A Watts Water Technology Company

USER MANUAL

Installation, Operation and Maintenance

BENCHMARK 6000 DUAL FUEL

Gas-Fired Boiler

Natural Gas and Propane
Modulating & Condensing
Hot Water Boiler

Applicable to Serial Numbers:
N- 15-0428 and above

Latest Update: 10/15/2015

GAS-FIRED
C UL US
LISTED

AHRI CERTIFIED™
www.ahridirectory.
Commercial Boilers
AHRI Standard BTS-2000

ASME H

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FOREWORD

The AERCO Benchmark 6000 MBH Dual Fuel (BMK 6000 DF) boiler is a modulating and condensing unit. It represents 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 ratio for this model is 15:1. This model provides extremely high efficiency and makes it ideally suited for modern low temperature, as well as, conventional heating systems.

The Benchmark 6000 operates within the following input and output ranges:

Input Range (BTU/hr.)		**Output Range (BTU/hr.)**	
Minimum	Maximum	Minimum	Maximum
400,000	6,000,000	372,000	5,670,000

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

When installed and operated in accordance with this Instruction Manual, the Benchmark 6000 boiler complies with the NO_x emission standards outlined in:

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

Whether used in singular or modular arrangements, the Benchmark 6000 boiler offers the maximum venting flexibility with minimum installation space requirements. These boilers are Category III and IV, positive pressure appliances. Single and/or multiple breeched units are capable of operation in the following vent configurations:

- Room Combustion Air:
  - Vertical Discharge
  - Horizontal Discharge
- Ducted Combustion Air:
  - Vertical Discharge
  - Horizontal Discharge

This boiler is capable of being vented utilizing Polypropylene and AL29-4C vent systems.

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

IMPORTANT

Unless otherwise specified, all descriptions and procedures provided in this Installation, Operation & Maintenance Manual apply to the Benchmark 6000 boiler.

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 of water 1° F.
BTU/HR	BTUs per Hour
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
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
FM	Factory Mutual. Used to define boiler gas trains.

Phrase, Abbreviation or Acronym	Meaning
GF-xxxx	Gas Fired (an AERCO document numbering system)
GPH	Gallons per Hour
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
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
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
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.
- 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.
- Before attempting to perform any maintenance on the unit, shut off all gas and electrical inputs to the unit.
- The exhaust vent pipe of the unit may operate under a positive pressure and therefore must be completely sealed to prevent leakage of combustion products into living spaces.
- Electrical voltages up to 575 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.
- 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 kinds of soap 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.
- 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.

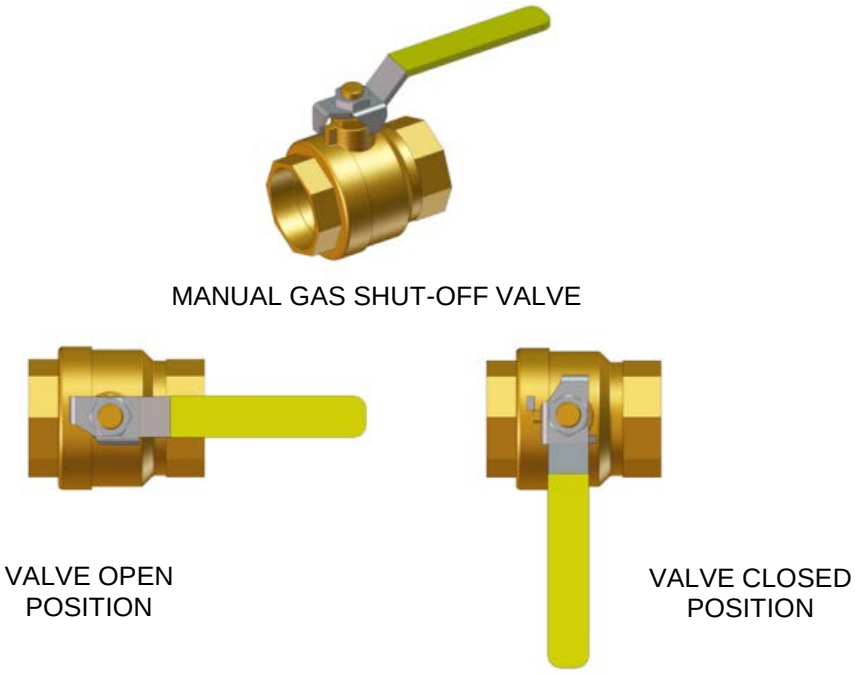


Figure 1-1: Manual Gas Shutoff Valve

1.3 PROLONGED SHUTDOWN

If the boiler will be shut down for an extended period of time (one year or more), it is recommended that the steps in Chapter 7, section 7.12 be performed to prepare the boiler.

After a prolonged shutdown, it is recommended that the steps in Chapter 7, section 7.12 be performed. In addition, the startup procedures in Chapter 4 and the safety device test procedures in Chapter 6 of this manual should be performed to verify that all system-operating parameters are correct. 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.

1.4 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.
- AERCO provides an optional external CO Detector, part number 58092. It can be installed and configured to simply sound an alarm or to shut down the boiler(s) if CO concentrations rise above a configurable threshold. Contact your AERCO representative for details.
- 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:

- 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 can not 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.

1. 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.

2. 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".**

3. 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 the AERCO Benchmark 6000 boiler.

2.2 RECEIVING THE UNIT

Each Benchmark boiler system is shipped as a single crated unit. The shipping weight for the Benchmark 6000 is approximately 3500 pounds. 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 shipping container. 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 MOVING & UNPACKING THE UNIT

While packaged in the shipping container, the unit can be moved using a forklift.

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 factory installed on the unit or packed separately with the unit:

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

When optional accessories are ordered, they may be packed with the unit, 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.

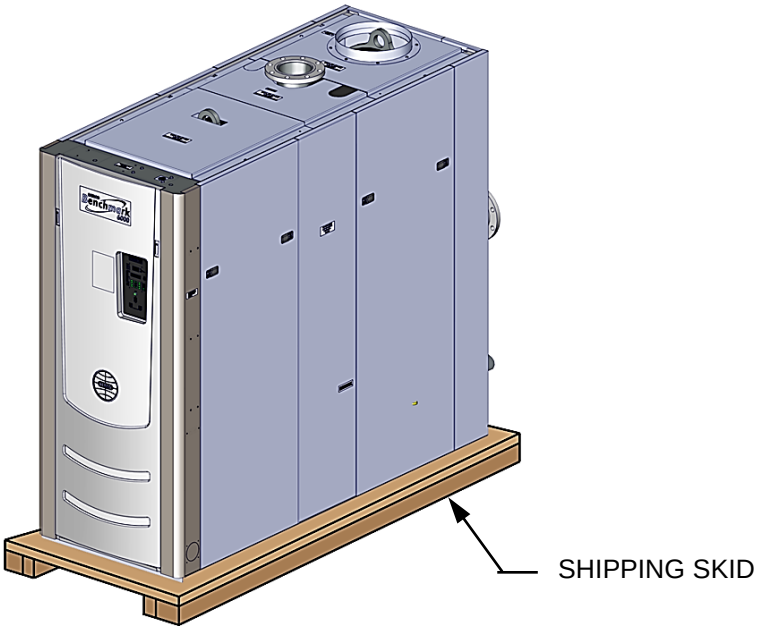


Figure 2-1: Benchmark 6000 Mounted on Shipping Skid

2.4 SITE PREPARATION

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

- Access to one of the following AC Input Power:
  - 208 VAC, Three-Phase, 60 Hz @ 30 Amps
  - 460 VAC, Three-Phase, 60 Hz @ 15 Amps
  - 575 VAC, Three-Phase, 60 Hz @ 20 Amps
- Access to both a NATURAL GAS and a PROPANE line with **a minimum pressure of 14 inches W.C. with the unit AT FULL FIRE** (approximately 20" W.C. static).

2.4.1 Installation Clearances

The Benchmark Model 6000 boiler dimensions and minimum acceptable clearances are shown in Figure 2-2. 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:

- Front : 36 inches (91 cm)
- Sides: 24 inches (61 cm)
- Rear: 24 inches (61 cm)
- Top: 18 inches (45.7 cm)

NOTE

Benchmark 6000 units may be installed with zero side clearances in pairs only. The perimeter clearances still apply (see drawings in Appendix E).

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.

IMPORTANT

Ensure that adequate clearance exists at the rear of the unit to permit installation and service maintenance of the AERCO Condensate Trap. Refer to section 2.7 for Condensate Trap installation details.

When using the AERCO Condensate Neutralizer Tank for condensate drainage, the tank must be installed in a pit, OR the boiler and AERCO Condensate Trap must be elevated **higher than 4" above the floor**. See Condensate Neutralizer Tank Instructions TID-0074 for details.

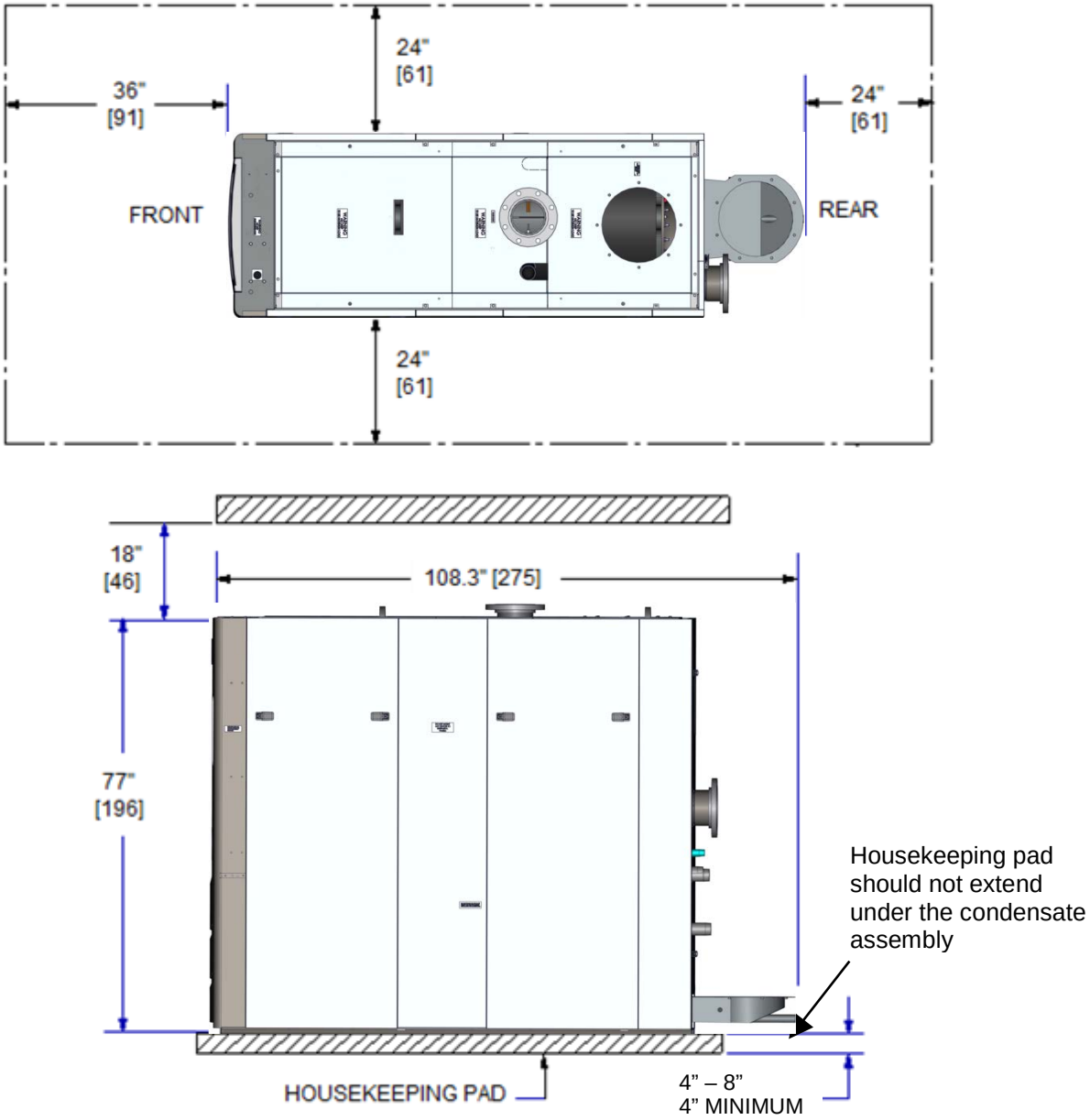


Figure 2-2a. Benchmark Boiler Model 6000 Clearances

WARNING!

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

FOR MASSACHUSSETTS ONLY

For Massachusetts installations, the unit must be installed by a plumber or gas-fitter who is licensed within the Commonwealth of Massachusetts. In addition, the installation must comply with all requirements specified in Chapter 1 – Safety Precautions.

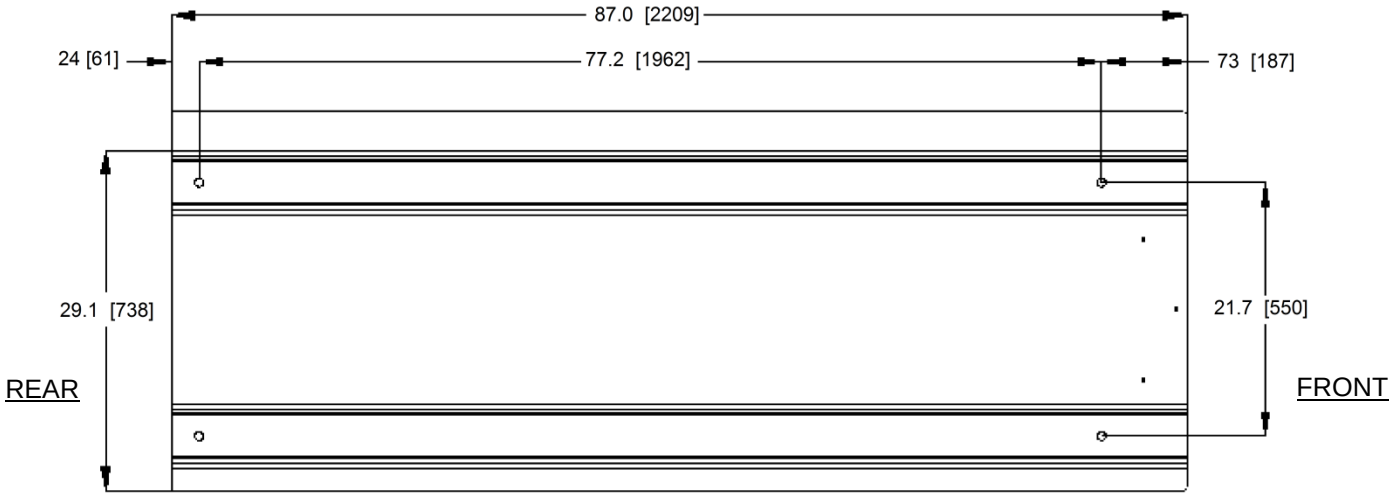
2.4.2 Setting the Unit

The unit must be installed on a concrete housekeeping pad, **a minimum of 4 inches and a maximum of 8 inches thick**, to ensure proper condensate drainage (see NOTE below).

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" above the floor. Ensure that the condensate assembly is not positioned above the housekeeping pad during installation so as not to interference with condensate piping. See Condensate Tank Instructions TID-0074 for details.

If anchoring the unit, refer to Figure 2-2b for anchor bolt locations.



- All holes are flush with the bottom surface of the frame.
- All dimensions shown are in inches [millimeters]

Figure 2-2b. Benchmark 6000 Anchor Bolt Locations

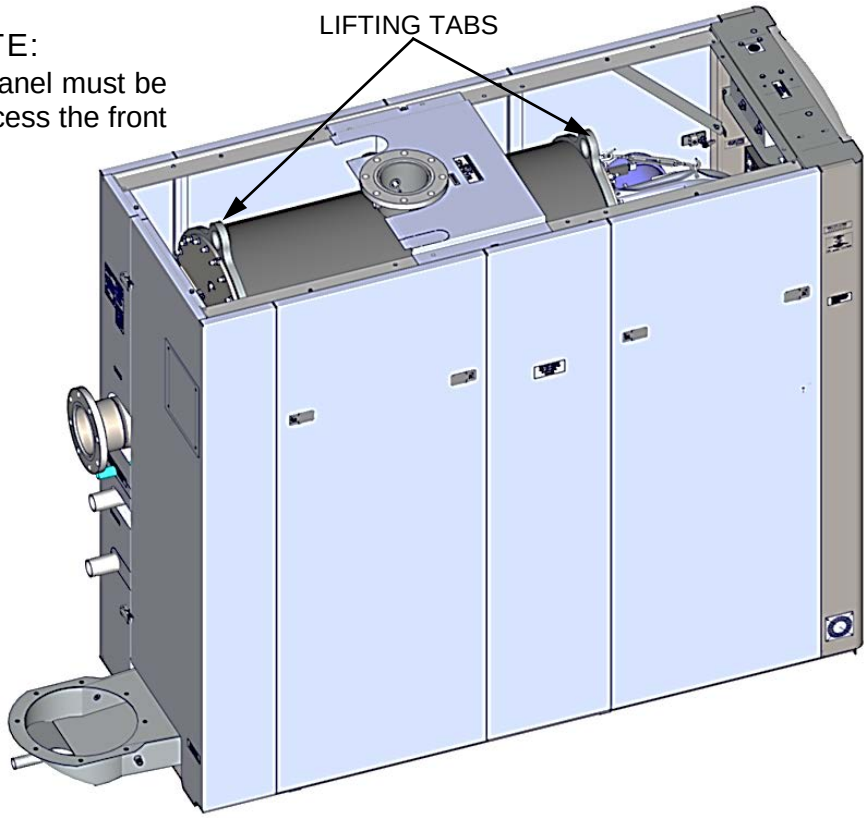
Two (2) lifting lugs are provided at the top of the primary heat exchanger as shown in Figure 2-3. The location of the lifting tabs is marked on the shrink-wrap coving the unit for shipping.

Remove the four (4) lag screws securing the unit to the shipping skid, and, if still in place, remove the front Top Panel. Lift the unit off the shipping skid using a spreader bar and position it on the concrete Housekeeping Pad (required) in the desired location.

WARNING!

When lifting or moving the boiler: do not attempt to manipulate the boiler using the gas train or blower. A spreader bar is required for all vertical lifts. Failure to use a spreader bar can put excessive force on the unit and can cause boiler failure.

NOTE:
The front top panel must be removed to access the front lifting lug.



TOP VIEW WITH TWO TOP PANELS REMOVED

Figure 2-3: 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

The Benchmark boiler utilizes 6" flanged fittings for the water system supply and return piping connections. The physical location of the supply and return piping connections are shown in Figure 2-4. For dimensional data, refer to Drawing AP-A-901 in Appendix E.

See Section 2.11 for information on the air intake and flue vent.

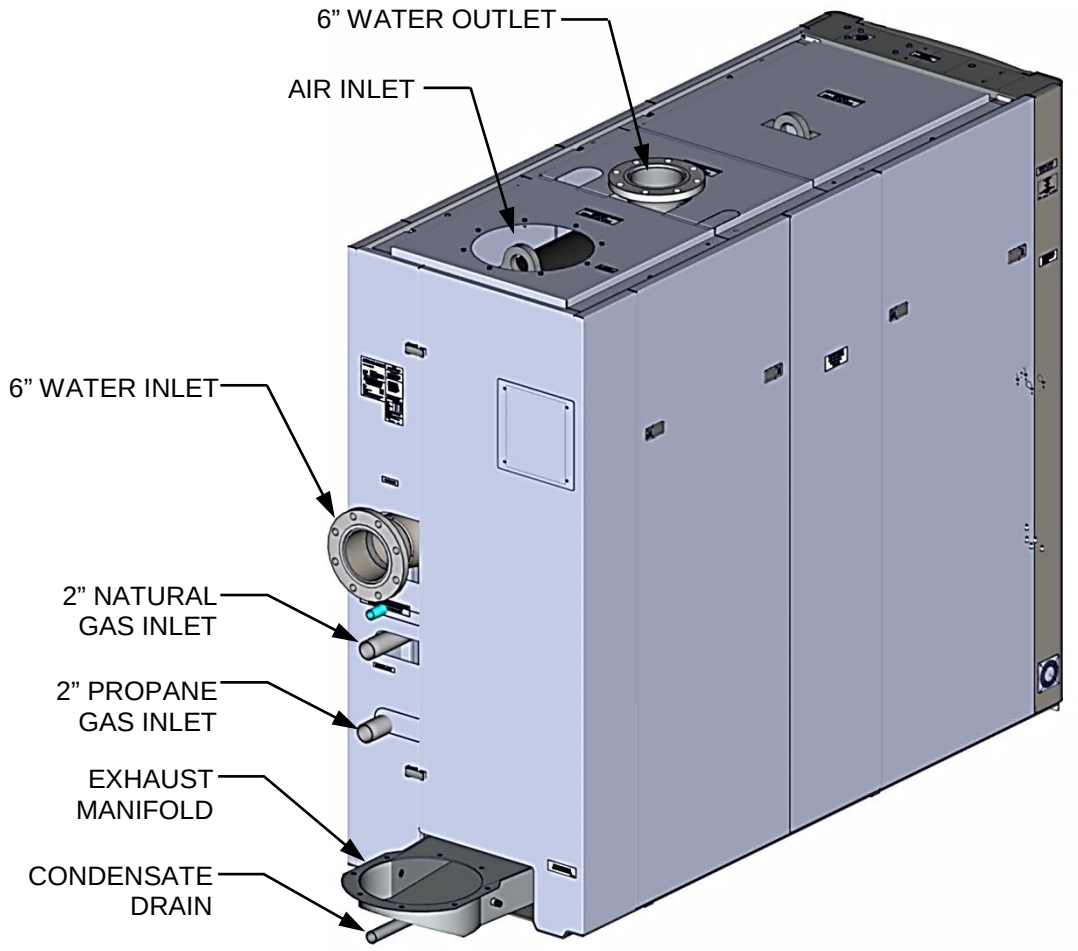


Figure 2-4: Supply and Return Locations

2.6 PRESSURE RELIEF VALVE & PRESSURE/TEMPERATURE INDICATOR INSTALLATION

2.6.1 Pressure Relief Valve Installation

Depending on the pressure required, the Benchmark 6000 is supplied with one or more ASME rated Pressure Relief Valves. All pressure relief valves supplied with the boiler must be installed to meet code and safety requirements. The pressure rating for the relief valve must be specified on the sales order. Available pressure ratings range from **30 psi to 160 psi**. Each pressure relief valve is furnished as a kit (P/N **92102-TAB**) which consists of the relief valve for the pressure rating specified on the Sales Order. The appropriate size reducing bushing and nipple are also included in the kit. The pressure relief valves, nipples and bushings are connected to 45º street elbows already installed on the heat exchanger of the boiler. The relief valves are installed on the

top of the boiler as shown in Figure 2-5A. A suitable pipe joint compound should be used on all threaded connections. Any excess should be wiped off to avoid getting any joint compound into the valve body. Each relief valve must be piped to **within 12 inches of the floor** to prevent injury in the event of a discharge. The discharge piping must be full size, without reduction. No valve or size reductions are allowed in the discharge line. In multiple unit installations the discharge lines must *NOT* be manifolded together. Each must be individually run to a suitable discharge location.

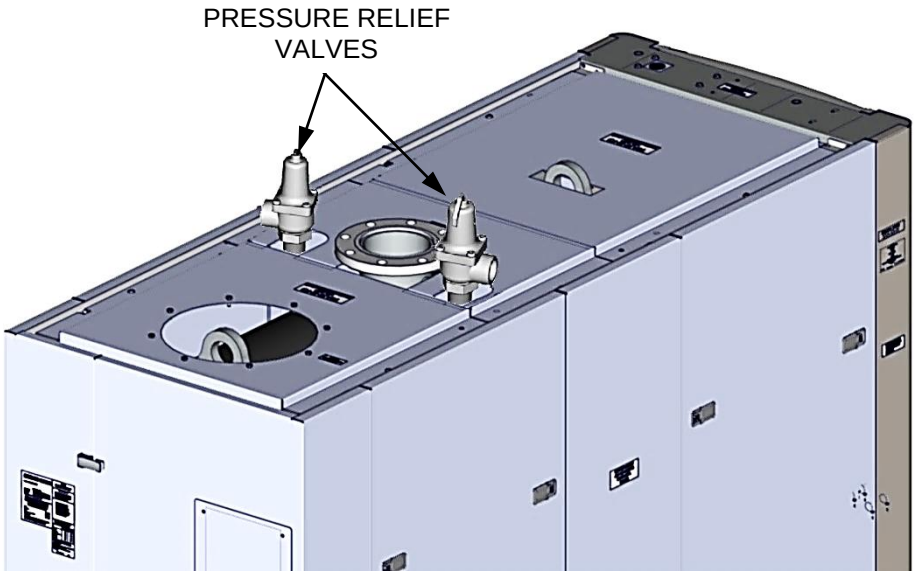


Figure 2-5A: Pressure Relief Valve Installation Locations

2.6.2 Pressure/Temperature Gauge Installation

A Pressure/Temperature Gauge is included in the loose parts kit for installation for installation in the boiler outlet piping. It must be installed so that the sensing bulb is inserted into the hot water outlet flow from the boiler. Refer to Figure 2-5B for sample installations.

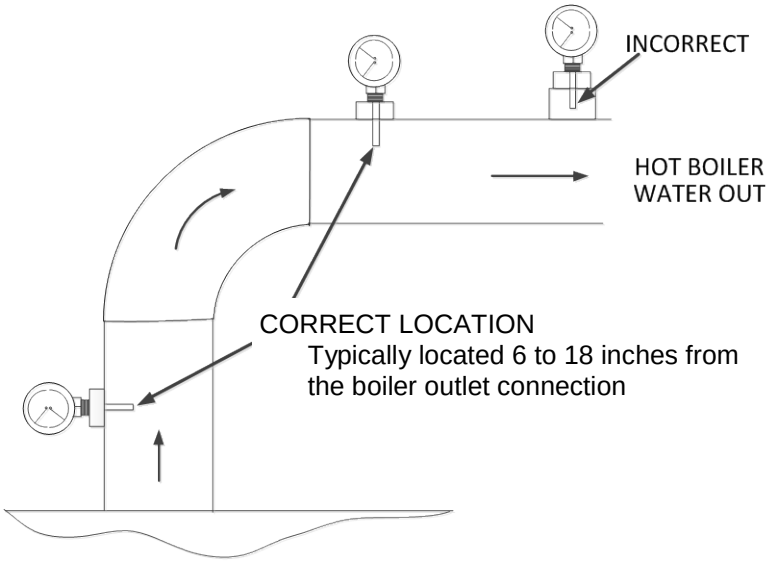


Figure 2-5B. Pressure/Temperature Gauge Installation Location

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 is located on the exhaust manifold (Figure 2-6) at the rear of the unit. This drain port must be connected to the condensate trap (P/N **24060**), which is packed separately within the unit's shipping container. The condensate trap outlet connection features a tapped 3/4" NPT drain port.

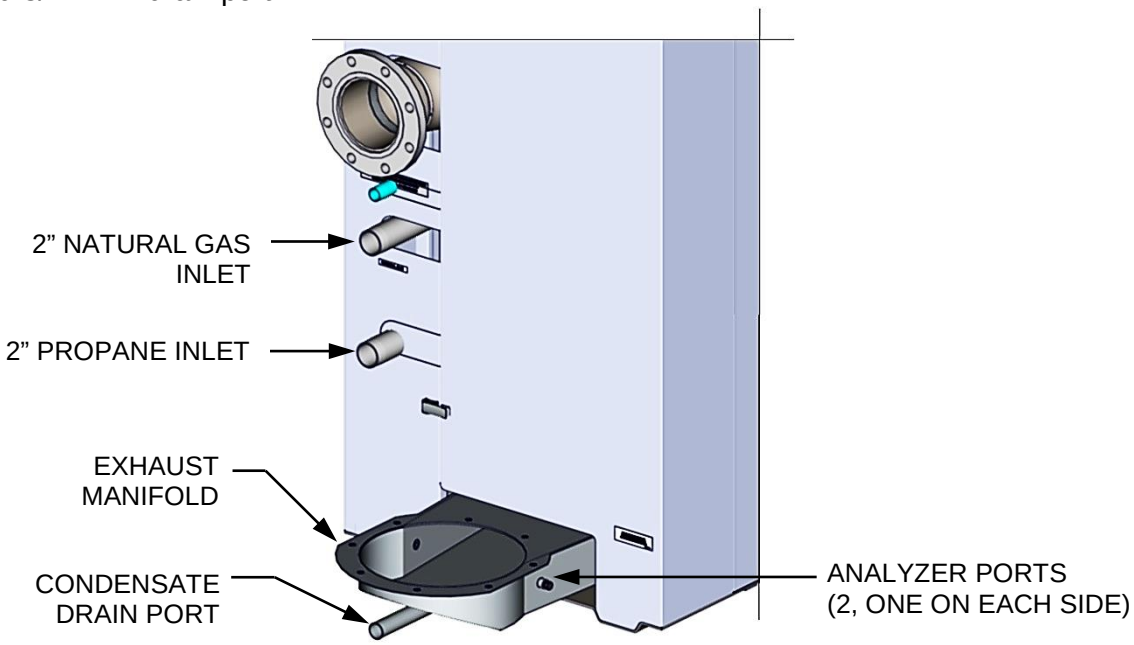


Figure 2-6. Partial Rear View – Condensate Drain Location

A sample condensate trap installation is shown in Figure 2-7. 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 2-7) 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:

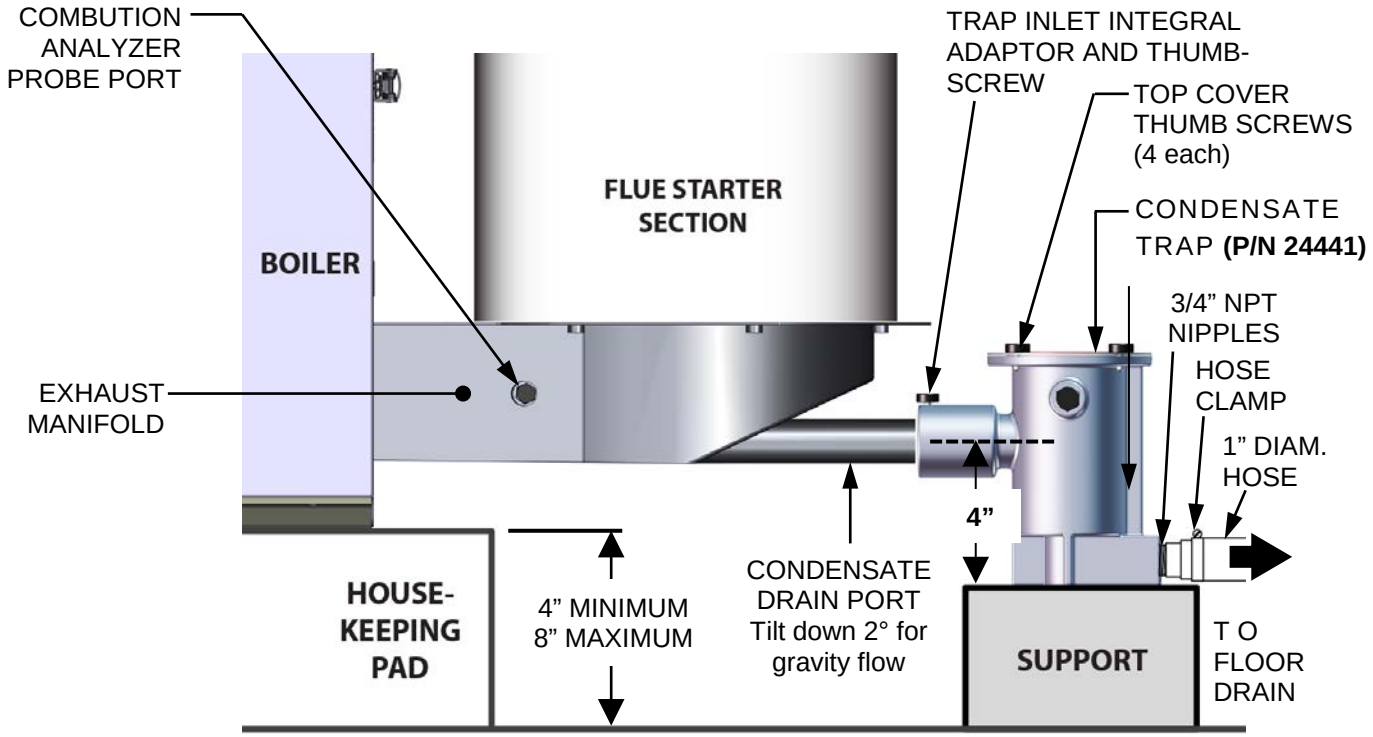
Condensate Trap Installation

1. Connect the condensate trap inlet to the exhaust manifold drain connection by sliding the trap inlet onto the drain port. Tighten the thumbscrew on the trap inlet.
2. At the condensate trap outlet, install a stainless steel or PVC 3/4" NPT nipple.
3. Connect a length of 1" 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 drain. The maximum condensate flow rate is **40 gallons per hour**. The condensate drain trap, associated fittings and drain line must be removable for routine maintenance.

CAUTION

Use PVC, stainless steel, aluminum or polypropylene for condensate drain piping (Figure 2-7). DO *NOT* use carbon or copper components.



NOTE
HOUSKEEPING PAD MUST NOT EXTEND UNDER THE CONDENSATE ASSEMBLY.

Figure 2-7: Sample Condensate Trap Installation

2.8 GAS SUPPLY PIPING

The AERCO Benchmark Gas 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 6000 DF units contain a 2 inch NPT natural gas inlet and a 2 inch NPT propane gas inlet on the back of the unit, as shown in Figure 2-4.

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 and propane, 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. **At no time should the gas pressure applied to the unit exceed 56" W.C. (2 psig).** 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 for both NATURAL GAS and PROPANE gas are as follows:

- The maximum static pressure to the unit must not exceed 56 inches W.C. (2 psi).
- To ensure full rated input capacity, the gas supply pressure to the unit must be sufficient to provide **6000 CFH** while maintaining a ***minimum*** gas pressure of **14 inches W.C.** for FM gas trains ***while in operation***, as measured upstream of the SSOV.
- The BMK6000 may be operated with inlet pressures less than 14 inches W.C. but will derate by approximately 265,000 BTU/Hr per inch under 14 inch W.C. The ***absolute minimum gas pressure*** while in operation is **11 inches W.C.**

2.8.2 Manual Gas Shutoff Valve

A manual shut-off valve must be installed in the gas supply lines upstream of the boiler, as shown in Figure 2-8. Maximum allowable gas pressure to the boiler is 56" W.C. (2 psi).

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:

- The external natural gas regulator must be capable of regulating 300,000 – 6,000,000 BTU/HR of natural gas while maintaining **a minimum gas pressure of 14" W.C.** to the unit.
- A lock-up style regulator MUST be used on all Benchmark 6000 DF units.

NOTE

The external regulator must be capable of regulating 300,000 – 6,360,000 BTU/HR of natural gas while maintaining a gas pressure of 14" W.C. to the unit ***while in operation***.

2.8.3.1 Massachusetts Installations Only

For Massachusetts installations, a mandatory external gas supply regulator must be positioned as shown in Figure 2-8. 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 all installations (other than Massachusetts) that ***exceed*** 1 PSI gas pressure, a mandatory external gas supply regulator must be positioned as shown in Figure 2-8. No regulator is required for gas pressures ***below*** 1 PSI of pressure, but above 2 PSI it is ***mandatory***. Consult the Benchmark Gas Supply Design Guide, GF-2030, and the local gas utility for detailed requirements concerning venting of the supply gas regulator.

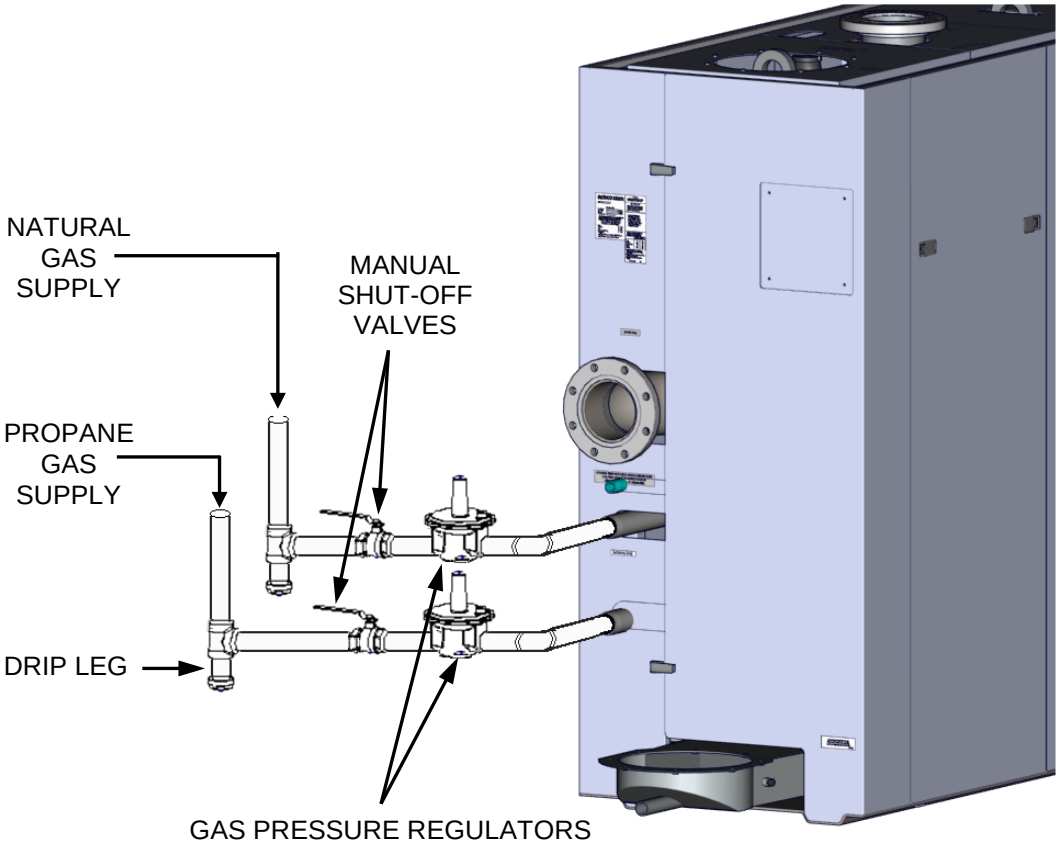


Figure 2-8. Manual Gas Shut-Off Valve Location

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 on the front of the unit. Remove the unit's front panel to access the Power Box, which is mounted in the upper right corner of the unit as shown in Figure 2-9. Loosen the four Power Box cover screws and remove the cover to access the AC terminal block connections, and other internal components shown in Figure 2-10.

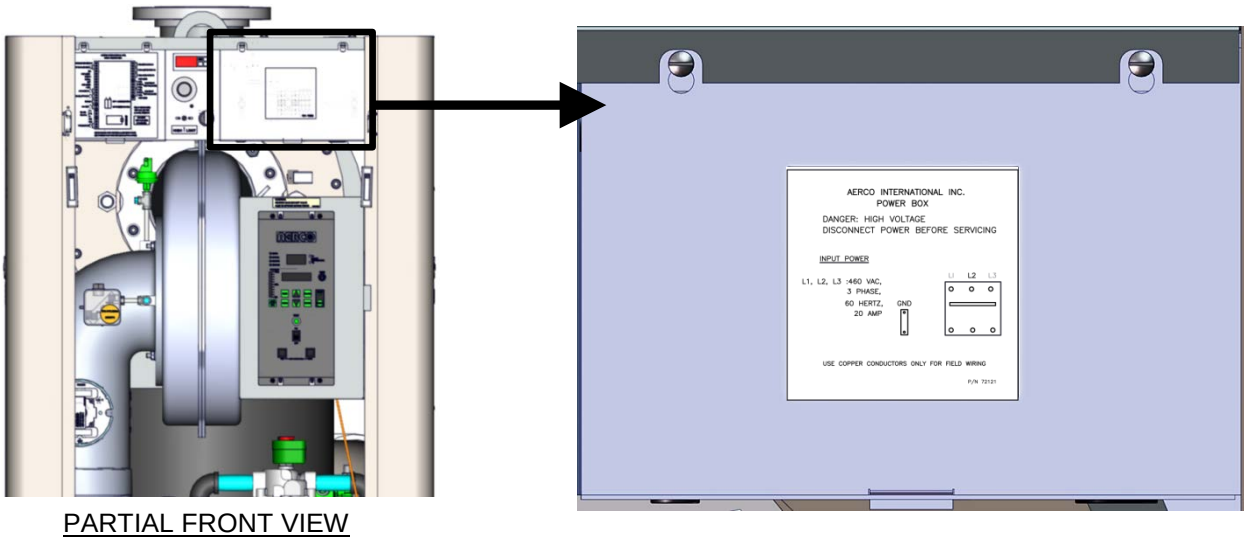


Figure 2-9. Power Box With Cover Closed (460V shown)

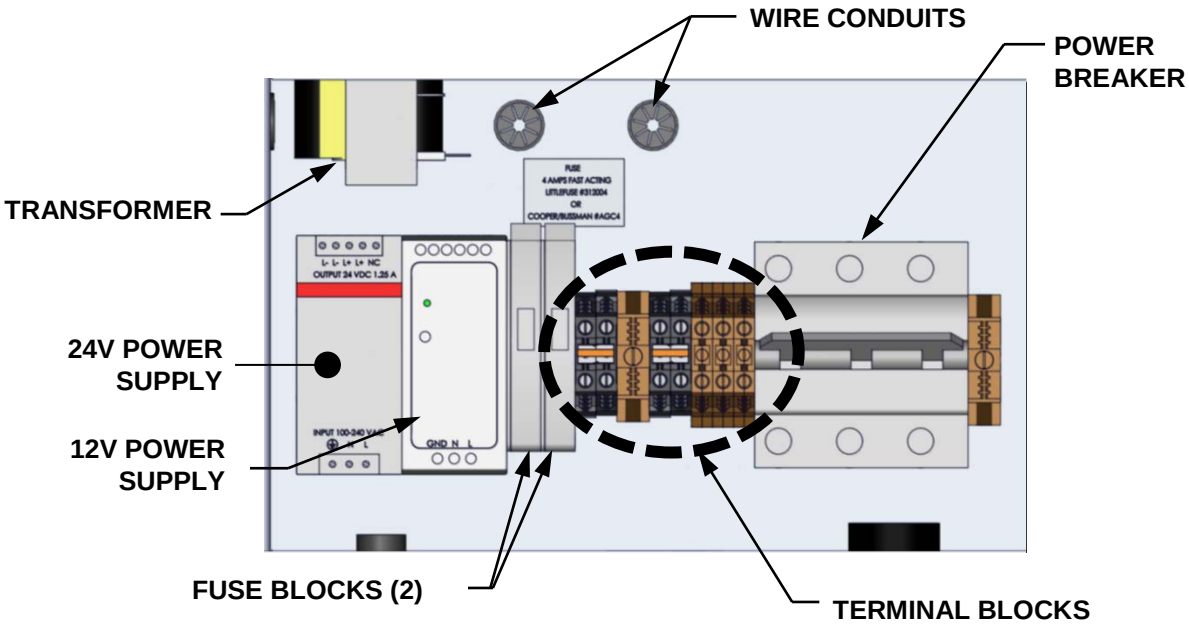


Figure 2-10. Power Box Internal Components (Cover Removed)

With the exception of the transformer shown in Figure 2-10, all of the components in the Power Box are mounted on a DIN rail.

NOTE

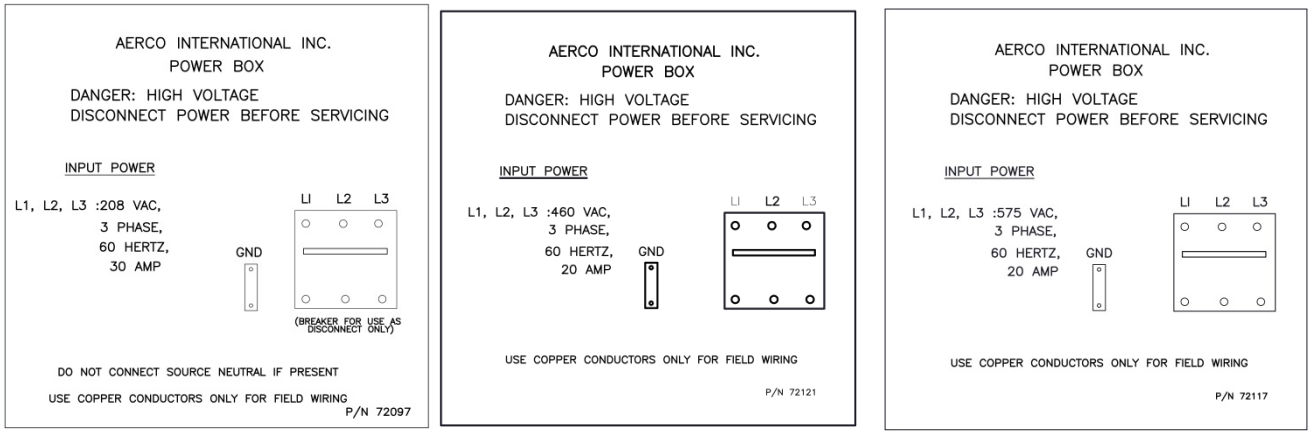
All electrical conduit and hardware must be installed so that it does not interfere with the removal of any unit covers, inhibit service/maintenance, or prevent access between the unit and walls or another unit.

2.9.1 Electrical Power Requirements

The Benchmark Boiler is available in three voltage configurations:

- 208 VAC, three-phase, 60 Hz @ 30A
- 460 VAC, three-phase, 60 Hz @ 20A
- 575 VAC, three-phase, 60 Hz @ 20A

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 2-11.



208VAC ***460VAC*** ***575VAC***

Figure 2-11: Power Box Cover Labels, 208VAC (Left), 460VAC (Center), 575VAC

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 I/O Box. The I/O board terminal strip connections are shown in Figure 2-13. 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 box.

Refer to the wiring diagram provided below the I/O Box (Figure 2-13) when making all wiring connections.

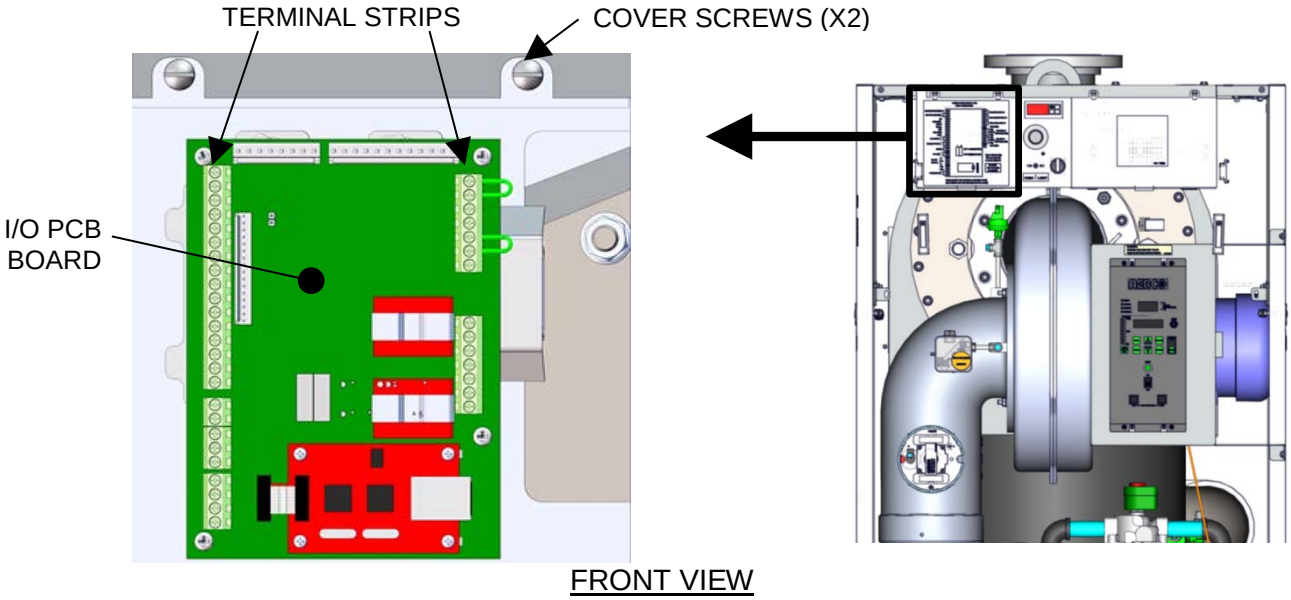


Figure 2-12. Input/Output (I/O) Box Location

NOTE

Use Figure 2-13 to determine the functions of the I/O PCB connections. Do not use the silkscreened labels on the PCB itself, as these may not match the function names. There is a diagram of the connection functions on the cover of the I/O Box as well.

WARNING!

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

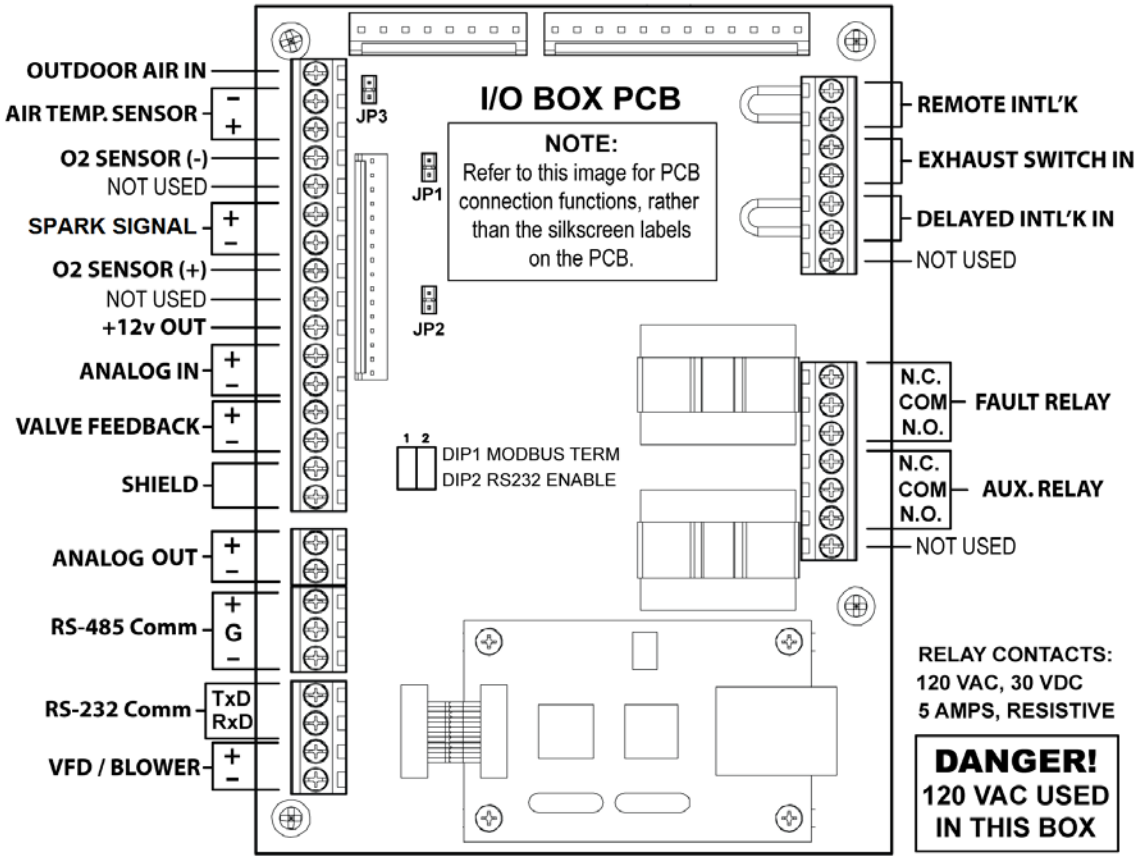


Figure 2-13. I/O Box Terminal Strips

2.10.1 OUTDOOR AIR IN Terminal

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

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

The outdoor sensor may be wired **up to 200 feet** from the boiler. It is connected to the OUTDOOR AIR IN and AIR SENSOR COMMON terminals of the I/O Box (see Figure 2-13). Wire the sensor using a twisted shielded pair wire between 18 and 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 cover 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 O2 SENSOR (–) and O2 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 7.14). 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 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 Control Box. Refer to Appendix D of the C-More Control Panel OMM, GF-112, 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 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 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:

1. When 0-10VDC is selected, the voltage output is used by the controller to modulate the combustion blower via the I/O Box terminals labeled ***VFD/Blower*** (Section 2.10.11).
2. If On Board Boiler Sequencing Technology (BST) is enabled, the Analog Output terminals are used to drive the sequencing isolation valve open and closed.

NOTE

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

WARNING!

DO NOT CHANGE OUTPUT TO ANYTHING OTHER THAN **0-10VDC**.

2.10.9 RS485 Comm Terminals

The RS-485 communication terminals (+, GND, & -) are used when the boiler plant is being controlled by an Energy Management System (EMS) or AERCO ACS (formerly BMS/BMS-II) 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 Terminals

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 Interlock Terminals

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 (labeled REMOTE INTL'K IN and DELAYED INTL'K IN in Figure 2-13). 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 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 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 (Chapter 3).

2.10.13 FAULT RELAY 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 2-13.

2.10.14 AUX.RELAY Terminals

Each unit is equipped with a single pole double throw (SPDT) auxiliary 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 2-13 to locate the AUX.RELAY terminals (N.C., COM, & N.O.) for wiring connections.

2.11 FLUE GAS VENT INSTALLATION

The 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 to avoid any condensate pooling and to allow for proper drainage.

A 12 inch Flue Vent may be used for applications with less than 20 PPM NOx. Installation with less than 9PPM NOx require a 14 inch Flue Vent. Consult your vent manufacturer for 12 inch vent adapters. See the Benchmark Combustion Venting and Combustion Air Guide, GF-2050, for additional information.

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 or 1.9" W.C. 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. 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 which conform to all applicable requirements for installations within the Commonwealth of Massachusetts:

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 for each 4000 BTUs input for each unit** or

1,500 square inches of free area for the BMK 6000. 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.

NOTE

The source of internal combustion air must be positive or neutral in pressure. Negative pressure inside a boiler room may have an adverse effect on combustion equipment.

2.13 DUCTED COMBUSTION AIR

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

In a ducted combustion air application, the combustion air ducting pressure losses must be taken into account when calculating the total maximum allowable venting run. See the AERCO Benchmark Venting and Combustion Air Guide, GF-2050. When using the unit in a ducted combustion air configuration, each unit must have a minimum 14 inch diameter connection at the unit.

2.14 SEQUENCING ISOLATION VALVE INSTALLATION

All Benchmark units are shipped with a connection for an optional motorized external sequencing isolation valve (P/N **92084-TAB**) included in the shipping container. This valve is an integral component of the AERCO's on-board Boiler Sequencing Technology (BST) solution. BST allows sites with multiple 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.

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.

Install the Sequencing Isolation Valve

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

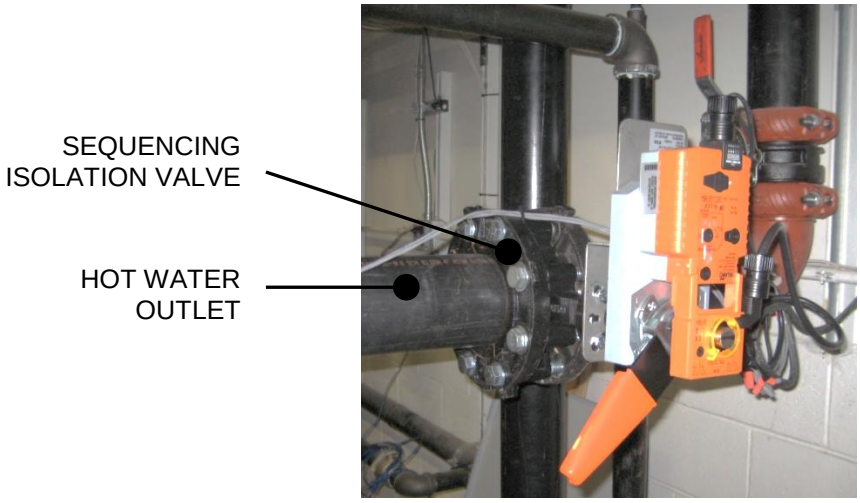


Figure 2-13: Sequencing Isolation Valve Installed

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 2-14) while the other end contains a Molex connector with a jumper wire inserted in it (this jumper wire allows units that do not have a sequencing isolation valve to operate normally). Find the free end of this cable inside the unit's enclosure.

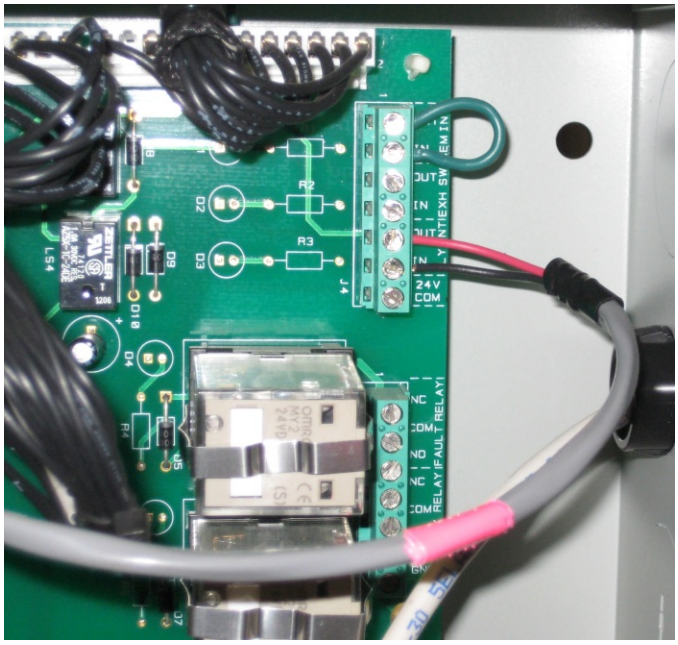


Figure 2-14: Sequencing Isolation Valve Installed

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

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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 575, 208 or 460, 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.

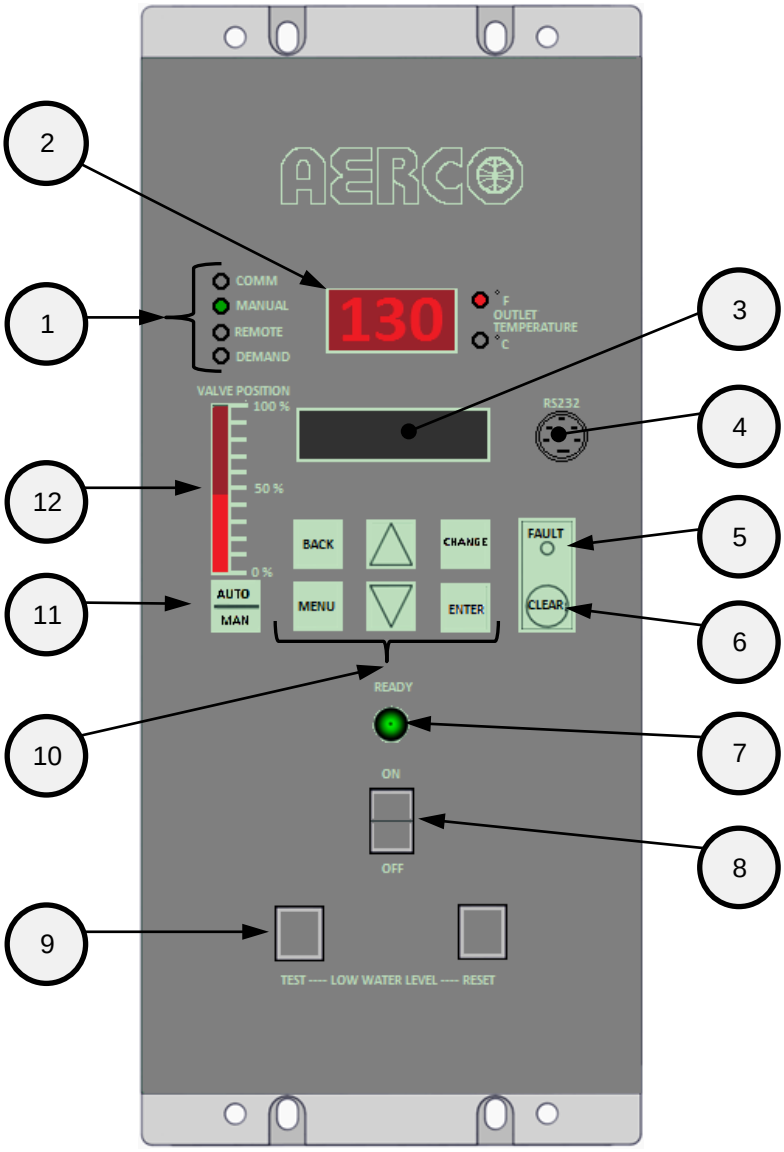


Figure 3-1: Control Panel Front View

Table 3-1: Operating Controls, Indicators and Displays

ITEM	FEATURE	FUNCTION
1	**LED Status Indicators** Four 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** Consists of 6 keys which 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 six major menu categories which are applicable to this manual. These categories are shown in Figure 3-2. Each of the menus shown, contain options which permit operating parameters to be viewed or changed. The menus are protected by password levels to prevent unauthorized use.

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

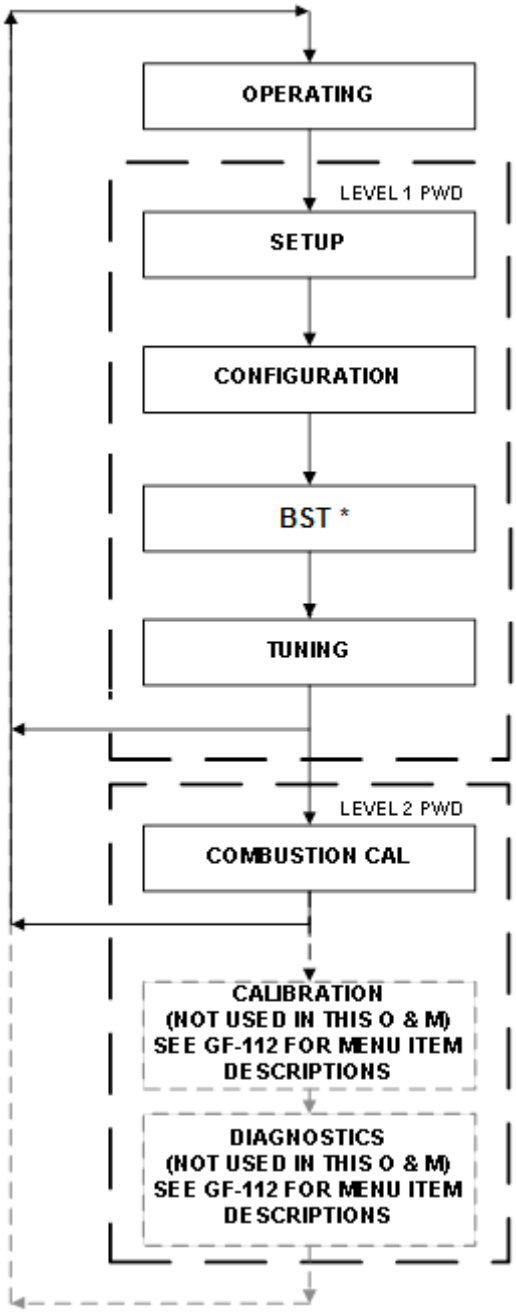
Once the valid **level 1 password (159)** is entered, the options listed in the *Setup*, *Configuration* and *Tuning* menus can be viewed and changed, if desired. The *Combustion Cal* menu is protected by the **level 2 password (6817)**, which is used in Chapter 4 to perform combustion calibration prior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

3.3.1 Menu Processing Procedure

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

Menu Processing Procedure

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



* Only if BST is enabled (see Chapter 9)

Figure 3-2: Menu Structure

NOTE

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

3.4 OPERATING MENU

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

Table 3-2: Operating Menu

Menu Item Display		Available Choices or Limits	
		Minimum	**Maximum**
1	Active Setpoint	40°F (4.4°C)	240°F (116°C)
2	Inlet Temp	40°F (4.4°C)	140°F (60°C)
3	Air Temp	-70°F (-56.7°C)	245°F (118°C)
4	* Outdoor Temp	-70°F (-56.7°C)	130°F (54.4°C)
5	Valve Position In	0%	100%
6	* Valve Position Out	0%	100%
7	Exhaust Temp	Current Temp, Read Only, in °F	
8	Flame Strength	0%	100%
9	Oxygen Level	0%	21%
10	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 isplayed)	6000 MBH (1758 kW)		6000 MBH (1758 kW)
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	Outdoor Sensor	Enabled or Disabled		Disabled
8	* Bldg Ref Temp (If Mode = Outdoor Reset)	40°F (4.4°C)	230°F (110°C)	70°F (21.1°C)
9	* Reset Ratio (If Mode = Outdoor Reset)	0.1	9.9	1.2
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* menu item is set to **Enabled**.

CAUTION

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

3.7 TUNING MENU

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

Table 3-5: Tuning Menu

Menu Item Display		Available Choices or Limits		Default
		Minimum	Maximum	
1	Prop Band	1°F (-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 then adjusts the rotational speed of the blower to maximize combustion efficiency and ensure the unit conforms to the Nitrogen Oxide (NO_x) 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 6000 *		Default
		Minimum	Maximum	
1	CAL Voltage 18%	1.70	2.70	2.20
2	CAL Voltage 30%	1.90	2.50	2.00
3	CAL Voltage 45%	1.90	3.40	2.25
4	CAL Voltage 65%	2.20	3.50	2.70
5	CAL Voltage 80%	3.20	4.40	3.95
6	CAL Voltage 100%	7.20	10.00	8.00
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 Menu*** item, located at the end of the *Configuration* menu (item 32 in Table 3-4), must be se to **Enabled**.

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

The five Item groups are:

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

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

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

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

Table 3-7: BST Menu

Menu Item Display		Available Choices or Limits			Default
		Minimum		Maximum	
1	**BST Mode**	Off	BST Slave	BST Master	Off
2	BST Setpoint	BST Setpt Lo Limit		BST Setpt Hi Limit	130°F
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
14	Head Temp Source	Network		FFWD Temp	FFWD Temp
15	Header Temp Addr	0		255	240
16	Header Temp Point	0		255	14

Table 3-7: BST Menu

Menu Item Display		Available Choices or Limits			Default
		Minimum		Maximum	
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
29	Setback Start	12:00am		11:59pm	12.00am
30	Setback End	12:00am		11:59pm	12.00am
31	Rate Threshold	1°F		30°F	15°F
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		210°F	210°F
45	BST Setpt Lo Limit	40°F		BST Setpt HI Limit	60°F
46	BST Setpt HI Limit	BST Setpt Lo Limit		220°F	195°F
47	BST Prop Band	1°F		120°F	100°F
48	BST Intgral Gain	0.00		2.00	0.50
49	BST Deriv Time	0.00 Min		2.00 Min	0.10 Min

Table 3-7: BST Menu

Menu Item Display		Available Choices or Limits		Default
		Minimum	Maximum	
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	230°F	70°F
55	BST Reset Ratio	0.1	9.9	1.2
56	System Start Tmp	30°F	120°F	60°F
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 Benchmark DF unit is set to natural gas, it checks only the natural gas side, and when it is set to propane, it checks the propane side.

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:

- Downstream 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.

NOTE

If any of the Pre-Purge safety device switches are open, the appropriate fault message will be displayed. Also, if the required conditions are not observed at any point during the start sequence, appropriate messages will be displayed and the unit will go into fault mode.

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

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 the downstream SSOV location.

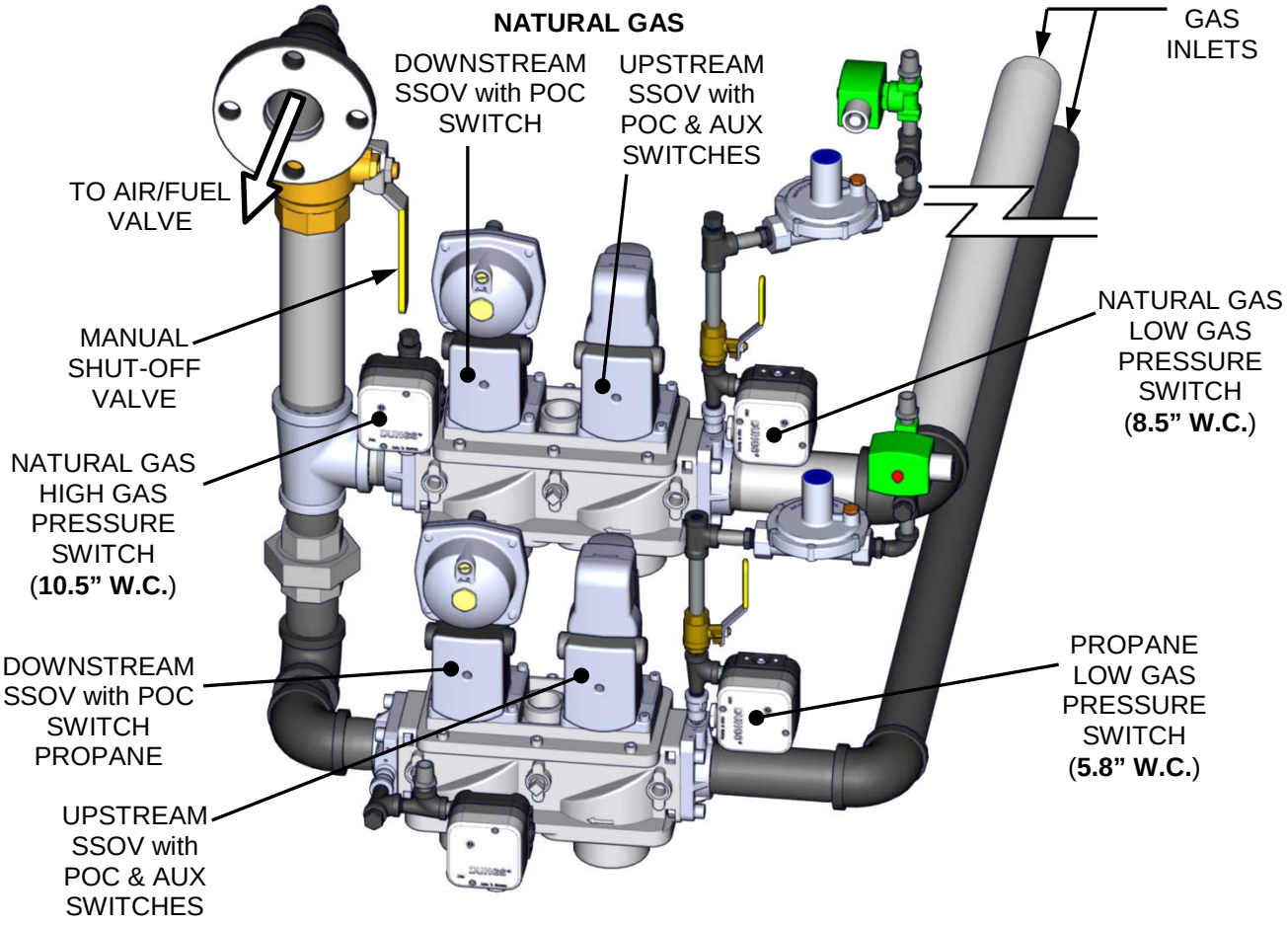


Figure 3-3: SSOV Location

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 **VALVE POSITION** on the front panel bargraph will show 100%.
   c) The Air/Fuel Valve rotates to the full-open purge position and closes purge position switch. The dial on the Air/Fuel Valve (see Figure 3-4) will read ***100*** to indicate that it is full-open (100%).

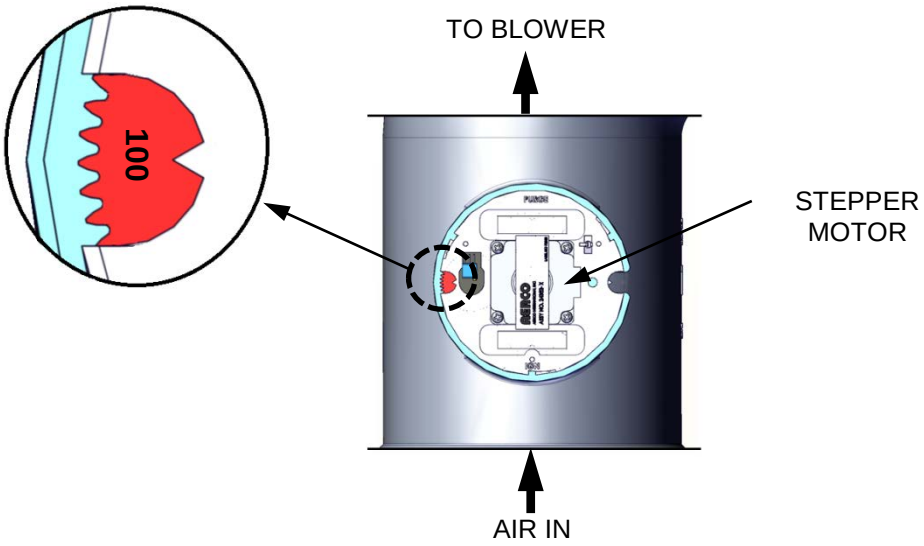


Figure 3-4: Air/Fuel Valve In Purge Position

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.

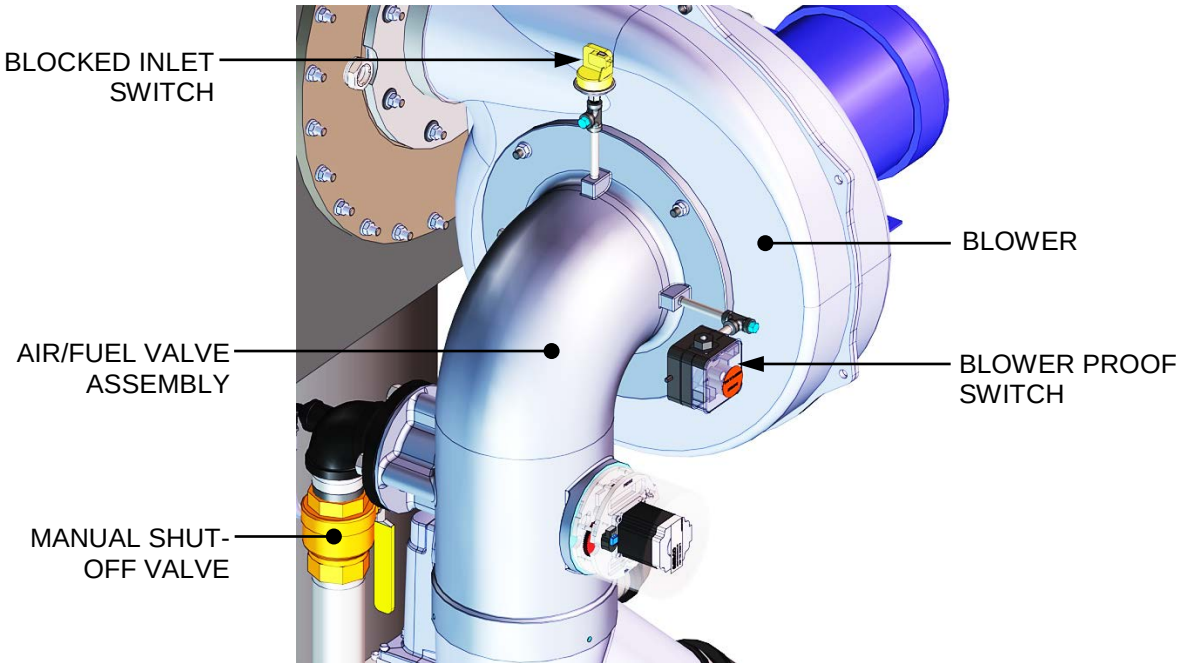


Figure 3-5: Blower Proof Switch

NOTE

A Function Timing Chart for the BMK6000 Proved Pilot Control System is provided in Figure 3-7, below.

5. Upon completion of the purge cycle, the Control Box initiates an ignition cycle and the following events occur in a 7 second period:
    a) The Air/Fuel Valve rotates to the low-fire (Ignition Position) position and closes the ignition switch. The dial on the Air/Fuel Valve will read between **45** and **50** (Figure 3-6) to indicate that the valve is in the low-fire position.
    b) Power is supplied to the Spark Igniter.
    c) Power is supplied to the Pilot Gas Solenoid.
    d) The Pilot Flame Detectors prove the Pilot Flame and the red LED stops blinking and changes to steady ON.
    e) Ignition relay 1 (R1) closes allowing the main Burner ignition sequence to start.

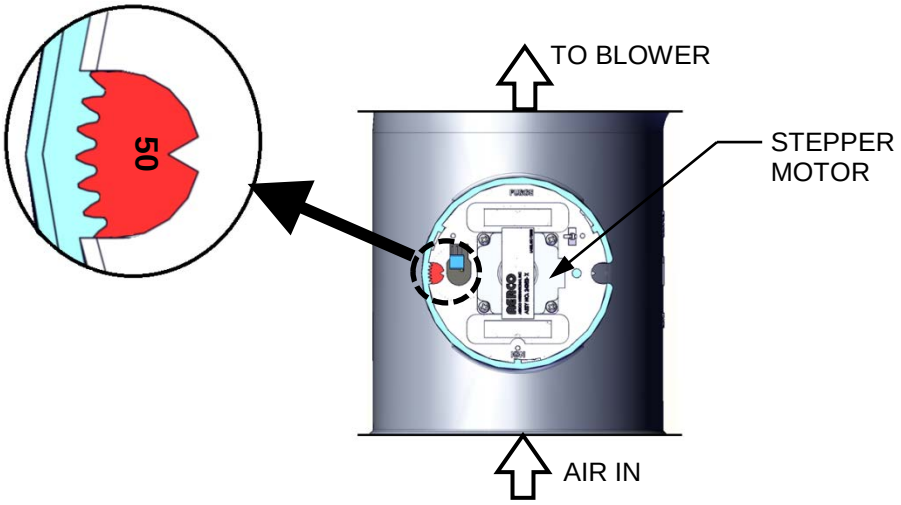


Figure 3-6: Air/Fuel Valve In Ignition Position

6. Once the spark cleaning period is finished and ignition relay 1 (R1) closes, power is supplied to the SSOVs and the following events occur in 7 seconds:
    a) The SSOVs open allowing gas to flow into the Air/Fuel Valve.
    b) The Main Burner ignites.
    c) Main Burner flame is sensed by the C-More Controller.
    d) The Control Box turns off power to the ignition transformer and Pilot solenoid valve.
    e) Relay 2 (R2) remains energized via the POC Normally Open (N.O.) contact of the upstream SSOV actuator.
7. A maximum of 14 seconds are allowed for the entire ignition sequence, from applying power to the ignition transformer through actual Burner flame establishment. The igniter relay will be turned off one second after flame is detected.
8. 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.
9. 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 C-More Controller will turn off the SSOV gas valves. The blower relay will be deactivated and the Air/Fuel Valve will be closed. ***STANDBY*** will be displayed.

	Operating State					
		C-More Pre-purge		PFEP	MFEP	
	Standby	T = 0	T = 30	T = 37	T = 44	Run
Component				PFEP	MFEP	
C-More						
Scanner Power						
Ignition Power						
SSOV Power						
Pilot Valve Closed						
Pilot Valve Open						
Ignition Transformer Off						
Ignition Transformer On						
UV Scanner Powered						
UV Scanner "Ignored"						
UV Scanner In Use						
Relay 1 Coil						
Relay 1 C-NC						
Relay 1 C-NO						
Relay 2 Coil Power from R1						
Relay 2 Coil Power from SKP 15 POC						
Relay 2 C-NC						
Relay 2 C-NO						
SKP15 Power from R1 Contacts						
SKP15 Power from R2 contact and POC C-NO						
SKP15 Proof of Closure C-NC						
SKP15 Proof of Closure C-NO						
SKP25						
Power through R1						
Power through R2 and AUX						
Proof of Closure C-NC						
Proof of Closure C-NO						

Figure 3-7: Timing Chart For Proved Pilot System

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. They are as follows:

Natural Gas Start Level:	**22%**	Propane Gas Start Level:	**22%**
Natural Gas Stop Level:	**18%**	Propane Gas 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 Tables 3-8 & 3-9 and the chart in Figure 3-8 for the relationship between the energy input and Air/Fuel Valve position for a Benchmark 6000 boiler running on natural gas.

Table 3-8: Relationship Between Air/Fuel Valve Position and Energy Input For 6000 MBH Units Running Natural Gas or Propane

Air Fuel Valve Position (% Full Open)	Boiler Energy Input		Turndown Ratio
	BTU/Hr	(% of Full Capacity)	
0%	0	0%	0.0
10%	0	0%	0.0
18% (Stop Level)	385,000	6%	15.6
20%	400,000	7%	15.0
30%	588,000	10%	10.2
40%	869,000	14%	6.9
50%	1,283,000	21%	4.7
60%	1,918,000	32%	3.1
70%	2,590,000	43%	2.3
80%	3,945,000	66%	1.5
90%	5,185,000	86%	1.2
100%	6,000,000	100%	1.0

Table 3-9: Gas Pressure De-Rating Char for Natural Gas

Gas Pressure @ SSOV (inches W.C.)		Energy Input (BTU/hr)	Oxygen (%O2)	DeRating (% Full Fire)
Inlet	Outlet			
56	8	6,000,000	5.40	0%
14	8	6,000,000	5.40	0%
13	8	5,860,000	5.45	2%
12	7.95	5,860,000	5.41	2%
11.5	7.5	5,740,000	5.77	4%
11	7.1	5,610,000	6.17	6%

Note

There is no de-rating for Propane.

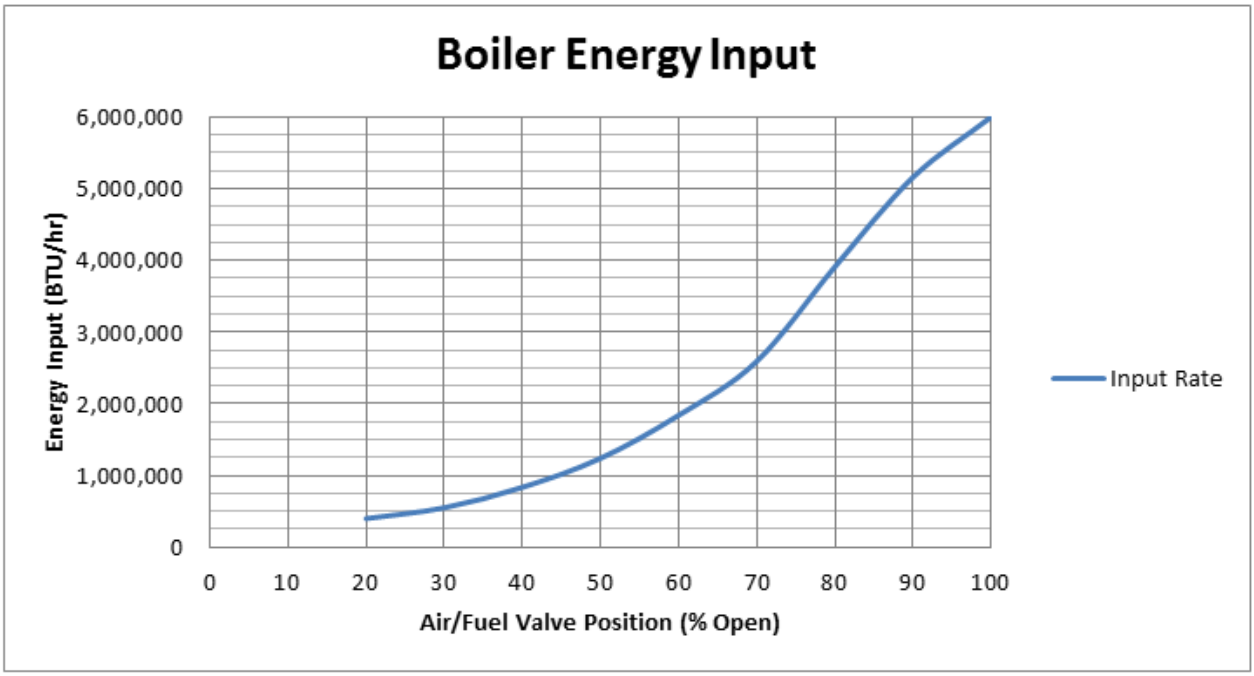


Figure 3-8: Relationship Between Air/Fuel Valve Position and Energy Input

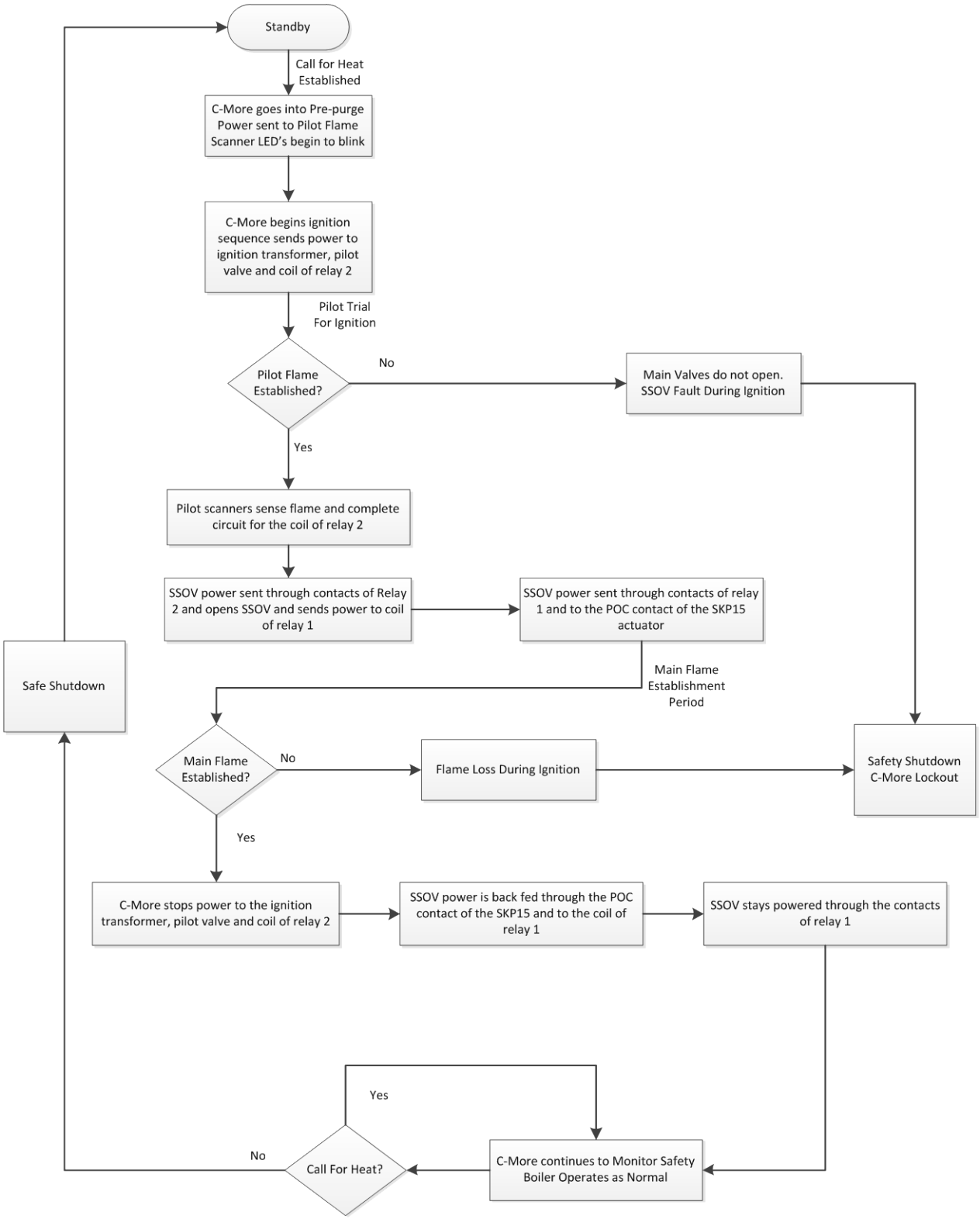


Figure 3-9: Burner Ignition Sequence Flowchart

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CHAPTER 4. INITIAL START-UP

4.1 INITIAL START-UP REQUIREMENTS

The requirements for the initial start-up of the Benchmark 6000 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 (NO_x) resolution to 1PPM.
- 0 to 16 inch W.C. manometer or equivalent gauge and plastic tubing.
- OPTIONAL: 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 (sections 4.4 & 4-5). The gas supply manometer is installed in the appropriate High Gas Pressure Switch port (Propane or Natural Gas), as shown in Figure 4-1.

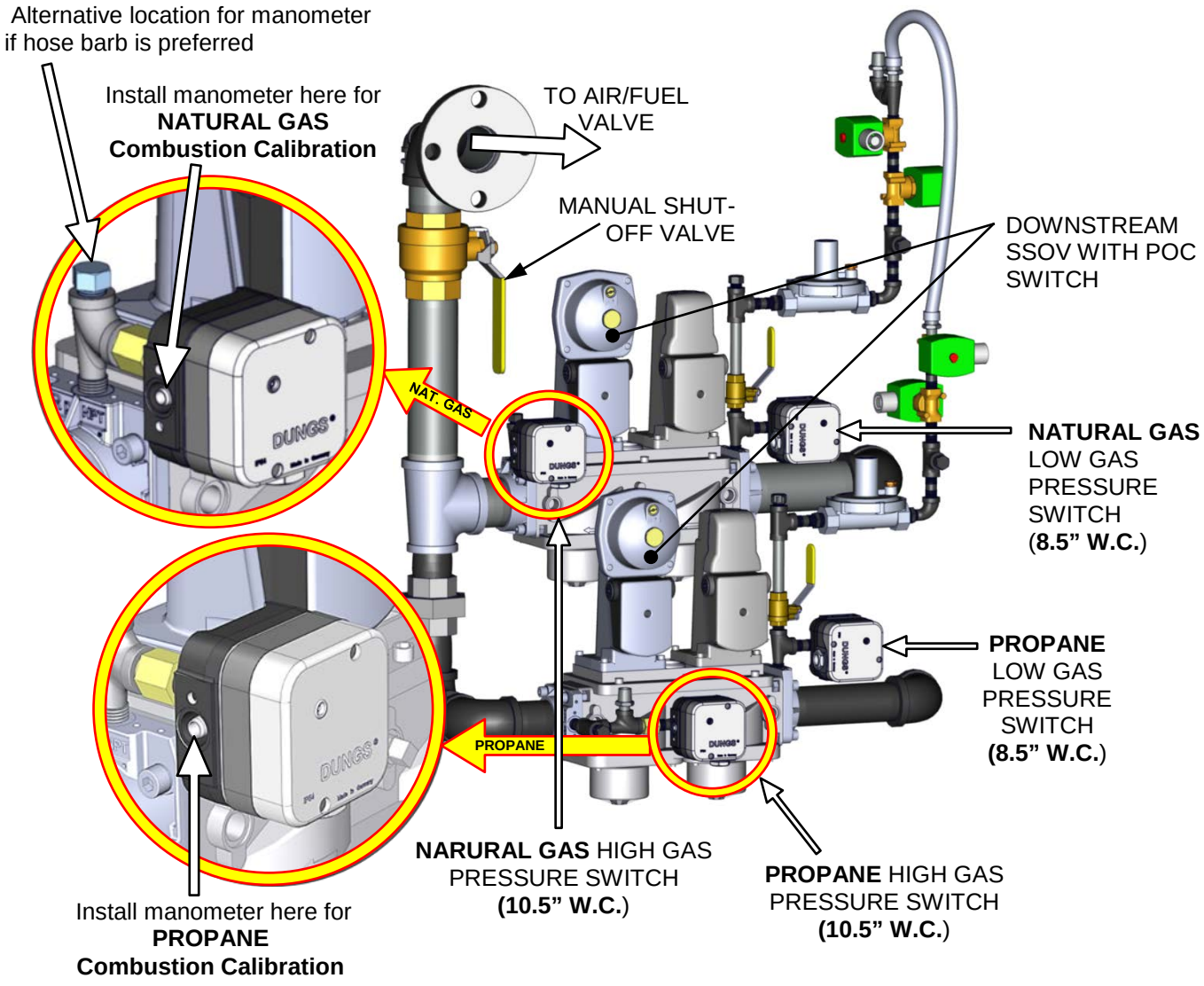

Figure 4-1: Port Locations for Combustion Calibration Measurements

Install the 0 to 16" W.C. 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 front panels 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 4.4 and 4.5), locate the appropriate port (Natural Gas or Propane) on the side of the High Gas Pressure Switch, as shown in Figure 4-1, and loosen the screw inside the port a few turns to open. Do not remove the screw. Alternatively, you can remove the 1/4 inch plug shown in Figure 4-1 and install a hose barb fitting in that location.

NOTE

Ensure the appropriate port (Natural Gas or Propane) is used according the the fuel type that the unit is setup and supplied for.

4. Attach one end of the plastic tubing to the port or barbed fitting and the other end to the 16" W.C. manometer.

4.2.3 Accessing the Analyzer Probe Port

Prepare the selected port for the combustion analyzer probe as follows:

Accessing the Analyzer Probe Port

1. Refer to Figure 4-2 and remove one of the three 1/4" NPT plug from the desired location on the exhaust manifold. There are three 1/4" NPT ports, one in the front of the exhaust manifold and two in the rear, on the left and right sides.
2. If necessary, adjust the stop on the combustion analyzer probe; if using the front port, the probe should be inserted as far as possible. DO NOT install the probe at this time.

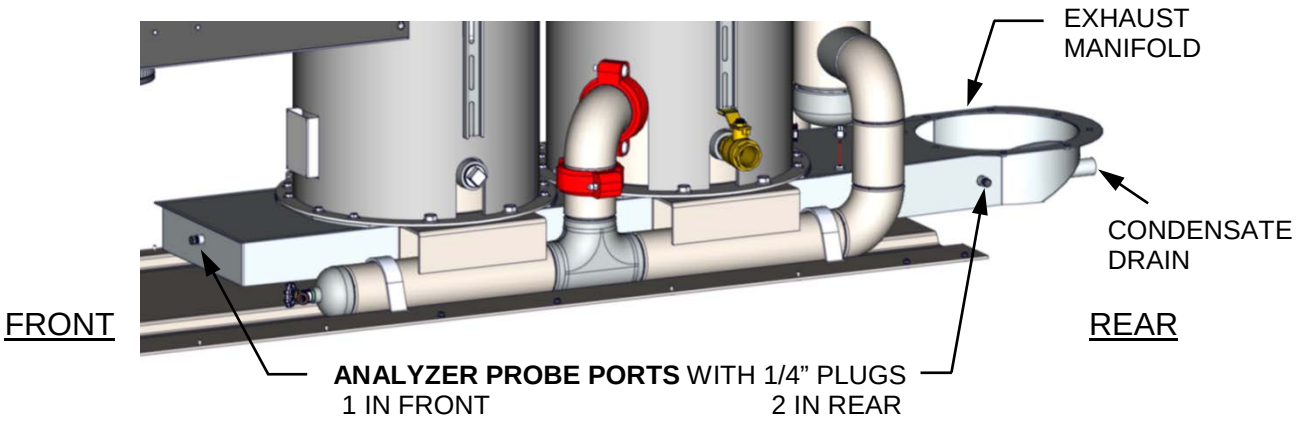

Figure 4-2: Analyzer Probe Hole Location

4.3 PILOT IGNITION

The Benchmark 6000 is equipped with an interrupted pilot ignition system. The pilot is ignited by a spark discharge within the Pilot Burner inside the combustion chamber. The input of the Pilot flame is approximately **18,000 BTU/hr.** The Pilot Burner flame will stay ignited until the main Burner flame has stabilized and ***FLAME PROVEN*** appears in the C-More Controller display.

A Pilot gas supply regulator ***reduces*** the supply pressure from line pressure to 4.9" W.C. An orifice (0.073" dia.) further restricts the gas flow to the Pilot in accordance with UL safety test requirements.

The Pilot Burner should be inspected at the beginning of each heating season, or every 6 months for continuous operation units. It is constructed of high quality, heat resistant stainless steel materials, however some darkening of the metal is to be expected. No adjustment of the Pilot should be required, however the gas pressure downstream of the regulator should be checked if an ignition issue is encountered. Refer to Figure 4-1 for test port location.

The Pilot flame is proven by two Pilot Flame Detectors, located above and below the Pilot. The Pilot Flame Detectors are optical sensors inserted into viewports. They have a red LED which changes from flashing to steady-ON when they encounter the flicker of a flame that meets or exceeds the internal sensing threshold. The Pilot Flame Detectors are inserted into tubes with quartz windows; they observe the Pilot through holes in the refractory. The holes in the refractory should be checked annually to ensure that the optical path to the Pilot Burner is clear.

NOTE

The Pilot Flame Detectors switch the signal to neutral when the flame is proven.

4.4 NATURAL GAS COMBUSTION CALIBRATION

If the unit is currently setup to run on PROPANE gas, complete the instructions in section 4.6.2 to switch the fuel source to NATURAL GAS.

NOTE

When installed and operated in accordance with the requirements specified in this section, the Benchmark 6000 boiler delivers low NO_x emissions of **<20 ppm** at all firing rates. Alternatively, these boilers can be combustion calibrated to provide ultra-low NO_x emissions of **<9 ppm**.

To combustion calibrate the boiler to produce ***low NO_x*** emissions of **<20 ppm**, complete the instructions in this section. To combustion calibrate the boiler to produce ***ultra-low NO_x*** emissions of **<9 ppm** (Natural Gas only) first complete the instructions in this section and then, *in addition*, complete the instructions in Appendix M.

The Benchmark 6000 boiler is combustion calibrated at the factory prior to shipping. The gas pressure, measured at 100% fire rate (Air/Fuel Valve % open position) on the downstream side of the SSOV, must be **within the range of 7.5" to 8.3" W.C.** Recalibration as part of initial start-up is necessary due to changes in the local altitude, gas BTU content, gas supply piping and supply regulators. Combustion Calibration Test Data sheets are shipped with each unit. These sheets must be filled out and returned to AERCO for proper Warranty Validation.

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

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 and then slowly open the Pilot gas valve.
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. Enter the password and then set the unit to MANUAL mode by pressing the **AUTO/MAN** key. A flashing ***MANUAL VALVE POSITION*** message will be displayed with the present position in % and 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 and the manometer is attached and functioning properly.
8. Set the ON/OFF switch to the **ON** position.
9. Change the valve position to **50%** 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 **7.5" to 8.3" 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 4-3). Make gas pressure adjustments using a flat-tip screwdriver to obtain a gas pressure between **7.5" and 8.3" W.C.**
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 required range of **7.5" to 8.3" W.C.** Readjust the gas pressure if necessary.

NOTE

Record this value as it will be used in the low & high pressure gas tests, in sections 6.3 and 6.4.

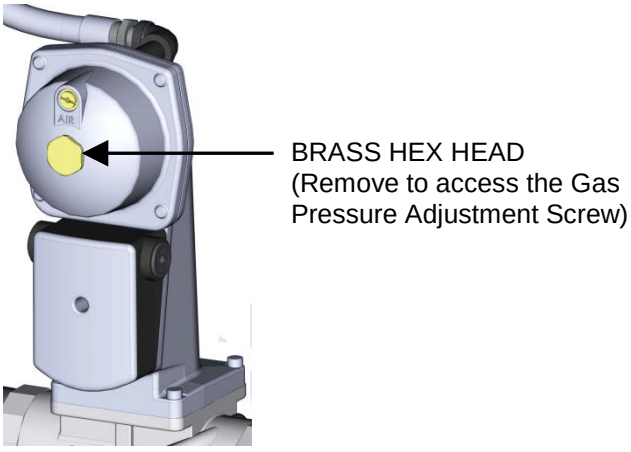

Figure 4-3: Gas Pressure Adjustment Screw Location

NATURAL GAS Combustion Calibration – *Continued*

12. With the valve position at 100%, insert the combustion analyzer probe into the selected analyzer probe port (as described in section 4.2.3, above) 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 O2 sensor may be defective and need to be replaced.
14. Compare the measured oxygen level to the oxygen range shown below. Also, ensure that the nitrogen oxide (NO_x) and carbon monoxide (CO) readings do not exceed the values shown. If you are not in a "NO_x-limited" area and/or do not have a NO_x measurement in your analyzer, set the oxygen (O_2) at **5.1% ± 0.5%**.

Table 4-1: Combustion Calibration Readings

Valve Position	Oxygen (O_2) %	Nitrogen Oxide (NO_x)	Carbon Monoxide (CO)
100%	5.4% - 6.3%	<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 (see 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, NO_x and CO readings on the Combustion Calibration Data Sheets provided with the unit.
17. Lower the valve position to **85%** 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 **85%, 65%, 45%, 30%** and **18%**, as described in the following steps. These steps assume that the **inlet air temperature is in the range of 50°F to 100°F**. If NO_x 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 on the front panel of the C-MORE until ***COMBUSTION CAL MENU*** appears on the display.

NATURAL GAS Combustion Calibration – *Continued*

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 the ***SET Valve Position*** reads ***85%***. Press the **ENTER** key.
23. Next, press the down (▼) arrow key until ***CAL Voltage 85%*** is displayed.
24. Press the **CHANGE** key and observe that ***CAL Voltage 85%*** is flashing.
25. The oxygen level at the **85%** valve position should be as shown below. Also, ensure that the nitrogen oxide (NO_x) and carbon monoxide (CO) readings do not exceed the following values:

Table 4-2: Combustion Calibration Readings

Valve Position	Oxygen (O_2) %	Nitrogen Oxide (NO_x)	Carbon Monoxide (CO)
85%	6.0% - 6.5%	<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 **85%**, press the **ENTER** key to store the selected blower output voltage for the 85% valve position. Record all readings on the Combustion Calibration Sheets provided.
28. Repeat steps 20 through 27 for valve positions of **65%**, **45%**, **30%** and **18%**. The oxygen (O_2), nitrogen oxide (NO_x) and carbon monoxide (CO) should remain within the same limits for all valve positions as shown in the following table.

NOTE

If NO_x 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 – *Continued*

Table 4-3: Combustion Calibration Readings

Valve Position	Oxygen (O_2) %	Nitrogen Oxide (NO_x)	Carbon Monoxide (CO)
65%	6% - 7%	<20 ppm	<100 ppm
45%	6% - 7%	<20 ppm	<100 ppm
30%	6% - 7%	<20 ppm	<100 ppm
18%	5% - 7%	<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 Figure 4-4). 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 65% down to 18% after making a change to the idle screw (TAC valve).

30. This completes the NATURAL GAS combustion calibration procedures.

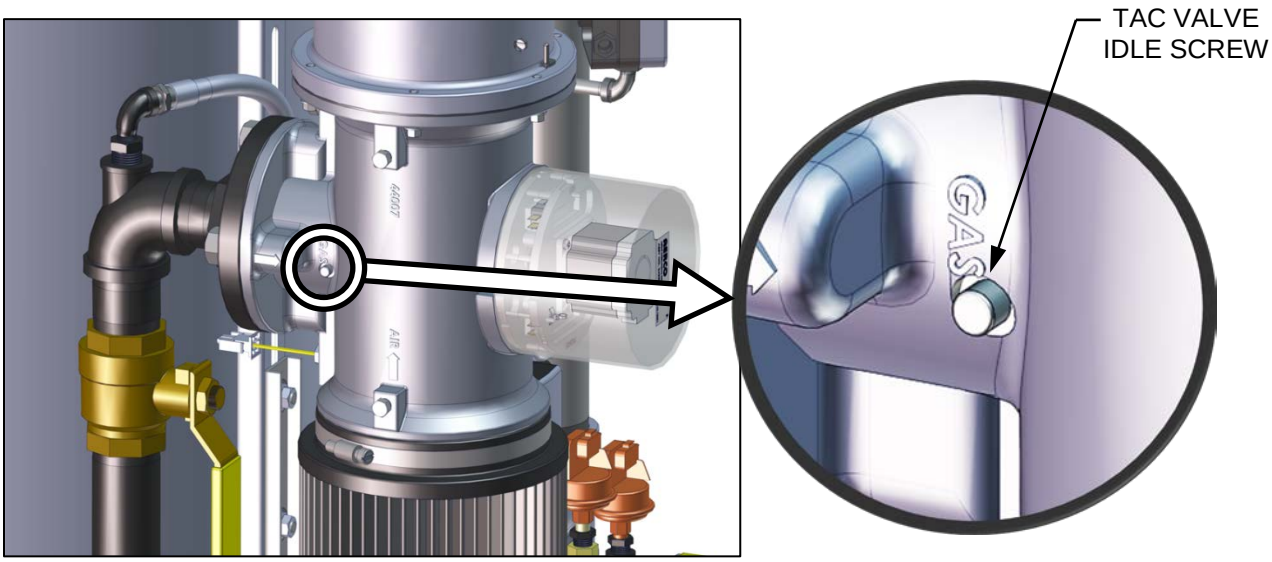

Figure 4-4: TAC Valve Adjust (Idle Screw)

4.5 PROPANE GAS COMBUSTION CALIBRATION

If the unit is currently setup to run on NATURAL GAS, complete the instructions in section 4.6.1 to switch the fuel source to PROPANE.

The Benchmark boiler is combustion calibrated and set for Natural Gas fuel at the factory prior to shipping. The gas pressure must be within the range of **3.8" W.C. ±0.4" W.C.**

Recalibration as part of initial start-up is necessary due to changes in the local altitude, gas BTU content, gas supply type (Natural or Propane), 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 Gas Combustion Calibration

1. Open the water supply and return valves to the unit and ensure that the system pumps are running.
2. Set the control panel ON/OFF switch to the **OFF** position
3. Turn on external ac power to the unit. The display will show loss of power and the time and date.
4. 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 % and the MANUAL LED will light.
5. Adjust the air/fuel valve position to **0%** by pressing the ▼ arrow key.
6. Ensure that the leak detection ball valve downstream of the SSOV is open.
7. Set the ON/OFF switch to the **ON** position.
8. Change the valve position to **50%** using the ▲ arrow key. The unit should begin its start sequence and fire.
9. Next, verify that the gas pressure downstream of the SSOV is set to **3.8" W.C. ± 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 4-5). Make gas pressure adjustments using a flat-tip screwdriver to obtain a gas pressure range of **3.8" W.C. ± 0.4" W.C.**

PROPANE Gas Combustion Calibration – Continued

Figure 4-5: Gas Pressure Adjustment Screw Location

10. 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 required range of **3.8" W.C. ± 0.4" W.C.** Readjust the gas pressure if necessary.

NOTE

Record this value as it will be used in the low & high pressure gas tests, in sections 6.3 and 6.4.

11. 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.
12. 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.
13. Compare the measured oxygen level to the oxygen range shown below. Also, ensure that the nitrogen oxide (NO_x) and carbon monoxide (CO) readings do not exceed the values shown. If you are not in a "NO_x-limited" area and/or do not have a NO_x measurement in your analyzer, set the oxygen (O_2) at **4.3% ± 0.3%**.

Combustion Calibration Readings

Valve Position	Oxygen (O_2) %	Nitrogen Oxide (NO_x)	Carbon Monoxide (CO)
100%	4.3% ± 0.3%	<200 ppm	<200 ppm

14. 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 4-5). 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.

PROPANE Gas Combustion Calibration – Continued

15. Once the oxygen level is within the specified range at 100%, record the O_2, NO_x and naivety CO readings on the Combustion Calibration Data Sheets provided with the unit.
16. Lower the valve position to **85 %** 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 85%, 65%, 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. If NO_x 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.

17. 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.
18. Press the **MENU** key on the front panel of the C-MORE until ***COMBUSTION CAL MENU*** appears on the display.
19. Press the ▲ arrow key until ***SET Valve Position*** appears on the display.
20. Press the **CHANGE** key. ***SET Valve Position*** will begin to flash.
21. Press the ▲ arrow key until the *SET Valve Position* reads ***85%***. Press the **ENTER** key.
22. Next, press the down (▼) arrow key until ***CAL Voltage 85%*** is displayed.
23. Press the **CHANGE** key and observe that ***CAL Voltage 85%*** is flashing.
24. The oxygen level at the 85% valve position should be as shown below. Also, ensure that the nitrogen oxide (NO_x) and carbon monoxide (CO) readings do not exceed the following values:

Combustion Calibration Readings

Valve Position	Oxygen (O_2) %	Nitrogen Oxide (NO_x)	Carbon Monoxide (CO)
85%	5.5% - ± 0.5%	<200 ppm	<200 ppm

25. 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.
26. Once the oxygen level is within the specified range at 85%, press the **ENTER** key to store the selected blower output voltage for the 85% valve position. Record all readings on the Combustion Calibration Sheets provided.
27. Repeat steps 20 through 26 for valve positions of **65%**, **45%**, **30%** and **18%**. The oxygen (O_2), nitrogen oxide (NO_x) and carbon monoxide (CO) should remain within the same limits for all valve positions as shown in the following table.

PROPANE Gas Combustion Calibration – Continued

NOTE

If NO_x 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.

Combustion Calibration Readings

Valve Position	Oxygen (O_2) %	Nitrogen Oxide (NO_x)	Carbon Monoxide (CO)
65%	5.5% ± 0.5	<100 ppm	<150 ppm
45%	5.5% ± 0.5	<100 ppm	<100 ppm
30%	5.5% ± 0.5	<100 ppm	<100 ppm
18%	6.0% ± 0.5	<100 ppm	<100 ppm

28. If the oxygen level at the 18% valve position is too high and the Blower voltage is at the minimum value, you can adjust the idle screw (TAC valve) which is recessed in the top of the Air/Fuel Valve (see Figure 4-4, above). 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 **45%** down to **18%** after making a change to the idle screw (TAC valve).
29. This completes the Propane gas combustion calibration procedures.

4.6 DUAL-FUEL SWITCHOVER INSTRUCTIONS

4.6.1 Switchover from NATURAL GAS to PROPANE

To switch from Natural Gas to Propane Gas operation, proceed as follows:

Switchover from NATURAL GAS to PROPANE

1. Set the ON/OFF switch on the C-More Controller to the **OFF** position.
2. Close the external Natural Gas supply valves.
3. Open the external Propane Gas supply valves.
4. Refer to Figure 4-6 and locate the Fuel Selector Switch on the unit, behind the front door.
5. Set the Fuel Selector Switch to the **PROPANE** position. A Gas pressure Fault message will be displayed on the Control Box.
6. Clear the Gas Pressure Fault by pressing the **CLEAR** key.
7. Set the ON/OFF switch on the C-More /control Box to the **ON** position.
8. Press the **MENU** key once. *Setup* menu will be displayed.
9. Press the ▲ arrow key once. Password will be displayed.
10. Press the **CHANGE** key. Password will begin to flash.

Switchover from NATURAL GAS to PROPANE – Continued

11. Using the ▲ arrow key, increment the display and stop at **159**.
12. Press the **ENTER** key to store the displayed password.
13. Password 1 will be displayed, indicating that the valid Level 1 password has been stored.
14. Next, access the *Configuration* menu by pressing the **MENU** key once.
15. Using the ▲ and ▼ arrow keys, scroll through the *Configuration* menu and stop at **Fuel Type**.
16. Press the **CHANGE** key. ***FUEL TYPE*** will begin to flash.
17. Press the ▲ arrow key. ***PROPANE*** will be displayed.
18. Press the **ENTER** key to store the Propane Fuel type.
19. Replace the front door panel previously removed from the boiler.
20. **This completes the switchover from NATURAL GAS to PROPANE.**

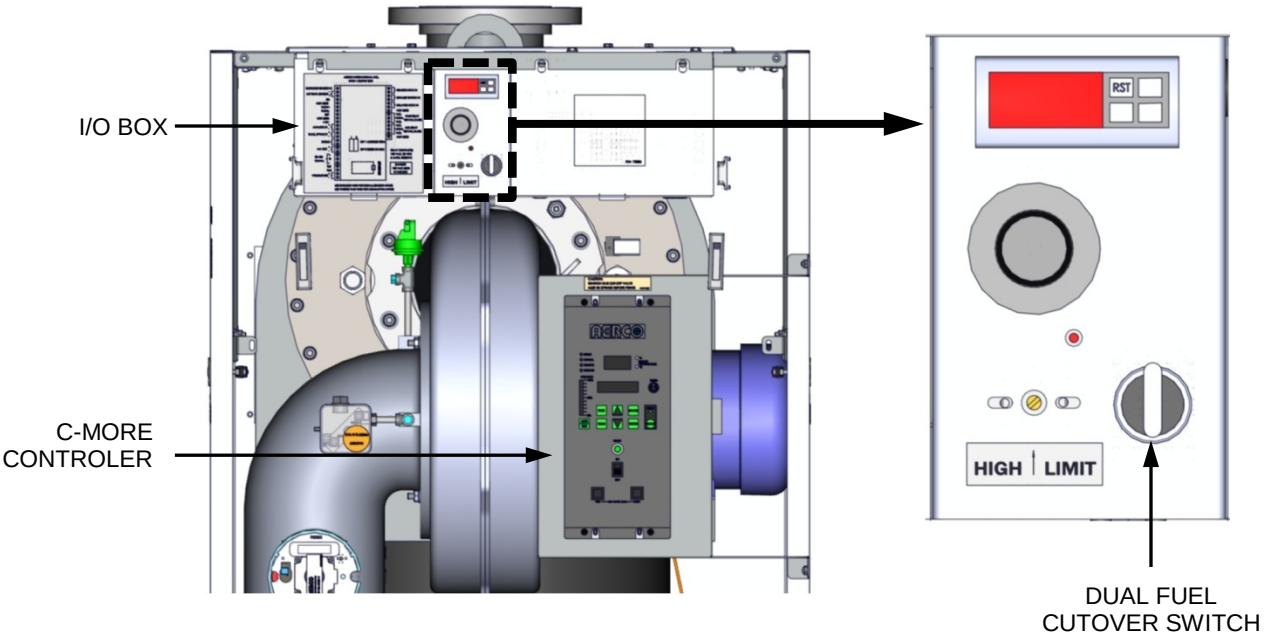

Figure 4-6: Dual Fuel Switch Location

4.6.2 Switchover from PROPANE to NATURAL GAS

To switch from Propane to Natural Gas, proceed as follows:

Switchover from PROPANE to NATURAL GAS

1. Set the ON/OFF switch on the C-More Controller to the **OFF** position.
2. Close the external Propane Gas supply valves.

Switchover from PROPANE to NATURAL GAS – Continued

3. Open the external Natural Gas supply valves.
4. Refer to Figure 4-6 and locate the Fuel Selector Switch on the front of the unit.
5. Set the Fuel Selector Switch to the **NATURAL GAS** position. A Gas pressure Fault message will be displayed on the Control Box.
6. Clear the Gas Pressure Fault by pressing the **CLEAR** key.
7. Apply AC power to the boiler.
8. Press the **MENU** key once. The *Setup* menu will be displayed.
9. Press the ▲ arrow key once. Password will be displayed.
10. Press the **CHANGE** key. ***PASSWORD*** will begin to flash.
11. Using the ▲ arrow key, increment the display and stop at **159**.
12. Press the **ENTER** key to store the displayed password.
13. Password 1 will be displayed, indicating that the valid Level 1 password has been stored.
14. Next, access the *Configuration* menu by pressing the **MENU** key once.
15. Using the ▲ and ▼ arrow keys, scroll through the *Configuration* menu and stop at **Fuel Type**.
16. Press the **CHANGE** key. ***FUEL TYPE*** will begin to flash.
17. Press the ▼ arrow key. ***NATURAL GAS*** will be displayed.
18. Press the **ENTER** key to store the Natural Gas Fuel type.
19. Replace the front door panel previously removed from the boiler.
20. **This completes the switchover from PROPANE to NATURAL GAS.**

4.7 REASSEMBLY AFTER COMBUSTION CALIBRATION

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

Reassembly

1. Set the ON/OFF switch in the **OFF** position.
2. Disconnect AC power from the unit.
3. Shut off the gas supply to the unit.
4. Remove the manometer and, if used, the barbed fitting from the port and turn the port screw clockwise to close the port.
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.
7. Repeat the instructions in sections 4.6.1 or 4.6.2 to select the fuel you want to use at the beginning of operation.

4.8 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 4-5. They can be accessed by opening the front panel door of the unit.

The Manual Reset button is not adjustable and is permanently fixed at 210°F (98.9°C). This button will shut down and lock out the 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 4-5 before the boiler can be restarted.

The adjustable 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.

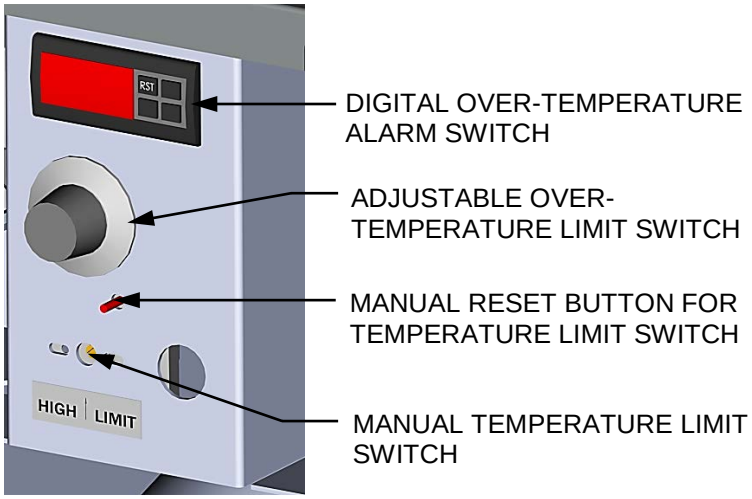

Figure 4-5: Over-Temperature Limit Switch Locations

4.8.1 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 4-6 and Table 4-1.

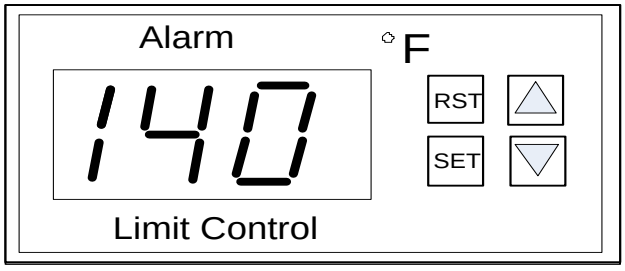

Figure 4-6: Digital Over-Temperature Alarm Switch Front Panel

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 switch to the **ON** position.
2. Press the **SET** button on the Over-Temperature Alarm switch. ***SP*** will appear in the display.
3. Press the **SET** button again. The current over-temperature limit value stored in memory will be displayed. (Default = 210°F, 98.9°C).
4. If the display does not show the required over-temperature alarm setting, press the ▲ or ▼ arrow button to change the display to the desired temperature setting.
5. Once the desired over-temperature alarm setting (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.

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. After reading this chapter, parameters can be customized to suit the needs of the specific application.

5.2 INDOOR/OUTDOOR RESET MODE

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

5.2.1 Reset Ratio

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

5.2.2 Building Reference Temperature

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

5.2.3 Outdoor Air Temperature Sensor Installation

The outdoor air temperature sensor must be mounted on the North side of the building in an area where the average outside air temperature is expected. The sensor must be shielded from the sun's direct rays, as well as 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 200 feet (61 m)** 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 2.9.1 for additional wiring information.

5.2.4 Indoor/Outdoor Reset Mode 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 Reset Mode Startup Procedure

8. Refer to the Indoor/Outdoor reset ratio charts in Appendix D.
9. Choose the chart corresponding to the desired Building Reference Temperature.
10. Go down the left column of the chart to the coldest design outdoor air temperature expected in your area.
11. 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.
12. Next, go up that column to the RESET RATIO row to find the corresponding reset ratio.
13. 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.
14. Press the **CHANGE** key. The display will begin to flash.
15. Use the ▲ and ▼ arrow keys to select the desired Building Reference Temperature.
16. Press **ENTER** to save any changes.
17. Next, scroll through the *Configuration* menu until the display shows ***RESET RATIO***.
18. Press the **CHANGE** key. The display will begin to flash.
19. Use the ▲ and ▼ arrow keys to select the Reset Ratio determined in step 5.
20. Press **ENTER** to save the change.

5.3 CONSTANT SETPOINT MODE

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

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

5.3.1 Setting the Setpoint

The setpoint temperature of the unit is adjustable from 40°F to 240°F. 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)

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

5.4 REMOTE SETPOINT MODES

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

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

The factory default setting for the REMOTE SETPOINT mode is 4 - 20 mA/1 - 5 VDC. With this setting, a 4 to 20 mA/1 to 5 VDC signal, sent by an EMS or BAS, is used to change the unit's setpoint. The 4 mA/1V signal is equal to a 40°F 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. Refer to GF-112, Appendix D for DIP switch settings, or 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.

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 RS485 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 (password required).

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. This will happen automatically after 1 hour after the password has expired.

5.5 DIRECT DRIVE MODES

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

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

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

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

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

NOTE

If a voltage, rather than current signal is used to control the remote setpoint, a DIP switch adjustment must be made on the PMC Board located in the Control Box Assembly. Refer to Appendix D of the C-More Control Panel OMM, GF-112, for DIP switch settings, or 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 (password required).

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. This will happen automatically after 1 hour after the password has expired.

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 an 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; 8 via pulse width modulation (PWM) and up to 32 via Modbus (RS-485) network communication. The ACS can control up to 32 boilers via RS-485 network communication. For programming, operation, and Header Sensor installation details, see GF-131 (ACS) Operations Guide. 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, and the RS485 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 RS485 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 (password required).

To change back to the ACS mode, simply press the **AUTO/MAN** switch. The REMOTE LED will again light and the MANUAL LED will go off. This will happen automatically after 1 hour after the password has expired.

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. 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.

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

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 (password required).

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. This will happen automatically after 1 hour after the password has expired.

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.

NOTE

MANUAL and AUTO modes of operation are required to perform the following tests. For a complete explanation of these modes, see Chapter 3. Also, it will be necessary to remove the front door and side panels from the unit to perform the following tests.

WARNING!

Electrical voltages in this system may include 575, 208 or 460, 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 TESTS

Refer to Figure 6-1A to locate both Low Gas Pressure switches and the proper locations to connect the water column manometer when performing the tests in this section.

The Low Gas Pressure Switch is adjustable; the instructions below set it to the correct position. The instructions below apply to both the Natural Gas and Propane gas trains.

Low Gas Pressure Fault Test

1. Shut off the external gas supply by closing the external gas supply ball valve.
2. Remove the front panel from the boiler to access the gas train components.
3. Locate the port on the top of the **NATURAL GAS Low Gas Pressure Switch** (see Figure 6-1A) and loosen the screw inside a few turns to open it. Do not remove this screw completely. Alternatively, you can remove the 1/4 inch plug shown in the top half of Figure 6-1A and install a hose barb fitting in that location.
4. Connect a 14“ W.C. to 2 psi manometer to the port or where the 1/4" plug was removed.
5. Apply the readings of the manifold pressure taken in Step 11 of section 4.4 (for Natural Gas) and Step 10 of section 4.5 (for Propane), and plug them into the following formulas, which calculate the ***minimum*** allowable gas pressure:
   - Natural Gas Pressure →____ x 0.5 + 6.0 = _____ min gas pressure
   - Propane Gas Pressure →____ x 0.5 + 3.7 = _____ min gas pressure
6. Remove the cover from the Low Gas Pressure Switch and set the dial indicator to **2** (the minimum).

Low Gas Pressure Fault Test – Continued

7. Open the external gas supply ball valve upstream of the unit.
8. Place the unit in MANUAL mode and adjust the Air/Fuel Valve position (% open) to **100%**.
9. While the unit is firing, read the CO value on the combustion analyzer and slowly decrease the incoming gas supply pressure until the CO reading is approximately **300 ppm**.
10. Take a reading of the inlet gas pressure. If the inlet pressure is below the minimum calculated in step 4, above, then increase the pressure to match the calculated minimum.
11. Slowly turn the indicator dial on the Low Gas Pressure Switch until the unit shuts down due to a gas pressure fault.
12. Readjust the inlet gas pressure to what it was prior to the test.
13. Press the **CLEAR** button on the Control Panel to clear the fault.
14. The fault message should clear and the *FAULT* indicator should go off. The unit should now restart.
15. Repeat the previous procedure on the PROPANE gas train, starting with the the PROPANE Low Gas Pressure Switch, shown in the bottom-half of Figure 6-1A.

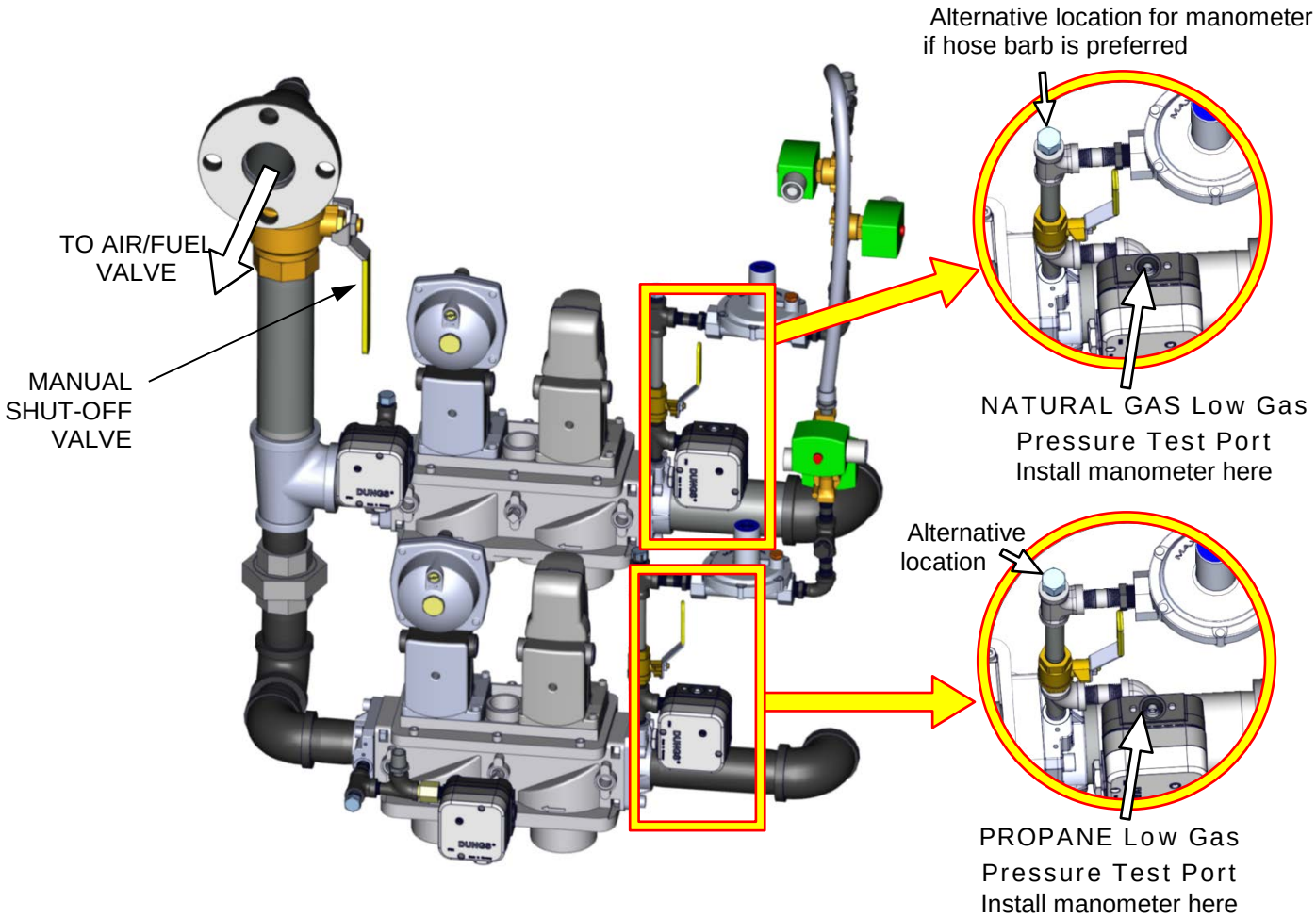

Figure 6-1A: Low Gas Pressure Switch Locations & Test Ports

6.3 HIGH GAS PRESSURE FAULT TEST

To simulate a high gas pressure fault, refer to Figure 6-1B and perform the following steps. The instructions below apply to both the Natural Gas and Propane gas trains.

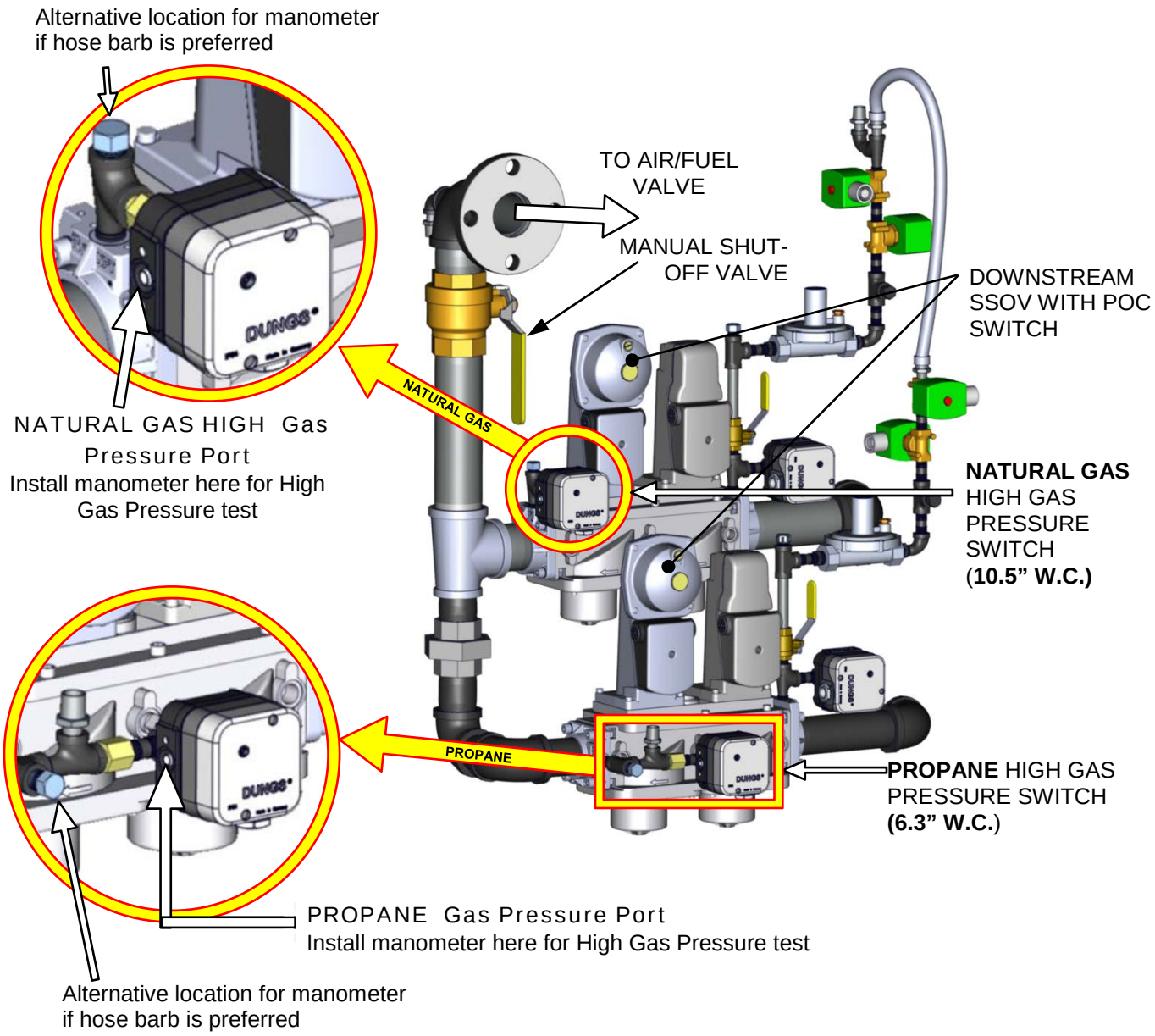

Figure 6-1B: High Gas Pressure Switch Locations & Test Ports

High Gas Pressure Fault Test

1. Shut off the **external** gas supply by closing the external gas supply ball valve.
2. Locate the port on the top of the **NATURAL GAS High Gas Pressure Switch** (see Figure 6-1A) and loosen the screw inside a few turns to open it. Do not remove this screw completely. Alternatively, you can remove the 1/4 inch plug shown in the top half of Figure 6-1A and install a hose barb fitting in that location.

High Gas Pressure Fault Test – Continued

3. Connect a 0 – 16" W.C. manometer to the port or where the 1/4" plug was removed.
4. Apply the readings of the manifold pressure taken in Step 11 of section 4.4 (for Natural Gas) and Step 10 of section 4.5 (for Propane), and plug them into the following formulas, which calculate the maximum allowable gas pressure:
   - Natural Gas Pressure → _____ x 1.5 = _____ max gas pressure
   - Propane Gas Pressure → _____ x 1.5 = _____ max gas pressure
5. Remove the cover from the High Gas Pressure switch and set the dial indicator to 20 (the maximum).
6. Open the **external** gas supply ball valve upstream of the unit.
7. Start the unit in MANUAL mode and adjust the Air/Fuel Valve position to bring the unit up to 100%,
8. Slowly increase the manifold gas supply pressure by turning the Gas Pressure Adjustment Screw in the Downstream SSOV (Figure 6-2) while reading the CO level on the combustion analyzer. Adjust the manifold pressure until the CO reading is **300 ppm**. Note the number of turns you make, as you will turn it back to its original position in step 10, below.

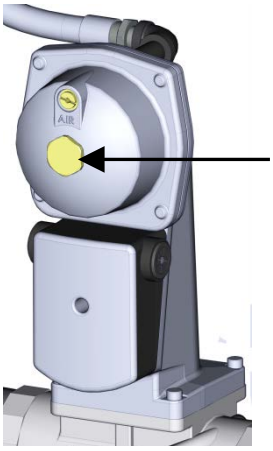

Figure 6-2: SSOV with Gas Pressure Adjustment Screw Location

9. Take a reading of the manifold gas pressure. If the manifold pressure is greater than the maximum calculated in step 3, then use the Gas Pressure Adjustment Screw to decrease the manifold pressure until it is at the maximum allowed.
10. Slowly turn the indicator dial on the High Gas Pressure Switch until the unit shuts down due to a gas pressure fault. This is the setpoint.
11. Readjust the manifold gas supply pressure to what it was before it was increased in step 7.
12. Press the **CLEAR** button on the Control Panel to clear the fault.
13. Upon test completion, remove the manometer, and turn the NATURAL GAS High Gas Pressure Switch port screw clockwise until port is closed.
14. Repeat this procedure on the PROPANE gas train, starting with opening the port on the side of the PROPANE High Gas Pressure Switch, as shown Figure 6-1B.

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 6-3.

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 until the water temperature is below the new setpoint.
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.

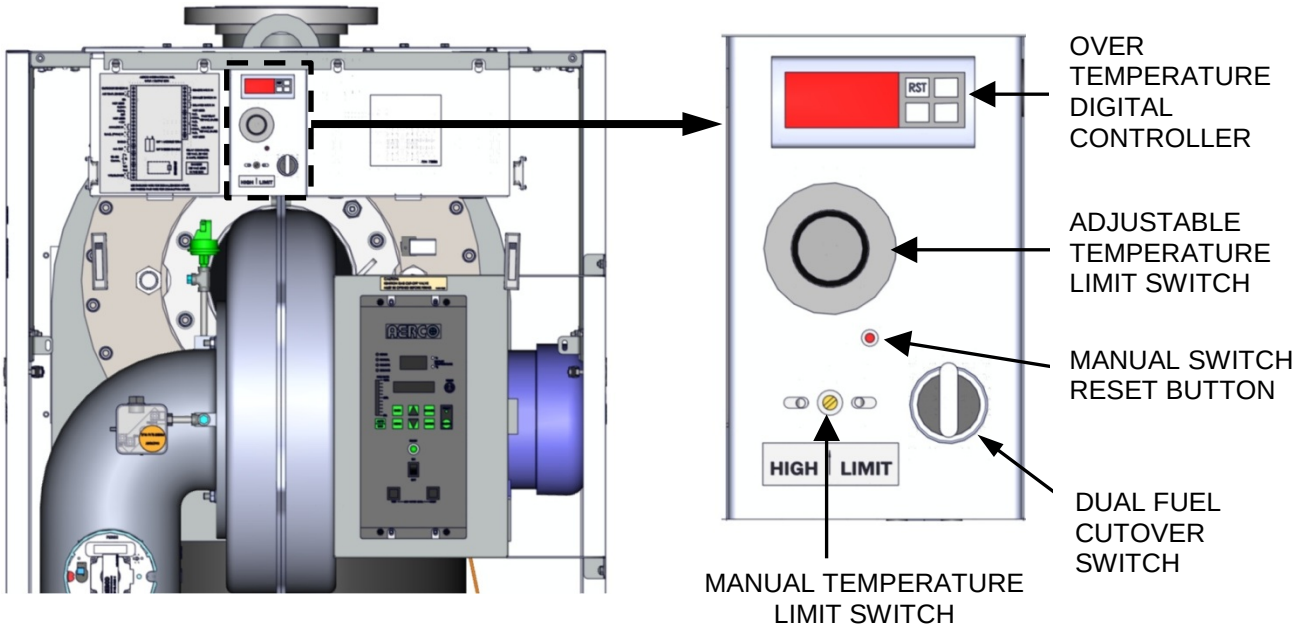

Figure 6-3: Temperature Limit Switch Setting

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 (Figure 2-13) and are labeled REMOTE INTL'K IN and DELAYED INTL'K IN. These circuits can shut down the unit in the event that an interlock is opened. These interlocks are shipped from the factory jumpered (closed). However, each of these interlocks may be utilized in the field as a remote stop and start, an emergency cut-off, or to prove that a device such as a pump, gas booster, or louver is operational.

6.6.1 Remote Interlock Test

Remote Interlock Test

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

6.6.2 Delayed Interlock Test

Delayed Interlock Test

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

6.7 FLAME FAULT TESTS

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

Flame Fault Tests

1. Set the ON/OFF switch to the **OFF** position.
2. Place the unit in the MANUAL mode and set the valve position **between 25% and 30%.**
3. Close the manual gas shut-off valve located between the Safety Shut-Off Valve (SSOV) and the Air/Fuel Valve (see Figure 6-4).
4. It may be necessary to jump out the high gas pressure switch.
5. Set the ON/OFF switch to the **ON** position to start the unit.
6. The unit should purge and light the Pilot flame and then shut down after reaching the main Burner Ignition cycle and display *FLAME LOSS DURING IGN*.
7. Open the valve previously closed in step 3 and press the CLEAR button.
8. Restart the unit and allow it to prove flame.
9. Once flame is proven, close the manual gas valve located between the SSOV and the Air/Fuel Valve (Figure 6-4).
10. The unit should shut down and Lockout. A flashing *FLAME LOSS DURING RUN* should appear in the display.
11. Open the valve previously closed in step 8.
12. Press the **CLEAR** button. The unit should restart and fire.

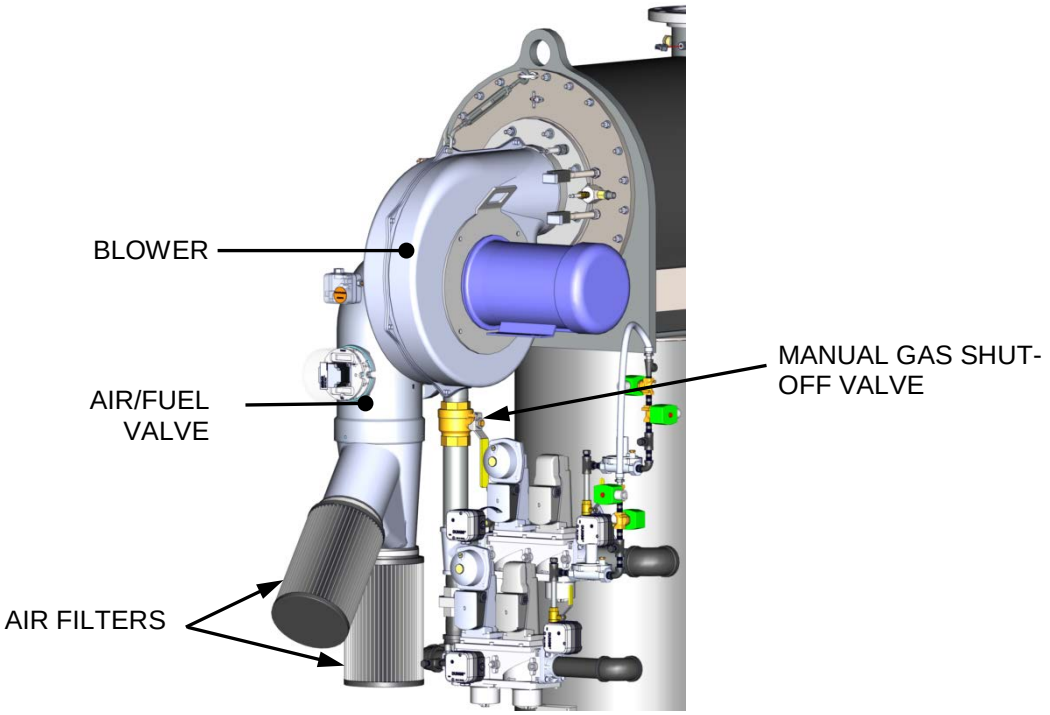

Figure 6-4: Bare Boiler – Partial View

6.8 AIR FLOW FAULT TESTS

These tests check the operation of the Blower Proof Switch and Blocked Inlet Switch shown in Figure 6-5.

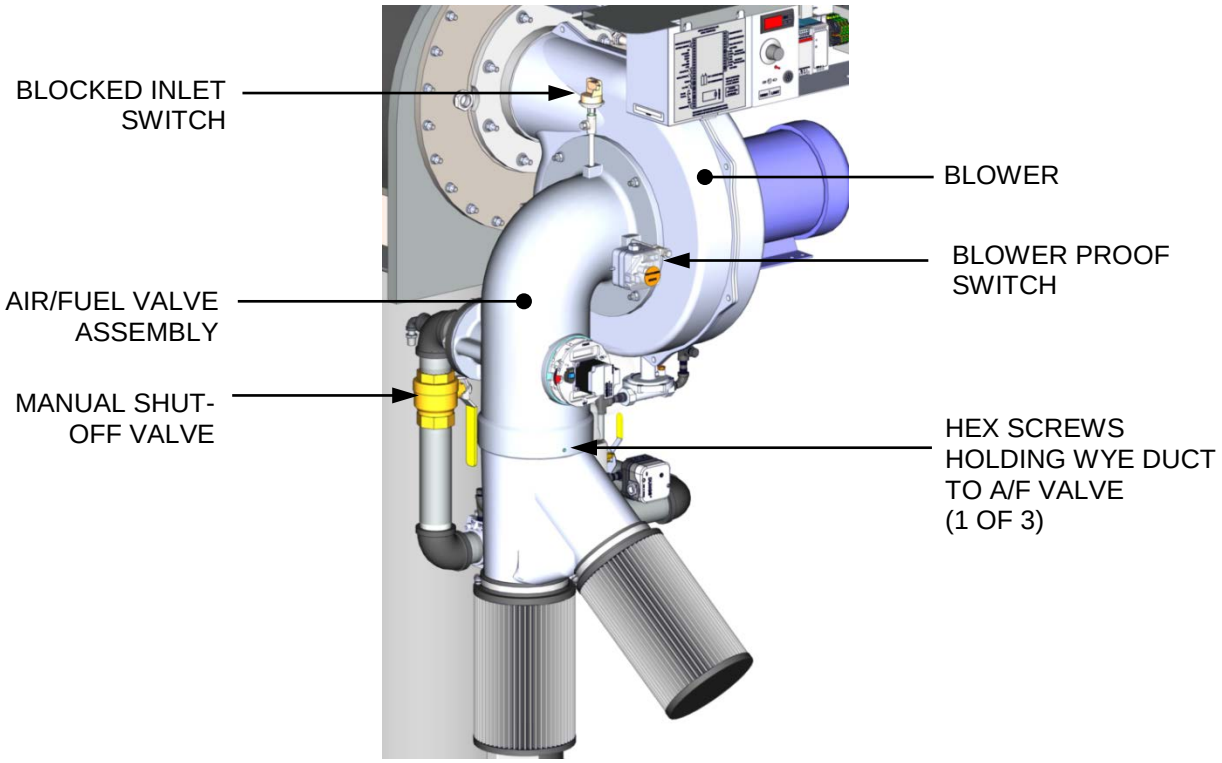

Figure 6-5: Blower Proof Switch & Blocked Inlet Switch Locations

6.8.1 Blower Proof Switch Test

Blower Proof Switch Test

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

6.8.2 Blocked Inlet Switch Test

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

Blocked Inlet Switch Test

1. Turn the main ON/OFF switch on the front of the Control Panel to the **OFF** position.
2. Remove the three (3) hex head screws securing the WYE-Duct and air filters to the Air/Fuel valve (see Figure 6-5, above) and carefully remove the WYE-Duct and air filter assembly.

WARNING!

The blower suction is very strong and can pull nearby objects into the blower's fan blades. **DO NOT ALLOW ANYTHING TO BE PULLED INTO THE BLOWER.** Do not wear anything that could get caught and pull you into the blower.

Blocked Inlet Switch Test – *Continued*

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.
   c) Connect the Flame Signal Generator to the black connector boot.

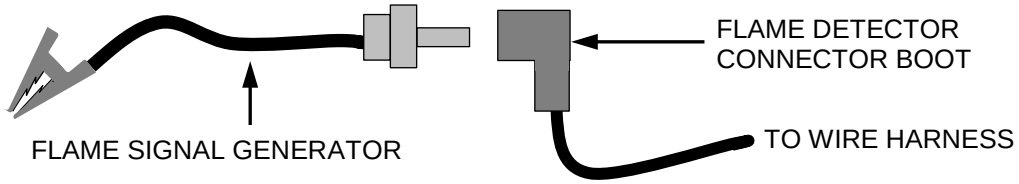

Figure 6.6: Connecting the Flame Signal Generator

   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 the main ON/OFF switch on the front of the Control Panel to the **ON** position.
   b) Push the **BACK** button three (3) times to return to the upper level menu.
   c) When the Controller gets into the ignition phase, the Control Panel will show ***IGNITION TRIAL***. At that point attach the alligator clip (see Figure 6.6) 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 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 2 and replace the black connector boot on the Flame Detector.
10. Press the **CLEAR** button. The unit should restart.

6.9 SSOV PROOF OF CLOSURE SWITCH

On both the Natural Gas and Propane gas trains, the downstream SSOV shown in Figure 6-1B contains the proof of closure (POC) 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 6-1B, above, to locate the downstream SSOV.
4. Remove the cover from the SSOV by loosening the screw, shown in Figure 6-7. 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 6-7: Downstream 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 6-8).
4. Remove one of the two wires (#171 or #172) from the Purge Switch (Figure 6-9).
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.

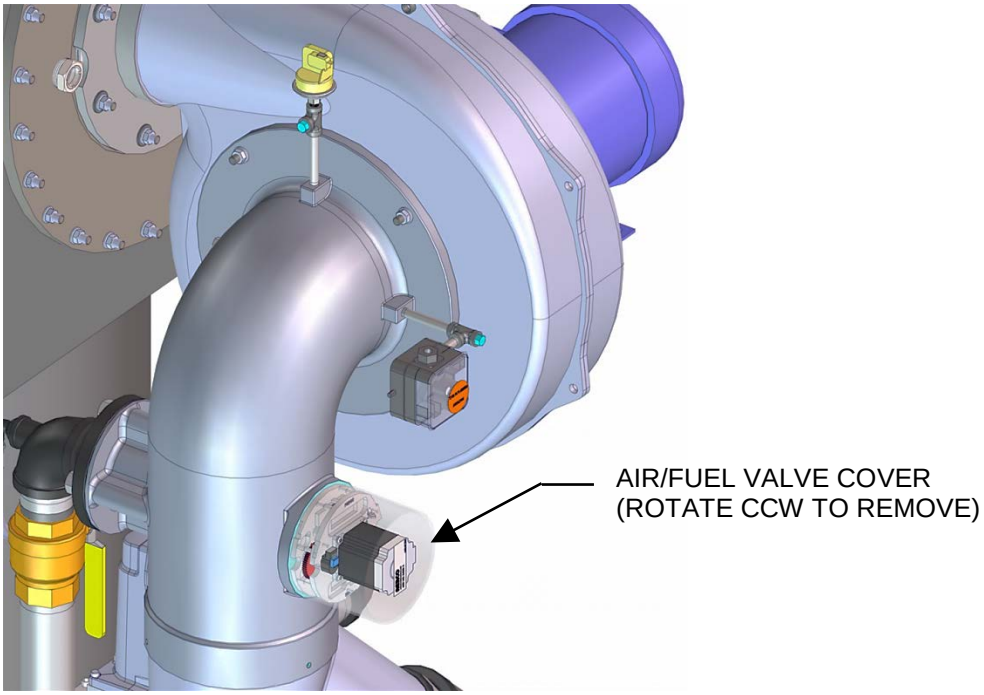

Figure 6-8: Air/Fuel Valve Cover Location

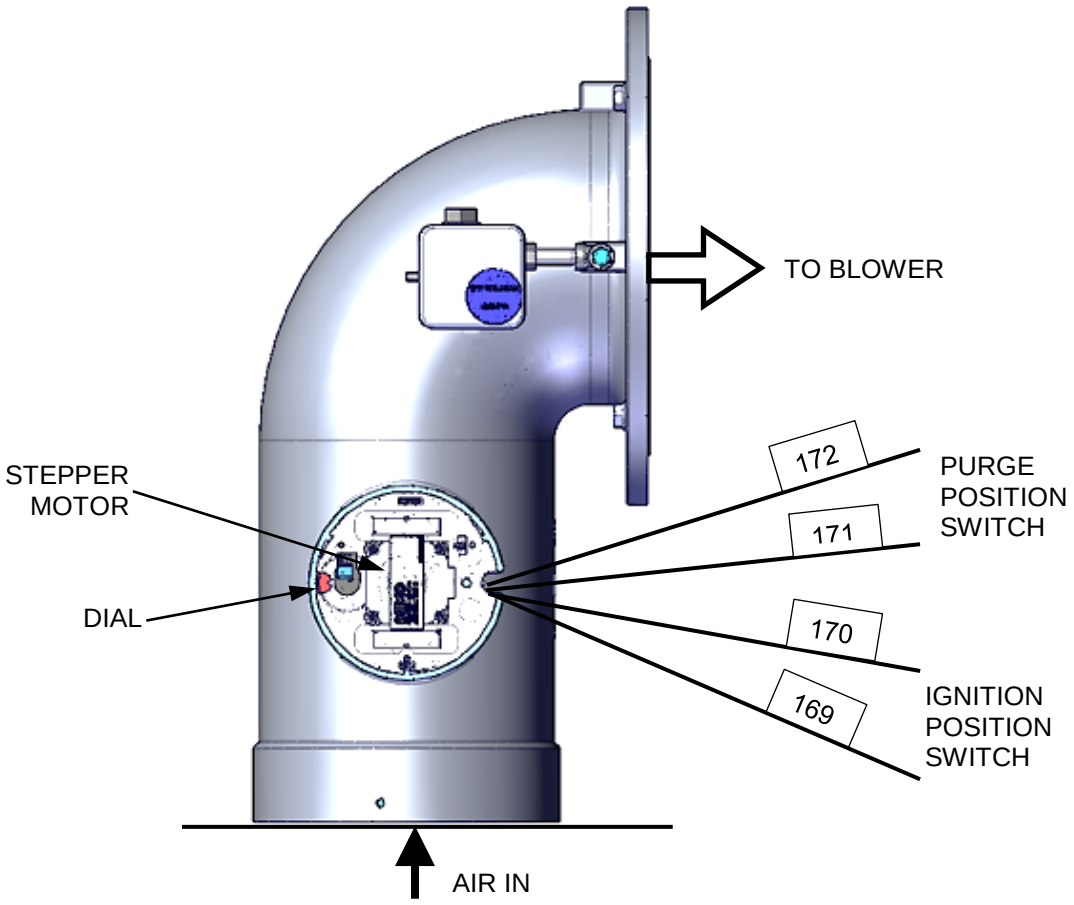

Figure 6-9: Air/Fuel Valve Purge and Ignition Switch Locations

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 (see Figure 6-8, 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 (see Figure 6-9).
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.

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 **58025-11**
- 24-Month Waterside/Fireside Inspection Kit, P/N **58025-12** (See NOTE below)

NOTE

The 24-Month Waterside/Fireside Inspection Kit also includes the items contained in the Annual Maintenance Kit (58025-11). Therefore, only Kit P/N **58025-12** is required when performing the waterside/fireside inspections. Refer to Appendix K for recommended spares.

WARNING!

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

- Use lockout/tagout procedures
- Disconnect the ac 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	Pilot Burner (P/N **29700**)	*Inspect	Inspect	Replace	15 min.
7.3	Main Flame Detector (P/N **65150**)	*Inspect	Inspect	Replace	15 min.
7.4	Lean O_2 Sensor (P/N **61026**)	*Inspect	Inspect	Inspect	15 min.
4.4	Combustion Calibration	*Check	Check	Check	1 hr.
7.6	Testing of Safety Devices	-	See ASME CSD-1 Chart	See ASME CSD-1 Chart	45 min.
7.7	Burner	-	-	Inspect	2 hr.
7.9	Condensate Drain Trap	*Inspect	Inspect, Clean & Replace Gaskets	Inspect, Clean & Replace Gaskets	30 min.
7.10	Air Filter (P/N **88014**)	-	Replace	Replace	15 min.
7.13	Low Water Cutoff (LWCO) Probe Capacitor	-	Test	Replace & Test	15 min.

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

7.2 PILOT BURNER

The Pilot Burner (P/N **29700**) is located on the right-front of the Burner Plate. It contains an ignition cable and a Pilot gas line connected to the bushing. Figure 7-1 shows the location of the Pilot Burner and related components.

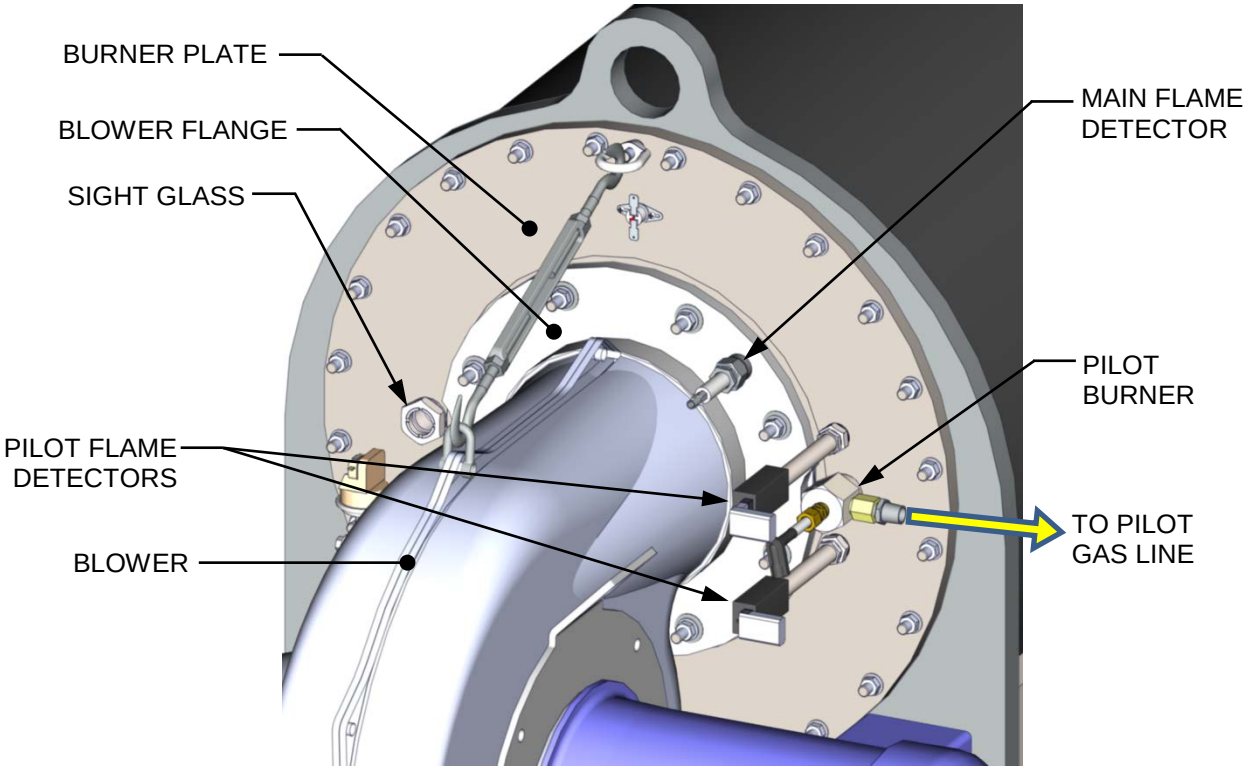

Figure 7-1: Pilot Burner, Main & Pilot Flame Detector Mounting Locations

The Pilot Burner may be hot, therefore care should be exercised to avoid burns. It is easier to remove the Pilot Burner from the unit after it has cooled to room temperature. To inspect/replace the Pilot Burner, perform the following procedure:

Pilot Burner Maintenance Procedure

1. Set the **ON/OFF** switch on the control panel, to the **OFF** position. Disconnect AC power from the unit
2. For easy access, open the front panel and right side door. If you are working on the left unit of a two-unit, zero side clearance installation, you may want to remove the top panel and service the unit from above.
3. Disconnect the ignition cable from the Pilot Burner (Figure 7-1).
4. Using a 1/2" open-end wrench, disconnect the Pilot gas line from the reducer fitting and elbow shown in Figure 7-1.
5. First, remove the reducer fitting and then the elbow from the Pilot Burner.
6. Remove one of the two Pilot Flame Detectors to provide clearance for Pilot Burner removal.
7. Using a 1-1/2" open end wrench, loosen and remove the Pilot Burner from the Burner Plate.

Pilot Burner Maintenance Procedure – Continued

8. Check the Pilot Burner tip for evidence of erosion or carbon build-up. If there is evidence of substantial erosion, the Pilot Burner should be replaced. If carbon build-up is present, clean the component using a wire brush.
9. Prior to reinstalling the Pilot Burner, a high temperature, conductive, anti-seize compound must be applied to the threads.
10. Reinstall the Pilot Burner on the Burner Plate. Torque to **170 - 180 in-lbs**.
11. Reassemble the remaining components in the reverse order that they were removed.
12. Reconnect the ignition cable.
13. Close the right side door and front panel. Replace the top panel if the unit was serviced from above.

7.3 MAIN FLAME DETECTOR

The Main Flame Detector (P/N **65150**) is located on the Blower Flange near the top of the unit (see Figures 7-1). The Main Flame Detector may be hot. Allow the unit to cool sufficiently before removing the Main Flame Detector. Inspect or replace the Main Flame Detector as follows:

Main Flame Detector Maintenance Procedure

1. Set the control panel ON/OFF switch to the **OFF** position. Disconnect AC power from the unit.
2. Remove the front panel from the unit by grasping the top handle and pulling straight out.
3. Disconnect the Main Flame Detector lead wire. Be careful not to yank the wire when it pops off the Main Flame Detector.
4. Remove the Main Flame Detector from the Blower Flange.
5. Thoroughly inspect the Main Flame Detector. If eroded, the detector should be replaced. Otherwise clean the detector with a fine emery cloth. Replacement is necessary every 24 months.
6. Apply a small amount of high temperature TFE-Based thread sealant and reinstall the Main Flame Detector on the Blower Flange.
7. Reconnect the Main Flame Detector lead wire.
8. Replace the front panel on the unit.

7.4 O_2 SENSOR

The Lean Oxygen Sensor (P/N **61026**) is located on the back plate at the right side of the unit as shown in Figure 7-2. As this Figure shows, there is also a gas suction line that supplies a sampling of the exhaust gases from the exhaust manifold to ensure accurate sampling of the O_2 levels. The sensor and the suction line may be hot, therefore allow the unit to cool sufficiently before removing or replacing the O_2 sensor.

NOTE

The O_2 Sensor needs to be replaced only once every 5 years.

The O_2 Sensor is removed and inspected by performing the following procedural steps:

O2 Sensor Maintenance Procedures

1. Set the ON/OFF switch on the control panel, to the **OFF** position. Disconnect AC power from the unit.
2. Remove the left-rear access panel from the unit's right side panel by removing the 4 Phillips head screws attaching it (Figure 7-2).
3. Disconnect the O2 sensor lead wire by pushing in on the release tab and pulling apart the connector.
4. Next, loosen and remove the O2 sensor and crush washer from the back plate using a 15/16" open-end wrench.
5. Thoroughly inspect the O2 sensor. If corroded, the sensor should be replaced. Ensure that the hole in the refractory is clean and that the gas sample suction tube is not clogged.
6. Reinstall the O2 sensor and crush washer on the back plate.
7. Reconnect the sensor lead wire.
8. Reinstall the left-rear access panel on the unit.

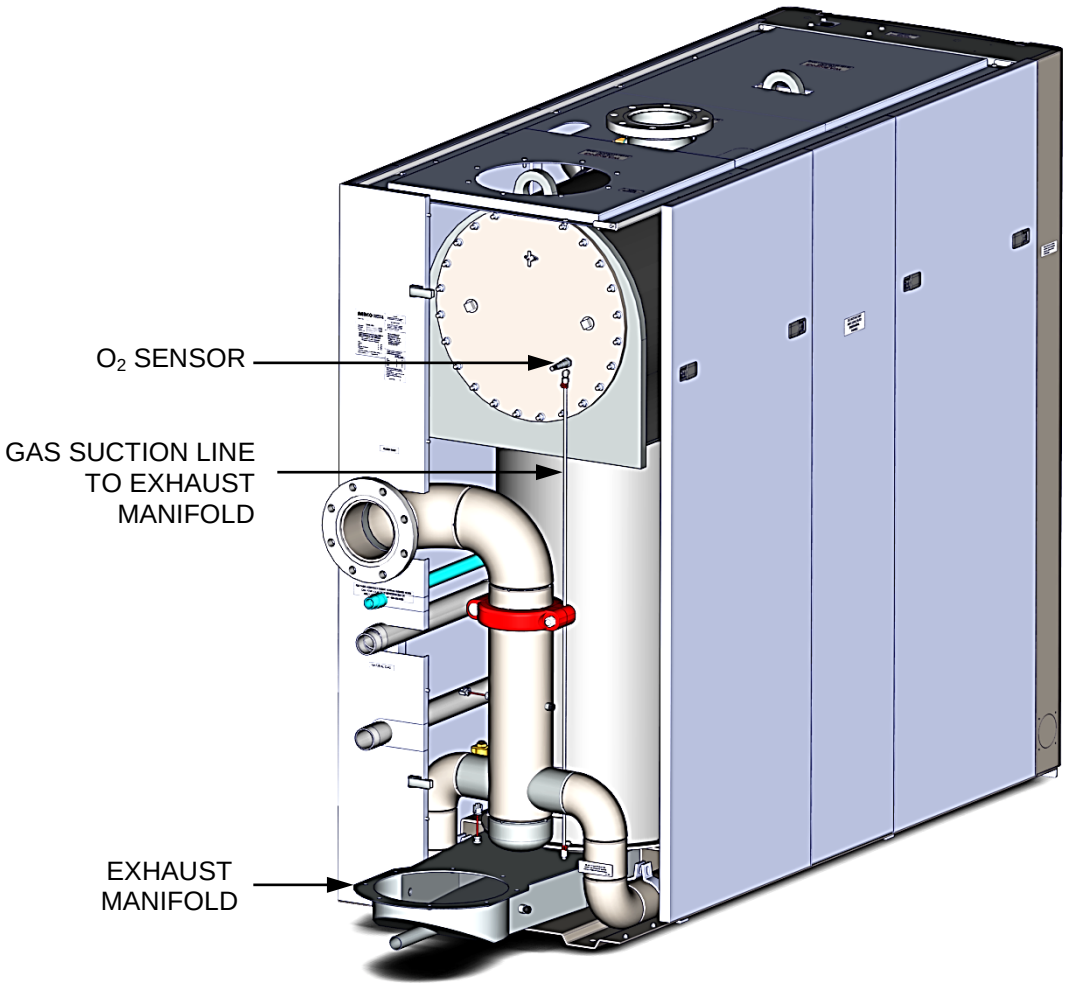

Figure 7-2. O_2 Sensor Mounting Location

7.5 COMBUSTION CALIBRATION & PILOT REGULATOR ADJUSTMENT

Combustion settings must be checked at the intervals shown in Table 7-1 as part of the maintenance requirements. Refer to Chapter 4 for combustion calibration instructions. Pilot Regulator tests and adjustments are performed using the procedures in sections 7.5.1 and 7.5.2 which follow.

7.5.1 Pilot Regulator Pressure Testing

Benchmark 6000 Dual Fuel units have two Pilot Regulator systems, one in the Natural Gas gas train and one in the Propane gas train (see Figure 7-3). Both Pilot Regulators should be pressure tested annually as described below. If the gas pressure is ***below* 4.6" W.C.** or ***above* 5.0" W.C.** in either regulator, then that regulator must be recalibrated using the instructions in section 7.5.2.

The following pressure test is performed on both the Natural Gas and Propane Pilot Regulators:

Pilot Regulator Pressure Test Procedure

1. Ensure that gas supply shut-off valve upstream of the unit is still turned **OFF**.
2. Turn OFF electrical power to the system.
3. Remove the 1/4" NPT plug from the Tee on the outlet side of the Pilot Regulator (Figure 7-3) and insert a NPT-to-barbed adapter fitting.
4. Attach one end of the plastic tubing to the barbed fitting and the other end to the 16" W.C. manometer.
5. Remove the cap from the Pilot Regulator to access the gas pressure adjustment. Rotate the regulator adjustment (beneath cap) clockwise (CW) to its highest possible pressure setting.
6. Next, rotate the adjustment screw 2 turns counterclockwise (CCW).
7. OPEN the main gas supply upstream of the unit.
8. Turn ON electrical power to the system.
9. Start the boiler in MANUAL mode. Observe the manometer pressure when the Pilot solenoid "clicks" open after purge. It should now provide a reading of **4.8 ± 0.2" W.C.**
10. Pull out one of the Pilot Flame Detectors (see Figure 7-1) and look into the observation port on the front plate. You should see the orange glow of the Pilot flame during the ignition trial period.
11. If the pressure is within specifications, return the unit to service. Make sure that the unit is operating in AUTO mode. The "MAN" light in the upper left of the control box should NOT be lit when in AUTO mode.
12. If the Pilot Regulator is NOT within specifications, proceed to section 7.5.2 and perform the Pilot Regulator Pressure Calibration procedure.

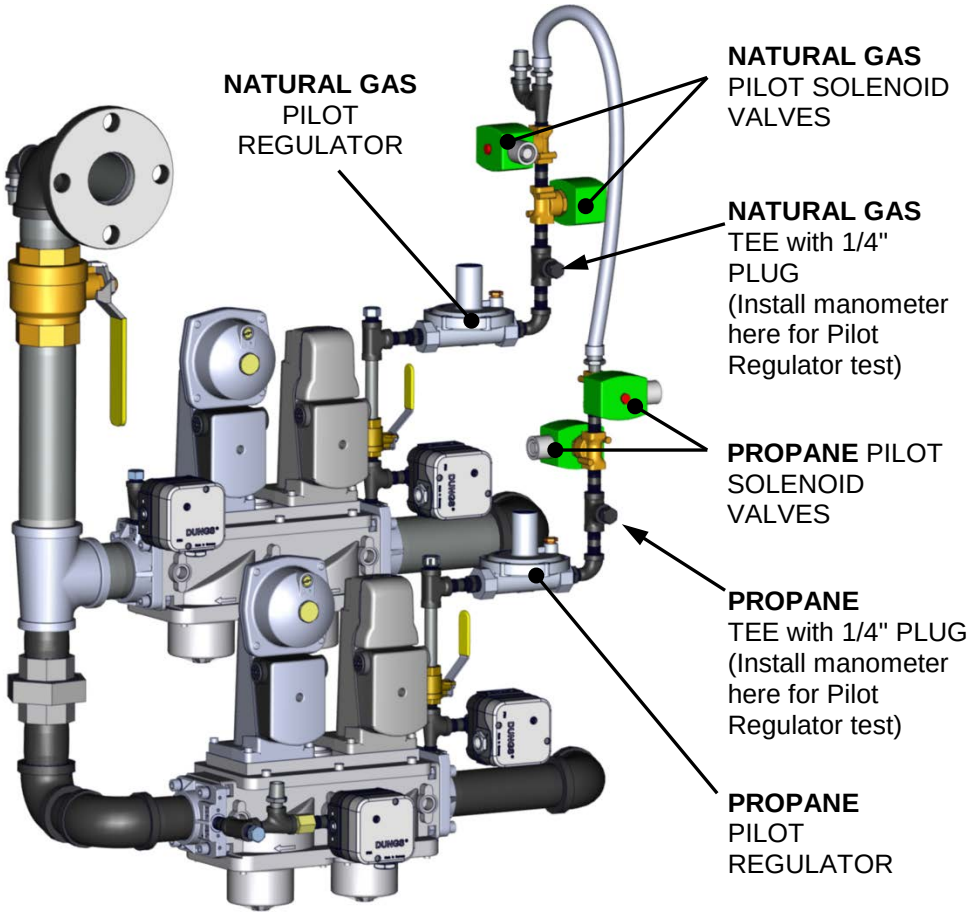

Figure 7-3: Pilot Regulator Mounting Location

7.5.2 Pilot Regulator Pressure Calibration

The instructions in this section apply to both the Natural Gas and Propane gas trains.

If either the Natural Gas or Propane Pilot Regulator pressure is ***below* 4.6" W.C.** or ***above* 5.0" W.C.** the Pilot Regulator pressure must be calibrated using the following procedure:

Pilot Regulator Pressure Calibration Procedure

1. Ensure that gas supply shut-off valve upstream of the unit is still turned **OFF**.
2. Turn **OFF** electrical power to the system.
3. Remove the pipe plug from the 1/4" NPT port on the outlet side of the Pilot Regulator (Figure 7-3) and insert a NPT-to-barbed adapter fitting.
4. Attach one end of the plastic tubing to the barbed fitting and the other end to the 16" W.C. manometer.
5. Remove the cap from the Pilot pressure regulator and rotate the regulator adjustment (beneath cap) clockwise (CW) to its highest possible pressure setting.
6. **OPEN** the main gas supply upstream of the unit.

Pilot Regulator Pressure Calibration Procedure – Continued

7. Turn **ON** electrical power to the system.
8. Start the boiler in the MANUAL mode. Observe the manometer pressure when the Pilot solenoid "clicks" open after purge. The manometer should now provide a reading of **4.8 ± 0.2" W.C.**
9. Pull one of the Pilot Flame Detectors out (see Figure 7-1) and look into the port in the front plate. You should see the orange glow of the Pilot flame during the ignition trial period.

NOTE

If you do ***not*** see the orange glow, contact AERCO technical support to ascertain the problem. If you DO see it, proceed to the next step.

10. If the manometer reading is less than **4.6" W.C.**, increase the regulator setting by rotating the adjustment screw clockwise (CW).
11. Repeat steps 8 through 10 until the gas pressure at the outlet of the Pilot Regulator pressure reads **between 4.6" W.C. and 5.0" W.C.** on the monometer.
12. Once the pressure reading is **between 4.6" W.C. and 5.0" W.C.**, conduct at least three safe Pilot ignitions while observing the observation port. Assure the igniter lights immediately with a strong orange flame after the Pilot ignition solenoid valve opens.

NOTE

Clear any *Flame Loss During Ignition* messages during the tests by pressing the **CLEAR** key on control panel.

13. **CLOSE** the external gas supply valve.
14. Disconnect the manometer, tubing and barbed fitting from the 1/4" NPT port hole.
15. Replace the 1/4" plug where the barbed fitting was removed
16. Replace the Pilot Flame Detector.
17. **OPEN** the external gas supply upstream of the unit.
18. Ensure power is restored and the boiler is turned on in the MANUAL mode.
19. Refer to sections 4.4 and 4-5 in Chapter 4 - Initial Start-up, to perform the Combustion Calibration procedure.
20. Return the unit to service following successful completion of the Combustion Calibration procedures. Make sure that the unit is operating in the AUTO mode. The "MAN" light in the upper left of the control box should NOT be lit in AUTO mode.

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 for Safety Device Testing Procedures.

7.7 BURNER ASSEMBLY INSPECTION

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

NOTE

In order to perform this procedure most efficiently with a minimum of steps, a simple support rig has been designed to hold up the blower and Air/Fuel Valve assembly while the blower plenum is removed to allow the Burner assembly to be removed for maintenance. Use of this support will prevent the blower's weight from stressing the connection to the gas train. This support rig prevents having to dismantle the entire Blower and Air/Fuel Valve assembly from the gas train. The support rig is available as an after-market part.

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

Part No.	Description
81159	Burner Gaskets (2)

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

Burner Assembly Inspection and Maintenance Procedures

1. Set the ON/OFF switch on the control panel, to the **OFF** position. Disconnect AC power from the unit and turn off the gas supply.
2. Remove the front panel, top panel and front side panels from the unit by grasping and lifting straight up and outward. This will expose the blower assembly for removal.
3. Remove the harnesses attached to the C-More control panel, remove 4 nuts (2 above and 2 below) from the C-More bracket and then remove the C-More and set it aside.
4. Disconnect the lead wire from the Main Flame Detector installed on the Blower Flange (Figure 7-1).
5. Remove the Main Flame Detector from the Blower Flange.
6. Remove the Pilot sensors and observation ports from the Burner Plate (Figure 7-4a).
7. Disconnect the cable from the Pilot Burner by pulling straight out.
8. Using a 1/2" open-end wrench, disconnect the Pilot gas line from the reducer fitting and elbow shown in Figure 7-1.
9. First, remove the reducer fitting and then the elbow from the Pilot Burner.
10. Next, loosen and remove the Pilot Burner from the Burner Plate using a 1-1/2" open-end wrench.
11. Remove the blower support turn-buckle (Figure 7-4A).
12. Attach a hoist rig, capable of lifting at least 300 pounds, to the lifting lug on the blower fan housing. **The Blower assembly weighs approximately 150-200 lbs. depending on which blower motor is installed**.
13. Remove the two inlet air filters from the galvanized WYE-duct.
14. Disconnect the wires from the Blower Proof and Blocked Inlet switches (see Figure 7-4b).

Burner Assembly Inspection and Maintenance Procedures – **Continued**

15. Disconnect the Molex connector from the temp sensor.
16. Place a support block of any appropriate material (such as a scrap 2X4 cut to length) under the gas train (see Figure 7-4b), and then remove the four 5/8-11 bolts & washers connecting the gas train to the Air/Fuel valve.
17. Remove the 6 3/8-16 nuts attaching the Air/Fuel valve to the Blower and then pull the Air/Fuel valve off and set it aside.
18. Loosen and remove the eight (8) 3/8" hex nuts and washers from the Blower Flange where it is attached to the Burner Plate (see Figures 7-4a & 7-4b).
19. Remove the Blower from the Burner by pulling outward. Be careful not to allow it to swing and damage other equipment components. Refer to the exploded view in Figure 7-5.
20. Lower the Blower assembly down approximately 16" until it is clear of the Burner Flange.
21. Remove the Burner by pulling straight out.
22. Gently slide the Burner out of the boiler using care to avoid tearing the mesh burner fabric, or cock the Burner to one side or the other.
23. Remove and replace the two (2) Burner Gaskets (see Figure 7-5) and clean the gasket surface on the burner front plate.
24. To reassemble, begin with the Burner assembly and reinstall all the components in the reverse order that they were removed. The Burner may have a nut installed at the base position to keep the Burner level while installing the Blower (Figure 7-5).
25. Ensure that the Pilot Burner and Pilot Flame Detectors cutouts in the Blower Flange are properly aligned with the Burner Front Plate.

Burner Assembly Inspection and Maintenance Procedures – **Continued**

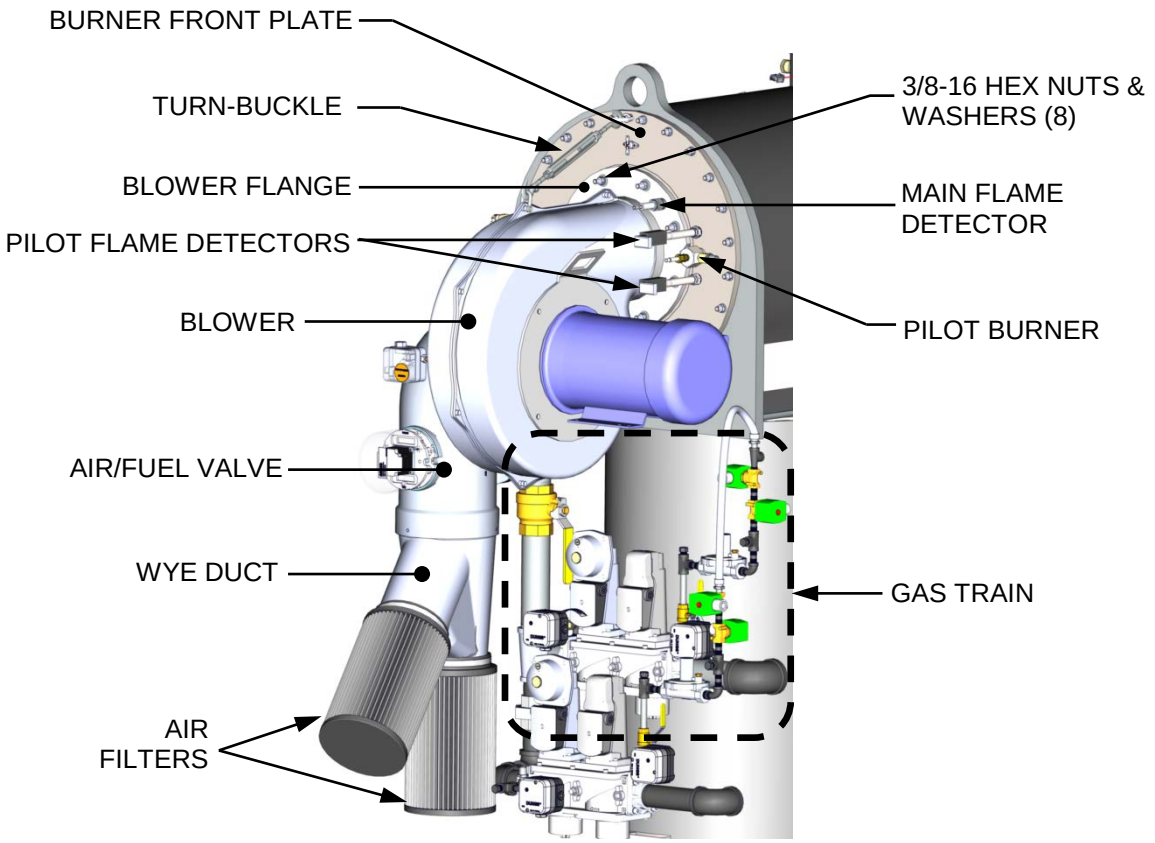

Figure 7-4a: Burner Assembly Mounting Details – Right-Front View

Burner Assembly Inspection and Maintenance Procedures – **Continued**

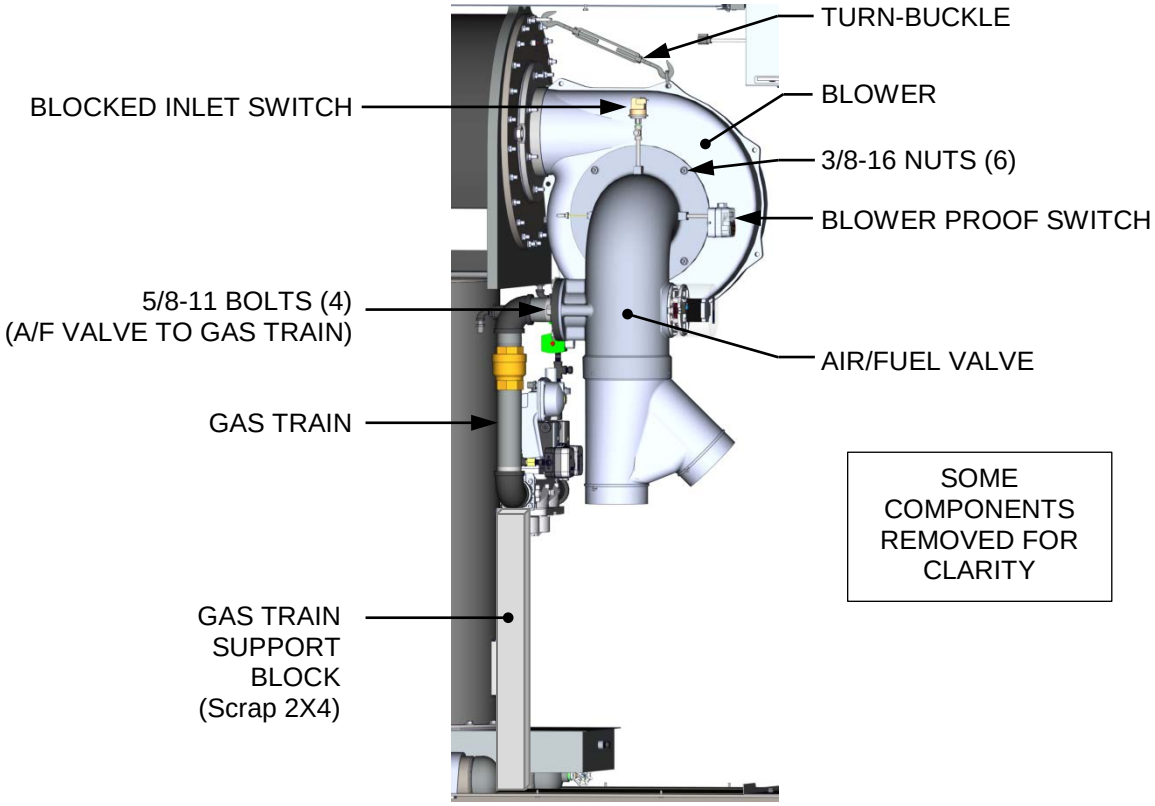

Figure 7-4b: Burner Assembly Mounting Details – Left Side View

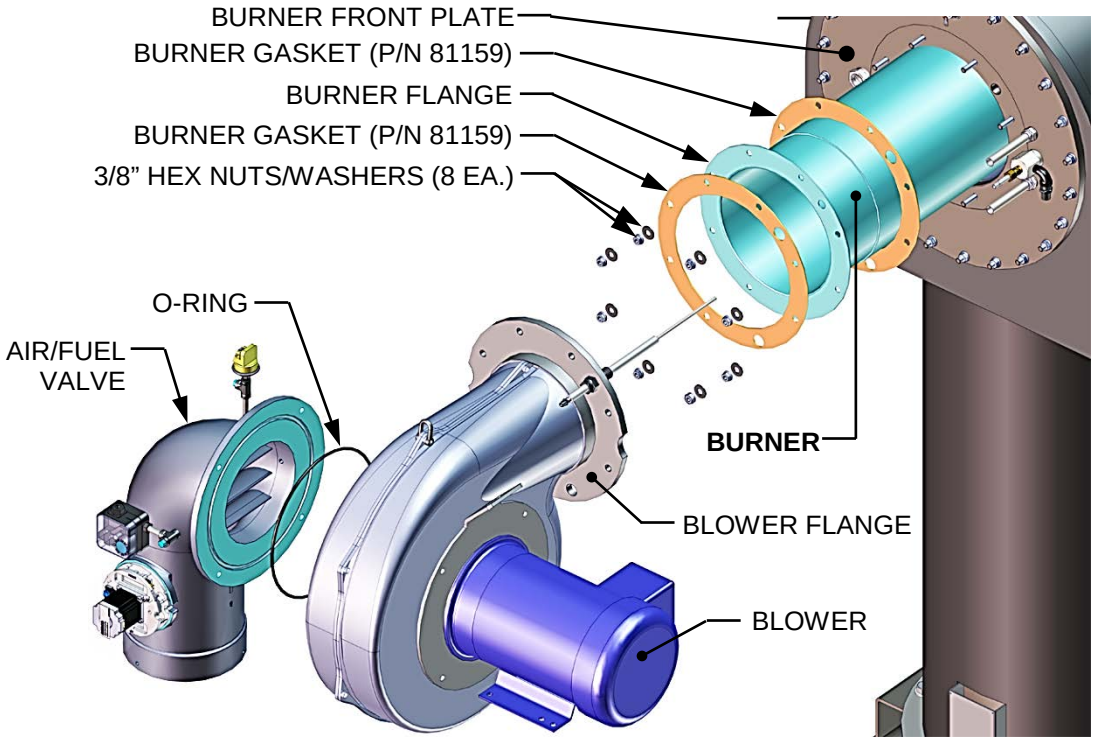

Figure 7-5: Burner Assembly – Exploded View

7.8 REFRACTORY REMOVAL & REPLACEMENT

WARNING!

The heat exchanger insulation utilizes ceramic fiber material. Wear a fitted NIOSH-approved particulate respirator (3m n95 or equiv.) When servicing the heat exchanger and burner assemblies. At high temperatures, ceramic fibers can be converted to crystaline silica fibers which have been identified as carcinogenic when inhaled.

Low mass, fiber-based material insulates the front and rear end plates of the combustion chamber. This material has very low thermal conductivity and is not susceptible to thermal shock conditions that cause failures of hard-faced refractory materials.

In the event that access to the unit's combustion chamber is required, the preferred method is to remove the rear refractory first, since it requires fewer and less complicated procedural steps. However, if the front refractory is removed first, the complete Burner assembly, blower assembly and air/fuel valve assembly must be removed to access the refractory material.

The procedures for removal of the rear refractory and front refractory materials are provided in sections 7.8.1 and 7.8.2, respectively.

7.8.1 Rear Refractory Removal & Replacement

Complete the following steps to access and replace the rear refractory:

Rear Refractory Replacement Procedure

1. Turn off gas and electrical power to the unit. In addition, turn off any other units sharing the exhaust flue.
2. Disconnect the flue from the exhaust manifold of the boiler being serviced and remove flue sections up to the top of the unit enclosure.

   NOTE

   At the top, the left-rear and right-rear covers are affixed to the left and right top rails by nuts. At the bottom, each rear cover is affixed to the base with one nut each. Access the nuts for removal through the side panel, as shown in Figure 7-6.

3. Remove the left-rear panel, which is held in place by 2 spring latches and 7/16" bolts, inside the panel on the top rail and bottom lip. See Figure 7-6.
4. With the panels removed, the rear plate of the combustion chamber can be accessed as shown in Figure 7-7.

   CAUTION

   The surfaces of the heat exchanger may be hot. Allow the unit to cool sufficiently before proceeding to the next step.

5. Remove the O2 sensor and the 1/4" stainless steel tube from the rear plate.
6. Disconnect the wires from the thermal switch on the rear plate.

Rear Refractory Replacement Procedure – **Continued**

7. Remove all of the nuts from the rear plate, EXCEPT for the one at the top of the plate.
8. Loosen (but DO NOT remove) the top nut and slide a thin metal object (such as a hacksaw blade) between the rear plate and the fiber material of the rear refractory to separate the material from the plate.

CAUTION

The rear plate weighs approximately 40 pounds. It is therefore recommended that 2 people be used when removing the plate.

9. Remove the top nut from the plate and remove it from the unit.
10. Optionally, you can thread 2 small nipples into the rear plate to act as handles, which will ease removal and reinstallation.
11. Refer to Figure 7-8 and note the position of the rear refractory. Prior to refractory removal, mark as necessary using a permanent marker or tape.
12. Gently pull on the two opposing metal tabs located on the outer edge of the fiber blanket, then alternately pull on the other two opposing tabs. Continue this process until the fiber refractory package can be removed from the combustion chamber. Be careful not to drop or damage the refractory.
13. Place the fiber insulation package, metal face down, in a safe location to avoid damage.
14. The combustion chamber can now be viewed and inspected with a full view of the Burner assembly and rear tubesheet. A borescope can be used to inspect the front tubesheet as well as under the expansion joints.
15. Following inspection, reinstall the components in the reverse order in which they were removed.

IMPORTANT

If the rear refractory (P/N **83027**) was damaged during removal, it should be replaced with a new part. If rear refractory replacement is required, a 2 hour burn-in period at a 30% fire rate must be performed to drive off organic binders. These organic binders are not hazardous materials, however they may emit an odor similar to burning wood.

16. Tighten the bolts on the rear plate using an alternating pattern to ensure a uniform seal. Torque bolts to approximately **20 ft-lbs**.
17. To avoid exhaust leaks, ensure that a uniform seal is established when reconnecting the flue system to the boiler.

Rear Refractory Replacement Procedure – **Continued**

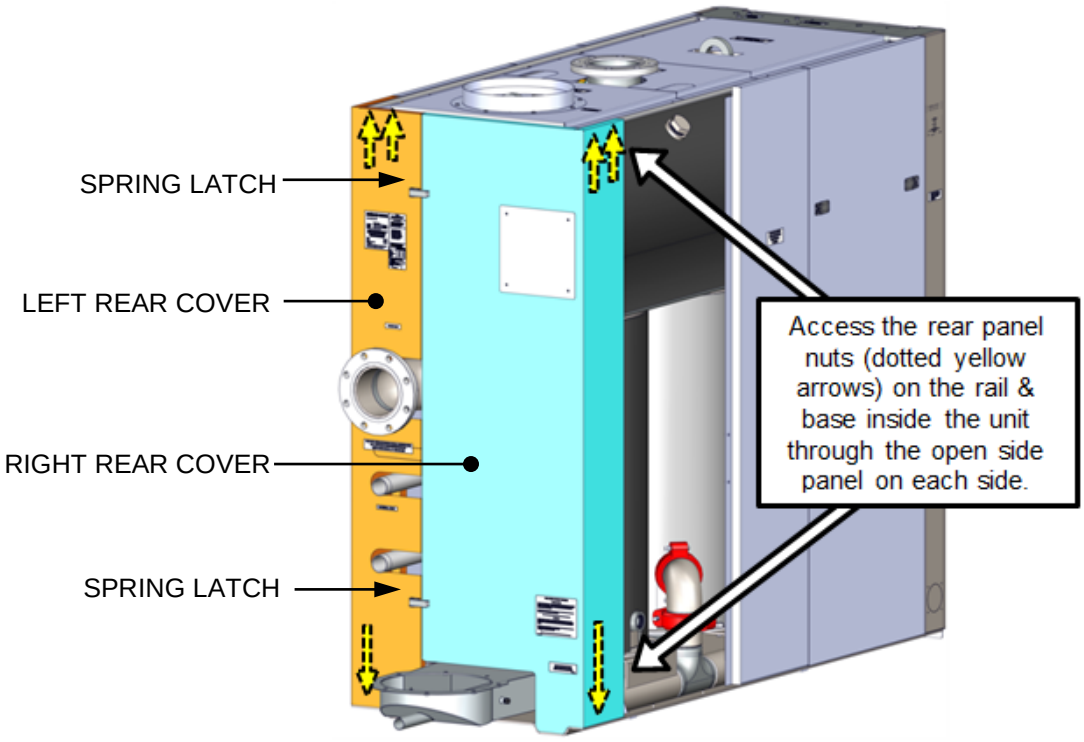

Figure 7-6: Rear View Showing Rear Panel Nut & Latch Locations

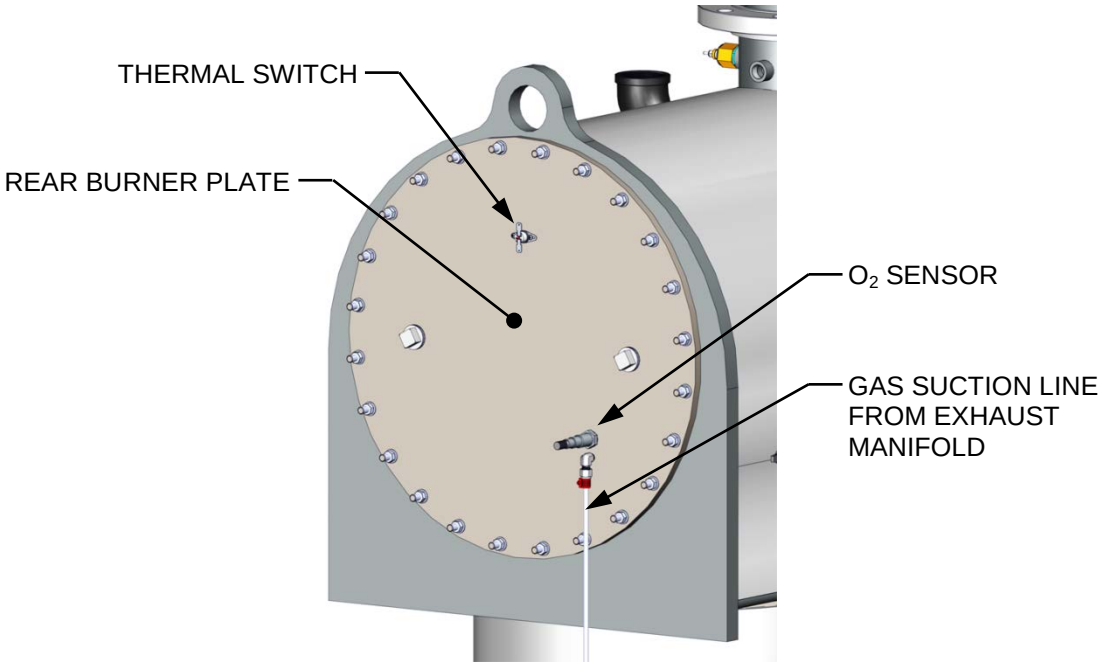

Figure 7-7: Partial Rear View Showing Rear Burner Plate

Rear Refractory Replacement Procedure – **Continued**

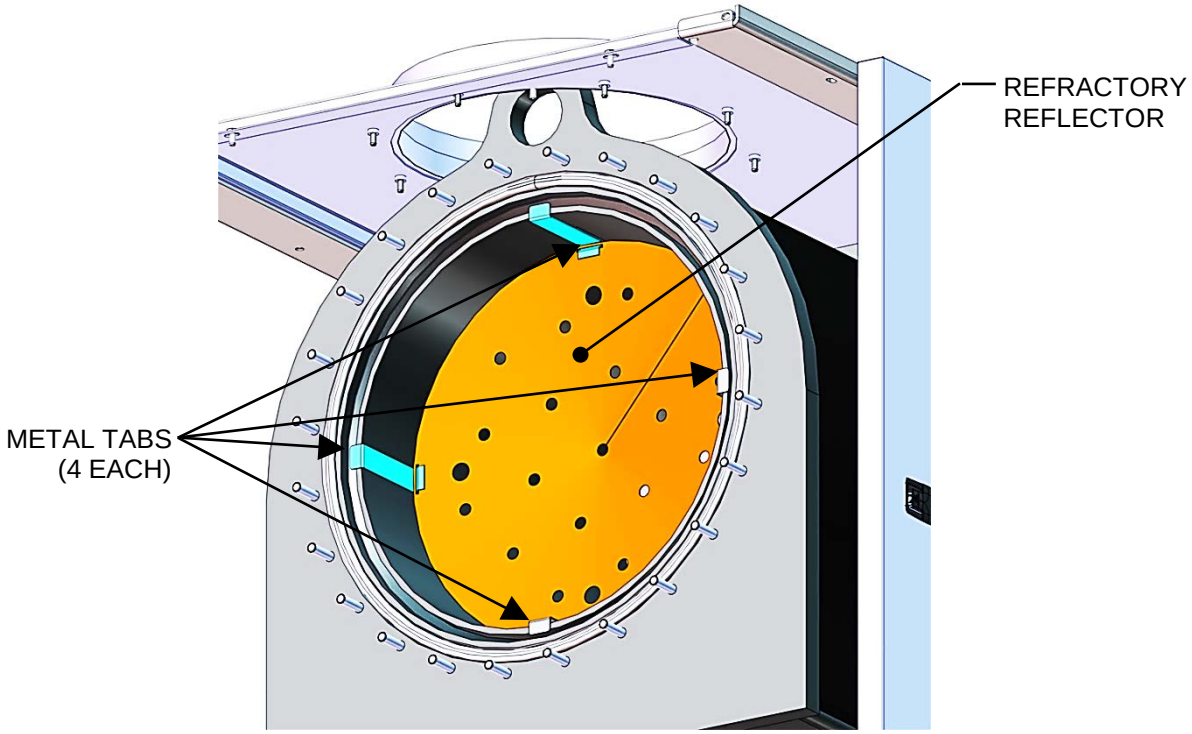

Figure 7-8: Partial Rear View – Rear Plate and Refractory Removed

WARNING!

The heat exchanger insulation utilizes ceramic fiber material. Wear a fitted NIOSH-approved particulate respirator (3m n95 or equiv.) When servicing the heat exchanger and burner assemblies. At high temperatures, ceramic fibers can be converted to crystaline silica fibers which have been identified as carcinogenic when inhaled.

7.8.2 Front Refractory Removal & Replacement

As previously mentioned in section 7.8, it is much easier to remove the rear refractory to inspect the combustion chamber of the unit. However if the front refractory must be removed, it must be replaced with a new refractory, P/N **83028**.

Front refractory removal and replacement requires that the Burner, Blower and Air/Fuel Valve assemblies be removed to access and remove the front refractory. This accomplished by performing the following steps:

Front Refractory Replacement Procedure

1. Turn off gas and electrical power to the unit.
2. Follow the instructions in section 7.7 for blower and Burner assembly removal. The instructions in section 7.7 include removal of the Pilot Burner assembly, Main Flame Detector and two Pilot Flame Detectors.
3. Disconnect the wires from the thermal switch on the upper portion of the front (Burner) plate.
4. Remove all bolts EXCEPT for the one at the top of the plate.
5. While supporting the plate, remove the remaining bolt and slide the plate outward. The front refractory and Burner Shield should slide out of the combustion chamber with the plate.
6. Spray the refractory with a water mist to reduce airborne dust.
7. Remove the three (3) 10-32 screws securing the Burner Shield to the Burner Plate.
8. Place the Burner Shield on a flat surface with the three tabs facing upward.
9. Straighten the 90º bend in each tab so they are even with the sides of the Burner Shield (Figure 7-9).
10. Place the new refractory (P/N **83028**) and shield, blanket-side down, onto the plate. Align the holes for mounting.
11. Place 1” diameter wood or metal dowels into the 2 large holes on the front plate.
12. Slide the refractory, blanket-side up, over the shield. Align the 3 holes in the refractory with the 3 tabs on the Burner Shield. Bend the tabs 90º and align them with the 3 tapped holes in the front plate.
13. Using a magnetized Phillips screwdriver, secure the Burner Shield to the plate using the 10-32 screws removed in step 7.
14. Reinstall the plate, with the new refractory, onto the combustion chamber. Ensure it is properly aligned to prevent damage to the fiber material.
15. Reassemble the items removed in section 7.7, steps 23 through 25.

IMPORTANT

Following front refractory (P/N **83027**) replacement, a two (2) hour burn-in period at a 30% fire rate must be performed to drive off organic binders. These organic binders are not hazardous materials, however they may emit an odor similar to burning wood.

Front Refractory Replacement Procedure – **Continued**

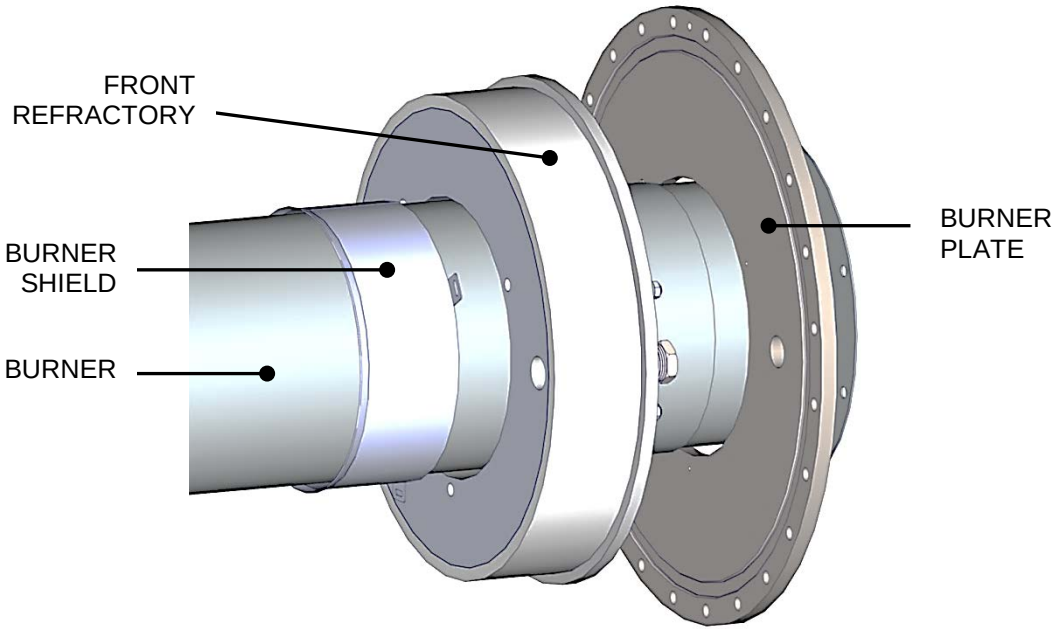

Figure 7-9a: Front Plate Assembly

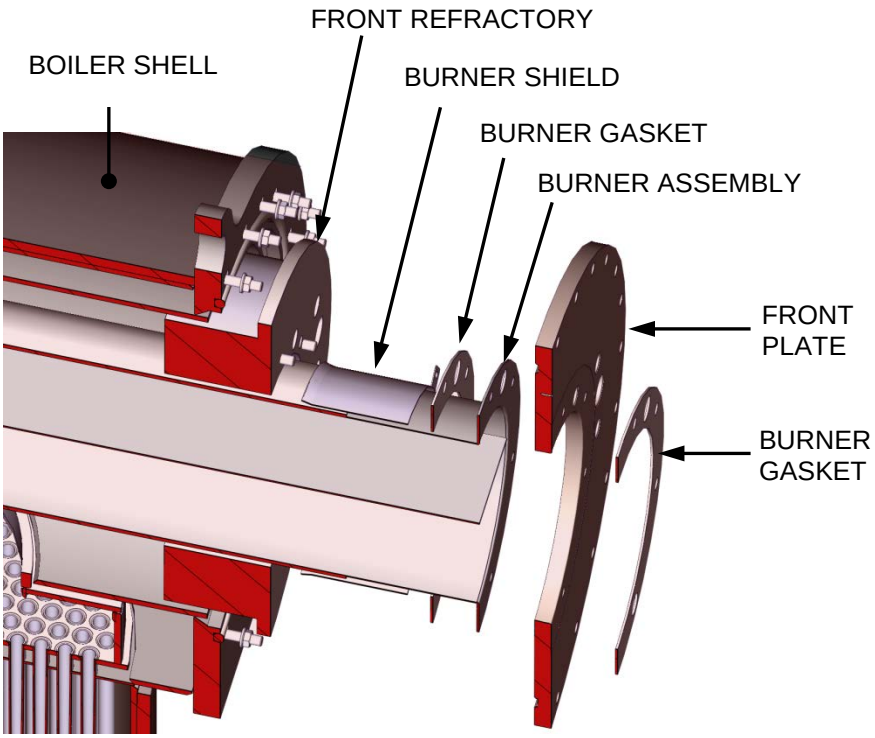

Figure 7-9b: Front Plate Assembly – Cut-Away View

7.9 CONDENSATE DRAIN TRAP

Benchmark boilers contain a condensate trap (P/N **24441**), 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 2-7. 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 7-10).
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.

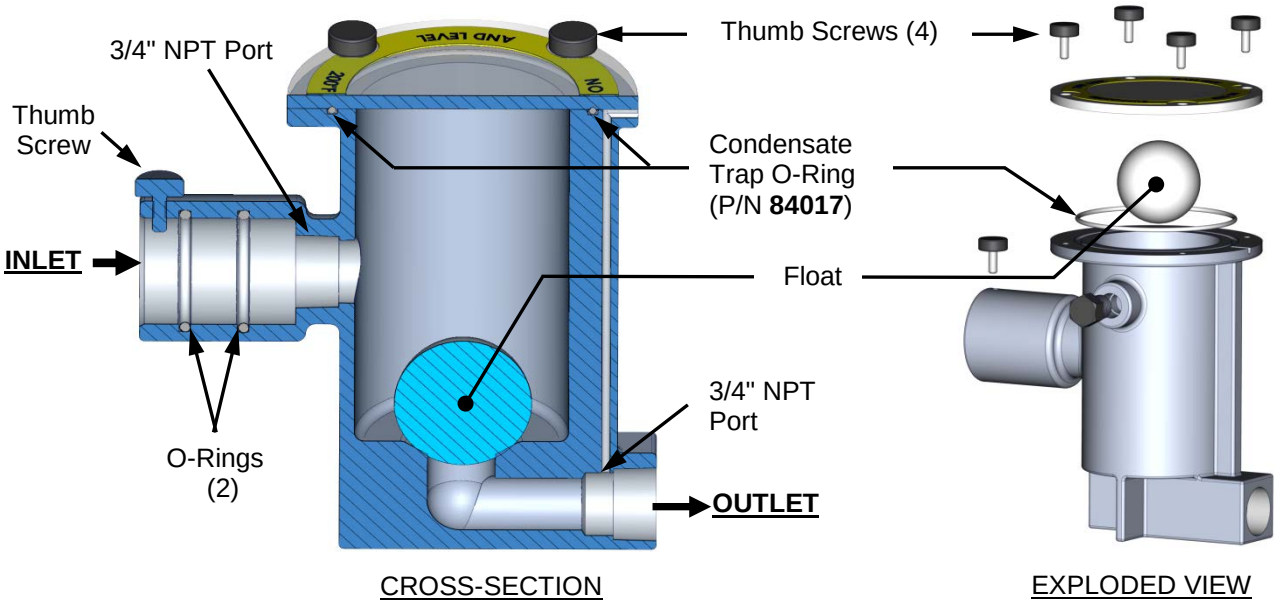

Figure 7-10: External Condensate Trap: Cross-Section & Exploded View

7.10 AIR FILTER CLEANING & REPLACEMENT

The Benchmark boiler is equipped with two (2) air filters (P/N **88014**) which should be cleaned and re-oiled every 12 months, or as needed if combustion air is dirty, and replaced every 24 months. The air filters are attached to a WYE shaped duct connected to the inlet of the air fuel valve as shown in Figure 7-11. To inspect/replace each air filter, proceed as follows:

Air Filter Cleaning & Replacement Procedures

1. Set the **ON/OFF** switch on the control panel, to the **OFF** position. Disconnect AC power from the unit.
1. Remove the front panel from the unit by grasping the handles and pulling outward.
2. Refer to Figure 7-11 and locate the air filters attached to the WYE duct connected to the air/fuel valve inlet.
3. Using a flat-tip screwdriver or 5/16" nut driver, loosen the clamp securing the filter to the WYE duct at the air/fuel valve inlet. Remove the filter and clamp.
4. The filters may be cleaned in hot soapy water to remove oil and dirt. The filter should be thoroughly dried and then sprayed with a light coating of oil, (NOT WD-40), prior to reinstallation.
5. Each replacement air filter is equipped with its own clamp. Therefore, simply install the replacement air filter on WYE duct and tighten the clamp with a flat-tip screwdriver or 5/16" nut driver.
6. Replace the front panel on the unit and return boiler to service use.

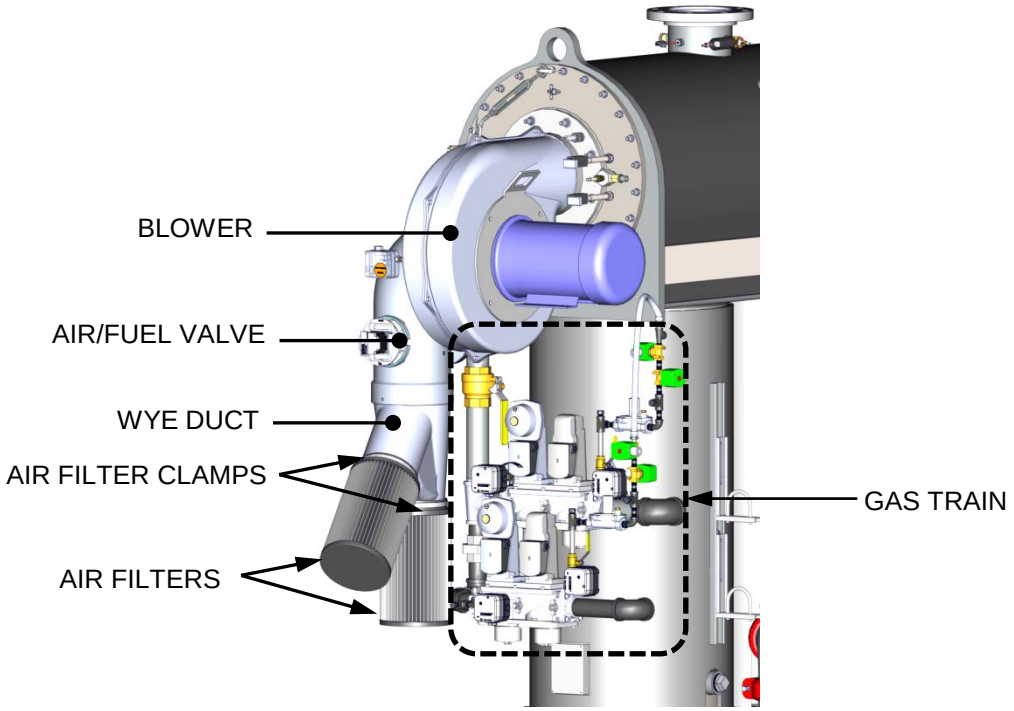

Figure 7-11: Air Filter Location and Removal

7.11 LOW WATER CUTOFF (LWCO) CAPACITOR INTEGRITY TEST

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

Refer to Figure 7-12 for an illustration of the LWCO probe assembly and its typical installation.

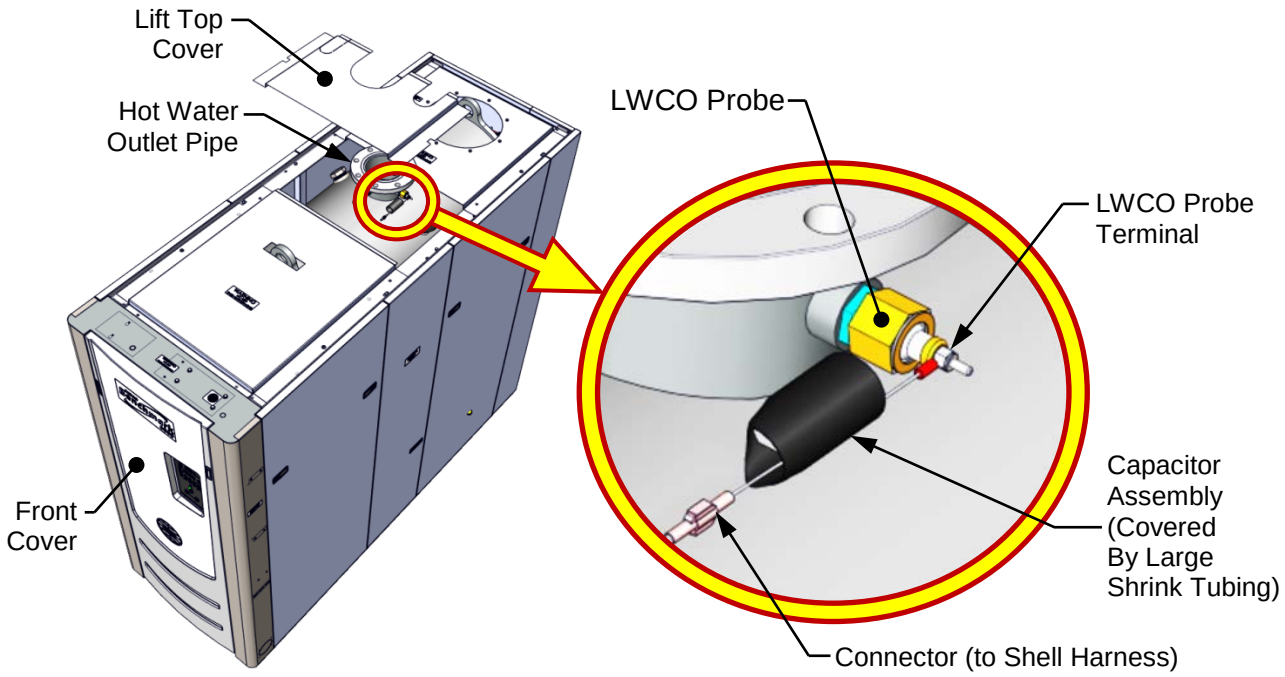

Figure 7-12: LWCO Probe Location for BMK6000

7.11.1 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 AC power to the unit to the **OFF** position.

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 7-13).

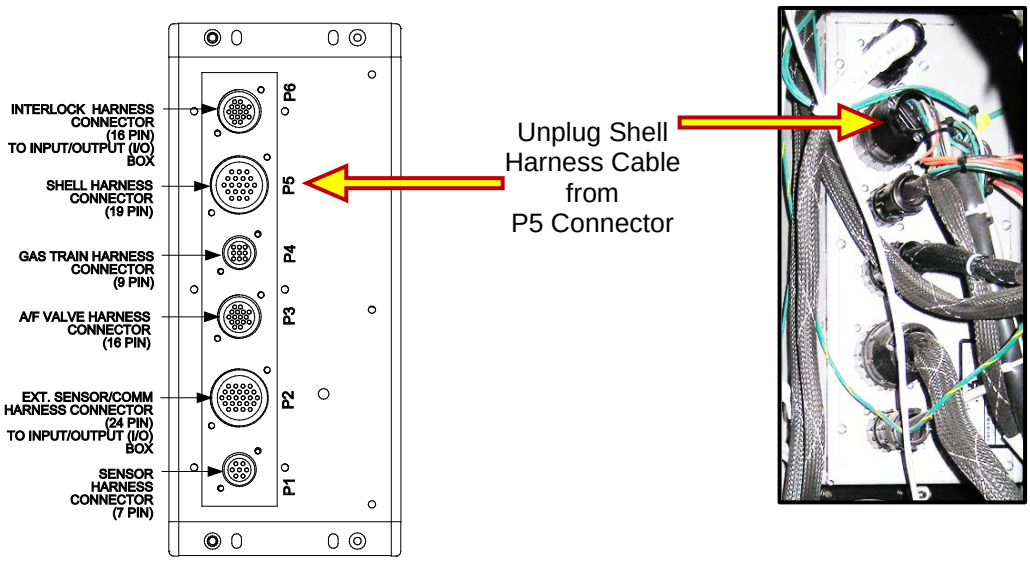

Figure 7-13: Removing Shell Harness Cable from P5 Conn. on C-More Rear Panel

3. Using an ohmmeter, connect one ohmmeter probe to the LWCO capacitor terminal on the unit shell as shown on left in Figure 7-14.
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 7-14.

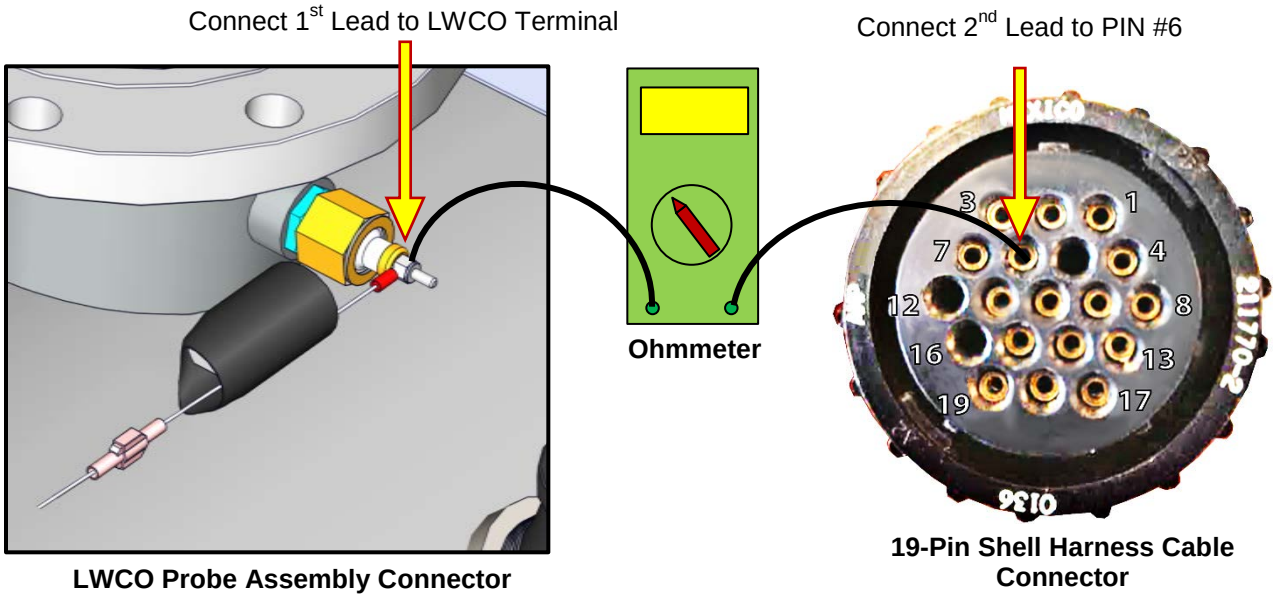

Figure 7-14: Connecting Ohmmeter between LWCO Probe & Shell Harness Cable

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-0096, 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.

7.11.2 Low Water Cutoff (LWCO) - Standard C-More Test

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

Note, this test must be performed with the heat exchanger shell filled with water.

Standard Low Water Cutoff C-More Test

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

7.12 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.

Extended Period Boiler Shut-Down Procedure

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. Refer to Appendix L for maintenance of blower during shut down.

7.13 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 the Boiler Back in Service

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.

IMPORTANT

The blower can be damaged if it is unused for a prolonged period of time. If this occurs, it is critical that you complete the instructions in Appendix L – Long Term Blower Storage. Failure to complete these instructions will void all warranties.

7.14 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 7-15), 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).

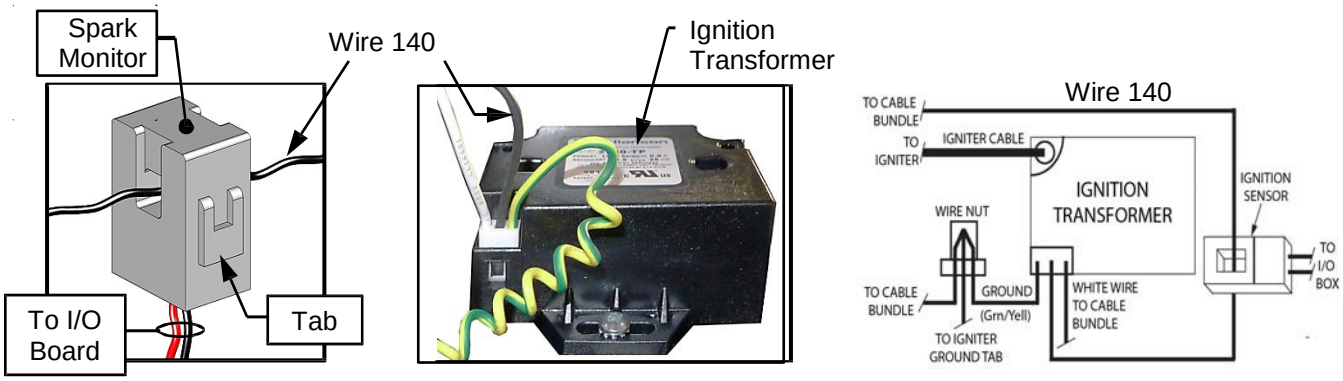

Figure 7-15: Spark Detector Sensor (AC Current Transducer) P/N 61034

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 6000 MBH 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:

Fault Isolation and Correction

1. Observe the fault messages displayed in the Control Box display.
2. Refer to the Fault Indication column in Troubleshooting Table 8-1 which follows and locate the Fault that best describes the existing conditions.
3. Proceed to the Probable Cause column and start with the first item (1) listed for the Fault Indication.
4. Perform the checks and procedures listed in the Corrective Action column for the first Probable Cause candidate.
5. Continue checking each additional Probable Cause for the existing fault until the fault is corrected.
6. Section 8.2 and Table 8-2 contain additional troubleshooting information which may apply when 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.	1. Check combustion blower for signs of excessive heat or high current drain that may trip thermal or current overload devices.
	2. Blocked Blower inlet or inlet air filter.	2. Inspect the inlet to the combustion blower including the air filter at the air/fuel valve for signs of blockage.
	3. Blockage in Blower Proof switch.	3. Remove the Blower Proof switch and inspect for signs of blockage, clean or replace as necessary.
	4. Blockage in Blocked Inlet switch.	4. Remove the Blocked Inlet switch and inspect for signs of blockage, clean or replace as necessary.
	5. Defective Blower Proof switch.	5. Check the continuity of the Blower Proof switch with the combustion blower running. If there is an erratic resistance reading or the resistance reading is greater than zero ohms, replace the switch.
	6. Defective Blocked Inlet switch.	6. Turn off unit and check the continuity of the Blocked Inlet switch. If there is an erratic resistance reading or the resistance reading is greater than zero ohms, replace the switch.
	7. VFD has loose wire connection	7. With power off, check VFD wire connections. Make sure they are tightly secured on the wire, not the insulation
	8. Loose temperature to AUX connection in I/O Box.	8. 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.
	9. VFD failure	9. LED Status indicator will indicate a failure mode. Use the display, if available, or observe the blinking LED code on the VFD and refer to the manufacturer's literature for directions.
	10. Defective temperature sensor.	10. Refer to CORRECTIVE ACTION 8 and verify that the voltage conforms to the values shown in Appendix C.
	11. Loose wire connection between the 0-10V signal from I/O box to the Blower input.	11. Check wire connection from I/O Box 0-10V signal to the Blower Motor.
	12. Defective I/O Box.	12. Measure voltage at the I/O box 0-10V output. A voltage of 8.2V equates to a 100% open valve position.
	13. Wrong 0-10V output selection on the control box.	13. Check the *Analog Out* option on the C-More *Configuration* menu. *Valve Position 0-10V* should be selected.

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

FAULT INDICATION	PROBABLE CAUSES	CORRECTIVE ACTION
AIRFLOW FAULT DURING IGNITION (continued)	14. Defective Air-Fuel Valve potentiometer. 15. Hard light.	14. 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. 15. Check igniter-injector for soot or erosion of electrode. Check injector solenoid valve to insure proper open/close operation
AIRFLOW FAULT DURING PURGE	1. Blower not running or running too slow. 2. Defective Blocked Inlet switch. 3. Blockage in air filter or Blocked Inlet switch. 4. Blocked blower inlet or inlet ductwork. 5. No voltage to Blocked Inlet switch from C-More Control Box. 6. PROBABLE CAUSES from 3 to 14 for AIRFLOW FAULT DURING IGNITION apply for this fault.	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. 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. Remove the air filter and Blocked Inlet switch and inspect for signs of blockage. Clean or replace as necessary. 4. Inspect the inlet to the combustion blower including any ductwork leading up to the combustion blower for signs of blockage. 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. See CORRECTIVE ACTIONS from 3 to 14 for AIRFLOW FAULT DURING IGNITION.
AIRFLOW FAULT DURING RUN	1. Blower stopped running due to thermal or current overload. 2. Blocked Blower inlet or inlet ductwork. 3. Blockage in air filter or Blocked Inlet switch. 4. Defective Blocked Inlet switch.	1. Check combustion blower for signs of excessive heat or high current draw that may trip thermal or current overload devices. 2. Inspect the inlet to the combustion blower, including any ductwork leading up to the combustion blower, for signs of blockage. 3. Remove the air filter and Blocked Inlet switch and inspect for signs of blockage, clean or replace as necessary. 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.

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

FAULT INDICATION	PROBABLE CAUSES	CORRECTIVE ACTION
AIRFLOW FAULT DURING RUN (continued)	5. Combustion oscillations. 6. PROBABLE CAUSES from 3 to 16 for AIRFLOW FAULT DURING IGNITION apply for this fault.	5. Run unit to full fire. If the unit rumbles or runs rough, perform combustion calibration. 6. See CORRECTIVE ACTIONS from 3 to 14 for AIRFLOW FAULT DURING IGNITION
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 **NOTE:** Before starting the Probable Causes and Corrective Action for this fault, refer to the Flow Chart provided in Figure 8-4 at the end of this Chapter.	1. Worn Flame Detector. 2. No spark from Spark Igniter. 3. Defective Ignition Transformer. 4. Defective Ignition/Stepper (IGST) Board. 5. Defective Safety Shut Off Valve (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 SSOV 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. Pilot Scanner failed.	6. Check scanner Red LED. It should change from flashing to steady when pointed at a small flame from a match or lighter.
	7. Pilot View Port is blocked.	7. Remove ad clean Pilot View Port. Also, ensure that the hole in the refractory is clear.
	8. Carbon or other debris on Burner.	8. 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.
	9. Pilot gas valve is closed.	9. Open the Pilot gas valve on the upstream side of the SSOV (see Figure 8-1).
	10. Pilot ignition solenoid valve does not open.	10. When unit goes to ignition, listen for a clicking sound at the Pilot ignition solenoid valve to ensure it is opening.
	11. Clogged Pilot ignition piece.	11. Remove and inspect staged ignition piece 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.
	6. Main Flame Detector is touching burner mesh.	6. Straighten or replace Main Flame Detector.
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^{o} F, check combustion calibration. Calibrate or repair as necessary.

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

FAULT INDICATION	PROBABLE CAUSES	CORRECTIVE ACTION
GAS PRESSURE FAULT (Due to High Gas Pressure)	1. Incorrect supply gas pressure.	1. Check to ensure gas pressure at inlet of SSOV does not exceed 14" W.C.
	2. Defective SSOV Actuator.	2. If gas supply pressure downstream of SSOV Actuator cannot be lowered to the range of 2.3" ± 0.4" W.C. using the gas pressure adjustment screw (see section 4.4, step 10 & section 4.5 step 9), the SSOV Actuator may be defective.
	3. Defective High Gas Pressure Switch.	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.	1. Test the temperature switch to insure it trips at its actual water temperature setting.
	2. Incorrect PID settings.	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. Faulty shell temperature sensor.	3. Using the resistance charts in the Appendix C, Measure the resistance of Shell sensor and BTU sensor at a known water temperature.
	4. Unit in Manual mode	4. If unit is in MANUAL mode switch to AUTO mode.
	5. Unit setpoint is greater than Over Temperature Switch setpoint.	5. Check setpoint of unit and setpoint of Temperature Switch. Ensure that the temperature switch is set higher than the unit's setpoint.
	6. System flow rate changes are occurring faster than units can respond.	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.
	7. Refractory failure.	7. Refractory temperature switches on the end plates are in series with the water temperature limit control to shut down the boiler if the end plates get too hot. Replace the refractory at the hottest end plate.

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

FAULT INDICATION	PROBABLE CAUSES	CORRECTIVE ACTION
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.
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
GAS PRESSURE FAULT (Due to Low Gas Pressure)	1. Incorrect supply gas pressure. 2. Defective Low Pressure Gas 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. For DBB gas trains, ensure it is between 4.5" W.C. and 14” W.C. (see section. 2.8.1). 2. Measure gas pressure at the Low Gas Pressure switch. If it is greater than 2.6” W.C., 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.

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

FAULT INDICATION	PROBABLE CAUSES	CORRECTIVE ACTION
O2 PERCENTAGE LOW	1. Dirty air filter..	1. Remove air filter and clean per section 7.10.
	2. Blockage in the inlet air duct.	2. Inspect all sections of the duct for foreign materials.
	3. Gas pressure too high.	3. Measure the gas pressure between the SSOV and the Air/Fuel Valve. Pressure should be 7.9" W.C. ± 0.2" W.C.
	4. Blocked flue.	4. Check flue for foreign material. Measure pressure at exhaust manifold and compare to pressure map (Figure 8-1).
	5. Blocked condensate trap.	5. Check condensate trap per section 7.9.
	6. Blower failure	6. Check blower rotational speed with strobe light and compare to VFD Hz output: RPM = 57.5 x Hz.
	7. VFD failure	7. Check VFD faceplate (available from AERCO after-market) using the VFD manufacturer's troubleshooting documentation.
O2 SENSOR MALFUNCTION	1. O_2 % reading <-4%, or >24%	1. Check the O_2 offset and gain values in the *Calibration* menu. If set to 1.0 and 1024 respectively, replace O_2 sensor
O2 % OUT OF RANGE	1. Combustion Calibration incorrect.	1. Check Combustion Analyzer and recalibrate boiler.
	2. Blocked inlet air duct.	2. Unblock inlet & measure open area for combustion air to room.
OUTDOOR TEMP SENSOR FAULT	1. Loose or broken wiring.	1. Inspect Outdoor Temperature sensor for loose or broken wiring.
	2. Defective Sensor.	2. Check resistance of sensor to determine if it is within specification.
	3. Incorrect Sensor.	3. Ensure that the correct sensor is installed.
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.
	2. Defective or shorted switch.	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. Switch wired incorrectly.	3. If the switch is wired correctly, replace the switch.

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

FAULT INDICATION	PROBABLE CAUSES	CORRECTIVE ACTION
PRG SWTCH CLOSED DURING IGNITION (Continued)	4. Defective Power Supply Board or fuse 5. Defective IGST Board.	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.
RECIRC PUMP FAILURE	1. Internal recirculation pump failed.	1. Replace recirculation pump.

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

FAULT INDICATION	PROBABLE CAUSES	CORRECTIVE ACTION
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 2" Gas Shut-Off Valve downstream of SSOV (Figure 8-1). 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 the C-More OMM, GF-112, 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.
SSOV FAULT DURING IGNITION	SSOV didn’t open	Check pilot assembly for carbon buildup. Check scanners sensed pilot flame. Check power through ignition relay. Scanners close neutral side of relay coil.

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. Clogged/damaged Gas Orifice on Pilot (Figure 8-2). 2. Defective Pilot Ignition Solenoid (Figure 8-2) 3. Pilot Regulator not calibrated correctly.	1. Disconnect the Pilot gas orifice from the Gas injector Tube (Figure 8-2) and inspect to ensure it is not clogged or damaged. 2. Close the 2" Manual Shutoff Valve and the 1/4" Pilot Gas Valve that connects to the flex hose of the Pilot Ignition Assy. (Figure 8-1). Attempt to start the unit and listen for a "clicking" sound that the Pilot Ignition Solenoid makes during Ignition Trial. If "clicking" sound is not heard after 2 or 3 attempts, replace the Pilot Ignition Solenoid. 3. Refer to Chapter 7, section 7.5.2 and check the calibration of the Pilot Regulator.
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 IRI (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.

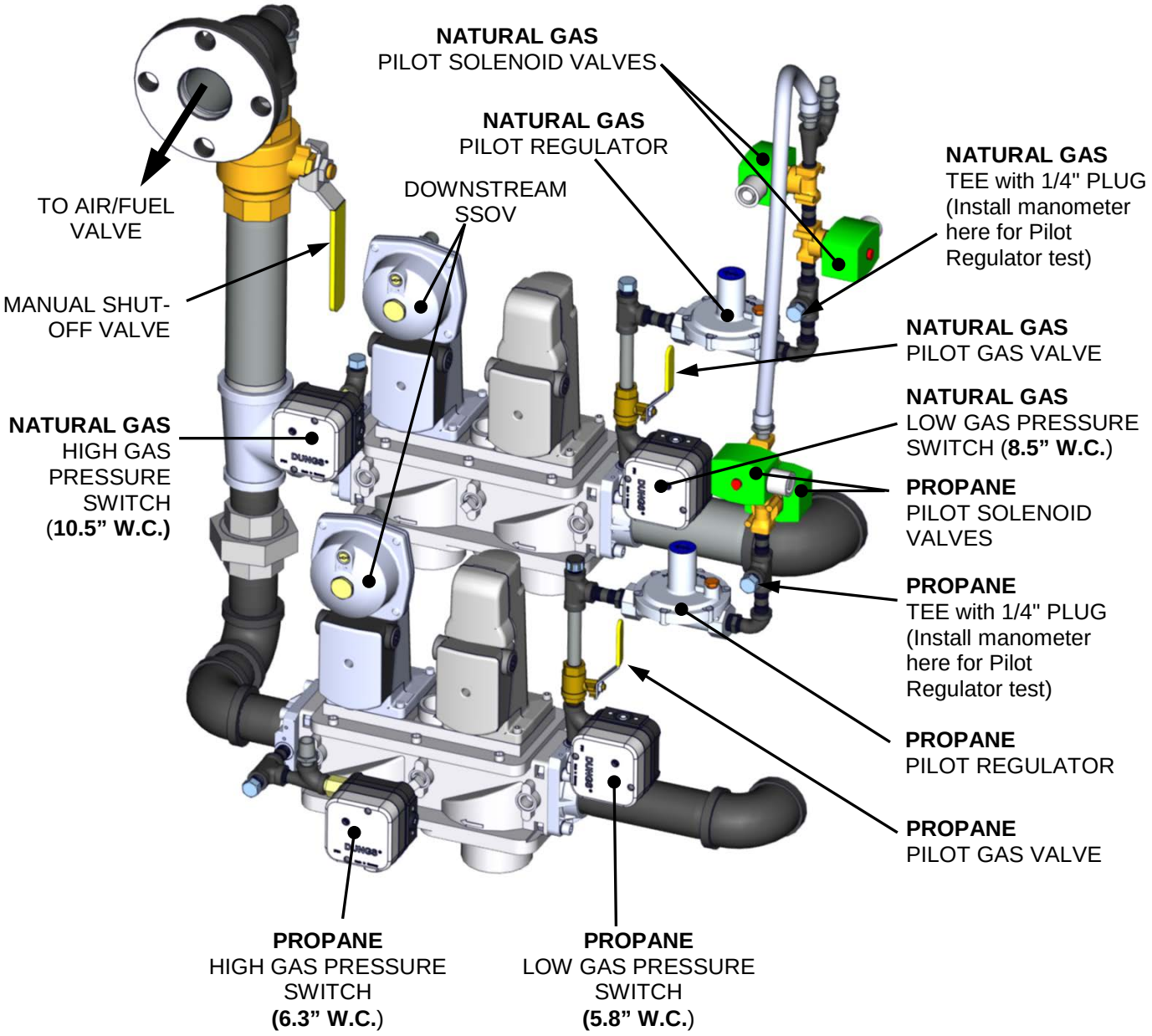


Figure 8-1: Gas Train Component and Pilot Gas Valve Location

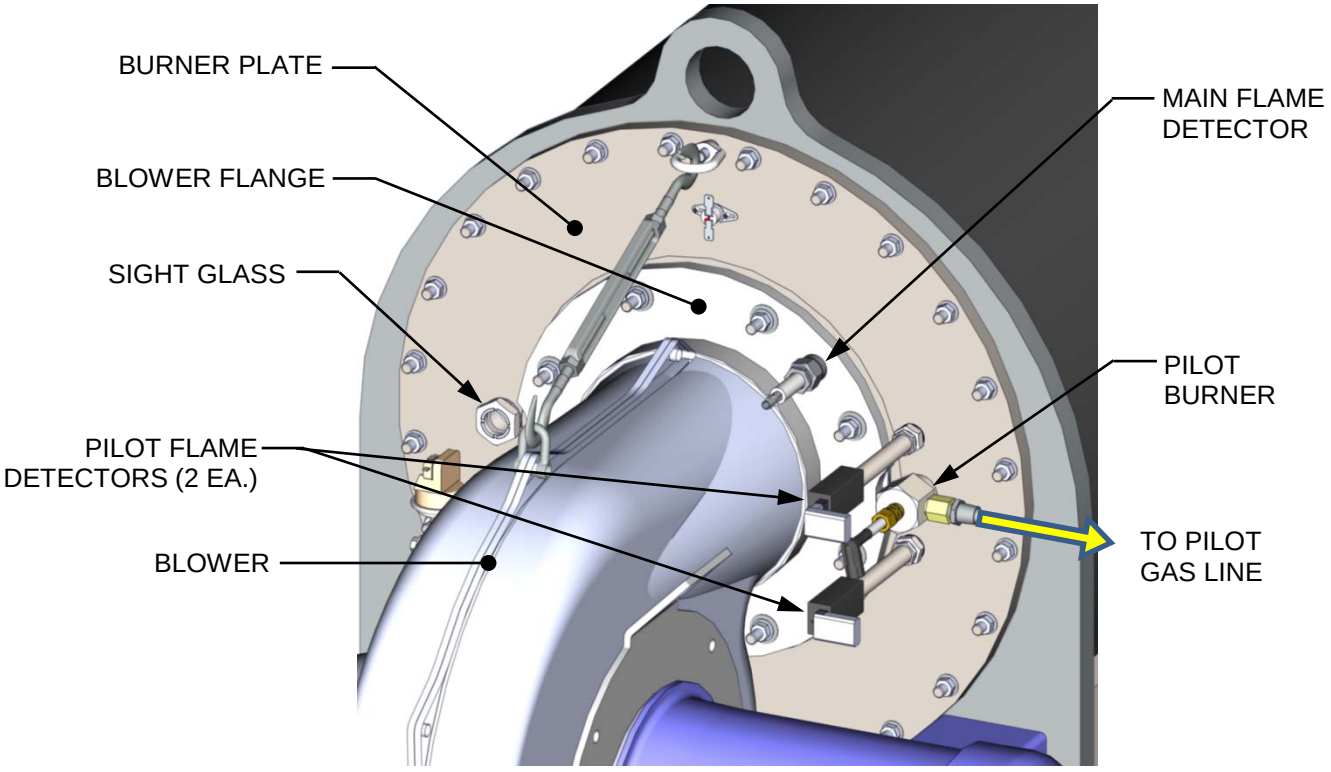


Figure 8-2: Pilot Burner & Flame Detector Locations

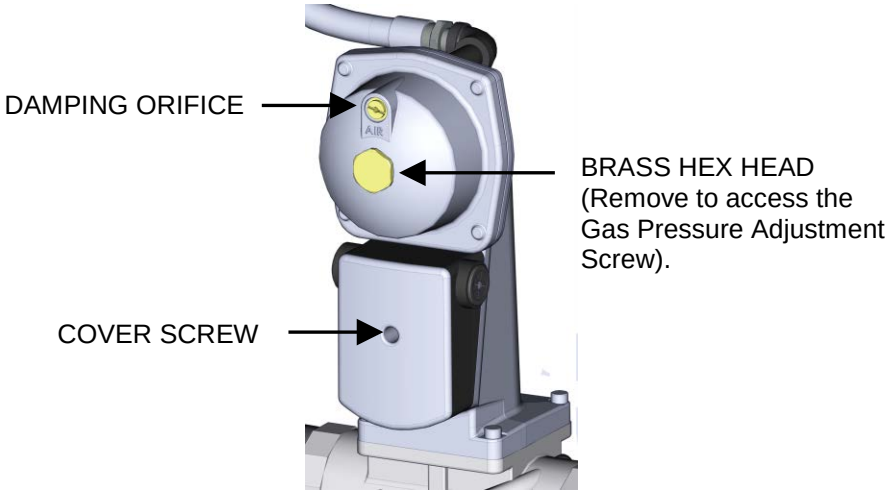


Figure 8-3: SSOV Actuator With Gas Pressure Adjustment (SKP25)

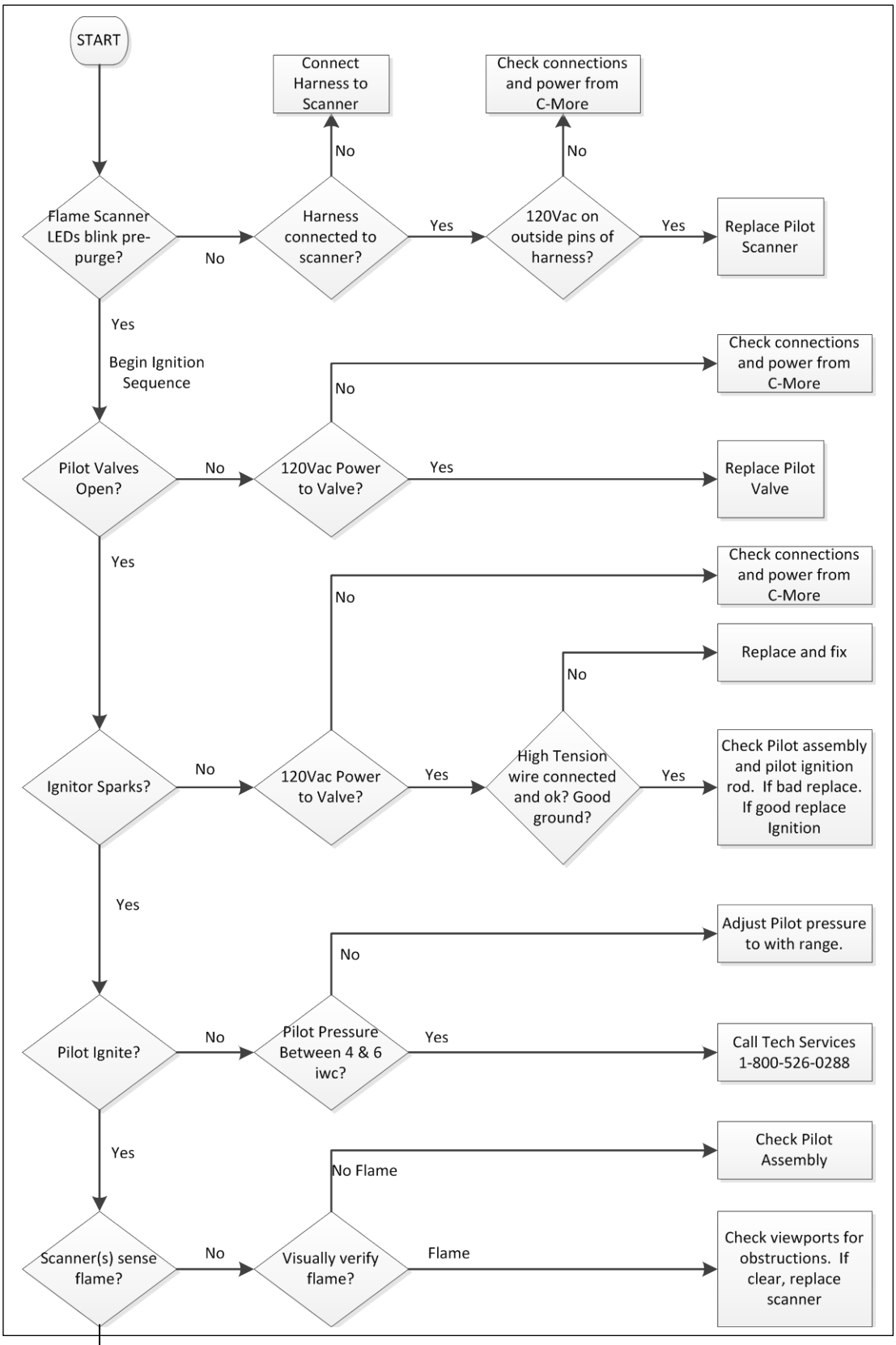


Figure 8-4: Pilot Assembly Troubleshooting Flow Chart (Sheet 1 of 2)

Continued from Sheet 1

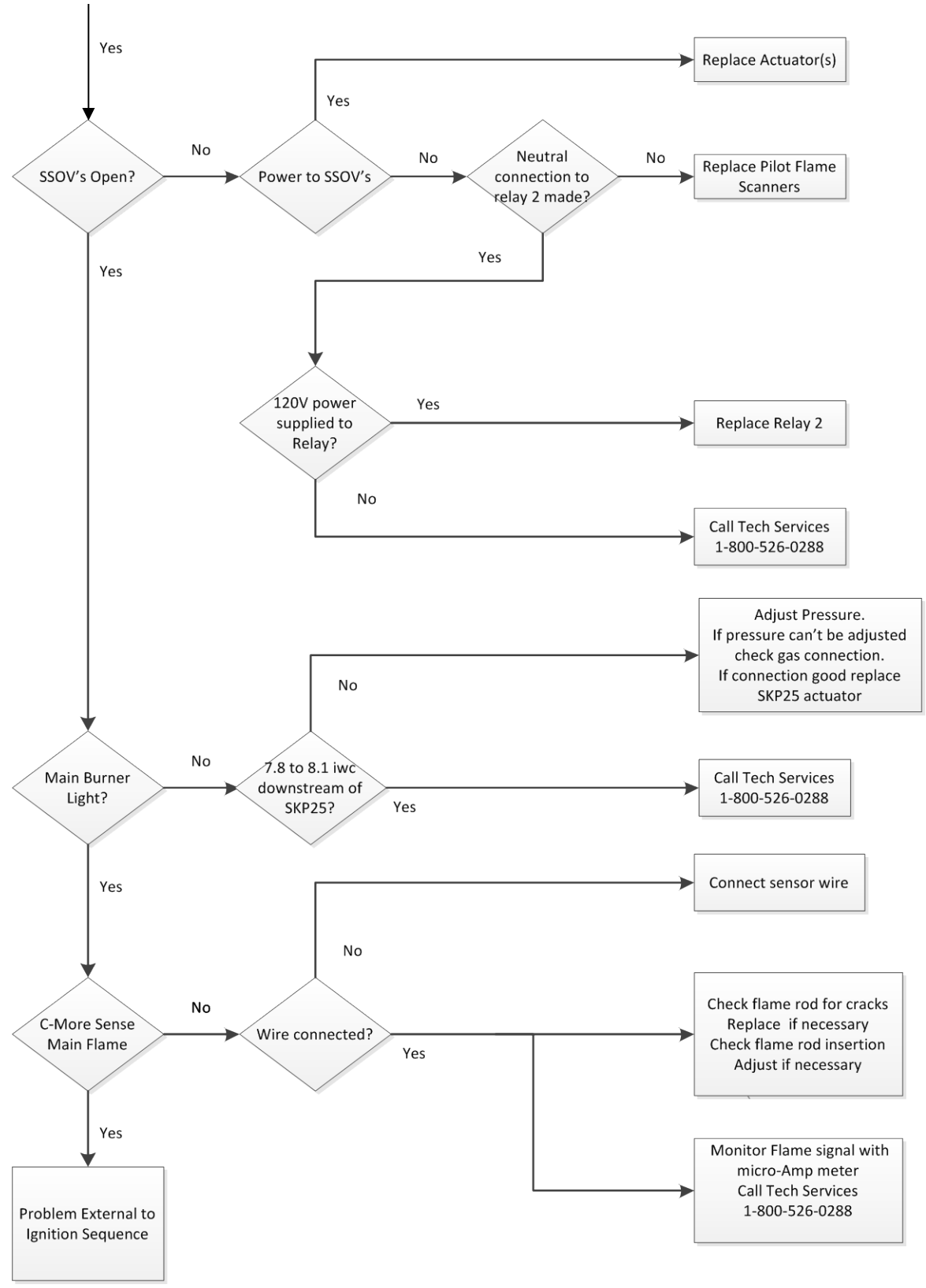


Figure 8-4: Pilot Assembly Troubleshooting Flow Chart (Sheet 2 of 2)

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.

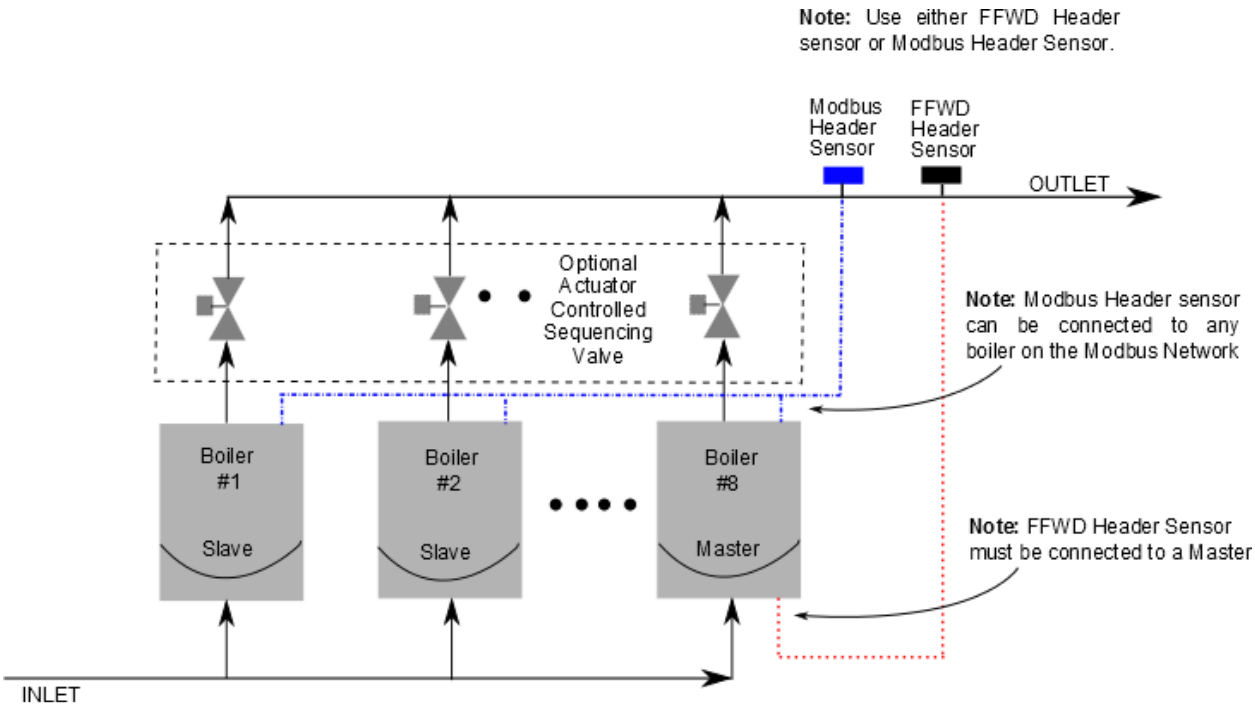


Figure 9-1: Simplified BST Block Diagram

9.1.1 Installation Notes

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

a) Do *NOT* install the ProtoNode Device at the outset of the installation. If the ProtoNode Device is already installed, you must physically disconnect it from the Modbus network in I/O board.

b) Make sure that the Modbus load and bias resistors are properly configured for the system to operate ***without*** the ProtoNode installed.

c) Temporarily set the BST system for CONSTANT SETPOINT mode of operation (see below).

d) Turn on and completely test the installation to verify that it is operating proper.

e) Once the installation is working properly as a BST system, install the ProtoNode device.

f) Make sure that the Modbus load and bias resistors are properly configured for the system to operate ***with*** the ProtoNode installed.

g) Set the BST system for desired mode of operation (SETPOINT mode).

h) Test the system completely with the ProtoNode installed.

9.2 AERCO BST QUICK START CHART

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

Constant Setpoint (choose option 1 or 2)

Option 1 – Direct Wired Header Complete section 9.3.1

OR

Option 2 – Modbus Header Complete section 9.3.2

Outdoor Reset (choose option 3 or 4)

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

OR

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

Remote Setpoint (choose option 5 through 8)

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

OR

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

OR

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

OR

Option 8 – Modbus Drive AND Modbus Header Complete section 9.3.8

9.3 BST IMPLEMENTATION INSTRUCTION

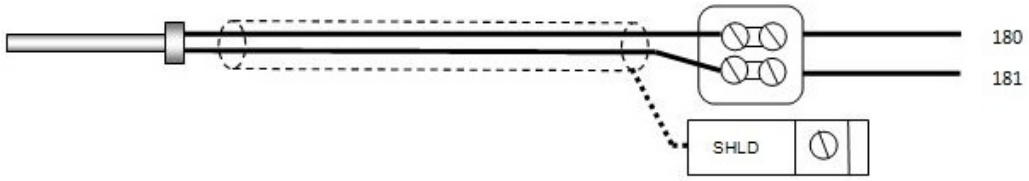
9.3.1 Option 1 - Constant Setpoint with DIRECT Wired Header Sensor

Step 1: Direct Wired Header Sensor Wiring

1. On the MASTER Unit, Connect the Header Temperature Sensor (**AERCO PN 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** and set the **BST Menu** item to **Enabled**.
2. Go to the **BST Menu** 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 **BST Menu** of the desired **Master** unit and set the **BST Mode** item to **BST MASTER**.

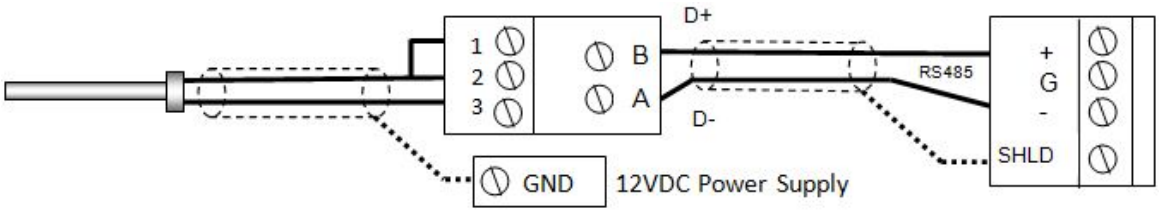
9.3.2 Option 2 - Constant Setpoint with MODBUS Wired Header Sensor

Step 1: MODbus Header Sensor Wiring

1. Using Shielded pair 18 - 22 AWG cable, connect the Temperature Transmitter (**AERCO 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 (**AERCO PN 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** and set the **BST Menu** item to **Enabled**.
2. Go to the **BST Menu** 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 **BST Menu** of the desired **Master** unit and set the **BST Mode** item to **BST MASTER**.

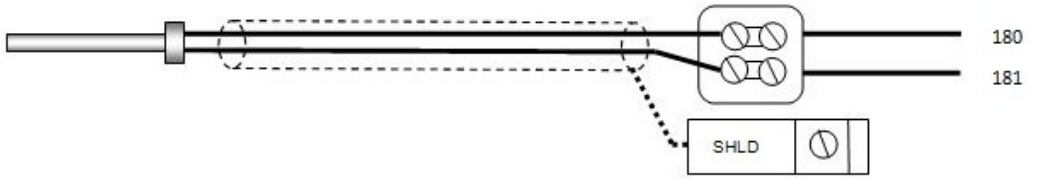
9.3.3 Option 3 - Outdoor Reset with DIRECT WIRED Header Sensor AND DIRECT WIRED Outdoor Sensor

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 (**AERCO PN 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.

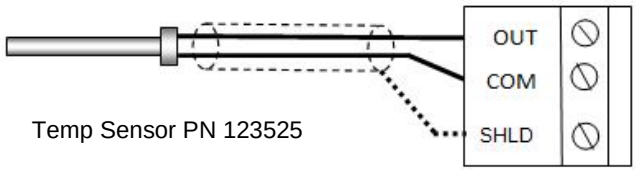


Step 2 - Direct Wired Outdoor Sensor

1. On the MASTER Unit, Connect the Outdoor Temperature Sensor (**AERCO PN 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** and set the **BST Menu** item to **Enabled**.
2. Go to the **BST Menu** 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 **BST Menu** 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

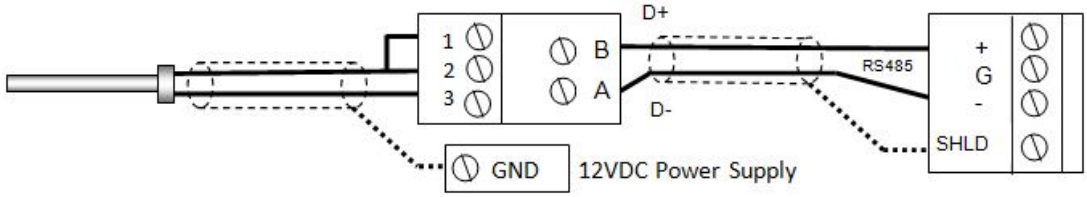
NOTE: Both Header Sensor AND Outdoor Sensor must be wired. See the C-More Controller User Manual, OMM-0032, GF-112 and ProtoNode User Manual, OMM-0080, GF-129 for more information.

Step 1 - Modbus Header Sensor Wiring

1. Using Shielded pair 18 - 22 AWG cable, connect the Temperature Transmitter (**AERCO 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 (**AERCO PN 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

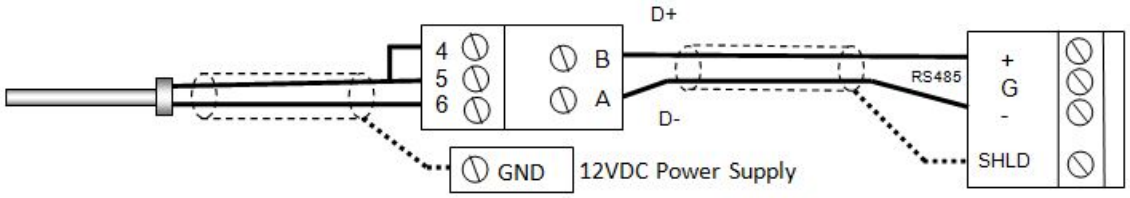
1. If you have not already done so when installing the Modbus Header Sensor, use Shielded pair 18 - 22 AWG cable to connect the Temperature Transmitter terminal Pin B to the RS485+ terminal on the I/O Box of any of the Boiler units, and Pin A of the Temperature Transmitter to the RS485- terminal on the I/O Box of any of the Boiler units.
2. Using Shielded pair 18 - 22 AWG cable, connect the Modbus Header Temperature Sensor (**AERCO PN 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** and set the **BST Menu item to Enabled**.
2. Go to the **BST Menu** 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 **BST Menu** 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 (**AERCO PN 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.

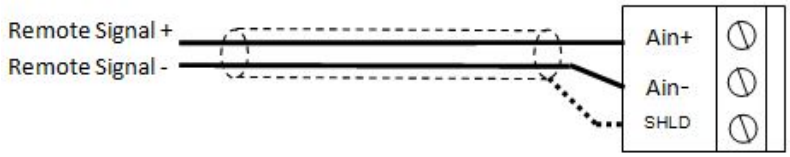
Temp Sensor PN 61040 Header Temp Sensor I/O Box

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

Step 3: Configure ALL C-More Units

On ALL Boilers:

1. Go to the **Configuration Menu** and set the **BST Menu** item to **Enabled**.
2. Go to the **BST Menu** 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 **BST Menu** 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 (**AERCO PN 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: 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** and set the **BST Menu** item to **Enabled**.
2. Go to the **BST Menu** 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 **BST Menu** 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

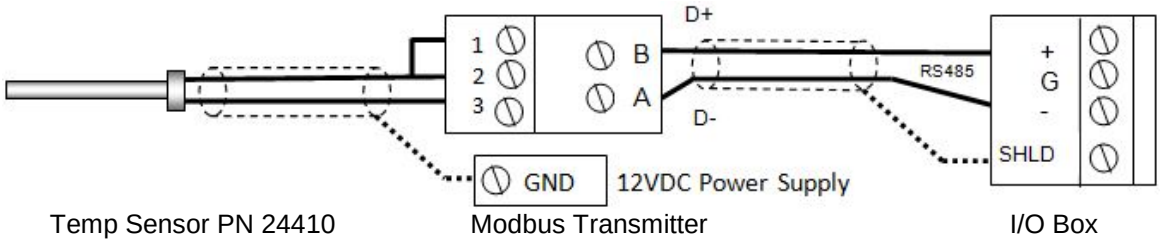
NOTE: Both Header Sensor AND 4-20ma Direct Drive must be wired. See the C-More Controller User Manual, OMM-0032, GF-112 and ProtoNode User Manual, OMM-0080, GF-129 for more information.

Step 1: MODbus Header Sensor

1. Using Shielded pair 18 - 22 AWG cable, Connect the Temperature Transmitter (**AERCO 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 (**AERCO PN 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.

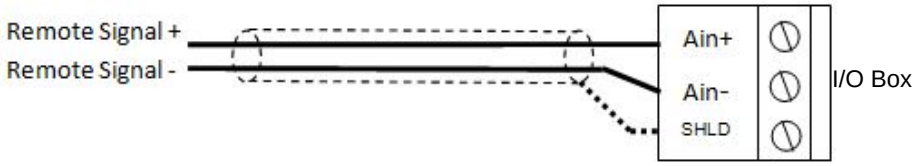


Step 2: Direct Wired 0-20ma or 4-20ma Wiring

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** and set the **BST Menu** item to **Enabled**.
2. Go to the **BST Menu** 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:

6. Go to the **BST Menu** 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

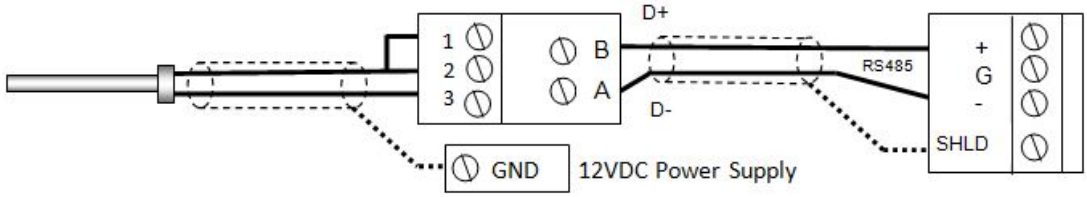
NOTE! Both Header Sensor AND ProtoNode SSD Device must be wired. See the C-More Controller User Manual, OMM-0032, GF-112 and ProtoNode User Manual, OMM-0080, GF-129 for more information.

Step 1: MODbus Header Sensor

1. Using Shielded pair 18 - 22 AWG cable, Connect the Temperature Transmitter (**AERCO 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 (**AERCO PN 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).

Step 3: Configure ALL C-More Units

On ALL Boilers:

1. Go to the **Configuration Menu** and set the **BST Menu** item to **Enabled**.
2. Go to the **BST Menu** 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 **BST Menu** 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.
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. 6000 MBH for Benchmark 6000.
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 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 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 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.
13	Temp Hi Limit	This is the maximum allowable outlet temperature, up to 210°F. Any temperature above this setting will turn off the unit. The temperature must then drop 5° below this setting to allow the unit to run.
14	Max Valve Position	Sets the maximum allowable valve position for the unit.
15	Pump Delay Timer	Specifies the amount of time, up to 30 minutes, to keep the pump running after the unit turns off.

CONFIGURATION MENU		
MENU OPTIONS		**DESCRIPTION**
16	Aux Start On Dly	Specifies the amount of time to wait, up to 120 seconds, between activating the Aux Relay (due to a demand) and checking the pre-purge string to start the 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 BMK 6000. **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.
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 to 25. (Default is 5 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.
32	BST Menu	When set to Enabled, the *BST* menu options appear.

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 to 120°F), 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 the next three menu items 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	Default = 95
5	Warmup Int Gain	Range = .00 – 2.00	Default = .50
6	Warmup PID Timer	Range = 0 - 240 seconds	Default = 20 seconds
5	Reset Defaults?	Allows *Tuning* menu options to be reset to their Factory Default values.	

Table A-5: Combustion Calibration Menu Item Descriptions

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

NOTE:

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

COMBUSTION CAL MENU		
MENU OPTIONS		**DESCRIPTION**
1	CAL Voltage 18%	Displays the default DC drive voltage provided to the blower at each Air/Fuel Valve position (Items 1 – 6). The drive voltage adjusts the rotational speed of the blower to maximize combustion efficiency.
2	CAL Voltage 30%	
3	CAL Voltage 45%	
4	CAL Voltage 65%	
5	CAL Voltage 85%	
6	CAL Voltage 100%	
7	Set Valve Position	Permits selection of the Air/Fuel Valve position (% open) to be set from 0 to 100%.
8	Blower Output	Permits the DC drive voltage to the blower to be monitored.
9	Set Stby V out	Permits the Standby Voltage to be set from 0 to 4.00 Volts.
10	Oxygen Level	Permits the combustion oxygen level to be displayed (0% to 25%).

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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.
EXHAUST TEMP HIGH	The exhaust temperature has exceeded
EXHAUST TEMP SENSOR OPEN	Exhaust Temperature Sensor is open.
EXHAUST TEMP SENSOR SHORT	Exhaust temperature sensor is shorted.
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.
GAS PRESSURE FAULT	The High Gas Pressure Limit Switch OR Low Gas Pressure Limit Switch is open.
HIGH WATER TEMPERATURE	The temperature measured by the Outlet Sensor exceeded the Temp Hi Limit setting.
HIGH WATER TEMP SWITCH OPEN	The High Water Temperature Limit Switch is open.
IGN BOARD COMM FAULT	A communication fault has occurred between the PMC board and Ignition board.
IGN SWTCH CLOSED DURING PURGE	The Ignition Position Limit switch on the Air/Fuel Valve closed during purge.
IGN SWTCH OPEN DURING IGNITION	The Ignition Position Limit switch on the Air/Fuel Valve opened during ignition.
INTERLOCK OPEN	The Remote Interlock is open.

Table B-2: Fault Messages

FAULT MESSAGE	FAULT DESCRIPTION
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.
MODBUS COMM FAULT	The RS-485 network information is not present or is corrupted.
O_2 PERCENTAGE LOW	The O_2 percentage measured by the O_2 sensor is below 2%
O_2 SENSOR MALFUNCTION	A fault exists in the O_2 sensor.
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.
WARNING EXHAUST TEMP HIGH	The exhaust temperature measured by the exhaust sensor has exceeded the value set in the Factory menu.
WARNING O_2 LEVEL HIGH	The O_2 level measured by the O_2 sensor has exceeded 9.0 %

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APPENDIX C – SENSOR RESISTANCE/VOLTAGE CHART

Temperature Sensor Resistance Voltage Chart (Balco)

TEMP (°F)	RES (OHMS)	VOLTS*
-40	779.0	1.93
-30	797.5	1.96
-20	816.3	1.99
-10	835.4	2.02
0	854.8	2.05
10	874.6	2.07
20	894.7	2.10
30	915.1	2.12
40	935.9	2.15
50	956.9	2.17
60	978.3	2.20
70	1000.0	2.23
80	1022.0	2.25
90	1044.4	2.27
100	1067.0	2.30
110	1090.0	2.32
120	1113.3	2.34
130	1137.0	2.36
140	1160.9	2.39
150	1185.2	2.41
160	1209.5	2.43
170	1234.7	2.45
180	1260.0	2.47
190	1285.6	2.50
200	1311.4	2.52
210	1337.7	2.54
220	1364.2	2.56
230	1391.0	2.58
240	1418.2	
250	1445.7	

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APPENDIX D – INDOOR/OUTDOOR RESET RATIO CHARTS

Table D-1: Header Temperature for a Building Reference Temperature of 50ºF

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

Table D-2: Header Temperature for a Building Reference Temperature of 60ºF

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

Table D-3: Header Temperature for a Building Reference Temperature of 65ºF

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

Table D-4: Header Temperature for a Building Reference Temperature of 70ºF

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

Table D-5: Header Temperature for a Building Reference Temperature of 75ºF

	RESET RATIO									
Air Temp	**0.6**	**0.8**	**1.0**	**1.2**	**1.4**	**1.6**	**1.8**	**2.0**	**2.2**	**2.4**
75F	75	75	75	75	75	75	75	75	75	75
70F	78	79	80	81	82	83	84	85	86	87
65F	81	83	85	87	89	91	93	95	97	99
60F	84	87	90	93	96	99	102	105	108	111
55F	87	91	95	99	103	107	111	115	119	123
50F	90	95	100	105	110	115	120	125	130	135
45F	93	99	105	111	117	123	129	135	141	17
40F	96	103	110	117	124	131	138	145	152	159
35F	99	107	115	123	131	139	147	155	163	171
30F	102	111	120	129	138	147	156	165	174	183
25F	105	115	125	135	145	155	165	175	185	195
20F	108	119	130	141	152	163	174	185	196	207
15F	111	123	135	147	159	171	183	195	207	219
10F	114	127	140	153	166	179	192	205	218	
5F	117	131	145	159	173	187	201	215		
0F	120	135	150	165	180	195	210			
-5F	123	139	155	171	187	203	219			
-10F	126	143	160	177	194	211				
-15F	129	147	165	183	201	219				

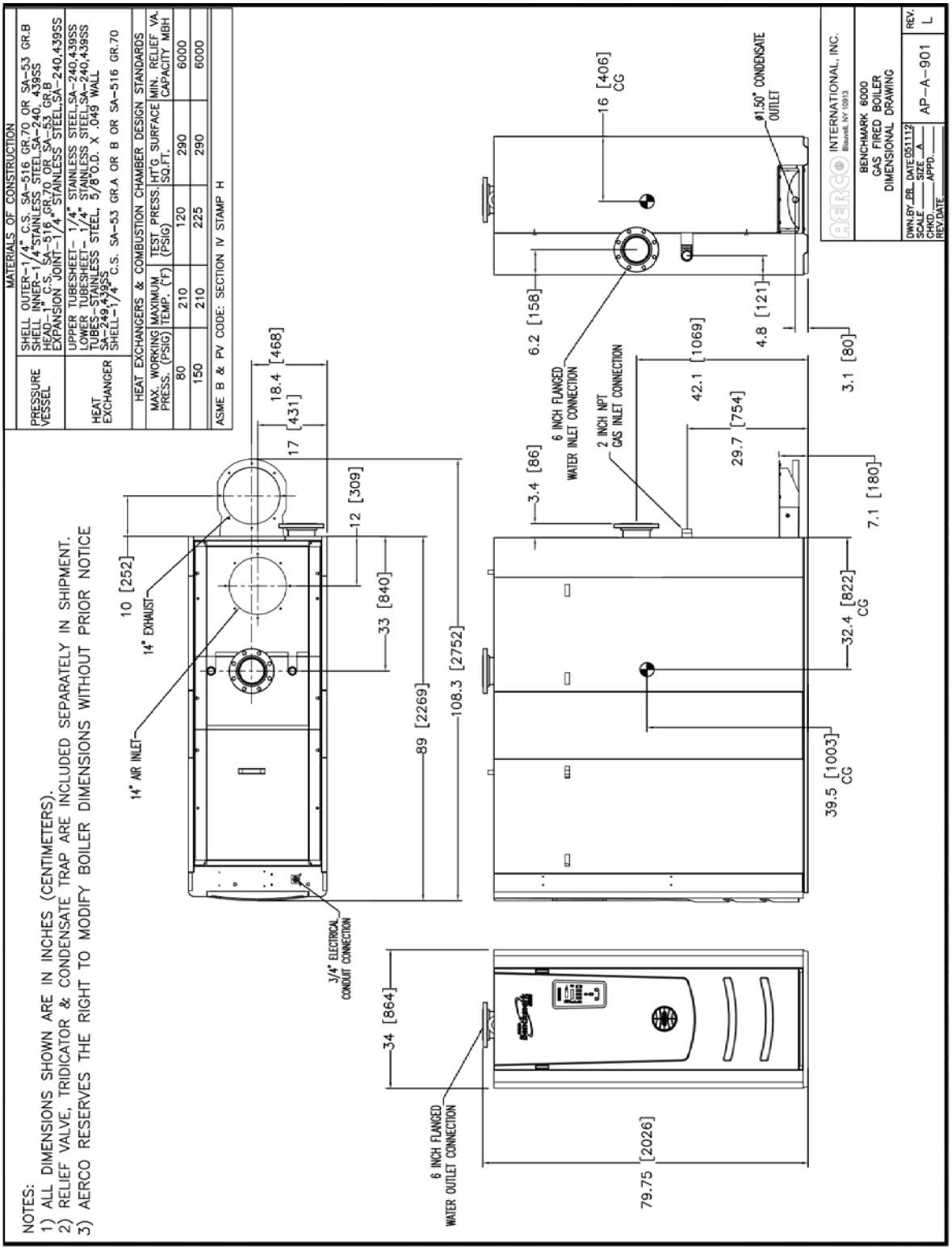
Table D-6: Header Temperature for a Building Reference Temperature of 80ºF

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

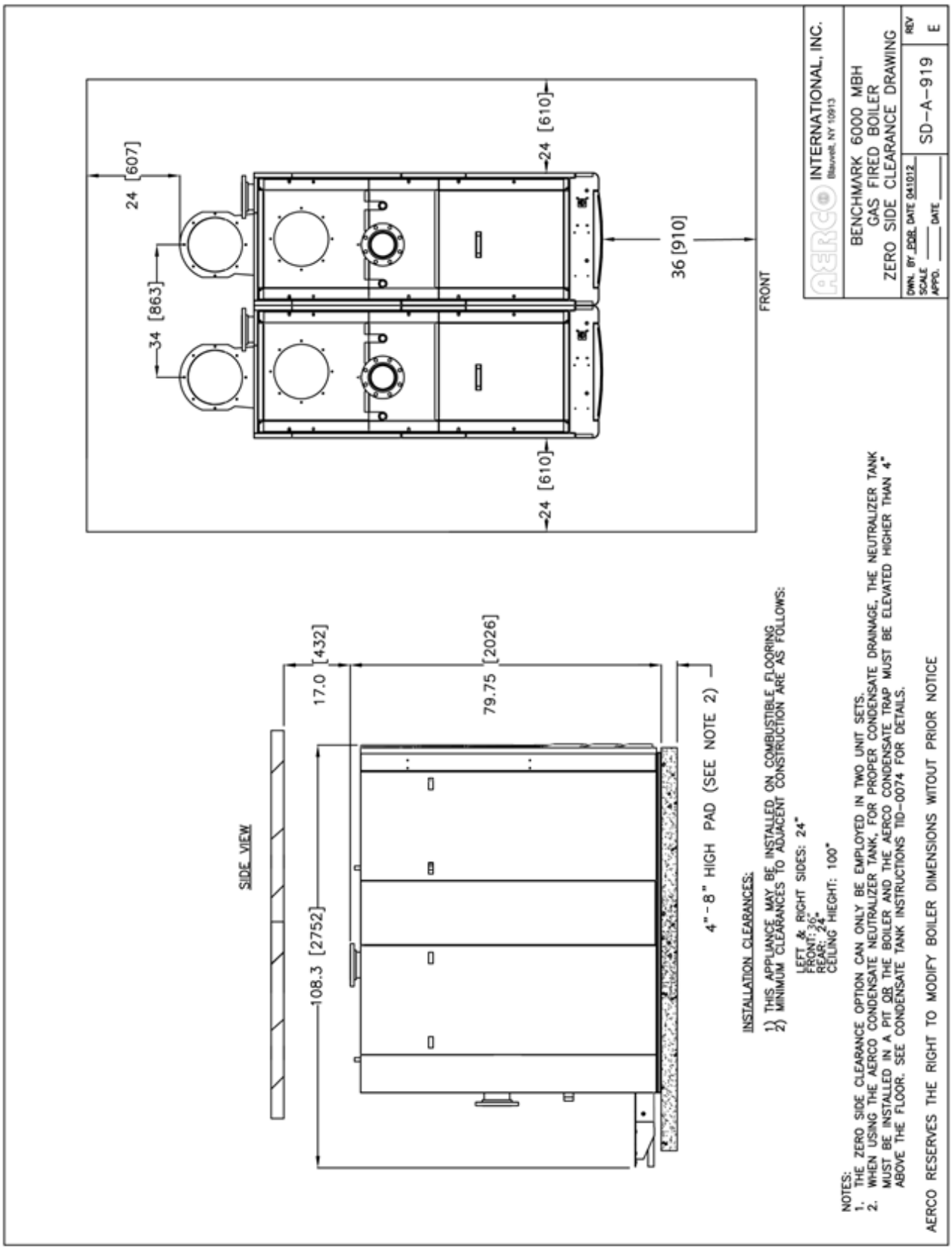
Table D-7: Header Temperature for a Building Reference Temperature of 90ºF

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

APPENDIX E – DIMENSIONAL & CLEARANCE DRAWINGS



Drawing Number: AP-A-901 rev L



Drawing Number: SD-A-919 rev E

APPENDIX F – PART LIST DRAWINGS

Benchmark 6000 Dual Fuel Part List

Item #	Qty	Part #	Description
EXHAUST MANIFOLD			
1	1	39131	EXHAUST MANIFOLD
2	3	9-22	PIPE PLUG: 1/4" NPT: STEEL
3	1	84042	SEAL: MANIFOLD
GAS TRAIN ASSEMBLY			
6	1	22187	STANDARD DUAL FUEL GAS TRAIN
7	1	22219	DBB VENT LINE
BLOWER ASSEMBLY			
19	1	58065-1	460V BLOWER REPLACEMENT KIT
	1	58065-2	208V BLOWER REPLACEMENT KIT
	1	65166	575V BLOWER REPLACEMENT KIT
20	1	88016	O-RING, BLOWER TO AIR FUEL VALVE
21	1	65182	FLAME DETECTOR REPLACEMENT KIT
23	1	58084	IGNITOR ROD REPLACEMENT KIT
25	1	29700	IGNITOR ASSEMBLY
26	2	59192	PILOT FLAME DETECTOR
27	1	59198	TURNBUCKEL
BURNER, AIR/FUEL VALVE & HEAT EXCHANGER			
30	1	24328-1	BURNER ASSEMBLY 460V
		24328-2	BURNER ASSEMBLY 208V
		24328-3	BURNER ASSEMBLY 575V
31	1	58066	AIR/FUEL VALVE REPLACEMENT KIT
33	2	81159	BURNER GASKET
34	2	88014	FILTER: AIR 6" X 12 LG
36	1	39167	SHIELD: BURNER
37	1	83028	FRONT REFRACTORY
38	1	83027	REAR REFRACTORY
39	1	96017	WYE-DUCT: 8" X 6" X 6"
40	1	39170	SHIELD ASSY
CONTROLS			
45 ❶	1	63112	HARNESS: O_2 SENSOR
46	1	65104	CABLE: H.V. IGNITION
47 ❶	2	63114	OPTICAL SENSOR HARNESS
48	2	61031	PILOT FLAME DETECTOR

Item #	Qty	Part #	Description
CONTROLS (Continued)			
50	1	69241	VFD DRIVE 208V, PROGRAMMED
		69240	VFD DRIVE 460V, PROGRAMMED
		69242	VFD DRIVE 575V, PROGRAMMED
51	1	65162	24V POWER SUPPLY (Sequencing Valve)
52	2	69141	DIN RAIL MOUNT END STOP
53 ❶	1	63113-1	SHELL HARNESS
54	1	69172	I/O ASSY WITH ONAER
55 ❶	1	63111	HARNESS: CONTROL
56 ❶	1	63004	HARNESS: 460V TRANSFORMER
57 ❶	1	63126	BLOWER CONTROL HARNESS
58 ❶	2	69169	JUMPER BAR: DIN TERMINALS
59 ❶	1	63121	HARNESS: 12V POWER SOURCE
60 ❶	1	63122	GROUND CABLE: #12
61	1	69186-1	CONTROL BOX: C-MORE
62	1	65085	IGNITION TRANSFORMER
63	2	65135	OMRON RELAY BASE
64	2	65134	OMRON RELAY 120V
65	4	39168	CLIP: SHIELD
66	2	61032	SURFACE TEMP SENSOR
67	1	123449	INLET WATER TEMP. SENSOR 1-1/2"
68	1	61026	LEAN OXYGEN SENSOR
69	1	61030	OUTLET TEMPERATURE SENSOR
70	1	44146	THERMOWELL
71	1	64081	ECU
72	1	65011	TRANSFORMER 115V/24V 100VA
73	1	65109	12V POWER SUPLY
74	1	123552	OVER TEMP-MANUAL RESET SWITCH
75	1	123966	ADJUSTABLE TEMP LIMIT SWITCH
76❶	1	69161-1	DIN RAIL

❶ Not shown on drawing

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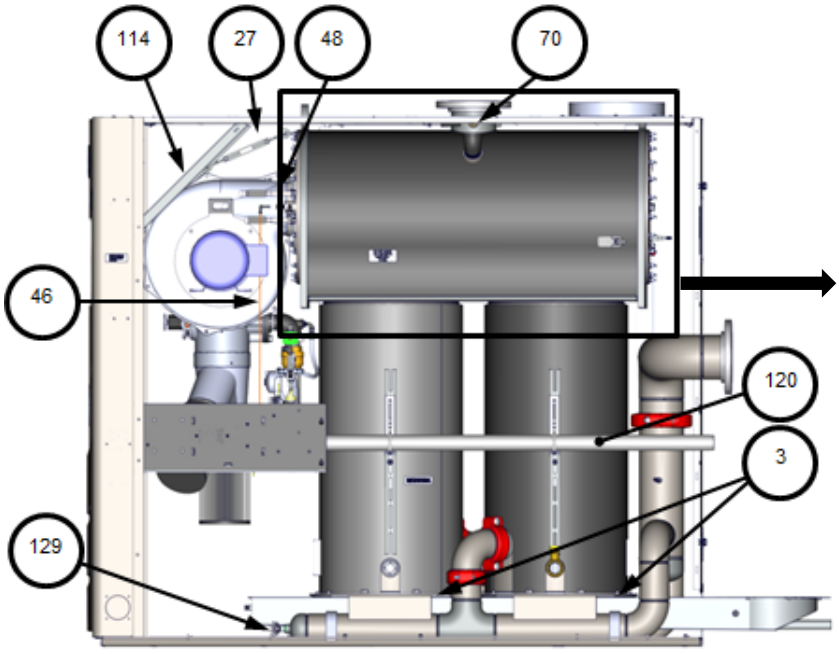
Benchmark 6000 Dual Fuel Part List

Item #	Qty	Part #	Description	Item #	Qty	Part #	Description
CONTROLS (Continued)				**SHEET METAL / PANEL ASSEMBLY**			
77	2	65120	TERMINAL BLOCK: DIN MOUNTED: BLK	101	4	30117	SIDE PANEL
78	2	65121	TERMINAL BLOCK: DIN MOUNTED: WHT	102	2	35025	SIDE PILLAR
79	3	65122	TERMINAL GROUND BLOCK: DIN MOUNTED	103	1	30126	TOP PANEL: FRONT
80	2	65118	FUSE TERMINAL: DIN MOUNTED	104	1	30128	PANEL: TOP MIDDLE
81	1	64088	LIMIT CONTROL TEMPERATURE: DIGITAL CONTROLLER	105	1	30127	PANEL: TOP REAR
82	1	65137	3 POLE 30A BREAKER	106	1	30125	BACK PANEL: RIGHT
83 ❶	2	124512	FUSE: 4 AMP	107	1	30124	BACK PANEL LEFT
84 ❶	1	63105	I/O SENSOR/COMM HARNESS	108	1	39174	AIR INLET ADAPTETR
85 ❶	1	63104	I/O INTERLOCK HARNESS	109	8	59133	LATCH: COMPRESSION
86 ❶	1	63090	HARNESS ASSY: TEMP LIM CONT PWR	110	1	25078	FRONT PANEL ASSEMBLY
87	1	124310	TRANSFORMER STEPDOWN 208/203/460V	111	2	35024	TOP RAIL
		65167	TRANSFORMER STEPDOWN 600V	112	1	72068	AERCO LOGO
88	1	69161-2	DIN RAIL	113	1	74024	LOGO: BMK 6000
89	1	61034	SPARK MONITOR	114	2	33148	BRACE: DIAGONAL
90 ❶	1	63125-1	GAS TRAIN HARNESS, 7 SEC IGNITION	115	1	25080	FRONT FRAME ASSEMBLY, WELDING
91❶	1	38035	PANEL COVER: I/O BOX	**HOSE & INSULATION**			
92❶	1	38036	POWER PANEL COVER	119	1	80084	INSULATION: UPPER
93	1	58060	O_2 SENSOR	120	2	80083	INSULATION: LOWER
94	1	63035-1	DUAL FUEL SELECTION SWITCH	121 ❶	1	97005-5	TUBE: FLEXIBLE GAS 18"
95	1	65147	VENTILATION FAN				
96	1	61024	AIR INLET TEMPERATURE SENSOR	**OTHER ACCESSORIES / PARTS**			
97❶	1	61034	SPARK MONITOR	127	1	69126	LOW WATER CAPACITY CUTOFF/CAPACITOR ASSY
				129	2	92094	DRAIN VALVE 3/4 NPT
				134	1	58067	SAMPLING TUBE KIT
				135 ❶	1	92084-6	MOTORIZED SEQUENCING VALVE (OPTIONAL)

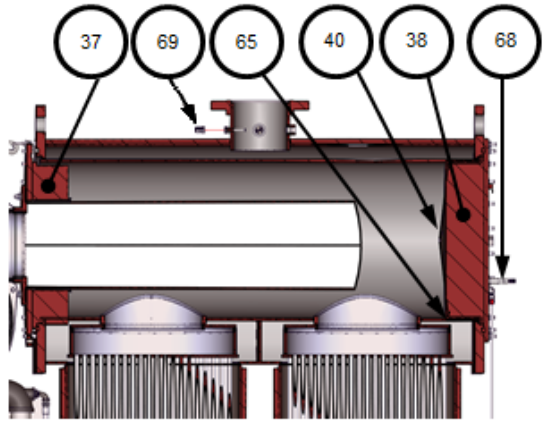
❶ Not shown on drawing

Additional Benchmark 6000 Kits Available

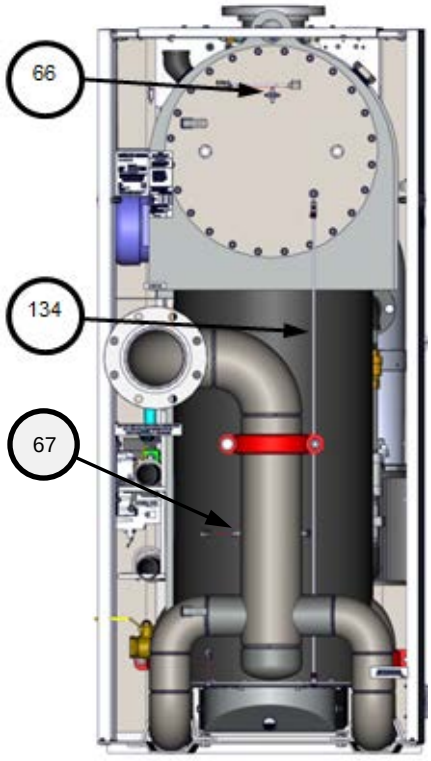
Part #	Description
27086-2	ACTUATOR REPLACEMENT KIT
64106	SSOV W/ REGULATOR KIT
58067	SAMPLING TUBE KIT
58084	IGNITER ROD REPLACEMENT KIT
BLOWER REPLACEMENT KITS	
58065-1	460V BLOWER
58065-2	208V BLOWER
65166	575V BLOWER
58053-TAB	**BENCHMARK 6000 SPARE PARTS KITS**
92102-TAB	RELIEF VALVE KIT
123675-TAB	TRIDICATOR
123540	2" BALL VALVE
24060	CONDENSATE VALVE ASSEMBLY
84017	O-RING #2-152



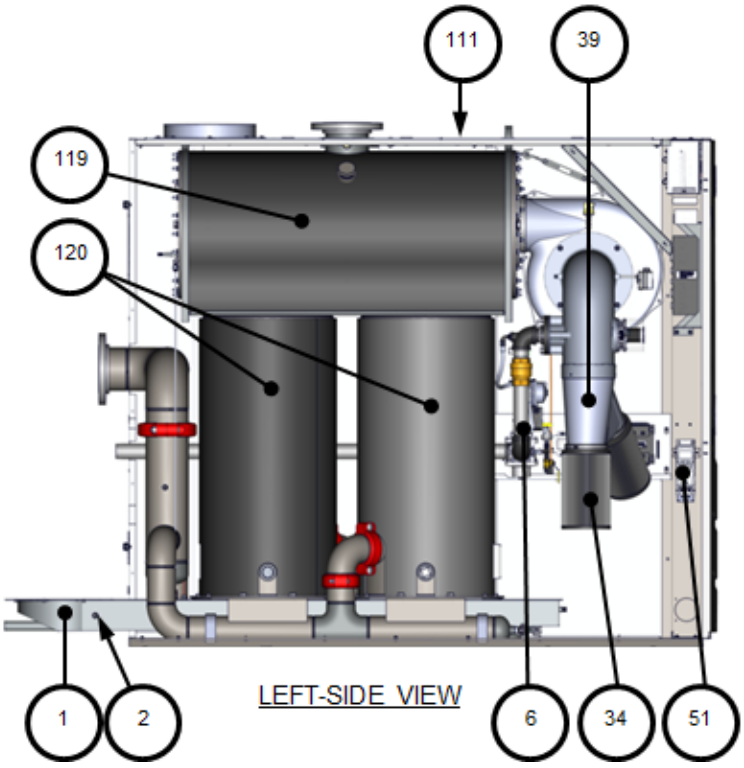
RIGHT-SIDE VIEW



CROSS-SECTION

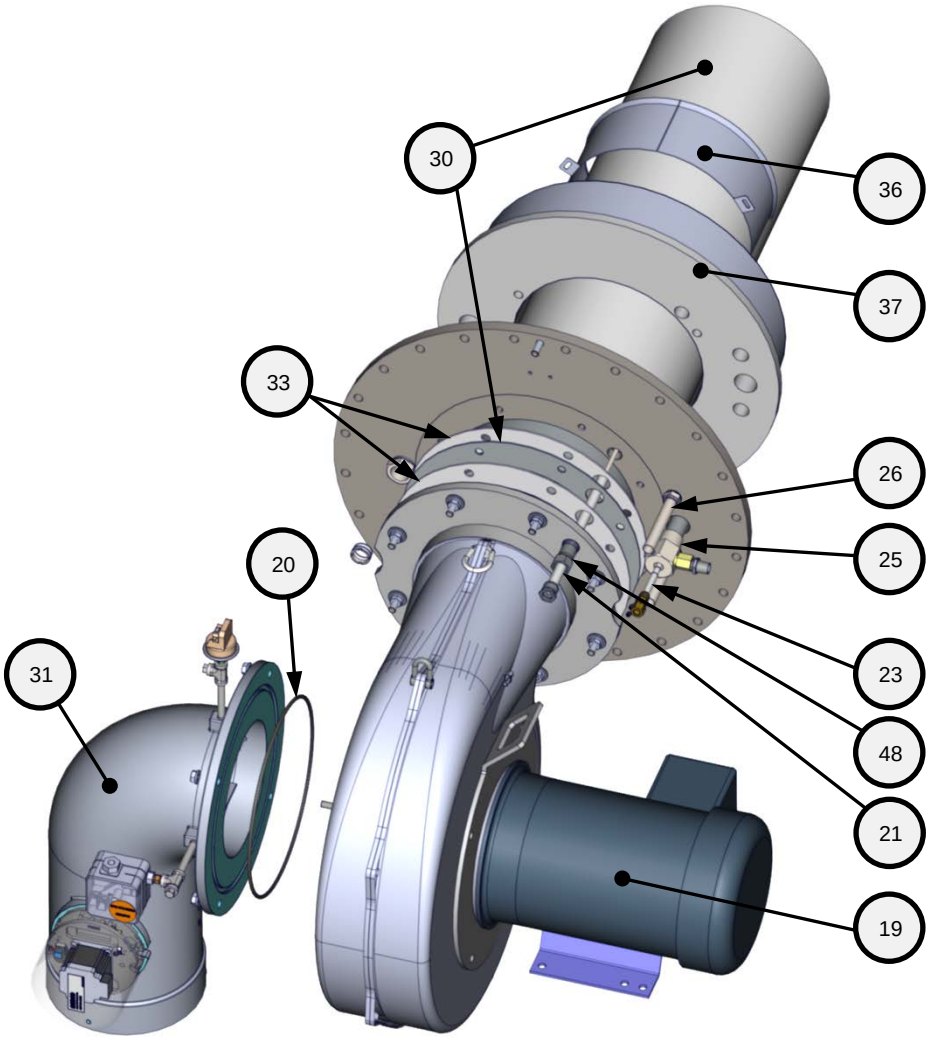


REAR VIEW



LEFT-SIDE VIEW

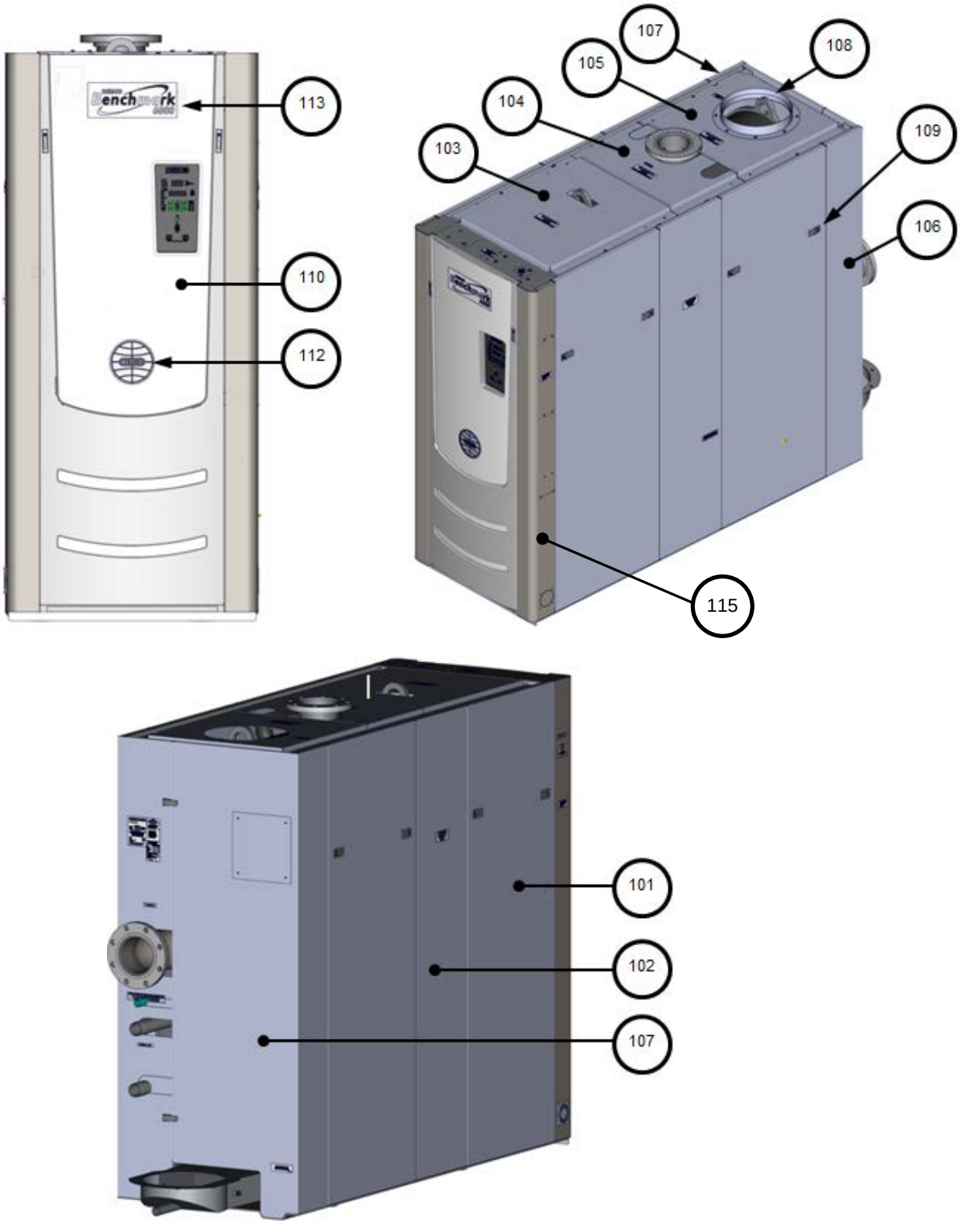
AERCO International, Inc. Blauvelt, NY 10913	**Benchmark 6000 DF Part List**	01/15/2015
	Whole Boiler P/N 28510-5	Sheet 3 of 8



460V BURNER ASSEMBLY – BLOWER 65127
208V BURNER ASSEMBLY – BLOWER 65127-1
575V BURNER ASSEMBLY – BLOWER 65166

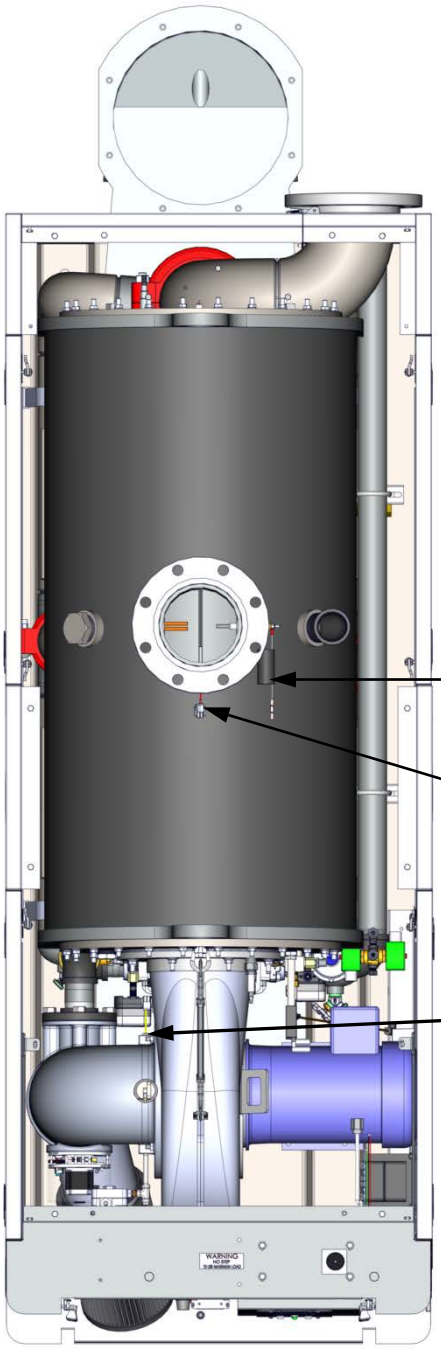
NOTE
A complete Air/Fuel Valve, Blower and
Burner part list is shown on pages below

AERCO International, Inc. Blauvelt, NY 10913	**Benchmark 6000 DF Part List**	01/15/2015
	Whole Boiler P/N 28510-5	Sheet 4 of 8



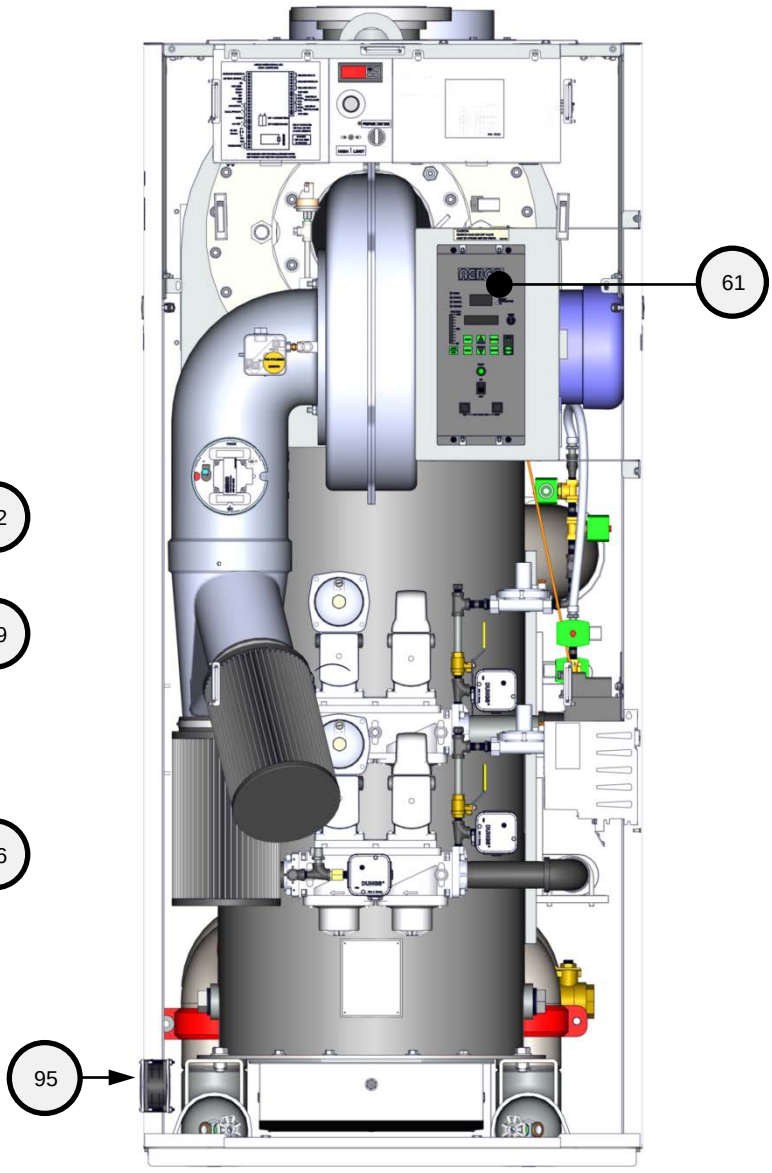
AERCO International, Inc. Blauvelt, NY 10913	**Benchmark 6000 DF Part List**	01/15/2015
	Whole Boiler P/N 28510-5	Sheet 5 of 8

REAR



FRONT

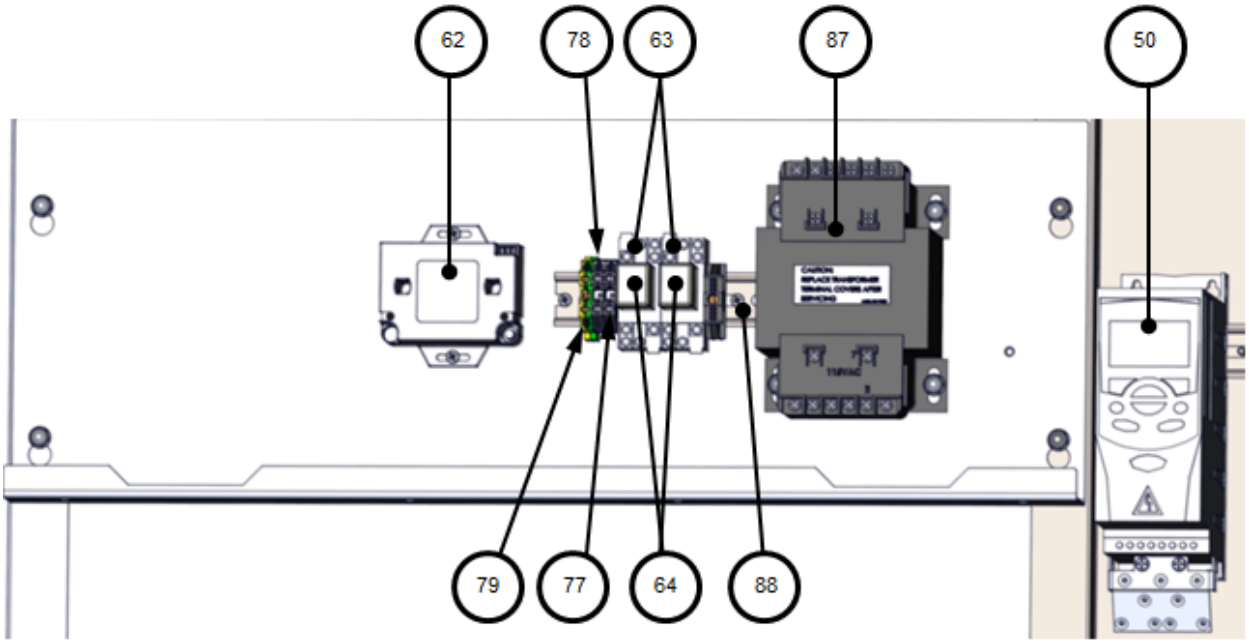
OVERHEAD VIEW



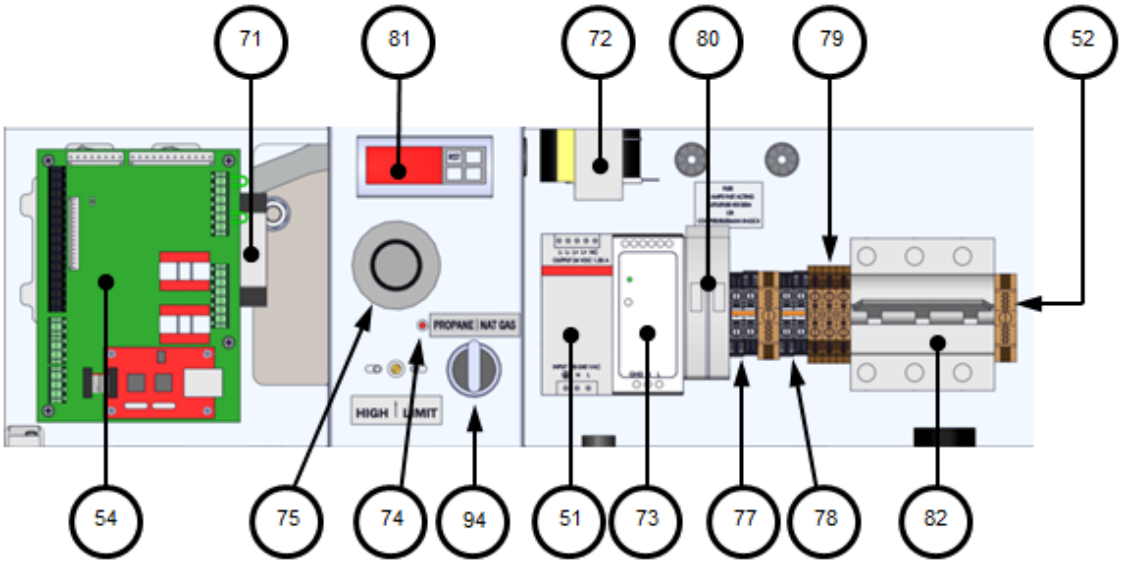
FRONT PANEL & FRAME REMOVED

FRONT VIEW

AERCO International, Inc. Blauvelt, NY 10913	**Benchmark 6000 DF Part List**	01/15/2015
	Whole Boiler P/N 28510-5	Sheet 6 of 8

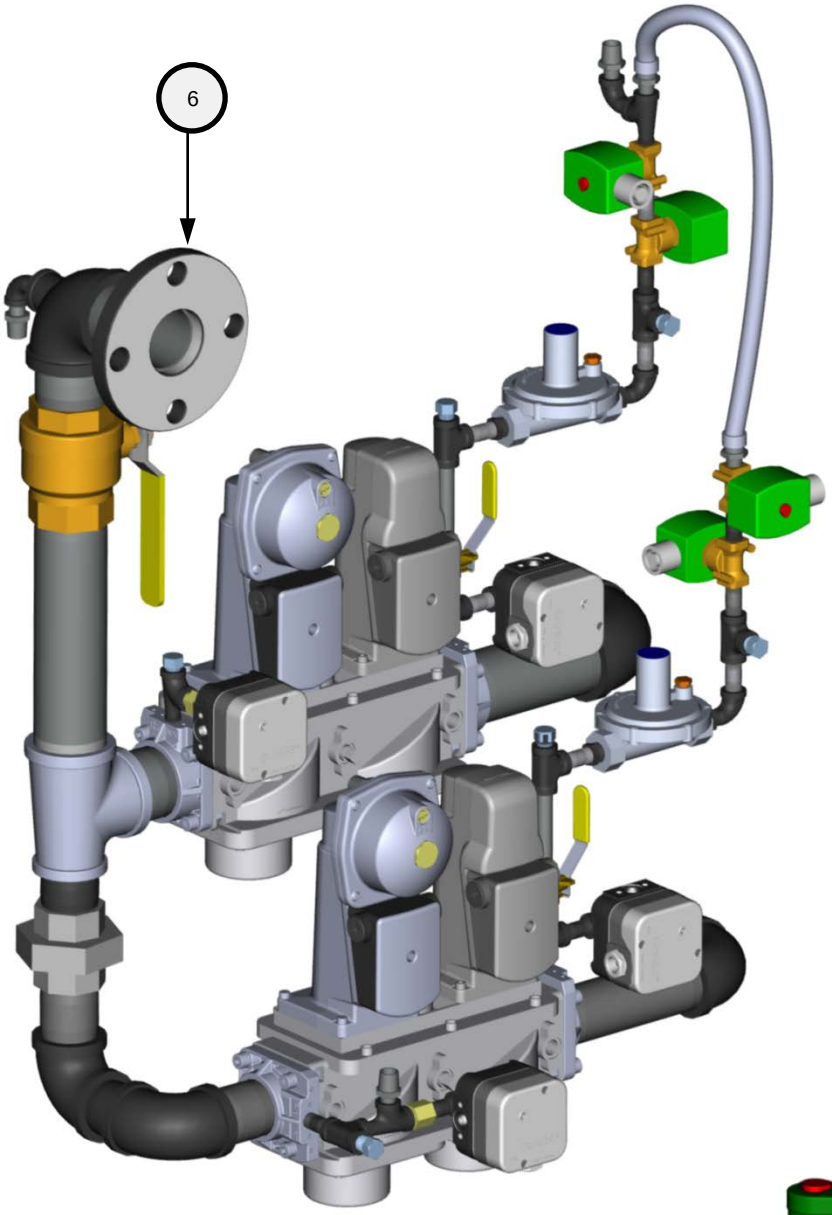


RELAY BOARD



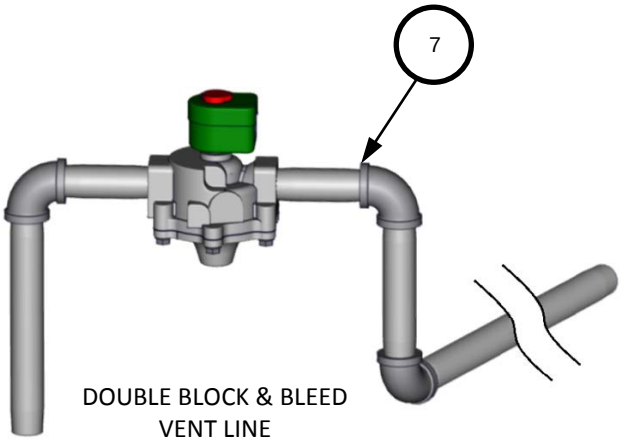
POWER I/O BOX P/N 24353-3

AERCO International, Inc. Blauvelt, NY 10913	**Benchmark 6000 DF Part List**	01/15/2015
	Whole Boiler P/N 28510-5	Sheet 7 of 8



BENCHMARK 6000 DUAL FUEL
GAS TRAIN
P/N 22187

NOTE
A complete gas train part list is shown on the pages below

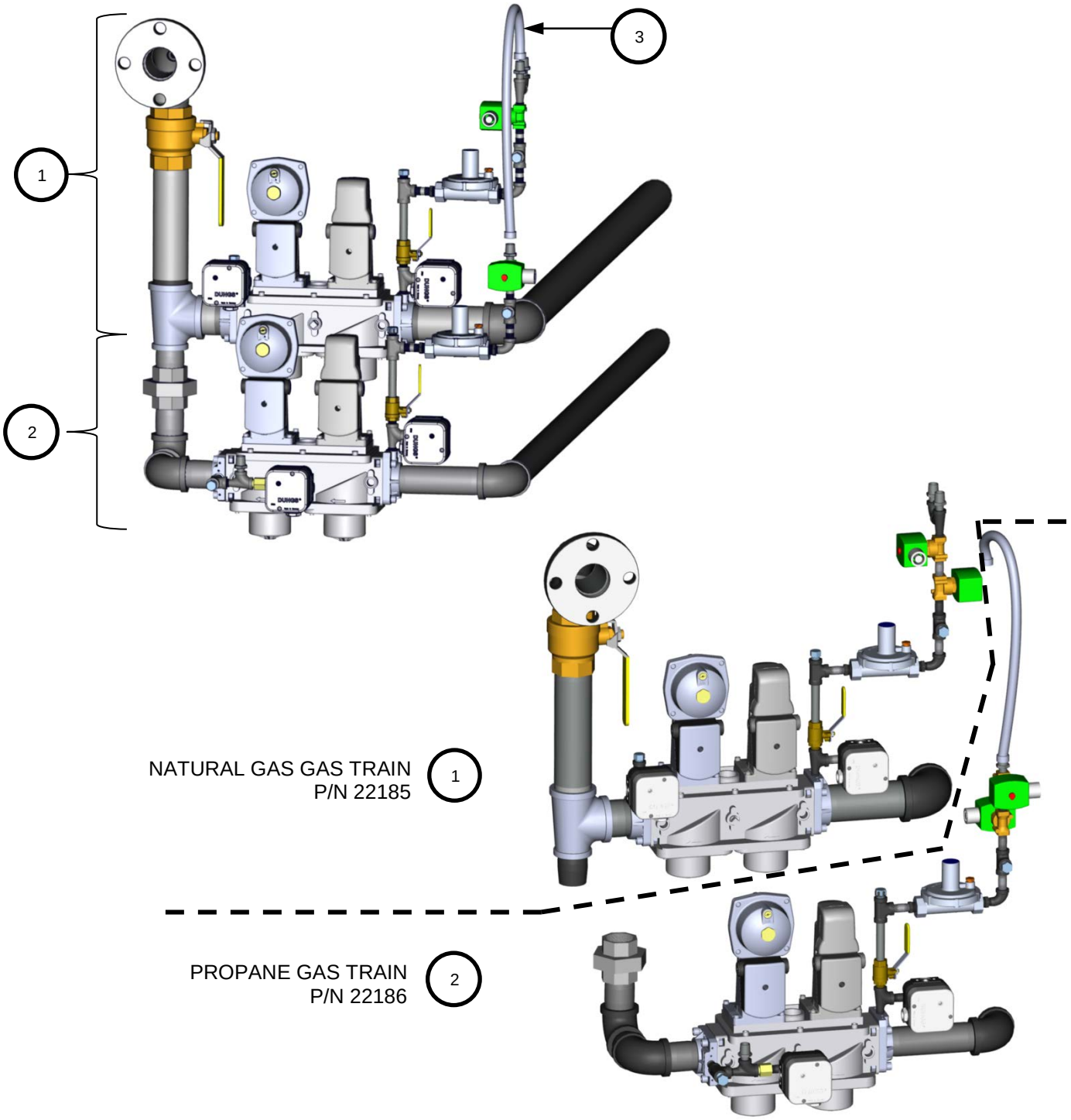


DOUBLE BLOCK & BLEED
VENT LINE
P/N 22219

AERCO International, Inc. Blauvelt, NY 10913	**Benchmark 6000 DF Part List**	01/15/2015
	Whole Boiler P/N 28510-5	Sheet 8 of 8

Benchmark 6000 DF Gas Train – P/N 22187

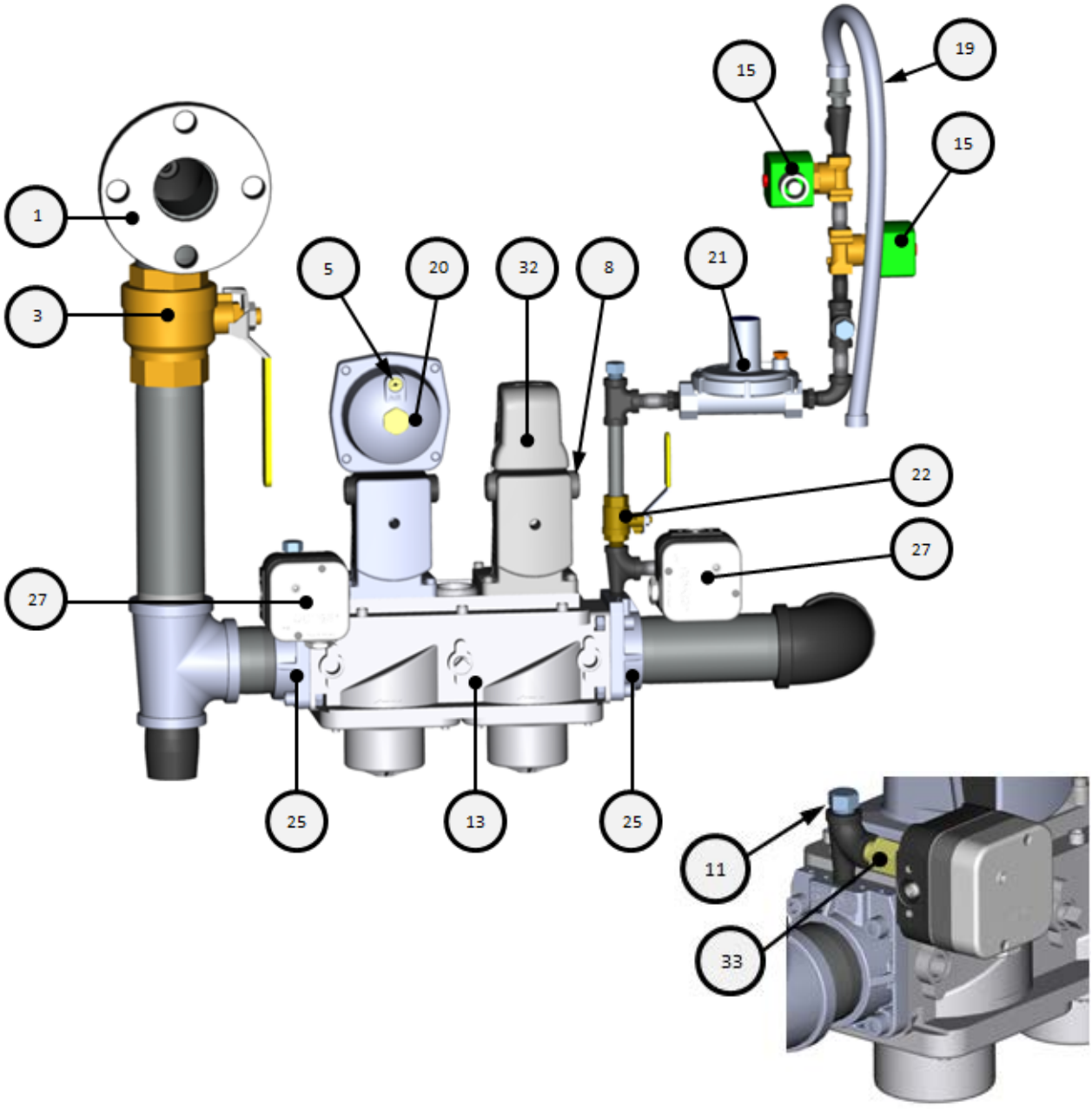
Item	Qty	Part #	Description
1	1	22185	DUAL FUEL GAS TRAIN – NATUAL GAS
2	1	22186	DUAL FUEL GAS TRAIN – PROPANE
3	1	97005-7	FLEXIBBLE GAS TUBE, 18”



AERCO International, Inc. Blauvelt, NY 10913	**Benchmark 6000 DF Gas Train**	01/15/2015
	P/N 22187 rev B	Sheet 1 of 1

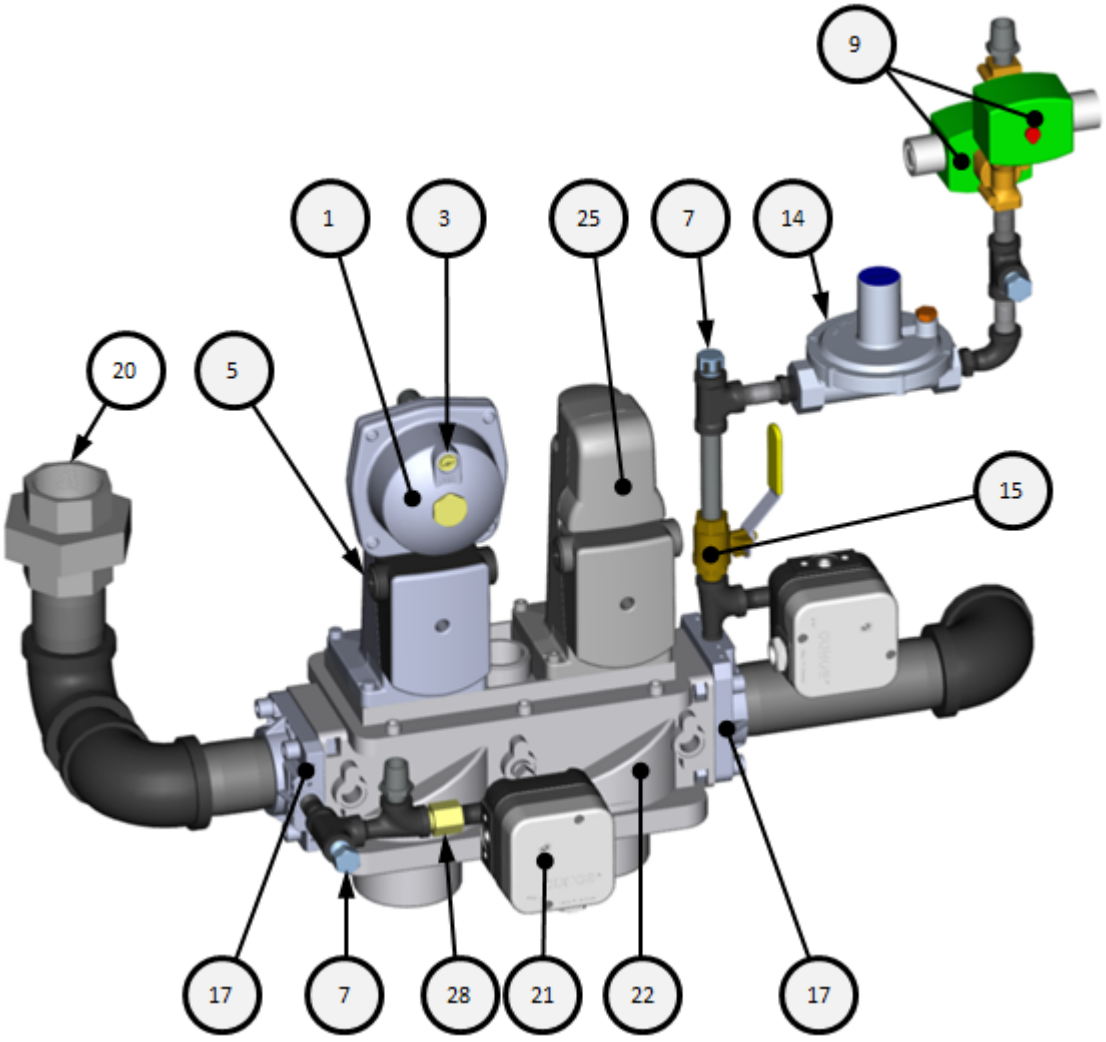
Benchmark 6000 DF Gas Train – Natural Gas – P/N 22185 rev C

Item	Qty	Part #	Description	Item	Qty	Part #	Description
1	1	123542	FLANGE 2" 125# 2"NPT	20	1	24383	SKP 25.011U1 W/ 15-120 SET PT
3	1	123540	VALVE: BALL 2" FULL PORT	21	1	24384	MAXITROL REGULATOR W/ 2-6" SPRING
5	1	99015	DAMPING ORIFICE: SSOV	22	1	92077	1/4" NPT MXF BRASS BALL VALVE
8	4	12951-2	BUSHING: CONTROL BOX	25	2	95030	FLANGE: SSOV 2" NPT
11	3	9-22	PIPE PLUG: 1/4" NPT: STEEL	27	2	60020	SWITCH: GAS PRESSURE 2-20" W.C.
13	1	124142	VALVE: SSOV: DOUBLE BODY: 2" NPT	32	1	124138	ACTUATOR: SSOV
15	2	124866	SOLENOID VALVE: 1/4" NPT	33	1	99017	SNUBBER: PRESSURE: 1/4"
19	1	97005-5	TUBE: FLEXIBLE GAS 18"				



AERCO International, Inc. Blauvelt, NY 10913	**Benchmark 6000 DF Gas Train – Natural Gas**	01/15/2015
	P/N 22185 rev C	Sheet 1 of 1

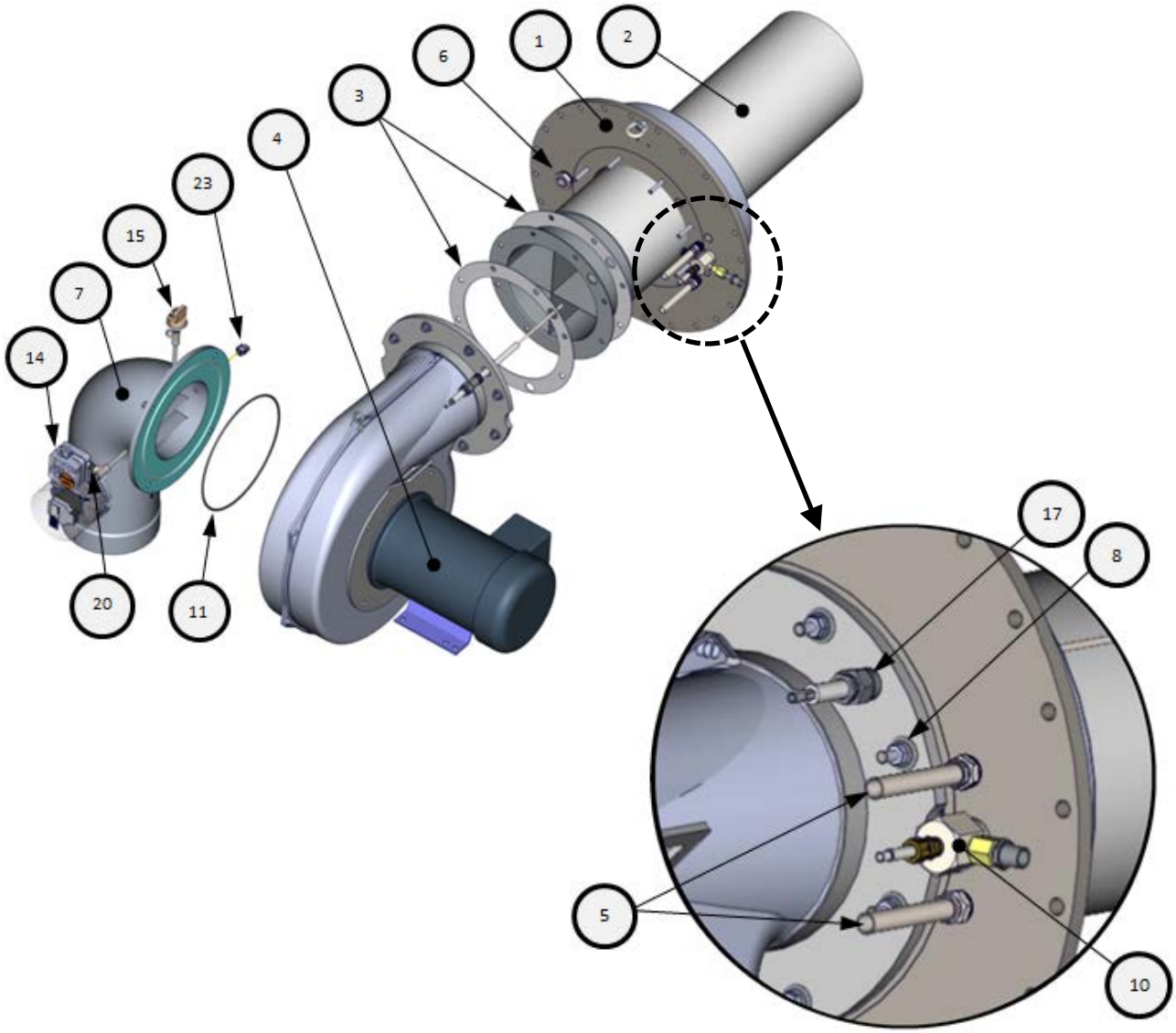
Benchmark 6000 DF Gas Train – Propane – P/N 22186 rev C							
Item	**Qty**	**Part #**	**Description**	**Item**	**Qty**	**Part #**	**Description**
1	1	69005	ACTUATOR: SSOV W/ REGULATOR	17	2	95029	FLANGE: SSOV 1 1/2" NPT
3	1	99015	DAMPING ORIFICE: SSOV	21	2	60020	SWITCH: GAS PRESSURE 2-20" W.C.
5	4	12951-2	BUSHING: CONTROL BOX	20	1	93310	1-1/2" 150# BLACK IRON UNION
7	4	9-22	PIPE PLUG: 1/4" NPT: STEEL	22	1	124137	VALVE: SSOV: DOUBLE BODY: 1-1/2" NPT
9	2	124866	SOLENOID VALVE: 1/4" NPT	25	1	124138	ACTUATOR: SSOV
14	1	24384	MAXITROL REGULATOR W/ 2-6" SPRING	28	1	99017	SNUBBER: PRESSURE: 1/4"
15	1	92077	1/4" NPT MXF BRASS BALL VALVE				



BMK 6000 A/F Valve, Blower & Burner Assembly – 24328 rev E

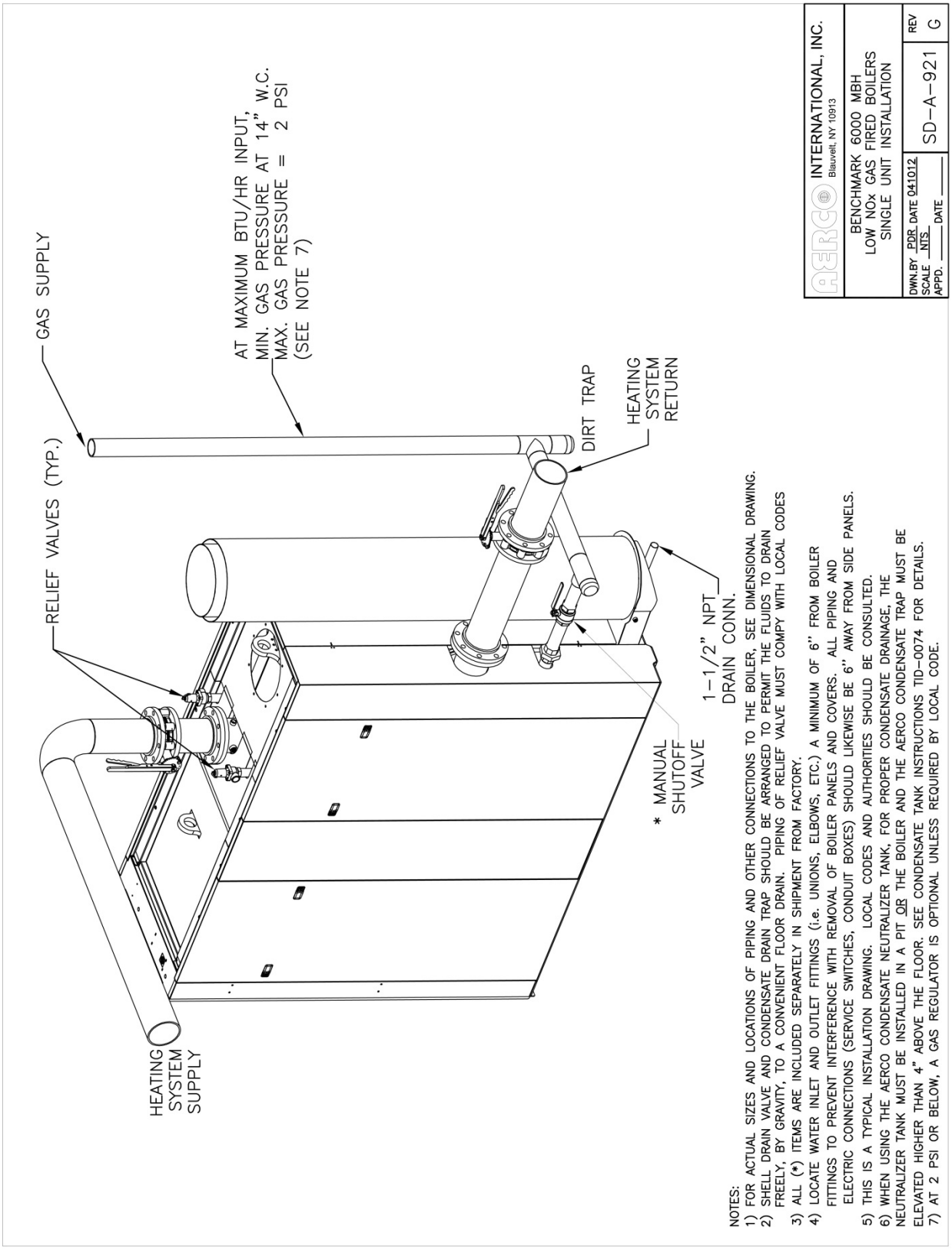
Item	Qty	Part #	Description	Item	Qty	Part #	Description
1	1	24371	FRONT PLATE ASSY	10	1	29700	IGNITOR: PILOT
2	1	46025	BURNER	11	1	88016	O-RING #2-378
3	2	81159	BURNER GASKET	14	1	60011-4	SWITCH ASSY: BLOWER PROOF
4	1	See Table	BLOWER	15	1	61002-5	BLOCKED INLET SWITCH -4.5" W.C.
5	2	59192	PILOT FLAME DETECTOR	17	1	65150	MAIN FLAME DETECTOR
6	1	59140	SIGHT GLASS 1"	20	1	93367	SNUBBER: FAN PROVING SWITCH
7	1	24352	A/F VALVE ASSY	23	1	61024	AIR INLET TEMPERATURE SENSOR
8	13	56004	3/8-16NUT: FLANGED				

460V BURNER ASSEMBLY – BLOWER P/N 65127
208V BURNER ASSEMBLY – BLOWER P/N 65127-1
575V BURNER ASSEMBLY – BLOWER P/N 65166



AERCO International, Inc. Blauvelt, NY 10913	**Benchmark 6000 Blower & Burner**	04/16/2015
	P/N 24328 rev E	Sheet 1 of 1

APPENDIX G – PIPING DRAWINGS



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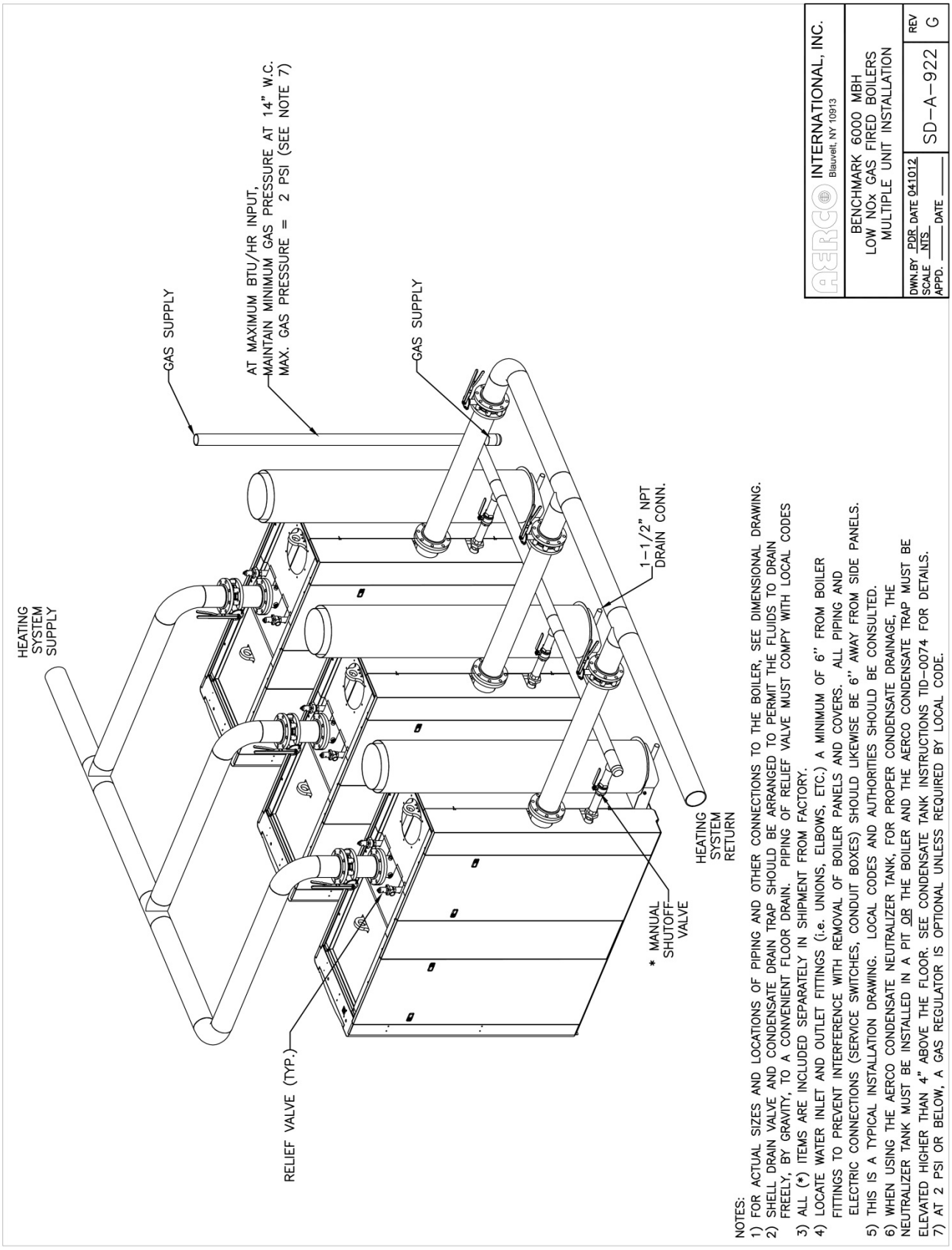

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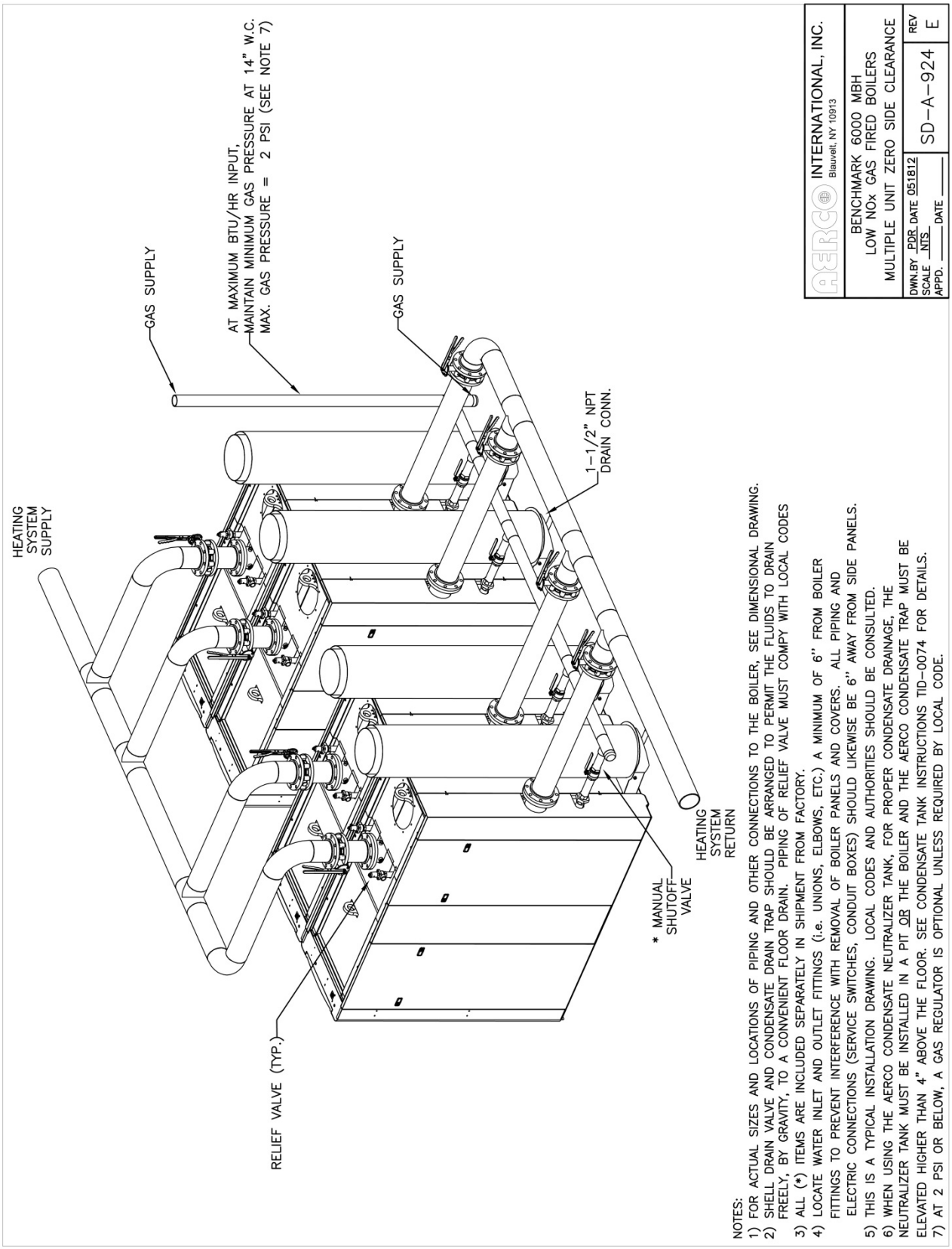

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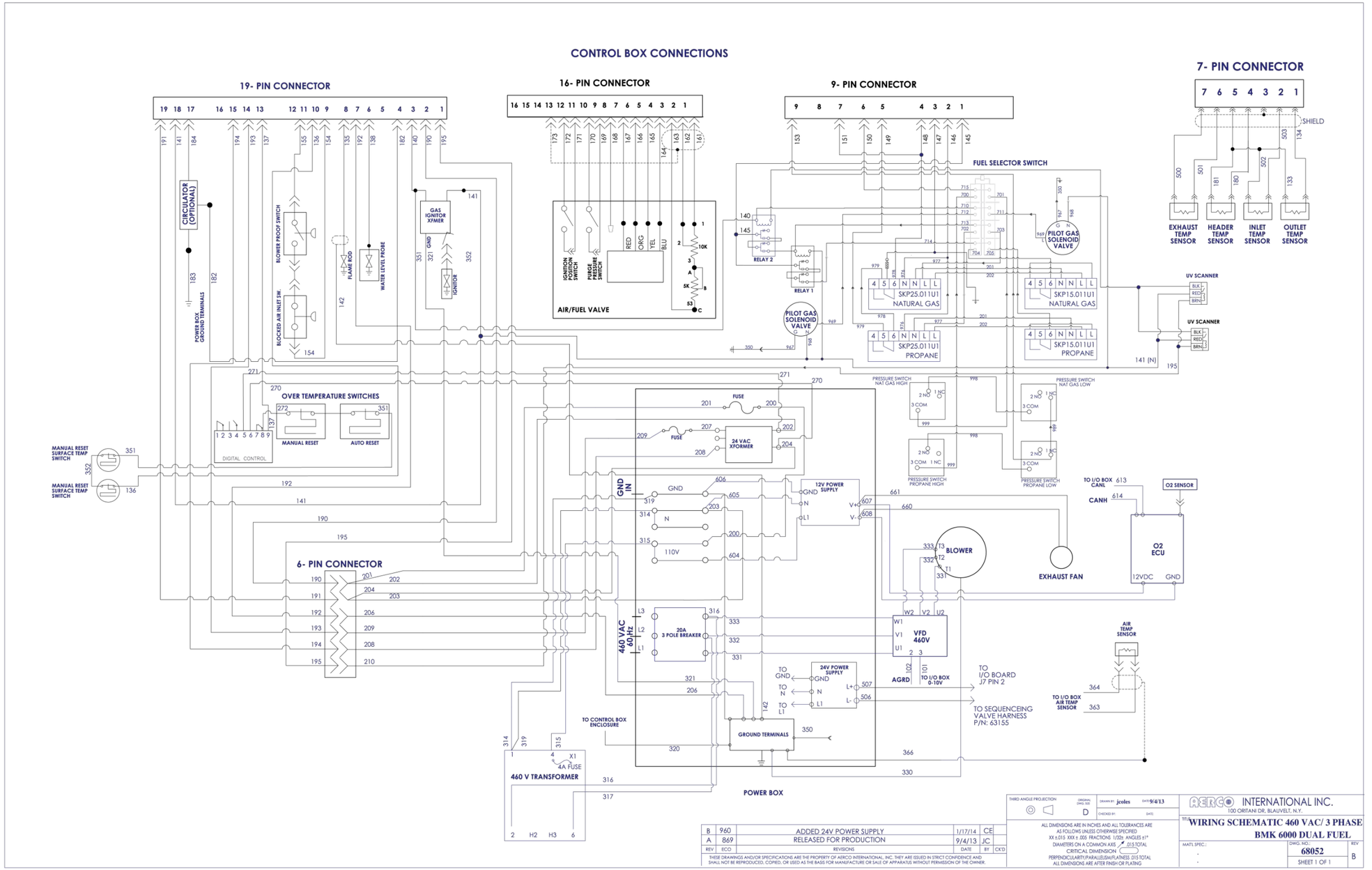
APPENDIX H – C-MORE WIRING DIAGRAMS



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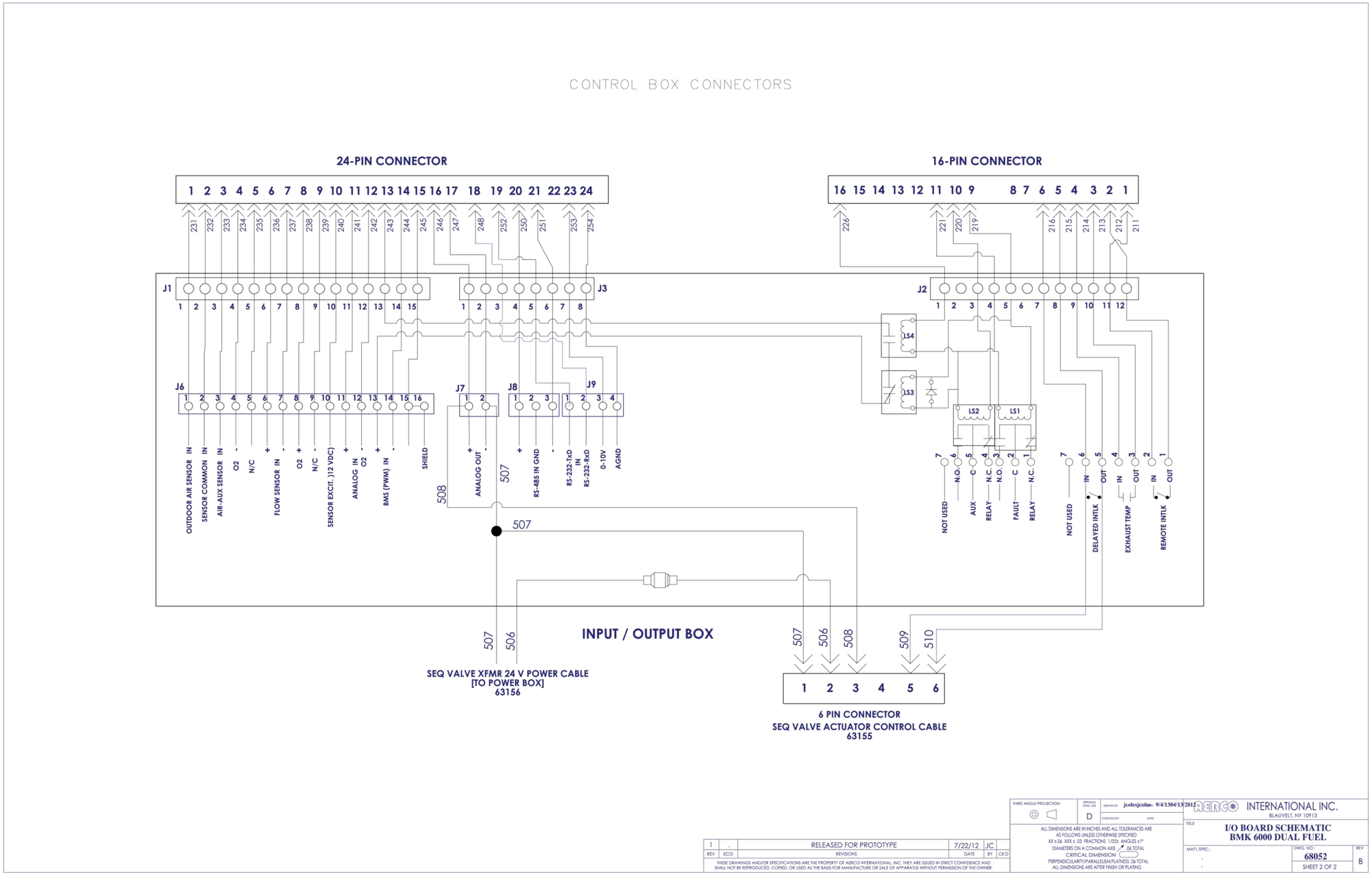

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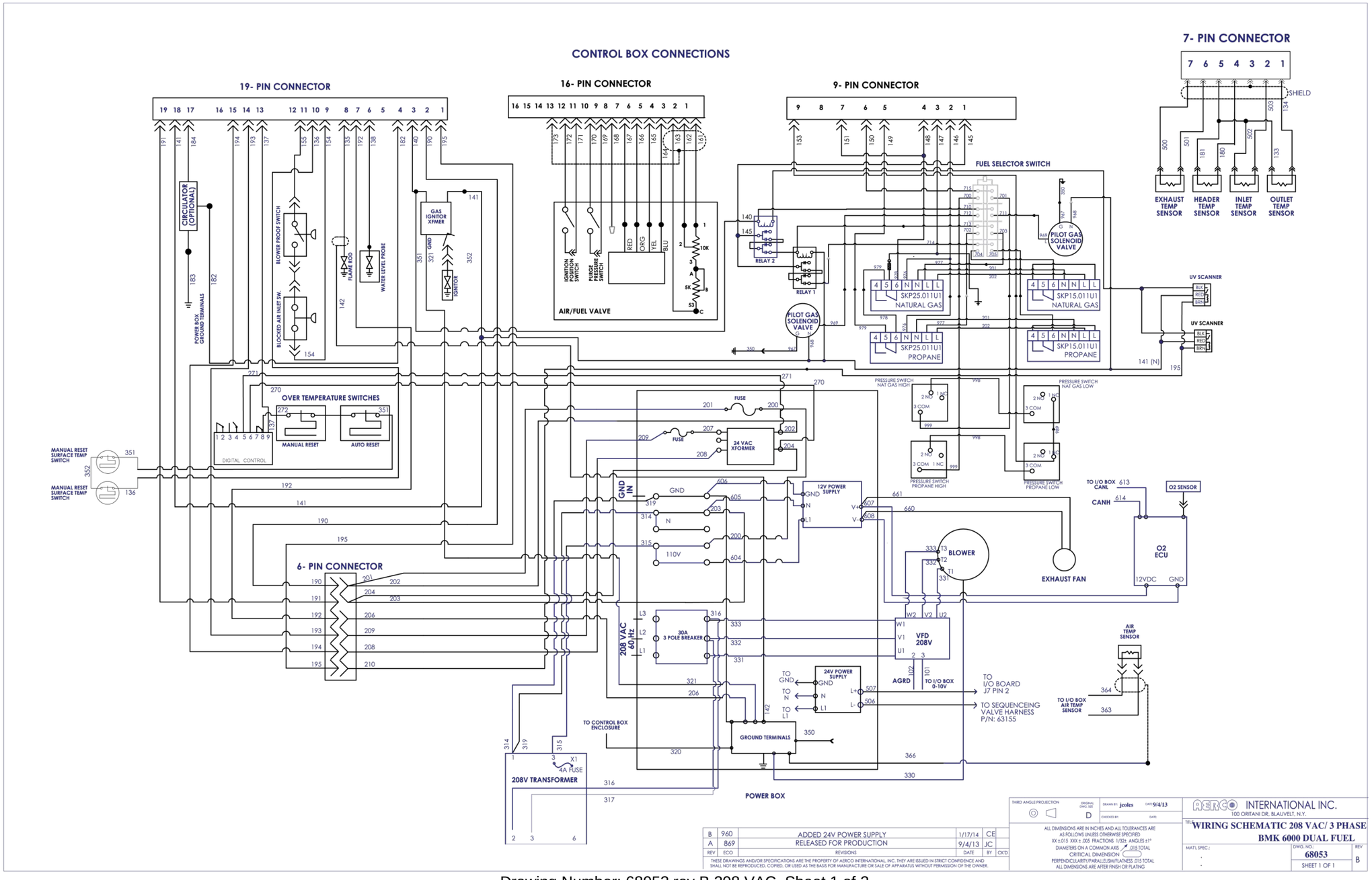

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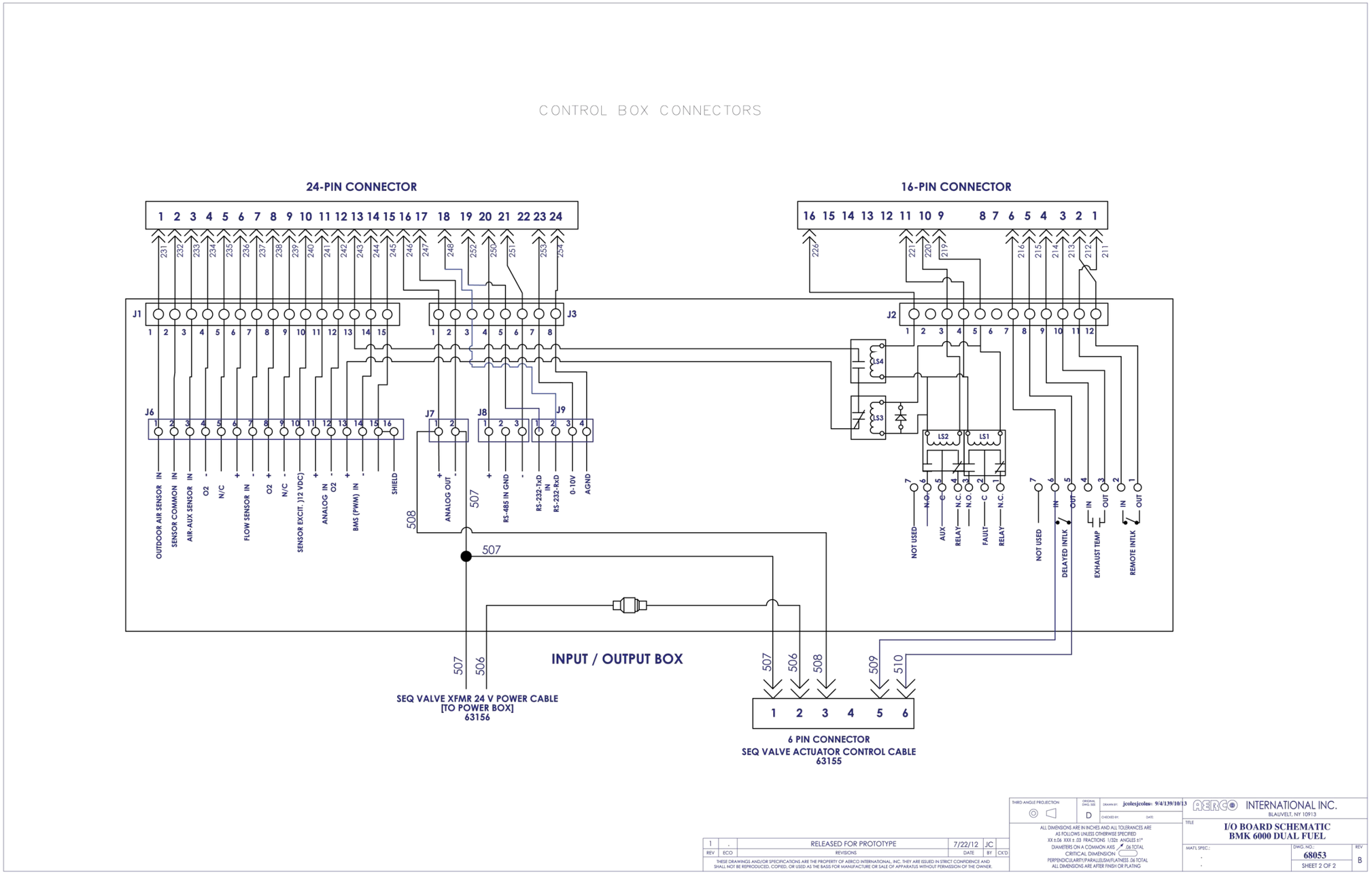

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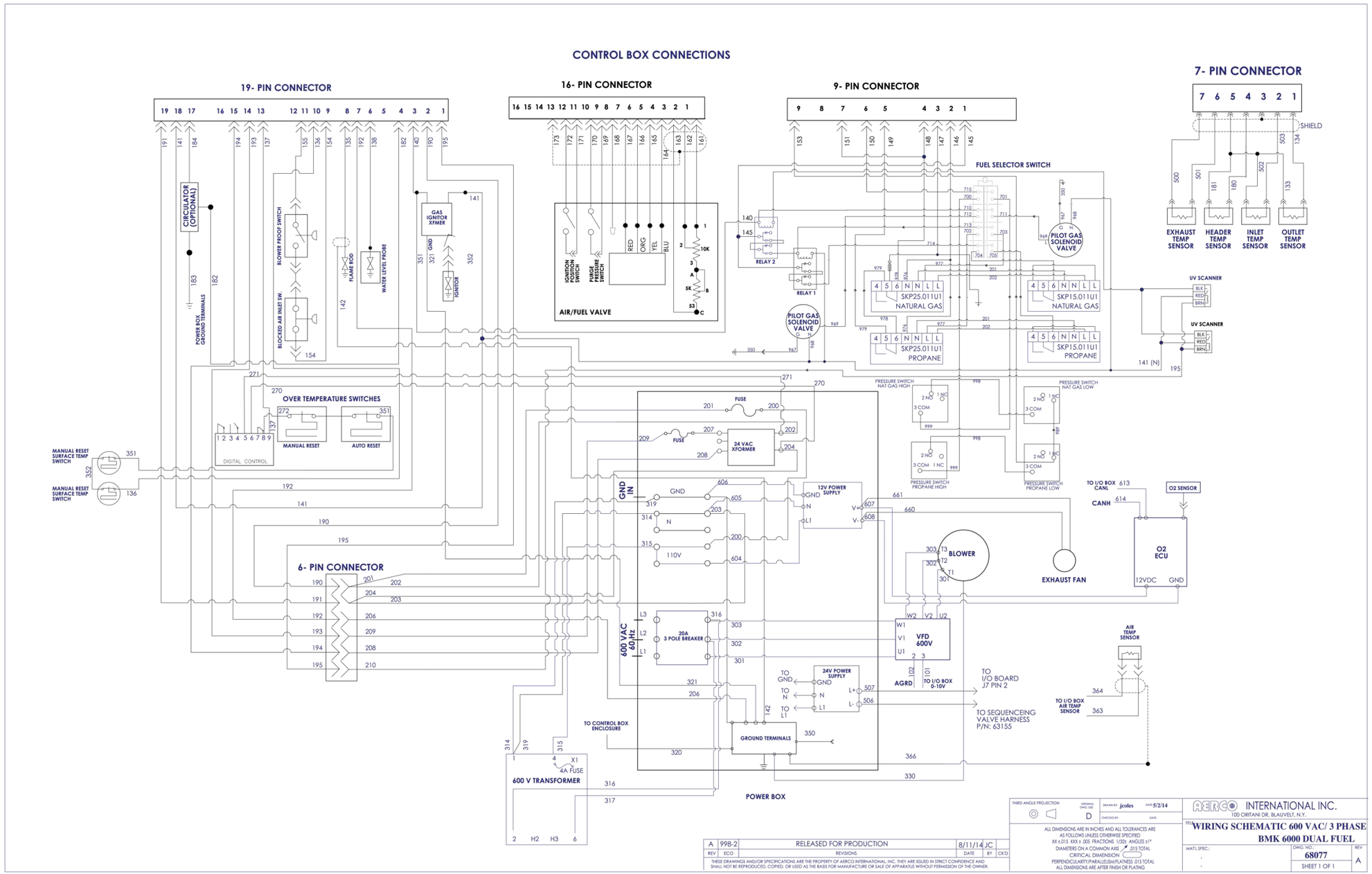

Drawing Number: 68077 rev A, 600 VAC, Sheet 1 of 2

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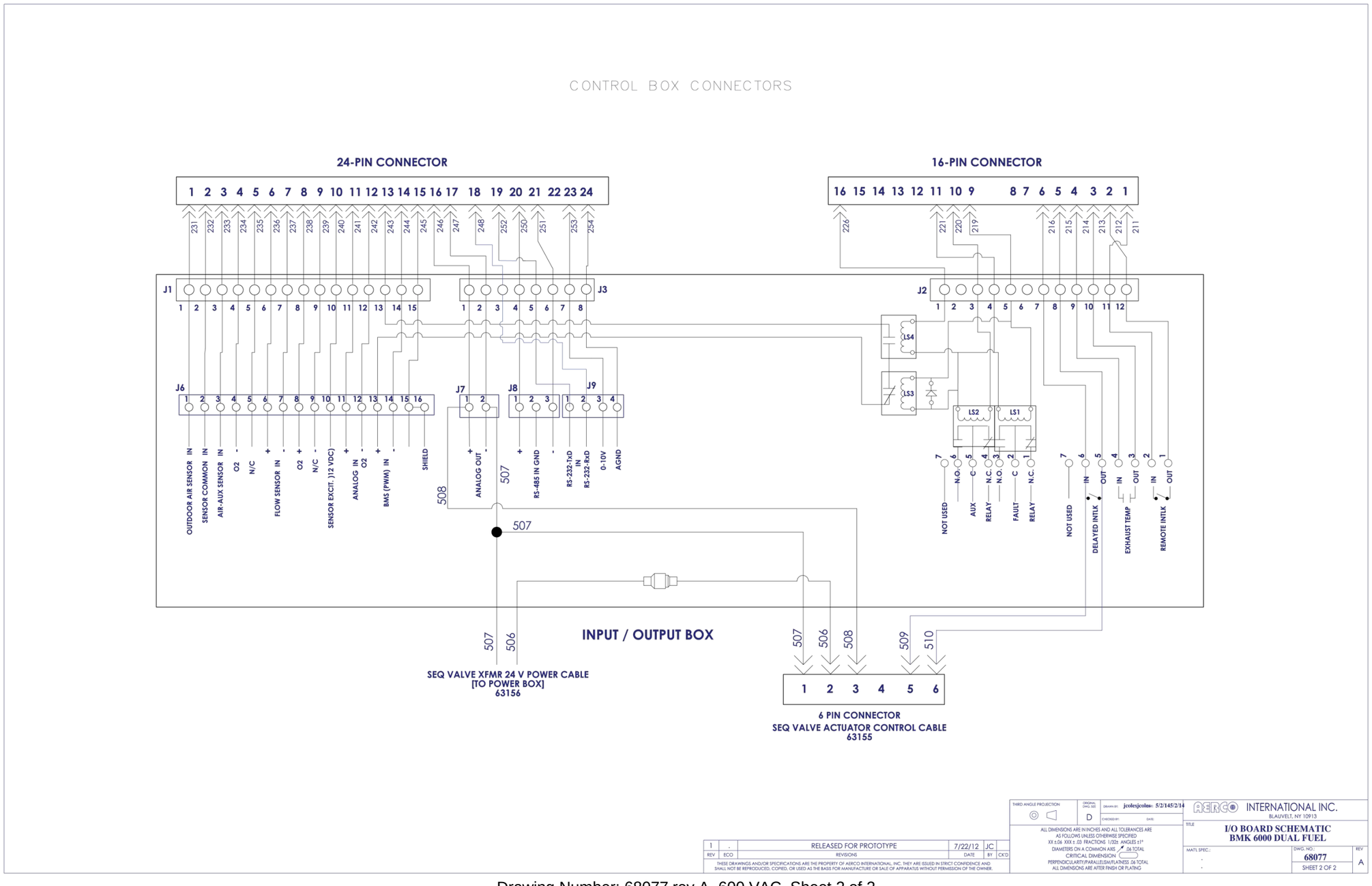

Drawing Number: 68077 rev A, 600 VAC, Sheet 2 of 2

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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.

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 7.5 and Chapter 4.
Flue, vent, stack or intake air duct	Monthly	Operator	Visually inspection condition and check for obstructions
Pilot Burner	Weekly	Operator	See section 7.2
Air/Fuel Valve position	Weekly	Operator	Check position indicator dial (section 3.10)
SSOV Leakage test	Annually	Service Technician	Check for leakage in accordance with the SSOV manufacturer's (Siemens) recommendations.
Flame failure	Weekly	Operator	Close manual gas shutoff valve and check safety shutdown. See section 6.7
Flame signal strength	Weekly	Operator	Check flame strength using the Control Panel *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
Low air flow	Monthly	Operator	See section 6.8
Low and high 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 7.9
Oxygen (O_2) Level	Monthly	Operator	Verify oxygen level is between 3% and 8% during boiler operation
Pilot Sensor	Semi-Annually	Operator	Red LED should be on when operating
Pilot View Port	Monthly	Operator	Turn off boiler first.

APPENDIX J – C-MORE CONTROL PANEL VIEWS

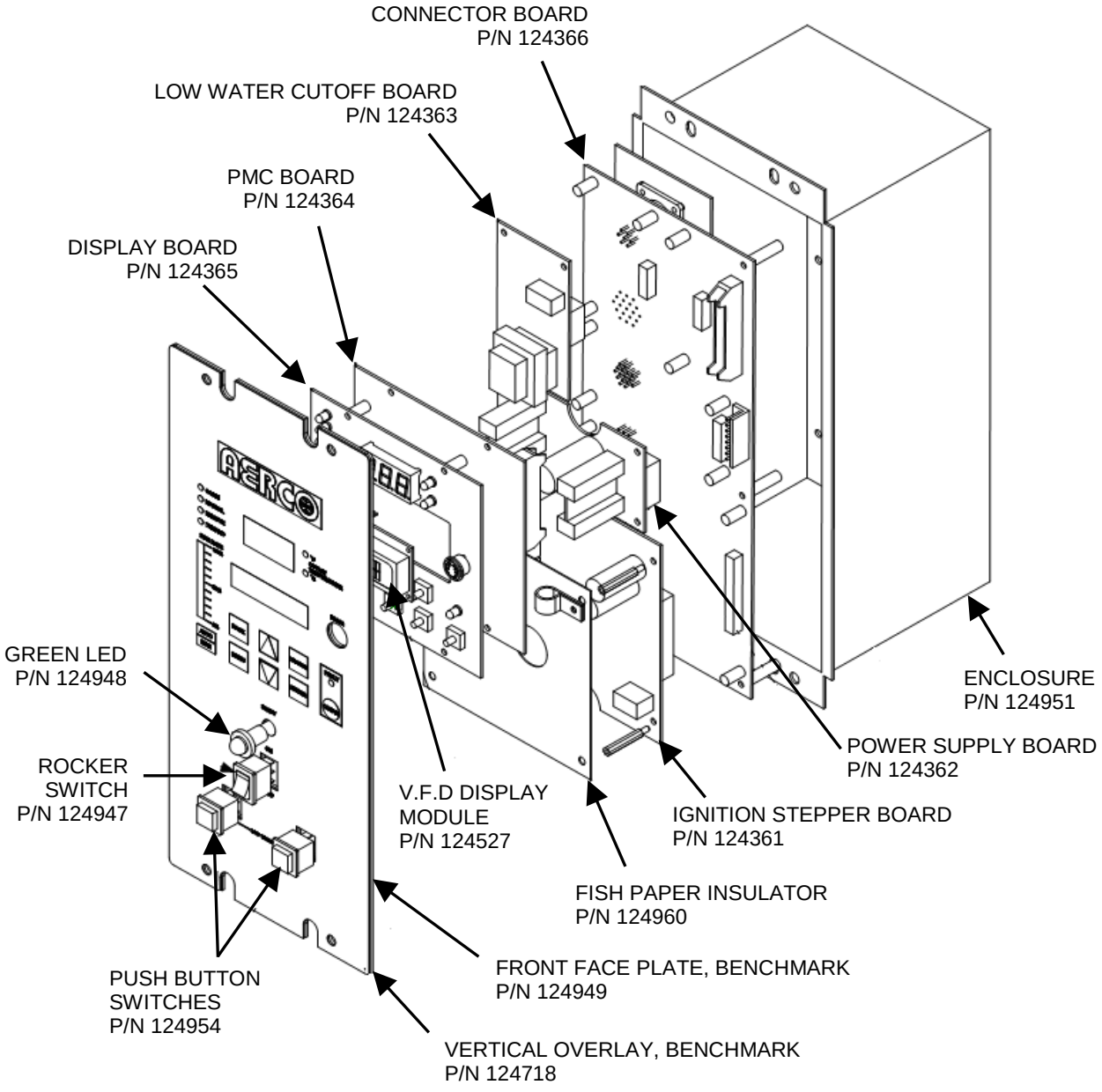

Figure J-1 – Benchmark Series Control Panel - Exploded View

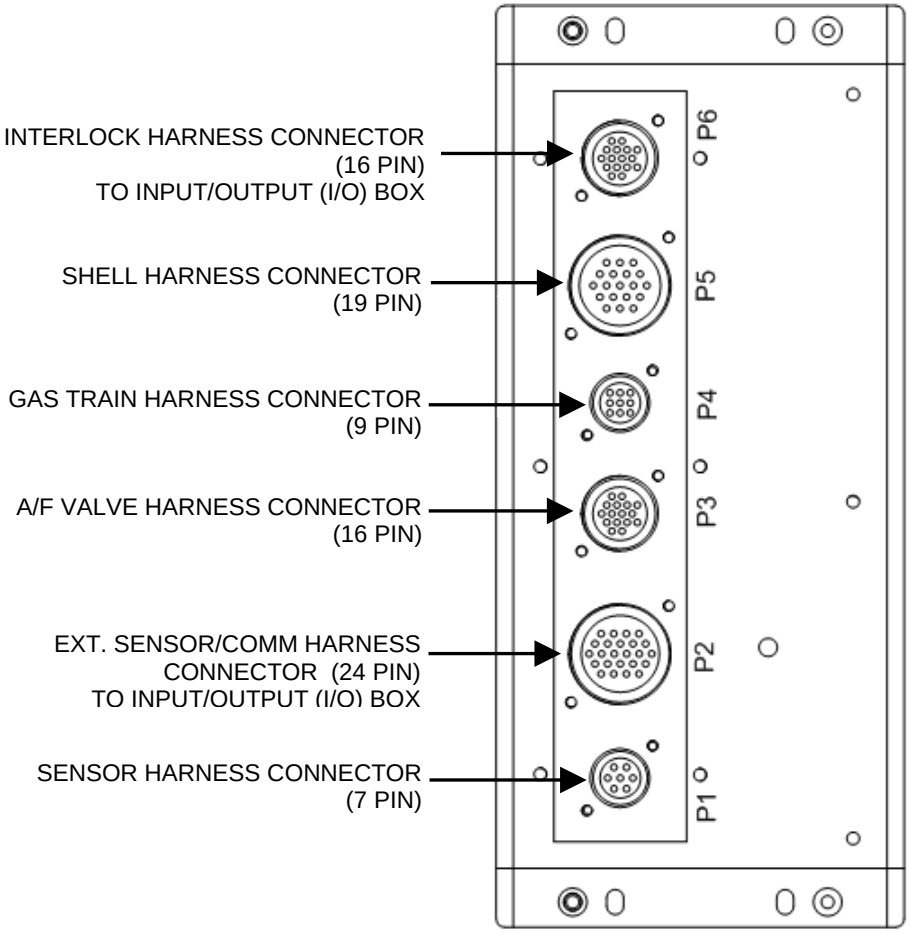

Figure J-2: Benchmark Control Panel Rear View

APPENDIX K – RECOMMENDED SPARES

NOTE

Refer to the Parts List Illustrations in Appendix 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
Actuator Replacement Kit: SSOV w/o P.O.C. Switch Kit	27086-2
Actuator Replacement Kit: SSOV w/ Regulator, POC Switch & Damping Orifice	64106
Pilot Regulator w/ 2-6" Spring	24384
Pilot Solenoid Valve, 1/4" NPT	124866
Temperature Switch - Manual Reset	123552

Table K-2: Spare Parts Recommended for Maintenance

DESCRIPTION	PART NUMBER
Annual Maintenance Kit	58025-11
24-month Waterside/Fireside Inspection Kit	58025-12

Table K-3: Optional Spare Parts

DESCRIPTION	PART NUMBER
C-More Control Box	69186-1
Temperature Sensor, 1-1/2"	123449
Lean Oxygen Sensor	61026
Over Temp - Auto Reset Switch	123966

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APPENDIX L – LONG TERM BLOWER STORAGE

If the Blower is left in long term storage (exceeding 30 days after receipt of equipment), damage can result. In the event that the Blower is to be kept in storage exceeding 30 days, you must you must complete the instructions below.

NOTE

Failure to adhere to the instructions below voids all warranties in their entirety.

LONG-TERM STORAGE INSTRUCTIONS

1. Select a suitable storage site:
   - Level, well-drained, firm surface, in clean, dry and warm location. Minimum temperature of 50°F (10°C).
   - Isolated from possibility of physical damage from construction vehicles, erection equipment, etc.
   - Accessible for periodical inspection and maintenance.
2. The blower should be supported under each corner of its base to allow it to “breath”. Supports (2 x 4’s, timbers, or railroad ties) should be placed diagonally under each corner.
3. If the equipment is to be stored for more than three (3) months, the entire blower assembly must be loosely covered with plastic, but not tightly wrapped.
4. Storage Maintenance:

NOTE

A periodic inspection and maintenance log, by date and action taken, must be developed and maintained for each blower. See example below. Each item must be checked monthly.

Example Storage / Maintenance Schedule Log

Item	Action	Dates Checked
1	Re-inspect units to insure any protective devices used are functioning properly. Check for scratches in the finish which will allow corrosion or rust to form	
2	Rotate wheel a minimum of 10 full revolutions to keep the motor bearing grease from separating and drying out. ***THIS STEP IS CRITICAL.***	

LONG-TERM STORAGE INSTRUCTIONS – Continued

5. General Motor Procedure:

   If the motor is not put into service immediately, the motor must be stored in a clean, dry, warm location. Minimum temperature of 50°F. (10°C,). Several precautionary steps must be performed to avoid motor damage during storage.

   d) Use a "Megger" each month to ensure that integrity of the winding insulation has been maintained. Record the Megger readings. Immediately investigate any significant drop in insulation resistance.

   e) DO NOT lubricate the motor bearings during storage. Motor bearings are packed with grease at the factory.

   f) If the storage location is damp or humid, the motor windings must be protected from moisture. This can be done by applying power to the motor's space heaters, (IF AVAILABLE) while the motor is in storage. If the motor does not have space heaters, storing it in a damp or humid location will, very quickly, cause internal corrosion and motor failure which is not warranted.

NOTE

For specific storage instructions, for the actual motor and any accessory parts that were supplied, refer to the manufacturer's instructions.

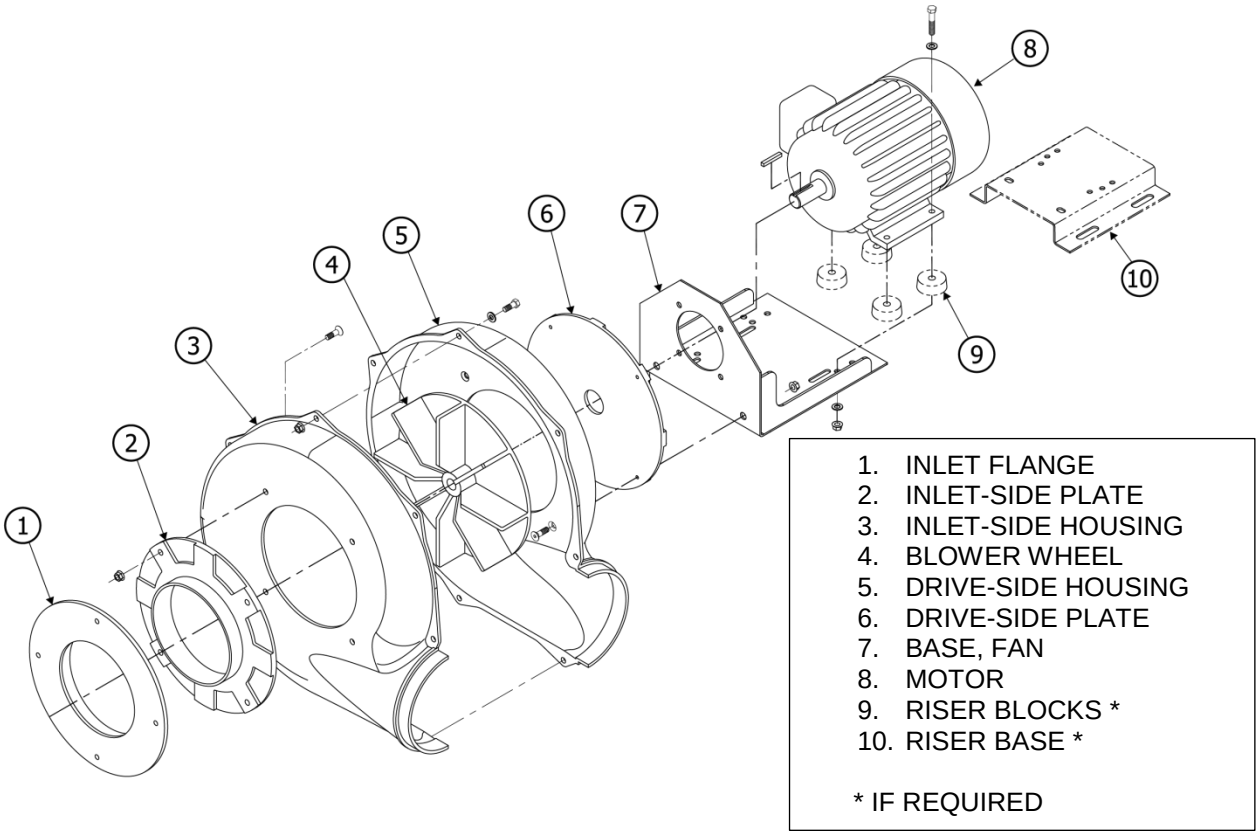


Figure L-1: Benchmark 6000 Blower Exploded View

APPENDIX M – ULTRA-LOW NO_x CALIBRATION

M-1. ULTRA-LOW NO_x COMBUSTION CALIBRATION

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

If the ultra-low NO_x 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.

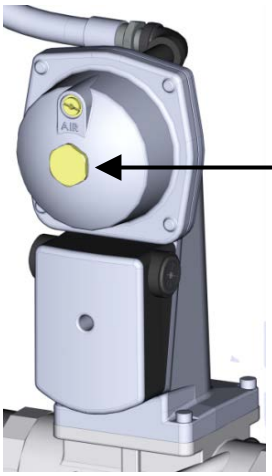
Prior to performing the procedure in this Appendix, the boiler must be set up as described in Chapter 4, section 4.1 through the **low NO_x** combustion calibration in section 4.4. Once that is complete, perform the following steps to combustion calibrate the boiler to the **ultra-low NO_x** requirement 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 NO_x 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 **50%** 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 **7.5" to 8.3" 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 M-1). Make gas pressure adjustments using a flat-tip screwdriver to obtain a gas pressure within the range of **7.5" to 8.3" W.C.**

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



TYPICAL SSOV ACTUATOR WITH REGULATOR

Figure M-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 **7.5" to 8.3" 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 O2 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 O2 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 NO_x Combustion Calibration Readings

Valve Position	Oxygen (O_2) %	Nitrogen Oxide (NO_x)	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 M-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 O2, NOx and CO readings on the Combustion Calibration Data Sheets provided with the unit.

Ultra-Low NO_x 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%**, **65%**, **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**. If NO_x 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 NO_x Combustion Calibration Readings

Valve Position	Oxygen (O_2) %	Nitrogen Oxide (NO_x)	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 **65%**, **45%**, **30%** and **18%**. The oxygen (O2), nitrogen oxide (NOx) and carbon monoxide (CO) should remain within the same limits for all valve positions as shown in the following table.

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

NOTE

If NO_x 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 NO_x Combustion Calibration Readings

Valve Position	Oxygen (O_2) %	Nitrogen Oxide (NO_x)	Carbon Monoxide (CO)
65%	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 Figure 4-4 in Chapter 4). Rotate the screw 1/2 turn clockwise (CW) to add fuel and reduce the O2 to the specified level. Recalibration MUST be performed again from 65% 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.**

M-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.
21. Disconnect AC power from the unit.
22. Shut off the gas supply to the unit.
23. Remove the manometer and barbed fitting from the port and turn the port screw clockwise to close it.
24. Remove the combustion analyzer probe from the 1/4” vent hole in the exhaust manifold. Replace the 1/4” NPT plug in the manifold.
25. Replace all previously removed sheet metal enclosures on the unit.

NOTES:

Change Log

Date	Description	Changed By
04/30/2015	**Rev C PIRs:** **934-45**: Modified Appendix L – Recommended Spare Parts **934-65**: Added explanatory paragraph to section 2.13 – Sequencing Isolation Valve Installation **934-79**: Warranty revision, dated 6/11/14, replaced “water heater” with “boiler.” **969**: Replaced VFD part numbers in Appendix F with “programmed” VFD **998-1**: Addition of 575V option; new blower motor, burner, transformer, power box label, & VFD. **999-2:** Replaced old style Condensate trap 20460 with new style, 24441 in section 7.9. **1011**: Changed Blocked Inlet Switch pressure from -8.0 to -4.5 in Appendix F. **934-87**: Updated graphic & instructions in section 2-10, updated tables 3-2, 3-3 and 3-4 **934-89**: Updated 3 Piping drawings in Appendix H. **934-99:** Added new section 7.11 - LWCO Cap Test Instructions **934-100**: Modified section 2.8.1; minimum gas pressure 11” W.C. is allowable, but unit will derate by 265,000 BTU/hr per inch under 14” W.C. **934-112:** changed combustion cal. & high gas press. port instructions and graphics per new port, general corrections **1092**: Removed Chapter 9 – RS232 Communication, per Firmware version 4.0 and above. **1110-2**: Updated gas train & Burner drawings drawings in Appendix F; **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 9.1.1	Curtis Harvey & Chris Blair
10/15/2015	**Rev D PIRs:** **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 44146 **DIR 225**: Section 7.10, replaced "use WD-40" with "use K&N® Air Filter Oil (or equivalent). Do NOT use WD-40." **DIR: 242:** Revise combustion calibration instructions (section 4.4) and Combustion Cal menu options (Section 3.8, 3.11, Appendix A table A-5).	Chris Blair

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