

# **HARSCO**

**INDUSTRIAL**

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Patterson-Kelley

## **MODU-FIRE® FORCED DRAFT**

### **GAS-FIRED BOILER**

### **750-1000-1500-2000**



C.S.A. Design-Certified  
Complies with ANSI Z21.13/CSA 4.9  
Gas-Fired Low Pressure Steam and Hot Water Boilers



ASME Code, Section IV  
Certified by Patterson-Kelley

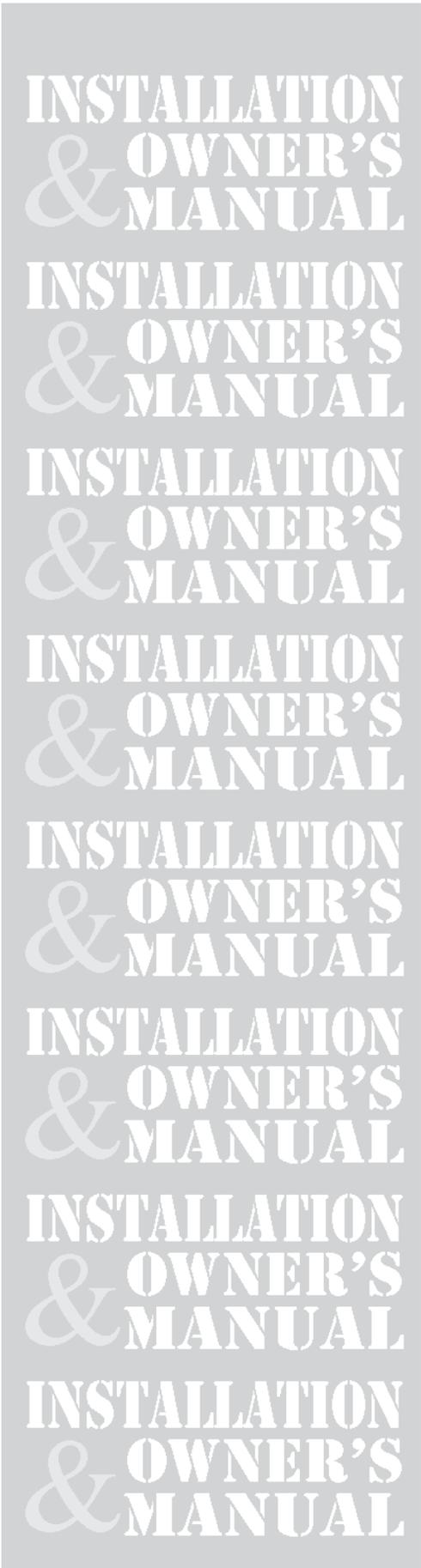


C.S.A. Design-Certified  
Complies with ANSI Z21.13/CSA 4.9  
Gas-Fired Low Pressure Steam and Hot Water Boilers

Model #: \_\_\_\_\_ Serial # \_\_\_\_\_

Start-Up Date: \_\_\_\_\_

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**WARNING**

If the information in this manual is not followed exactly, a fire or explosion may result causing property damage, personal injury or loss of life.

Do not store or use gasoline or other flammable vapors or liquids in the vicinity of this or any other appliance.

Installation and service must be performed by a qualified installer, service agency, or the gas supplier.

**WARNING** It is essential to read, understand, and follow the recommendations of this manual before installing, operating, or servicing this equipment.

**WARNING** Installation and service must be performed by a qualified and knowledgeable individual who has been trained on the MODU-FIRE® Forced Draft boiler. The same features which permit this boiler to achieve high-efficiency performance make it unlike most other boilers of this general size, so it is important to understand how this boiler operates.

**What to do if you smell gas:**

- Do not try to light any appliance.
- Do not touch any electrical switch; do not use any phone in your building.
- Immediately call your gas supplier from a neighbor's phone. Follow the gas supplier's instructions
- If you cannot reach your gas supplier, call the fire department.

## 1.0 INTRODUCTION

The MODU-FIRE® Forced Draft gas-fired boiler is a revolutionary advance. Harsco Industrial, Patterson-Kelley now combines full-modulation burner control and forced draft advances with our time-tested modular hot water boiler design. The result is a full-modulation boiler utilizing reduced vent sizing for installation and cost efficiencies. This boiler combines the best of our earlier designs with a new generation of burner, control and operating technology. You will achieve high part-load efficiencies – but without the complexity you might expect in this type of high performance boiler. It is high performance made simple and dependable for years of trouble-free operation.

This manual covers installation of the MODU-FIRE® Forced Draft boilers 750MFD, 1000MFD, 1500MFD and 2000MFD. The model numbers will include a prefix and may include a suffix to indicate special features or different options. While details may differ slightly, basic operation is the same for all models. Boilers are built to operate with natural gas or propane. Check the rating label for the correct gas type and flow rate.

The boiler is only a part of the complete heating system. This boiler may be fully operational and yet, because of poor circulation, controls, or other operating characteristics, not deliver heat to the desired location. Additional equipment such as temperature sensors, pumps, flow switches, balancing valves and check valves will be required for satisfactory operation of any system. Harsco Industrial, Patterson-Kelley cannot be responsible for the design or operation of such systems and a qualified engineer or contractor must be consulted.

## 2.0 SAFETY

### 2.1 GENERAL

The MODU-FIRE® Forced Draft gas-fired boiler **must** be:

- Installed, operated, and serviced in accordance with instructions contained in this manual and other supplemental MODU-FIRE® Forced Draft boiler manuals.
- Installed by qualified personnel in accordance with designs prepared by qualified engineers including: structural, mechanical, electrical, and other applicable disciplines.
- Operated and serviced in accordance with a comprehensive safety program determined and established **by the customer**. Do not attempt to operate or service until such a program has been established.
- Operated and serviced by experienced, qualified, properly trained personnel in accordance with all applicable codes, laws, and regulations.
- Installation and service must be performed by a qualified installer or service agency.

### 2.2 TRAINING

 <p><b>AVERTISSEMENT</b></p> <p>Une installation, un réglage, un changement ou un entretien inappropriés peuvent causer des dommages matériels, des blessures corporelles ou la mort.</p> <p>Lire et bien comprendre le Manuel d'installation et du propriétaire fourni avec cette chaudière. L'installation et le service doivent être effectués par un personnel expérimenté et compétent qui a reçu une formation sur la chaudière de cette série.</p>	 	 <p><b>WARNING</b></p> <p>Improper installation, adjustment, alteration, service, or maintenance can cause property damage, personal injury, or loss of life.</p> <p>Read and understand the Installation and Owner's manual provided with this boiler. Installation and service must be performed by experienced and knowledgeable personnel who have been trained on this series boiler.</p>
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Proper training is the best protection against accidents

It is **essential** to read, understand, and follow the recommendations of this manual before installing, operating, or servicing this equipment. Failure to do so could result in serious injury, death, and/or property damage.

Operating and service personnel must be thoroughly familiar with the basic construction of the MODU-FIRE® Forced Draft boiler, the use and locations of the controls, the operation of the boiler, adjustment of its various mechanisms, and all applicable safety precautions. If any of the provisions of this manual are not fully and completely understood, contact the Harsco Industrial, Patterson-Kelley Technical Service toll free at (877) 728-5351.

### 2.3 SAFETY FEATURES

It is the responsibility of the customer to maintain the safety features of this machine, such as: guards, safety labels, safety controls, interlocks, lockout devices, etc., in place and operable.

### 2.4 SAFETY LABELS

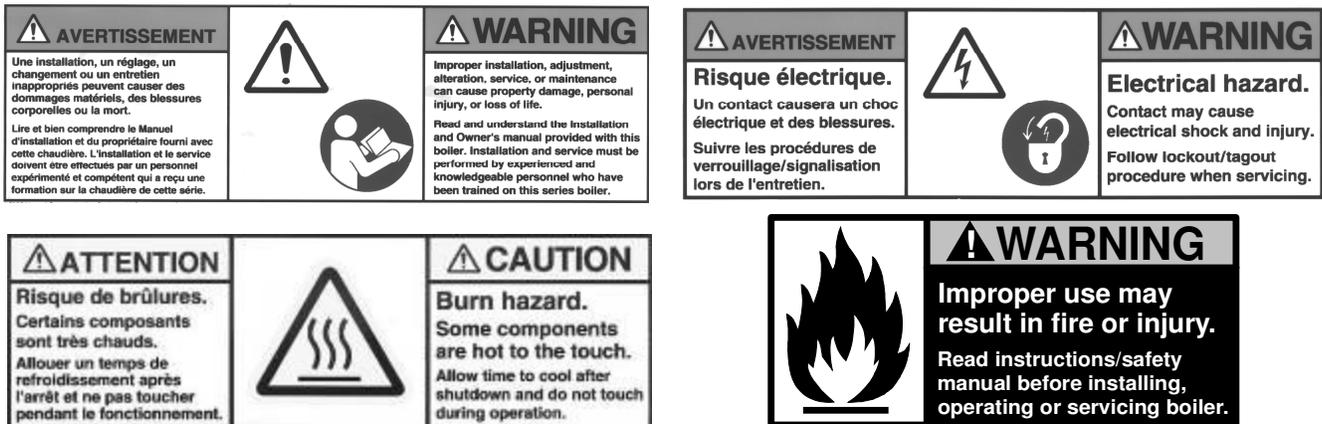
The following words are used in this manual to denote the degree of seriousness of the individual hazards.

**⚠ DANGER** indicates an imminently hazardous situation which, if not avoided, **will** result in death or serious injury. This signal word is to be limited to the most extreme situations.

**⚠ WARNING** indicates a potentially hazardous situation which, if not avoided, **could** result in death or serious injury.

**⚠ CAUTION** indicates a potentially hazardous situation which, if not avoided, **may** result in minor or moderate injury. It may also be used to alert against unsafe practices.

**NOTICE/NOTE** - NOTICE is the preferred signal word to address practices not related to personal injury. The safety alert symbol is not used with this signal word.



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Reorder No. 6020-V2WHPK

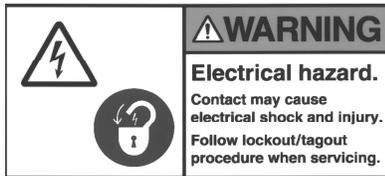
The safety labels shown above are affixed to your boiler. Although the labels are of high quality, they may become dislodged or unreadable over time. Contact Harsco Industrial, Patterson-Kelley toll-free at (877) 728-5351 for replacement labels.

## 2.5 SAFETY PRECAUTIONS

Provide a suitable location for the boiler, away from normal personnel traffic, with adequate working space, adequate clearances, proper ventilation and lighting, with a structure sufficiently strong and rigid to support the weight of the boiler, all piping, and accessories.

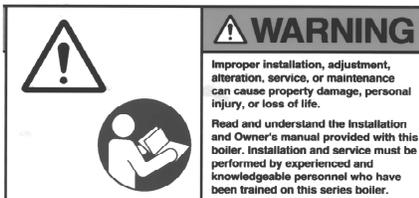
**Proper lockout/tagout procedures must be employed whenever this unit is serviced.**

### 2.5.1 Electrical Hazards



- Shock hazard! Properly lockout/tagout the electrical service and all other energy sources before working on or near the machine.
- Shock hazard! Boiler is not rated for wash-down service. Do not spray water directly on this boiler or on any electrical components.
- Electrical hazard! Do not alter wiring connections.
- Power down unit for at least 10 minutes before servicing inverter or blower.

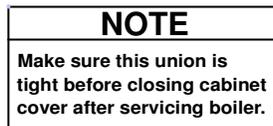
### 2.5.2 Burn, Fire, and Explosion Hazards



- Burn, fire, and explosion hazards! Installation must be in strict conformance to all applicable codes and standards including NFPA 54, ANSI Z223.1 and CSA B.149.
- Hazard from incorrect fuels! Possible fire, explosion, overheating, and damage. Do not use any fuels except the design fuel for the unit.
- Overfire hazards! High pressure in gas or propane supply could result in overfiring of other devices supplied from the same source.



- Fire and explosion hazards! Close the main gas shutoff before servicing boiler.
- Fire and explosion hazards! Do not store or use gasoline or other flammable vapors or liquids in the vicinity of this or any other gas fired appliance.
- Burn hazard! Possible hot surfaces. Do not touch the stack during firing operations. Use only factory recommended vent components.
- Burn hazard! Hot fluids. Use caution. Allow boiler to cool before servicing or draining boiler.
- Fire and explosion hazards! Use caution when servicing burner or heat exchanger. Fuel may linger in the combustion chamber, vent lines, or elsewhere.
- Gas leak hazard! Make sure all connections to main burner are tight when reassembling the burner.



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Reorder No. 8033-0291AK

- Gas leak hazard! All threaded gas connections must be made using a pipe compound that is resistant to liquefied petroleum. **Do not** use Teflon tape on threaded gas piping.
- Gas leak hazard! Check entire gas train for leaks after installation. If there is a smell of gas, shut down the boiler, close all gas valves and obtain immediate assistance from factory-trained personnel and/or your local fire department.
- Overfire hazard! Possible fire and explosion from excess gas pressure. Make sure that gas inlet pressure does not exceed 14 inches W.C. to the boiler main gas valve.
- Overfire hazard! Possible fire and explosion. Possible malfunction of regulators and/or gas valves. Maintain all gas train components in good condition. Do not alter wiring connections. Annual inspection by factory-trained personnel for proper set-up and operation is recommended.
- Overfire and underfire hazards! Possible fire, explosion, overheating, and component failure. Do not attempt to adjust firing rate of the boiler. The firing rate must be adjusted **only** by factory-trained personnel.

**2.5.3 Crush Hazards**



General Warning

- Lifting hazards! Use properly rated lifting equipment to lift and position the boiler. The load is unbalanced. Test balance before lifting 3 ft. above the floor. Do not allow personnel beneath the lifted load. Refer to approximate weights in the table:
- Bump hazard from overhead piping. Install piping with adequate vertical clearance.

Boiler Size	Weight in Pounds
750,000 Btu	745
1,000,000 Btu	745
1,500,000 Btu	915
2,000,000 Btu	930

**2.5.4 Chemical Hazards**



General Warning

- Chemical hazards from cleaning products. Use caution when cleaning the system. The use of professional assistance is recommended. Use safe procedures for the disposal of all cleaning solutions.

**2.5.5 Pressure Hazards**



General Warning

- Pressure hazard! Hot fluids. Install isolation valves on boiler water inlet and outlet. Make sure isolation valves are closed before servicing boiler.
- Pressure hazard! Hot fluids. Test safety relief valve bimonthly for proper operation. Do not operate boiler with faulty relief valve.

### 2.5.6 General Hazards



- Tripping hazard! Do not install piping on floor surfaces. Maintain clear path around boiler.
- Slip and fall hazard! Use drip pan to catch water while draining the boiler. Maintain dry floor surfaces.
- Slip and fall hazard! Through-the-wall vents shall not terminate over public walkways or over an area where condensate or vapor could create a nuisance or hazard.
- Fall hazard! Do not stand on any part of the boiler.
- Catch hazard! Do not wear rings, jewelry, long hair, loose clothing while working on the boiler.

## 3.0 INSTALLATION

**⚠ WARNING** Installation and service must be performed by a qualified installer or service agency.

### 3.1 RECEIVING AND STORAGE

#### 3.1.1 Initial Inspection

**Upon receiving the boiler, inspect it for signs of shipping damage.** Since some damage may be hidden, we recommend unpacking the boiler, removing the top, front, and side covers and inspect the boiler. Verify that the total number of pieces shown on the packing slip agrees with those actually received.

**NOTICE!** Note any damage, suspected potential damage, or shortage of materials on the freight bill and immediately notify the carrier. File all claims for shortage or damage with the carrier. Claims for hidden damages must be filed with your carrier within 7 days. The boiler carton is equipped with a “Tip (N) Tell”. If “Tip (N) Tell” arrow point is blue, that indicates that the package has been on its side or tipped over in transit.

#### 3.1.2 Storage Prior to Installation

If the boiler is not installed immediately, it must be stored in a location adequately protected from the weather and freezing conditions, preferably indoors. If this is not possible, then it should remain in the shipping container and be covered by a tarpaulin or other waterproof covering.

**NOTICE!** Controls and other equipment that are damaged or fail due to weather exposure are not covered by warranty.

### 3.2 COMPLIANCE WITH CODES

The MODU-FIRE® Forced Draft boiler with standard components and many options complies with American National Standard/CSA Standard ANSI Z21.13/CSA 4.9, Gas-Fired Low Pressure Steam and Hot Water Boilers, latest edition. The heat exchanger is constructed and stamped in accordance with ASME Boiler and Pressure Vessel Code, Section IV for 160 psig maximum operating pressure and/or 250° F maximum operating temperature.

Installation of the boiler must conform to all the requirements of all national, state and local codes established by the authorities having jurisdiction or, in the absence of such requirements, in the U.S. to the National Fuel Gas Code, ANSI Z223.1/NFPA 54, latest edition. In Canada, the equipment shall be installed in accordance with the current Installation Code for Gas Burning Appliances and Equipment, CSA-B.149.1, 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.

Where required by local codes, the installation must conform to American Society of Mechanical Engineers Safety Code for Controls and Safety Devices for Automatically Fired Boilers (ASME CSD-1).

In the Commonwealth of Massachusetts, (a) this unit must be installed by a licensed pipe fitter / plumber, (b) field installed gas cocks must be "T" handle type, (c) piping of condensate shall conform to the State Plumbing Code, and (d) refer to the Massachusetts supplement for further details.

### 3.3 SETUP

#### 3.3.1 Foundation

Provide a firm, level foundation, preferably of concrete.

**NOTICE!** The boiler may be installed on a combustible floor; however, the boiler must **never** be installed on carpeting.

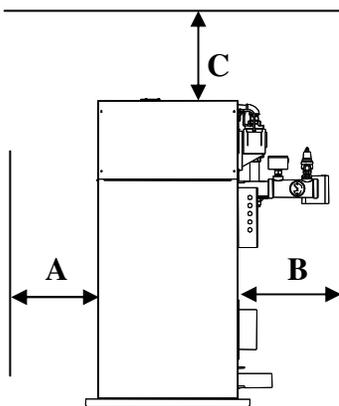
**NOTICE!** This boiler is certified for **indoor** installation only.

#### 3.3.2 Placement

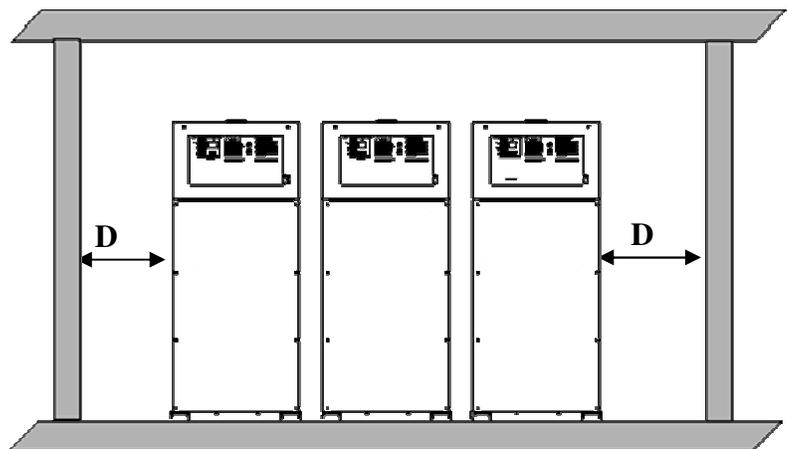
The boiler must be level and upright to function properly. Use shims or other approved structural devices to properly level boiler.

#### 3.3.3 Installation Clearances

If the boiler is to be installed near combustible surfaces, six (6") inches minimum clearance to the combustible surface must be maintained. Failure to provide for the service access clearances, even with non-combustible surfaces, may cause future problems servicing the boiler. The boiler must be installed in a space large in comparison to the boiler as described in the National Fuel Gas Code, NFPA 54/ANSI Z223.1, latest edition.



**Clearances from Adjacent Walls,  
Ceiling and Obstructions**



**Side Clearances for a Row of Boilers**

Type of Surface	Dimensions (inches)			
	A	B	C†	D
CSA Minimum Clearances to Combustibles	24	24*	24	24
Recommended Service Clearances	30	24*	24	24**

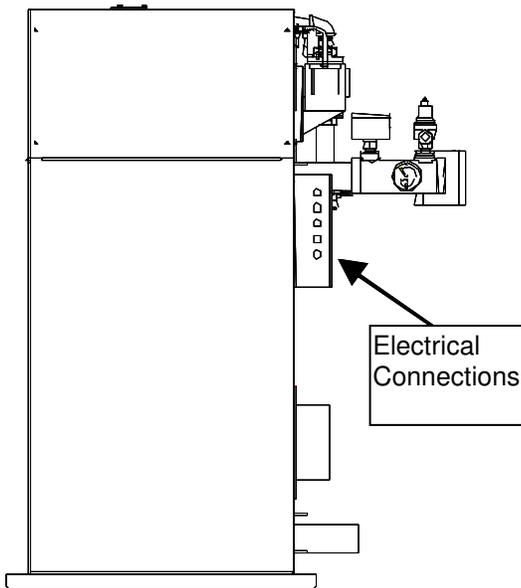
† "C" dimension includes clearance to remove the burner. Do not put pipes, ducts, etc. in this area above the boiler.

\*CSA minimum. Actual clearance depends upon venting requirements.

\*\* Service access need be only on one side of a boiler or row of boilers. Boilers may be installed immediately adjacent to each other. However, Harsco Industrial, Patterson-Kelley recommends this clearance between **each boiler** when there is insufficient access at the rear to allow for service and adjustment.

### 3.4 ELECTRICAL CONNECTIONS

All field wiring connections for power and controls are in the junction box on the back of the boiler.



The boiler wiring label is attached to the inside front door of the boiler. An external electrical disconnect (not supplied with the boiler) with adequate overload protection is required. The boiler must be grounded in accordance with local codes or in the absence of such requirements, in the U.S. with National Electrical Codes, ANSI/NFPA No. 70 latest edition and in Canada, wire according to the current Canadian Electrical Code.

**NOTICE!** A dedicated earth ground (green wire) is required to avoid nuisance shutdowns. It is also important that proper polarity be maintained.

The junction box at the rear of the boiler contains terminal strips for power and control connections. A detailed schematic of the connections is shown in 6.1.7. These connections are as follows:

#### 3.4.1 High Voltage (HV) Terminal Block

The boiler power circuit requires 240 volts, single phase, 60 hertz, with a dedicated neutral and ground as labeled. The voltage between L1 (HV-1) and L2 (HV-2) must be approximately 230V, while the voltage from each line to the neutral (HV-3) must be approximately 120V AC. Electrical service must be rated for 17 amps minimum. Before starting the boiler, check to ensure that the proper voltage and amperage are connected to the boiler and that the boiler is connected to a suitable fused disconnect switch or circuit breaker. There must be less than 1.0V from Neutral (HV-3) to Ground (HV-10)

**120VAC Switched Output-** This contact closes when the boiler is switched on. This provides 120VAC 5Amp service to HV12 and HV13. The neutral for this circuit is provided on HV4 and HV5. When the boiler is switched off, these terminals are switched off as well.

**3 Way Valve-** This output is normally energized, maintaining the three way valve in the position to provide heat to the building. The Domestic Hot Water (DHW) call for heat de-energizes this circuit, causing the 3 way valve to

drive to the position to provide heat to the DHW loop. This output provides 120VAC 0.5Amp service to HV14. The neutral for this circuit is provided on HV 6.

**DHW Pump Relay w/Delay Off** - This output is enabled when there is a call for DHW. When the call for heat is removed, the output remains enabled for a predetermined period of time. The time delay is adjustable through the ENVI™ control system. This output provides 120VAC 0.5Amp service to HV15. The neutral for this circuit is provided on HV 7.

**Circ Pump Relay w/Delay Off** - This output is enabled when there is a call for heat. When the call for heat is removed, the output remains enabled for a predetermined period of time. The time delay is adjustable through the ENVI™ control system. This output provides 120VAC 0.5Amp service to HV16. The neutral for this circuit is provided on HV 8.

**Damper Relay** - This output is enabled when the call for heat is enabled. This output provides 120VAC service to HV17. The neutral for this circuit is provided on HV 9. This circuit is for pilot duty only (less than 1 amp).

**Master Alarm Relay** – This contact closes in the event of an alarm output from the boiler control, connecting HV18 and HV19.

**Flame Detected Relay** – This contact closes whenever the boiler is firing, connecting HV20 and HV21.

### 3.4.2 Low Voltage (LV) Terminal Block

**Enable/Disable**– Use for boiler enable. Closing this circuit allows the boiler to run. Opening this circuit prevents the boiler from running, provided the remote/local enable switch is in the remote position. This circuit is energized by the boiler. It has a 24VAC potential. Devices connected to these terminals must be rated for 24VAC.

#### **WARNING**

The remote/local enable switch bypasses the Enable/Disable (LV1 to LV2) when in the local position. Do not connect safety devices into the Enable/Disable circuit.

**Auxiliary Low Water Cutoff** – These terminals are used for connection of a secondary low water cutoff used in the system. This circuit is energized by the boiler. It has a 5V potential. Devices connected to these terminals must be rated for 5V.

**Start Interlock** - Use for attachment of an additional field safety device to the boiler control circuit. Closing this circuit allows the boiler to run. Opening this circuit prevents the boiler from running. This circuit is energized by the boiler with a 5V potential. Devices connected to these terminals must be rated for 5V.

**Outdoor Temp Sensor** – LV7 and LV8 are connected to the outdoor temperature sensor. The temperature control must be programmed to run an outdoor air schedule. The outdoor air sensor and programming help are available from the ENVI™ Advanced User's Guide (ENVI™ 09) or from your local Harsco Industrial, Patterson-Kelley Representative. This circuit is energized by the boiler with a 5V potential. The temperature sensor must be a NTC having 12k@25°C.

**DHW Stat/Sensor** – LV9 and LV10 are connected to the DHW temperature sensor or thermostat. This circuit is energized by the boiler with a 5V potential. The temperature sensor must be a NTC having 12k@25°C.

**Header Temp Sensor** – LV11 and LV12 are connected to the header temperature sensor. This circuit is energized by the boiler with a 5V potential. The temperature sensor must be a NTC having 12k@25°C.

**DHW Flow Switch** – LV13 is energized by the boiler with a 5V potential. This circuit connects through a flow switch on the domestic side of a domestic hot water system. The flow switch should close upon flow to provide a closed circuit back to LV14.

**Analog Input**– Remote signal for controlling the boiler. The boiler can be operated in a remote setpoint or a remote firing rate control mode. Input 0-10VDC signal only. The temperature control must be programmed to run with the analog input.

**MODBUS®** – LV19 and LV20 are used for connecting a MODBUS® building management system. (See the ENVI™ control Advanced Users Guide for more information)

**Cascade** – LV21 and LV22 are used to connect between boilers that are part of a Master/Member Network. Up to 24 boilers may be connected together. (See the ENVI™ control Advanced Users Guide for more information)

### 3.5 INLET AIR AND EXHAUST VENTING

#### 3.5.1 Applicable Codes & Standards

##### CODES

United States:

NFPA 54/ANSI Z223.1

NFPA/ANSI 211

National Fuel Gas Code

Chimneys, Fireplaces, Vents and Solid Fuel Burning Appliances

Canada

CAN/CSA B149.1

Installation Codes for Gas Burning Equipment

##### STANDARDS

UL 1738

Venting Systems for Gas-Burning Appliances, Categories II, III, and IV

These codes and standards contain information for the venting of gas fired appliances, including, but not limited to vent sizing, location, clearance to combustibles, and safe installation practices. The installation must comply with both the above Federal Codes and with state, provincial and local codes.

#### **⚠ WARNING**

Design and installation of venting systems should be done only by qualified and knowledgeable venting systems personnel and in accordance with vent system manufacturer's installation instructions. Installing a boiler or vent system using improper installation methods or materials can result in serious injury or death due to fire or asphyxiation.

#### **⚠ WARNING**

Before connecting a boiler to a venting system, it must be determined whether the boiler is to be installed in a conventional or direct vent configuration. In the US, provisions for combustion and ventilation air must be in accordance with NFPA 54/ANSI Z223.1, *National Fuel Gas Code*, latest edition, or applicable provisions of the local building codes. In Canada, combustion and ventilation air openings shall comply with CAN/CSA B-149.1 *Natural Gas and Propane Installation Code*.

**⚠ WARNING**

For correct installation of vent system, read all of these instructions and refer to vent manufacturer's instructions.

Failure to use a proper vent system (types and materials), as described in this manual will void the boiler warranty and may result in rapid deterioration of the venting system, creating a health or life safety hazard.

Faulty vent installation can allow toxic fumes to be released into living areas. This may cause property damage, serious bodily injury or death.

**3.5.1.1 Gas Vent Categories**

Several codes and standards have categorized appliances in accordance with the flue gas temperature and pressure produced by the appliance. Categories are defined as follows:

- **Category I** An appliance that operates with a non-positive vent static pressure and with a vent temperature that avoids excessive condensate production in the vent.
- **Category II** An appliance that operates with a non-positive vent static pressure and with a vent temperature that may cause excessive condensate production in the vent.
- **Category III** An appliance that operates with a positive vent static pressure and with a vent temperature that avoids excessive condensate production in the vent.
- **Category IV** An appliance that operates with a positive vent static pressure and with a vent temperature that may cause excessive condensate production in the vent.
- **Direct Vent** An appliance that is constructed and installed so that all air for combustion is derived directly from outdoors and all flue gases are discharged to the outdoors.

**3.5.1.2 Venting Materials for Flue/Exhaust Systems**

MODU-FIRE® Forced Draft boilers are Category IV appliances, which vent with a positive exhaust pressure and with a temperature that is likely to cause condensation in the vent. Therefore, any venting system used with the MODU-FIRE® Forced Draft boiler must comply with the requirements for Category IV venting systems as specified in the latest edition of NFPA 54/ANSI Z223.1 in the US or the latest edition of CAN/CSA B-149.1 in Canada.

**⚠ WARNING**

The venting materials listed below are intended for the venting of gas burning appliances only. Do not use these venting materials for venting liquid or solid fuel (such as oil, kerosene, wood or coal) appliances.

Maintain clearances to combustibles as listed in the vent manufacturer's installation instructions or as set forth in the codes and standards listed in this section.

Do not use these vent pipes for incinerators of any sort.

**3.5.2 Combustion Air**

Combustion air must be free from dust, lint, etc. The presence of such materials in the air supplied to the burner could cause nuisance "Low Air" shutdowns or premature burner failure. The boiler should not be operated during construction while the possibility of drywall dust, demolition dust, etc. exists.

The combustion air supply must be completely free of chemical fumes which may be corrosive when burned in the boiler. Common chemicals which must be avoided are fluorocarbons and other halogenated compounds, most commonly present as refrigerants or solvents, such as freon, trichloroethylene, perchlorethylene, chlorine, etc.

These chemicals, when burned, form acids which quickly attack the boiler and the boiler stack. The result is improper combustion and premature boiler failure.

**⚠ WARNING**

Under no circumstances shall the boiler room ever be under a negative pressure. Particular care should be taken when exhaust fans, compressors, air-handling units or other equipment may rob air from the boiler. Note that this equipment might be in rooms other than the boiler room.

**3.5.2.1 Air Inlet Requirements – United States (NFPA 54/ANSI Z223.1 & NFPA/ANSI 211)**

When air is supplied from inside the building, the total required volume shall be the sum of the required volume for all the appliances located in the mechanical room. Adjacent rooms furnished with fixed openings communicating directly with the mechanical room are considered part of the required volume. The minimum volume is 50 ft<sup>3</sup> per 1000 Btu/hr (4.8 m<sup>3</sup>/kW) of installed appliance input capacity.

Openings used to connect indoor spaces to obtain the required minimum volume shall be sized as follows:

- When rooms are on the same floor, each opening shall have an area equal to 1 square inch for each 1000 Btu/hr (2200 mm<sup>2</sup> / kW) of installed appliance input capacity, but not less than 100 square inches. One opening should commence less than 12 inches above the floor and the other less than 12 inches below the ceiling. The minimum dimension of air openings shall be 3 inches.
- When rooms are on different floors, each opening shall have an area equal to 2 square inches for each 1000 Btu/hr (4400 mm<sup>2</sup> / kW) of installed appliance input capacity.

When combustion air is supplied from outside the building, the boiler room shall be provided with one or two openings to ensure adequate combustion air and proper ventilation.

When using one permanent opening, the opening shall commence within 12 inches of the ceiling and shall communicate directly with the outdoors or through a vertical or horizontal duct that communicates to the outdoors.

- Minimum free area of the opening is 1 square inch for each 3000 Btu/hr (700 mm<sup>2</sup> / kW) of installed appliance input capacity, and
- Not less than the sum of the areas of all vent connectors in the room.

When using two permanent openings, one opening shall commence within 12 inches above the floor and the other within 12 inches below the ceiling, preferably on opposite walls. The openings shall communicate directly, or by way of ducts, with free outdoor air. The minimum net free area of the openings shall be calculated in accordance with the following:

- When air is taken directly from outside the building, each opening (minimum of two, as outlined above), 1 square inch for each 4,000 Btu per hour (550 mm<sup>2</sup>/kW) of total boiler input is required.
- When air is taken from the outdoors through a vertical duct into the mechanical room, 1 square inch per 4,000 Btu per hour (550 mm<sup>2</sup>/kW) of total boiler input is required.
- When air is taken from the outdoors through a horizontal duct into the mechanical room, 1 square inch per 2,000 Btu per hour (1100 mm<sup>2</sup>/kW) of total boiler input is required.

**NOTICE!**

1. The required size of openings for combustion and ventilation air shall be based on the net free area of the opening.
2. Screens shall be not smaller than ¼"
3. Motorized louvers shall be interlocked with the appliance so that they are proven open prior to main burner ignition and operation.

**Table of US Minimum area of ventilation openings per boiler (sq inches)**

MFD MODEL	AIR SOURCE					
	INDOOR AIR SUPPLY		OUTDOOR AIR SUPPLY			
	SAME FLOOR	DIFF FLOORS	ONE OPENING	TWO OPENINGS		
				DIRECT	VERT DUCT	HORIZ DUCT
N750	750	1500	250	188	188	375
N1000	1000	2000	333	250	250	500
N1500	1500	3000	500	375	375	750
N2000	2000	4000	667	500	500	1000

**3.5.2.2 Air Inlet Requirements – Canada (CAN/CSA B149.1)**

- A. Ventilation of the space occupied by fuel burning appliance(s) or equipment shall be supplied by a ventilation opening at the highest practicable point communicating with the outdoors. The total cross sectional area of the ventilation opening must be either 10% of the net free area required for combustion air or 10 sq. in. (6500 mm<sup>2</sup>), whichever is greater.
- B. Use the following opening calculation for MACH® or MODU-FIRE® FD boilers: When combustion air is supplied for a forced draft burner by natural airflow from the outdoors and there is no draft regulator or draft hood in the same space, there shall be a permanent opening with a cross sectional area not less than 1 sq. in/ 30,000 Btu/Hr (70 mm<sup>2</sup>/kW) of the total rated input to the burner(s). This opening must not interfere with the ventilation air opening defined in paragraph A.
- C. Use the following opening calculation for P-K THERMIFIC® boilers or other natural draft or fan-assist appliances: When combustion air is supplied for natural or fan-assisted burners by natural airflow from the outdoors, there shall be a permanent opening with a cross sectional area not less than 1 sq. in/ 7000 Btu/Hr (321 mm<sup>2</sup>/kW) up to and including 1,000,000 Btu/Hr plus 1 sq. in. / 14,000 Btu/Hr (155 mm<sup>2</sup>/kW) in excess 1,000,000 Btu/Hr. This opening must be either located at or ducted to a point not more than 18 in. (450 mm) nor less than 6 in. (150 mm) above floor level. This opening is in addition to the ventilation air opening defined in paragraph A.
- D. When combustion air is supplied by natural airflow into a space containing both types of appliances described in paragraphs B and C, the cross sectional area of the opening shall be not less than the sum of the cross sectional areas for all appliances in the space as calculated by the applicable method . This opening is in addition to the ventilation air opening defined in paragraph A.
- E. When a duct is used to meet the requirement for combustion air supply, as described in paragraphs A through D, above, the opening of the duct shall be located so there is no possibility of cold air affecting steam or water piping, electrical equipment or mechanical equipment.
- F. When combustion air is supplied by mechanical means, an airflow-sensing device must be installed. It must be wired into the pre-ignition limit string to prevent the burner from starting or to stop an operating burner in case of air supply failure.
- G. When all combustion air is supplied through a make-up air heater, and the appliance is interlocked to the heater, the requirements of paragraphs A through F do not apply.

**NOTICE!**

1. The free area of a combustion air supply opening is calculated by deducting the blockage area of any fixed louvers, grilles or screens from the total area of the opening.
2. Screens shall be not smaller than ¼”
3. Motorized louvers shall be interlocked with the appliance so that they are proven open prior to main burner ignition and operation

**Table of Canadian Minimum Area of Combustion and Ventilation Air Openings**

MFD Model #	Input (Btu/Hr)	Required Combustion Air Opening		Ventilation Air Opening	
		in <sup>2</sup>	mm <sup>2</sup>	in <sup>2</sup>	mm <sup>2</sup>
N750	750,000	25	16,129	10	6,452
N1000	1,000,000	33	21,290	10	6,452
N1500	1,500,000	50	32,258	10	6,452
N2000	2,000,000	67	43,226	10	6,452

### 3.5.3 Flue Venting

**This boiler is not certified for use with Type "B" vent nor with any type of plastic venting.**

This boiler is a Category IV appliance (condensing – positive pressure) as it is defined in ANSI Z21.13/CSA 4.9, latest edition. The vent material must be as described in section 3.5.1.2. The exhaust vent can be run horizontally or vertically.

Vent installations shall be in accordance with NFPA54/ANSI Z223.1, the *National Fuel Gas Code*, or CAN/CSA-B149.1, the *Natural Gas and Propane Installation Code*, or applicable provisions of the local building codes.



**WARNING**

**Do not use a barometric damper with this boiler.** This is a positive pressure system. Flue gases may leak into the room.



**WARNING**

This equipment **MUST NOT** be used with a heat actuated automatic vent damper.



**CAUTION**

All boiler venting systems should be designed by a qualified venting professional experienced in venting system design. The information contained herein should be used as a guide only and is not intended to be used in lieu of qualified technical expertise.

#### 3.5.3.1 Vent Sizing

The vent must be sized in accordance with the ASHRAE Systems and Equipment handbook, Chapter 30 or according to the vent manufacturer's recommendations. When using manufactured venting systems, consult your vent supplier for correct sizing and structural support requirements.

**The vent must be sized according to the vent manufacturer's recommendations.** Consult your vent supplier for correct sizing and structural support requirements.

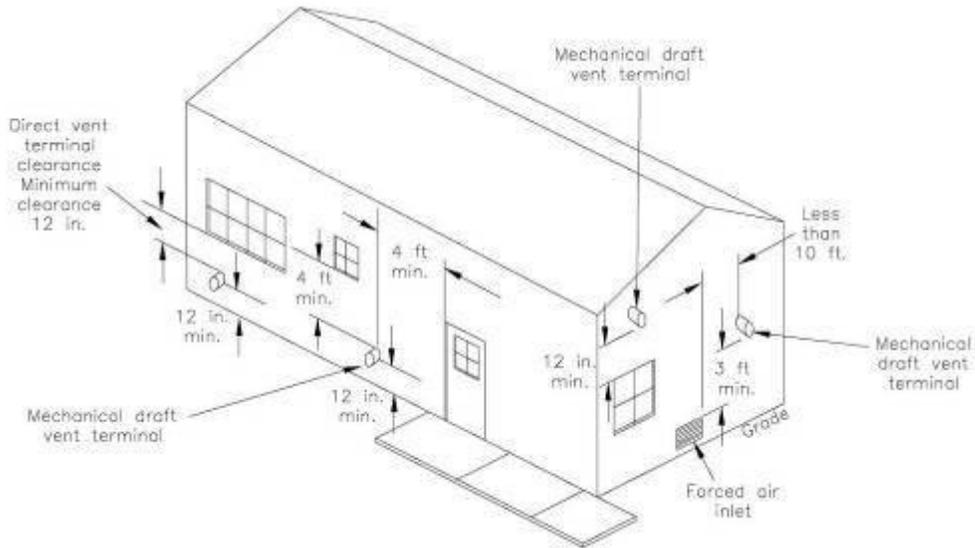
Design calculations for a single boiler/single stack installation should be based on a positive pressure at the flue collar of 1.0" w.c. (not to exceed 2.0" w.c.) with a stack temperature of 325° F (gross) and a CO<sub>2</sub> level of 8.5% (natural gas) or 9.9% (propane).

The vent should be designed to provide positive pressure at the flue collar at all firing rates.

Additional care must be used with sidewall venting as the exhaust velocity is high and the exhaust gas plume may extend significantly beyond the termination.

**3.5.3.2 Required Clearances**

Provide clearances between combustion air intake, exhaust vent, roof and wall surfaces, doors and window, and snow line. Refer to Figure below: Termination Clearances – Forced Draft and Direct Vent Installations.



**⚠ WARNING**

Do not locate intake or exhaust terminations directly above a walkway; dripping of condensation can cause icing of the walking surface. Maintain a minimum clearance of 4 ft (1.22 m) horizontally from any electric or gas meter, regulator or relief equipment.

**3.5.3.2.1 Conventional Vent Systems**

The following termination clearance requirements are for conventional, non-direct vent installations.

- The vent system shall terminate at least 3 ft above a forced air inlet that is within 10 feet horizontally.
- The vent system shall terminate at least 4 ft below, 4 ft horizontally from or 1 ft above any door, operable window or gravity inlet into any building. The bottom of the vent terminal shall be at least 12 in. above grade or highest expected snow line (if applicable).
- Through the wall terminations shall not terminate over public walkways or over an area where condensate or vapor could create a nuisance or hazard or could be detrimental to the operation of regulators, relief valves or other equipment.

**3.5.3.2.2 Direct Vent (Sealed Combustion) Systems**

- The vent terminal shall be located at least 12 in. from any air opening into a building. The bottom of the vent terminal shall be at least 12 in. above grade. Both the vent and air intake terminals must be at least 12 in. above the highest expected snow line.
- Through the wall terminations shall not terminate over public walkways or over an area where condensate or vapor could create a nuisance or hazard or could be detrimental to the operation of regulators, relief valves or other equipment.
- When multiple direct vent appliances are adjacent, the exhaust must terminate at least 10 feet horizontally or three feet vertically from the air intake of another appliance.

**3.5.3.2.3 Interior Component Installation Clearances**

All vent system components shall be installed so as to maintain the vent manufacturer's required minimum clearances to combustibles and non-combustibles.

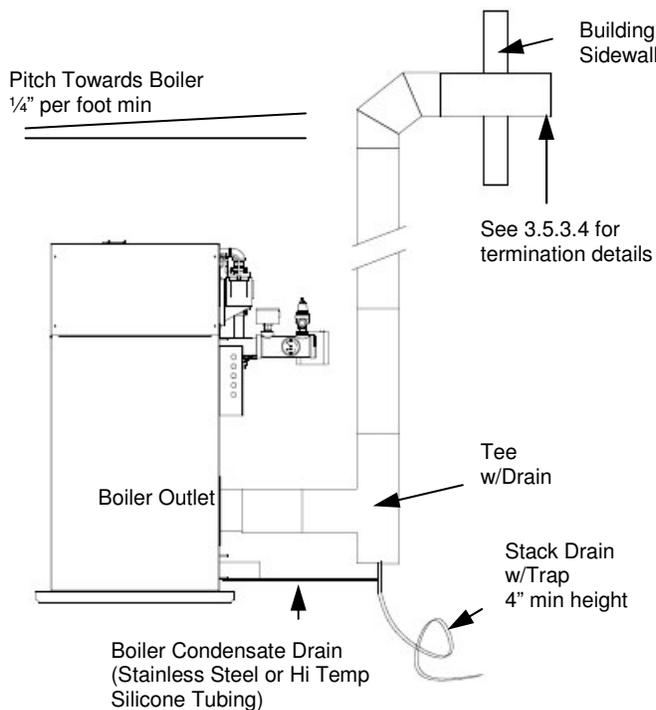
**3.5.3.3 Flue Connection**

**⚠ WARNING** The boiler vent should not be connected into any portion of another mechanical draft system without consulting the vent manufacturer. This boiler operates under a positive vent pressure. The boiler shall not be connected to any part of a vent system serving a Category I or II appliance, nor shall a Category I or II appliance be connected to any part of the vent system serving this appliance. Improper interconnection of venting systems may result in leakage of flue gases into occupied spaces.

**NOTICE!** Make sure that the weight of the vent is **not supported** by the boiler vent collar. **The collar is not designed to support the weight of the vent.** The vent system shall be supported in accordance with the manufacturer's instructions. Horizontal vent sections shall be supported in a manner to prevent sags or low spots where condensate can collect. Structural supports must be connected to building elements of sufficient strength to withstand the weight of the vent system and any bending forces imposed by the venting system.

The 750,000 Btu & 1,000,000 Btu boilers have 6" OD connections for the vent. If venting design permits, this connection may be reduced to 4" or 5" diameter.

The 1,500,000 Btu & 2,000,000 Btu boilers have 8" OD connections for the vent. If venting design permits, this connection may be reduced to 6" diameter.



The connection from the boiler to the vent should be made using an adapter that is designed to fit the OD of the boiler outlet. The vent manufacturer's adapter must be sealed to the boiler outlet with sealant listed for use with the vent material. The connection from the boiler to the vent should be as direct as possible and the upward slope of any horizontal breaching should be at least 1/4 inch per linear foot. Provisions must be made for supports to prevent contact of the vent with combustible surfaces.

The complete exhaust with drain system is shown in the figure. The appliance connector should incorporate provisions to drain condensate formed in the vent system. The first turn from horizontal to vertical should be made with either a standard tee with condensate drain cap or an elbow with an "inline" drain installed immediately above the elbow. The condensate drain line from the boiler must be connected to the stack drain upstream of the stack trap using a material that will withstand condensate corrosion and a maximum temperature of 400 °F. The stack trap shall have a

minimum height of 4 inches. The condensate must be routed to a suitable drain that complies with all local codes.

**⚠ WARNING**

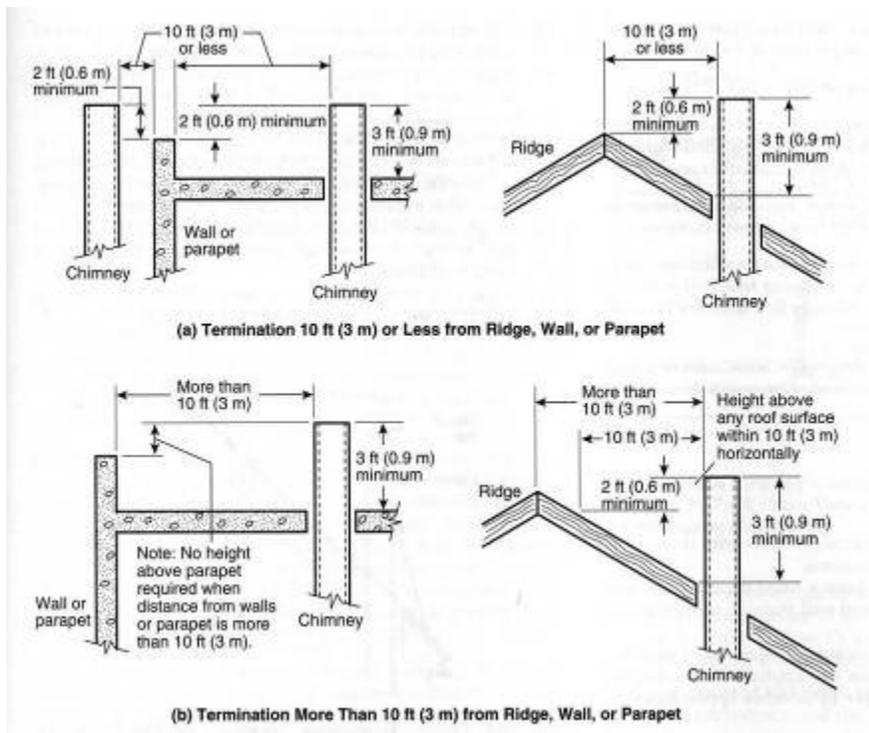
The boiler condensate drain line can get as hot as the stack. This may be up to 400°F. This line should be insulated to prevent thermal injury or burns.

**⚠ WARNING**

Do NOT use copper or plastic for the boiler condensate line, as these may fail and allow exhaust gas to leak into the room.

**3.5.3.4 Vent Terminations**

The vent shall extend at least three (3) feet above the roof, or at least two (2) feet above the highest part of any structure within ten (10) feet of the vent. This is illustrated in the following diagram.



Reference: NFPA 54/ANSI Z223.1 National Fuel Gas Code

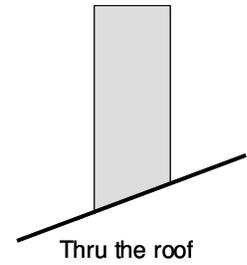
To prevent the possible re-circulation of flue gases, the vent designer must take into consideration such things as prevailing winds, eddy zones, building configurations, etc. Harsco Industrial, Patterson-Kelley can not be responsible for the effects such adverse conditions may have on the operation of the boilers. Dimensions listed above are minimums and may not be sufficient for conditions at a specific job site. It is important to locate the exhaust duct in such a way that it does not become blocked due to snow, ice, and/or other natural or man-made obstructions.

**3.5.3.4.1 Vertical Venting**

Harsco Industrial, Patterson-Kelley does not recommend the use of a vent cap. A screen termination is not recommended due to the possibility of ice formation on the screen. Vent terminations include open or reducing cone. Rain is actually beneficial to the vent internals.

**3.5.3.4.2 Sidewall Venting**

Harsco Industrial, Patterson-Kelley requires a “T” or 90 degree elbow to be used on the termination end of sidewall venting on these models. The venting connection for this “T” or 90 degree elbow should extend a minimum of 12” from the wall, in addition to other venting requirements.



**3.5.4 Venting for Multiple Boilers**

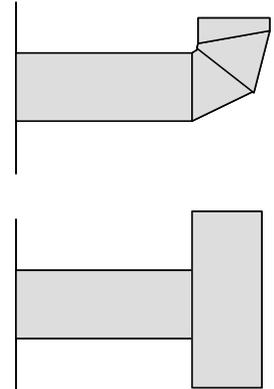
The venting instructions in this manual apply to a **single** boiler.

**Venting systems for multiple boilers must be designed by experienced and knowledgeable professionals.**

**The venting system must prevent backflow of exhaust gas through idle boilers.**

Thru the Wall

Note:  
Elbow and Tee  
May be oriented  
in any direction



**3.5.5 Sealed Combustion/Direct Vent Systems**

The MODU-FIRE® Forced Draft boilers are also certified for operation with a sealed combustion air and pressurized venting system. Such a system employs a sealed combustion air intake duct leading from outdoors to the boiler and a sealed exhaust vent leading from the boiler and terminating outdoors. Air flow through the system is maintained by the combustion air fan.

**3.5.5.1 Intake Duct Materials and Sizes**

The air intake duct can be fabricated from PVC, CPVC, single wall galvanized steel, or other suitable materials. The duct must be rigid enough to maintain the full required cross sectional area under all operating conditions. Proper sealing of the intake ductwork is necessary to prevent infiltration of air from conditioned space. Joints in PVC or CPVC must be cemented. For galvanized duct, wrap each joint and seam with adhesive aluminum tape or other sealant. Connect the air supply duct to the inlet air collar on the boiler. This collar is 7-7/8” OD. Fasten the duct to the collar with sheet metal screws and seal with aluminum tape or sealant. The installation of a birdscreen on the intake termination is recommended. Ensure that the screen does not become blocked with snow, ice, insects and other natural or man-made obstructions.

**The combined pressure drop of the air supply duct and exhaust vent must not exceed 2.0” w.c.** This combined pressure drop can be distributed over the intake or exhaust as needed provided that the air inlet pressure loss does not exceed -0.5” w.c.

**Minimum Air Requirements – SCFM**

MFD MODEL	Min Required SCFM
750	188
1000	251
1500	364
2000	501

**3.5.6 Removing an Existing Boiler**

When an existing boiler is removed from a common venting system, the common venting system is likely to be too large for proper venting of the appliances remaining connected to it.

At the time of removal of an existing boiler, while the other appliances remaining connected to the common venting system are not in operation, the following steps should be followed with each appliance remaining connected to the common venting system placed in operation:

1. Seal any unused openings in the common venting system.
2. Visually inspect the venting system for proper size and horizontal pitch and determine that there is no blockage or restriction, leakage, corrosion or other deficiency which could cause an unsafe condition.
3. Insofar as is practical, close all building doors and windows and all doors between the space in which the appliances remaining connected to the common venting system are located and other spaces of the building. Turn on clothes dryers and any appliances not connected to the common venting system. Turn on any exhaust fans, such as range hoods and bathroom exhausts, so they will operate at maximum speed. Do not operate a summer exhaust fan. Close fireplace dampers.
4. Place the appliance being inspected in operation. Follow the lighting instructions. Adjust the thermostat so that the appliance will operate continuously.
5. Test for spillage at the draft hood relief opening after 5 minutes of main burner operation. Use the flame of a match or candle or smoke from a cigarette, cigar or pipe.
6. After it has been determined that each appliance remaining connected to the common venting system properly vents when tested as outlined above, return doors, windows, exhaust fans, fireplace dampers and any other gas-burning appliance to their previous conditions of use.

Any improper operation of the common venting system should be corrected so the installation conforms with the National Fuel Gas Code, ANSI Z223.1 and CSA B149 Installation Code. When resizing any portion of the common venting system, the common vent system should be resized to approach the minimum size as determined using the appropriate tables.

**3.6 GAS PIPING**

Before making the gas hook-up, make sure the boiler is being supplied with the type of fuel shown on the boiler nameplate.

The boiler must be installed such that the gas system components are protected from water (dripping, spraying, rain, etc.) during appliance operation and service (circulator replacement, control replacement, etc.)

The boiler is factory fire-tested and adjusted for proper combustion with a natural gas supply pressure of 7 inches W.C. Typical supply gas pressure is 7 inches W.C. for natural gas (11 inches W.C. for propane). The gas train

components are certified to handle a maximum inlet pressure of 14 inches W.C. (1/2 psig.). If the available gas pressure exceeds 14 inches W.C., a suitable additional intermediate gas pressure regulator of the "lock up" type must be provided to reduce the pressure to less than 14 inches W.C.

The minimum allowable gas pressure for proper operation of the unit is dependent on the vent resistance at high fire. The following chart details the minimum gas pressure required based on the static pressure at the boiler flue gas outlet.

For Natural Gas:

Stack pressure:	Min. gas pressure required:
Less than 1" W.C.	4.5" W.C.
More than 1" W.C.	7.0" W.C.

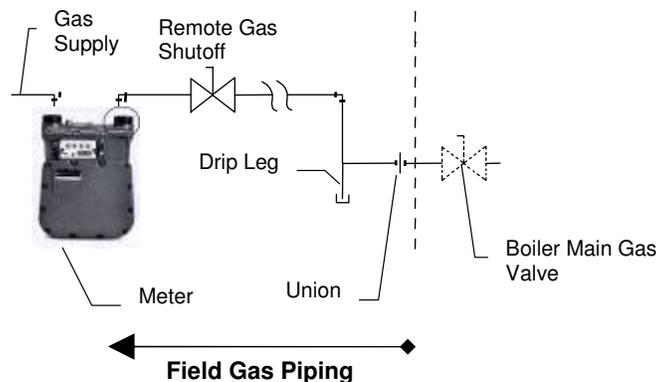
For Propane, a minimum of 7 inches W.C. inlet gas pressure is required.

**⚠ WARNING** All threaded connections must be made using a pipe compound that is certified resistant to the action of liquefied petroleum gases. **Do not use Teflon tape on gas line threads.**

**NOTICE!** Piping must be installed such that no piping stresses are transmitted to the boiler. The boiler **shall not** be used as a pipe anchor.

The boiler and all gas piping connections should be pressure-tested and must be checked for leaks before being placed into service. Test with compressed air or inert gas if possible. The boiler must be **disconnected** at the boiler manual shutoff valve (located at the end of the supplied gas train) from the gas supply piping system during any pressure testing of the system at pressures in excess of 1/2 psig (14 inch W.C.). Some leak test solutions, including soap and water, may cause corrosion. These solutions should be rinsed off with water after testing.

**RECOMMENDED GAS PIPING INSTALLATION**



NOTICE! A sediment trap (drip leg) and a union connection should be installed downstream of the primary manual shutoff valve on the boiler. Gas piping should be installed in accordance with National Fuel Gas Code, ANSI Z223.1 and any other local codes which may apply. In Canada, please refer to CSA-B.149.

### 3.6.1 Pipe Capacity for Natural Gas

NOTICE! See Pipe Capacity for Natural Gas chart for required pipe size, based on overall length of pipe from meter plus equivalent length of all fittings. Approximate sizing may be based on 1 cubic foot of natural gas per 1,000 Btu per hour input, i.e., 500,000 Btu per hour requires about 500 cubic feet per hour. (See "Typical Boiler Operating Conditions," Section 4.3, for more information.)

Nominal Iron Pipe Size (Inches)	Internal Diameter (Inches)	Equivalent Pipe Length		Maximum Capacity in Cubic Feet of Natural Gas per Hour Pressure Drop of 0.5 inch Water Column/Equivalent Length of Pipe (in feet)							
		90° Ell (Feet)	Tee (Feet)	20	40	60	80	100	150	200	
1-1/4	1.380	3.45	6.9	950							
1-1/2	1.610	4.02	8.04	1,460	990	810					
2	2.067	5.17	10.3	2,750	1,900	1,520	1,300	1,150	950	800	
2-1/2	2.469	6.16	12.3	4,350	3,000	2,400	2,050	1,850	1,500	1,280	
3	3.068	7.67	15.3	7,700	5,300	4,300	3,700	3,250	2,650	2,280	
4	4.026	10.1	20.2	15,800	10,900	8,800	7,500	6,700	5,500	4,600	

## 3.7 BOILER WATER PIPING

### 3.7.1 Piping Design

#### 3.7.1.1 Water Flow in System

Ideal operation of the MODU-FIRE® Forced-Draft boiler would consist of a 20° F temperature differential across the heat exchanger at high fire. Insufficient flow may result in excessive short cycling of the boiler and eventual damage or premature failure of the equipment.

NOTICE! The closing of the flow switch does not prove that flow is adequate. It only indicates that some flow is present. **Proper flow rates are 60-120 gpm for N750MFD and N1000MFD boilers, 90-150 gpm for N1500MFD and 120-180 gpm for N2000MFD boilers.**

Minimum Return Water Temperature should be greater than 130° F to avoid problems of condensation on the outside of the heat exchanger or in the flue passages.

Proper flow rates and return water temperature may be achieved through a combination of primary and secondary flow loops. Multiple zones and pumps may result in different flow rates at different times. Consideration must be given to all possible conditions and their consequences.

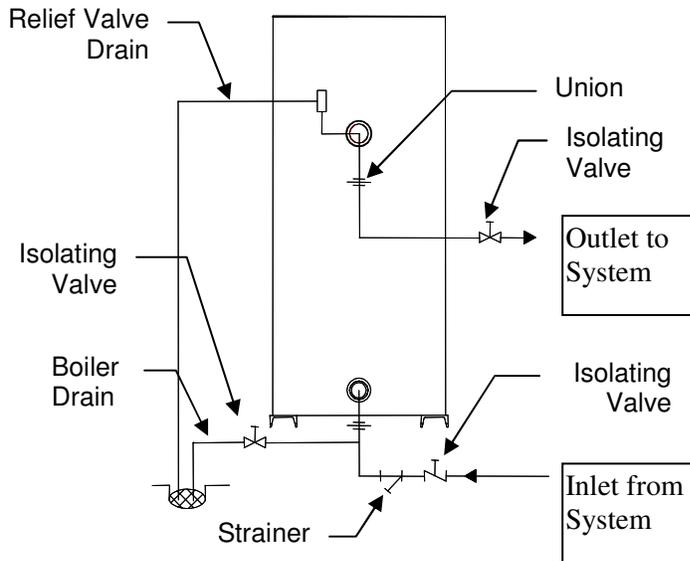
**3.7.1.2 Piping with Refrigeration Machines**

When used with a refrigeration system, the boiler shall be installed so that chilled medium is piped in parallel with the boiler. Valves should be installed to prevent chilled water from entering the boiler when the system is operated in the cooling mode.

**3.7.1.3 Piping with Air Handling Units**

The boiler piping system of a hot water heating boiler connected to heating coils located in air handling units, where they may be exposed to refrigerated air circulation, must be equipped with flow control valves or other automatic means to prevent gravity circulation of the boiler water during the cooling cycle.

**3.7.2 Boiler Water Connections**



**Boiler Water Connections**

Make water connections as the application warrants, or at a minimum, as shown, but always in compliance with the local requirements.

**NOTICE!** Pipe unions and isolating valves must be installed in both water connections for ease of service.

The bottom connection to the boiler is the INLET and must be used for the return from the system.

The top connection to the boiler is the OUTLET and must be connected as the supply to the system.

Piping must be installed such that no piping stresses are transmitted to the boiler. The boiler **shall not** be used as a pipe anchor.

### **3.7.3 Boiler Water Piping by Installer**

#### **3.7.3.1 Strainer**

To avoid possible contamination of the boiler with dirt, rust or sediment from the system, a strainer near the boiler inlet is strongly recommended. Even new systems may contain sufficient foreign material to eventually reduce the performance of the heat exchanger. Adequate circulation of good clean water is essential to maximum efficiency and long life of the boiler.

#### **3.7.3.2 Relief Valve and Piping**

Each boiler is supplied with a pressure-relief valve sized in accordance with ASME requirements. The relief valve must be piped to a suitable drain prior to placing the boiler into service and in a manner that prevents water spray from contacting any person. Reducing couplings or other restrictions are not permitted in the discharge line.

**▲ WARNING**

Do not plug or obstruct the discharge of the relief valve.

#### **3.7.3.3 Low Water Cut-off**

The boiler is furnished with a flow-switch-type low water cut-off as required by the ASME BPV Code, Section IV; no field piping is required. If the flow switch does not sense water flow, the boiler will shut down and a red indicator will be illuminated on the control panel.

Installation of an external low water cutoff or manual reset low-water switch may be required by certain codes or in certain installations. Consult your local code for details.

**▲ WARNING**

Never install a valve that can isolate the low water cut-off from the boiler.

#### **3.7.3.4 Drain Valve and Piping**

The boiler is not provided with external drain connections. A drain valve should be installed near the inlet (system return) connection to the boiler and piped to a suitable floor drain. The boiler can be completely drained through the bottom header by removing the flush plug in the bottom end plate.

This plug may also be used to flush accumulated sediment from the bottom of the boiler.

### **3.7.4 Flushing and Filling**

#### **3.7.4.1 Flushing the System**

Before filling the boiler, flush the system to remove the debris. Clean and flush old piping thoroughly before installing the boiler as recommended by your water conditioning or chemical treatment supplier.

Under no circumstances should the hydronic system be flushed while the boiler is attached to the system since the debris or corrosion products could accumulate in the boiler and plug the boiler heat exchanger.

If the piping system attached to this unit will be chemically cleaned, the boiler must be disconnected from the system and a bypass installed so that the chemical cleaning solution does not circulate through the boiler.

#### **3.7.4.2 Filling**

To be sure that the boiler is not air-bound, open the pressure-relief valve located at the rear of the boiler. Leave the relief valve open until a steady flow of water is observed. Close the valve and finish filling the system.

### **3.7.5 Water Quality**

The boiler is designed to operate in a closed-loop system using water or water/glycol only. As such, the system should be tight and not require make-up water. A high percentage of untreated make-up water can cause premature failure due to build up of scale. Such failure is not covered by warranty.

Scale can also reduce efficiency. For example, a scale thickness of 1/16 inch will result in a 12.5% loss of efficiency.

The water quality should be within the guidelines established by the American Boiler Manufacturers Association, as follows:

- Total solids: 2,500 ppm
- Total alkalinity: 500 ppm
- Total hardness: 150 ppm

In addition, the amount of oils, fats, grease, and other organic matter should be limited to 10 ppm.

Consult your water conditioning or chemical treatment supplier for analysis and recommendations. Employing a conscientious and competently administered program with emphasis on good maintenance practices as outlined by your water treatment specialist is recommended.

If water/glycol is to be used in the system, the customer should perform a hazard analysis to determine proper use and disposal.

## **3.8 BURNER AND IGNITION SYSTEM**

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### **3.8.1 Inspection**

Inspect the burners to be sure nothing was damaged or knocked loose during shipment. Inspect the main gas train and ignition assembly to be sure they were not damaged during shipment or installation.

Check all gas unions for tightness.

## **3.9 PRE-START CHECK LIST**

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Before attempting to start the boiler, make sure the following items have been completed.

1. Flue gas from the boiler is properly vented. (See section 3.5)
2. Gas connection has been made, pressure tested for leakage, and the line purged of air. (See section 3.6)
3. Water connections are complete, and the boiler and system have been filled and purged of air. (See section 3.7)
4. The boiler must be connected to a 230 volt / 60 Hz / 1 Ph power source with proper polarity, a dedicated machinery ground, and provided with a disconnect having adequate overload protection. (See section 3.4)
5. Combustion air openings are not obstructed in any way and have adequate capacity. (See section 3.5)
6. The boiler is located with the proper clearances as shown in this manual. (See Section 3.3.3)
7. Relief valves have been properly piped to floor drains. (See section 3.7)
8. There are no flammable liquids, materials or hazardous fumes present in the environment.
9. Remove/account for all tools and parts.
10. All panels and parts should be properly installed.

### 3.10 SAFETY CHECKS

The following checks of safety systems must be made before putting the boiler into normal operation.

Before firing the boiler refer to Sections 4.1 and 4.2 for information on the use of the controls, lighting, and shut-down procedures.

**⚠ WARNING**

Never attempt to operate a boiler that has failed to pass all the safety checks described below.

**⚠ WARNING**

After checking controls by manual adjustment, make sure they are always reset to their proper settings.

#### 3.10.1 Test of Ignition Safety System

Test the ignition system safety shutoff as follows:

1. Remove the black plug/connector from the main gas valve (it is held on with a central screw).
2. With the main gas cock (inlet manual gas valve) open, the burner should be cycled on. After all the safety limits such as gas pressure, water flow and temperature are satisfied, the blower will run and pre-purge the boiler.
3. Once the purge is complete (30 seconds), the ignition transformer will be energized. There will be a 4 second trial for ignition period. During this period, indicator lights on the flame safeguard (pilot and main) will illuminate indicating the boiler is attempting to light.
4. The main gas valve will not open because there is no power to the valve due to the disconnected wires. Hence, no flame will be established and the flame safeguard will not receive a flame signal from the UV scanner.
5. After 4 seconds, the flame safeguard programmer will assume a "Flame Failure" condition and go to a "lockout" mode. Lockout will require manual reset of the flame safeguard.

After completing this test, turn off the boiler and reconnect the wires to the main gas valve.

#### 3.10.2 Test of Flow Switch (Low Water Cut-off)

The boiler is furnished with a flow-switch-type low water cut-off in the outlet nozzle. Test as follows:

1. Turn boiler and then system pump off.
2. Turn boiler back on.
3. The boiler control panel will display "LOW FLOW/ILK". This is a manual reset error and the boiler should not start until the pump is started and the control is reset.

Perform appropriate tests on any external probe-type low water cut-off.

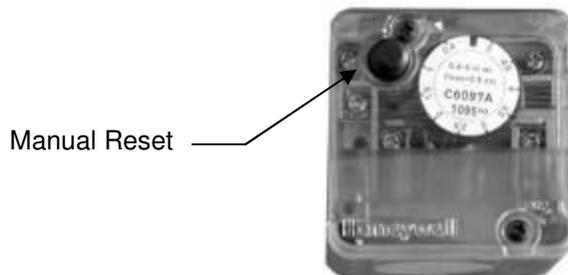
#### 3.10.3 Test of Limit Controls

Fire the boiler and test the high limit control as follows:

With the main burner operating, turn down the temperature setting on the "high-limit" thermostat (located in the control panel below the digital operating control) until the main burner shuts off. The high-limit switch must be manually reset by pushing the small green lever. A similar check should also be made for the digital operating

temperature control (see Section 3.11 for instructions on setting this control). After completion of these tests, re-adjust the operating thermostat to the desired operating temperature and set high-limit temperature, typically 20° F above operating temperature.

### 3.10.4 Test of Low Gas Pressure Switch



**Hi/Low Gas Pressure Switch**

The boiler is furnished with a low gas pressure switch. The operation of this switch must be checked by slowly closing the main gas cock while the burner is operating. The switch should shut down the main burner. The control will display LOW GAS PRESSURE. This is a manual reset error and the boiler should not start until the gas valve is opened, the low gas pressure switch is reset, and the control is reset.

### 3.10.5 Test of High Gas Pressure Switch

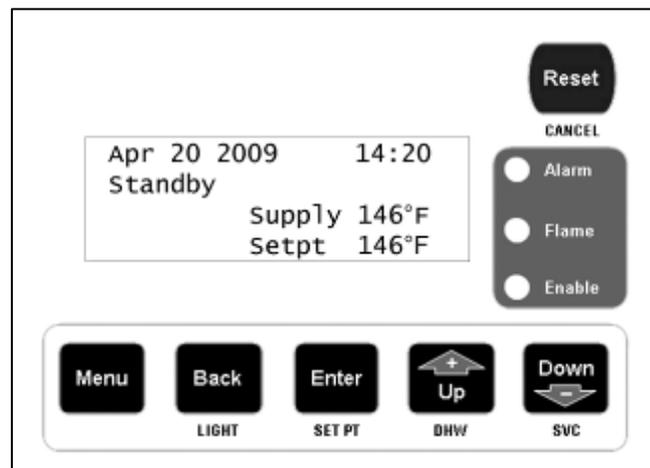
The boiler is furnished with a high gas pressure switch. The operation of this switch must be checked by closing the downstream main gas cock, and starting the boiler. Once the trial for ignition period is reached, the main gas valve will open, pressurizing the line. This will trip the high gas pressure switch. The switch should shut down the main burner. The control will display HIGH GAS PRESSURE. This is a manual reset error and the boiler should not start until the gas valve is opened, the low gas pressure switch is reset, and the control is reset.

## 3.11 Boiler Operating Control

The MODU-FIRE® Forced Draft boiler is equipped with a combination combustion and temperature control. This control monitors combustion and lighting of the boiler, as well as maintaining temperature of the supply water. The temperature control portion modulates the boiler to maintain the desired outlet temperature based on the selected operating configuration.

### 3.11.1 Initial Adjustments

The MODU-FIRE® Forced Draft 750-2000 boilers are equipped with ENVI™ control; an intelligent control system with advanced features such as text-based display, communication capabilities, and boiler sequencing. Errors are date and time stamped providing built-in history of boiler status and performance. This control constantly tracks the load by recording burner high, low and mid run hours. One control to do it all – temperature control, flame safeguard, firing rate control, blocked flue protection, outdoor air reset, freeze protection, built-in cascade sequencing, MODBUS® communication and more.

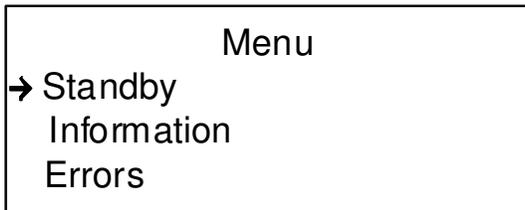


**⚠ CAUTION**

The user should become thoroughly familiar with the operation of the boiler and controls before attempting to make any adjustments.

The boiler control has a text display panel. The display panel is used to setup and monitor boiler operation by means of six push buttons MENU, BACK, ENTER, UP, DOWN, and RESET as shown above. The buttons across the bottom are used to navigate through the various screens. The four line screen shows boiler operating information on various screens. The display screen is backlit for ease of viewing. Pressing any key will illuminate the backlight.

The standby screen is shown upon startup.

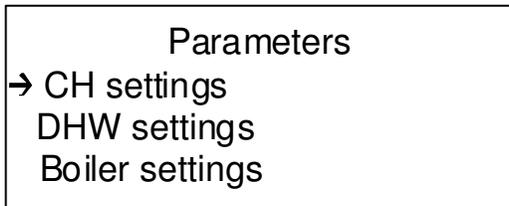


This screen shows the date, time, boiler status, supply temp and setpoint temp. Pushing the menu button displays a menu of options.

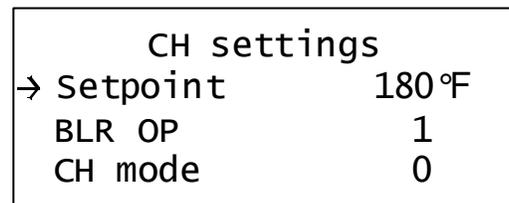
The menu includes access to the STANDBY, INFORMATION, ERRORS, PROGRAM PARAMETERS, CONFIGURATION, CASCADE, and SERVICE menus. The UP and DOWN buttons are used to position the arrow next to the desired option and the ENTER button is pushed to access that option.

**3.11.1.1 Configuring the Control**

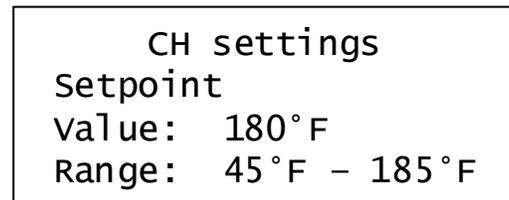
First push the MENU button and then select PROGRAM PARAMETERS from the menu. A screen opens that allows the user to view and change various operating parameters.



Select the CH SETTINGS to adjust parameters related to the boilers Comfort Heat function.



For example, selecting the SETPOINT parameter opens up a screen that allows the setpoint to be changed.



The UP or DOWN buttons are used to adjust the CH setpoint up or down as desired.

**3.11.2 Other Control Parameters**

Other parameters are available and may be changed by contacting the factory for assistance. The ENVI™ control Getting Started Guide contains additional information regarding the operation of this control.

**NOTICE!** Changing parameters requires an understanding of the parameters and the functionality of the boiler. The boiler may not function properly if parameters are changed from the factory values.

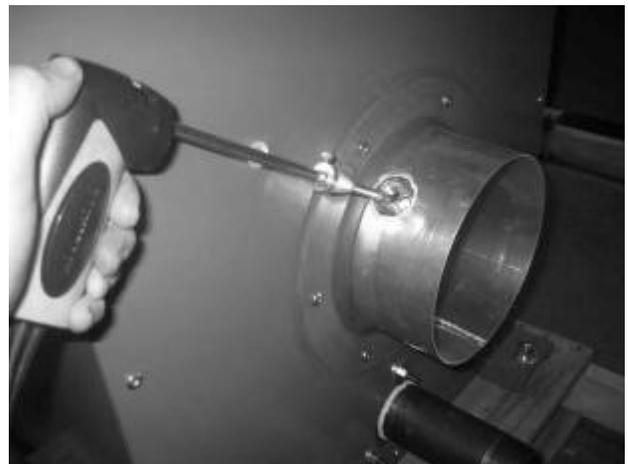
**3.12 BURNER ADJUSTMENT**

**There are no required start-up or field adjustments for air flow control. DO NOT attempt to change any parameters in the blower speed control (inverter).** The MODU-FIRE® Forced Draft boiler uses a microprocessor controlled variable frequency inverter to control the speed of the blower. The air flow is set at the factory. Should an error occur during operation, the inverter will automatically reset after 30 seconds. If the error recurs, log the flashing error code and call for authorized service.

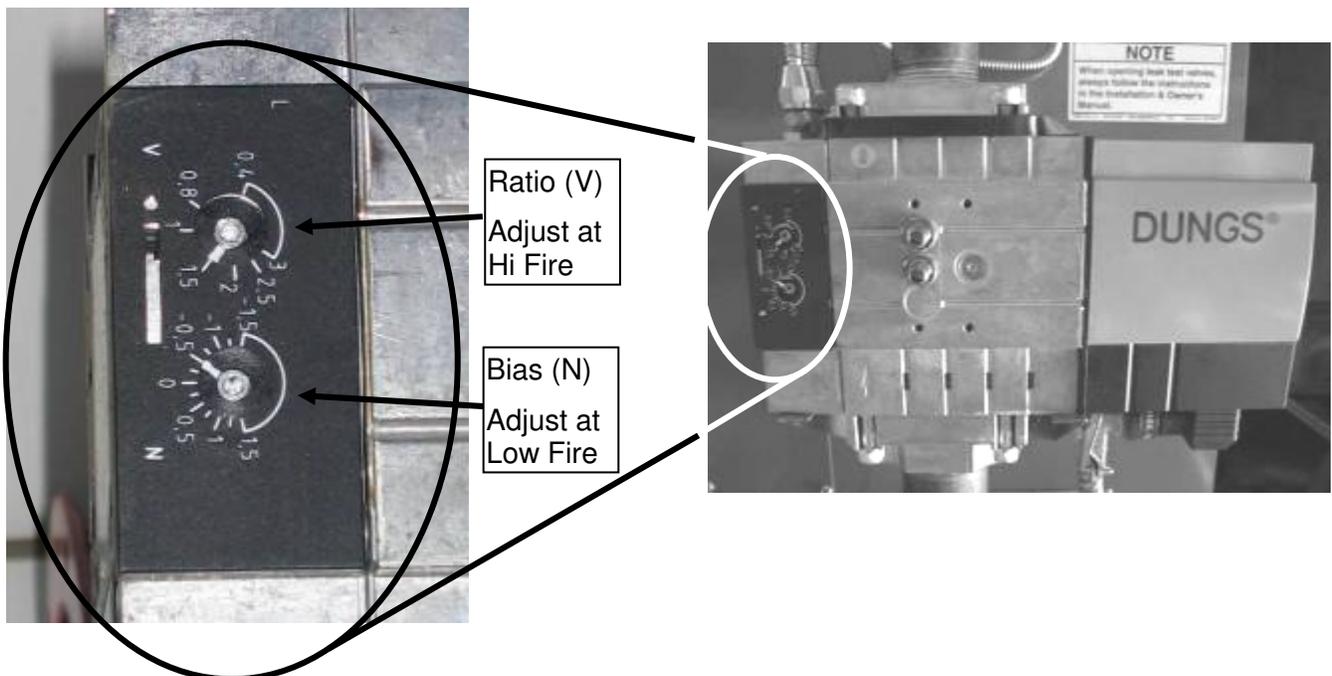
**3.12.1 Combustion Setup and Adjustment**

The fuel/air ratio is controlled by the automatic air gas ratio valve. This valve is adjusted at the factory to give 5.5-6% O<sub>2</sub> at high fire and 7.5-7.9% O<sub>2</sub> at low fire in the exhaust gas. However, the fuel/air ratio should be checked using a combustion analyzer at start-up to verify that the combustion is proper. Remove the vent plug and place the analyzer probe in the vent as shown. Be sure to replace the plug after combustion has been set.

Start the boiler. Place the probe of a combustion gas analyzer in the stack as shown (right). Using the toggle switch on the boiler control panel, place the boiler in High Fire. If the % O<sub>2</sub> is not within the range above, the gas valve should be adjusted.

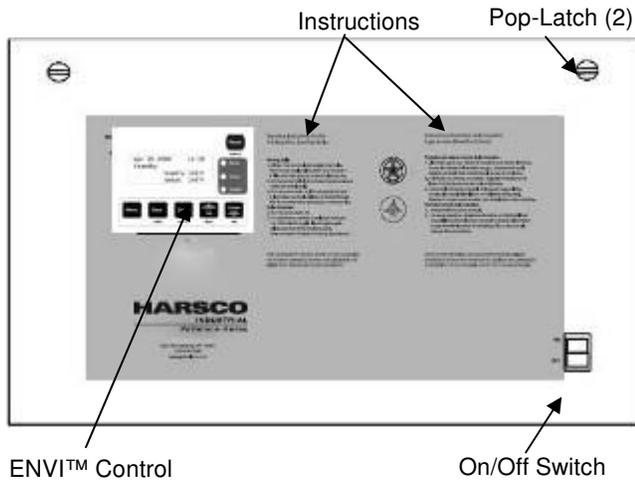


To adjust the gas valve on hi fire, turn the top screw "V" counterclockwise to reduce the % O<sub>2</sub> or turn it clockwise to raise the % O<sub>2</sub>. Once high fire is adjusted, place the boiler in low fire using the toggle switch and adjust the % O<sub>2</sub> if necessary, by turning the bottom screw "N" counterclockwise to reduce the % O<sub>2</sub> and clockwise to increase the % O<sub>2</sub>.



## 4.0 OPERATION

### 4.1 GENERAL



The front of the control panel shows Operating Instructions and a series of illuminated indicator lights and the temperature control. The boiler operating controls are accessed by turning the pop-latches ¼ turn, and opening the front cover.

#### 4.1.1 Normal Operation

Under normal operating circumstances, this boiler functions as a fully automatic appliance. The automatic control senses the water outlet temperature and fires the boiler when heat is needed by the system. Additionally this boiler may function as part of an integrated building management system.

### 4.2 LIGHTING AND SHUT-DOWN PROCEDURES

#### **WARNING**

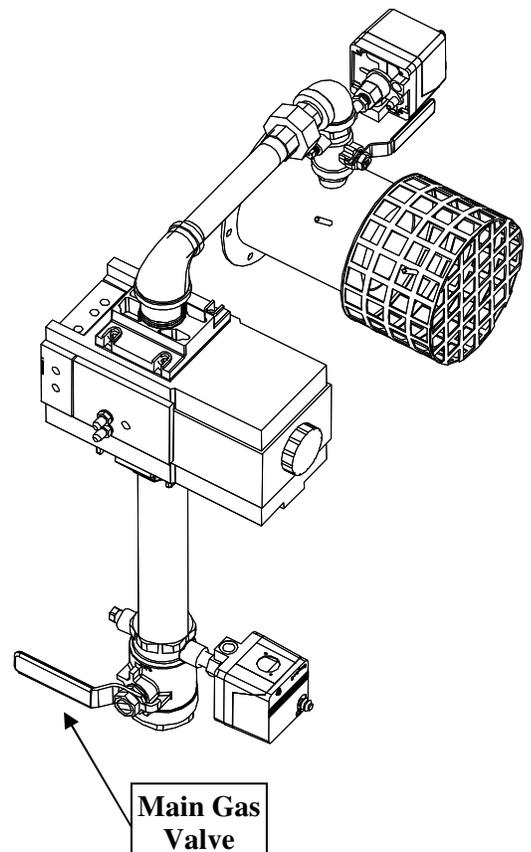
Do not use this boiler if any part has been under water. Immediately call factory-trained personnel to inspect the boiler and replace any part of the control system and any gas control which has been exposed to water.

#### 4.2.1 Initial Lighting Procedures

1. Utilities: Turn on electrical supply to the boiler. Open the gas supply valves. Make sure the system is filled with water and turn on the circulation pump.
2. Reset Switches: Press the reset button on both the high gas and low gas pressure switches if the gas supply had previously been turned off. Press the control reset button after a safety lockout.
3. Set the desired high temperature limit and operating temperature.
4. Turn on the power switch. If a error is displayed, see Section 5.6 of this manual to troubleshoot the problem and take the necessary corrective action before proceeding.

#### 4.2.2 Normal Shut Off Procedures

1. Place the on/off switch in the off position.
2. Close all manual gas valves.
3. Turn off electrical power.



### 4.2.3 Emergency Shut Off Procedures

The main gas cock should be closed immediately. If overheating occurs or the gas supply fails to shut off, do not turn off or disconnect the electrical supply to the pump. Instead, shut off the gas supply at a location external to the boiler.

## 5.0 MAINTENANCE

**All weekly, monthly and annual maintenance checks should be performed by qualified and knowledgeable personnel.**

### **⚠ WARNING**

Installation and service must be performed by a qualified and knowledgeable individual, such as a Harsco Industrial, Patterson-Kelley representative, qualified installer, service agency, or gas supplier.

### **⚠ WARNING**

Proper lockout / tagout procedures must be employed when servicing this unit.

Hazard analysis should be performed by end user to insure safety of their employees and/or service technicians.

## 5.1 MAINTENANCE AND INSPECTION SCHEDULE

### **⚠ WARNING**

Label all wires prior to disconnection when servicing controls. Wiring errors can cause improper and dangerous operation.

Verify proper operation after servicing.

### 5.1.1 Daily

Observe operating temperature and general conditions. Make sure that the flow of combustion and ventilating air to the boiler is not obstructed. Determine the cause of any illuminated red indicators, unusual noises or operating conditions and make the necessary corrections.

### **⚠ WARNING**

Check daily to be sure that the boiler area is free and clear of any combustible materials, including flammable vapors and liquids.

### 5.1.2 Weekly

Observe the conditions of the main flame. A normal high fire flame shows an orange screen with a blue halo. In Low fire the burner should display a reddish orange glow. However, do not attempt to adjust the flame "by eye".

Correct air adjustment is essential for the efficient operation of this boiler. If an adjustment to the combustion is necessary, the flue gas composition should be checked with a carbon dioxide (CO<sub>2</sub>) or oxygen (O<sub>2</sub>) analyzer to set conditions. Refer to Section 3.12.

### **5.1.3 Monthly**

1. Using the control panel, enter the information mode and scroll down to view the flame signal. When the boiler is firing, the signal will be “yes” and when the boiler is not firing, the signal will be “no”.
2. Test high-limit control by reducing setting below the operating temperature. Burner should shut off. After readjusting the thermostat, press the button to reset the switch.
3. Test operating temperature control by reducing temperature setting as necessary to check burner operation.
4. Check flue gas temperature at outlet. If there is a temperature increase over previous readings, the probable cause is soot or water-scale build-up on the tubes.
5. Test the water flow switch by trying to restart boiler with the system pump off. The boiler should not operate and the control should display LOW FLOW/ILK.
6. Test low gas pressure switch and high gas pressure switch utilizing the procedure in sections 3.11.4 & 3.11.5. The boiler should fail to start and the control should display LOW GAS or HIGH GAS
7. Inspect and clean the inlet screen of any accumulated dust or lint.
8. The relief valve should be tested as per manufacturer’s instructions or every two months by lifting the lever for 5 seconds and allowing the valve to snap shut. Please see the manufacturer’s recommendations on the relief valve tag.

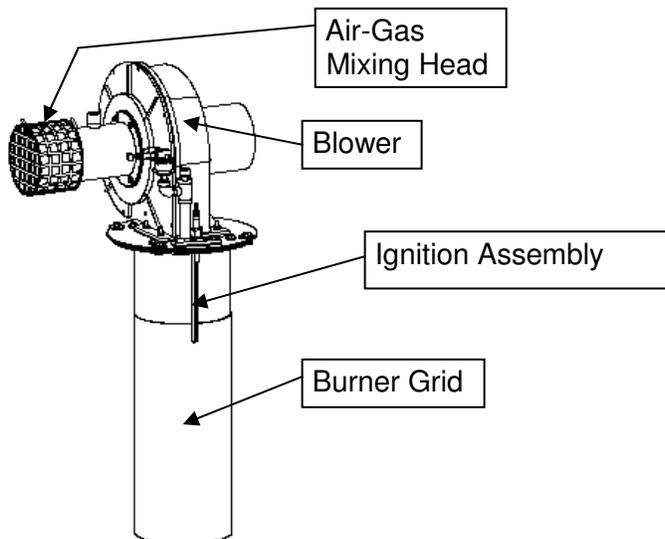
### **5.1.4 Annually**

In addition to the recommended monthly service:

1. Inspect burner and ignition system. Wash the burner (do not scrub or use wire brush) to remove any soot or foreign material that may have accumulated. See Section 5.2 on "Cleaning the Burner." Check the burner and its parts. If there is evidence of deterioration or corrosion, replace immediately.
2. Inspect combustion chamber. To access the heat exchanger, remove the front door and the front inner wrapper. Note any signs of deterioration. Examine the gasket and replace if necessary, using a Harsco Industrial, Patterson-Kelley gasket kit only.
3. Inspect and clean heat exchanger. Wash the copper tubes with water and non corrosive soap. Be sure to rinse thoroughly. Green scale on the tubes indicates that the boiler is condensing which is detrimental to boiler life. Perform corrective action as necessary.
4. Examine the venting system.
  - a. Check all joints and pipe connections for tightness.
  - b. Check vent for corrosion or deterioration. If any venting needs replacing, do so immediately.
5. Inspect heating system for other problems.
6. Perform combustion analysis and adjust if necessary (See 3.12.3).
7. Leak test gas valves. Leak Test must be performed only by qualified Harsco Industrial, Patterson-Kelley certified personnel, who have been trained in this procedure. This procedure is available on request from the Harsco Industrial, Patterson-Kelley factory.

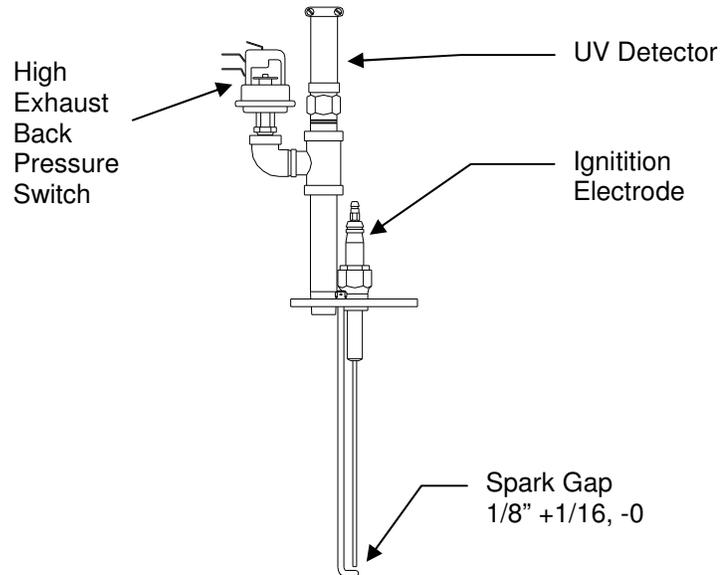
## 5.2 CLEANING THE BURNER

### 5.2.1 Burner Assembly



1. Follow proper lockout / tagout procedures for the electrical, gas, and water connections. Use caution when lifting heavy parts.
2. Remove top and side covers from the boiler.
3. Disconnect the gas union, high gas pressure switch wires and the wire plug connector to the blower. Disconnect the UV scanner, ignition wire, ground wire and the wires to the back pressure switch.
5. Disconnect the air gas mixer sensing tubes. Note: these tubes are color coded and must be correctly reinstalled.
6. Remove the blower/air gas mixer assembly from the top of the burner.
7. Clean the blower vanes. Do not disassemble the blower motor or aluminum housing.
8. Remove the burner using the four hold down screws.
9. Clean the burner to remove any soot or foreign material that may have accumulated. Blow the burner with compressed air or wash off (do not scrub or use wire brush).
10. Check that gap between the electrode and the ground rod. It should be 1/8" (+1/16, -0). For Propane, the gap should be exactly 1/8".

### 5.2.2 Ignition Assembly



**NOTICE!** The electrode height is not adjustable. If adjustment is necessary, only the ground rod should be adjusted. Check for cracking of the electrode. Do NOT over tighten the electrode (finger tight plus a quarter turn).

1. Use a soft, clean cloth to remove accumulated contaminants from the UV detector/scanner glass envelope.
2. Before re-installing the burner, check the cleanliness of the heat exchanger and the condition of the combustion chamber. If corrosion or leaks are noticed, please call for service.
3. Install the burner and blower assembly. Reconnect the green ground wire, ignition wire, high gas pressure switch wires, the wire plug to the blower, the two air gas mixer sensing tubes, the UV scanner, and wires to the back pressure switch. **Before starting the boiler make sure to reconnect and tighten the gas union!**
4. Reinstall all covers.
5. Fire Test the boiler and use a combustion analyzer to ensure that the fuel/air ratio is set correctly. If adjustment is required, refer to section 3.12.3.

### 5.3 REMOVING THE HEAT EXCHANGER

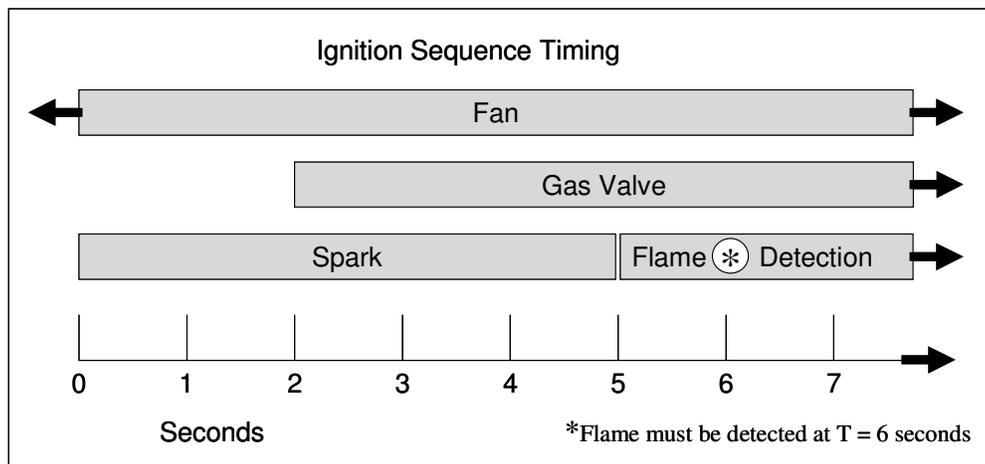
**WARNING** Heat Exchanger is heavy and may cause injury if improperly handled. Removal of the heat exchanger should be performed only by knowledgeable and experienced personnel.

### 5.4 AFTER ALL REPAIRS OR MAINTENANCE

1. Follow "Pre-Start Check List" (Section 3.10) and all "Safety Checks" (Section 3.11).
2. Fire the Boiler and perform combustion check.
3. Adjust gas flow if necessary. (See "Gas Pressure Adjustment", Section 3.12.3)

**5.5 SEQUENCE OF OPERATION**

1. In order for the boiler to start, the following limits must be satisfied:
  - a) Water flow switch
  - b) High & low gas pressure switches
  - c) High temperature limit
  - d) High back pressure switch
  - e) High stack temperature switch
2. When the Boiler On/Off switch is turned on, power is provided through a circuit breaker to the boiler control and the combustion blower.
3. If the high gas, low gas or low water level control is open, the boiler control locks out and displays an error.
4. When the water temperature is below the boiler control setpoint minus the hysteresis (On Differential), a heat request is generated.
5. Provided all limits are made, the boiler will attempt to start.
6. The controller checks that the air pressure switch is open indicating no airflow. The blower is driven towards the prestart fan speed. When the air pressure switch closes, the 25 second pre-purge time is started. After the pre-purge, the blower is driven to the ignition speed.
7. A trial for ignition begins. The sequence of events is illustrated graphically below.
8. After ignition, the fan may be driven to low fire before the boiler is released to modulation.
9. The control modulates the firing rate between low and high fire to maintain the desired outlet water temperature.
10. The burner will continue firing until the outlet water temperature reaches set point plus hysteresis (Off Differential). At this temperature the fuel supply is shut off and the combustion air fan continues to run for a 30 second post-purge.
11. When the water temperature is reduced by the load on the system, a heat request is generated. The operating sequence will recycle to step 4.



**NOTICE!** Once the boiler begins the ignition sequence, the firing sequence will continue until main flame is reached regardless of heat request. The sequence can be interrupted by turning the power switch off.

## 5.6 TROUBLESHOOTING

### **WARNING**

If any “Manual Reset” limit device trips,  
**DO NOT RESET**  
without determining and correcting the cause.

(Manual Reset Limits include: Flame safeguard,  
high or low gas pressure, high temperature limit,  
stack temperature.)

#### 5.6.1 Loss of Power

In the event of loss of power, the entire boiler system is de-energized, closing all automatic valves and halting all boiler operations. When power is restored the sequence of operation will resume at Step 3, provided that all the limits are satisfied.

#### 5.6.2 Loss of Water Flow

When there is insufficient water flow to close the flow switch, the burner operation is interrupted and the control displays LOW FLOW / ILK. When water flow is re-established, the sequence returns to Step 3, provided that the other limits are satisfied. This error also indicates that the interlock jumper is removed or the interlock is wired to an open device.

#### 5.6.3 Low Gas Pressure

The low gas pressure switch opens when there is insufficient gas pressure available for proper operation of the boiler. LOW GAS PRESSURE is displayed, and burner operation is interrupted. If a gas-supply shut-off valve is closed for any reason, a low gas condition will result. When gas pressure is restored, LOW GAS PRESSURE will remain on the display panel. A manual reset is required to restart the boiler, provided that all other limits are satisfied.

#### 5.6.4 High Gas Pressure

The high gas pressure switch opens when there is excessive manifold gas pressure for the proper operation of the boiler. HIGH GAS PRESSURE is displayed and the burner operation is interrupted. When proper gas manifold pressure is restored, HIGH GAS PRESSURE remains on the display panel. A manual reset is required to restart the boiler, provided that all other limits are satisfied.

#### 5.6.5 High Water Temperature

When the boiler water has exceeded both the operating and high-limit temperature the high limit switch opens, and HIGH LIMIT is shown on the display. When the water temperature falls below the high-limit temperature, the boiler will remain locked out until the water high limit switch is manually reset and the front panel reset button is pressed. Once the switch and the control are reset, the sequence returns to Step 3 to await heat demand provided that the other limits are satisfied.

#### 5.6.6 Low Air

### **CAUTION**

The air switch has been factory set and should not be adjusted in the field.

If the display panel indicates AIR SWITCH NOT OPEN or AIR SWITCH NOT CLOSE this indicates improper airflow through the boiler. Check the hoses leading to the air switches. Verify proper blower operation. An air switch error does not necessarily mean that the air switch is defective.

When AIR SWITCH NOT OPEN is shown on the display, check that the air switch is open when the fan is off. Check that there is no air flow through the boiler when the fan is off.

When AIR SWITCH NOT CLOSE is shown on the display, check that the air switch is closed when the fan is running. If the air switch does not close within 5 minutes during purge, the boiler locks out. Check that the burner is clean and that there are no obstructions to airflow in the intake or exhaust ducts.

### **5.6.7 Vent Pressure**

BLOCKED FLUE indicates that the high exhaust back pressure switch has tripped. This may be caused by a blocked stack, a blocked air inlet, or a blocked condensate system. When the blockage is removed, the boiler will automatically restart.

### **5.6.8 Ignition Failure**

In the event the flame is not detected by the UV scanner during the 4 second trial-for-ignition period (Step 9), the gas valve and spark ignition are de-energized. At this time a safety lockout occurs. A manual reset of the programmer (located inside the control panel) is required.

### **5.6.9 Flame Failure**

In the event of a flame failure, the main fuel valves are de-energized and a manual reset lockout occurs. IGNITION ERROR or FLAME ERROR is shown on the display. The cause of flame failure must be diagnosed and repaired before the control is reset.

When IGNITION ERROR is shown on the display, the boiler has not lit during a trial for ignition. Check that the spark, electrode, ignition wire, and gas valve are functioning properly.

When FLAME ERROR is shown on the display, the boiler has lost the flame during run. Check that the combustion is setup properly, the gas pressure is correct, as well as other combustion parameters.

### **5.6.10 Flame Error**

LATE FLAME and EARLY FLAME and FALSE FLAME. These errors signify flame error. This may be caused by a failed or leaky gas valve or a flame detector malfunction. If gas valve leakage is suspected, the unit must be isolated by turning off the main gas supply line. Qualified and knowledgeable service personnel must be called to evaluate and repair/replace the failed parts.

A comprehensive listing of the locking and blocking error codes is provided below.

**5.7 MANUAL RESET ERROR CODES – A##**

Code	ENVI Display	Lockout	Description
A00	NED	Unassigned	No Error Description, Call For Service
A01	IGNITION FAILURE	Ignition Failure	During an attempt to light, no flame was detected
A02	FLAME FAILURE	Flame Failure	During run, the flame was lost
A03	HIGH LIMIT	High Limit	The temperature in the boiler exceeded the setting on the High Limit Control
A05	INT ERR GAS VLV RLY	Internal Error Gas Valve Relay	Call for service.
A06	INT ERR SAFETY RLY	Internal Error Safety Relay	Call for service.
A07	LOW FLOW / ILK	Low Water Flow or Open Interlock Jumper (ILK)	Water Flow is Inadequate or Interlock Jumper (ILK) is Open
A09	INTERNAL ERROR 9 or 27 or 28 or 29 or 30	Internal Error 9 or 27 or 28 or 29 or 30	Call for service.
A10	INT ERR E2PROM ERR	Internal Error E2PROM Err	Call for service.
A12	INT ERR E2PROM SIG	Internal Error E2PROM Sig	Call for service.
A13	INTERNAL ERROR 13	Internal Error 13	Call for service.
A14	INTERNAL ERROR 14	Internal Error 14	Call for service.
A15	INTERNAL ERROR 16	Internal Error 16	Call for service.
A16	INTERNAL ERROR 22	Internal Error 22	Call for service.
A18	INTERNAL ERROR 19	Internal Error 19	Call for service.
A19	LATE FLAME	Late Flame	Flame still present after boiler gas valve closed during post purge
A20	EARLY FLAME	Early Flame	Flame detected before boiler gas valve opened during pre purge
A30	HIGH GAS PRESSURE	High Gas Pressure Error	The gas pressure is too high and has tripped the HGPS
A31	LOW GAS PRESSURE	Low Gas Pressure Error	The gas pressure is too low and has tripped the LGPS
A32	INTERNAL ERROR 23	Internal Error 23	Call for service.
A33	FAN WRONG SPEED	Wrong Fan Speed Error	Fan deviation more than 300 rpm for > 1 sec (ignored when fan > 4200 rpm)
A34	AIR SWITCH NOT OPEN	Air Switch Not Open	Air switch does not open when fan is off
A35	AIR SWITCH NOT CLOSE	Air Switch Not Closed	Air switch does not close when fan is running
A37	UV SENSOR DEFECT	UV Sensor Defective	Self Check function of UV detector has indicated a failure
A38	MAX DT EXCEEDED	Max Delta Temp Exceeded	Maximum temperature differential across the boiler has been exceeded
A39	RAPID RISE INLET TMP	Rapid Rise Inlet Error	Inlet temperature is rising too rapidly
A40	RAPID RISE OUT TEMP	Rapid Rise Outlet Error	Outlet temperature is rising too rapidly
A41	RAPID RISE HX TEMP	Rapid Rise HX Temp	Temperature across heat exchanger is rising faster than allowed
A43	LOW WATER LEVEL	Low Water Cutoff	Water is too low for boiler to operate
A45	INTERNAL ERROR 31	Internal Error 31	Call for service.

**NOTICE!** When an Internal Error occurs, as identified above, the failure is internal to the ENVI™ boiler control and replacement of the ENVI™ control is required. A qualified service technician must replace the ENVI™ control.

**5.8 AUTO-RESET ERROR CODES – E##**

Code	ENVI Display	Lockout	Description
E01	OUT TEMP SENS OPEN	Outlet Temperature Sensor Open	Boiler outlet water temperature sensor open circuit
E02	IN TEMP SENS OPEN	Inlet Temperature Sensor Open	Boiler inlet water sensor temperature open circuit
E03	FLUE TMP SENS OPEN	Flue Temperature Sensor Open	Boiler flue gas temperature sensor open circuit
E04	DHW TEMP SENS OPEN	DHW Temperature Sensor Open	Domestic Hot Water temperature sensor open circuit
E05	HX TEMP SENS OPEN	Heat Exchanger Temperature Sensor Open	Heat Exchange temperature sensor open circuit
E11	OUT TEMP SENS SHORT	Outlet Temperature Sensor Short	Boiler outlet water temperature sensor short circuit
E12	IN TEMP SENS SHORT	Inlet Temperature Sensor Short	Boiler inlet water temperature sensor short circuit
E13	FLUE TMP SENS SHORT	Flue Temperature Sensor Short	Boiler flue gas temperature sensor short circuit
E14	DHW TEMP SENS SHORT	DHW Temperature Sensor Short	Domestic Hot Water temperature sensor short circuit
E15	HX TEMP SENS SHORT	Heat Exchanger Temperature Sensor Short	Heat Exchange temperature sensor short circuit
E16	HEADER SENS SHORT	Header Temperature Sensor is defective	Header temperature sensor on IF board has a short circuit or an open circuit
E18	LINE NEUTRAL REV	Electrical Error	Hot and Neutral are reversed
E20	FALSE FLAME	False Flame	Flame detected when no flame should be present
E21	LOW FLOW / ILK	Low Water Flow or Open Inter-lock Circuit	E21 converts to A07 after 5 minutes
E22	NO GROUND 60 HZ ERR	No Ground error	No ground connected or voltage on ground
E23	LINE FREQUENCY ERR	Line Frequency Error	Line frequency deviates from 60Hz by more than 2%
E24	FAULTY GROUND	Faulty Ground	Ground/Earth connection is not functioning correctly
E30	HIGH FLUE TEMP	Flue Gas Temperature Too High	Temperature of the flue gas is greater than setpoint + differential
E32	HIGH INLET TEMP	Inlet Temp Too High	Inlet water is greater than 194°F
E34	BLOCKED FLUE	Blocked Flue	Hi exhaust back pressure switch is tripped due to excess pressure in the flue/stack or excessive negative cabinet pressure
E41	REVERSE FLOW IN OUT	Reversed Water Flow	The water flow through the boiler is reversed (Inlet water is hotter than outlet water)
E42	INTERNAL ERROR 48	Internal Error 48	Call for service.
E46	INTERNAL ERROR 35	Internal Error 35	Call for service.
E47	INTERNAL ERROR 36	Internal Error 36	Call for service.
E48	INTERNAL ERROR 37	Internal Error 37	Call for service.
E49	RAPID RISE HX ERROR	Rapid Rise Heat Exchanger Temperature	Temperature across heat exchanger is rising faster than allowed
E50	RAPID RISE ERROR	Rapid Rise Outlet Temp	Temperature of the Outlet water is rising faster than allowed
E51	INTERNAL ERROR 67	Internal Error 67	Call for Service
E52	WRONG BOILER TYPE	Wrong Boiler Type	Control and Boiler do not match (control is programmed for another type of Harsco boiler)
E 54	IF COMM FAILURE	Interface Board Failure	No communication with Interface Board

## 6.0 PARTS/TECHNICAL SUPPORT

Spare and replacement parts can be ordered from your local representative or Harsco Industrial, Patterson-Kelley by calling (877) 728-5351. The fax number is (570)476-7247. Refer to the parts list shown on the assembly drawing provided with this manual. Factory direct replacement parts must be used to ensure that the boiler operates correctly. Technical information is also available at the above number or at the Harsco Industrial, Patterson-Kelley website [www.harscopk.com](http://www.harscopk.com). When ordering replacement parts please have the **model number** and **serial number** of your boiler available.

### **⚠ WARNING**

Use of non-factory-authorized replacement parts is not recommended for this equipment. All control components are engineered for safety and are designed to work in unison with each of the other components. Use of non-factory-authorized replacement parts would jeopardize the functionality of the safety features as well as the performance of the boiler.

## 6.1 SCHEMATIC DIAGRAMS

Typical schematic drawings are shown on the following pages. Drawings specific to your particular boiler can be supplied by your local Harsco Industrial, Patterson-Kelley representative.

### 6.1.1 Terminal Block Assignments - High Voltage Circuit (HV)

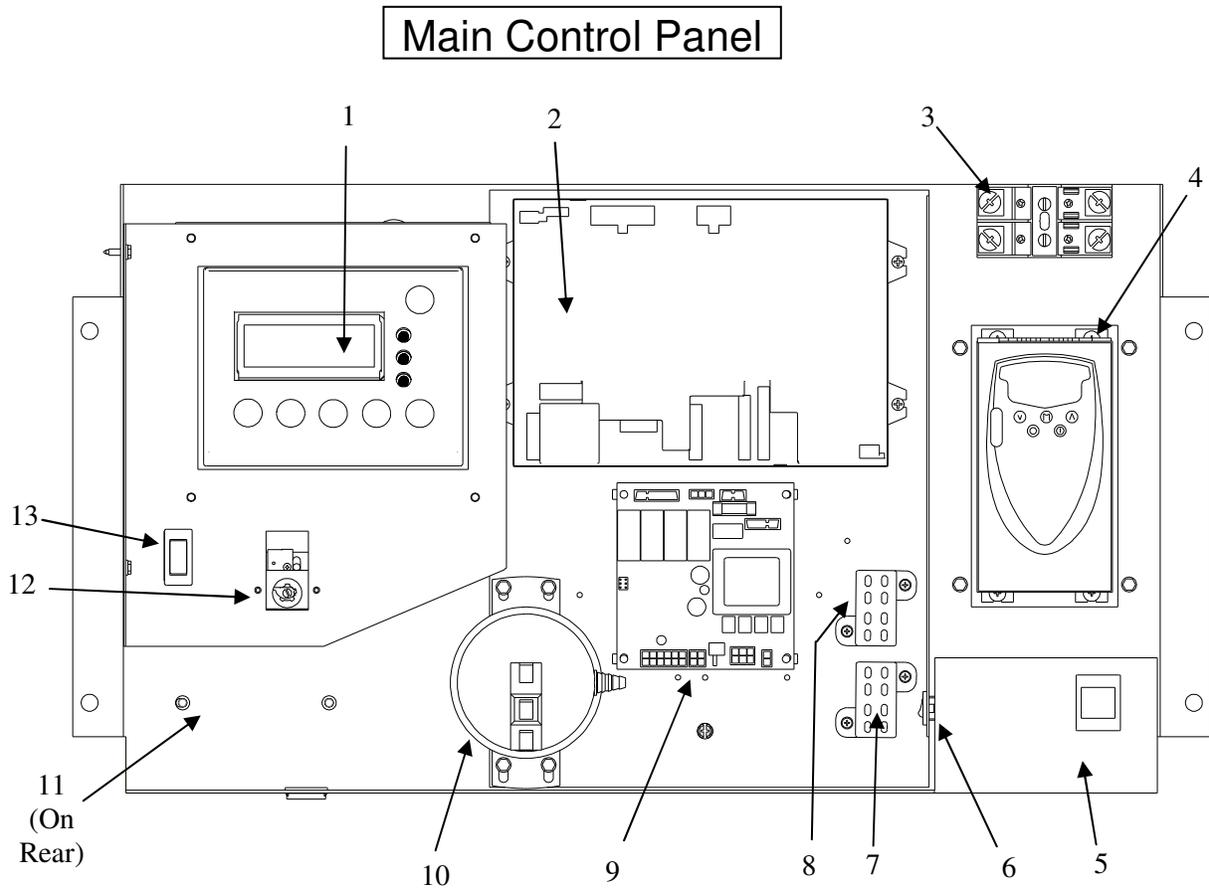
Terminal Number	Label	Description
1	L1 208-240 V	Boiler Supply Power L1, 230 VAC, 1 ph , 60 Hz
2	L2 208-240 V	Boiler Supply Power L2, 230 VAC, 1 ph , 60 Hz
3	N 208-240 V	Boiler Supply Neutral, 0 VAC
4	120 VAC Switched Output	Neutral Line for HV-12, Switched Output
5	120 VAC Switched Output	Neutral Line for HV-13, Switched Output
6	3 Way Valve	Neutral Line for HV-14, 3 Way Valve
7	DHW Pump Relay	Neutral Line for HV-15, DHW Pump Relay
8	Circ Pump Relay	Neutral Line for HV-16, Circ Pump Relay
9	Damper Relay	Neutral Line for HV-17, Damper Relay
10	GROUND	Boiler Supply Ground, 0 VAC
11	GROUND	Boiler Supply Ground, 0 VAC
12	120VAC Switched Output	120VAC Output when boiler power is switched ON (pilot duty only)
13	120VAC Switched Output	120VAC Output when boiler power is switched ON (pilot duty only)
14	3 Way Valve	120 VAC output during CH Mode, 3 way valve is normally close (not powered) for DHW mode, and powered open for CH mode.
15	DHW Pump Relay	120 VAC Output when boiler is in DHW mode (pilot duty only)
16	Circ Pump Relay	120 VAC Output when boiler is in CH mode (pilot duty only)
17	Damper Relay	120 VAC Output when boiler is enabled (pilot duty only)
18	Master Alarm Relay	Contacts close when boiler is in alarm state (120/24 VAC at 1 amp max)
19		
20		
21	Flame Detected Relay	Contacts close when boiler is firing (120/24 VAC at 1 amp max)

**6.1.2 Terminal Block Assignments – Low Voltage Circuit (LV)**

Terminal Number	Label	Description
1	Enable / Disable	Boiler Enable, Contact Closure.
2		<b>DO NOT ENERGIZE.</b>
3	Auxiliary Low Water Cutoff	External Limit, Contact Closure.
4		<b>DO NOT ENERGIZE.</b>
5	Start Interlock	External Limit, Contact Closure.
6		<b>DO NOT ENERGIZE.</b>
7	Outdoor Temp Sensor	Outdoor Temperature Sensor Circuit
8		
9	DHW Stat or Sensor	Domestic Hot Water Thermostat (contact closure) or Temperature Sensor
10		
11	Header Temp Sensor	Header Temperature Sensor
12		
13	DHW Flow Switch	Domestic Hot Water flow switch (contact closure)
14		
15	0-10V Analog Input	0-10VDC Remote Control Input
16	0V Analog Input	0VDC Remote Control Common
17	For Future Use	Not Used
18	For Future Use	Not Used
19	MODBUS® COM 1A	MODBUS® connection to boiler
20	MODBUS® COM 1B	
21	CASCADE A TO A	Cascade connection between boilers
22	CASCADE B TO B	



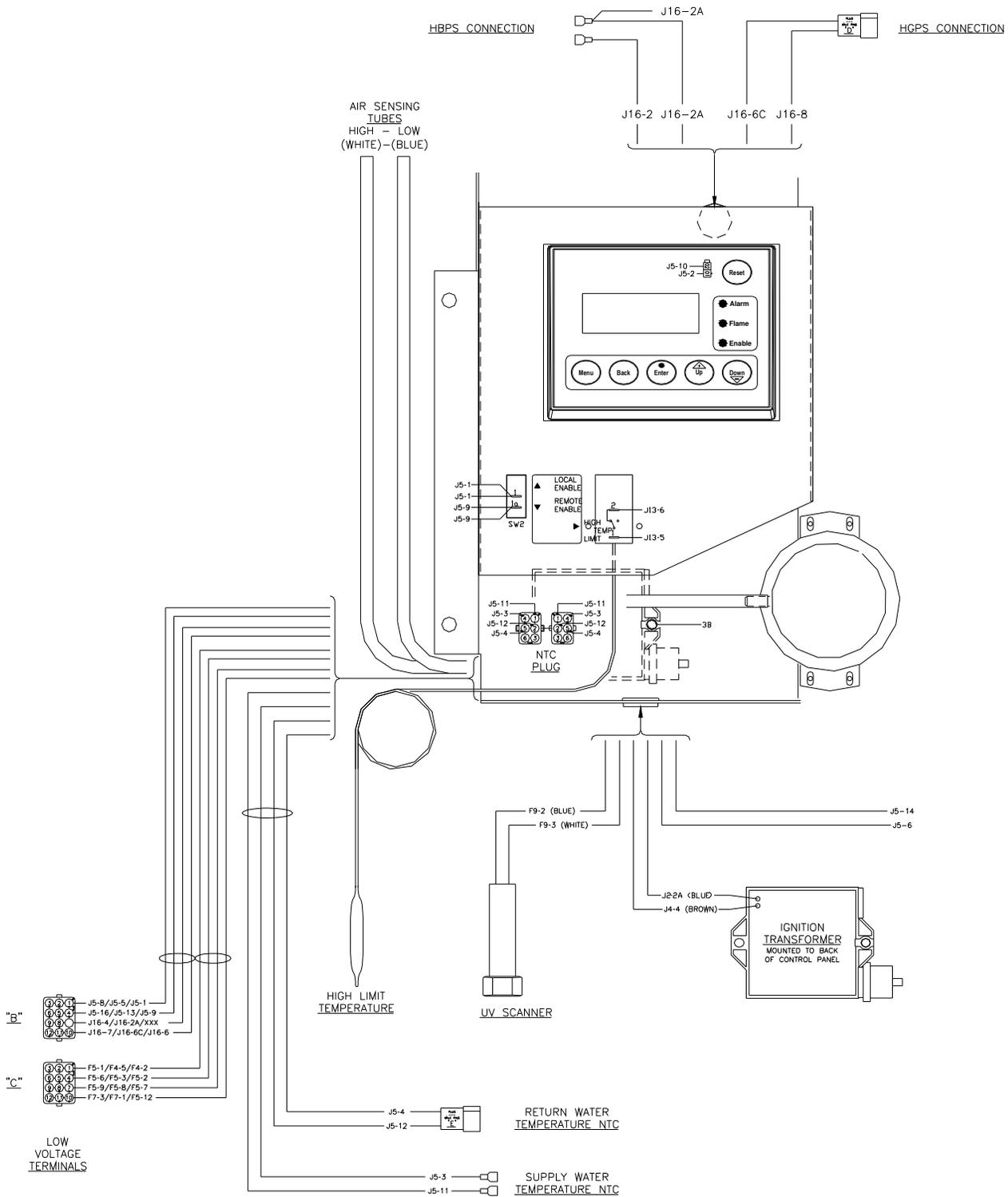
**6.1.4 Main Control Panel Components**



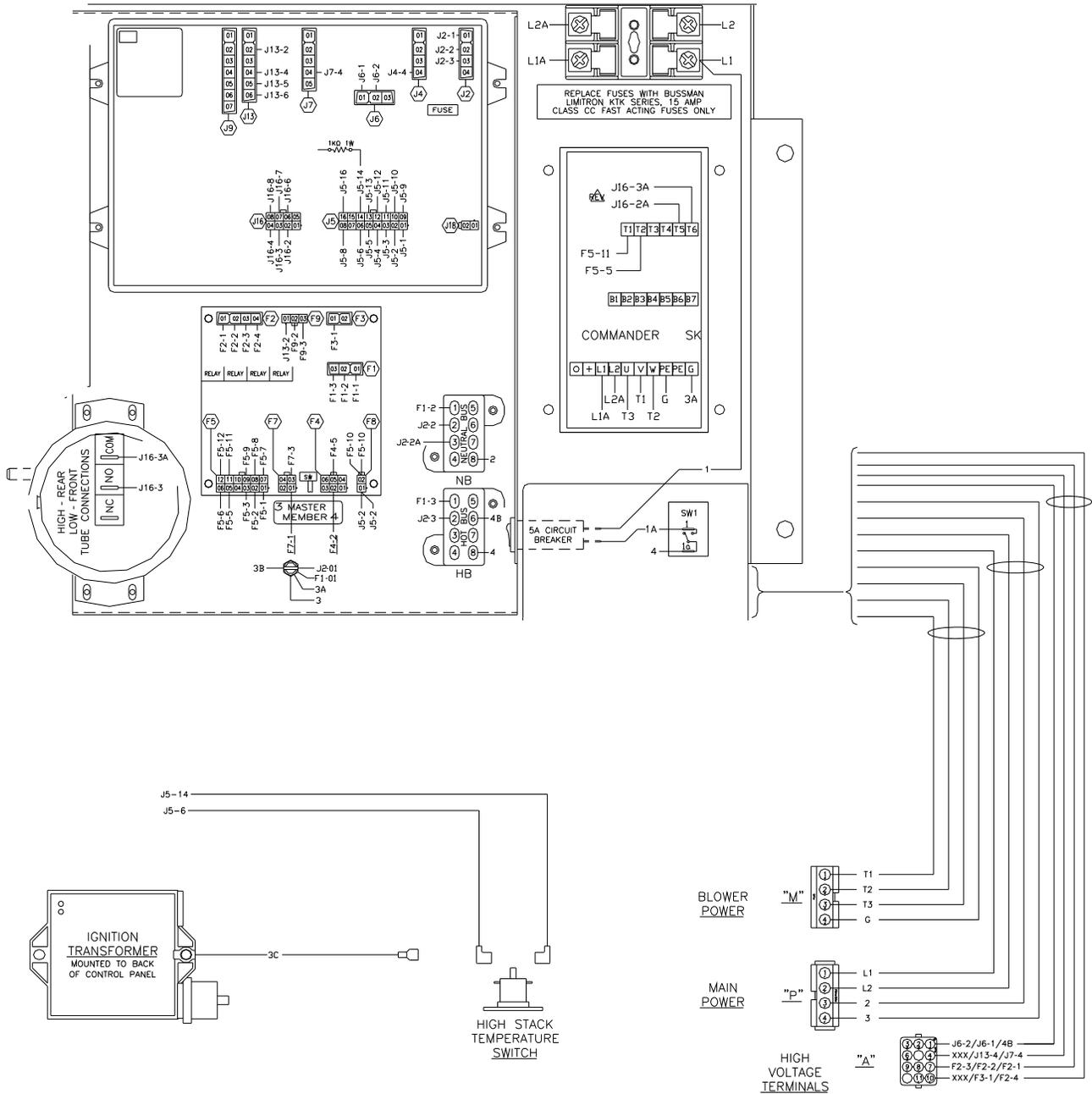
Mark	Description
1	ENVI™ Display Panel
2	ENVI™ Main Board
3	Inverter Fuses
4	Blower/Inverter Control
5	On/Off Switch
6	Circuit Breaker
7	Hot 120V Terminal Block

Mark	Description
8	Neutral Terminal Block
9	ENVI™ Interface Board
10	Air Switch
11	Ignition Transformer
12	High Water Temp Limit
13	Remote/Local Enable

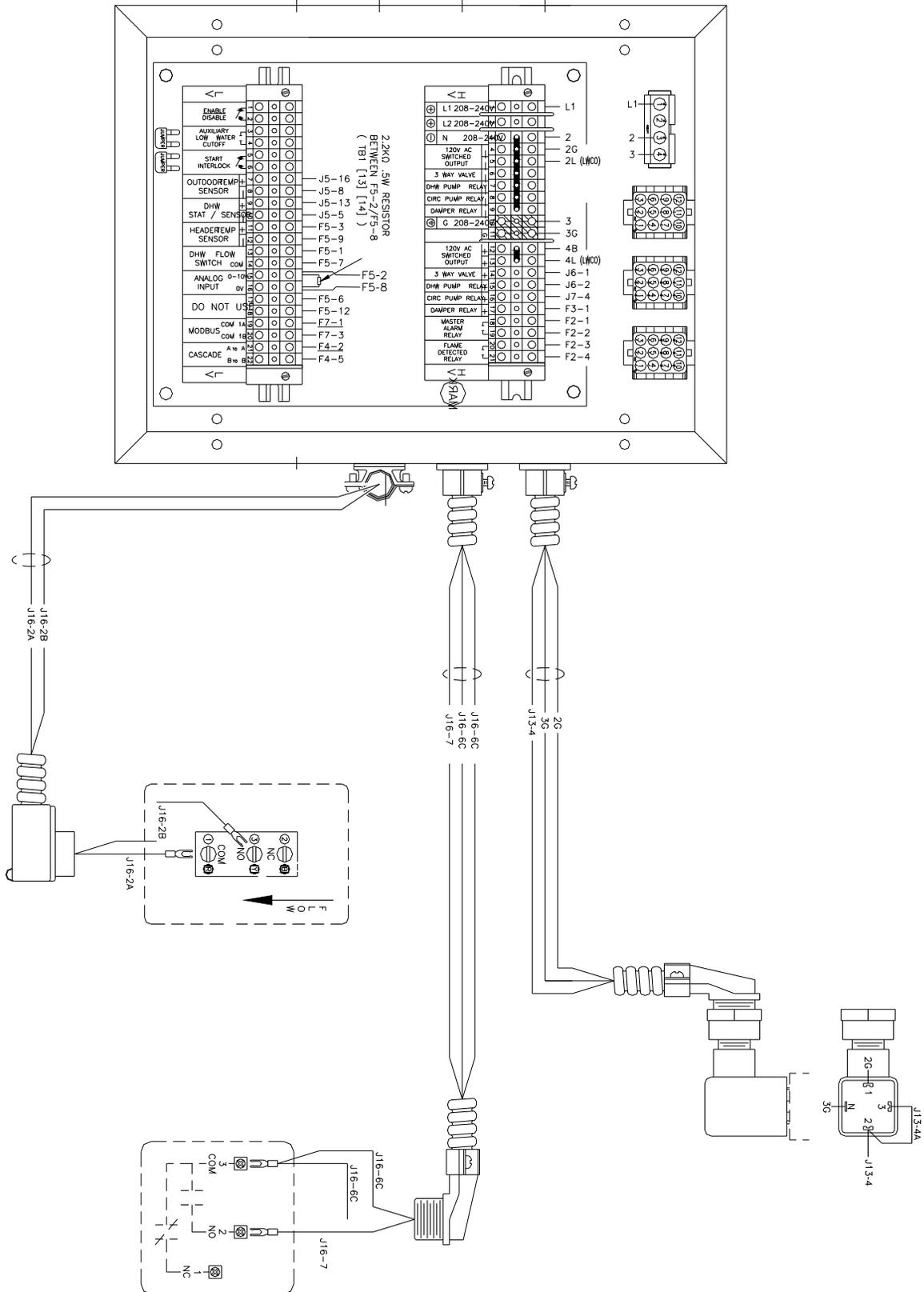
**6.1.5 Main Control Panel Point to Point Left Side**



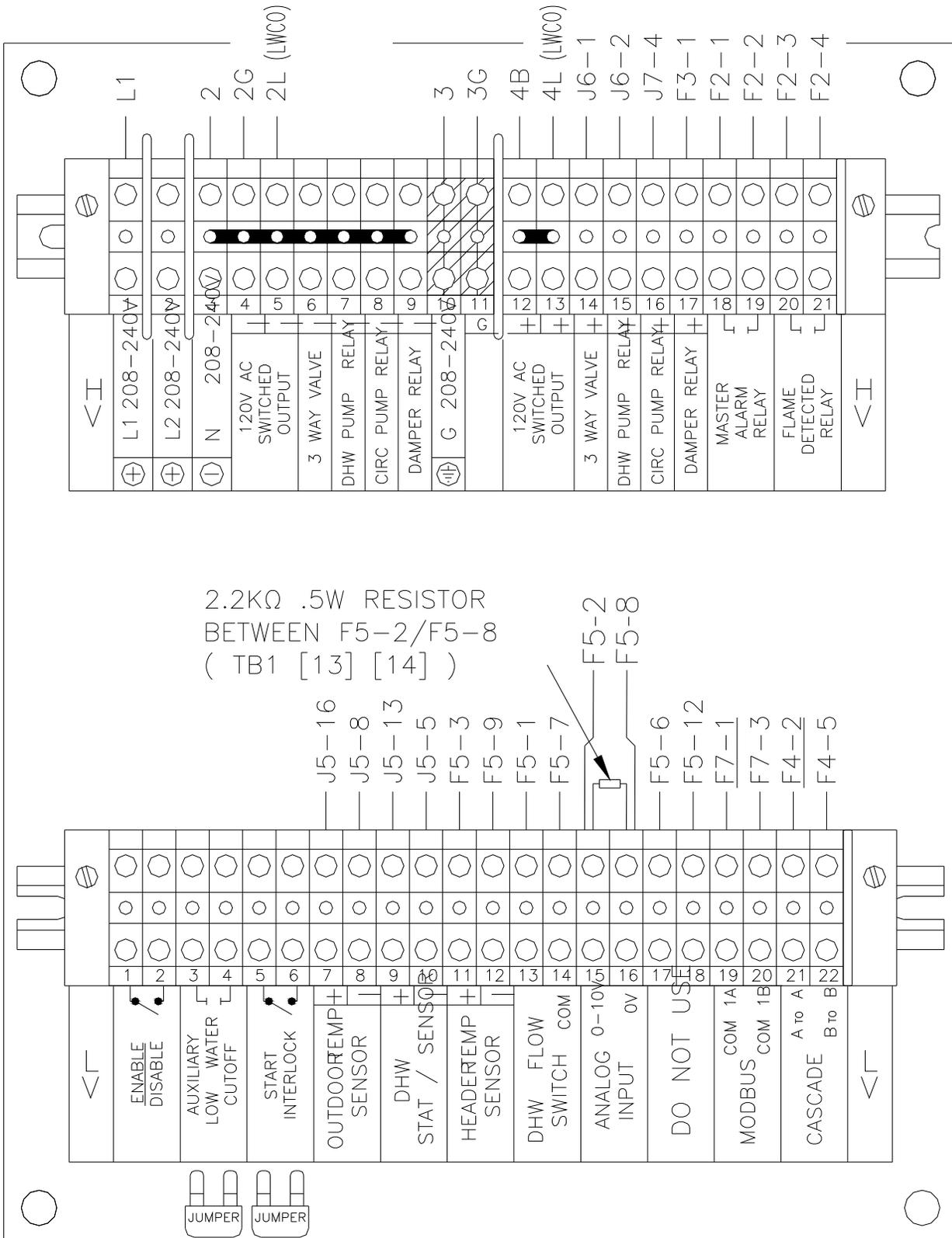
**6.1.6 Main Control Panel Point to Point Right Side**



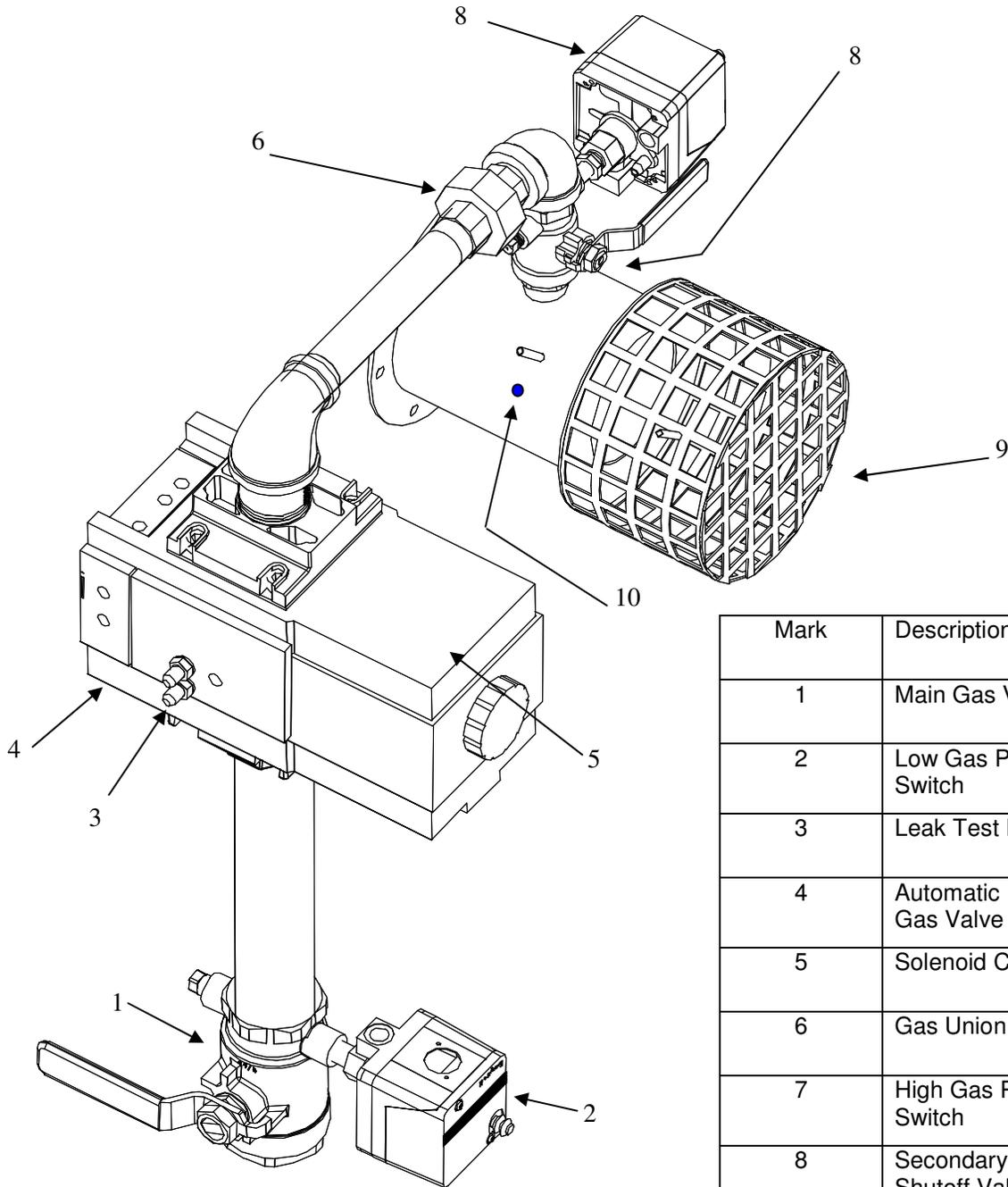
**6.1.7 Junction Box Point to Point and Customer Connections**



**6.1.8 Customer Connections Details**

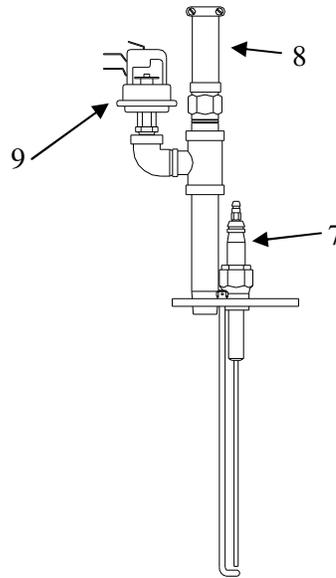
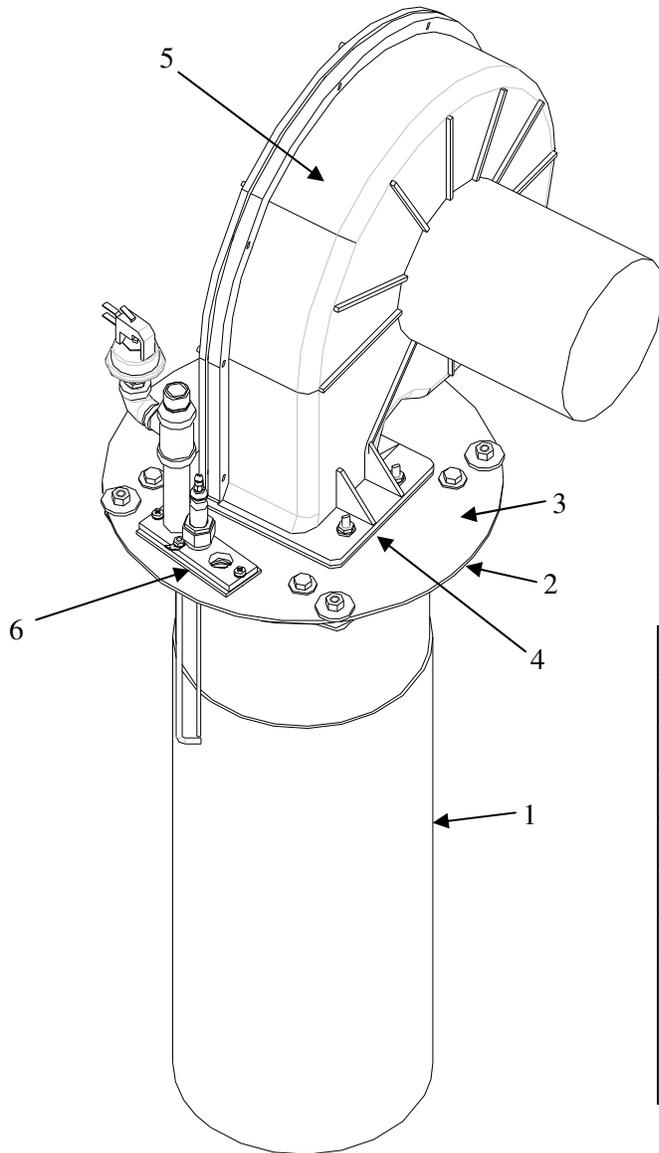


**6.1.9 Gas Train**



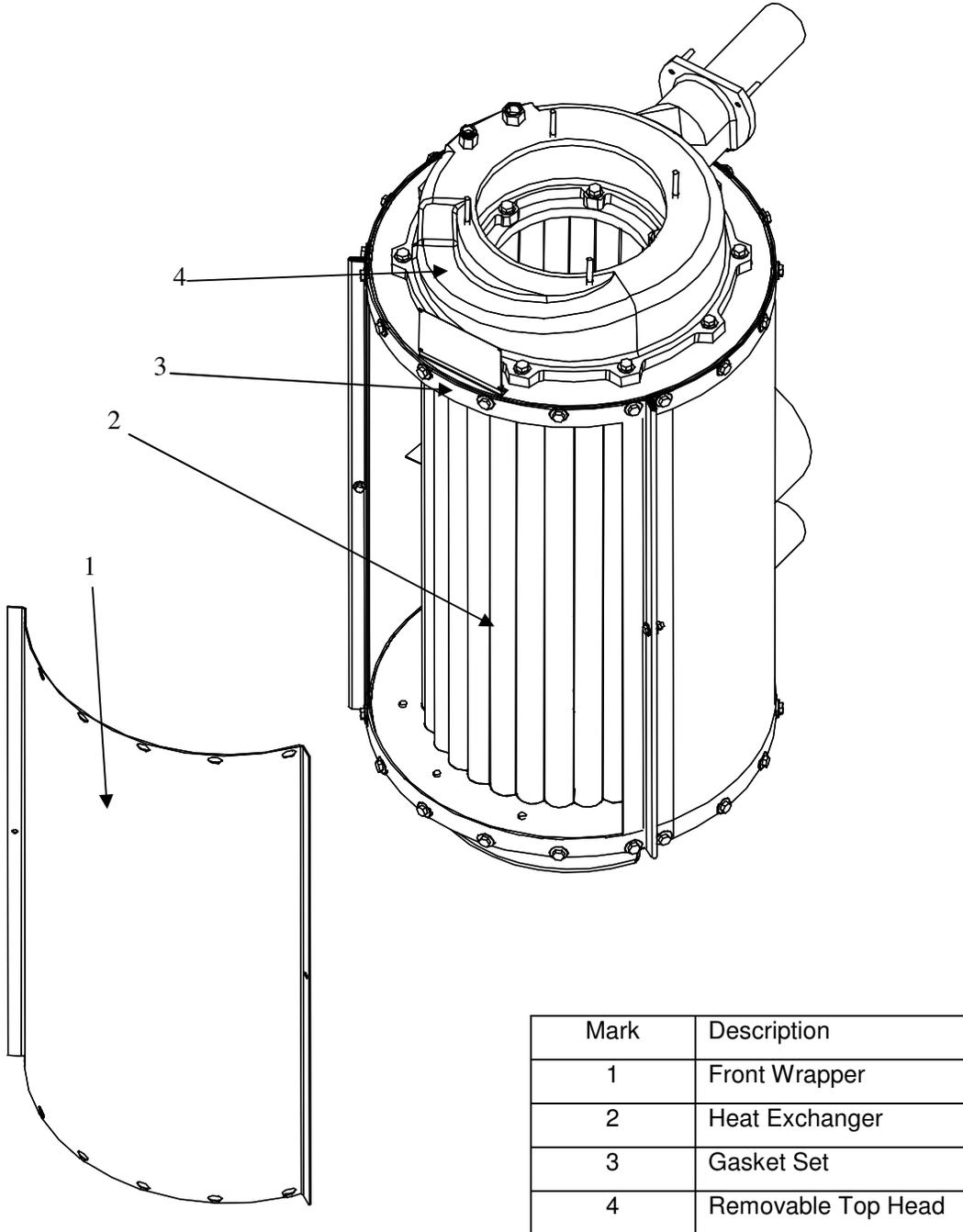
Mark	Description
1	Main Gas Valve
2	Low Gas Pressure Switch
3	Leak Test Ports
4	Automatic Dual Gas Valve
5	Solenoid Coils
6	Gas Union
7	High Gas Pressure Switch
8	Secondary Gas Shutoff Valve
9	Air Gas Mixer Head
10	Blue Dot (attach Blue Hose Here)

**6.1.10 Blower/Burner/Ignition Assembly**



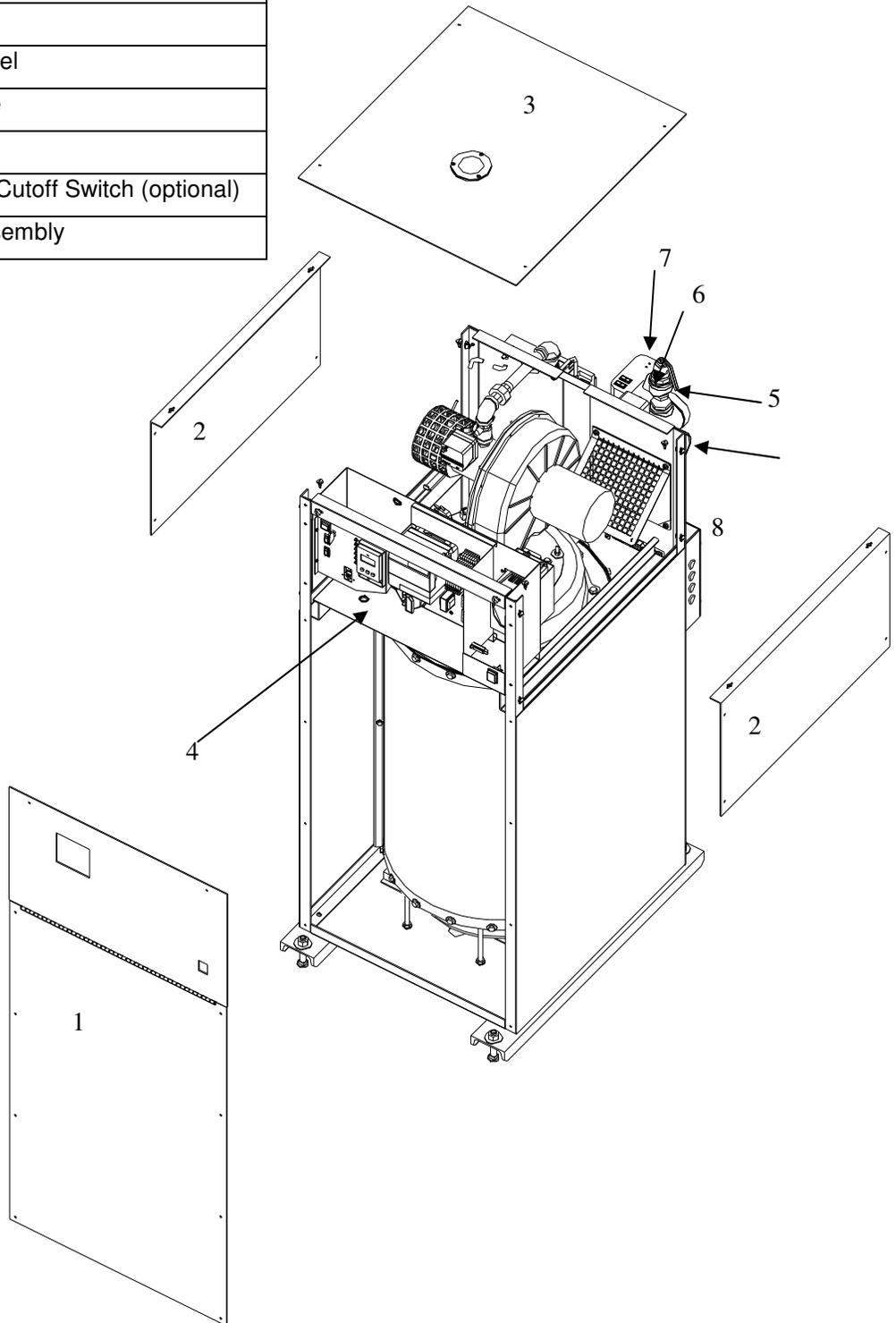
Mark	Description
1	Burner Grid
2	Burner Gasket
3	Mounting Plate
4	Blower Gasket
5	Blower w/Motor
6	Ignition Gasket
7	Ignition Electrode
8	UV Scanner
9	Backpressure Switch

**6.1.11 Heat Exchanger and Combustion Chamber**



**6.1.12 Cabinet Assembly**

Mark	Description
1	Front Door
2	Side Covers
3	Top Cover
4	Control Panel
5	Relief Valve
6	Flow Switch
7	Low Water Cutoff Switch (optional)
8	Air Inlet Assembly



## **7.0 LIMITED WARRANTY**

Subject to the terms and conditions herein, Harsco Industrial, Patterson-Kelley, Seller warrants to the original owner at the original installation site that products manufactured by Seller will be free from defects in materials and workmanship for a period of one (1) years from date of start up (the "Warranty Period"), provided that startup is completed within six months from the date of shipment. The heat exchanger and burner will be warranted for a period of five (5) years from the date of shipment (the "Warranty Period").

### **REMEDY**

The sole remedy of this warranty is expressly limited to the repair or replacement of any part found to be defective under conditions of normal use within the Warranty Period. Installation is not included.

### **WARRANTY**

The owner must notify the original installer of the Product and Seller (Attention: Harsco Industrial, Patterson-Kelley, 100 Burson Street, East Stroudsburg, PA 18301), in writing, within the Warranty Period, providing a detailed description of all claimed defects. Transportation to the factory or other designated facility for repairs of any products or items alleged defective shall, in all events, be the responsibility and at the cost of the owner.

### **EXCLUSIONS**

Seller shall have no liability for and this warranty does not cover:

- A. Incidental, special or consequential damages, such as loss of the use of products, facilities or production, inconvenience, loss of time or labor expense involved in repairing or replacing the alleged defective Product.
- B. The performance of any Product under conditions varying materially from those under which such Product is usually tested under industry standards at of the time of shipment.
- C. Any damage to the Product due to abrasion, erosion, corrosion, deterioration, abnormal temperatures or the influence of foreign matter or energy.
- D. The design or operation of owner's plant or equipment or of any facility or system of which any Product may be made a part.
- E. The suitability of any Product for any particular application.
- F. Any failure resulting from misuse, modification not authorized by Seller in writing, improper installation or lack of or improper maintenance.
- G. Equipment furnished by the owner, either mounted or unmounted, or when contracted for by the owner to be installed or handled.
- H. Leakage or other malfunction caused by:
  1. Defective installations in general and specifically, any installation which is made:
    - a. in violation of applicable state or local plumbing housing or building codes,
    - b. contrary to the written instructions furnished with the unit
  2. Adverse local conditions in general and, specifically, sediment or lime precipitation in the tubes and/or headers or corrosive elements in the atmosphere.
  3. Misuse in general and, specifically, operation and maintenance contrary to the written instructions furnished with the unit, disconnection, alteration or addition of components or apparatus, not approved by Seller, operation with fuels or settings other than those set forth on the rating plate or accidental or exterior damage.
- I. Production of noise, odors, discoloration or rusty water.
- J. Damage to surrounding area or property caused by leakage or malfunction.
- K. Costs associated with the replacement and/or repair of the unit including: any freight, shipping or delivery charges, any removal, installation or reinstallation charges, any material and/or permits required for installation, reinstallation or repair, charges to return the boiler and or components. Seller's liability under this warranty shall not in any case exceed the amount paid for the Product found to be defective.

### **THIRD PARTY WARRANTIES**

For goods or components not manufactured by Seller, the warranty obligations of Seller shall, in all respects, conform and be limited to one (1) year from the date of shipment.

### **SEVERABILITY**

To the extent that any provision of this warranty would be void or prohibited under applicable law, such provisions shall be limited in effect to the minimum extent necessary to render the remaining provisions hereof enforceable.

### **NO OTHER WARRANTIES**

Seller makes no implied warranty of merchantability or fitness for a particular purpose or other warranties with respect to any products or services except as expressly set forth in this limited warranty.

**8.0 MODU-FIRE® FORCED DRAFT BOILER FIRE TEST REPORT**



**MODU-FIRE® FORCED DRAFT BOILER  
START-UP REPORT**

Boiler Serial #: \_\_\_\_\_ Model#: \_\_\_\_\_ Date: \_\_\_\_\_

Installation Name: \_\_\_\_\_ Address: \_\_\_\_\_ City: \_\_\_\_\_

State: \_\_\_\_\_ Zip: \_\_\_\_\_ Contact: \_\_\_\_\_ Phone: \_\_\_\_\_

Installer Name: \_\_\_\_\_ Type of Installation: \_\_\_\_\_

1. Factory Fire-Test: (copy from boiler label)		
	High	Low
Inlet Gas	_____ "w.c.	_____ "w.c.
Oxygen (O2)	_____ %	_____ %
Carbon Dioxide (CO2)	_____ %	_____ %
Carbon Monoxide (CO)	_____ ppm	_____ ppm
Stack Temperature	_____ °F	_____ °F
Main Flame Signal	_____ Yes/No	_____ Yes/No
Inlet Air Temperature	_____ °F	_____ °F

2. Sealed Combustion: \_\_\_\_\_ YES or NO

2a. Combustion Air Temperature: \_\_\_\_\_ °F

2b. Approximate Elevation: \_\_\_\_\_ Ft.

3. Water Inlet Temperature: \_\_\_\_\_ °F

4. Water Outlet Temperature: \_\_\_\_\_ °F

5. Water Flow: \_\_\_\_\_ gpm

5a. Glycol ? \_\_\_\_\_ YES or NO

6. Operating Temperature Setpoint: \_\_\_\_\_ °F  
(from internal OR external control)

7. Gas Valve a. Low Fire Setting (N) \_\_\_\_\_  
b. High Fire Setting (V) \_\_\_\_\_

8. Approximate Stack Lengths:  
\_\_\_\_\_ Ft. Horizontal  
\_\_\_\_\_ Ft. Vertical  
\_\_\_\_\_ Flue Pipe Diameter

Start-Up Field Test: DATE: _____		
	High	Low
Inlet Gas	_____ "w.c.	_____ "w.c.
Oxygen (O2)	_____ %	_____ %
Carbon Dioxide (CO2)	_____ %	_____ %
Carbon Monoxide (CO)	_____ ppm	_____ ppm
Stack Temperature (net)	_____ °F	_____ °F
Main Flame Signal	_____ Yes/No	_____ Yes/No
Inlet Air Temperature	_____ °F	_____ °F

9. Stack Pressure (measured where stack exits boiler):  
\_\_\_\_\_ "w.c. (High)  
\_\_\_\_\_ "w.c. (Low)

10. Electrical Supply Power: L1 to L2 \_\_\_\_\_ Volts  
L1 to N \_\_\_\_\_ Volts  
Less than 1 volt between neutral and ground: YES or NO

11. Total Cycles: \_\_\_\_\_

12. Total Hours: \_\_\_\_\_

13. Any Faults? Describe with \_\_\_\_\_  
code, time and description: \_\_\_\_\_

14. Condensate drain from boiler connected to stack drain with Stainless Steel or High-Temp (500 °F) Silicon piping or tubing, and then trapped YES or NO

Performed by: \_\_\_\_\_

Additional Comments: \_\_\_\_\_

\_\_\_\_\_