT KIT
27	1	59139	AIR FILTER: 6" X 4.5 (11.4 cm) LG
CONTROLS			
28	1	123966	SWITCH: OVER TEMP-AUTO RESET
29	1	123552	SWITCH: OVER TEMP-MANUAL RESET
30	1	60011-4	BLOWER PROOF SWITCH ASSY:

Item #	Qty	Part #	Description
CONTROLS (Continued)			
31	1	61002-5	BLOCKED INLET SWITCH -4.5 W.C.
32	1	65085	IGNITION TRANSFORMER
33	1	65119	POWER OUTLET: DIN MOUNT
34	2	69141	DIN RAIL MOUNT END STOP
35	1	64081	ECU
36	1	65011	TRANSFORMER 115V/24V 100VA
37	1	65109	12V POWER SUPLY
38❶	1	69145	RAIL: DIN: 8 1/2"(21.6 cm) LG
39	2	65120	TERMINAL BLOCK: DIN MOUNTED: BLK
40	2	65121	TERMINAL BLOCK: DIN MOUNTED: WHT
41	3	65122	TERMINAL GROUND BLOCK: DIN MOUNTED
42	2	65118	FUSE TERMINAL: DIN MOUNTED
43	1	69177	LIMIT CONTROL TEMP CONTROLLER
44	1	69005	ACTUATOR, SSOV w PRESSURE REG
45	1	24327	ASSEMBLY: POWER SUPPLY COVER
46	1	60019	DISCONNECT: FUSIBLE
47❶	2	124512	FUSE: 4 AMP
48	1	123449	SENSOR: TEMPERATURE
49	1	58132	THERMOWELL
50	1	33137	ELECTRICAL PANEL
51	1	181197	CONTROL BOX: C-MORE
52	1	69151	PCB ASSY
53	2	124326	RELAY: OMRON MY2DC24[S]
54	2	51006	CLIP: HOLD-DOWN
55 ❶	1	63097	I/O SENSOR/COMM HARNESS
56 ❶	1	63090	TEMP LIM CONT PWR HARNESS
57 ❶	1	124327	HARNESS: INTERLOCK HARNESS
58 ❶	1	63182	SHELL HARNESS
59 ❶	1	63147	HARNESS: WIRING: GAS TRAIN
60	1	65156	FLAME ROD SIGNAL AMPLIFIER
61	1	61030	OUTLET TEMP SENSOR
62	1	61024	AIR INLET TEMPERATURE SENSOR
63 ❶	1	65104	CABLE: H.V. IGNITION
64 ❶	1	63083	HARNESS: O2 SENSOR
65 ❶	1	63085	CONTROL HARNESS: BMK 1000 & 750
67	1	69038	ACCTUATOR, SSOVE w/o P.O.C. SWITCH
68	1	GP-122774	VALVE, VENT 3/4"
69	1	65162	24V POWER SUPLY (SEQUENCING ISOLATION VALVE)

❶ NOT SHOWN ON DRAWINGS BELOW

AERCO International, Inc. Blauvelt, NY 10913	**Benchmark 750-1000 Part List**	03/07/2014
	28321-1 rev D, 28253-1 rev F (reference PL-A-173)	Sheet 1 of 6

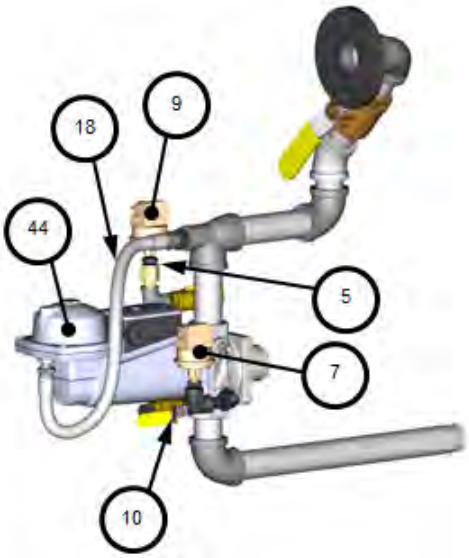
Benchmark 750 - 1000 Parts List

Item #	Qty	Part #	Description	Item #	Qty	Part #	Description
SHEET METAL/PANEL ASSEMBLY				**OTHER ACCESSORIES / PARTS**			
70	1	37110	PANEL: LEFT	85	1	SEE TABLE A	3/4 " CLOSE NIPPLE
71	1	37111	PANEL: RIGHT	86 ❶	1	SEE TABLE A	PRESS./TEMP GAUGE
72	1	37114	COVER ASSY	87 ❶	1	SEE TABLE A	PRESSURE RELIEF VALVE KIT
73	1	25068	FRONT FRAME ASSY.	88 ❶	1	92006-5	VALVE: BALL 1" NPT
74	1	25078	FRONT PANEL	89	1	122843	LOW WATER CUTOFF
75	1	72068	LABEL: DOME	90	1	123863	VALVE: BALL 1/8" NPT
76	2	59179	HANDLE: CONCEALED PULL	91	1	92094	VALVE: 3/4 BOILER DRAIN MNPT x GHT
77	2	59133	LATCH: COMPRESSION	92 ❶	1	59043	CONDENSATE FLOAT
78	1	50010	LATCH: DRAW	93 ❶	1	24441	COND. TRAP ASSEMBLY
79	1	50011	KEEPER: DRAW LATCH	94	1	59178	VENT: AIR 1/8 NPT
80	1	74023	LOGO LABEL, BMK 1000	95	1	124008	NIPPLE: 1/8 NPT X 3.0" (7.6 cm) LG
		74026	LOGO LABEL, BMK 750	100 ❶	1	92084-6	MOTORIZED SEQUENCING ISOLATION VALVE (OPTIONAL)
81	4	123621	BOLT, HEX HD 1/4-20 X .50 (1.27cm) LG.	101❶	1	63150	HARNESS: FLAME ROD
82	1	39125	ADAPTER: AIR INLET 6" PVC				

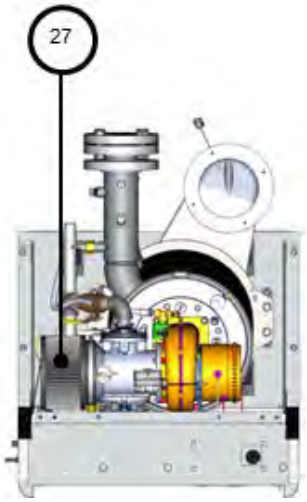
NOTES:
❶ NOT SHOWN ON DRAWINGS BELOW

TABLE A

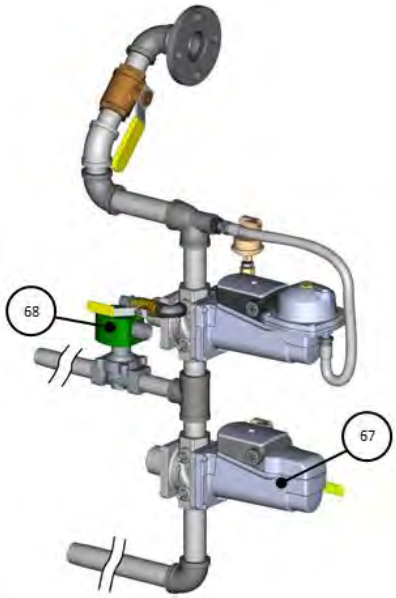
Item 85	Item 86	Item 87	Available in Kit Number	Description
9-234	123675-2	92015-1	58037-1	30 PSI (207 kPa) Kit (Apollo)
NOT REQUIRED	123675-2	92014	58037-2	50 PSI (345 kPa) Kit (Conbraco)
9-234	123675-3	92015-20	58037-3	75 PSI (517 kPa) Kit (Apollo)
9-234	123675-3	92015-15	58037-4	100 PSI (689 kPa) Kit (Watts)
9-234	123675-4	123659	58037-5	150 PSI (1034 kPa) Kit (Watts)
9-234	123675-3	92015-13	58037-6	60 PSI (414 kPa) Kit (Watts)
9-234	123675-3	92015-16	58037-7	125 PSI (862 kPa) Kit (Watts)
9-234	123675-4	92015-23	58037-8	160 PSI (1103 kPa) Kit (Kunkle)



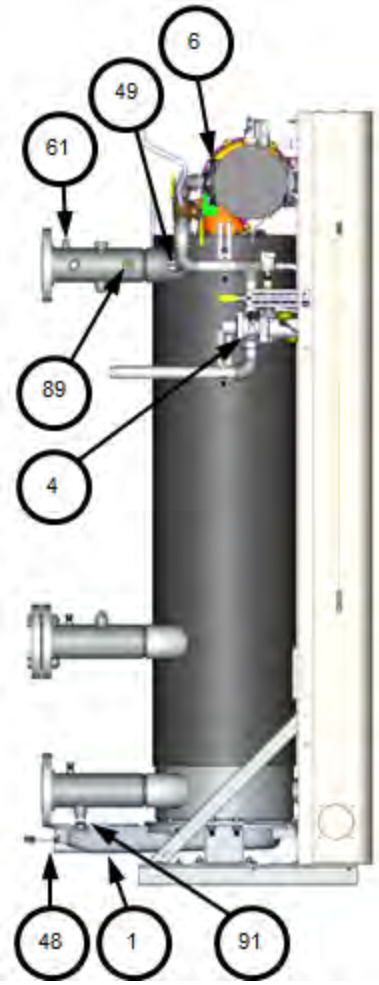
ITEM 4 – FM GAS TRAIN 22140-1

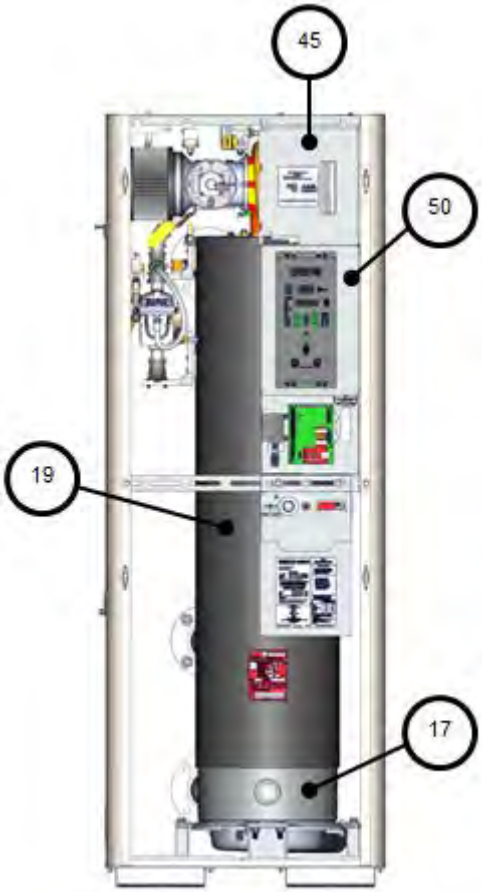


TOP VIEW



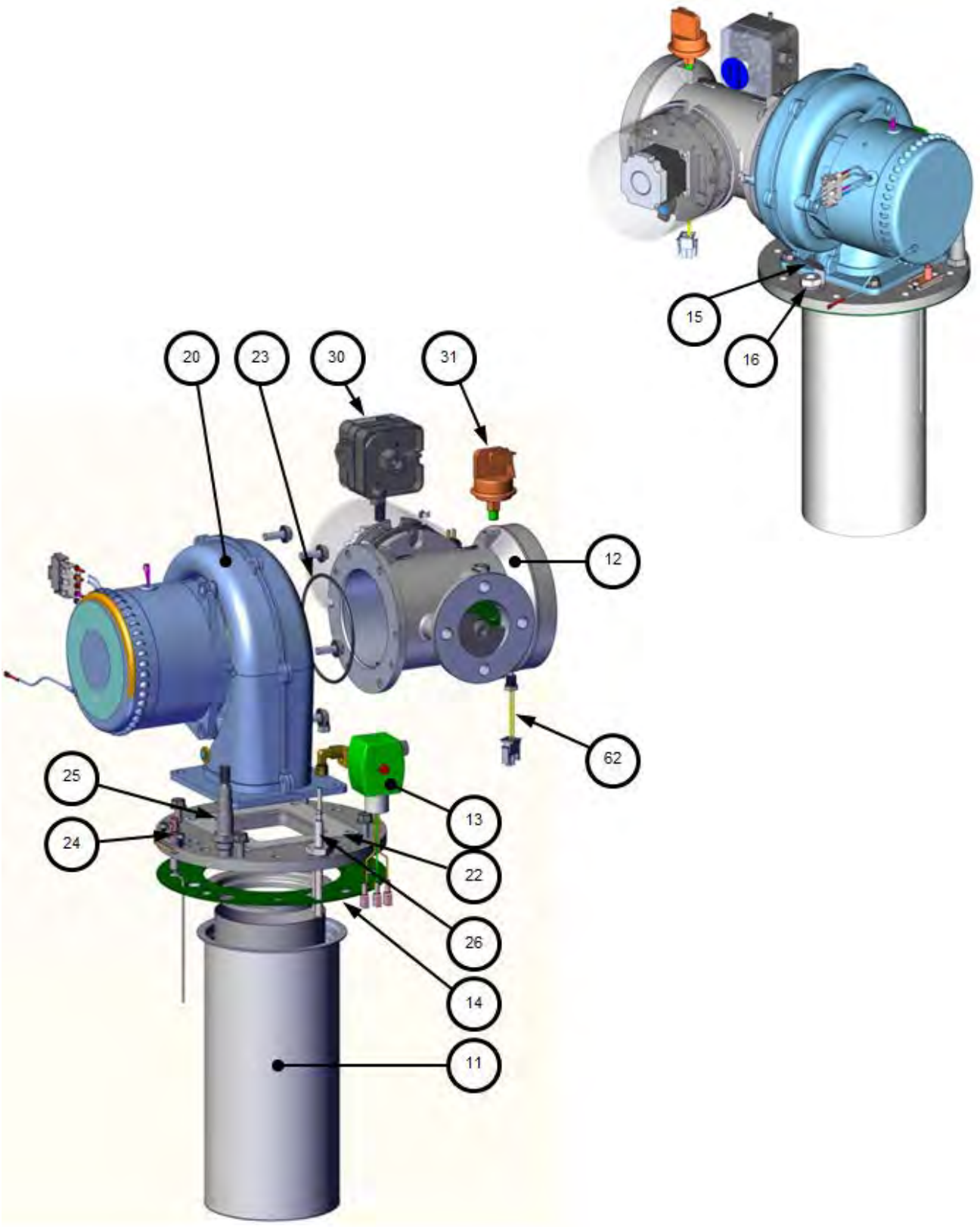
ITEM 4 – DBB GAS TRAIN 22140-2



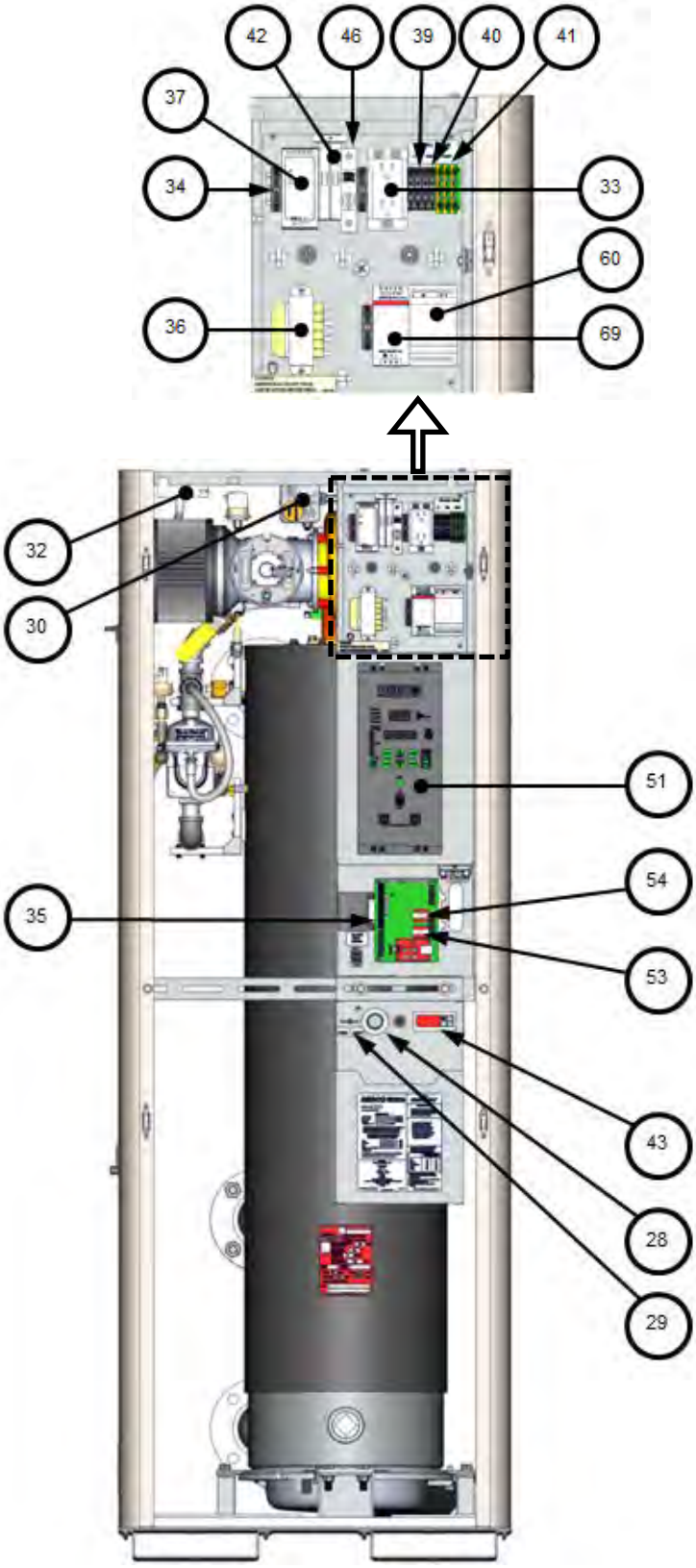


FRONT VIEW

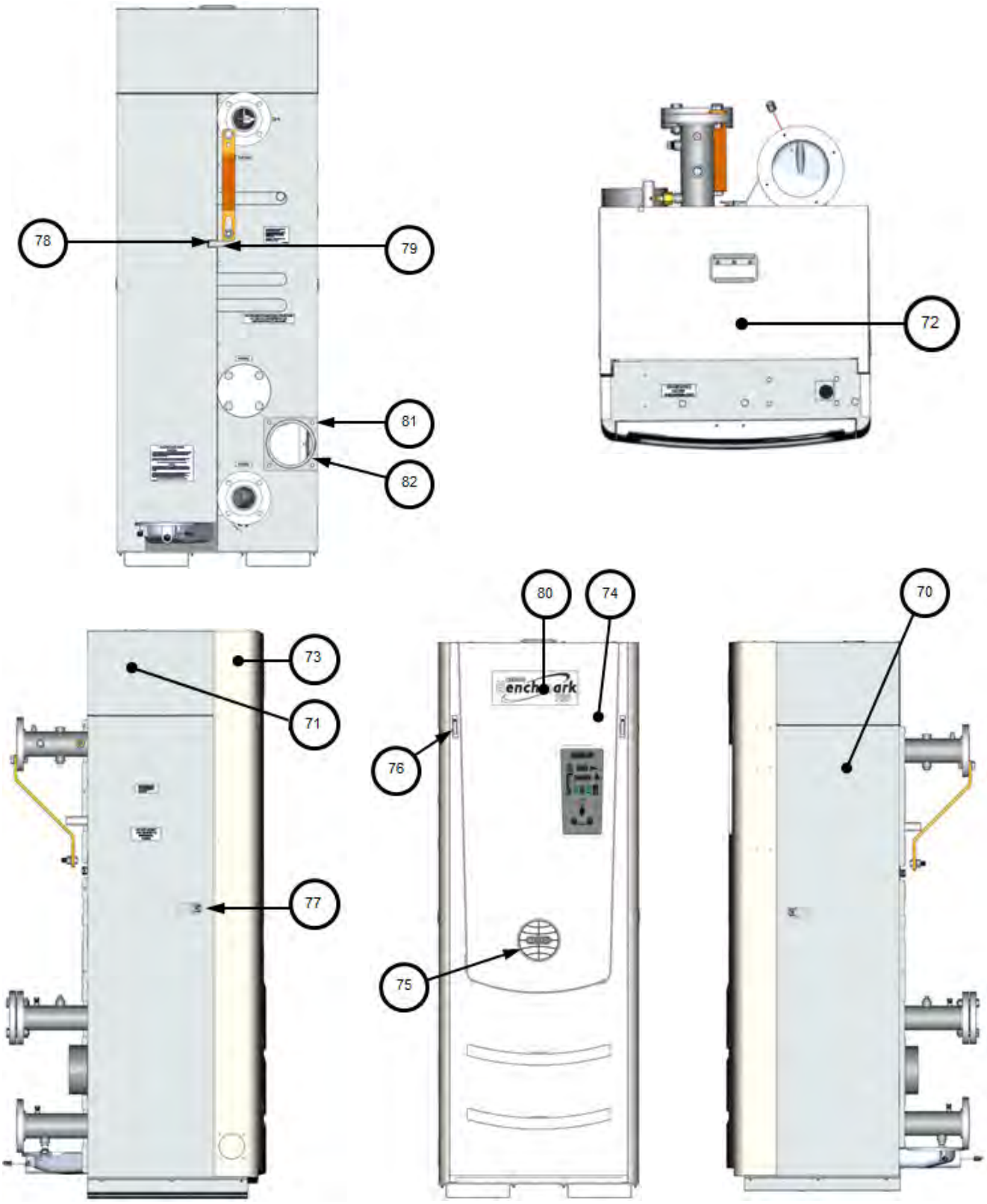
AERCO International, Inc. Blauvelt, NY 10913	**Benchmark 750-1000 Part List**	03/07/2014
	28321-1 rev D, 28253-1 rev F (reference PL-A-173)	Sheet 3 of 6



AERCO International, Inc. Blauvelt, NY 10913	**Benchmark 750-1000 Part List**	03/07/2014
	28321-1 rev D, 28253-1 rev F (reference PL-A-173)	Sheet 4 of 6



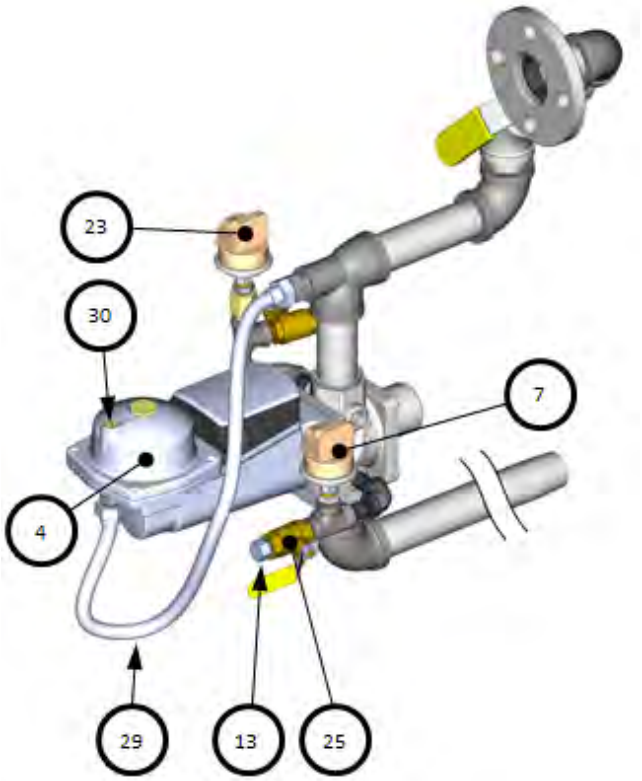
AERCO International, Inc. Blauvelt, NY 10913	**Benchmark 750-1000 Part List**	03/07/2014
	28321-1 rev D, 28253-1 rev F (reference PL-A-173)	Sheet 5 of 6

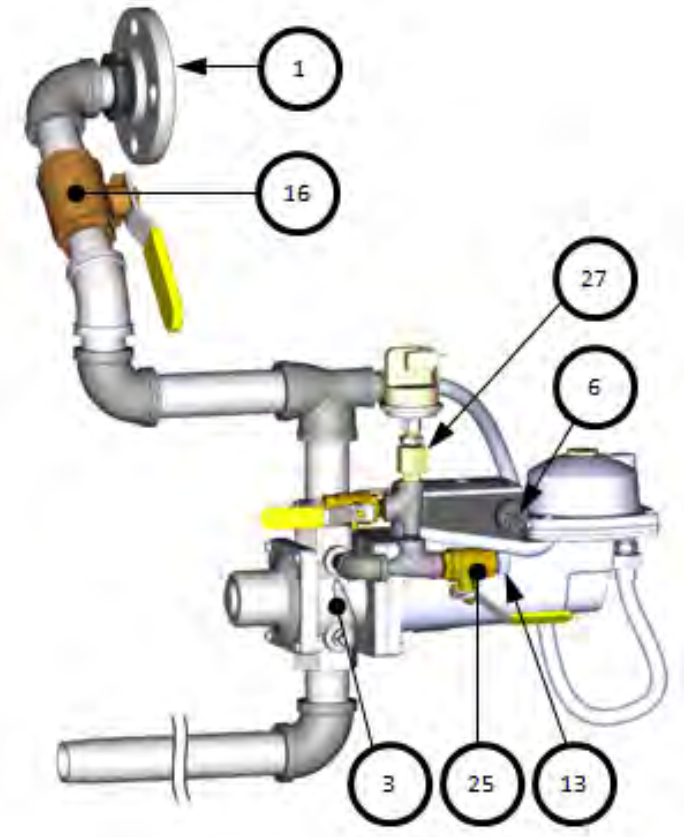


AERCO International, Inc. Blauvelt, NY 10913	**Benchmark 750-1000 Part List**	03/07/2014
	28321-1 rev D, 28253-1 rev F (reference PL-A-173)	Sheet 6 of 6

Benchmark 750-1000 FM Gas Train – 22140-1 rev F

Item	Qty	Part #	Description	Item	Qty	Part #	Description
1	1	95026	1.25"NPT 125#: THREADED FLANGE	16	1	92006-5	VALVE: BALL 1" NPT
3	1	92036	VALVE: SSOV 1" NPT	23	1	61002-12	HIGH GAS PRESSURE SWITCH 4.7" W.C.
4	1	69005	ACTUATOR: SSOV W/ REGULATOR	25	3	92077	1/4" NPT MXF BRASS BALL VALVE
6	2	12951-2	BUSHING: CONTROL BOX	27	1	99017	SNUBBER: PRESSURE: 1/4"
7	1	61002-1	PRESSURE SWITCH: 2.6" W.C. FALL N.O.	29	1	97087-20	TUBE: FLEXIBLE GAS 20" (50.8 cm) LG
13	2	9-22	PIPE PLUG: 1/4" NPT: STEEL	30	1	99015	DAMPING ORIFICE: SSOV

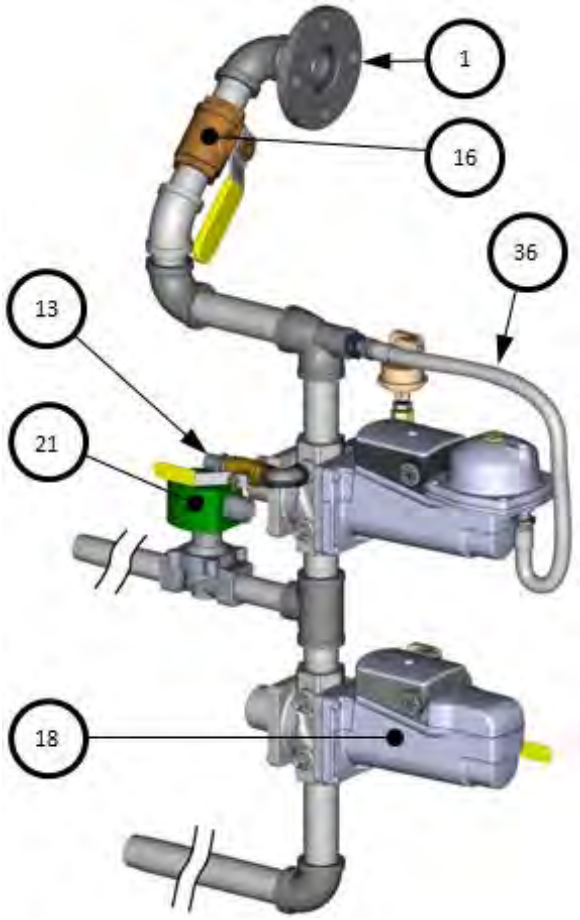


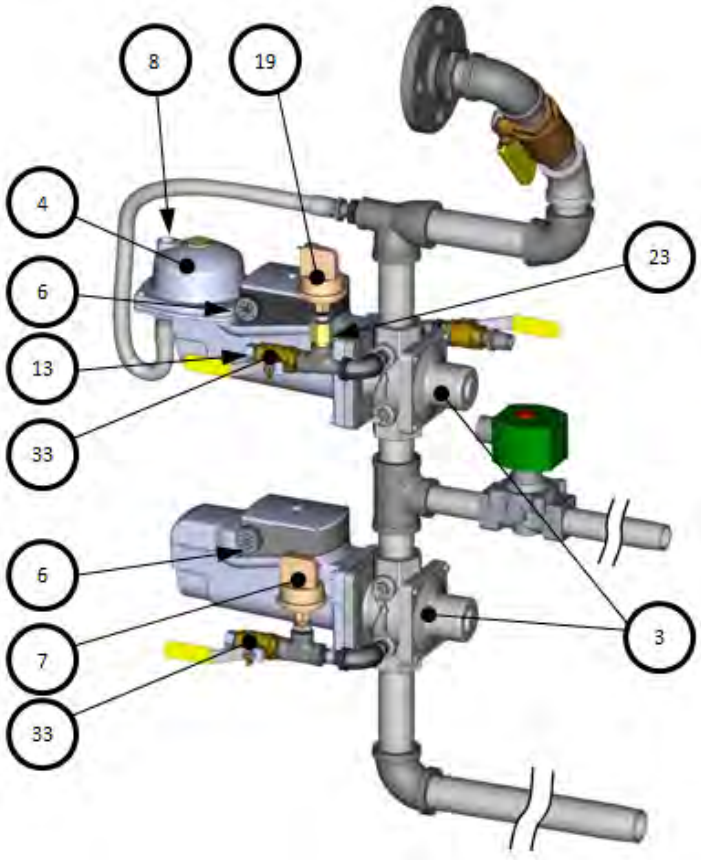


AERCO International, Inc. Blauvelt, NY 10913	**Benchmark 750-1000 FM Gas Train**	09/15/2015
	22140-1 rev F	Sheet 1 of 1

Benchmark 750-1000 DBB Gas Train – 22140-2 rev E

Item	Qty	Part #	Description	Item	Qty	Part #	Description
1	1	95026	1.25"NPT 125#: THREADED FLANGE	16	1	92006-5	VALVE: BALL 1" NPT
3	2	92036	VALVE: SSOV 1" NPT	18	1	69038	ACTUATOR: SSOV W/O P.O.C. SWITCH
4	1	69005	ACTUATOR: SSOV W/ REGULATOR	19	1	61002-12	HIGH GAS PRESSURE SWITCH 4.7" W.C.
6	4	12951-2	BUSHING: CONTROL BOX	21	1	122774	VALVE: VENT 3/4" NPT
7	1	61002-1	PRESSURE SWITCH: 2.6" W.C. FALL N.O.	23	1	99017	SNUBBER: PRESSURE: 1/4"
8	1	99015	DAMPING ORIFICE: SSOV	33	3	92077	1/4" NPT MXF BRASS BALL VALVE
13	2	9-22	PIPE PLUG: 1/4" NPT: STEEL	36	1	97067-20	TUBE: FLEXIBLE GAS 20" " (50.8 cm) LG

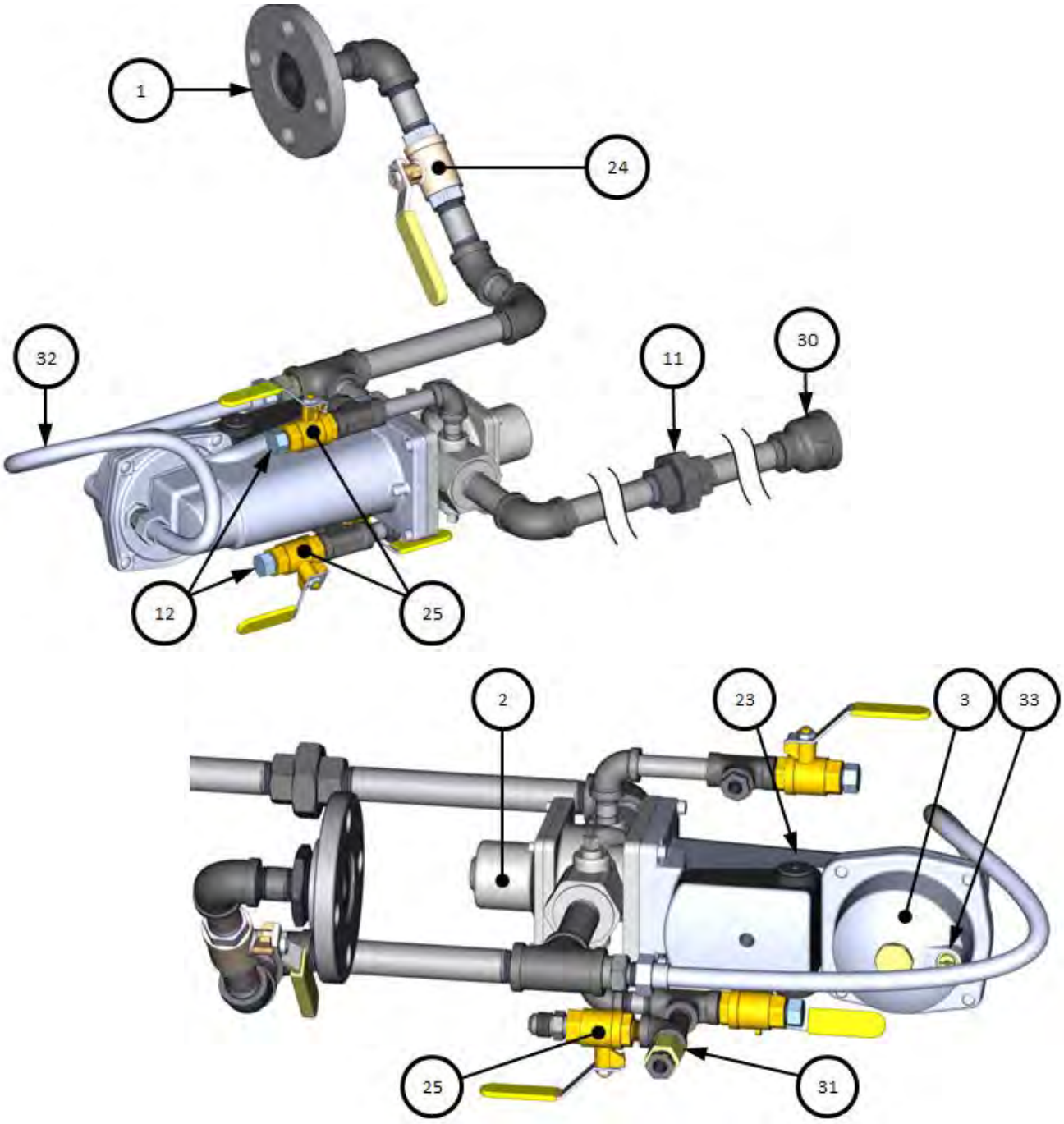




AERCO International, Inc. Blauvelt, NY 10913	**Benchmark 750-1000 DBB Gas Train**	10/15/2015
	22140-2 rev E	Sheet 1 of 1

BMK 750-1000 PROPANE Gas Train – P/N 22140-3 rev G

Item	Qty	Part #	Description	Item	Qty	Part #	Description
1	1	95026	THREADED FLANGE: 1.25" NPT 125#	24	1	92006-3	VALVE: FULL PORT BALL 1/2" NPT BRASS
2	1	92103	VALVE: SSOV 1/2" NPT	25	3	92077	1/4" NPT MXF BRASS BALL VALVE (OPEN)
3	1	69005	ACTUATOR: SSOV W/ REGULATOR	31	1	99017	SNUBBER: PRESSURE: 1/4"
11	1	93420	UNION ½" NPT FEMALE BLACK MI	32	1	97087-20	TUBE, FLEXIBLE GAS 20"
12	2	9-22	PIPE PLUG: 1/4" NPT: STEEL	33	1	99015	DAMPING ORIFICE: SSOV
23	2	12951-2	BUSHING: CONTROL BOX				

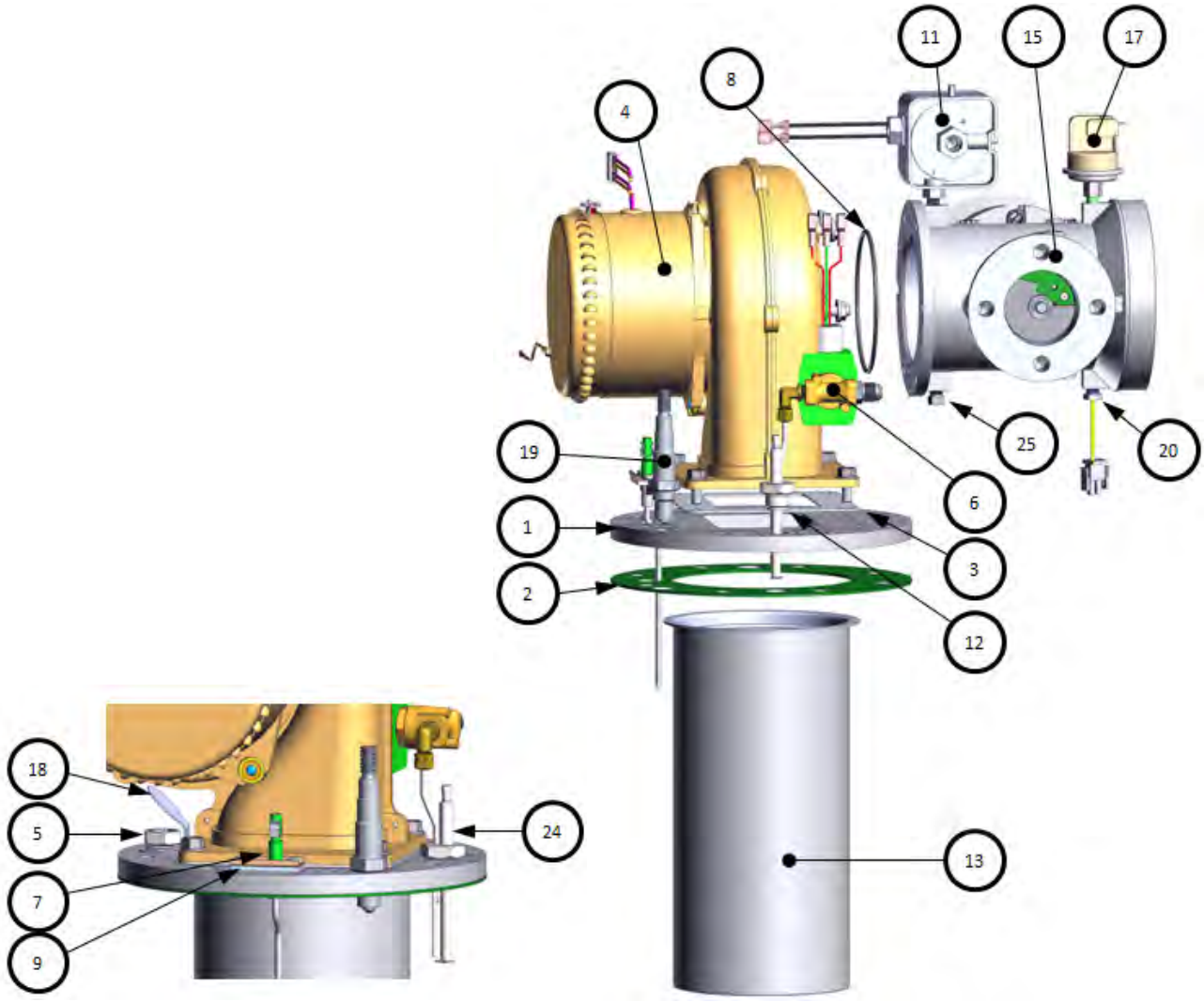


AERCO International, Inc. Blauvelt, NY 10913	**Benchmark 750-1000 Gas Train – Propane**	10/28/2015
	22140-3 rev G	Sheet 1 of 1

Benchmark 750-1000 Burner, Blower, Air/Fuel Valve – 24276

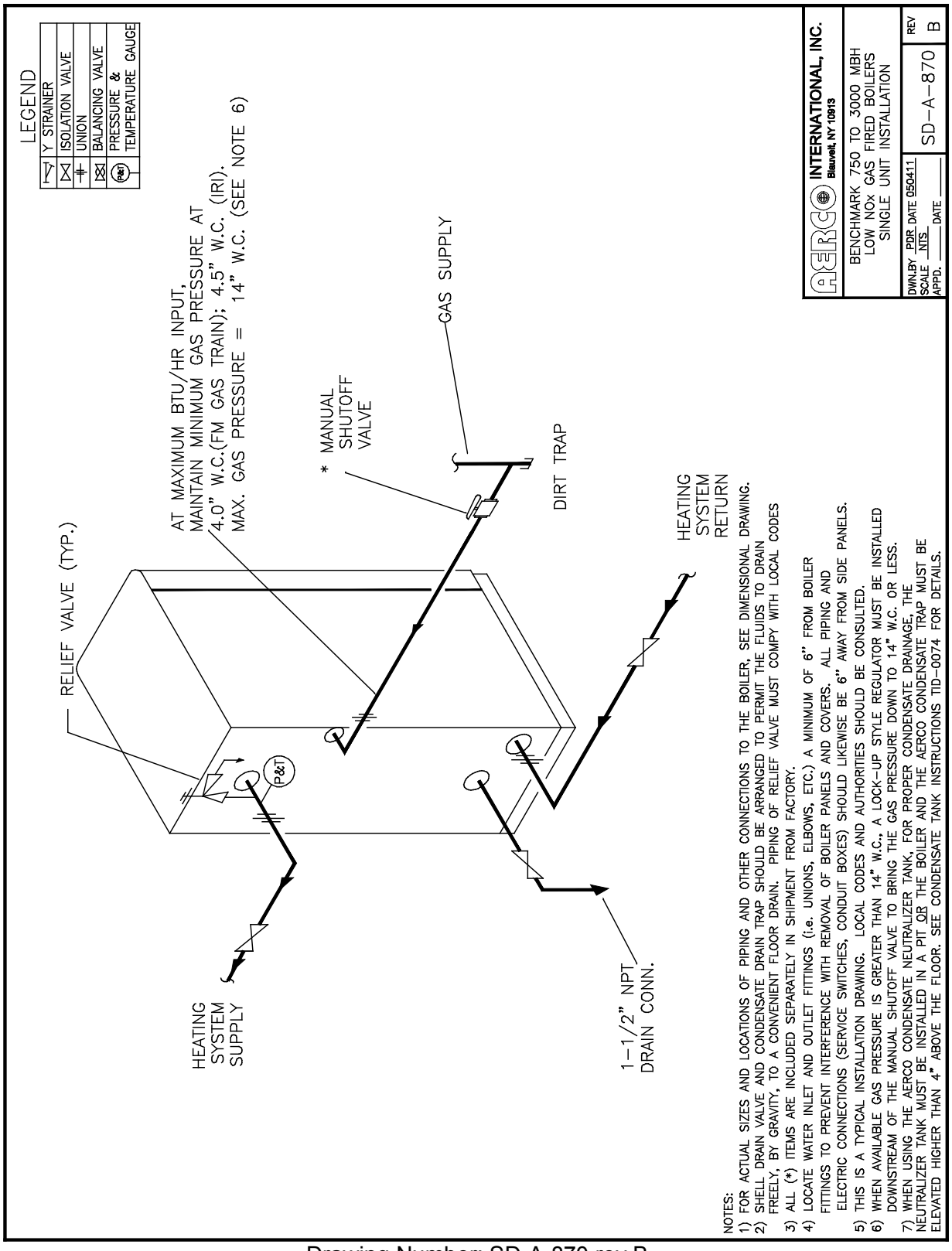
Item	Qty	Part #	Description	Item	Qty	Part #	Description
1	1	42140	PLATE: BURNER	12	3	53033	WASHER: CLOCKING
2	1	81143	GASKET: BURNER	13	1	46026	BURNER: BMK 1.0
3	1	81064	GASKET: BLOWER	15	1	See Table	A/F VALVE ASSY
4	1	24111	BLOWER: AMETEK 8.9"	17	1	61002-5	BLOCKED INLET SWITCH -8.0" W.C.
5	1	59104	OBSERVATION PORT	18	1	59171	REFLECTOR: SIGHT GLASS
6	1	24277	STAGED IGNITION ASSY	19	1	61026	O2 SENSOR
7	1	66034	FLAME ROD	20	1	61024	AIR INLET TEMPERATURE SENSOR
8	1	88004	O-RING #2-244 BUNA-N	24	1	66026	IGNITOR-INJECTOR
9	1	81048	GASKET: FLAME ROD LOW NOX	25	1	9-21	PLUG: HEX HD 1/8 NPT
11	1	60011-4	SWITCH ASSY: BLOWER PROOF				

Part #	Qty	Item 15	Description
24276	1	24298	A/F VALVE ASSY BMK 1000
24276-1	1	24298-1	A/F VALVE ASSY BMK 750
24276-2	1	24298-2	A/F VALVE ASSY BMK 750/1000 PRROPANE



AERCO International, Inc. Blauvelt, NY 10913	**Benchmark 750-1000 Burner Assembly**	10/28/2015
	24276 rev J	Sheet 1 of 1

APPENDIX G – PIPING DRAWINGS



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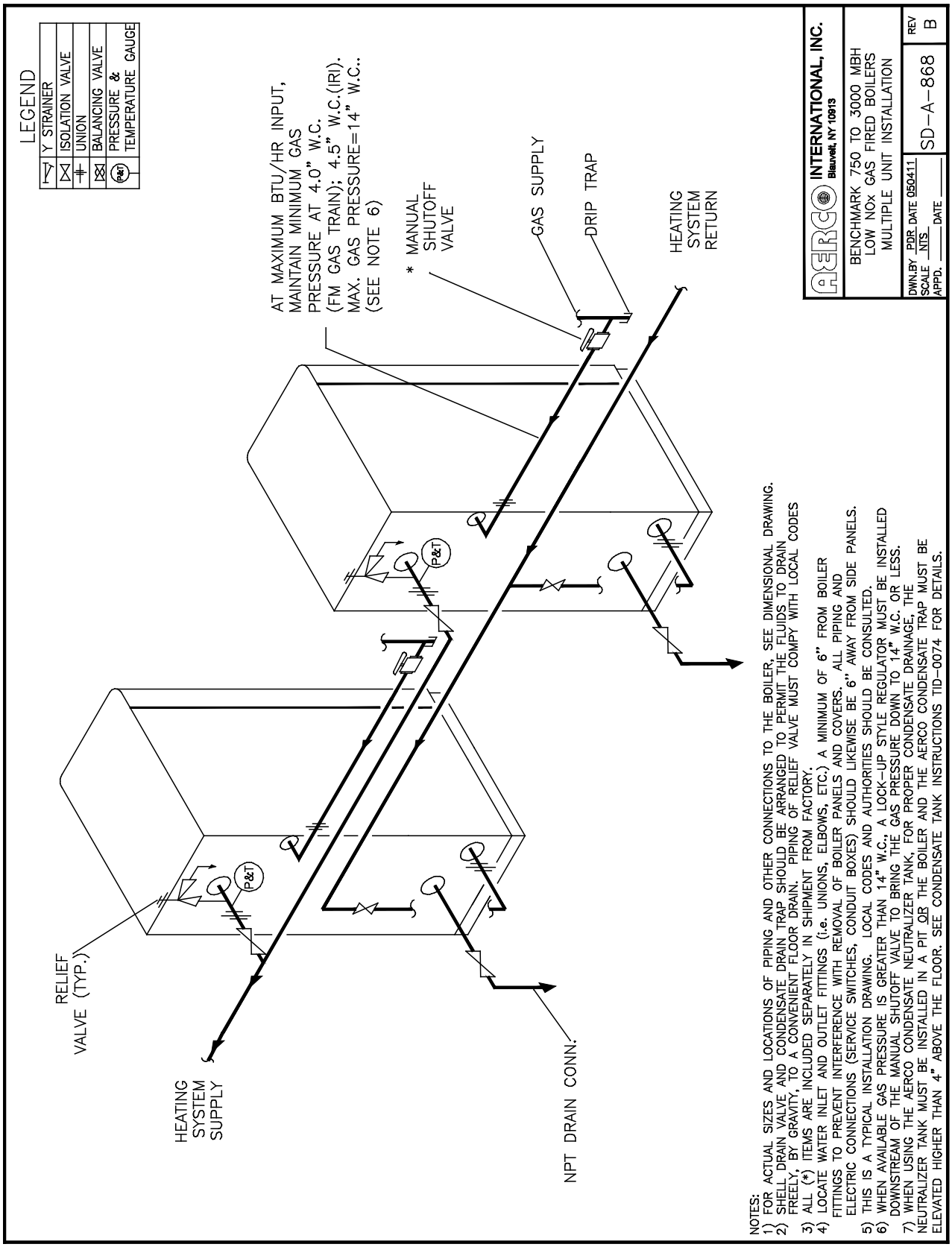

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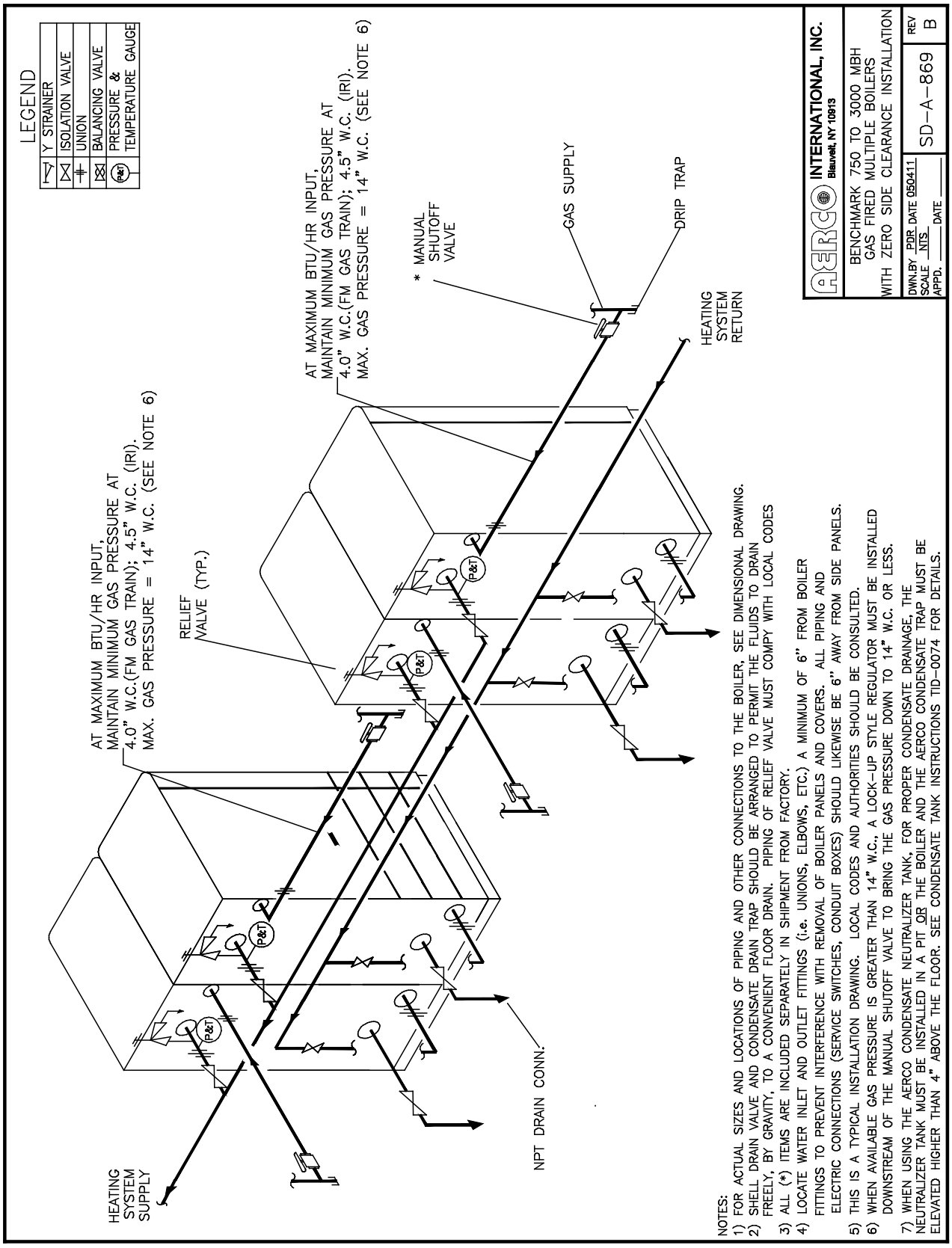

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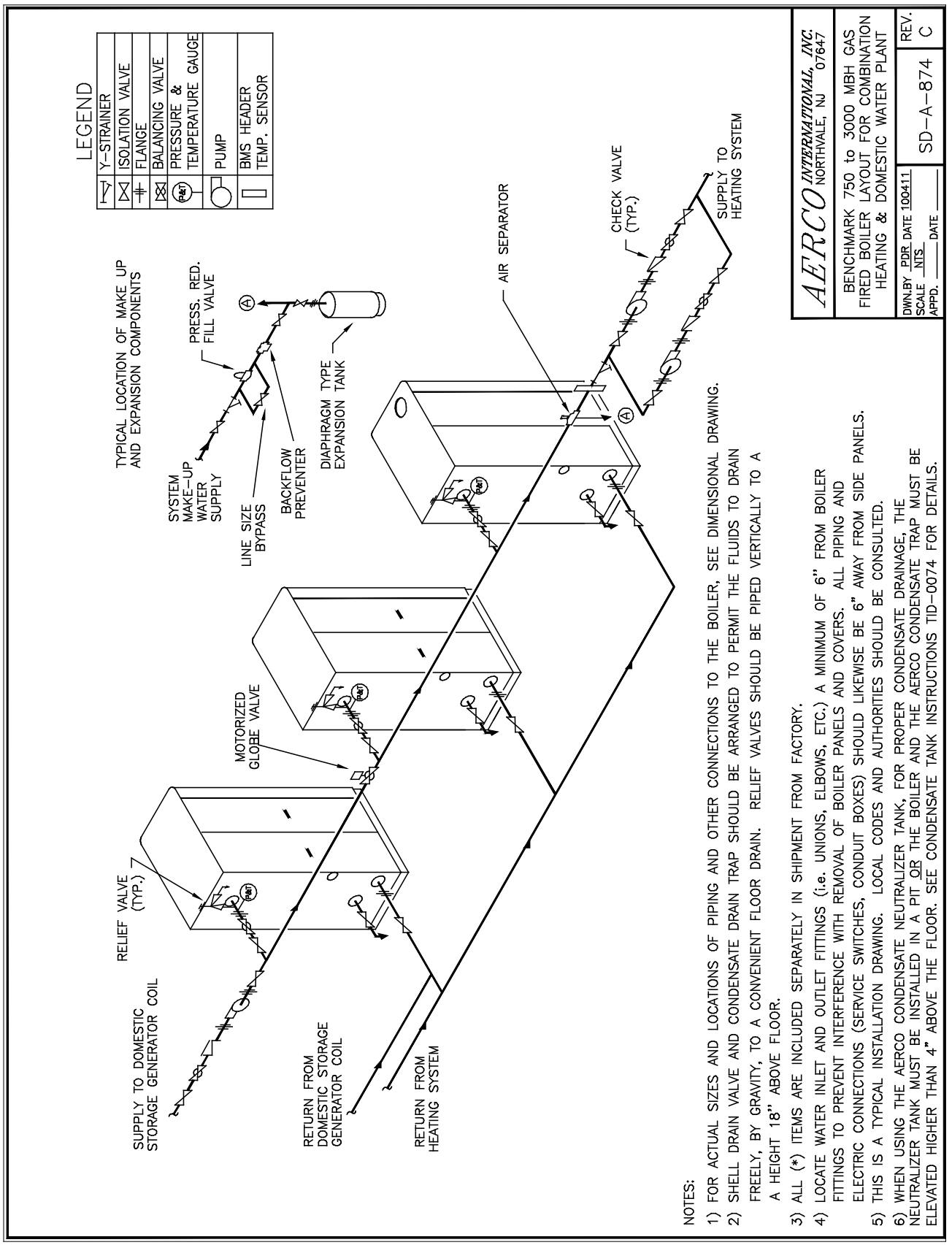
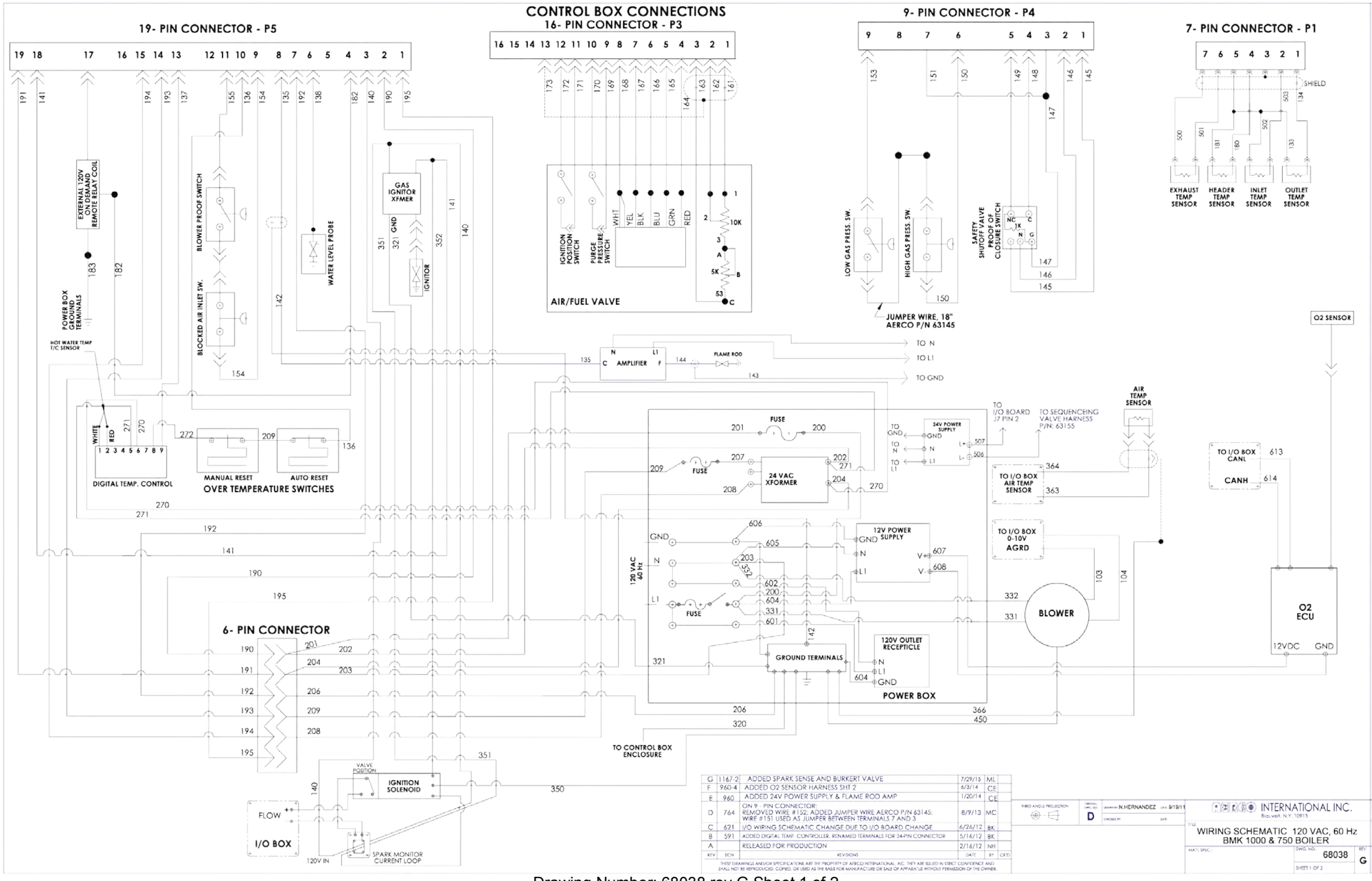


Drawing Number: SD-A-874 rev C

APPENDIX H – C-MORE WIRING DIAGRAMS



Drawing Number: 68038 rev G Sheet 1 of 2

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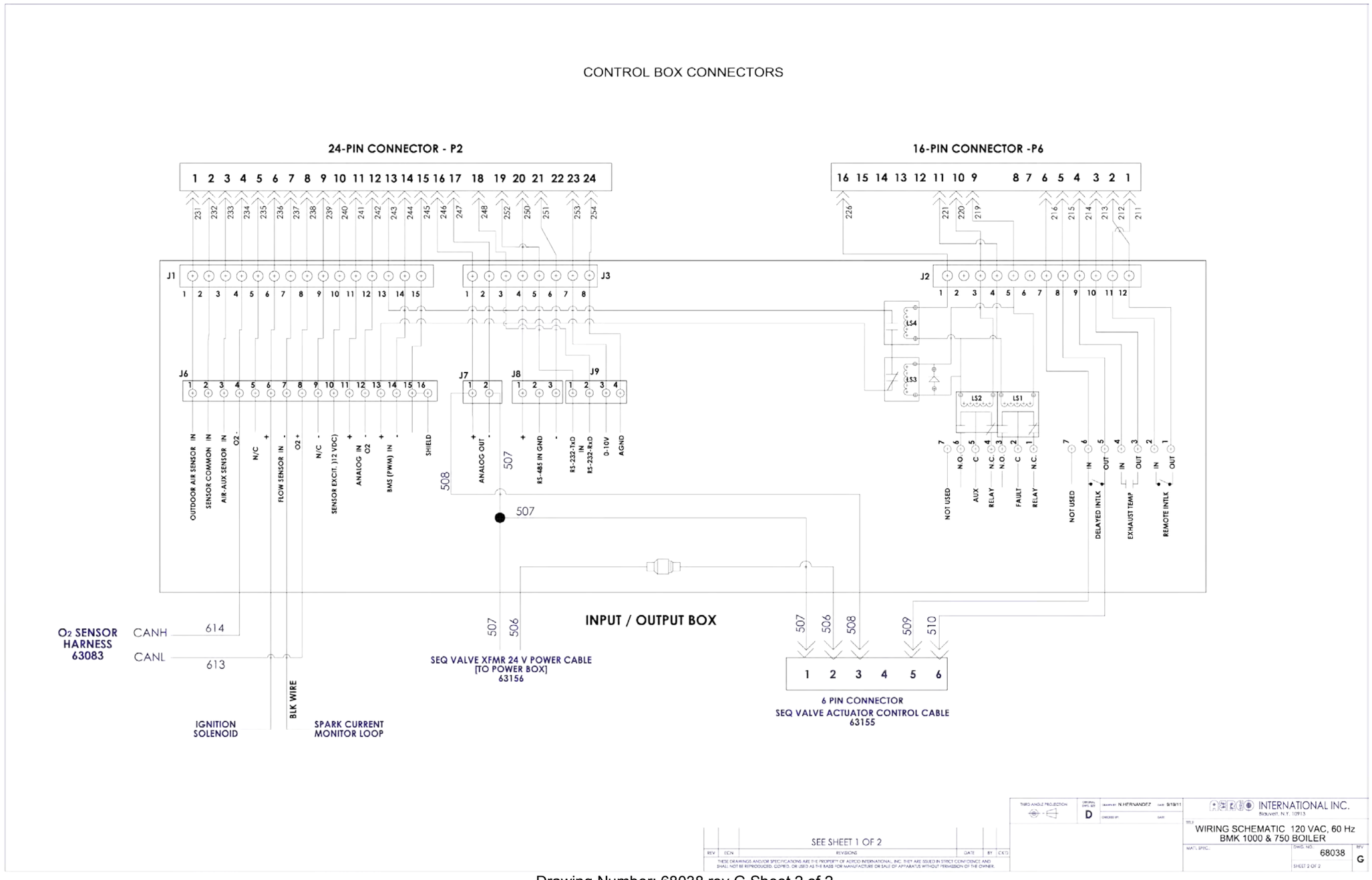

Drawing Number: 68038 rev G Sheet 2 of 2

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APPENDIX I – RECOMMENDED PERIODIC TESTING

WARNING

Periodic testing of all 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 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.

Table I1: Recommended Periodic Testing

Item	Frequency	Accomplished By	Remarks
Refer to indicated sections of this manual for detailed procedures			
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 section 7.4 and Chapter 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 3.11)
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 *Operating* 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

Item	Frequency	Accomplished By	Remarks
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 7.7
Condensate Trap	Semi-Annually	Operator	See section 7.8
Oxygen (O_2) Level	Monthly	Operator	Verify oxygen level is between 3% and 8% during boiler operation

APPENDIX J – C-MORE CONTROL PANEL VIEWS

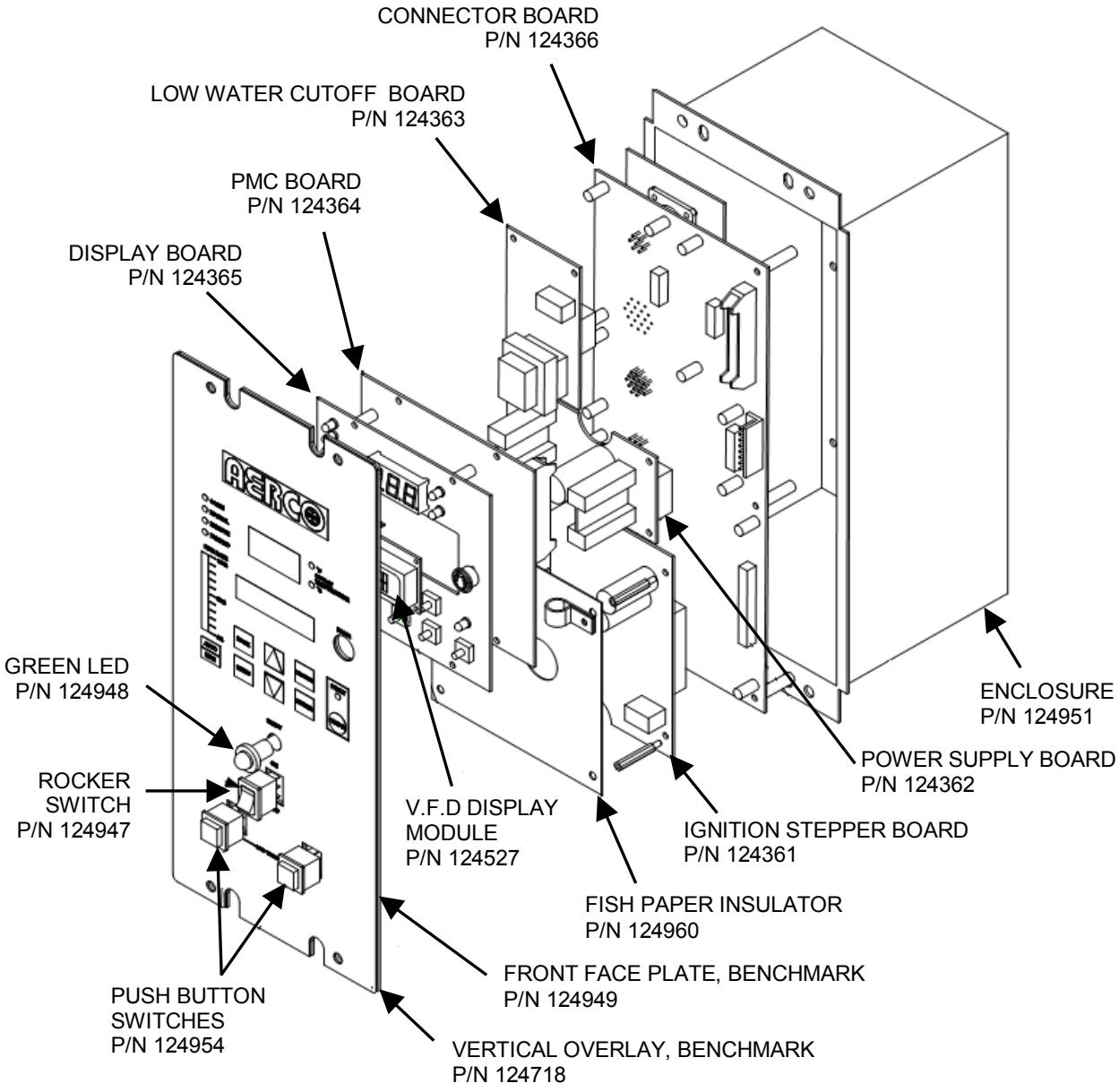

Figure J-1 – Benchmark Series Control Panel - Exploded View

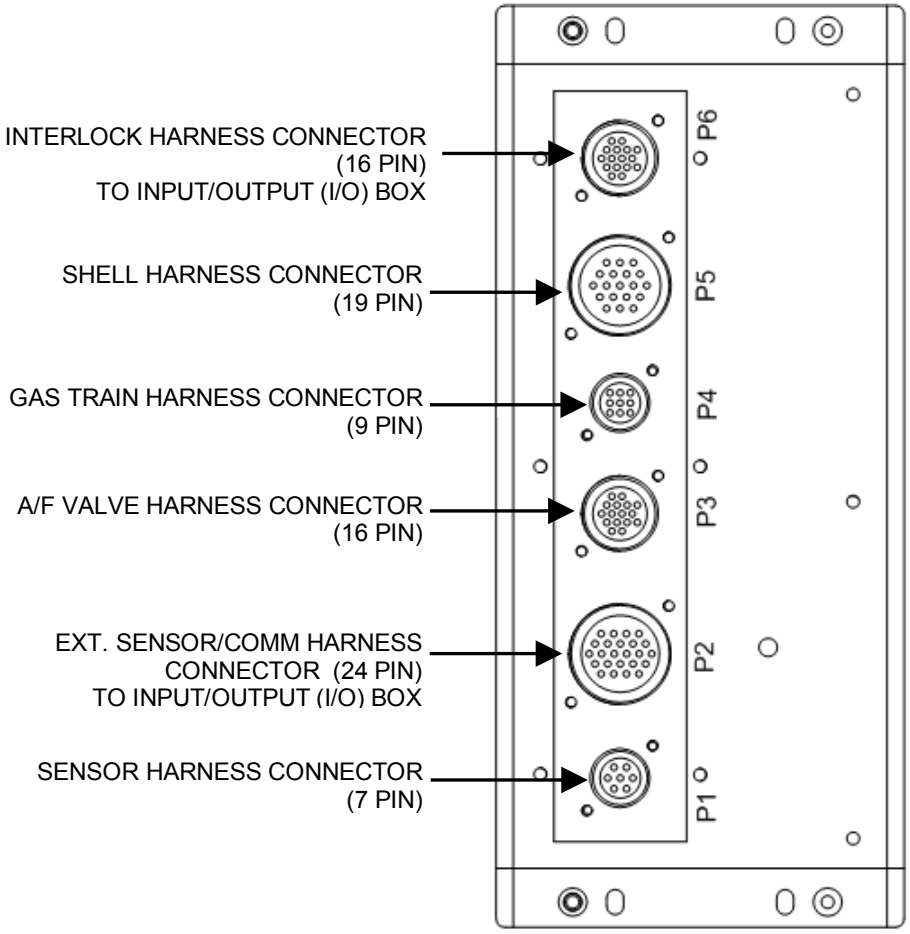

Figure J-2 – Benchmark Series Control Panel - Rear View

APPENDIX K: RECOMMENDED SPARES

NOTE

Refer to the Parts List Illustrations in Appendix F 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/Single-Phase Blower	58061
SSOV Actuator/Regulator Combo - Used on: • ALL FM gas train models • **Downstream SSOV** of DBB gas train models	64048
SSOV Actuator Without **Proof of Closure** switch - Used on: • **Upstream SSOV** of DBB gas train models	69038
Temperature switch - Manual Reset	123552
Staged Ignition Assembly	24277

Table K-2: Spare Parts Recommended for Maintenance

DESCRIPTION	PART NUMBER
Annual Maintenance Kit	58025-01
24-month Waterside/Fireside Inspection Kit	58025-08

Table K-3: Optional Spare Parts

DESCRIPTION	PART NUMBER
C-More Control Box	181197
Burner	46023
Lean Oxygen Sensor	61026
Temperature switch - Auto Reset (See Note)	123966
Limit Control – Temperature Digital Controller	69177

NOTE

If the unit is installed in the state of Kentucky, contact your local AERCO Sales Representative for a Temperature switch rated for 200ºF (93.3ºC).

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APPENDIX L – ULTRA-LOW NOx CALIBRATION

L-1. ULTRA-LOW NOx COMBUSTION CALIBRATION

The procedures provided in this Appendix are used to combustion calibrate the boiler to produce ultra-low NOx emissions of less than 9 ppm when running on natural gas.

NOTE

The instructions below do not apply to units running Propane gas.

If the ultra-low NOx requirement was specified on the Sales Order, the Benchmark Boiler was combustion calibrated at the factory prior to shipping. However, 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. Factory Test Data sheets are shipped with each unit. These sheets must be filled out and returned to AERCO for proper Warranty Validation.

Prior to performing the procedure in this Appendix, the boiler must be set up as described in Chapter 4, section 4.1 through the **low NOx** combustion calibration in section 4.3. Once that is complete, perform the following steps to combustion calibrate the boiler to the **ultra-low NOx** requirement of less than 9 ppm.

IT IS IMPORTANT TO PERFORM THE FOLLOWING PROCEDURE AS OUTLINED BELOW. THIS WILL KEEP READJUSTMENTS TO A MINIMUM AND PROVIDE OPTIMUM PERFORMANCE.

Ultra-Low NOx 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(s) 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 the range of **2.0 ± 0.4" W.C.** If gas pressure adjustment is required, remove the brass hex nut on the SSOV actuator to access the gas pressure adjustment screw (Figure L-1). Make gas pressure adjustments using a flat-tip screwdriver to obtain a gas pressure within the range of **2.0 ± 0.4" W.C.**

Ultra-Low NOx Natural Gas Combustion Calibration – *Continued*

TYPICAL SSOV ACTUATOR WITH REGULATOR

Figure L-1. Gas Pressure Adjustment Screw Location

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 2.0 ± 0.4" W.C.** 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_2 sensor value displayed in the *Operating* menu of the C-More Control Panel. If the values differ by more than ±0.5%, have your combustion analyzer calibration checked as soon as possible. If the readings differ by more than ±1.5%, use the on-board O_2 sensor to calibrate the unit. Have your combustion analyzer serviced.
14. Compare the measured oxygen level to the oxygen range shown below. Also, ensure that the nitrogen oxide (NOx) and carbon monoxide (CO) readings do not exceed the values shown.

Ultra-Low NOx Combustion Calibration Readings

Valve Position	Oxygen (O_2) %	Nitrogen Oxide (NOx)	Carbon Monoxide (CO)
100%	5% - 7%	<9 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 L-1). 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_2, NOx and CO readings on the Combustion Calibration Data Sheets provided with the unit.

Ultra-Low NOx Natural Gas Combustion Calibration – *Continued*

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 80%, 60%, 45%, 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 to 37.8°C). If NOx readings exceed the target value of 9 ppm, increase the O_2 level up to 1% higher than the listed calibration range. Record the increased O_2 value on the Combustion Calibration sheet.

17. Lower the valve position to 80% using the ▼arrow key.
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 ▲ arrow key until ***SET Valve Position*** appears on the display.
21. Press the **CHANGE** key. ***SET Valve Position*** will begin to flash.
22. Press the ▲ arrow key until ***SET Valve Position*** reads ***80%***. Press the **ENTER** key.
23. Next, press the down (▼) arrow key until ***CAL Voltage 80%*** is displayed.
24. Press the **CHANGE** key and observe that ***CAL Voltage 80%*** is flashing.
25. The oxygen level at the 80% 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:

Ultra-Low NOx Combustion Calibration Readings

Valve Position	Oxygen (O_2) %	Nitrogen Oxide (NOx)	Carbon Monoxide (CO)
80%	5% - 7%	<9 ppm	<100 ppm

26. 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.
27. Once the oxygen level is within the specified range at 80%, press the **ENTER** key to store the selected blower output voltage for the 80% valve position. Record all readings on the Combustion Calibration Sheets provided.
28. Repeat steps 20 through 27 for valve positions of 60%, 45%, 30% and 18%* (see *NOTE below). The oxygen (O_2), nitrogen oxide (NOx) and carbon monoxide (CO) should remain within the same limits for all valve positions as shown in the following table.

*NOTE

Set the Valve Position at 18% but make adjustments to the Combustion Calibration value designated as 16%.

Ultra-Low NOx Natural Gas Combustion Calibration – *Continued*

NOTE

If NOx readings exceed the target values shown (<9 ppm), increase the O_2 level up to 1% higher than the listed calibration range shown in the table. Record the increased O_2 value on the Combustion Calibration sheet.

Ultra-Low NOx Combustion Calibration Readings

Valve Position	Oxygen (O_2) %	Nitrogen Oxide (NOx)	Carbon Monoxide (CO)
60%	5% - 7%	<9 ppm	<100 ppm
45%	5% - 7%	<9 ppm	<100 ppm
30%	5% - 7%	<9 ppm	<100 ppm
18%	5% - 7%	<9 ppm	<100 ppm

29. 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 Appendix F). Rotate the screw 1/2 turn clockwise (CW) to add fuel and reduce the O_2 to the specified level. Recalibration MUST be performed again from 60% down to 18% after making a change to the idle screw (TAC valve).
30. **This completes the ultra-low NOx Natural Gas combustion calibration procedures.**

L-2. REASSEMBLY

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

Reassembly

1. Set the ON/OFF switch to 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.

NOTES:

Change Log:

Date	Description	Changed By
05/21/2014	Rev J PIRs: **749**: Added Propane to section 2.8 Gas supply Piping; new Propane combustion calibration section 4.4; modified sections 6.2 & 6.3; added Propane gas train 22140-3 drawings to Appendix G. **934-65**: Added explanatory paragraph & note to section 2.15 – Sequencing Isolation Valve Installation	Chris Blair
03/11/2016	Rev K PIRs: **749-1**: Updated 24276 Burner Assy to rev G in Appendix G **960-4**: Updated schematic 68038 to rev F. **992-1**: Replaced old style Condensate trap 20460 with new style, 24441 in section 7.7 **1011**: Changed Blocked Inlet switch pressure from -8.0 to -4.5 in Appendix A. **1014**: Explained secondary water inlet option, in section 2.5. **1028**: Replaced fuel rod 66020 with 66034 **934-79**: Warranty revision, dated 6/11/14, replaced “water heater” with “boiler.” **934-87**: Updated graphic & instructions in section 2-10, updated tables 3-2, 3-3 and 3-4 **1077**: Exhaust manifold seal 84045 replaces 84033 **934-99**: Added new section 7.12 - LWCO Cap Test Instructions **1092**: Removed Chapter 9 – RS232 Communication, per Firmware version 4.0 and above. **1094:** Replaced Tridicator P/N 69087-TAB with 123675-TAB. **934-145**: Warranty pages removed. Warranty information for all BMK units is now included in a new stand-alone document, *All Benchmark Limited Warranty*, posted on the AERCO web site. **934-150**: Clarified references to & function of spark monitor (p/n 61034) (or AC current transducer) in section 2.10.4, added new section 7.13 Spark Monitor **934-155:** Added Installation Notes regarding BST with ProtoNode SSD to new section 9.1. **DIR 199**: Replaced sections 2.12.1 & 2.12.2 with statement about opening size of not less than one square inch for each 4000 BTUs input for each unit. Applies to both inside and outside air. **1152:** Replace Thermowell 93359 with 58132 **DIR 225:** Section 7.9, replaced "use WD_40" with "use K&N Air Filter Oil (or equivalent). Do NOT use WD-40." **1167-2**: Modified schematics in Appendix H. **1173**: Replaced Shell Harness 63086 with 63182 in Appendix F. **1240**: Replace Blower Proof switch 60011-1 with 60011-4, updated gas train and burner part lists and drawings in Appendix F. **DIR 301:** Clarified 2nd bullet in section 2.10.8, added recommendation to use Sequencing Valve at site that implement BST in section 2.14, added new Note to Figure 9.1. **DIR 319**: Change torque value in section 7.7 Burner Assembly Inspection, step 16 (page 98), from 22 ft. lbs. to 30 ft. lbs. **DIR 324**: Updated Section 2.5 2.5 SUPPLY AND RETURN PIPING, clarified duel water inlet	Chris Blair

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