



**PATTERSON-KELLEY**

**THERMIFIC®**

**MODU-FIRE® GAS-FIRED BOILER**

Installation and Owner's Manual



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



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Complies with ANSI Z21.13/CSA 4.9  
Gas-Fired Low Pressure Steam and Hot Water Boilers

Installation Date: \_\_\_\_\_



**Patterson-Kelley**

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**WARNING!**

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 fire or explosion and serious injury, death, and/or property damage.

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.

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

**WARNING!**

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

**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 P-K MODU-FIRE® Gas Fired Boiler is a revolutionary advance; Patterson-Kelley now combines full-modulation burner control with our time-tested modular hot water boiler design. The result is “modular full-modulation”- Modu-Fire! This new hybrid boiler combines the best of our earlier designs with a new generation of burner and control technology. You will achieve even higher part-load efficiencies – but without the complexity you might expect in this type of high performance boiler. High performance made simple and dependable for years of trouble-free operation.

This manual covers installation of the P-K MODU-FIRE® Boiler Series 1000, 1500, and 2000. The model numbers may be followed by a prefix or suffix letter in some cases 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 plate 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. 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® gas-fired boiler **must** be:

- Installed in accordance with designs prepared by qualified facility 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 qualified, factory-trained personnel in accordance with all applicable codes, laws, and regulations.
- The use of the term “factory-trained personnel” throughout this manual indicates Patterson-Kelley trained on this specific piece of equipment.

### 2.2 TRAINING



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.

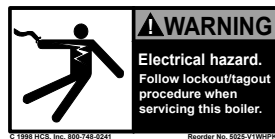
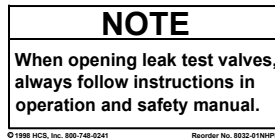
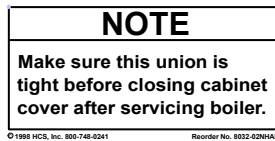
Proper training is the best protection against accidents. Operating and service personnel must be thoroughly familiar with the basic construction of the MODU-FIRE® boiler, the use and locations of the controls, the operation of the boiler, adjustment of its various mechanisms, and all applicable safety precautions. If any of the provisions of this manual are not fully and completely understood, contact the Patterson-Kelley Sales Department.

### 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 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 Patterson-Kelley for replacement labels.

## 2.5 SAFETY PRECAUTIONS

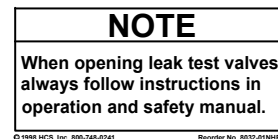
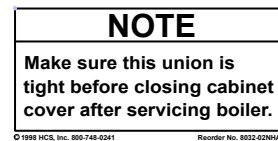
Provide a suitable location for the boiler, away from normal personnel traffic, with adequate working space, adequate clearances, proper ventilation and lighting, with a structure sufficiently strong and rigid to support the weight of the boiler, all piping, and accessories.

### 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.

### 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 CAN/CGA B.149. Install all required ventlines for gas devices. Refer to Section 3.7.2.
- 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 gas vent during firing operation. Use only factory recommended vent components.
- Burn hazard! Hot fluids. Use caution when servicing or draining boiler.
- Fire and explosion hazards! Use caution when servicing burner. Propane (LPG) is heavier than air and 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. These connections cannot be tested after the burner is assembled.
- 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 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 regulator.
- Overfire hazard! Possible fire and explosion. Possible malfunction of regulators and/or motorized 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 below:

Boiler Size	Weight in Pounds
1,000,000 Btu	595
1,500,000 Btu	990
2,000,000 Btu	1,025

- Bump hazard from overhead piping. Install piping with adequate vertical clearance.

### 2.5.4 Chemical Hazards



General Warning

- Environmental hazard! The motorized gas valves may contain hydraulic oil. Use safe procedures for the disposal of all lubricants.
- 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



- 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. Annually test safety relief valve for proper operation. Do not operate boiler with faulty relief valve.

### 2.5.6 Slip, Fall 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! **Do not** locate intake or exhaust terminations directly above a walkway; dripping of condensation can cause icing of the walking surface.



## 3.0 INSTALLATION

### 3.1 RECEIVING AND STORAGE

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#### 3.1.1 Initial Inspection

Upon receiving the boiler, inspect it for signs of shipping damage. Pay particular attention to the control panel on the top of the boiler and the components mounted on the back, which may show damage from mishandling.

The exterior cabinet must be reasonably air-tight for the burner to operate correctly. Leaks caused by dents in the sheet metal or panels out of position may cause the limit controls to show Low Air. Check to be sure that the mixer core in the top burner is centered and has not moved in shipment; (see Section 5.2, "Cleaning the Burner" for proper location). Verify that the total number of pieces shown on the packing slip agrees with those actually received.

**Important:** Note any damage or shortage on the freight bill and immediately notify the carrier. File all claims for shortage or damage with the carrier.

#### 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, 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.

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

### 3.2 COMPLIANCE WITH CODES

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The P-K MODU-FIRE® Boiler with standard components and many options complies with American National Standard/CSA Standard ANSI Z21.13/CSA 4.9, latest edition, Gas-Fired Low Pressure Steam and Hot Water Boilers. 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. Other codes or approvals which apply will be labeled on the boiler.

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, CAN/CGA-B.149, 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, and (c) piping of condensate shall conform with the State Plumbing Code.

### 3.3 SETUP

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#### 3.3.1 Foundation

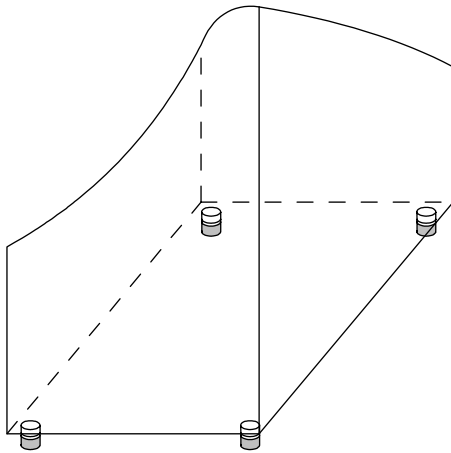
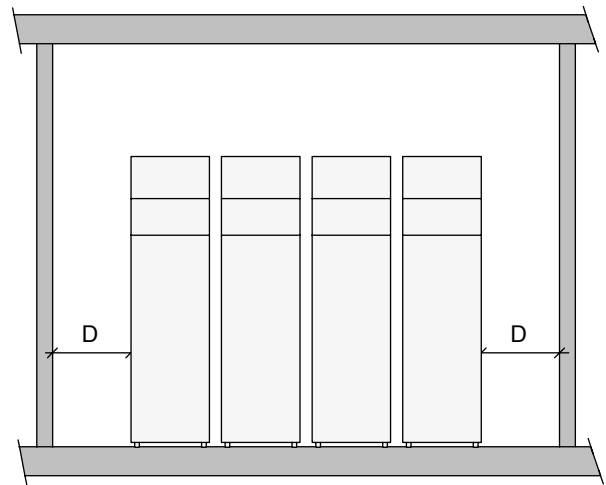
Provide a firm, level foundation, preferably of concrete.

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

#### 3.3.2 Placement

The boiler must be level to function properly. To assist in leveling the boiler, the four (4) leg bolts (1/2"-NC) holding the boiler to the shipping skid must be reinstalled in the threaded legs on the bottom. The adjustable legs are also necessary to provide adequate floor clearance and prevent distortion on the cabinet, (twisting, etc.) in addition to leveling.



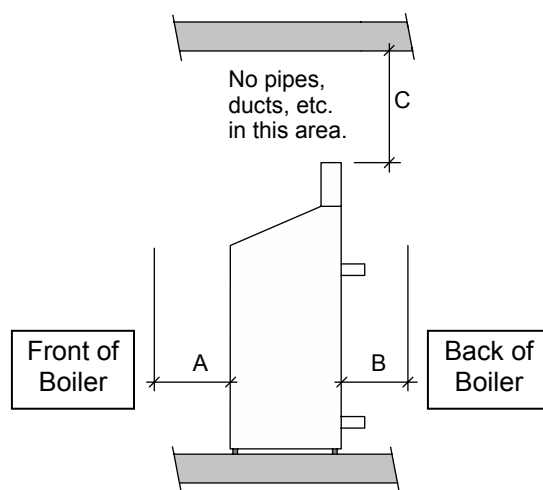
**Adjustable Legs for Leveling and Floor Clearance****Minimum Clearances from Adjacent Walls, Ceiling, and Obstructions**

### 3.3.3 Clearances

If the boiler is to be installed near combustible surfaces, the minimum clearances shown in the table below 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 Section 6.3 of the National Fuel Gas Code, ANSI Z223.1, latest edition.



Type of Surface	Dimensions (inches)			
	A	B	C†	D
Combustible Surfaces	30	24	30	24
Non-combustible Surfaces	30	24*	30	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 stacking 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, P-K recommends this clearance between **each boiler** when there is insufficient access at the rear to allow for service and adjustment.

**In Canada:** The boilers are approved for installation with zero clearance to combustible surfaces, but 24 inch service clearances are recommended.

### 3.4 ELECTRICAL CONNECTIONS

All field wiring connections for power and control are in the rear service panel on the back of the boiler. Low voltage and high voltage terminal strips are indicated on the wiring diagram. The boiler power circuit



is wired for 120 volts, single phase, 60 hertz. The total operating amperage is indicated on the rating nameplate. The 1000 series require less than 9 amps; the 1500 and 2000 series less than 12 amps. Before starting the boiler, check to ensure that the proper voltage and amperage are connected to 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.

**Note:** A dedicated earth ground (green wire) is required to avoid nuisance shutdowns. Do not ground through the conduit. It is also important that proper polarity be maintained.

### 3.5 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.

Provisions for combustion and ventilation air must be in accordance with Section 5.3, Air for Combustion and Ventilation, of the National Fuel Gas Code, ANSI Z223.1, latest edition, or applicable provisions of the local building codes. In Canada, combustion air openings shall comply with CSA 4.9. The formula is "1 sq. in. per 1,000 Btu/hr of gas input not less than 100 sq. in." The location shall be "neither more than 18," nor less than 6" above the floor level."

The boiler room shall be provided with two openings to ensure adequate combustion air and proper ventilation. One opening should be 6 to 12 inches above the floor and the other 6 to 12 inches below the ceiling, preferably on opposite walls. The size of each opening is determined by whether air is taken from inside or outside the building. In Canada, ventilation air openings shall be at least 10% of the cross sectional area required for combustion air, but not less than 10 square inches. It is to be located at the highest practical point communicating with outdoors.

If air is taken directly from outside the building, each opening should have a net free area of 1 square inch for each 4,000 Btu per hour of total boiler input. For instance, 300 square inches (2-1/12 square feet) are required for 1,200,000 Btu per hour input.

When air is taken from the outdoors through a vertical duct, 1 square inch per 4,000 Btu per hour is required. If a horizontal duct is used, 1 square inch per 2,000 Btu per hour is required, i.e., 600 square inches for 1,200,000 Btu per hour input.

If air is taken from another interior space, each opening should have a net free area of 1 square inch for each 1,000 Btu per hour of boiler input (1,200 square inches for a 1,200,000 Btu per hour.)

#### **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.

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, trichlorethylene, perchlorethylene, chlorine, etc. These chemicals, when burned, form acids which quickly attack the boiler tubes, tube sheets, flue collectors and the boiler stack. The result is improper combustion and premature boiler failure.

### 3.6 FLUE VENTING

This boiler requires a special vent system. Vent installations shall be in accordance with Part 7, Venting of Equipment, of the National Fuel Gas Code, ANSI Z223.1, CSA B149 code or applicable provisions of the local building codes.

This boiler is Category II as it is defined in ANSI Z21.13/CSA 4.9 latest edition. The vent material must be listed Category II Vent pipe (316L or AL-29 4C Stainless). Under **no circumstances** shall a Category I material (e.g. B-vent) be used.

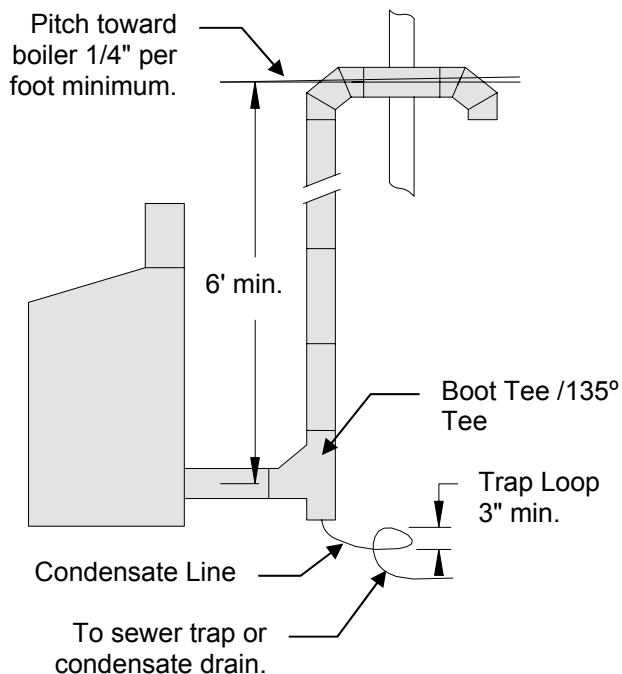
**WARNING!**

This boiler should not be installed with an automatic damper on the flue. Damper failure could create an explosion hazard.

In Canada, the boiler is certified for installation with a "Power Venter" by the Canadian Gas Association when installed with the "listed accessories." Consult your local distributor for information on proper selection.

The venting system and the horizontal portions of the venting system shall be supported to prevent sagging.

Consult your local vent supplier for correct vent sizing and structural support requirements. Vent diameter is dictated by the length and height of horizontal and vertical portions of the vent installation and the materials of construction. It is not necessarily the same size as the boiler connection. Correct sizing should be based on High fire input at a nominal  $-.04''$  w.c. draft pressure at the boiler outlet with a gross stack temp of  $325^{\circ}\text{F}$  and  $\text{CO}_2$  ratings at 7.5%.

**3.6.1 Vent Elbows**

The first turn from horizontal to vertical should be made with a  $135^{\circ}$  boot tee. A tee cover with a condensate drain shall be provided at the bottom of the boot

tee. The condensate drain must be routed to a sewer drain trap or pump in accordance with local codes. Refer to diagram under Vent Elbows.

**3.6.2 Barometric Damper**

This boiler is certified for operation without a barometric damper. P-K does not recommend the use of one.

**3.6.3 Automatic Vent Damper****WARNING!**

This equipment, as manufactured, **MUST NOT** be used with an automatic vent damper.

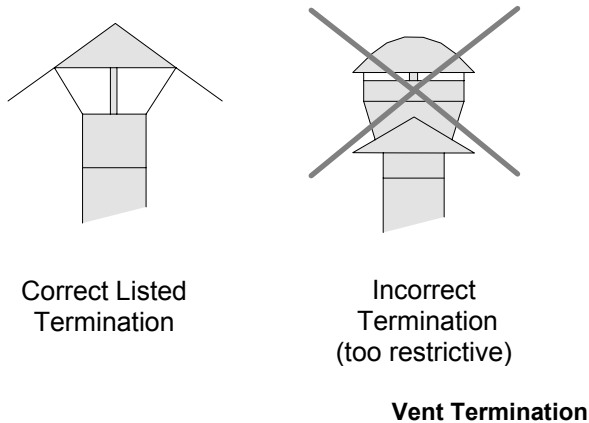
**3.6.4 Flue Connection**

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. This boiler should not be connected into any portion of a mechanical draft system operating under positive pressure. Provisions must be made for supports to prevent contact of the vent with combustible surfaces.

**Note:** 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. Structural support and spacing from combustible surfaces must be in accordance with the vent manufacturer's requirements.

**3.6.5 Vent Termination**

The minimum vent height above the flue outlet must be five (5) feet and the vent should extend at least three (3) feet above the roof / snowline, or at least two (2) feet above the highest part of any structure within ten (10) feet of the vent.



The vent must be provided with a weather cap of approved design and adequate capacity.

### 3.6.6 Removing an Existing Boiler (from a common venting system)

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.

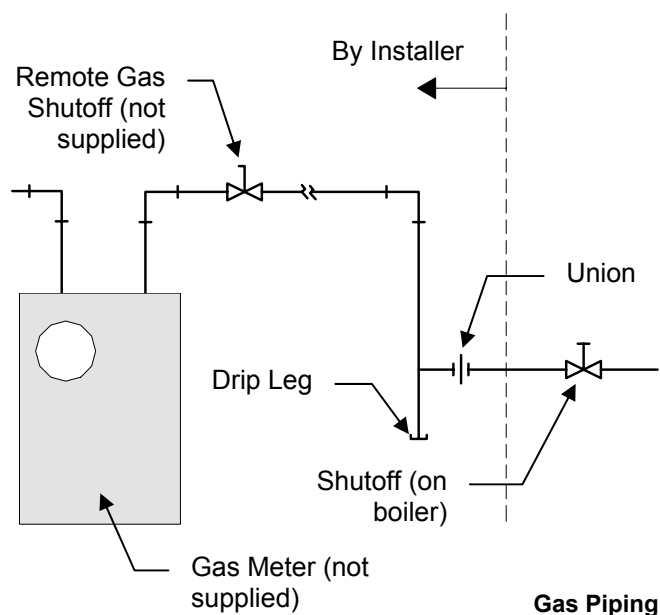
Any improper operation of the common venting system should be corrected so the installation conforms with the National Fuel Gas Code, ANSI Z223.1. When resizing any portion of the common venting system, the common venting system should be resized to approach the minimum size as determined using the appropriate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

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

The gas train components are designed to handle a maximum inlet pressure of 14 inches water column (1/2 psig.). If the available gas pressure exceeds 14 inch 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 inch w.c.



on the boiler. Gas piping should be installed in accordance with National Fuel Gas Code, ANSI Z223.1, latest edition, and any other local codes which may apply; in Canada see CAN/CGA-B 149.

**Note:** See chart below 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., 900,000 Btu per hour requires about 900 cubic feet per hour. (See Typical Boiler Operating Conditions, Section 4.3, for more information.)

**WARNING!**

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

**Note:** Install a sediment trap (drip leg) and a union connection ahead of the primary manual shutoff valve

### Pipe Capacity for Natural Gas

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



### 3.7.1 Gas Supply Piping by Installer

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 shut-off 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.).

During any pressure testing of the gas supply piping system at pressures equal to or less than 1/2 psig (14 inch w.c.), the boiler should be isolated from the gas supply piping system by closing the manual shut-off.

Some leak test solutions, including soap and water, may cause corrosion. These solutions should be rinsed-off with water after testing.

### 3.7.2 Gas Bleeds and Vents by Installer

If your unit is equipped with a diaphragm gas valve, the bleed line must be vented to the outdoors. Maintain size of vent line consistent with vent connection size.

If a N.O. (normally open) vent valve is provided, it must be vented independently of any other bleeds and vents. Discharge of vent lines should be protected by an insect screen.

The pilot regulator is equipped with a vent limiting device and does not require external venting!

Under no circumstances should a vent limiting device be installed in any vent line.

### 3.7.3 Air Gas Ratio Control Valve Venting

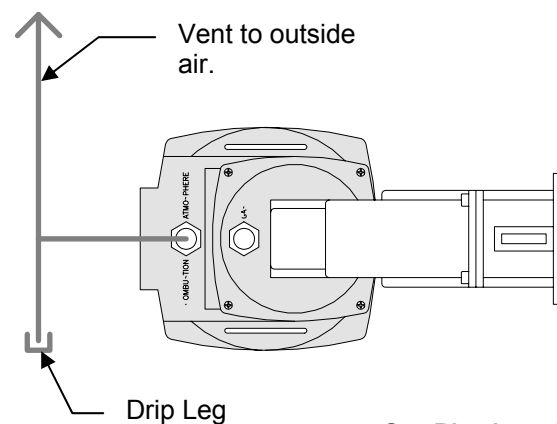
The air gas ratio control valve is equipped with a “reference chamber vent filter” which does not require any additional venting. This connection is labeled COMBUSTION / ATMOSPHERE.

If local conditions require venting to outdoors, the vent line connection must be piped by the installer in accordance with the National Fuel Gas Code

(NFPA 54), ANSI Z223.1, 2002 edition, which states:

*“In the case of vents leading outdoors, means shall be employed to prevent water from entering this piping and also to prevent blockage of vents by insects and foreign matter.”*

The National Fuel Gas Code Handbook goes on to say that *“Insects, insect nests, ice, or freezing rain can block outdoor vents....”*



**Gas Bleeds and Vents**

**Note:** Provide a drip leg, as shown, in the vent line. All vent lines should be pitched up at all times to prevent building a trap into the vent line.

## 3.8 BOILER WATER PIPING

### 3.8.1 Piping Design

#### Water Flow in System

Ideal operation of the P-K MODU-FIRE® 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.

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.

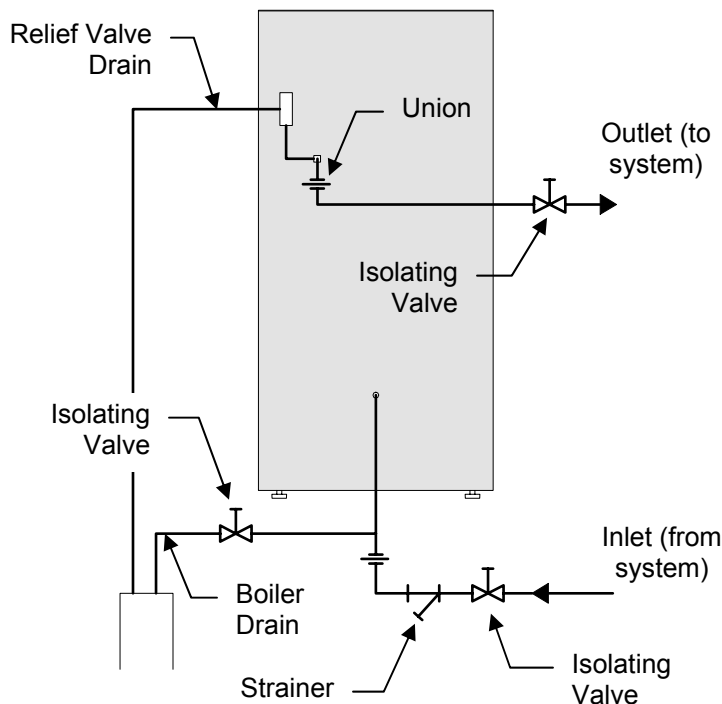
### **Piping With Refrigeration Machines**

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.

### **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.

## **3.8.2 Boiler Inlet and Outlet Connections**



**Boiler Inlet and Outlet Connections**

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

**Note: 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 **should not** be used as a pipe anchor.

## **3.8.3 Boiler Water Piping by Installer**

### **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.

### **Relief Valve and Piping**

Each boiler is supplied with a pressure-relief valve sized in accordance with ASME requirements. The relief valve should be piped to a suitable floor drain. Reducing couplings or other restrictions are not permitted in the discharge line.

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

The boiler is furnished with a flow-switch-type low water cut-off as required by Section IV ASME Code; 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. This flow switch only proves that flow is present. It does not prove adequate flow as required by this boiler.



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 cutoff from the boiler.

***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.

**3.8.4 Flushing and Filling*****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.

***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.

**3.8.5 Water Quality**

The boiler is designed to operate in a closed-loop system. 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 buildup of scale. Such failure is not covered by warranty.

Scale can also reduce efficiency. For example, a scale thickness of 1/16" 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

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.

If antifreeze is to be used in the system, the customer should perform a hazard analysis to determine the use and disposal of the antifreeze.

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**3.9 BURNER AND IGNITION SYSTEM****3.9.1 Inspection**

Inspect the burners to be sure nothing was damaged or knocked loose during shipment. Make sure that the mixer core in the top of the burner is centered in the burner head; (see burner photo in section on "Cleaning the Burner" Section 5.2). Inspect the pilot line, main gas train and ignition electrode to be sure they were not damaged during shipment or installation. Check to see that the pilot is securely attached and that it is properly positioned to ignite the main burner.





### 3.10 PRE-START CHECK LIST

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

1. Flue gas from the boiler is properly vented.
2. Gas connection has been made, pressure tested for leakage, and the line purged of air. Make sure all required bleeds and vents have been installed.
3. Water connections are complete, and the boiler and system have been filled and purged of air.
4. The boiler must be connected to a 120 volt / 60 Hz power source with proper polarity and dedicated machinery ground. Provide a disconnect having adequate overload protection.
5. Combustion air openings are not obstructed in any way and have adequate capacity. (See Section 3.5)
6. The boiler is placed the proper distance from any combustible walls or substances, in accordance with Section 3.3.3.
7. Relief valves have been properly piped to floor drains.

### 3.11 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.

### 3.11.1 Test of Ignition Safety System

Test the ignition system safety shutoff as follows:

1. Close the gas cock which is downstream from the two safety shut off valves (in the vertical line).
2. With the main gas cock (inlet manual gas valve) open and the pilot gas cock open, the burner should be cycled on. After all the safety limits on gas pressure, water flow and temperature are satisfied, the blower will run and pre-purge the boiler.
3. When air flow is established, the ignition transformer and pilot will operate. Both functions will be indicated by separate indicator lights on the flame safeguard.
4. If a satisfactory pilot is established, the spark will terminate and the pilot will remain on, alone, for 10 seconds.
5. After 10 seconds, the "Main" light on the flame safeguard will go on; gas will not flow since the downstream cock is closed. The "Pilot" will remain on, along with the "Main Gas", for another 10 - 15 seconds and then go out. Since the gas cock is closed, at this point there will be no main flame signal and the flame safeguard programmer will assume a "Flame Failure" and go to a "lockout" mode. Lockout will require manual reset of the flame safeguard.

After completing this test, turn off the boiler and reopen the downstream gas cock.

### 3.11.2 Test of Low Water Cut-off

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

Operation of the switch can be checked by first turning the boiler off and then turning the system pump off, stopping water flow in the system. After turning off the pump, turn the boiler back on. It should not operate, and a red indicator for "Low Water" or "Water Flow" should be illuminated. Do not shut the pump off while the boiler is operating.

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

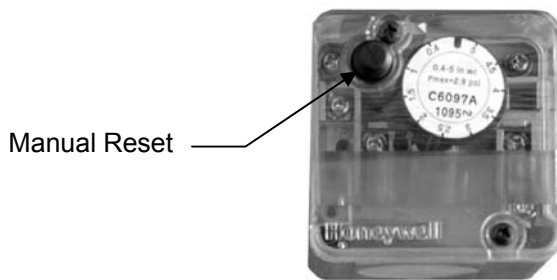


### 3.11.3 Test of Limit Controls

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 until the main burner shuts off (the green "Heat" indicator will go out). The high-limit switch must be manually reset after testing. This same check should also be made for the "Operating Temperature" control. After completion of these tests, readjust thermostats to desired operating temperature and set high-limit temperature, typically 20° F above operating temperature.

### 3.11.4 Test of Low Gas Pressure Switch



**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. When the gas pressure switch opens, the "Gas Press." indicator will light. Upon reopening the main gas cock, the "Gas Press." indicator should remain on until the low gas pressure switch is manually reset.

### 3.11.5 Test of High Gas Pressure Switch

The correct setting of the high gas pressure switch is essential for proper operation of the boiler. This switch is set by the factory at 4.0" w.c. and must not be changed.

This switch must be checked by factory-trained personnel.

## 3.12 INITIAL ADJUSTMENTS

### 3.12.1A – Configuring the Local Controller

(Applies to models furnished with programmable temperature control.)

#### **Operating Modes:**

- Internal Setpoint
- Night Setback (Alternate Setpoint)
- Outdoor Air Reset
- Analog Input Setpoint (See Section 3.12.1B.)
- Analog Input Direct Drive (Multiple boiler Controls)

#### **Definitions:**

- SP1-** Setpoint 1: ..... This is the primary setpoint of the boiler.
- SP2-** Setpoint 2 : ..... An alternate setpoint. Available through the alternate setpoint contact closure.
- dSP-** Differential Setpoint : .. An alternate setpoint differential from SP1. Available through the alternate setpoint contact closure.
- tA-** Air temperature: ..... Measurement of outside air temperature.
- SP.E-** External Setpoint: ..... Measurement of the external setpoint.
- HyS1:** ..... Low temperature differential.
- HyS3:** ..... High temperature differential.

#### **Internal Setpoint**

The boiler water outlet temperature is controlled to SP1 (setpoint 1) and the boiler modulates to maintain SP1 subject to the upper and lower temperature differentials and the upper and lower setpoint limit.



For example, assume the following settings:

Item	Display	Value
Setpoint 1	SP1	160
Low Temp Differential	HyS1	-5
High Temp Differential	HyS3	12
Low Temp Setpoint	SPL	150
High Temp Setpoint	SPH	195

The boiler will modulate to try to maintain 160 °F. If the temperature increases to 172 °F which is Setpoint 1 (SP1) **160** + High Temp Differential (HyS3) **12**, it will shut off. Once it shuts off, it will not restart until the temperature drops to 155 °F which is Setpoint 1 (SP1) **160** + Low Temp Differential (Hys1) **-5**. The Low Temp Setpoint (SPL) prevents the operator from setting Setpoint 1 (SP1) lower than Low Temp Setpoint (SPL) **150**. The High Temp Setpoint (SPH) prevents the operator from setting Setpoint 1 (SP1) higher than the High Temp Setpoint (SPH) **195**.

### **Alternate Setpoint**

The control must be configured for night setback. (See the configuration menu.) When the Alternate Setpoint contact is closed the boiler switches to its alternate setpoint.

The alternate setpoint can be determined by several different values. It can be a fixed alternate setpoint SP2. It can be a fixed differential from SP1 called dsP. dsP will “offset” the main setpoint SP1 by the value of dsP. dsP can be positive or negative.

The Alternate Setpoint can also be determined by an external analog source such as a 4-20 mA signal.

### **Outdoor Air Reset**

The control must be configured for outdoor air reset. (See the configuration menu.)

The setpoint of the boiler is controlled by an outdoor temperature sensor. As the outdoor temperature falls the setpoint of the boiler is increased.

The boiler modulates to maintain this setpoint. The boiler functions as indicated in internal setpoint; however, SP1 is determined by the outdoor air temperature.

The setpoint SP1 is reset using a linear relationship with outdoor air temperature. As the outdoor air temperature drops the setpoint SP1 is increased a proportional amount. This increase is determined by the Heating Slope H. (See Table 1 at the end of this section.) For example if H is set at 1 then for every degree the outdoor air temp drops, the setpoint SP1 will increase 1 degree.

This heating curve has a reference temperature of 68°. This reference can be offset using the Parallel shift parameter P. (See Table 1 at the end of this section.) If P is set to 0 the setpoint SP1 will be 68° when the outdoor temp is 68°. If P is set to 10, the setpoint SP1 will be 78° when the outdoor temp is 68°. The minimum setpoint of the boiler is limited by the control. In the above example the actual setpoint SP1 of the boiler will not go below 150°.

### **Analog Input Setpoint**

The control must be configured for external setpoint. (See the configuration menu.)

The setpoint of the boiler is controlled by an external signal. The boiler functions as described with the internal setpoint, using the value determined by the external analog signal.



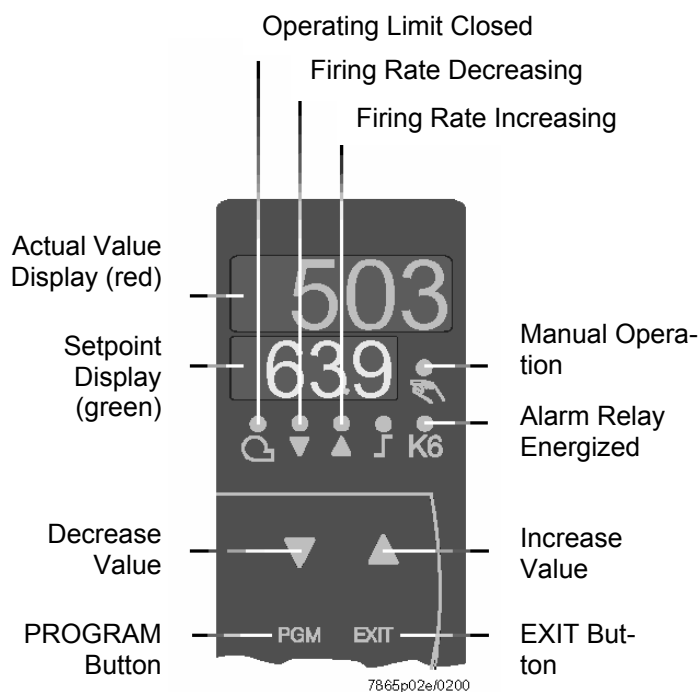
### Analog Input Direct Drive

The firing rate of the boiler is controlled by an external analog signal, usually from a multiple boiler control. The boiler turns on and off as directed by the external control.

An operating limit control ensures that the boiler temperature does not exceed the set value.

Refer also to Section 3.12.1B.

### Use of the Controller



The diagram shows the RWF40 after switching on power. This condition is called the basic display. The actual value and the currently active setpoint are shown here. Manual operation, self-setting, and the user, parameter, and configuration levels can be activated from here.

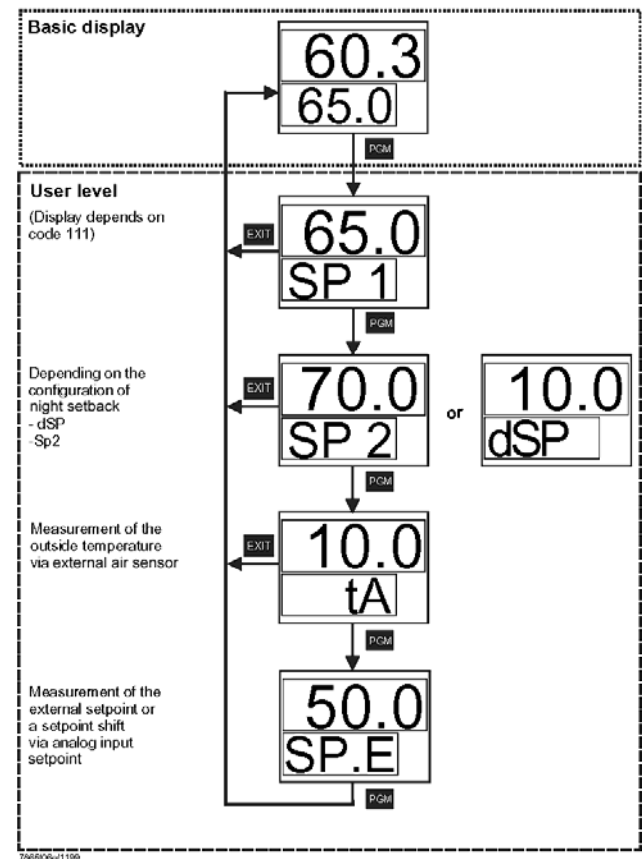
### Operation of the Control

The temperature control has three levels of cascading menus. They are:

- **USER level,**

- **PARAMETER level,** and the
- **CONFIGURATION level.**

The following table indicates the menu options available from each level. The options available depend on the operating mode of the boiler.



### User Level:

- To access the **User level** from the basic display press **PGM**.
- Change the setpoint **SP1** with **↑** or **↓**.
- Change to setpoint **SP2** or **dSP** with **PGM**.
- Change the setpoint **SP2** or **dSP** with **↑** or **↓**.
- Return to the basic display with **EXIT**.

### Manual Operation of the Boiler

The boiler firing rate can be controlled manually.



- To change to manual operation press **EXIT** for 5 seconds.
- The LED above the hand symbol lights up.
- Change the firing rate of the boiler with **↑** or **↓**.
- The firing rate increases as long as **↑** is pressed.
- The firing rate decreases as long as **↓** is pressed.  
LED's on the control indicate if the firing rate is increasing or decreasing.
- To change back to automatic operation press **EXIT** for 5 seconds.

Manual operation can only be activated if the burner relay is on. If the control sets the burner relay to off

during manual operation, then the control is changed to automatic operation.

### ***Parameter Level***

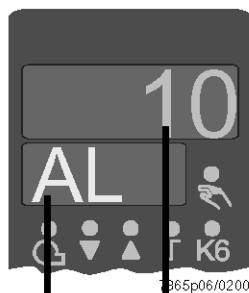
To access the parameter level press and hold the **PGM** button for longer than two (2) seconds. The parameters available in this level are used for proper functioning of the boiler with the system.

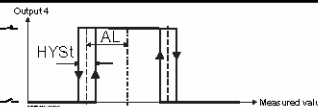
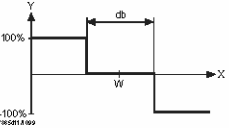
Within the parameter level you can go to the next parameter by pressing **PGM**.

The parameters and their functions are listed in Table 1 on the following page. The actual parameters available depend on the configuration of the control.



Table 1 - Table of Parameters



Parameter	Display	Value range	PK Settings	Remarks
Setpoint range alarm value <sup>1)</sup>	<b>AL</b>	-1999...+9999 digit	0	 <p>⇒ «C112 – limit comparator, controller type, setpoint «SP1», locking»</p>
Alarm hysteresis <sup>1)</sup>	<b>HYSt</b>	0.1...999.9 digit	1	<p>Switching differential at the edges for the limit comparators</p> <p>⇒ «C112 – limit comparator, controller type, setpoint «SP1», locking»</p>
Proportional band <sup>1)</sup>	<b>Pb.1</b>	0.1...999.9 digit	20	Affects the P-response of the controller
Derivative time	<b>dt</b>	0...9999 sec	80	Affects the D-response of the controller. Within dt = 0, the controller has no D-response.
Integral action time	<b>rt</b>	0...9999 sec	100	Affects the I-response of the controller. With rt = 0, the controller has no I-response
Contact spacing (dead band) <sup>1)</sup>	<b>db</b>	0...999.9 digit	2	<p>For floating output</p> 
Actuator running time	<b>tt</b>	10...3000 sec	20 sec	Stroke time of the actuator
Switch-on burner <sup>1)</sup>	<b>HYS 1</b>	0...-199.9 digit	-5	⇒ Boiler turns on when the temperature of HYS 1 is below the setpoint.
Unused	<b>HYS 2</b>	0...HYS3 digit	3	Unused
Switch-off <sup>1)</sup>	<b>HYS 3</b>	0...999.9 digit	10	⇒ Section 5.2 «High-fire operation»
Response threshold	<b>q</b>	0...999.9	90	⇒ Section 5.6 «Response threshold Q»
Slope for outdoor air reset	<b>H</b>	0...4	1	⇒ Section 5.5.1 «Heating curve slope»
Offset for outdoor air reset <sup>1)</sup>	<b>P</b>	-90...+90	0	⇒ Section 5.5 «Weather-dependent setpoint shift»

<sup>1)</sup> This parameter is affected by the setting of the decimal place.



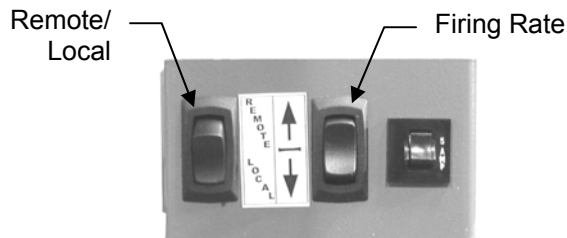
### Configuration Level

The configuration level is used to set up the control for the sensors used, and the functioning of the alarm relay. The configuration level must be adjusted by factory-trained personnel only.

#### 3.12.1B Optional Remote Control

This option is used when the firing rate of the boiler is controlled by an external analog signal, usually from a multiple boiler control. The boiler turns on and off as directed by the external control.

An operating limit control ensures that the boiler temperature does not exceed the set value.



Remote/Local and Firing Rate Switches

Local control is used for setting up and testing the boiler. Local control of the boiler firing rate can be obtained by placing the Remote/Local switch in the local position (This does not bypass # 1 start interlock, # 1 start interlock must be made for the boiler to fire). With the boiler in local mode, the up/down switch can be used to control the firing rate of the boiler. Pressing this switch in the up direction increases the firing rate. Placing this switch in the down position decreases the firing rate.

To operate the boiler independently from the BMS (Building Management System) or sequencer, an external bypass switch of the BMS must be installed by the control contractor.

#### WARNING!

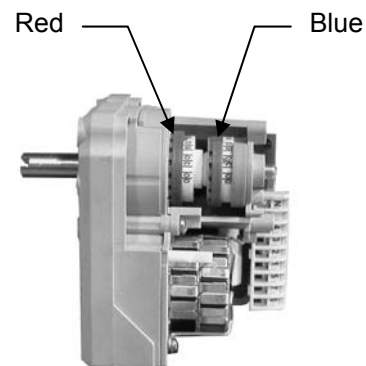
Do not bypass any safety limits with this switch.

#### 3.12.2 Air Flow Adjustments

The air flow is pre-set at the factory prior to shipment. The air (and gas) may have to be adjusted for local conditions. **All air flow adjustments must be performed by factory-trained personnel.**

The air and gas are adjusted at two firing rates: High fire and Low fire. The boiler modulates between these two rates to maintain a steady outlet temperature.

Fuel adjustments for proper fuel/air ratio are made first at High fire, then at Low fire.



Air Flow Adjustments

The air flow rates are adjusted by setting the end switches in the damper actuator. The red end switch sets the High fire position. The blue end switch sets the Low fire position. To set the position of the switch, rotate the colored wheel corresponding to either High fire or Low fire until it indicates the desired setting. Once the desired setting is set, move the damper to a mid position and then back to either Low or High fire as desired.

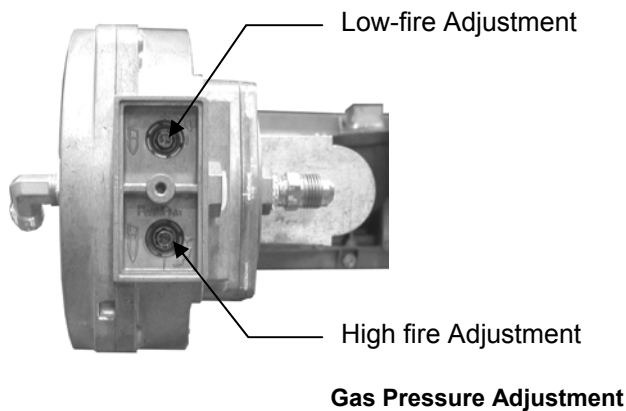
The red air flow cam should be set so that the cabinet pressure at High fire is at or below that indicated on the rating plate for High fire. The blue cam should be set so that the cabinet pressure at Low fire is at or above that indicated on the rating plate for Low fire.

The cabinet air pressure at Low fire must be at least 0.3" w.c.



### 3.12.3 Gas Pressure Adjustment

See rating plate for the minimum and maximum gas pressure of the boiler. Each boiler is furnished with two plugged taps in the gas manifold for test gauge connections. One tap is located at the main gas cock for measuring the gas supply pressure (1/4" IPS). The supply pressure during main burner operation must be greater than the minimum indicated on the rating plate. The second tap is located downstream from the last main gas control in the union elbow where the gas line enters the back of the cabinet and is for measuring the manifold gas pressure (1/8" I.P.S.)



To adjust the gas pressure, remove the cover plate from the air / gas ratio control valve. Set the boiler at High fire as described in the boiler operation section of the manual. The High fire gas pressure is adjusted with the lower screw of the air / gas ratio control valve. Using a combustion analyzer, adjust the oxygen reading between 6.5% and 7.5%. Set the boiler at Low fire as described in the boiler operation section of the manual. For initial adjustment the cabinet pressure should be the same as shown on the "Factory Firetest" label. The Low fire gas pressure is adjusted with the upper screw of the air / gas ratio control valve. Using combustion measurement equipment, adjust the oxygen reading between 6.5% and 7.5%.

Run the firing rate up and down through the complete firing range and verify that the oxygen readings are within the proper range.

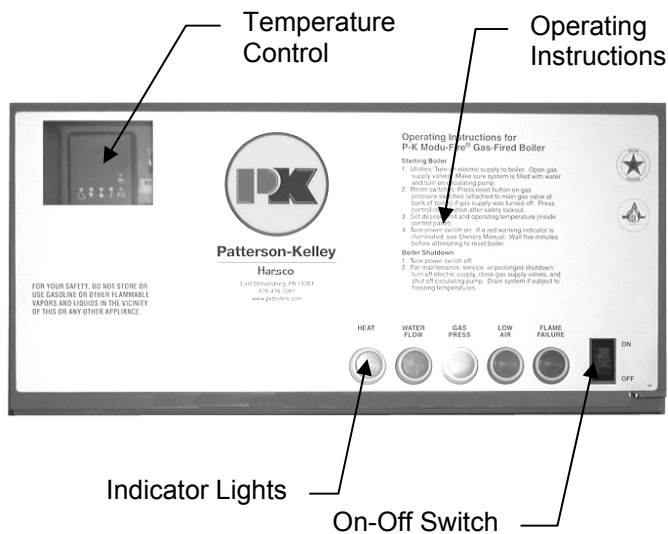




## 4.0 OPERATION

### 4.1 GENERAL

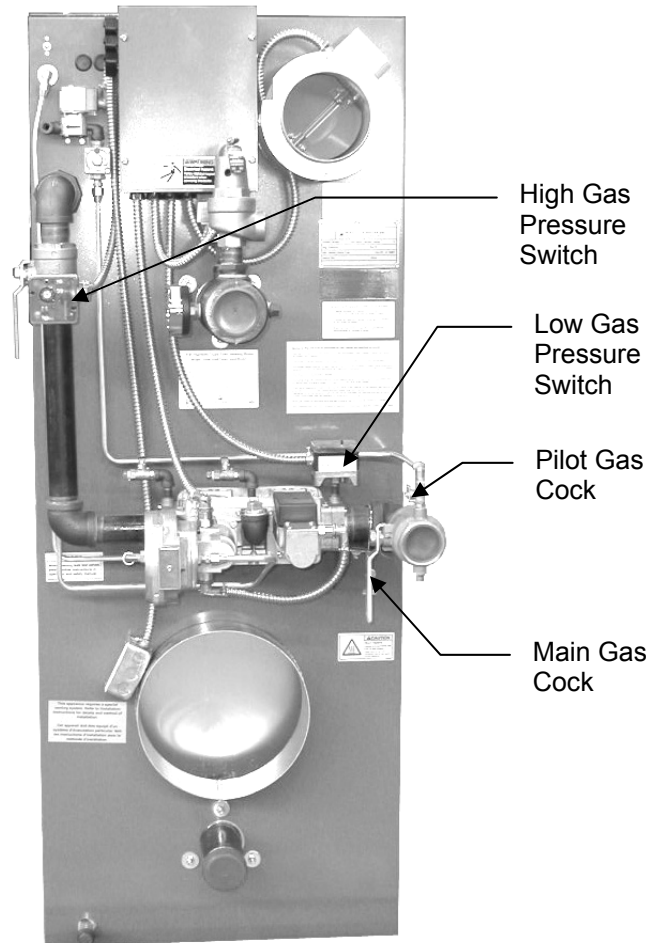
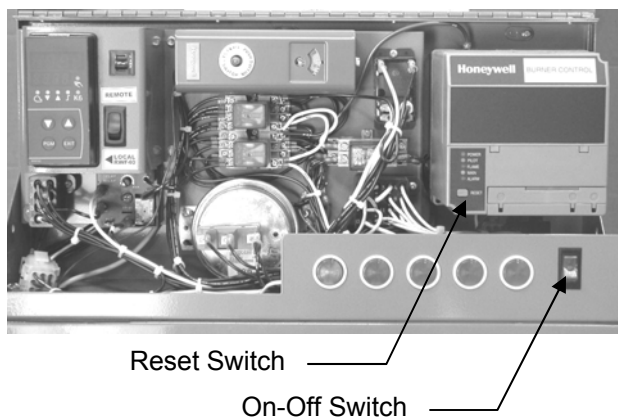
#### 4.1.1 Control Panel Front



The front of the control panel shows Operating Instructions and a series of illuminated indicator lights which show the condition of the boiler.

### 4.2 LIGHTING AND SHUT-DOWN PROCEDURES

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



#### 4.2.1 Lighting Procedures

1. Utilities: Turn on electric supply to boiler. Open gas supply valves. Make sure system is filled with water and turn on circulation pump.
2. Reset Switches: Press reset button on gas pressure switches (attached to main gas valve at back of boiler) if gas supply was turned off. Press control reset button after safety lockout.
3. Set desired limit and operating temperature (inside control panel).



4. Turn power switch on. If a red warning indicator is illuminated, see call for factory-trained personnel to troubleshoot the problem and implement corrective action. Wait five minutes before attempting to reset boiler.

#### **4.2.2 Normal Shut Down Procedures**

1. Close all manual gas valves.
2. Turn off electric power.

#### **4.2.3 Emergency Shut Off**

Main and pilot gas cocks should be closed immediately if an emergency situation occurs; see Section 4.2.1 for the location of the gas cocks.

If overheating occurs or the gas supply fails to shut off, do not turn off or disconnect the electrical sup-

ply to the pump. Instead, shut off the gas supply at a location external to the boiler.

#### **4.3 TYPICAL BOILER OPERATING CONDITIONS**

Model No.	Input Rating (Btu/hr)	Natural Gas (1030 Btu/cu. Ft.)		
		Gas Rate (CFH)	Manifold Pressure (in. w.c.)	Output Capacity (Btu/Hr.)
<b>1000</b>	1,000,000	971	3.3 Max. 0.3 Min	850,000
<b>1500</b>	1,500,000	1,456	2.7 Max. 0.3 Min	1,275,000
<b>2000</b>	2,000,000	1,942	2.5 Max. 0.3 Min.	1,700,000



## 5.0 MAINTENANCE

General Lock out / Tag out procedure must be employed when servicing unit.

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

In addition to the requirements of Section 2.1, maintenance performed on the Siemens gas valve requires that the valve be removed from the boiler and securely placed in a vice prior to performing any maintenance.

### 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.

The motorized gas valves contain hydraulic oil which may be hazardous to the environment. Should a leak develop, use safe procedures for disposal of this or any other lubricant.

#### 5.1.2 Weekly

Observe the conditions of the pilot and main flame. A normal High fire flame is blue. If the flame is yellow, then corrective action must be taken. In Low fire the burner will glow a yellowish orange.

Correct air adjustment is essential to the efficient operation of this boiler. If an adjustment in 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 3.12.2 and 3.12.3.

#### 5.1.3 Monthly (During Operation)

1. Test flame detection by voltage reading at the control programmer.
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 controls by reducing or increasing temperature setting as necessary to check burner operation.
4. Check flue gas temperature at outlet. If there is a temperature increase over previous readings, this probably indicates sooting or water scale build-up.
5. Test the water cutoff by trying to restart boiler with the system pump off. The boiler should not operate. Water flow indicator should light.
6. Test low gas pressure switch by closing main gas cock and attempting to restart boiler.

This work should be performed by factory-trained personnel.

#### 5.1.4 Semi-Annually

In addition to the recommended monthly service:

1. Inspect and clean blower fan and inlet screen of any accumulated dust or lint.
2. Clean burner of any accumulated dust or lint. See Section 5.2 on "Cleaning the Burner."



3. Inspect burner for any signs of deterioration or corrosion. Replace immediately if deterioration or corrosion is evident.

The blower motor is permanently lubricated and does not require periodic lubrication.

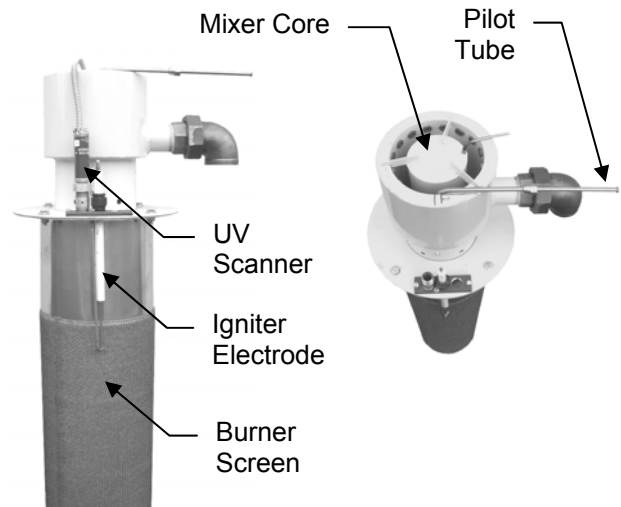
This work should be performed by factory-trained personnel.

### 5.1.5 Annually

In addition to the recommended monthly service:

1. Check burner and clean off any soot or foreign material that may have accumulated. See Section 5.2 on "Cleaning the Burner." Check for corrosion of the burner and its parts. If there is evidence of deterioration or corrosion, replace immediately.
2. Inspect combustion chamber through access door on front side of boiler. To remove doors, remove fasteners, pull door forward slightly, then pull upward. Note any signs of deterioration. Take corrective action as necessary.
3. Inspect and clean heat exchanger. Clean exterior of finned tubes and flush inside of heat exchanger as required (separate from system flush).
4. Examine the venting system at least once a year.
  - a. Check all joints and pipe connections for tightness.
  - b. Check pipe for corrosion or deterioration. If any piping needs replacing, do so immediately.
5. Inspect heating system for other problems. This work should be performed by factory-trained personnel.
6. Perform combustion analysis.
7. The relief valve should be tested as per the valve manufacturer's recommendations at least annually or as indicated by local codes.
8. Leak test gas valves.

## 5.2 CLEANING THE BURNER



**Burner Assembly**

1. Follow Lock out / Tag out procedures.
2. Close pilot and main gas cocks.
3. Remove the top cover of the boiler.
4. Disconnect the electrode wire.
5. Disconnect the UV scanner.

### 5.2.1 Semi-Annual Cleaning

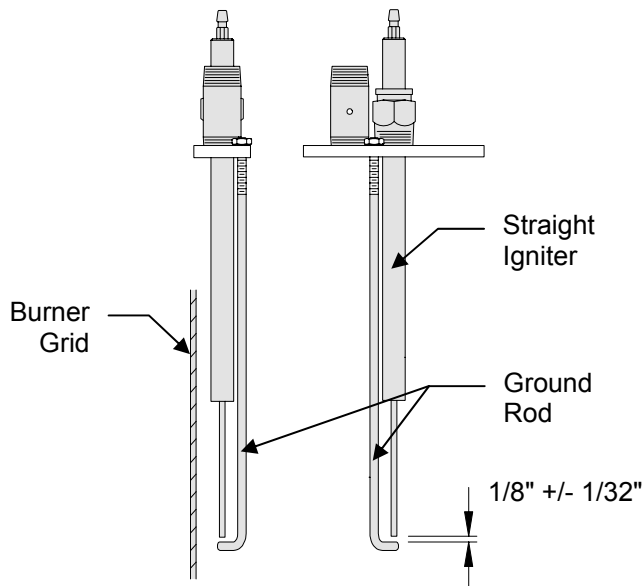
1. Remove mixer core.
2. Use low pressure air, Max. 20 psig inside the burner to remove any accumulated dust or lint build-up.

### 5.2.2 Annual Cleaning

1. Disconnect the union in the line at the burner.
2. Disconnect pilot and vent line, being careful not to disturb the position of the pilot.
3. Loosen and remove the four (4) hold down bolts and washers.
4. Carefully remove the burner.



5. Use low pressure air, max. 20 psig inside the burner to remove any accumulated dust or lint build-up.
6. Check that the ceramic portion of the ignition electrode is not cracked.



7. Check the position of the ignition electrode:  $1/8'' \pm 1/32''$  spark gap. Check the tightness of the electrode clamp.
8. Use a soft, clean cloth to remove accumulated contaminants from the UV radiation tube (UV scanner) glass envelope.
9. Before re-installing the burner, check the cleanliness of the heat exchanger and the condition of the combustion chamber.

### 5.3 REMOVING THE EXCHANGER

1. Remove the burner as above.
2. Remove the front doors by pulling forward and upward.
3. Remove the top panel of the inner cabinet.
4. Close the isolation valves to the system.

5. Drain the boiler.
6. Disconnect the supply and return lines.
7. Remove the manifold assembly containing the temperature-pressure indicator, relief valve and the water flow switch (on the D series units disconnect at the grooved pipe coupling [Victaulic]).
8. Remove the nuts and bolts from the flanges of the inlet and outlet nozzles at the rear of the outer casing.
9. Remove the exchanger and clean the fins.

**Note:** The inner and outer cabinets are separate parts and reassembly is easier if the inner cabinet and exchanger are removed together as one unit.

#### WARNING!

The heat exchanger is heavy; use proper lifting equipment and techniques.

### 5.4 AFTER ALL REPAIRS OR MAINTENANCE

1. Follow "Pre-Start Check List" (Section 3.10) and all "Safety Checks" (Section 3.11).
2. Check gas pressure and adjust gas flow if necessary. (See "Gas Pressure Adjustment", Section 3.12.3.)
3. Check air pressure and adjust air flow if necessary. (See "Air Flow Adjustment", Section 3.12.2.)
4. Perform combustion check.



## 5.5 SEQUENCE OF OPERATION

---

### 5.5.1 Standard Modulating

1. When the On/Off (Main power) switch is turned on, the switch illuminates. Power is provided to the flame safeguard control, the temperature control, and through normally closed contacts of relays 2 and 3 to the damper close terminal. Power is also applied through the “start logic string” a series of normally closed switches, including water flow, gas pressure, high stack temp, high limit temperature, and operating temperature to the flame safeguard programmer.
2. The water flow limit switch is closed when there is water flow through the boiler.  
**Note:** The closing of this switch does not prove that flow is adequate. Refer to Technical Data Sheet # TD110 for proper flow requirements.
3. When adequate gas pressure is available, the low gas pressure limit switch is closed. Manual reset is required following conditions resulting in low gas pressure.
4. When the temperature sensed by the high limit temperature control is below the set limit, the switch is closed. Manual reset is required following conditions exceeding high limit temperature.
5. When heat is required as indicated by the outlet water temperature, power is applied to Terminal 6 of the programmer, which initiates the burner ignition and operation sequence.
6. The programmer first energizes Terminal 4 which supplies power to a normally open contact of relay 2, the air damper position limit switch, and the air flow switch. If the damper motor is on the low fire side of the damper position limit switch, relay 3 is energized through normally closed contact of relay 2. This supplies power to the open terminal of the air damper through the normally open contact of relay 3. The air damper opens to its start position and the damper position limit switch applies power to terminal 6 on the damper motor. This energizes relay 2 and stops the air damper motor. The motor contactor is energized through relay 2. The air flow switch initially shows low air flow with the “LOW AIR” indicator. This indicator will remain on until sufficient air flow is sensed. If the damper motor is not open enough for purge, relay 2 is not energized, the combustion air blower will not start and the combustion sequence does not go any farther.
7. Once sufficient airflow is indicated by the air flow switch, Terminal 7 of the combustion control is energized. This starts the Prepurge period. The combustion chamber is Prepurged for 30 seconds.
8. A 10-second “trial for ignition” period is initiated with both Terminal 8 and 10 being energized. Terminal 10 of the combustion control powers the ignition transformer. The transformer output creates a spark at the igniter. Terminal 8 powers the pilot gas valve.
9. When a pilot flame is detected by the UV scanner a signal is sent to the combustion control. When this signal is detected, Terminal 10 of the combustion control is de-energized terminating the spark.
10. After the 10 second “trial for ignition” period, if pilot flame has been established, Terminal 9 of the Combustion Control is energized. This opens the main gas valve and energizes the air gas ratio control. The 10 second Main trial for ignition” period begins. If pilot flame has not been established, the unit will lock out on pilot flame failure.
11. After the 10 second “main trial for ignition period” if flame has been established, Terminal 8 of the combustion control is de-energized, closing the pilot valve. Terminal 21 is energized, energizing Relay-1. If main flame has not been established, the unit will lock out on main flame failure.
12. Relay 1 releases the temperature control to modulate.
13. The unit modulates between the low fire setting and the high fire setting to maintain the desired outlet water temp set point.



14. When the load is below the low fire rating of the boiler the boiler will continue firing and the outlet water temperature will rise until it reaches the set point + hysteresis value. At this point the operating control switch opens and the combustion control is de-energized at Terminal 6 and the indicator for HEAT is turned off. This action also de-energizes Terminal 9 thus closing the main gas valve and the air gas ratio control valve. Relay-1 and 2 are de-energized which applies power to the close terminal of the air damper motor. The air damper closes.
15. When the water temperature is reduced by the load on the system, the operating control switch will close again. The operating sequence will recycle to step 5, provided the limits on water flow, gas pressure and high temperature are all met.

### 5.5.2 IRI Modulating

1. When the On/Off (Main power) switch is turned on, the switch illuminates. Power is provided to the flame safeguard control, the temperature control, and through the flame safeguard control to the damper close terminal. Power is also applied through the proof of closure switch on the air gas ratio control, and to the “start logic string” a series of normally closed switches, including water flow, gas pressure, high stack temp, high limit temperature, and operating temperature to the flame safeguard programmer.
2. The water flow limit switch is closed when there is water flow through the boiler.
3. **Note:** The closing of this switch does not prove that flow is adequate. Refer to Technical Data Sheet # TD110 for proper flow requirements.
4. When gas pressure is available, the low gas pressure limit switch is closed. Manual reset is required following conditions resulting in low gas pressure.
5. When the temperature sensed by the high limit temperature control is below the set limit, the switch is closed. Manual reset is required following conditions exceeding high limit temperature.
6. When heat is required as indicated by the outlet water temperature, power is applied to Terminal 6 of the programmer, which initiates the burner ignition and operation sequence.
7. The flame safeguard control first energizes Terminal 5 which energizes control relay R1, energizes the motor contactor for the blower motor, and supplies power to the air flow switch, which initially shows low air flow with the “Low Air “ indicator. This indicator will remain on until air flow is sensed. Terminal 12 is also energized which drives the air damper to the open position. When the damper motor is at the full open position, the high fire limit switch is made which energizes the high fire switch input terminal 19 on the flame safeguard control.
8. Once sufficient airflow is indicated by the air flow switch, Terminal 7 of the flame safeguard control is energized. If the high fire switch and proof of closure switch are in the correct state, this starts the Prepurge period. The combustion chamber is Prepurged for 30 seconds.
9. When the Prepurge time period elapses the flame safeguard control energizes terminal 14, which drives the damper motor through the position switch to the start position.
10. When the damper motor is at the start position, the start position limit switch is made, which energizes the low fire switch input terminal 18 on the flame safeguard control. A 10-second “trial for ignition” period is initiated with both Terminal 8 and 10 being energized. Terminal 10 of the combustion control powers the ignition transformer. The transformer output creates a spark at the igniter. Terminal 8 powers the pilot gas valve.
11. When a pilot flame is detected by the UV scanner a signal is sent to the combustion control. When this signal is detected, Terminal 10 of the combustion control is de-energized terminating the spark.
12. After the 10 second “Pilot Flame Establishing” period, if pilot flame has been established, Ter-



terminal 9 of the Combustion Control is energized. This opens the main gas valve and energizes the air gas ratio control. The 15 second "Main Flame Establishing" period begins. If pilot flame has not been established, the unit will lock out on pilot flame failure.

13. After the 15 second "Main Flame Establishing Period" if flame has been established, Terminal 8 of the combustion control is de-energized, closing the pilot valve. Terminal 15 is energized, providing power to the modulating control of the boiler. If main flame has not been established, the unit will lock out on main flame failure.
14. The unit modulates between the low fire setting and the high fire setting to maintain the desired outlet water temp set point.
15. When the load is below the low fire rating of the boiler the boiler will continue firing and the outlet water temperature will rise until it reaches operating limit setpoint value. At this point the operating control switch opens and the combustion control is de-energized at Terminal 6 and the indicator for HEAT is turned off. This action also de-energizes Terminal 9 thus closing the main gas valve and the air gas ratio control valve. Terminal 14 is energized which applies power to the close terminal of the air damper motor. The air damper closes.
16. When the water temperature is reduced by the load on the system, the operating control switch will close again. The operating sequence will recycle to step 5, provided the limits on water flow, gas pressure and high temperature are all met.

## **5.6 TROUBLESHOOTING**

### **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 5, provided that all the limits are satisfied.

### **Loss of Water Flow**

When the "Water Flow" indicator is illuminated, there is insufficient water flow to close the switch, and burner operation is interrupted. When water flow is re-established, the sequence returns to Step 5, provided that the other limits are satisfied.

### **Gas Pressure**

When the "Gas Press" indicator is illuminated, there has been either insufficient gas pressure or the gas pressure to the manifold is too high for safe and proper operation of the boiler. The power to the programmer will be interrupted.

If a gas-supply shut-off valve is closed for any reason, a low gas condition will result.

When gas pressure is restored, the "Gas Press" indicator will remain on and the boiler will remain locked out until the gas pressure switch is manually reset.

In the event of a high gas manifold pressure condition, the "Gas Press" indicator will illuminate indicating a potential air gas ratio control failure. This must be corrected by factory-trained personnel before restarting the boiler.

Once the switch is reset, the sequence returns to Step 5, provided that the other limits are satisfied.

### **High Water Temperature**

When the boiler water has exceeded both the operating and high-limit temperature, power to the programmer is interrupted. When the water temperature falls below the high-limit temperature, the boiler will remain locked out until the switch is manually reset. Once the switch is reset, the sequence returns to Step 5 to await heat demand provided that the other limits are satisfied.

### **Low Air**

If the "Low Air" indicator remains on for longer than 20 seconds, there is insufficient airflow through the burner. An extended low air indication does not mean that the low air switch is defective.





- Check the cabinet pressure for a minimum of 0.3" w.c.
- Check burner is clean (refer to Section 5.2).

#### ***Ignition Failure***

In the event the pilot flame is not detected by the UV scanner during the 10 second trial-for-ignition period (Step 9), the pilot gas valve and spark ignition are de-energized. At this time a safety lockout occurs which de-energizes all outputs from the programmer except Terminal A, which is connected to the "Flame Failure" indicator. A manual reset of the programmer (located inside the control panel) is required.

#### ***Flame Failure***

In the event of a main flame failure during a firing period, the main fuel valves are de-energized and the programmer immediately goes into "lockout" mode. If flame failure occurs and the indicator is illuminated, the programmer must be manually reset.

### **WARNING**

If any "Manual Reset" limit device trips,  
**DO NOT**  
reset without determining and correcting the cause.

(Flame safeguard, high or low gas pressure,  
high temperature limit, stack temperature.)



## 6.0 PARTS/TECHNICAL SUPPORT

Spare parts and replacement parts can be ordered from Patterson-Kelley by calling (570) 476-7261 or Toll Free (877) 728-5351. Ask for the Heat Transfer Department. The fax number is (570) 476-7247. Refer to the parts list shown on the assembly drawing provided with this manual.

Technical information is also available at the above number.

When ordering replacement parts please have the **model number** and **serial number** of your boiler available.

### 6.1 SCHEMATIC DIAGRAMS

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Typical schematic drawings are shown on the following pages. Drawings specific to your particular equipment can be supplied by your local P-K representative.

#### Table of Contents for this Section:

Standard Unit - Local Control - Logic Diagram

Standard Unit - Remote Control - Logic Diagram

Standard Unit - Local & Remote Control- Logic Diagram

Standard Unit - Local & Remote Control w/ Options - Logic Diagram

IRI Unit - Local Control - Logic Diagram

IRI Unit - Remote Control - Logic Diagram

IRI Unit - Local & Remote Control - Logic Diagram

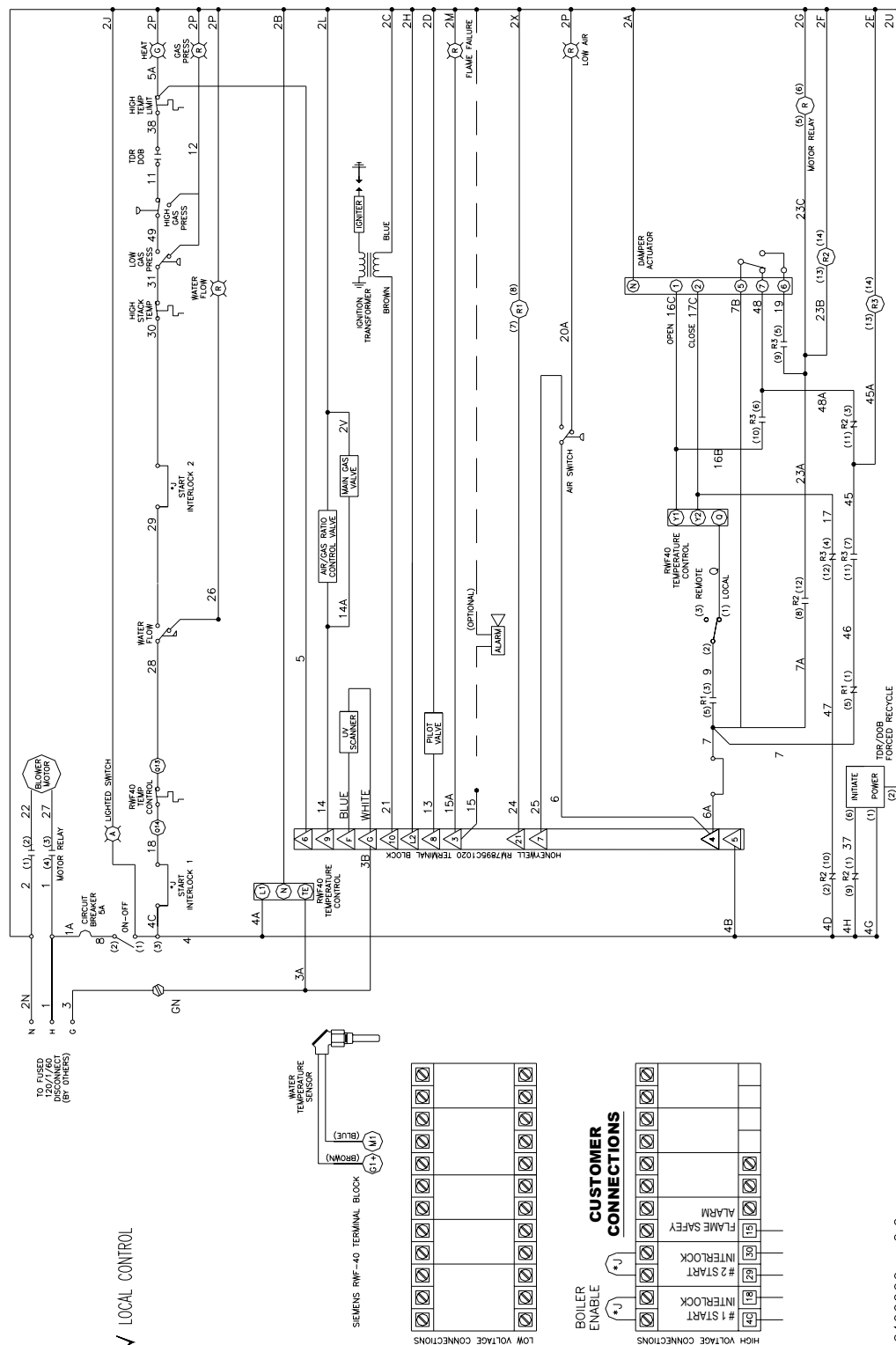
IRI Unit - Local & Remote Control w/ Options - Logic Diagram

Standard Unit – Panel Layout

IRI Unit – Panel Layout



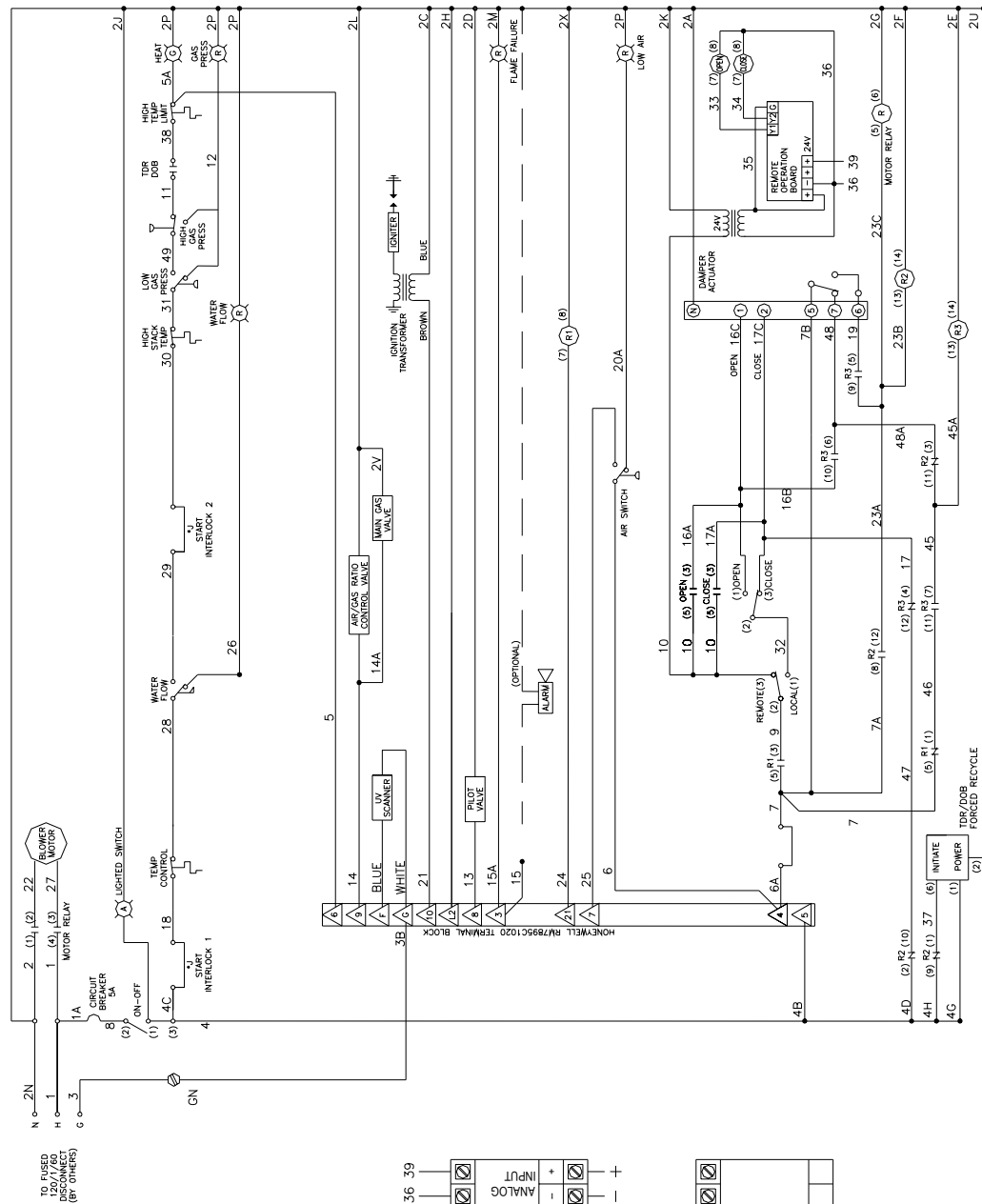
### Standard Unit - Local Control - Logic Diagram



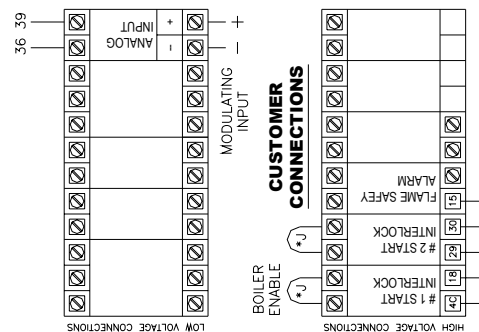
M000100000 -2.2



### Standard Unit - Remote Control - Logic Diagram



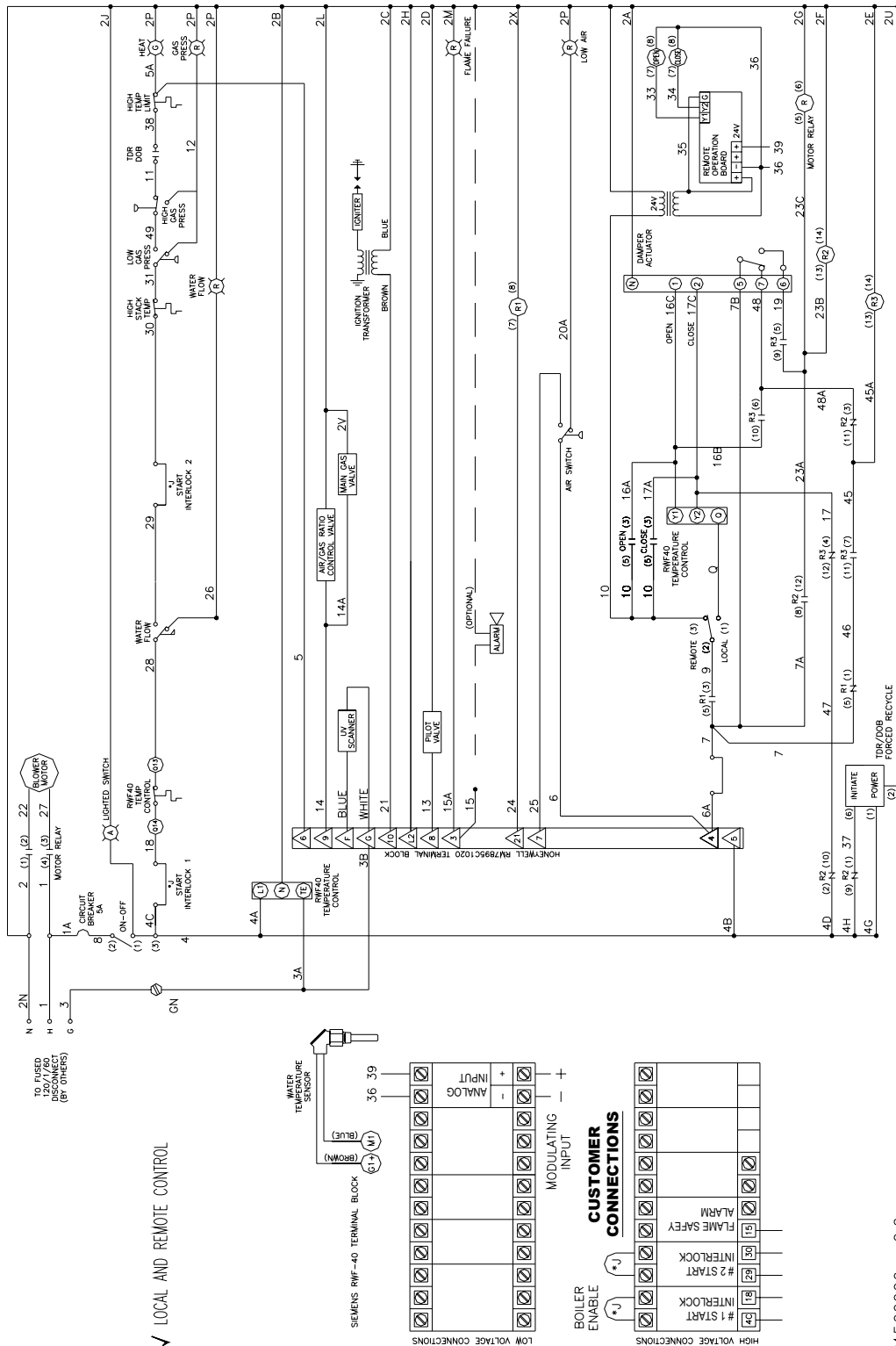
✓ REMOTE CONTROL



M000500000 -2.2



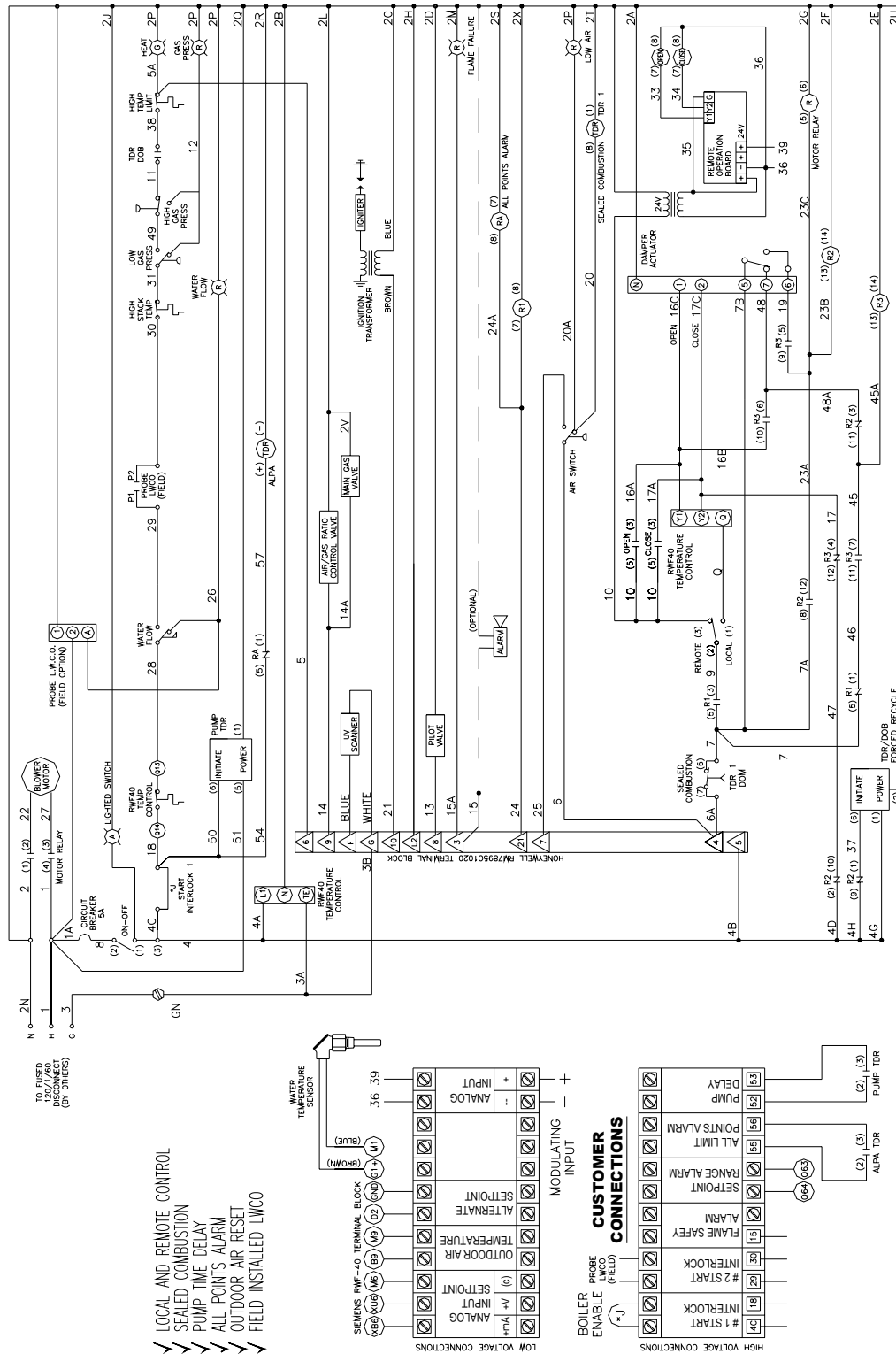
# Standard Unit - Local & Remote Control - Logic Diagram



M001500000 -2.2



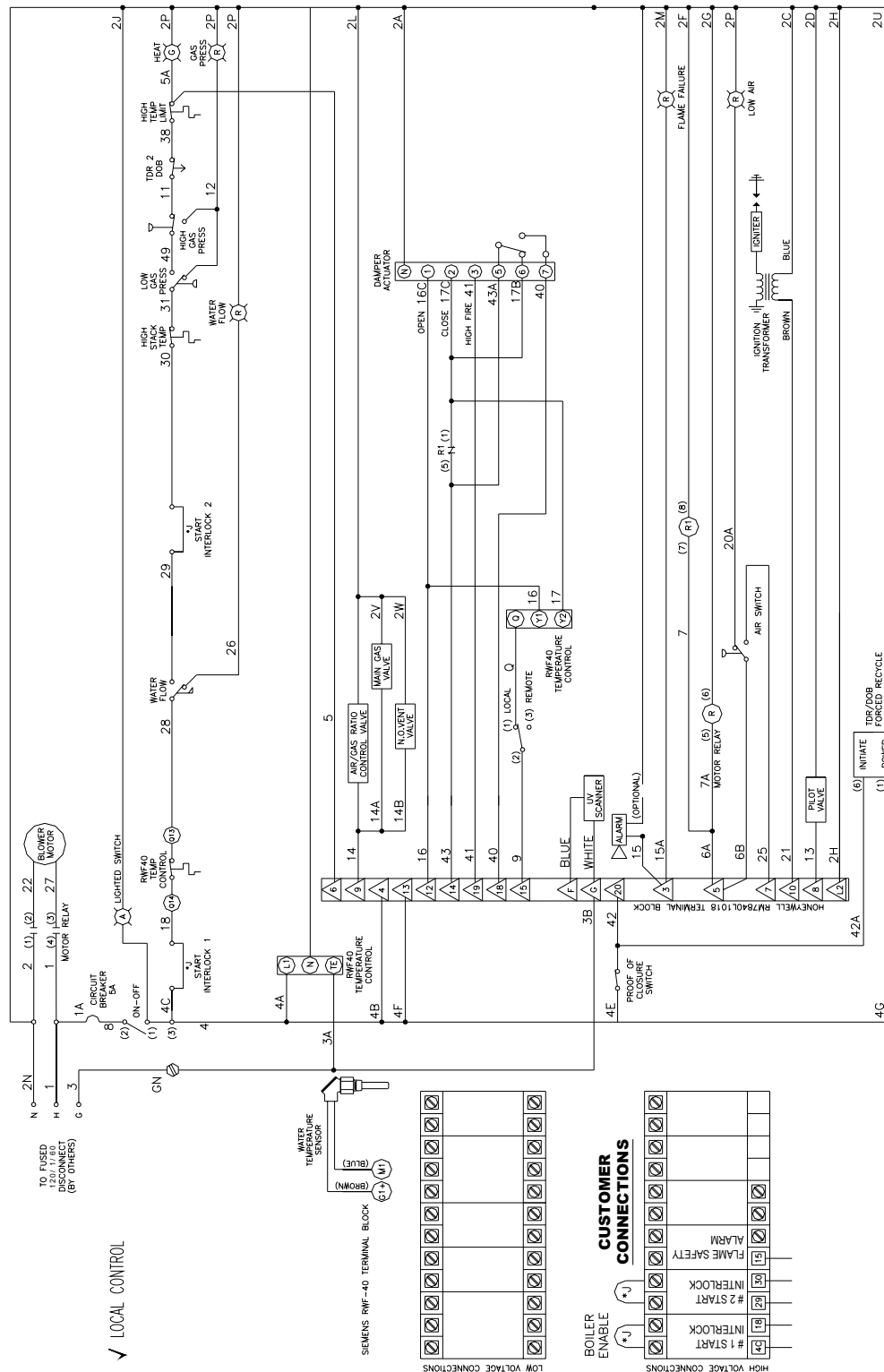
# Standard Unit - Local & Remote Control w Options - Logic Diagram



M011523402 -2.2



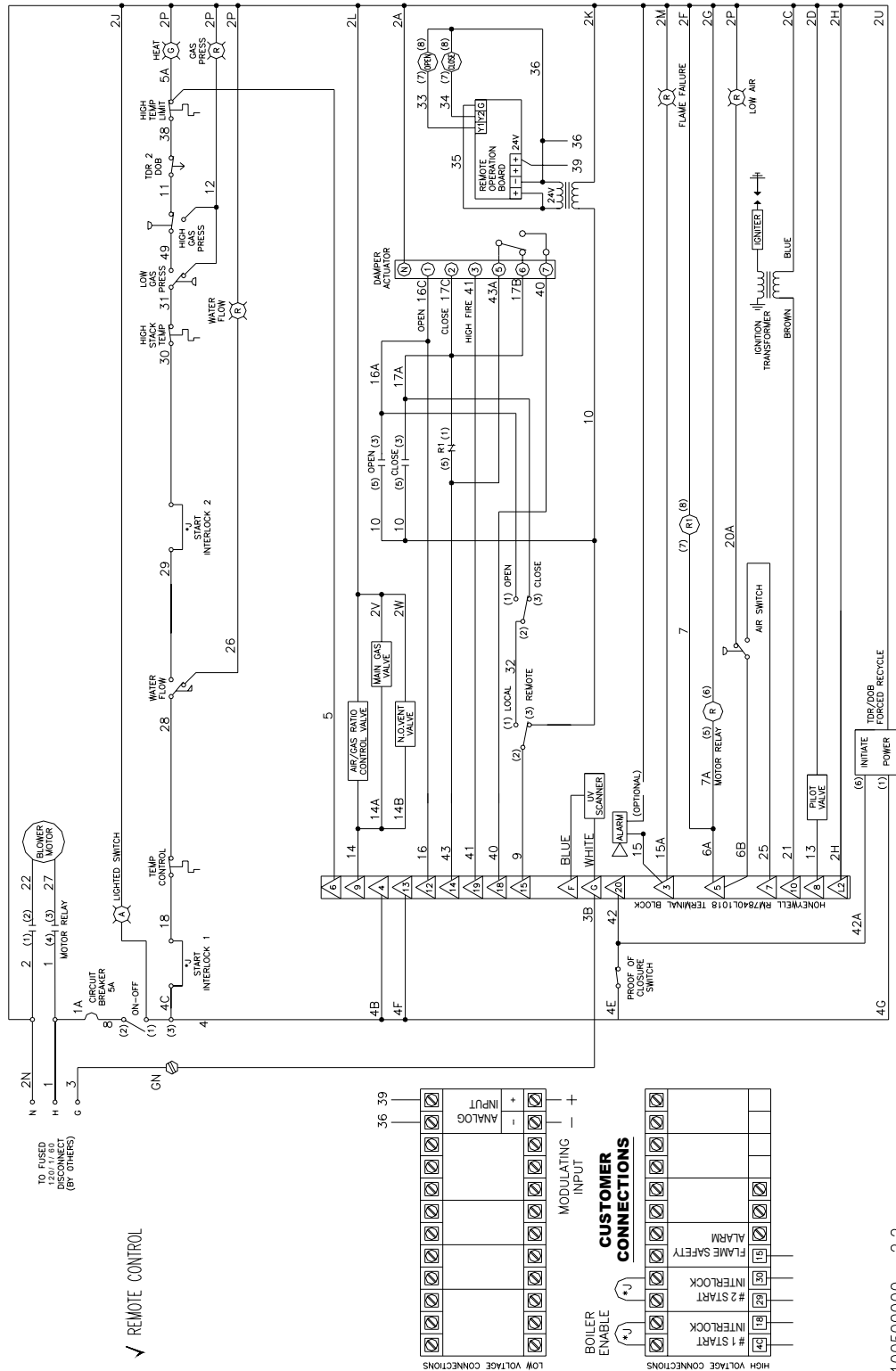
### IRI Unit - Local Control - Logic Diagram



M100100000 -2.2

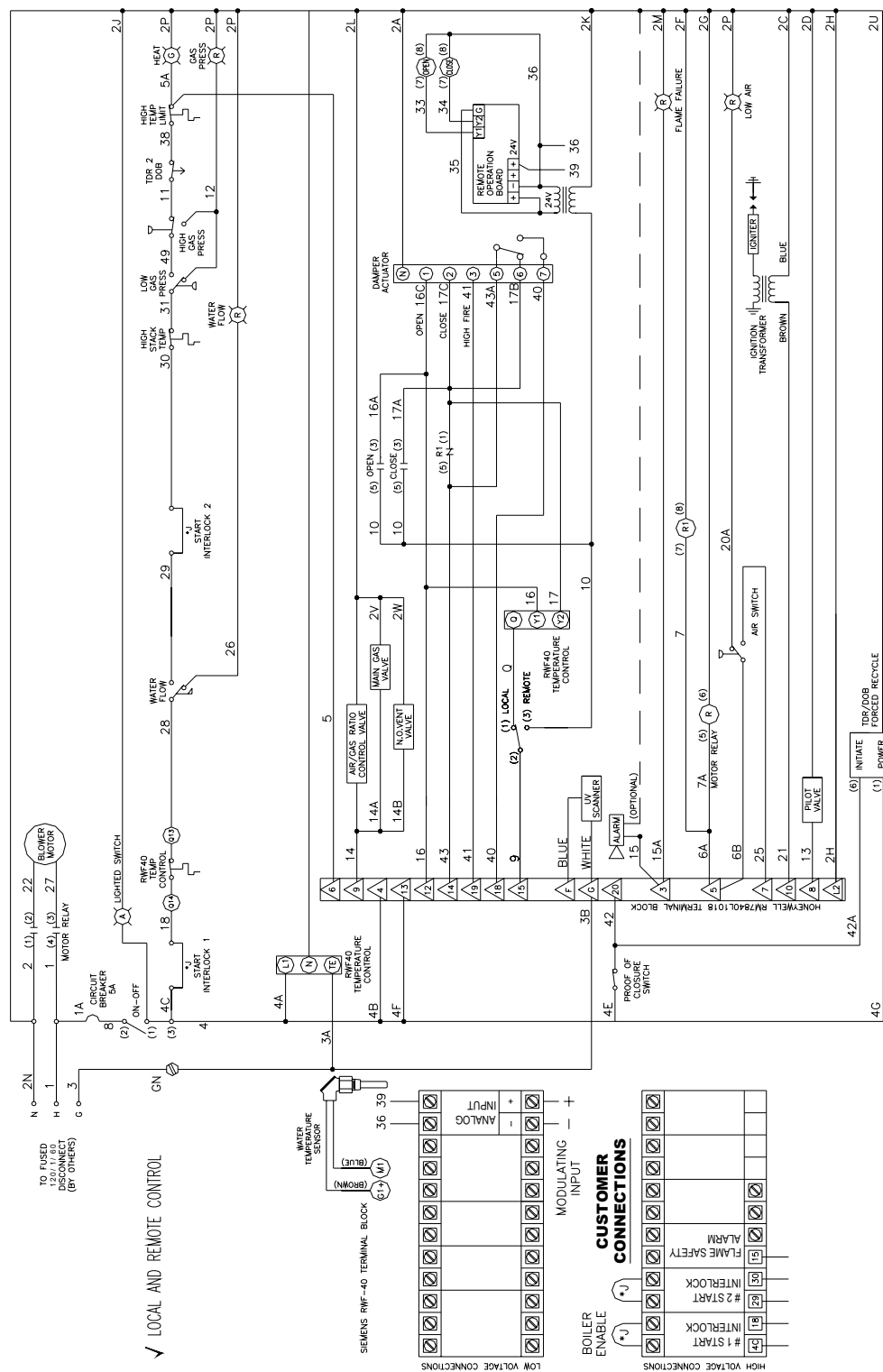


# IRI Unit - Remote Control - Logic Diagram



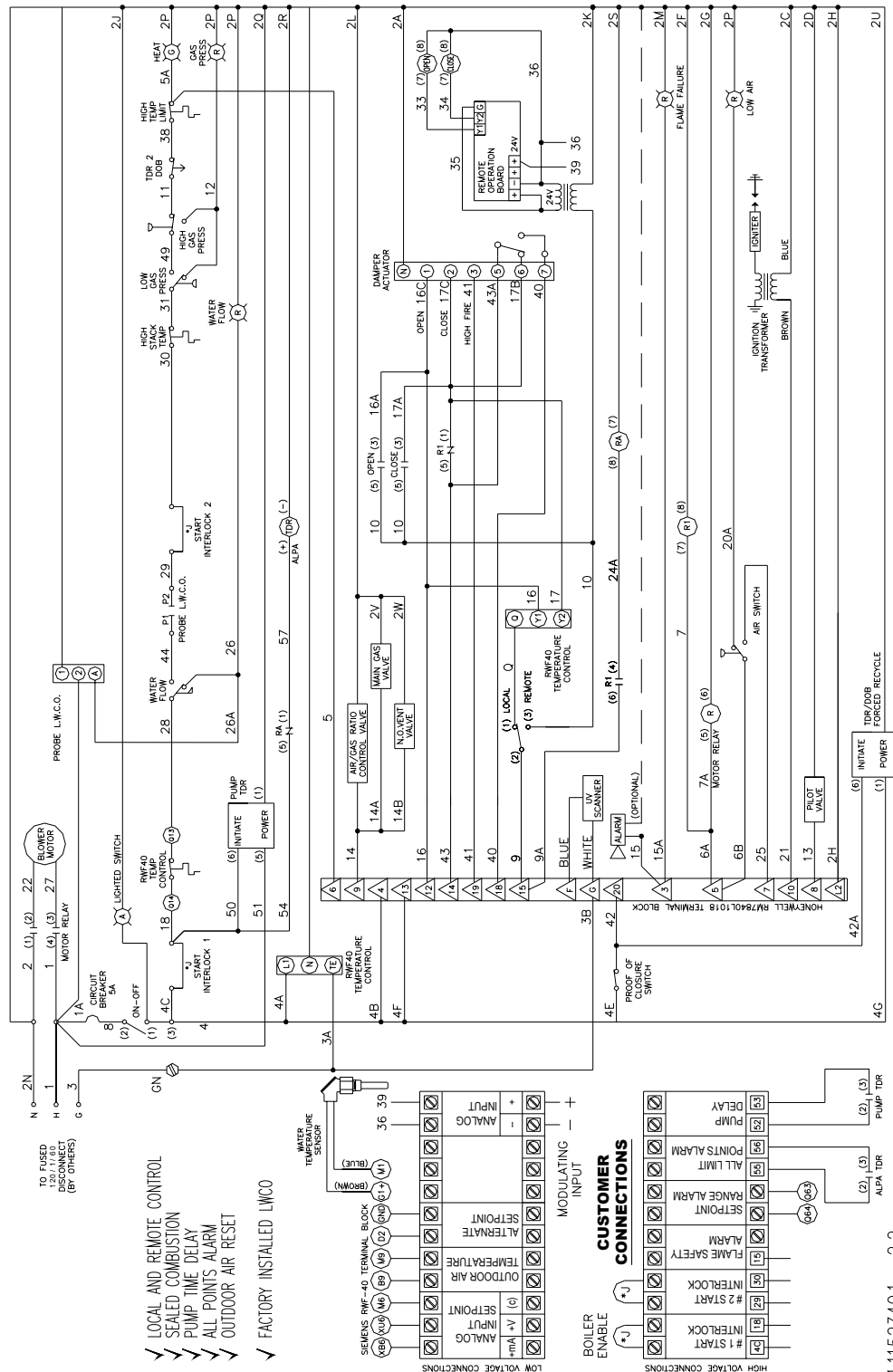


### IRI Unit - Local & Remote Control - Logic Diagram



M101500000 -2.2

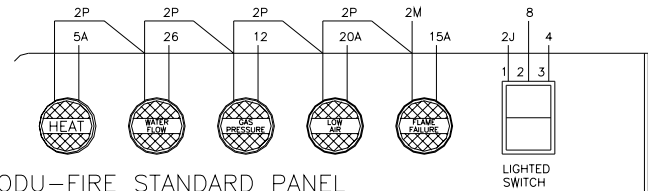
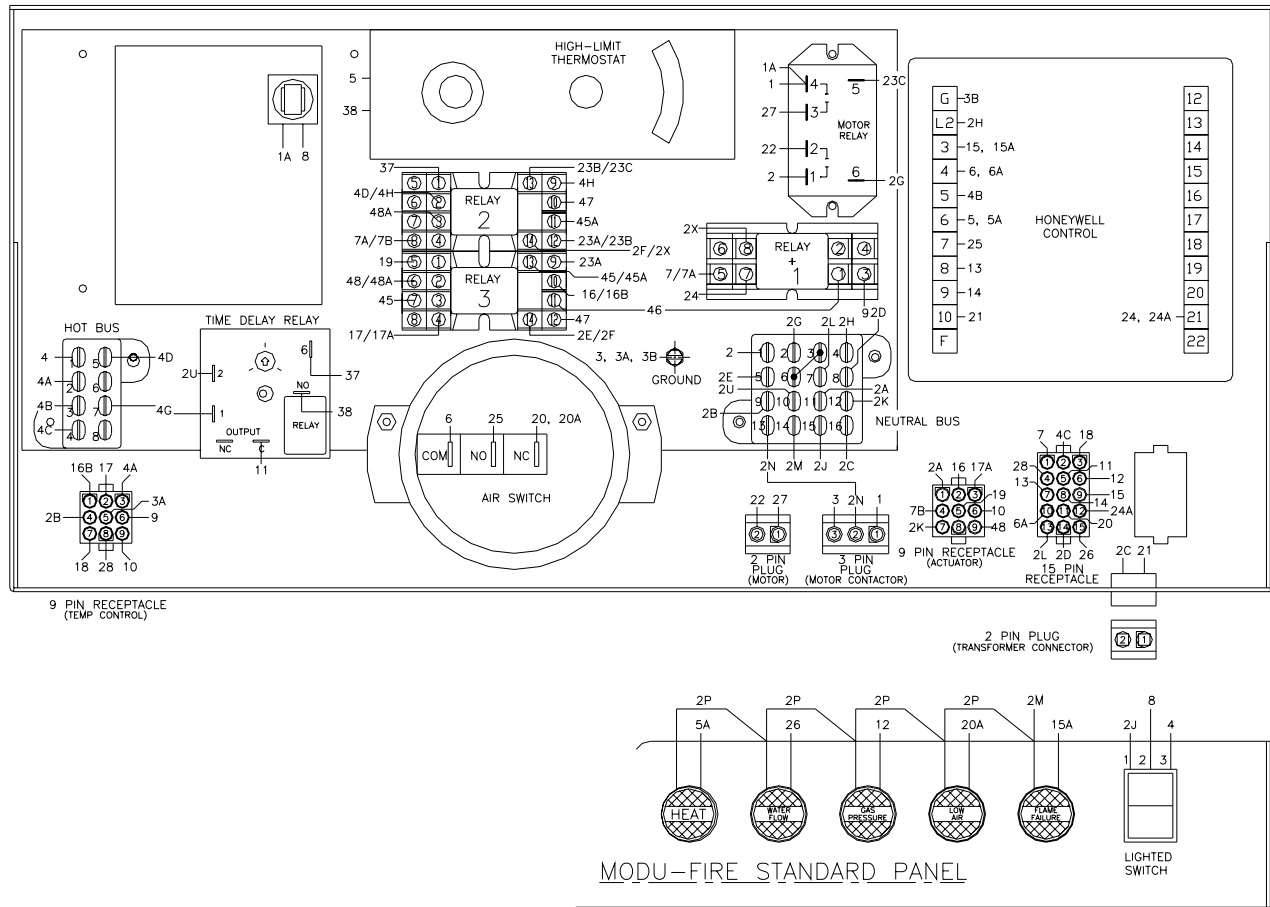
### IRI Unit - Local & Remote Control w Options - Logic Diagram



M111523401 -2.2

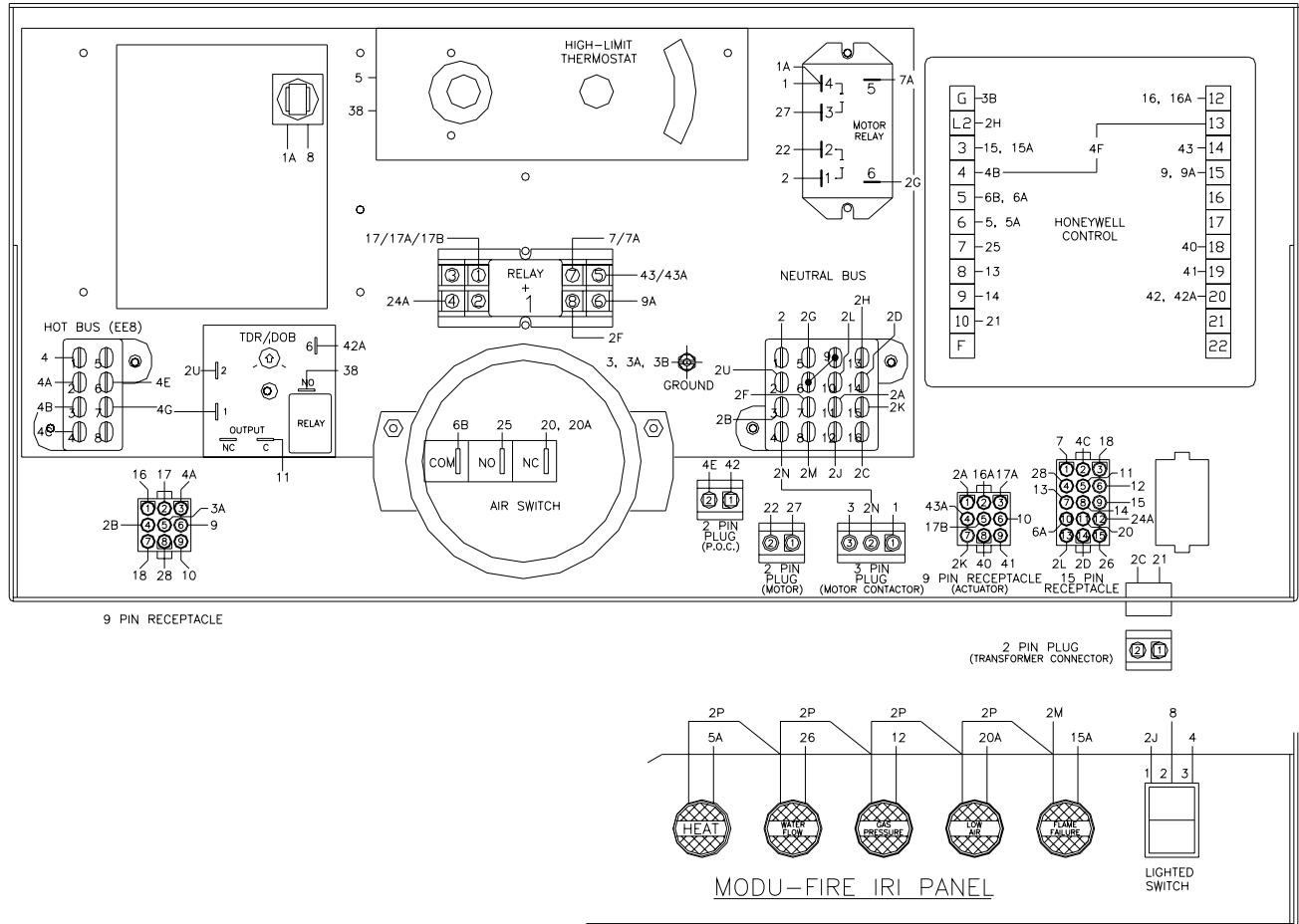


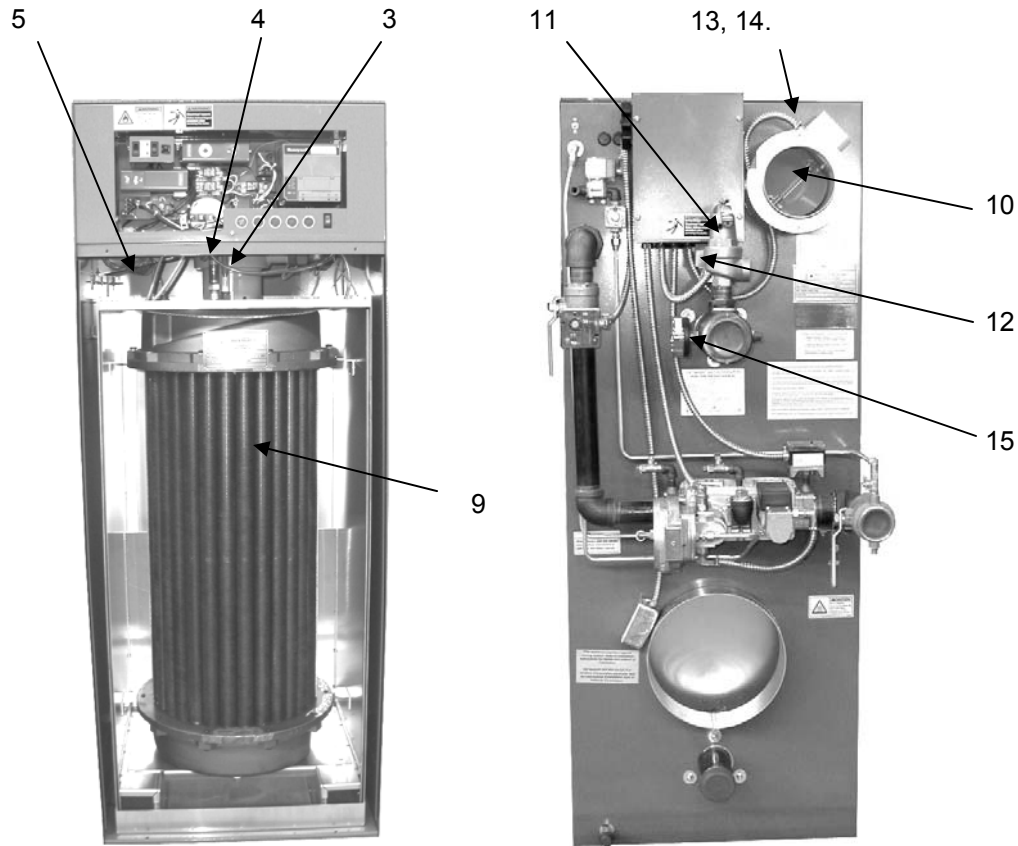
## Standard Unit – Panel Layout





## IRI Unit – Panel Layout



**6.2 BOILER PARTS LIST****6.2.1 Main Assembly**

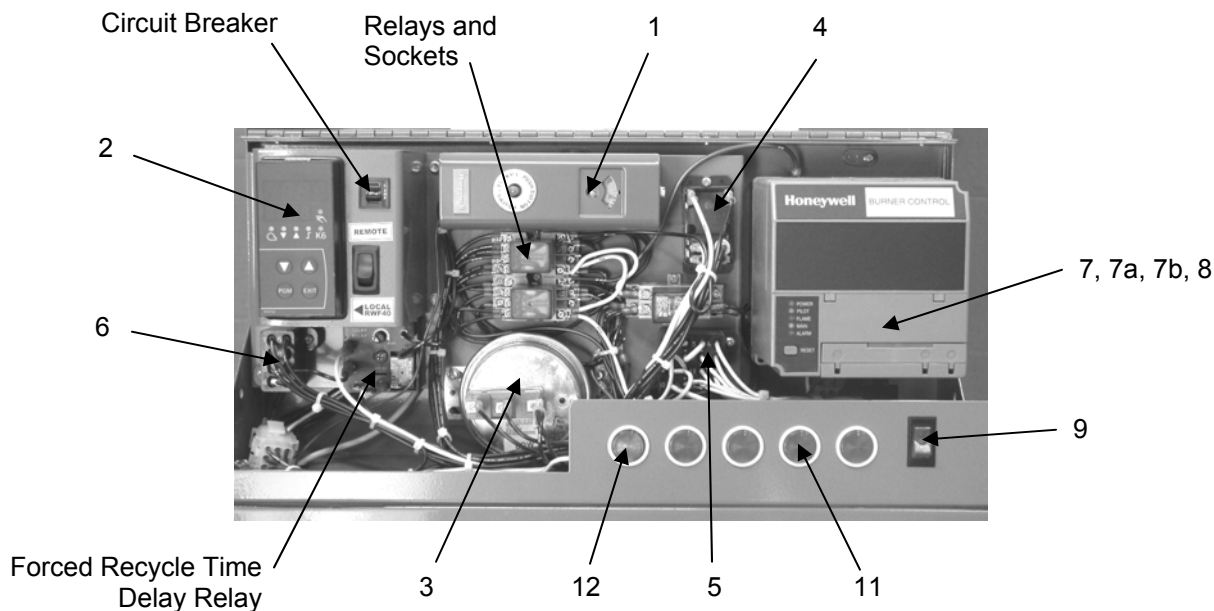
<b>No.</b>	<b>Part</b>
1.	Mixer Core, Burner (Inside Cabinet)
2.	Burner Orifice (Inside Cabinet)
3.	Spark Igniter Electrode
4.	UV Scanner
5.	Thermowell w/Clamp
6.	Electrode Assembly w/Mica (Inside Cabinet)
7.	Pilot Tube (Inside Cabinet)
8.	Burner (Inside Cabinet)
9.	Heat Exchanger
10.	Blower Damper
11.	Pressure Relief Valve (100 PSI)

<b>No.</b>	<b>Part</b>
12.	Water Flow Switch
13.	Blower, Motor (Inside Cabinet)
14.	Blower, Wheel (Inside Cabinet)
15.	Press./Temp. Gauge

Installation/Owner's Manual All Models-MOD  
 CP Control Panel (Section 6.2.2)  
 EC Exterior Cabinet (Section 6.2.4)  
 IC Interior Cabinet (Section 6.2.4)  
 PG Pilot Gas Train (Section 6.2.3)  
 MG Main Gas Train (Section 6.2.3)



## 6.2.2 Control Panel



Local Control Panel

No.	Part
-----	------

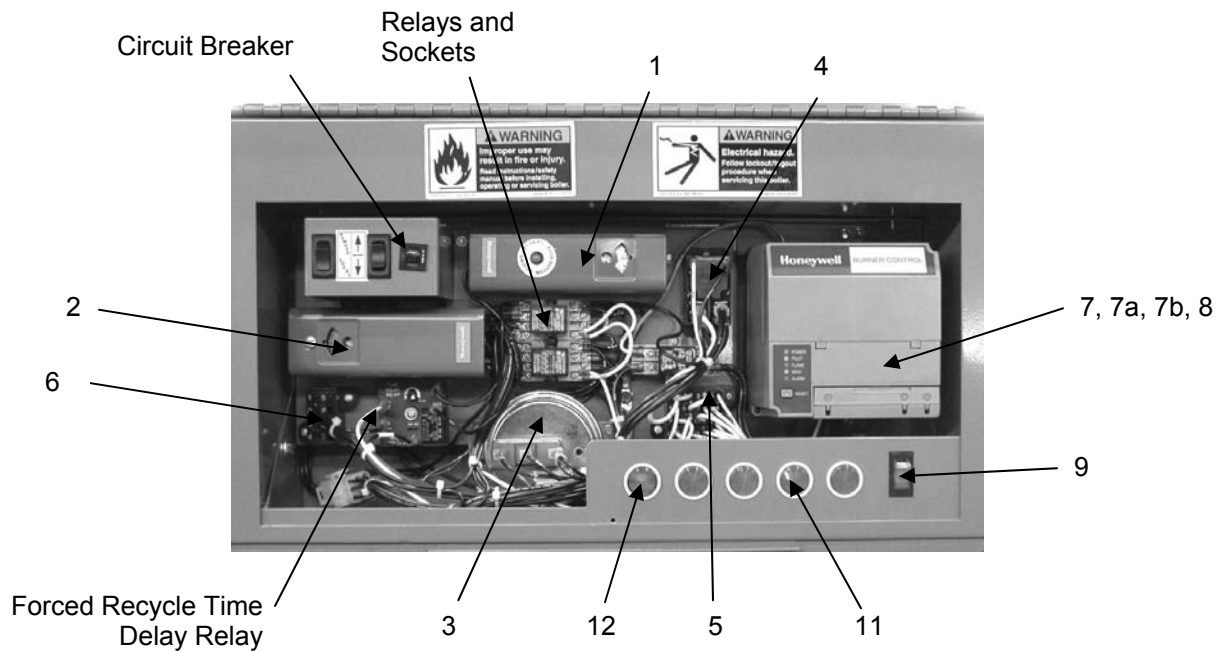
- |    |                           |
|----|---------------------------|
| 1. | Thermostat (Manual Reset) |
| 2. | Thermostat (Oper. Temp)   |
| 3. | Air Flow Switch           |
| 4. | Motor Start Relay         |
| 5. | Terminal Block, Neutral   |
| 6. | Terminal Block, Power     |

No.	Part
-----	------

- |     |                                    |
|-----|------------------------------------|
| 7.  | Flame Safeguard Programmer         |
| 7a. | Amplifier (UV Scanner)             |
| 7b. | Timing Card, 30 sec.               |
| 8.  | Programmer, Sub-Base               |
| 9.  | Switch, On/Off, Lighted            |
| 10. | Ignition Transformer (not visible) |

No.	Part
-----	------

- |      |                              |
|------|------------------------------|
| 10a. | Ignition Cable (not visible) |
| 11.  | Indicator Light, Red         |
| 12.  | Indicator Light, Green       |



Remote Control Panel

No.	Part
-----	------

- |    |                            |
|----|----------------------------|
| 1. | Thermostat (Manual Re-set) |
| 2. | Thermostat (Oper. Temp)    |
| 3. | Air Flow Switch            |
| 4. | Motor Start Relay          |
| 5. | Terminal Block, Neutral    |
| 6. | Terminal Block, Power      |

No.	Part
-----	------

- |     |                                    |
|-----|------------------------------------|
| 7.  | Flame Safeguard Programmer         |
| 7a. | Amplifier (UV Scanner)             |
| 7b. | Timing Card, 30 sec.               |
| 8.  | Programmer, Sub-Base               |
| 9.  | Switch, On/Off, Lighted            |
| 10. | Ignition Transformer (not visible) |

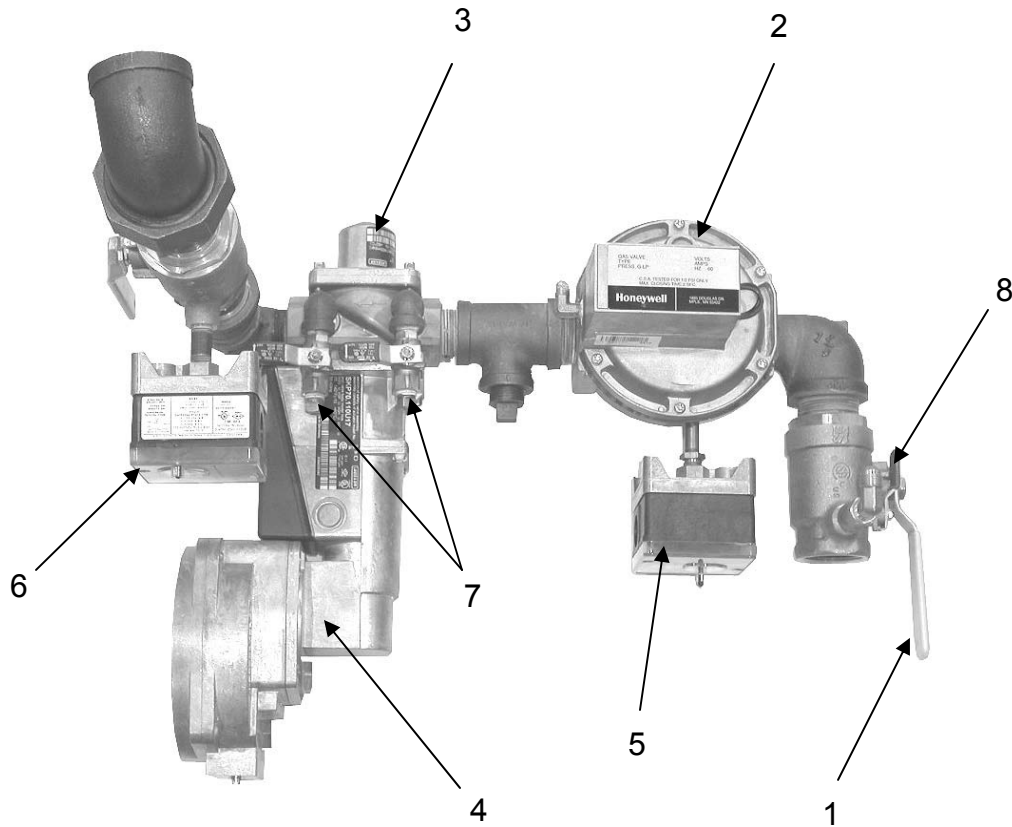
No.	Part
-----	------

- |      |                              |
|------|------------------------------|
| 10a. | Ignition Cable (not visible) |
| 11.  | Indicator Light, Red         |
| 12.  | Indicator Light, Green       |



## 6.2.3 Gas Trains

### 6.2.3.1 Standard Gas Train - 1000

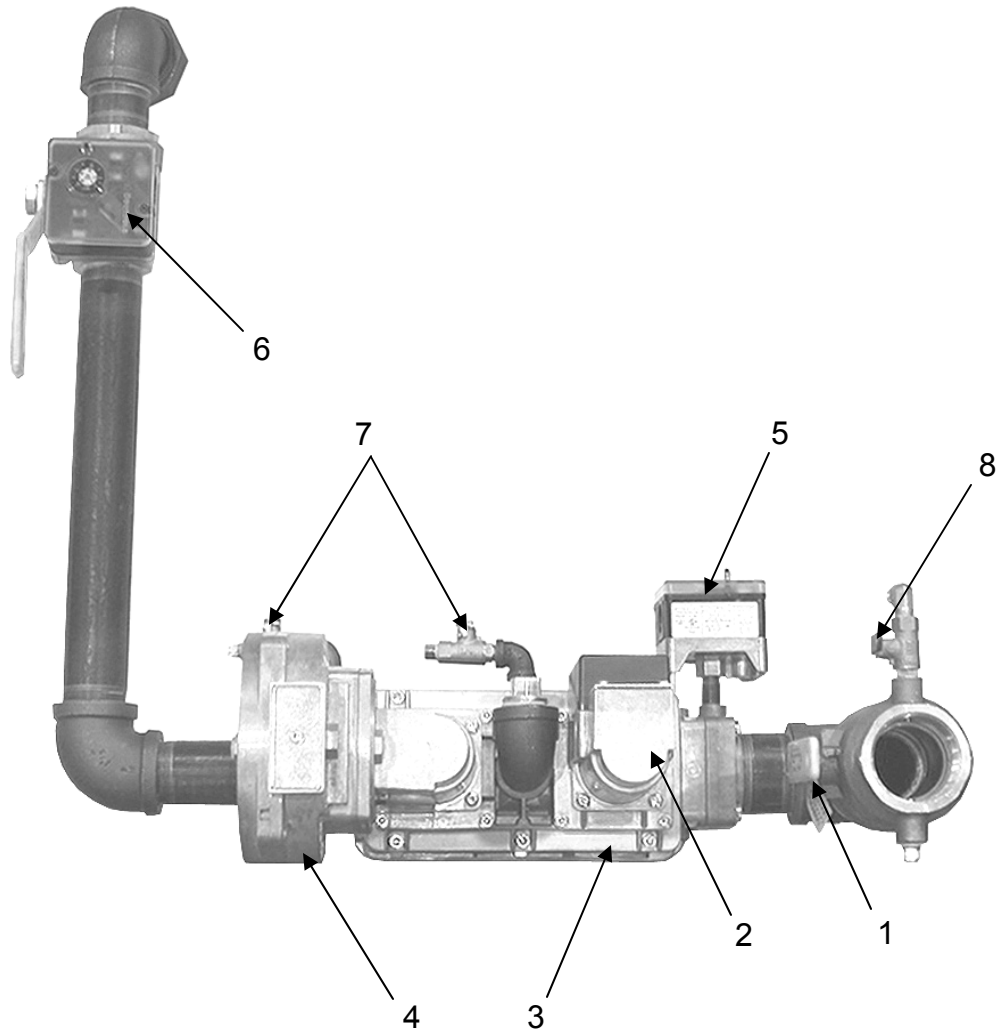


No.	Part
1.	Main Gas Shutoff Cock
2.	Main Gas Valve Actuator
3.	Main Gas Valve
4.	Air/Gas Ratio Control
5.	Low Gas Pressure Switch
6.	High Gas Pressure Switch
7.	Leak Test Valve
8.	Pilot Gas Cock





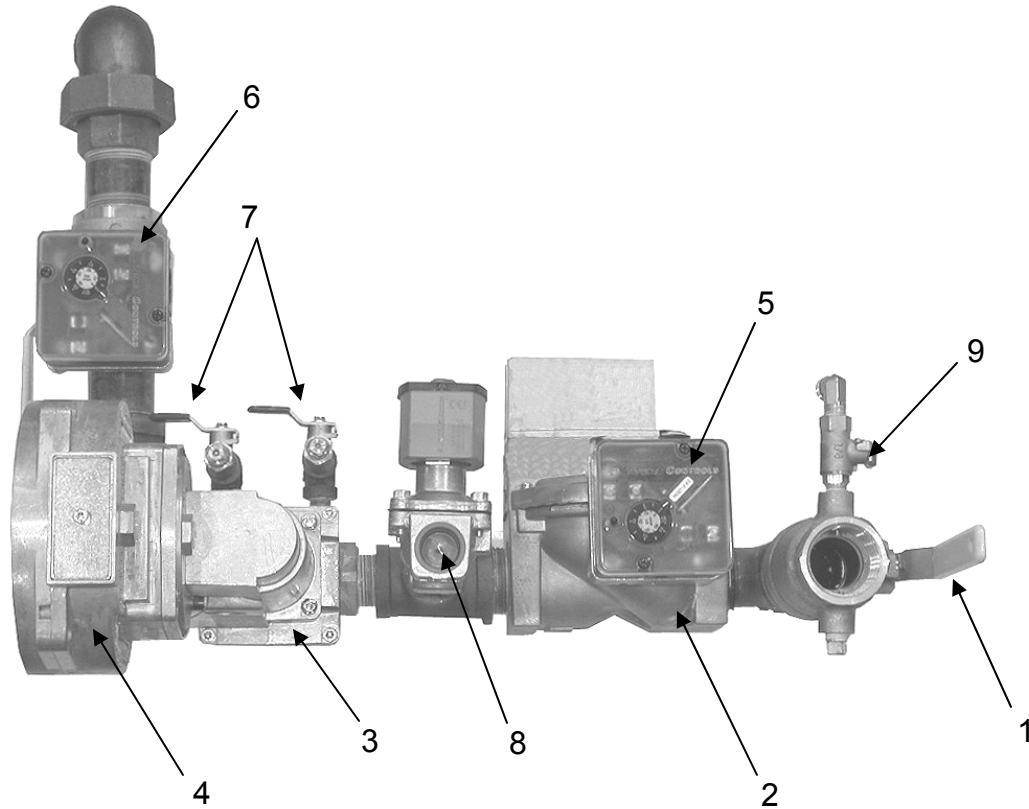
6.2.3.2 Standard Gas Train - 1500 & 2000



No.	Part
1.	Main Gas Shutoff Cock
2.	Main Gas Valve Actuator
3.	Main Gas Valve
4.	Air/Gas Ratio Control
5.	Low Gas Pressure Switch
6.	High Gas Pressure Switch
7.	Leak Test Valve
8.	Pilot Gas Cock



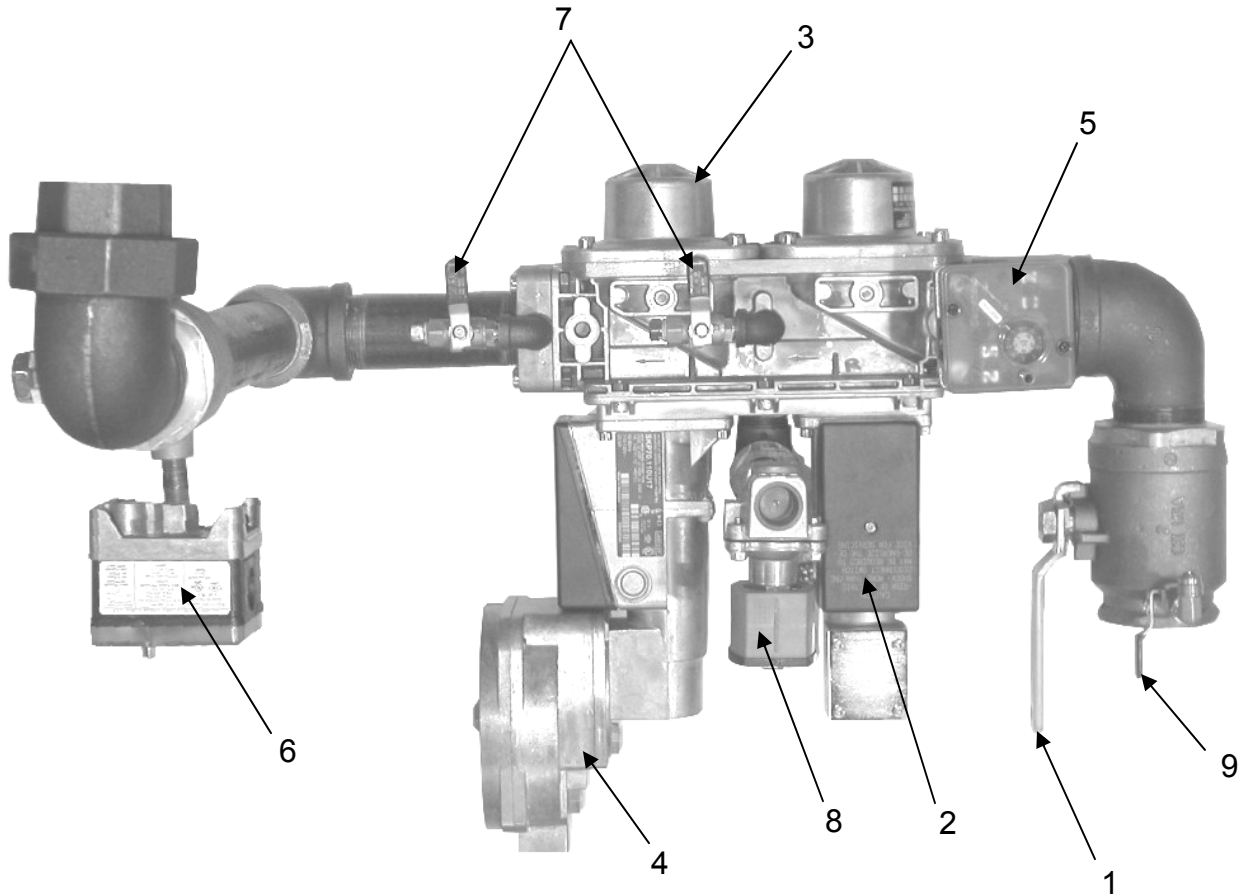
6.2.3.3 IRI Gas Train - 1000



No.	Part
1.	Main Gas Shutoff Cock
2.	Main Gas Valve Actuator
3.	Main Gas Valve
4.	Air/Gas Ratio Control
5.	Low Gas Pressure Switch
6.	High Gas Pressure Switch
7.	Leak Test Valve
8.	Normally Open Vent Valve
9.	Pilot Gas Cock



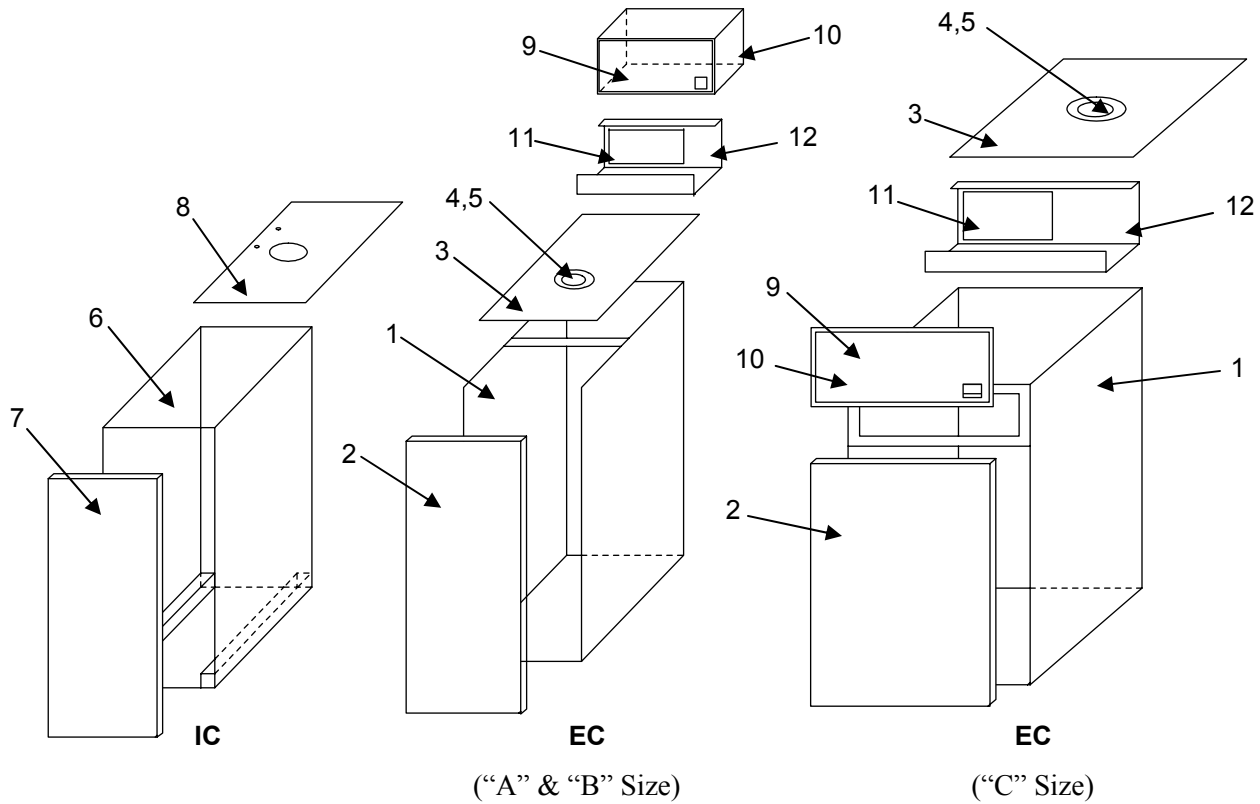
6.2.3.4 IRI Gas Train - 1500 & 2000



<b>No.</b>	<b>Part</b>
1.	Main Gas Shutoff Cock
2.	Main Gas Valve Actuator
3.	Main Gas Valve
4.	Air/Gas Ratio Control
5.	Low Gas Pressure Switch
6.	High Gas Pressure Switch
7.	Leak Test Valve
8.	Normally Open Vent Valve
9.	Pilot Gas Cock



## 6.2.4 Cabinet



No.	Part
1.	Exterior Cabinet, Assy.
2.	Exterior Cabinet, Door
3.	Exterior Cabinet, Top
4.	Sight Glass
5.	Sight Glass Bezel
6.	Combustion Chamber, Assy.
7.	Combustion Chamber, Door
8.	Combustion Chamber, Top
9.	Control Panel, Label
10.	Control Panel, Cover
11.	Control Panel, Sub Panel
12.	Control Panel, Base Assy.



## 7.0 LIMITED WARRANTY

Subject to the terms and conditions herein and except as provided below with respect to products or parts not manufactured by Patterson - Kelley Co., Seller warrants to the original owner at the original installation site that products manufactured by Seller ("Products") comply, at the time of manufacture, with recognized hydronics industry regulatory agency standards and requirements then in effect and will be free from defects in materials and workmanship for a period of five (5) years from date of shipment (the "Warranty Period"). For products or parts not manufactured by Patterson - Kelley, the warranty obligations shall, in all respects, be limited to one year.

### 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: Patterson-Kelley Co, Box 458, 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 as 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 this 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 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.