



PATTERSON-KELLEY

MACH® SERIES BOILER

GAS-FIRED BOILER



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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Installation Date: _____



Patterson-Kelley

Harsco

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MACH® Series Gas-Fired Boiler



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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.

WARNING!

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

WARNING!

Chemicals, fuels, or other potentially hazardous or toxic materials must not be stored in the same room as the boiler.

WARNING!

Installation and service must be performed by a qualified installer or service agency who has been trained on the Patterson-Kelley MACH® Boiler.

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 MACH® Series Gas-Fired Boilers are fully modulating using a variable speed combustion blower, sophisticated microprocessor controls, modulating gas safety shut off / control valves and a unique aluminum alloy heat exchanger capable of operating in a fully condensing mode to provide maximum efficiency in a minimum amount of space. The high-quality materials and thoroughly tested design of the boiler should provide years of trouble-free service if the instructions in this manual are followed carefully.

This manual covers installation of P-K MACH® Series Boilers. 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 may be built to operate with natural gas or liquefied petroleum gas (propane). Check the rating plate for correct fuel usage and gas pressures.

The boiler is only a part of the complete heating system. This boiler may be fully operational and yet because of poor circulation, control, 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 MACH® Series gas-fired boiler **must** be:

- Installed, operated, and serviced in accordance with instructions contained in this manual.
- Installed by qualified personnel 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, properly trained personnel in accordance with all applicable codes, laws, and regulations.

Note: Each safety device must be maintained and checked per the recommended schedule; refer to Section 5.1 of this manual.

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 property damage, serious injury, or death.

Proper training is the best protection against accidents. Operating and service personnel must be thoroughly familiar with the basic construction of the P-K MACH® Series 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 toll-free at (877) 728-5351 for assistance.

2.3 SAFETY FEATURES

It is the responsibility of the customer to maintain the safety features, 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 toll-free at (877) 728-5351 for replacement labels.

2.5 SAFETY PRECAUTIONS

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

2.5.1 Electrical Hazards



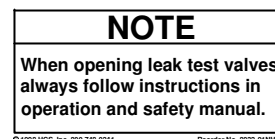
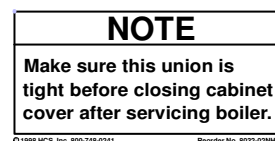
- Shock hazard! Properly lockout/tagout the electrical service and all other energy sources before working on or near the boiler.
- Shock hazard! Do not spray water directly on any electrical components.

2.5.2 Burn, Fire, and Explosion Hazards



General Warning

Hot Surface



- 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 vent lines for gas devices. Refer to Section 3.7.1.
- Hazard from incorrect fuels! Possible fire, explosion, overheating, and damage. Do not use any fuels except the design fuels 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! Pipes, vents, and boiler components could be hot. Do not touch piping or stack surfaces during operation or immediately after shutdown of the boiler.
- 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 the burner is installed correctly and burner hood is securely fastened following any maintenance performed on them. 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 trained service 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 gas safety shut off / control 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
450,000 Btu	440
300,000 Btu	354

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

2.5.4 Chemical Hazards



General Warning

- Chemical hazards from cleaning products. Use caution when cleaning the system. The use of professional assistance is recommended. Use safe procedures for the disposal of all cleaning solutions.
- Combustion Condensate – a pH of approximately 4 to 5 can be expected. Use PVC or CPVC piping. Collection and disposal must be in accordance with all applicable regulations.



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

3.1.1 Initial Inspection

Upon receiving the boiler, inspect it for signs of shipping damage. Since some damage may be hidden, we recommend unpacking the boiler and removing the top cover and inspecting the boiler.

Verify that the total number of pieces shown on the packing slip agrees with those actually received.

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

3.1.2 Storage Prior to Installation

If the boiler is not installed immediately, it must be stored in a location adequately protected from the weather, 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

The P-K MACH® Series 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 50 psig maximum operating pressure and/or 200° F maximum 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

3.3.1 Foundation

Provide a firm, level foundation, preferably of concrete.

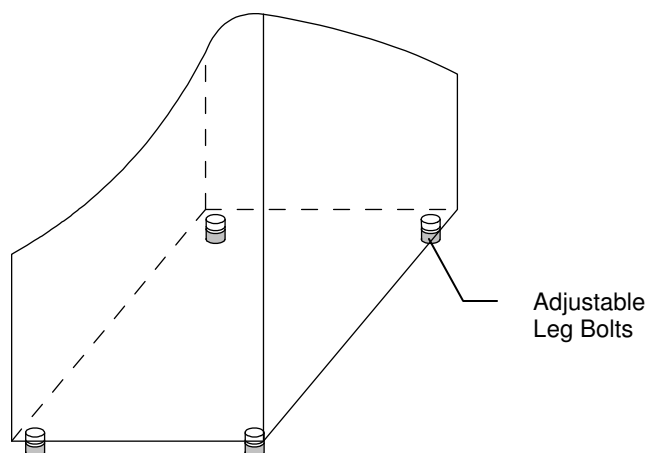
Note: The boiler may be installed on a combustible floor; however, the boiler must **never** be installed on carpeting.

3.3.2 Placement

The boiler must be level to function properly. To assist in leveling the boiler, the four (4) adjustable leg bolts (1/2"- 13 NC) must be installed. The adjustable legs are also necessary to provide adequate floor



clearance and prevent distortion of the cabinet, (twisting, etc.) in addition to leveling.



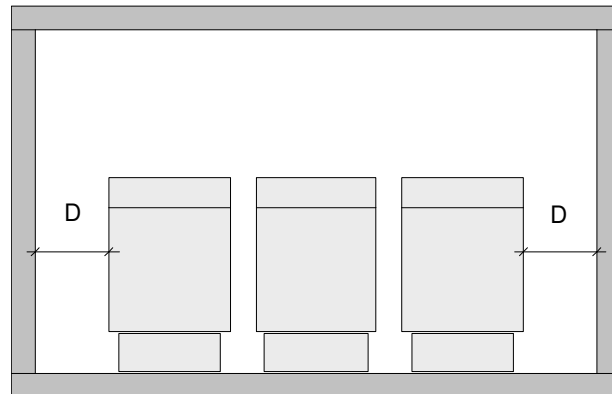
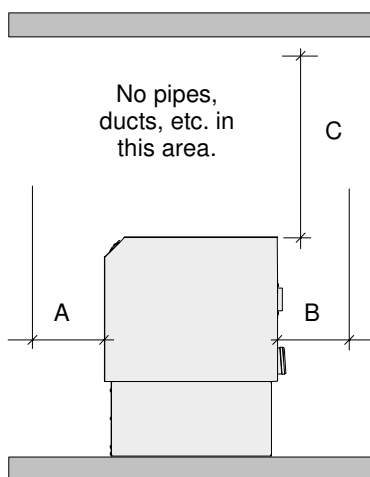
Adjustable Legs for Leveling and Floor Clearance

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.



Minimum Clearances from Adjacent Walls, Ceiling, and Obstructions

Type of Surface	Dimensions (inches)			
	A	B	C†	D
Combustible Surfaces	36	24	24	24
Non-combustible Surfaces	36	*	24	24**

† "C" Do not put pipes, ducts, etc. in this area above the boiler.

CAUTION!

Bumping hazard from overhead ducts! Install all components with adequate vertical clearances.

* Clearance depends upon vent configuration.

** 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.

3.4 ELECTRICAL CONNECTIONS

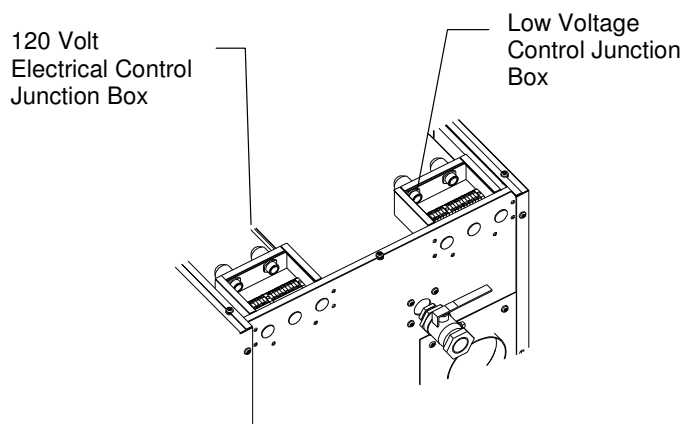
The boiler is wired for 120 volts, single phase, 60 hertz. The total operating amperage is indicated on the rating nameplate. The 300 and 450 units require less than 8 amps. Before starting the boiler, check to ensure that the proper electrical service is connected to the boiler.



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 to the current Canadian Electrical Code, Part I, CSA C22.1.

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.

Note: Refer to Terminal Block Assignments (Section 6.1.1).



Electrical Connections at Rear of Boiler

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

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 B.149 Installation Code. 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.

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.

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.

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,

3.5.1 Air Inlet Requirements

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, 112.5 square inches are required for 450,000 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., 225 square inches for 450,000 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 (450 square inches for a 450,000 Btu per hour.)

3.6 FLUE VENTING

This boiler requires a special vent system. **This boiler is not certified for use with Type "B" vent.**

This boiler is Category IV (condensing – positive pressure) as it is defined in ANSI Z21.13/CSA 4.9, latest edition. The vent material must be listed Category IV vent pipe (316L or AL29-4C Stainless Steel) and comply with UL 1738 or UL103. In Canada it must comply with ULC-636. The exhaust vent can be run horizontally or vertically.

Vent installations shall be in accordance with Part 10, Venting of Equipment, of the National Fuel Gas Code, ANSI Z223.1 or CSA B.149 code, or applicable provisions of the local building codes.

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

The vent must be sized according to the vent manufacturer's recommendations. Consult your vent supplier for correct sizing and structural support requirements. Design calculations should be based on a maximum of 0.22" W.C. total frictional resistance in the stack (measured at the boiler flue gas discharge) approximately 100 equivalent feet, with a stack temperature of 240° F (gross) and a CO₂ level of 9% (natural gas) or 10.4% (propane). These values are to be used for vent sizing calculations.

The installation of a bird screen on the vent termination is recommended. Consult your local vent manufacturer for proper sizing.

3.6.1 Barometric Damper

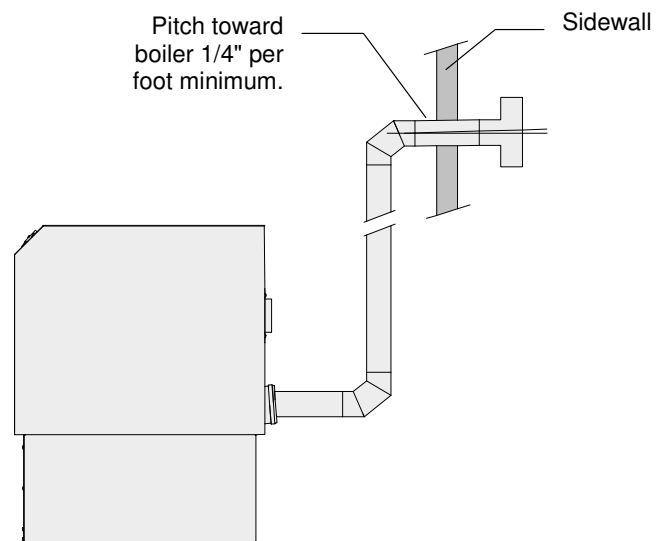
WARNING!

Do not use a barometric damper with this boiler. (This is a positive pressure system; combustion gas may leak into the room.)

3.6.2 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 another mechanical draft system operating under positive pressure without consulting your local venting representative. Provisions must be made for supports to prevent contact of the vent with combustible surfaces.

Note: If the vent is erected directly behind the boiler, 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.



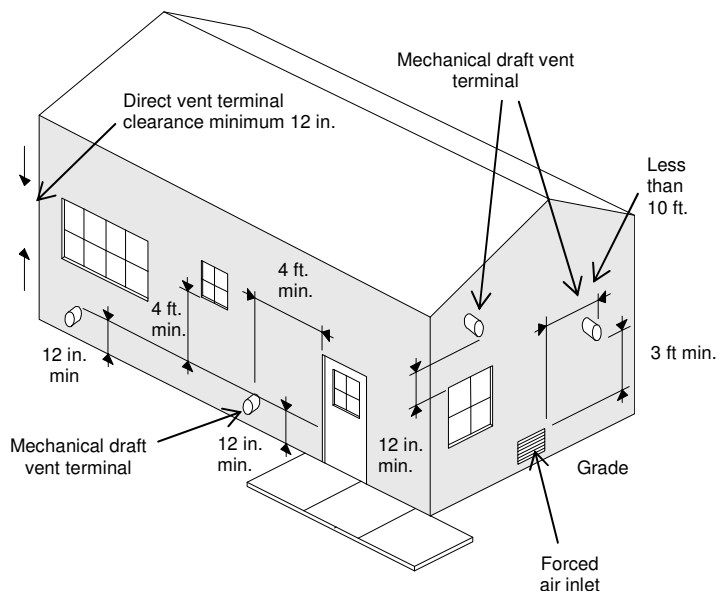
Flue Connection at Boiler

3.6.3 Required Clearances

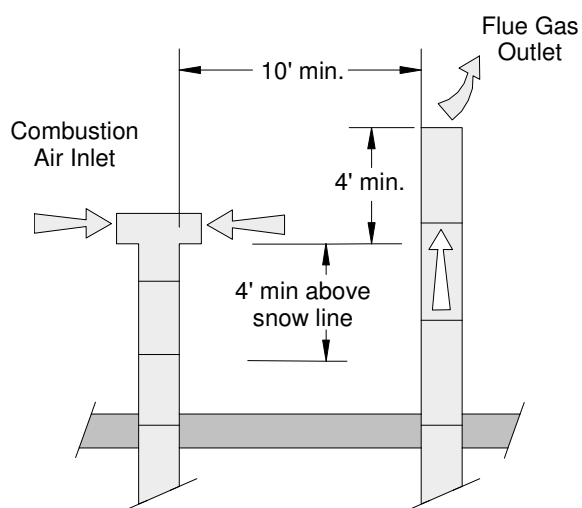
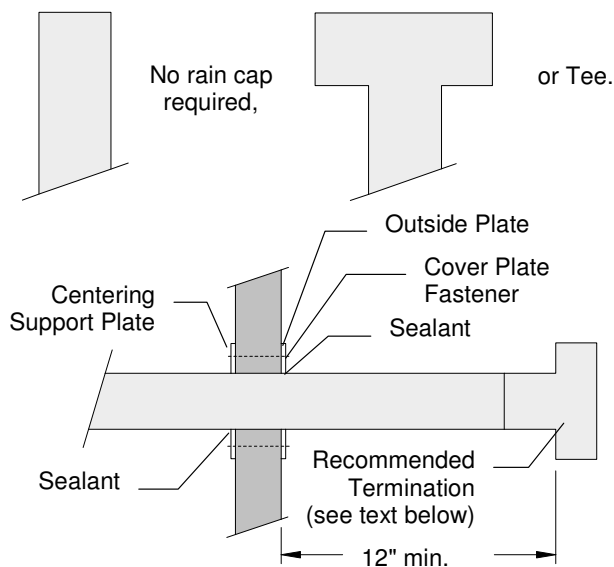
Provide clearances between combustion air intake, exhaust vent, roof and wall surfaces, doors and window, and snow line as shown in the following diagrams. The exhaust vent termination must be 14 feet above grade when located adjacent to a public walkway. It must also have a minimum 6 foot horizontal and 6 foot vertical clearance (above or below) any electric meters, gas meters, regulators, or relief equipment.

**WARNING!**

Do not locate intake or exhaust terminations directly above a walkway; dripping of condensation can cause icing of the walking surface.



Reference: ANSI Z223.1 - 2002

Sidewall Installations**Rooftop Installations****3.6.4 Vent Terminations****Vent Termination Details**

The vent should extend at least three (3) feet above the roof, or at least two (2) feet above the highest part of any structure within ten (10) feet of the vent.

To prevent the possible re-circulation of flue gases, your vent designer must take into consideration such things as prevailing winds, eddy zones, building configurations, etc. P-K can not be responsible for the effects such adverse conditions may have on the operation of the boilers. Dimensions listed above or those illustrated are minimum, and may or may not be sufficient for conditions at a specific job site.

A tee must be of approved design and adequate capacity.

3.6.5 Venting for Multiple Boilers

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

Venting systems for multiple boilers must be designed by qualified professionals and verified by the stack manufacturer. The venting system must prevent backflow of exhaust gas through idle boilers which are not operating.



3.6.6 Sealed Combustion Air/Venting System

The MACH® Series Boilers are also certified for operation with a sealed combustion air and pressurized venting system. Such a system employs a sealed combustion air intake duct leading from outdoors and a sealed exhaust vent terminating outdoors. Air flow through the system is maintained by the fan inside the boiler assembly.

Vent Installation Details

Installation must conform to the vent manufacturer's instructions in all respects including joining, clearances, fastening, fire-stopping, and other matters.

Vent ductwork may be run horizontally or vertically if so certified.

3.6.7 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:

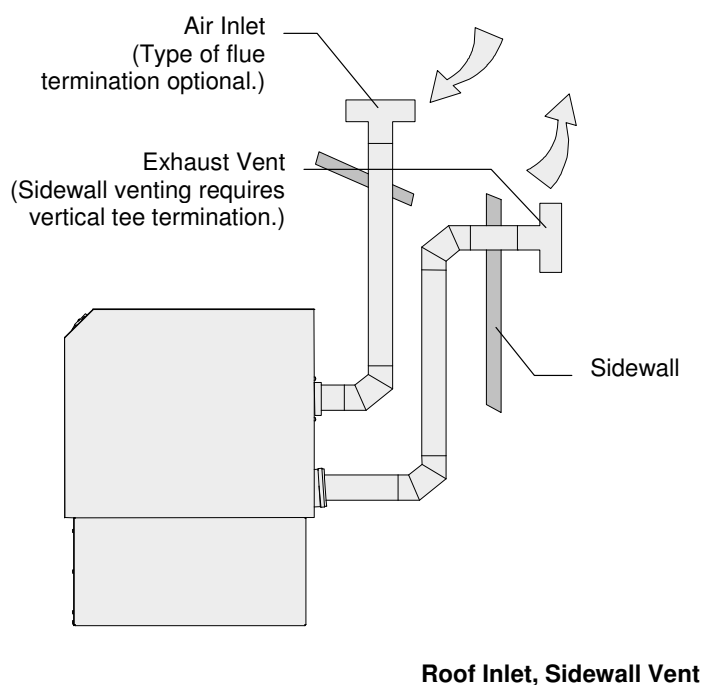
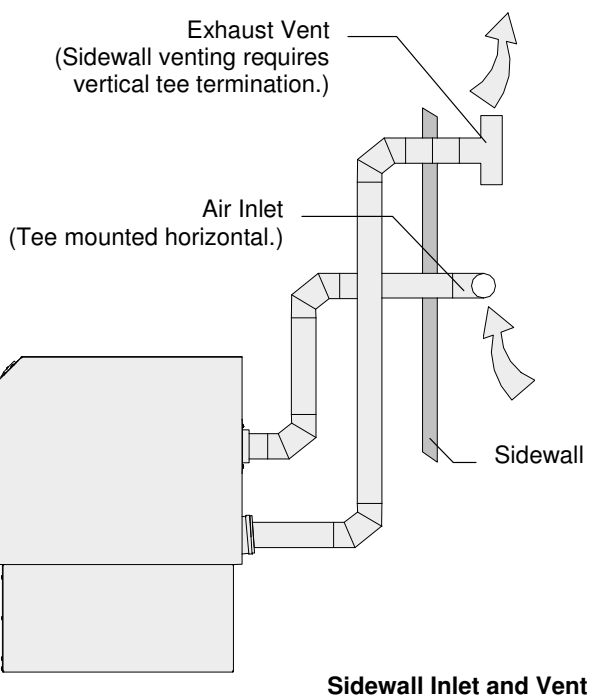
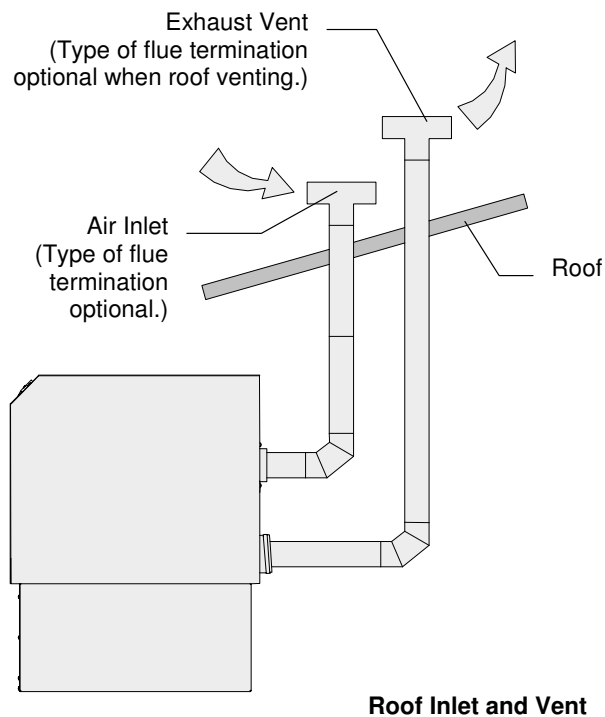
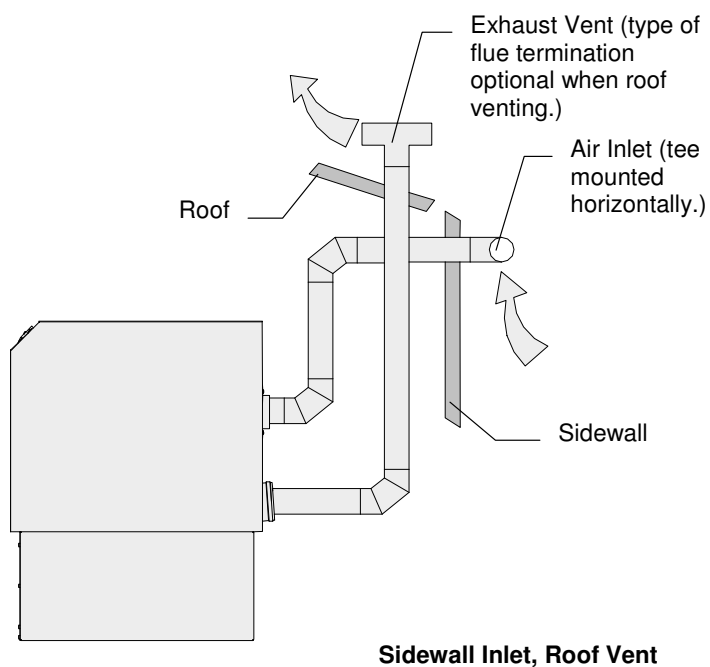
1. Seal any unused openings in the common venting system.
2. Visually inspect the venting system for proper size and horizontal pitch and determine that there is no blockage or restriction, leakage, corrosion or other deficiency which could cause an unsafe condition.

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 and CSA B149 Installation Code. When resizing any portion of the common venting system, the common vent system should be resized to approach the minimum size as determined using the appropriate tables.

3.6.8 Intake/Exhaust Layout

Four basic configurations for the intake/exhaust may be used. **Refer to Section 3.6.3 for required clearances for all terminations shown in the four following figures.**



Basic Air Inlet/Vent Configurations



3.6.13 Vent Elbows

The turn from horizontal to vertical should be made with two 45° elbows or with one long radius 90° ell for best operation. Do not use "short radius" ell.

3.7 GAS PIPING

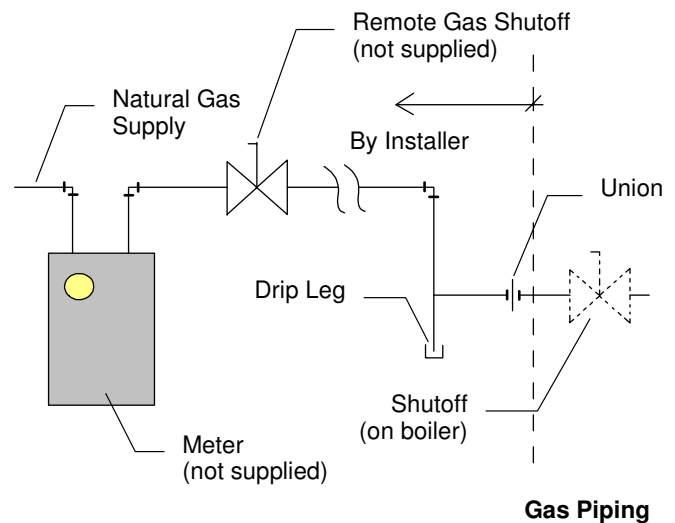
Before making the gas hook-up, make sure the boiler is being supplied with the type of fuel shown on the boiler nameplate.

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 boiler is factory fire-tested and adjusted for proper combustion with natural gas supply pressure of 7" W.C. Typical gas pressure supply for natural gas is 7" W.C. (11" W.C. for propane). The gas train components are certified to handle a maximum inlet pressure of 14" W.C. (1/2 psig.). If the available gas pressure exceeds 14" 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" W.C.

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.**



In the Commonwealth of Massachusetts, the gas cock must be a "T-handle type."

Note: Install a sediment trap (drip leg) and a union connection ahead of the primary manual shutoff valve 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 Pipe Capacity for Natural Gas chart on the following page for required pipe size, based on overall length of pipe from meter plus equivalent length of all fittings. Approximate sizing may be based on 1 cubic foot of natural gas per 1,000 Btu per hour input, i.e., 500,000 Btu per hour requires about 500 cubic feet per hour. (See "Typical Boiler Operating Conditions," Section 4.3, for more information.)

**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
1/2	0.622	1.55	3.1	120	82	66	57	50	40	35
3/4	0.824	2.06	4.12	250	170	138	118	103	84	72
1	1.049	2.62	5.24	465	320	260	220	195	160	135
1- 1/4	1.380	3.45	6.9	950	660	530	460	400	325	280
1- 1/2	1.610	4.02	8.04	1460	990	810	690	620	500	430
2	2.067	5.17	10.3	2750	1900	1520	1300	1150	950	800
2- 1/2	2.469	6.16	12.3	4350	3000	2400	2050	1850	1500	1280
3	3.068	7.67	15.3	7700	5300	4300	3700	3250	2650	2280
4	4.026	10.1	20.2	15800	10900	8800	7500	6700	5500	4600

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" W.C.).

During any pressure testing of the gas supply piping system at pressures equal to or less than 1/2 psig (14" 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.

3.8 BOILER WATER PIPING**3.8.1 Piping Design*****Water Flow in System***

For proper water flow requirements see below. Incorrect flow may result in eventual damage or premature failure of the equipment.

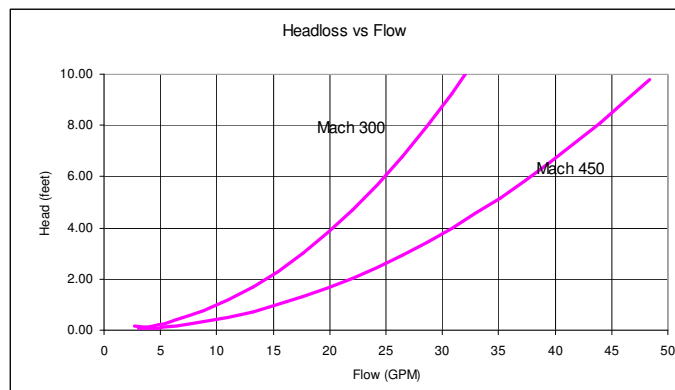
MACH® Series 450

- Max. Flow: 45 gpm
- Min. Flow: 22 gpm (at max. firing rate)

MACH® Series 300

- Max. Flow: 30 gpm
- Min. Flow: 15 gpm (at max. firing rate)

Contact factory for minimum flow at other than maximum firing rate.



Proper flow rates 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.

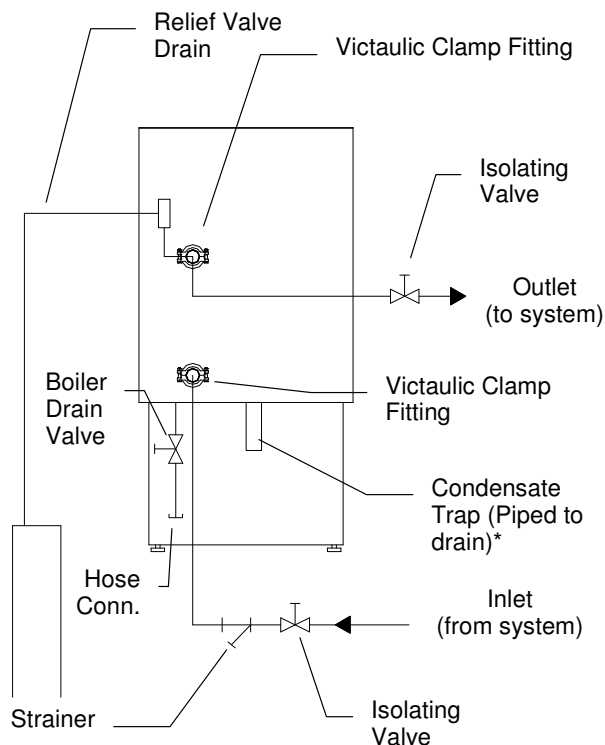
Piping With Refrigeration Machines

When installed in a two-pipe system that provides both chilled and hot water, the control system should be configured so as to limit the time rate of change of temperature at the boiler. Consult your authorized Patterson-Kelley boiler representative for application guidance.

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: The boiler is furnished with 2" grooved connections for Victaulic Style 75 Couplings. These coupling must be used with the EPDM Victaulic seals. 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.

* Note: Condensate Trap must be piped to drain in accordance with all state and local codes.



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 probe-type low water cut-off; no field piping is required. If the water level in the boiler drops below the probe, the boiler will shut down and a flashing **E 12** service code will be displayed on the control panel. The low water cutoff circuit will automatically reset when the low water condition clears; however the boiler controls will retain the lockout condition until the reset button on the display is depressed.

IMPORTANT!

The low water cutout probe only prevents boiler operation when the water level in the boiler is insufficient. It does not detect low water conditions in other parts of the system. Installation of high point vents or additional low water safety devices to protect the system should be considered.

Installation of external limit controls may be required by certain codes or in certain installations. Review applicable local codes for details.

Drain Valve and Piping

A drain valve is installed in the inlet (system return) header connection to the boiler. Prior to draining the boiler for maintenance or testing, electrical power and gas supply must be turned off to the boiler. The boiler must then be isolated from the system at the supply and return connections prior to draining water from the boiler.

Note: This drain valve is installed for draining of the boiler water only, not the entire system. Draining of the system through the boiler will result in depositing sediment from the system in the boiler which will result in poor heat transfer characteristics of the boiler and early boiler failure.

Condensate Drain

The condensate can be slightly acidic (pH between 3.0 and 5.0). This may be corrosive to some building drain systems. A condensate neutralization system may be required.

Disposal of condensate must comply with all state and local codes.

3.8.4 Flushing and Filling

Water Quality

The MACH® Series boiler heat exchanger is made of an aluminum alloy. The heat exchanger requires special water conditions to retain efficiency and function properly.

IMPORTANT!

Chemicals added to the system must be approved by the chemical manufacturer for use in aluminum boilers.

IMPORTANT!

Under no circumstances should petroleum based cleaning or sealing compounds be used in the boiler system.

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 will 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.

Water pH

The pH of the hydronic system fluid must be between 6.0 and 8.5. A periodic check of the system pH should be conducted to ensure these pH levels are maintained.

IMPORTANT!

Glycol and other additives must be approved by the chemical manufacturer for use in aluminum boilers and must meet the required pH levels listed above to prevent damaging the boiler.

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

Total solids:..... 2,500 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.

Flushing the System

Before filling the boiler, flush the system to remove any debris from construction or maintenance. Clean and flush old piping thoroughly before installing the boiler.

IMPORTANT!

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.

IMPORTANT!

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. Following chemical cleaning, the system should be thoroughly rinsed to remove cleaning agents prior to reconnecting the boiler to the system.

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.

3.9 BURNER AND IGNITION SYSTEM

3.9.1 Inspection

Inspect the unit to be sure nothing was damaged or knocked loose during shipment. Since some damage may be hidden, remove the top cover and inspect the boiler.

Inspect the gas train, blower, ignition electrode and boiler in general to be sure there was no damage during shipment or installation.



3.10 PRE-START CHECK LIST

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

1. Section 3.9.1 Inspection.
2. Flue gas from the boiler is properly vented; (refer to Section 3.6)
3. Gas connection has been made, pressure tested for leakage, and the line purged of air. Make sure all required vents have been installed.
4. Water connections are complete, and the boiler and system have been filled and purged of air.
5. The boiler is connected to a 120 volt power source with a disconnect having adequate overload protection.
6. Combustion air openings are not obstructed in any way and have adequate capacity.
7. The boiler is placed the proper distance from any combustible walls, in accordance with Section 3.3.3.
8. Relief valves have been piped to floor drains.
9. Condensate piping is properly connected.
10. Verify system fluid pH level is within specification.

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 4.1.1 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 shutdown as follows:

1. Loosen the retaining screw and remove the 5 pin connector from one of the two gas safety shut off / control valves.
2. Cycle the boiler on by generating a heat request. (The method for this will depend on your boiler configuration. See Section 3.12.1.2)
3. The boiler should run through the normal startup sequence, checking all of the limits and switches as in a normal start up. (See Sequence of Operation, Section 5.4)
4. When the boiler reaches the ignition period, a 2 will display as the first digit in the display, the spark terminal will energize, and one of the gas safety shut off / control valves will open. One open gas valve should not provide sufficient fuel to light the burner.
5. After 3 seconds the combustion control should lock out, and the display will flash **E-02** indicating a flame failure.

After completing this test, turn off the boiler and reconnect the 5 pin connector to the gas safety shut off / control valves retightening the retaining screw.

3.11.2 Test of Low Water Cut-out

The boiler is furnished with a probe-type low water cut-out 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. Isolate the boiler from the system pressure. After isolating the system, drain the water level below the low water cut-out probe. Turn the boiler back on. It should not operate, and a manual reset lockout displaying **E 12** on the display panel



will occur. The LED indicator for Low Water cut-out will no longer be illuminated.

Return the system to normal operation and restart the boiler. Refer to Section 4.2.1.

3.11.3 Test of High-Limit Control

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. A manual reset lockout displaying **E 12** on the display panel will occur. The high-limit switch must be manually reset prior to resetting the boiler at the display panel. Readjust the high-limit thermostat to the desired setpoint.

3.11.4 Test of 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, a manual reset lockout displaying **E 12** on the display panel will occur. Upon re-opening the main gas cock, the **E 12** indicator will remain on until the display panel is manually reset.

Units equipped with a high pressure switch must be checked by closing the downstream gas cock while the burner is operating. The switch should shut down the main burner. When the gas pressure switch opens, a manual reset lockout displaying **E 12** on the display panel will occur. Upon re-opening the gas cock, the **E 12** indicator will remain on until the display panel is manually reset.

3.12 INITIAL ADJUSTMENTS

3.12.1 Operating Temperature Controller for MACH® Series Boilers

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

CAUTION!

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

3.12.1.1 Operation of the Control

The boiler is operated through the control/display panel. The display has 3 modes of standard operating menus. The modes are:

- Standby mode will display (**Stby**)
- Parameter mode will display (**PArA**)
- Information mode will display (**InFo**)

At each level the keys and the display have different functions. To ascertain which mode you are in, the displayed information will be shown as indicated under "display".

Mode	Description	Display	Example
Standby (Stby)	Normal display mode	1st digit without a dot	0 180
Parameter (PArA)	Parameter settings	1st digit with a dot	1.125
Information (InFo)	display boiler sensors	1st digit with a blinking dot*	1.180*

**Standby Mode:**

The display defaults to this mode at startup or reset of the control. If no key is pressed for 20 minutes the display will return to this mode. The function of the keys may be two-fold as shown below.

Key(S)	Duration	Function
Mode	momentary	Change to next mode
Reset	momentary	Reset the control
Plus	momentary	Show the comfort heat setpoint, or max setpoint (outdoor reset only)
Plus	long*	Turn the comfort heat system on or off
Minus	momentary	Show the domestic hot water setpoint
Minus	long*	Turn the domestic hot water system on or off

***Note:** Long duration is greater than 2 seconds.

When in the Standby Mode the control indicates boiler status with the first digit of the display. The remaining digits indicate the boiler's actual temperature or lockout code. The following table indicates the meaning of the display digits when in the standby level.

First Digit	Boiler Status
0	Burner off - No call for heat
1	Pre purge or post purge
2	Ignition
3	Burner on in Comfort Heat mode
4	Burner on in Domestic Hot Water mode
5	Checking the airflow switch
6	Burner off - An internal setpoint has been reached. System is still calling for heat.
7	Burner off - Comfort Heat pump running on delay. No system call for heat.
8	Burner off - Domestic Hot Water pump running on delay. No system call for heat.
9 and b flashing	Burner off – auto reset lockout. A code is displayed indicating the reason for the lockout. (See Troubleshooting Section 5.5.)
A	Adjusting the 3 way valve if used
H	Burner on in manual high fire
L	Burner on in manual low fire

Parameter Mode:

The parameter mode is used to change the settings of the boiler. The parameter mode is accessed by pressing the MODE key several times until the display shows **PARA**.

The parameters are selected with the STEP key, and changed with the plus “+” and minus “-” keys. Once the desired value is reached, pressing the STORE key accepts the new setting.

Parameters 1 through 4 are accessible directly at the parameter level.

Parameters higher than 4 are only accessible by authorized service personnel trained on the P-K MACH Series Boiler.

Parameter	Description	Lower Limit	Upper Limit
1	DHW setpoint if used	68°	158°
2	DHW system ON/OFF	0=OFF 1=ON 2=OFF +pump continuous 3=ON + pump continuous	
3	Comfort heat system ON/OFF	0=OFF 1=ON 2=OFF +pump continuous 3=ON + pump continuous	
4	Setpoint or max boiler temp outdoor air mode	68°	182°

Information Mode:

The information mode is used to display the values of the various sensors such as inlet water temp, outlet water temp etc. The information mode is accessed by pressing the MODE key several times until InFo is displayed. The desired sensor is selected with the STEP key. The following table indicates the displayed value:



Step	Value
1	Outlet water temp
2	Inlet water temp
3	Domestic Hot Water temp *
4	Outdoor air temp *
5	Flue gas temp
6	Boiler outlet setpoint
7	Rate of change outlet temp °F/second
8	Rate of change inlet temp °F/second
9	Rate of change Domestic Hot Water °F/second
A	Second Comfort Heat system temperature

* If the sensors for these functions are not installed, the display will indicate -22.

3.12.1.2 Operating Configurations

The boiler has several different operating configurations. These are:

- Internal Setpoint
- Domestic Priority
- Outdoor Air Reset
- Analog Input Setpoint
- Analog Input Direct Drive

CAUTION!

Do not modify any parameters other than those specifically mentioned.

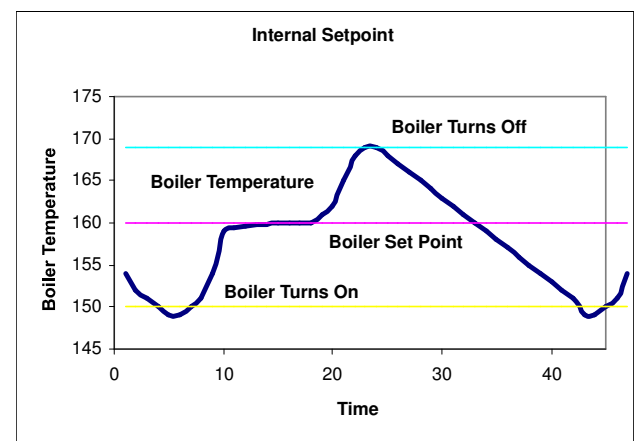
Internal Setpoint:

The internal setpoint is set with parameter 4. The boiler temperature control modulates the boiler to maintain this internal setpoint. The upper and lower temperature differentials are used to instruct the boiler at what temperature to turn on and at what temperature to turn off.

Item	Parameter	Value	Allowable Range
Setpoint	4	160	68-185
Low Temp. Differential	22	10	0-36

High Temp. Differential	23	9	0-36
Low Temp. Setpoint	5	68	59-140

The boiler will modulate to try to maintain 160° F. If the temperature increases above 169° F which is the setpoint 160° F + High Temp Differential 9°F the boiler will shut off. Once it shuts off it will not restart until the temperature drops below 150° F which is the setpoint – Low Temp Differential. The Low Temp Set Point will not permit the operator to adjust the setpoint below 68° F. (See graph below.)



Domestic Priority:

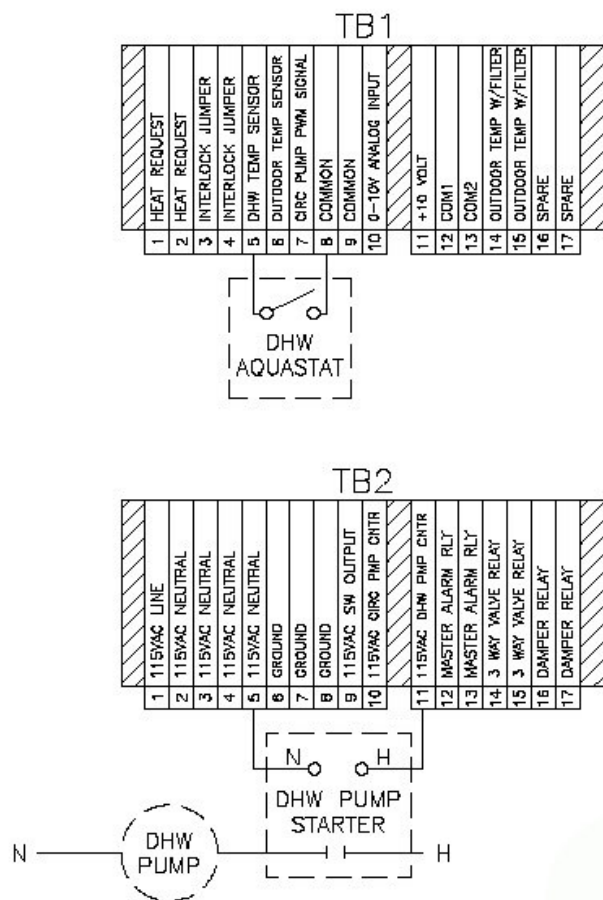
If an indirect domestic hot water (DHW) tank is connected, the DHW function of the boiler will activate when the DHW temperature controller (supplied by others) closes (Terminal 5 to 8 TB 1, refer to Section 6.1.1), indicating a call for heat from the DHW system. The parameters should be set as follows:

Item	Parameter	Value
DHW Setpoint	1	140
DHW Setpoint Addition	33	30
DHW Status	2	1
DHW High Temp. Differential	25	6
DHW Low Temp. Differential	24	6
DHW Options	35	13

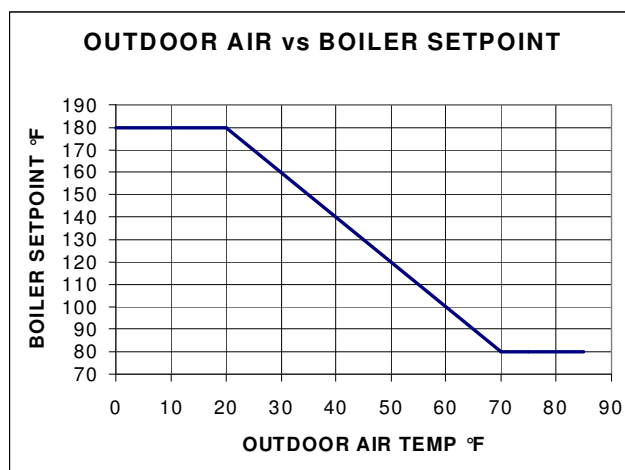
In the above example, the boiler temperature will be set to the DHW Setpoint + the DHW Setpoint Addition (140°F + 30°F = 170°F) when the DHW



temperature controller indicates a call for heat from the DHW system. When the DHW system calls for heat, the Central heat pump output (Terminal 10 TB2) deenergizes and the DHW pump output (Terminal 11 TB2) energizes providing 120 VAC power is provided to energize a relay coil for the DHW pump. The DHW status should be set to 1 (DHW system ON).

**CAUTION!**

Terminal 10 and 11 on TB2 are for pilot duty only. they should not be connected directly to the pump.

Outdoor Air Reset (optional):

The control automatically detects the presence of the outdoor air sensor. If an outdoor air sensor is present, the boiler automatically defaults to outdoor air reset for setting boiler temp. The parameters should be set according to the following table:

Item	Parameter	Value °F	Allowable Range °F
Maximum Setpoint	4	180	68-185
Minimum Setpoint	5	80	60-140
Outdoor Air Minimum Temp.	6	20	4-50
Outdoor Air Maximum Temp.	7	70	59-77
Boiler Shutoff Temp.	10	90	32-140 (32=off)
Outdoor Air Offset	12	0	0-144
Boiler Configuration	34	01	

The set point 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.

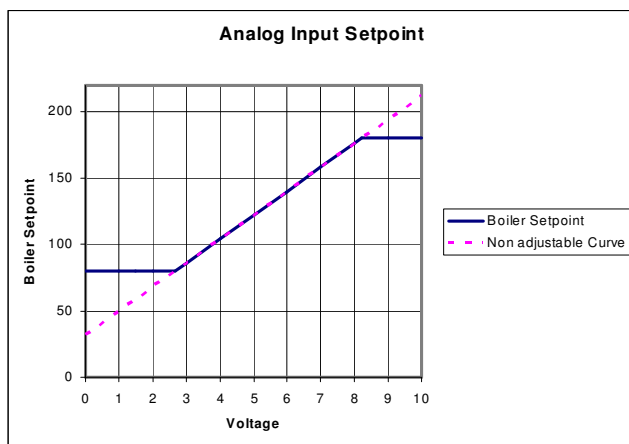
The setpoint is adjusted according to the above parameters. The boiler setpoint will be the maximum value (180° F) when the outdoor air is at or below a minimum temperature value (20° F). The boiler setpoint will be at the minimum value (80° F), when outdoor air is at or above a maximum temperature value (70° F). The setpoint for “in between” values of outdoor air temperature, is linearly proportional to



the above settings. Using the values in the table above, the boiler setpoint will be 80° F when the outdoor air temperature is 70° F. As the outdoor air temperature drops, the boiler setpoint will be increased until the outdoor air temperature is 20° F. At this point the boiler will reach its maximum setpoint of 180° F. If the outdoor air temp drops further, the boiler setpoint remains at 180° F.

The boiler shutoff temperature can be used to turn the boiler off at a given setpoint. For example if you wanted to shut the boiler off when the outdoor air temperature was above 65° F you would set the boiler shutoff temp to 90° F since this is the setpoint that is called for at 65° F outside air temp.

Analog Input to Adjust Setpoint:



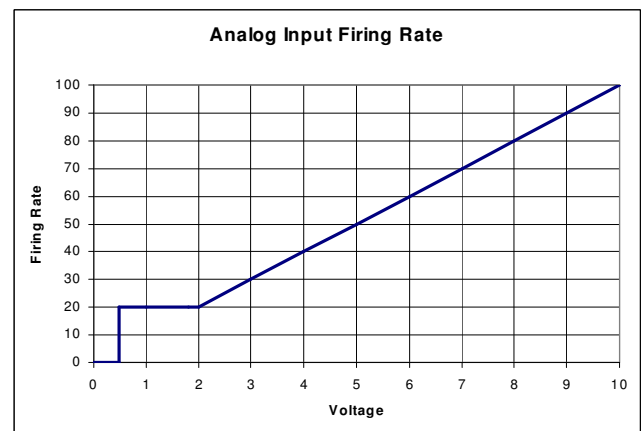
The control must be configured for a remote analog input setpoint according to the following table:

Item	Parameter	Value °F	Allowable Range °F
Maximum Setpoint	4	180	68-185
Minimum Setpoint	5	80	60-140
Boiler Configuration	34	03	

The setpoint of the boiler is controlled by an external 0-10 VDC signal. A signal of at least 0.5 VDC is required to start the boiler. At 0 VDC the setpoint is 32° F; at 10 VDC the setpoint is 212° F. This setpoint is low and high limited by maximum and minimum setpoint parameters. The controlled setpoint voltage range narrows when these limits are used. If the above

tables values are used the boiler setpoint will be 80° F when the voltage is anything less than approximately 3 VDC. It will then increase linearly with voltage until approximately 8.5 VDC when it will be 180° F. The setpoint will remain at 180° F even if voltage is increased further.

Analog Input to Control Firing Rate:



The control must be configured for analog input direct drive by setting parameter 34 to 02.

The firing rate of the boiler is controlled by an external 0 to 10 VDC signal. At a voltage greater than 0.5 VDC the boiler turns on and runs at low fire until 1.8 VDC is reached. The firing rate increases linearly with voltage until high fire is reached at 10 VDC. The boiler setpoint Parameter 4 remains active to shut down the boiler when the temperature in the boiler exceeds this value plus the high temp differential. These voltage levels, as explained above, are all “non-adjustable”.

3.12.2 Gas Pressure Adjustment

Note: Adjustments shall only be performed by service representative specifically trained and certified to perform maintenance on the Patterson-Kelley MACH® Series boiler.

See rating plate for the minimum and maximum gas pressure of the boiler. Each boiler is furnished with a manual shut-off valve which has an integrated test port. This port is located on the upstream side of the



valve body for measuring supply pressure. (See figure below.)



Test Port

Gas Pressure Test Port

The supply pressure during main burner operation must be greater than the minimum indicated on the rating plate (3.5" W.C. for natural gas, 7" W.C. for propane).

3.12.3 Air Flow Adjustments

The air flow is pre-set at the factory prior to shipment. In unusual situations the air/gas ratio may have to be adjusted to obtain proper combustion readings for specific local conditions.

Combustion measurement instrumentation must be used to adjust the boiler for local conditions (See instructions below). Adjust the carbon dioxide (CO₂) or oxygen (O₂) reading to achieve conditions as listed in the following Table 3-1.

3.12.4 Gas Valve Setup and Adjustment

Required Tools:

- 2 mm hex wrench
- Slotted screwdriver
- Combustion analyzer

Note: Verify gas pressure at inlet to boiler is in accordance with Table 3-1 below. Gas flow is dependent primarily on fan speed not upstream gas pressure. When set up for natural gas operation, the boiler is capable of operating with gas supply pressure as low as 3.5" W.C.

Each MACH® Series boiler is equipped with two combined gas/air control and gas safety shut off control valves. The valves function in parallel with the variable speed combustion blower to supply the correct gas air ratio for optimum performance and efficiency. The combustion blower speed is controlled automatically and determines the amount of negative pressure felt at the gas safety shut off / control valves. The gas valve servo regulators adjust gas flow for each valve to maintain zero pressure at the outlet nozzle of the associated valves.

Boiler Test Mode:

The test mode should be used when checking and setting the gas safety shut off / control valves on the MACH® Series boiler series boilers. In this mode an automatic heat request is simulated as follows:

Test Mode High:

Simultaneously pressing the "Mode" button and the "+" button for 3 seconds activates the "Test Mode High" function to drive the boiler output to maximum. The display will blink and indicate "H" in the first digit of the display to indicate the boiler is being driven to the maximum output rating. This test mode will automatically terminate after 15 minutes or can be terminated from the control/display panel by simultaneously pressing the "+" and "-" buttons for three seconds.

Test Mode Low:

Simultaneously pressing the "Mode" button and the "-" button for 3 seconds activates the "Test Mode Low" function to drive the boiler output to minimum. The display will blink and indicate "L" in the first digit of the display to indicate the boiler is being driven to the minimum output rating. This test mode will automatically terminate after 15 minutes or can be terminated from the control/display panel by simultaneously pressing the "+" and "-" buttons for three seconds.



Table 3-1 Combustion Reading For Setting Gas Safety Shut Off / Control Valves

Model	Fuel	Nominal Gas Pressure	High Fire Setting		Low Fire Setting	
			% O ₂	% CO ₂	% O ₂	% CO ₂
300	Natural Gas	7" W.C.	4.9+ 0.2	9.1+ 0.2	5.1+ 0.2	8.9+ 0.2
450	Natural Gas	7" W.C.	5.0+ 0.2	9.0+ 0.2	5.2+ 0.2	8.8+ 0.2
300	Propane	11" W.C.	4.9+ 0.2	10.5+ 0.3	5.1+ 0.2	10.3+ 0.3
450	Propane	11" W.C.	5.0+ 0.2	10.4+ 0.3	5.2+ 0.2	10.3+ 0.3

Adjustment:

There must be sufficient load to operate the boiler at high fire to perform the following adjustments. Start the boiler and observe proper operating parameters for the system.

Note: The MACH® Series boilers are equipped with two gas safety shut off / control valves that operate in parallel. When making any adjustment to the valves, the adjustment must be performed on **each of the valves equally**.

Example: If an increase in the gas flow is required to lower the O₂ level, turn each of the maximum flow restrictors equivalent amounts (i.e. ¼ or ½ turn each) and allow the analyzer readings to respond and stabilize before proceeding with additional adjustment. Adequate response time must be allowed for combustion readings to stabilize. This response time will be longer for low firing rates than for high firing rates.

clockwise or counterclockwise to achieve the desired CO₂ or O₂ level; see Table 3-1 for correct settings. (There will be a slight time delay between the adjustment and the response of the CO₂/O₂ measuring instrument). Clockwise rotation decreases gas flow. Counterclockwise rotation increases gas flow.

High Fire Setting

Set boiler to the “Test Mode High”, as described above, to achieve maximum firing rate of the boiler. Check combustion readings using a combustion analyzer. If combustion readings are not in accordance with Table 3-1 adjust as follows:

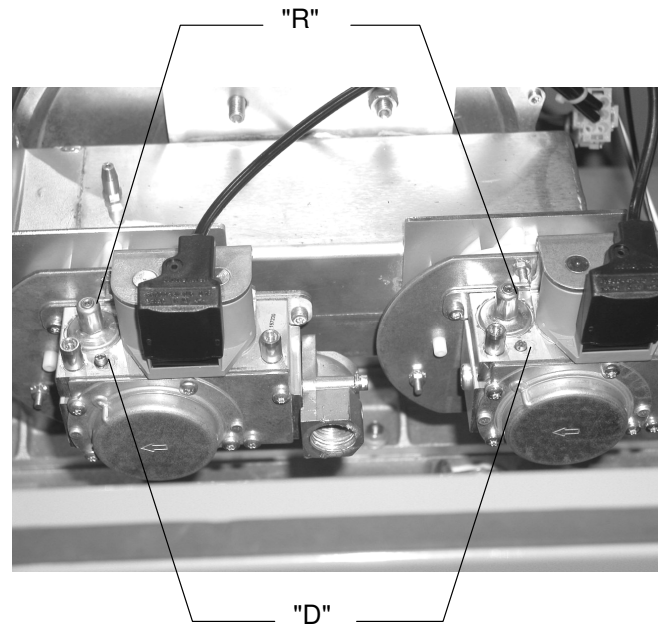
- Using a slotted screw driver or 2 mm hex wrench, set the maximum restrictor (high fire screw – see the figure below, item “D”) on each of the gas safety shut off / control valves by turning



Low Fire Setting

Set boiler to the “Test Mode Low”, as described above, to achieve minimum firing rate of the boiler. Check combustion readings using a combustion analyzer. If combustion readings are not in accordance with Table 3-1 adjust as follows:

- Using a 2 mm hex wrench, adjust the pressure regulator offset adjustment (see the figure below, item “R”) to achieve the CO₂ /O₂ level prescribed in Table 3-1. Note that equal adjustments must be made to each of the valves. Adjustments to the offset pressure regulators should not exceed ¼ turn at a time before allowing the readings to respond and stabilize. Please note, the rotation of the Low Fire adjustment is opposite of the High Fire as follows: Clockwise rotation increases gas flow, counterclockwise rotation decreases gas flow.



Adjusting Low and High Fire



4.0 OPERATION

4.1 GENERAL

4.1.1 Control Panel Front



Control Panel

Become familiar with the basic operation of the boiler. The front of the control panel shows Operating Instructions.

4.1.2 Tests

Safe lighting and other performance criteria were met with the gas manifold and control assembly provided on this boiler when the boiler underwent tests specified in ANSI Z21.13/CSA 4.9, latest edition. (See "Factory Firetest" label.)

4.2 NORMAL LIGHTING AND SHUT-DOWN PROCEDURES

If a fault is indicated please refer to Troubleshooting, Section 5.5, to determine the cause of the fault prior to start up.

WARNING!

Do not use this boiler if any part has been under water. Immediately call a qualified service technician 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. Close main gas valve.
2. Turn On-Off switch to "OFF" position.
3. Wait 5 minutes.
4. Open main gas valve.
5. Turn On-Off switch to "ON" position.
6. Push reset button on display panel if required.
7. Push reset on low gas pressure switch and high gas pressure switch.

The controller will now complete the automatic firing sequence.

4.2.2 Normal Shut Down Procedures

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

4.2.3 Emergency Shut-Off



Emergency Shut-Off

The main gas cock should be closed immediately if an emergency situation occurs.

**WARNING!**

If overheating occurs or the gas supply fails to shut off, do not turn off or disconnect the electrical supply to the pump. Instead, shut off the gas supply at a location external to the boiler.

4.3 TYPICAL BOILER OPERATING CONDITIONS

Model Number	Input Rating (Btu/hr)	Natural Gas *(1030 Btu/cu. ft.)		LP Gas **(2500 Btu/cu. ft.)		Total Amperage
		Gas Rate (CFH)	Output Capacity (Btu/hr)	Gas Rate (CFH)	Output Capacity (Btu/hr)	
300	300,000	291*	275,000	120**	275,000	8 amps or less
450	450,000	437*	414,000	180**	414,000	8 amps or less

Note: The heat exchanger is constructed and stamped for 50 psig maximum operating pressure and/or 200° F maximum temperature.



5.0 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.

WARNING!

Use care when reassembling main gas line to assure all connections are tight.

WARNING!

Use care when servicing boiler in order to prevent the accumulation of gas in or around the combustion chamber.

WARNING!

General lockout/ tagout procedure must be employed when servicing this unit.

WARNING!

Determine the cause of the lockout before resetting the boiler. If able to determine cause of lockout, then appropriate corrective action should be taken. If not able to determine cause of the problem, call a qualified service technician.

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 service codes or lockouts on the display panel. Observe any unusual noises or operating conditions and make the necessary corrections. Notify responsible individuals for required corrective action or repair.

WARNING!

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

5.1.2 Weekly

Observe the conditions of the main flame. A normal high fire flame is blue. If the high fire flame is yellow then corrective action must be taken. In normal 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 (CO₂) or oxygen (O₂) analyzer to set conditions. Refer to Table 3-1, Section 3.12.4 for proper combustion readings.

5.1.3 Monthly (During Operation)

1. Test flame detection by voltage reading at the terminal strip (Terminal 9 on TB-1 and ground screw). The voltage reading should be between (5 and 10 VDC).
2. Test high-limit Control. Refer to Section 3.11.3.
3. Test operating temperature controls by reducing or increasing temperature setting as necessary to check burner operation.
4. Test the low water level cut-out. Refer to Section 3.11.2.
5. Test low gas pressure switch. Refer to Section 3.11.4.
6. Check the condensate drain system. Clean and flush as necessary.

Installation and service must be performed by a qualified installer or service agency who has been trained on the Patterson-Kelley MACH® boiler.

5.1.4 Semi-Annually (every 6 months)

In addition to the recommended monthly service:

1. Clean burner of any accumulated dust or lint. See Section 5.2 on "Cleaning the Burner."



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

Installation and service must be performed by a qualified installer or service agency who has been trained on the Patterson-Kelley MACH® boiler.

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

5.1.5 Annually

In addition to the recommended monthly service:

1. Inspect and clean the inlet screen of any accumulated dust or lint.
2. 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.
3. Inspect combustion chamber when the burner is removed for inspection. Note any signs of deterioration. Clean as necessary.
4. Inspect and clean heat exchanger. Use vacuum to remove accumulations from the heat exchanger pins and surfaces. Clean the casting pins by flushing with clean water and air drying. Do not use any cleaning agents or solvents. A soft nylon brush may be used in accessible areas.
5. Drain and flush the inside of the heat exchanger as required (separate from system flush).
6. Examine the venting system at least once a year. Refer to the vent manufacturer's instructions for requirements in addition to those listed below.
 - a. Check all joints and pipe connections for tightness.
 - b. Check pipe for corrosion or deterioration. If any piping needs replacing, do so immediately.
7. Qualified service personnel should thoroughly inspect the heating system and correct any problems prior to re-starting the boiler.
8. Perform combustion analysis and readjust to manufacturer's specifications as necessary. It is

recommended that a copy of this report is filed for future reference.

9. Perform a leak test of the gas valves in accordance with the manufacturer's instructions.

Installation and service must be performed by a qualified installer or service agency who has been trained on the Patterson-Kelley MACH® boiler.

5.2 CLEANING THE BURNER

1. Lockout and tagout gas supply to the boiler.
2. Lockout and tagout electrical power to the boiler.
3. Remove the top cover of the boiler.
4. Disconnect the electrical connections to the blower and gas safety shut off / control valves.
5. Unbolt burner hood and remove the gas train assembly.
6. Carefully remove the burner. Use low pressure air to remove any dust or lint from the burner. Using a soft clean cloth, wipe the inside surface of the burner. DO NOT wipe the mesh side (flame side) of the burner.

5.3 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. (Section 3.12.2.)
3. Perform combustion check. Adjust gas flow if necessary. (Section 3.12.4.).



5.4 SEQUENCE OF OPERATION

1. When the On/Off (Main power) switch is turned on, power is provided through a circuit breaker to the boiler control and the combustion blower. The boiler control powers a 24 V transformer. The boiler control supplies 24 V power through a high limit temperature switch and a low water level control.
2. The low water level control is closed when there is water in the boiler up to the probe.
3. When the temperature sensed by the high limit temperature control is below the set limit, the switch is closed. Manual reset of the switch is required following conditions exceeding high limit temperature.
4. If either the high limit temperature control or the low water level control is open, the boiler control locks out and indicates **E 12** on the display.
5. Depending on the settings in the boiler control, a heat request is generated.
6. The controller checks that the low air pressure switch is open indicating no airflow. The blower is driven towards the prestart fan speed. When the air pressure switch closes the 15 second prepurge time is started, and the blower is driven toward the ignition speed.
7. After the 15 second prepurge the gas pressure switch circuit is checked to ensure the gas pressure is within design parameters.
8. If there are no lockouts then when the blower speed is within 200 rpm of the ignition fan speed, a trial for ignition period of 3 seconds is initiated. The internal spark generator and the gas safety shut off / control valves are energized.
9. The internal spark generator is de-energized .3 seconds before the end of the trial for ignition period. After the trial for ignition period, if a flame signal is detected by the flame rectification system, the control initiates a flame stabilization period of 5 seconds at the ignition rpm of the fan. The fan is driven to low fire for 1 minute before the boiler is released to modulation.
10. The unit modulates between the low fire setting and the high fire setting to maintain the desired outlet water temp set point.
11. 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 + temperature differential. At this point the burner is turned off, and the fan continues to run to post purge the boiler for 15 seconds.
12. When the water temperature is reduced by the load on the system, a heat request is again generated. The operating sequence will recycle to step 6, provided the limits on water level, gas pressure and high temperature are all met.

5.5 TROUBLESHOOTING

The MACH® Series boiler will display service codes to indicate some problems with the boiler. There are two types of lockouts the control may experience: manual reset lockouts requiring an operator to press the reset button, and automatic reset lockouts, where the control will automatically attempt to restart the boiler. A listing of service codes is included at the end of this section.

Should the unit fail to operate, call a qualified service technician to troubleshoot the problem and implement corrective action.

The Loss of Power

In the event of a power failure (or when the On/Off switch is in the Off position), the display panel is not illuminated and the entire 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. If any manual reset lockout was present when the power is lost, the display will flash **E 04** when the power is resumed. This indicates that the control was in lockout mode but does not indicate which service code was present.



Loss of Water Level

The low water switch opens when there is insufficient water level in the boiler. **E 12** is shown on the display, and burner operation is interrupted. When the correct water level is re-established, pushing the reset button will return the sequence to Step 5, provided that the other limits are satisfied.

Low Gas Pressure

The low gas pressure switch opens when there is (or has been) insufficient gas pressure available for proper operation of the boiler; **E 12** is shown on the display, and burner operation is interrupted. If a gas-supply shut-off valve is closed for any reason, a low gas condition will result.

When gas pressure is restored, **E 12** will remain on the display panel, and the boiler will remain locked out until the low gas pressure switch is manually reset, and then the front panel reset button is pressed.

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

High Gas Pressure

The high gas pressure switch opens when there is (or has been) excessive gas pressure for the proper operation of the boiler. An **E 12** service code is displayed and the burner operation is interrupted.

WARNING!

An inspection of the gas train shall be conducted to determine if any damage has occurred. This inspection shall include a leak check of the associated gas piping and an operational check of the boiler. Combustion readings shall be taken at the low and high fire settings to confirm proper operation of the modulating gas valves.

When proper gas pressure is restored, **E 12** remains on the display with the boiler locked out until the high gas pressure switch is reset and then the front display panel reset button is pressed.

High Water Temperature

When the boiler water has exceeded both the operating and high-limit temperature the high limit switch opens, and **E 12** is shown on the display. When the water temperature falls below the high-limit temperature, the boiler will remain locked out until the switch is manually reset and the front panel reset button is pressed. Once the switch, and the front panel are reset, the sequence returns to Step 5, provided that the other limits are satisfied.

Low Air

If the display panel indicates **E 08** this indicates insufficient airflow through the burner. Check that the burner is clean ("Cleaning the Burner," Section 5.2) and that there are no obstructions to airflow in the intake or exhaust ducts. A low air indication does not necessarily mean that the low air switch is defective.

Air Switch Closed

If the display panel indicates **B 61** this indicates the air pressure switch did not open when the blower was shut off. Check that there is no air flow through the boiler when the fan is off. If there is no hidden source of air flow, replace the switch.

Flame Failure

In the event of a flame failure during a firing period or a trial for ignition, the main fuel valves are de-energized and a manual reset lockout occurs. After the spark ignition is re-energized, the 3 second trial-for-ignition begins again. If flame failure occurs during a trial-for-ignition, a safety lockout occurs. The display will indicate **E 02**. If flame failure occurs an **E 02** service code is displayed, the combustion control must be manually reset.

E 00 signifies a leaky gas valve. In the event of a false flame signal **E 00** fault code is indicated. This fault code could indicate a gas valve failure or leakage of the gas valve. If gas valve leakage is suspected, the unit must be isolated by turning off the main gas supply line until the gas valve is replaced.



5.5.1 Manual Reset Service Codes

Code	Lockout	Description
E 00	False flame.	A flame signal is present when it shouldn't be.
E 02	Flame failure.	The burner did not light on startup, or loss of flame during run.
E 03	Gas Valve error.	Check all gas valves electrical connections.
E 04	General lockout.	The power was lost after a lockout. The control loses the description of the lockout on power loss.
E 05	Internal control failure.	Call for service.
E 06	Internal control failure.	Call for service.
E 07	Internal control failure.	Call for service.
E 08	Air pressure switch open.	The air pressure switch failed to close to indicate sufficient air flow to start the boiler.
E 11	Internal control failure.	Call for service.
E 12	External limit open.	One of the external limits has opened. (High/Low Gas Pressure, High Temp, Low water).
E 13	Internal control failure.	Call for service.
E 14	Internal control failure.	Call for service.
E 15	Internal control failure.	Call for service.
E 16	Internal control failure.	Call for service.
E 17	Internal control failure.	Call for service.
E 18	Outlet high limit temp.	The outlet water temperature has exceeded the internal high limit temperature setting.
E 19	Return high limit temp.	The return water temperature has exceeded the internal high limit temperature setting.
E 25	Outlet temp rapid change.	The outlet water temperature is increasing too fast. Indicating low flow condition.
E 28	No blower feedback.	The blower should be running but it is not, or the feedback signal has been interrupted.
E 29	Blower feedback will not zero.	The blower will not go to zero speed even though it should be off.
E 31	Outlet sensor shorted.	The outlet temperature sensor is short circuited.
E 32	Return sensor shorted.	The return temperature sensor is short circuited.
E 33	DHW sensor shorted.	The DHW temperature sensor is short circuited.
E 35	Flue sensor shorted.	The flue gas temperature sensor is short circuited.
E 36	Outlet sensor open.	The outlet temperature sensor is indicating an open circuit.
E 37	Return sensor open.	The return temperature sensor is indicating an open circuit.
E 38	DHW sensor open.	The DHW sensor is indicating an open circuit.
E 40	Flue sensor open.	The flue gas temperature sensor is indicating an open circuit.
E 44	Internal control failure.	Call for service.
E 52	High flue temp.	The flue temperature has exceeded the maximum allowable setting.
E 60	Internal control failure.	Call for service.

Note: When an Internal Control Failure occurs, as identified by E-Codes listed above, the failure is internal to the MCBA and replacement of the MCBA is required. A qualified service technician must be called to replace the MCBA device.



5.5.2 Auto-reset Service Codes

Code	Lockout	Description
b 08	Air pressure switch open.	The air pressure switch failed to close to indicate sufficient air flow to start the boiler.
b 18	Outlet high limit temp.	The outlet water temperature has exceeded the internal high limit temperature setting.
b 19	Return high limit temp.	The return water temperature has exceeded the internal high limit temperature setting.
b 24	Switched inlet / outlet.	The inlet water temperature has been more than 18° F above the outlet for more than 75 seconds.
b 25	Outlet temp rapid change.	The outlet water temperature is increasing too fast. Indicating low flow condition.
b 26	High exhaust back pressure.	The high exhaust back pressure switch is tripped indicating a blocked stack, inlet, or condensate system.
b 30	Max delta T.	The temperature rise across the heat exchanger is greater than maximum allowed, indicating insufficient flow.
b 40	Flue sensor open.	The flue gas temperature sensor is indicating an open circuit.
b 52	High flue temp.	The flue temperature has exceeded the maximum allowable setting.
b 61	Air pressure switch closed.	The air pressure switch failed to open prior to starting the blower.
b 65	Fan speed incorrect.	The fan is being directed to a higher speed than it is achieving.

WARNING

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



6.0 PARTS/TECHNICAL SUPPORT

Spare parts and replacement parts can be ordered from Patterson-Kelley by calling 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 WIRING DIAGRAMS

6.1.1 Terminal Block Assignments – High Voltage Circuit (TB2)

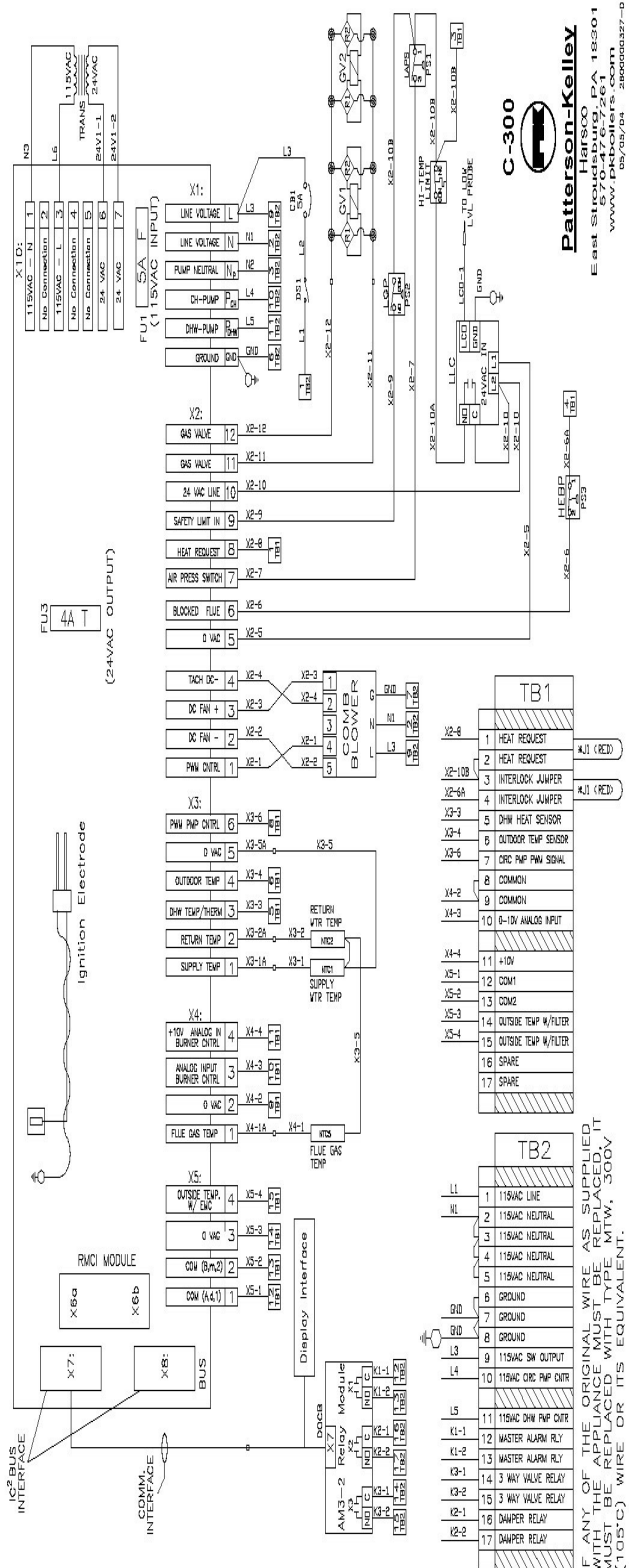
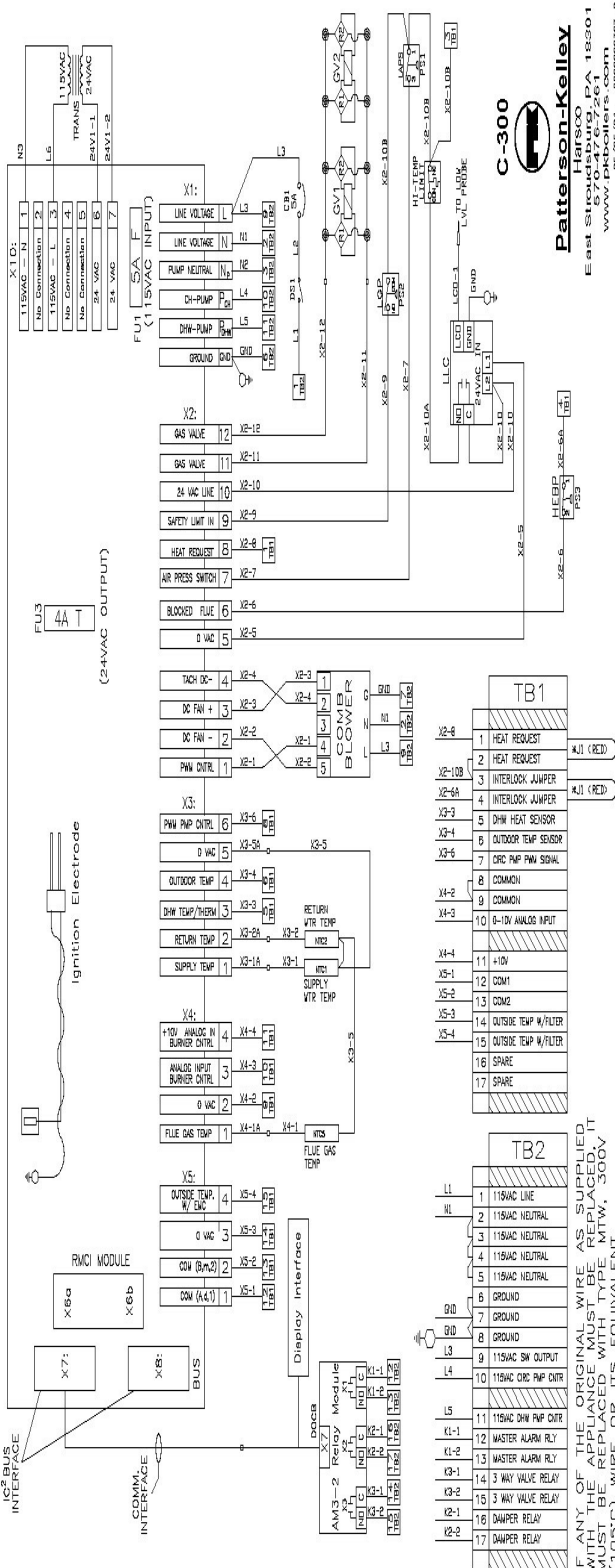
Terminal Number	Label	Description
1	115 VAC LINE	Boiler Supply Power, 115 VAC, 60 HZ, 1 ph, 8 amp
2	115 VAC NEUTRAL	
3	115 VAC NEUTRAL	Aux. Switched Output
4	115 VAC NEUTRAL	Boiler Circ. Pump
5	115 VAC NEUTRAL	DHW Circ. Pump
6	GROUND	Boiler Supply Ground
7	GROUND	Aux. Ground
8	GROUND	
9	115 VAC SW. OUTPUT	Aux. Switched Output, Pilot duty only, 1 amp max.
10	115 VAC CIRC. PMP CONTACTOR	Boiler Circ. Pump, Pilot duty only, 1 amp max.
11	115 VAC DHW PMP CONTACTOR	DHW Circ. Pump, Pilot Duty only, 1 amp max.
12	MASTER ALARM RELAY	Dry Contacts, 24 VAC max, 1 amp max.
13	MASTER ALARM RELAY	
14	THREE WAY VALVE RELAY	DHW Dry Contacts, 24 VAC max, 1 amp max.
15	THREE WAY VALVE RELAY	
16	DAMPER RELAY	Combustion Air Damper, Dry Contacts, 24 VAC max, 1 amp max.
17	DAMPER RELAY	

**6.1.1a Terminal Block Assignments – Low Voltage Circuit (TB1)**

Terminal Number	Label	Description
1	HEAT REQUEST	Boiler Enable, Contact Closure. DO NOT ENERGIZE.
2	HEAT REQUEST	
3	INTERLOCK JUMPER	External Limit (auto reset), Contact Closure. DO NOT ENERGIZE.
4	INTERLOCK JUMPER	
5	DHW TEMP. SENSOR	
6	OUTDOOR TEMP SENSOR	Thermistor - factory option.
7	CIRC. PMP PWM SIGNAL	Pulse Width Modulation.
8	COMMON	Common to be used with 5, 6, 7, and 10 when used.
9	COMMON	Common to be used with 5, 6, 7, and 10 when used.
10	O-10 V ANAL. INPUT CONTROL	Remote control of firing rate or setpoint.
11	+10 VOLT	Regulated 10V output.
12	COM 1	RS-485 port A.
13	COM 2	RS-485 port B.
14	OUTSIDE TEMP W/ FILTER	Thermistor - factory option.
15	OUTSIDE TEMP W/ FILTER	Thermistor - factory option.
16	SPARE	
17	SPARE	



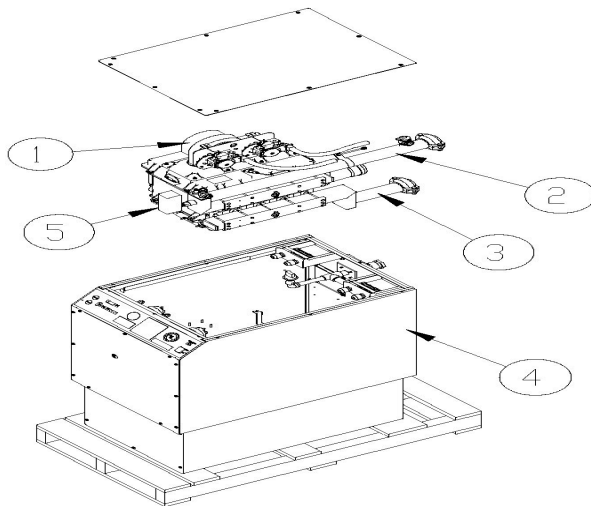
6.1.2 Wiring Series C-300



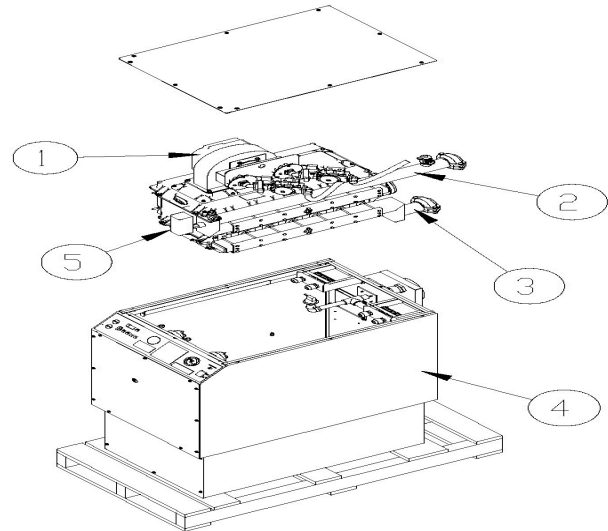


6.2 BOILER PARTS LIST

6.2.1 Main Assembly



MACH Series 300

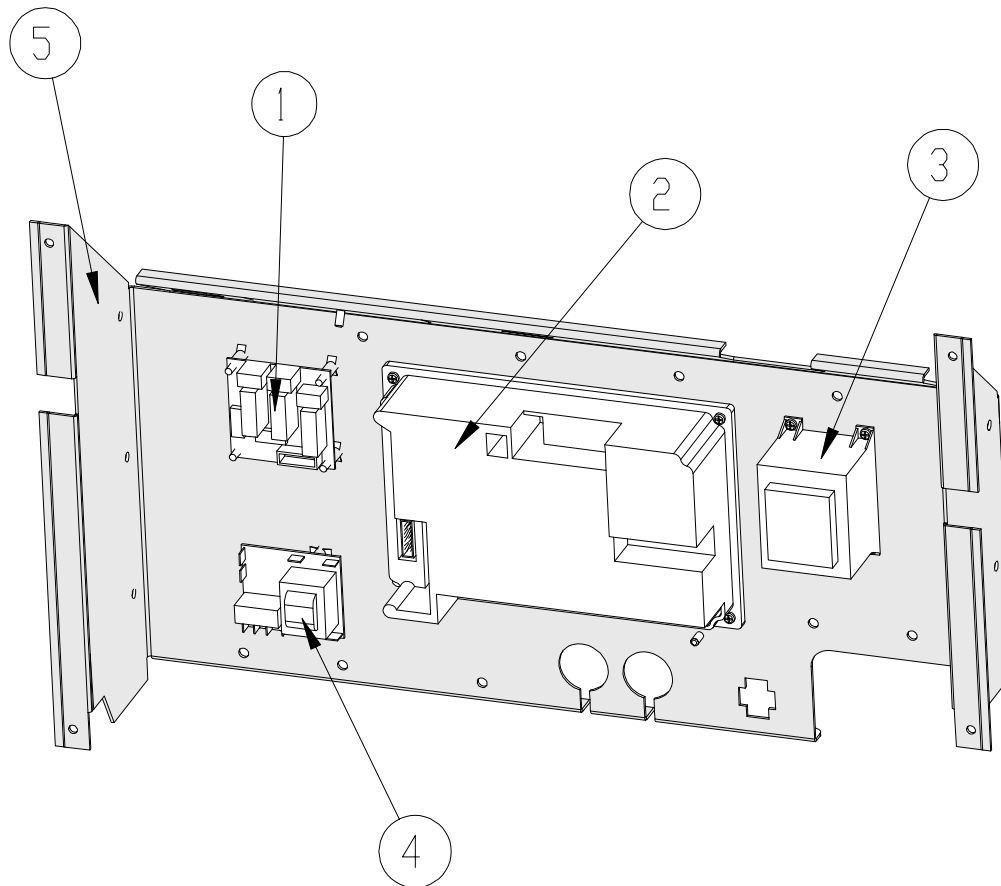


MACH Series 450

Mark	Description
1	Blower and Gas Train
2	Manifold, System Return, Boiler Outlet
3	Manifold, System Supply, Boiler Inlet
4	Cabinet
5	High Temperature - Aquastat



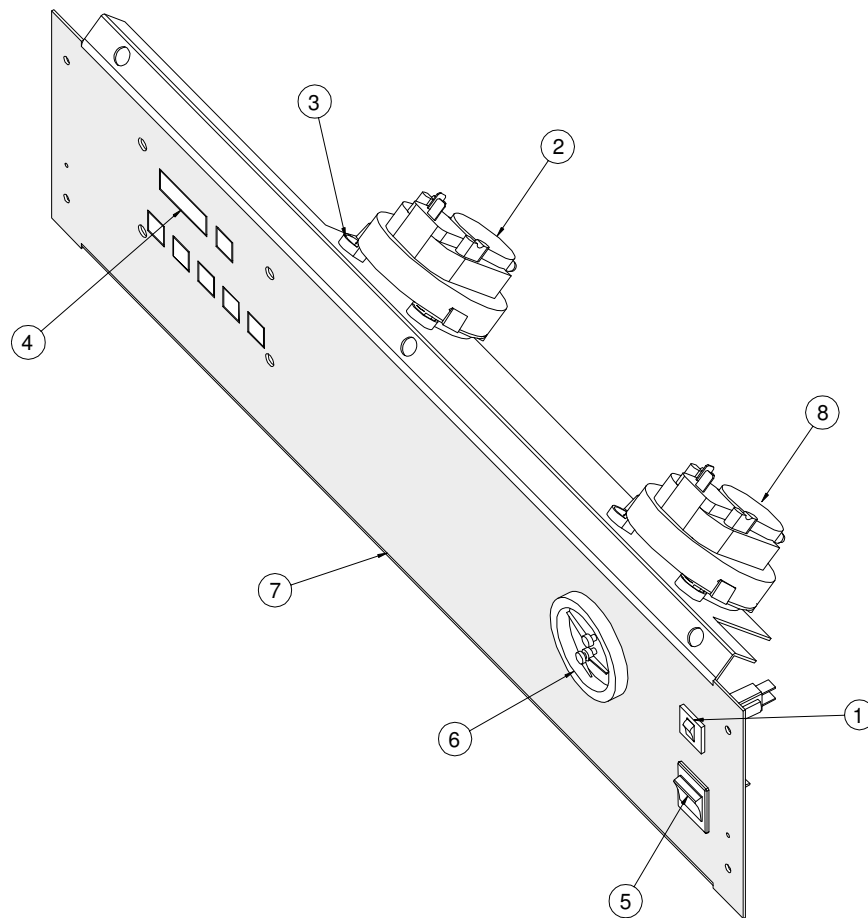
6.2.2 Control Panel



Mark	Description
1	AM-3 Relay Module
2	Boiler Control MACH Series - MCBA
3	Transformer
4	Low Water Cutoff
5	Control Mounting Plate



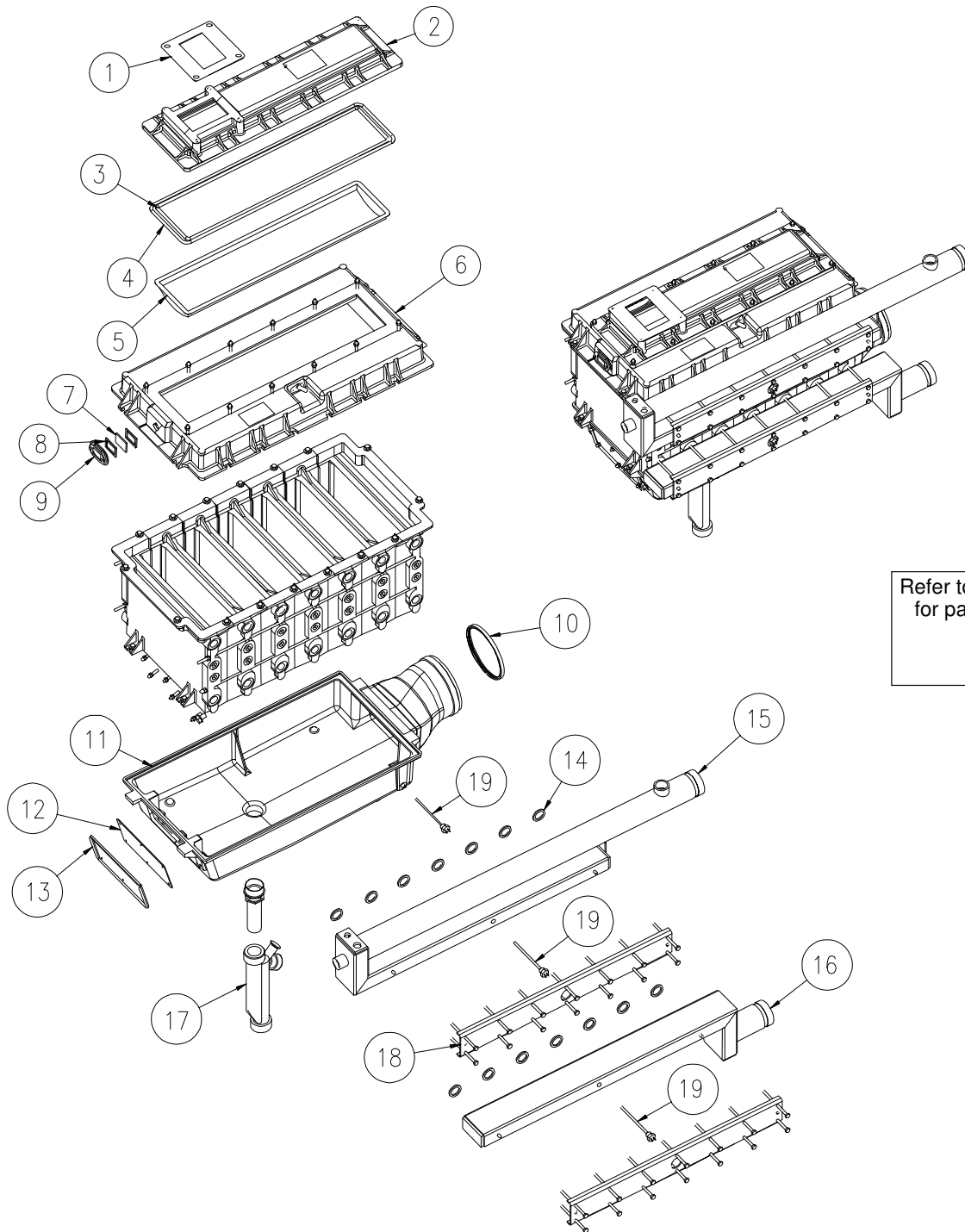
6.2.3 Display Panel



Mark	Description
1	Circuit Breaker
2	Air Pressure Switch
3	Fastening Clip
4	Display Panel
5	On/Off Switch
6	Pressure Temperature Gauge
7	Panel Sheet Metal
8	Stack Pressure Switch



6.2.4 Heat Engine



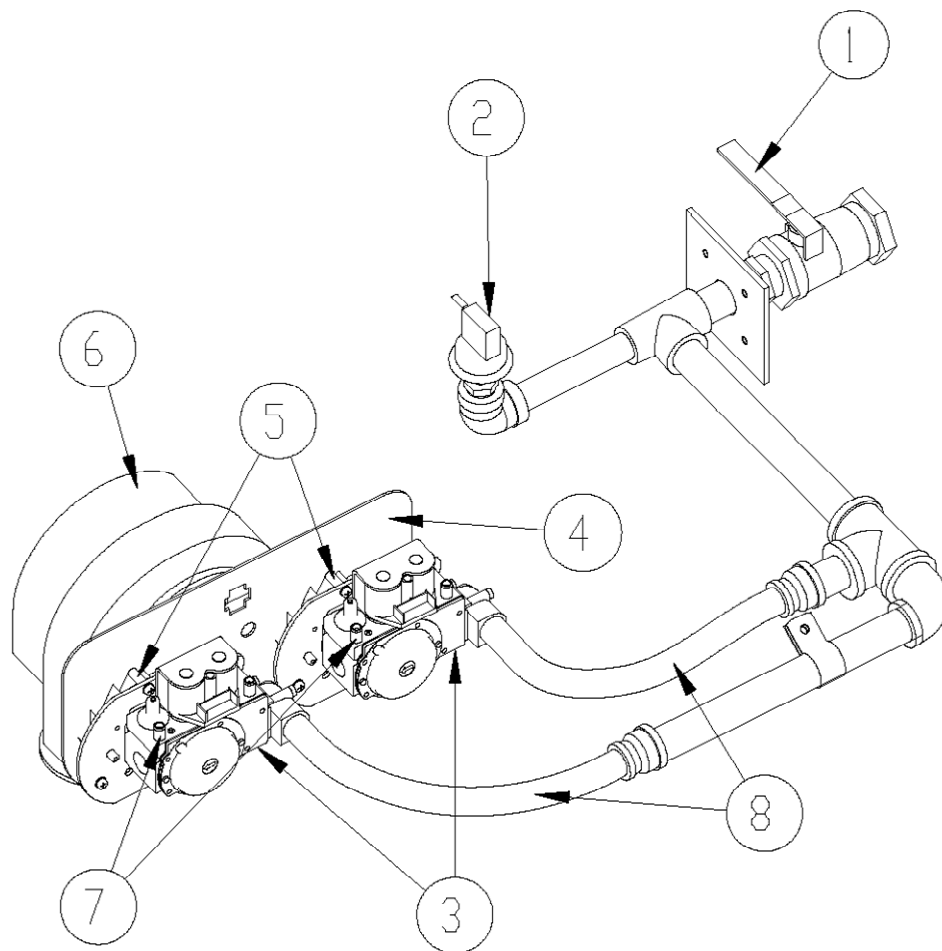
Refer to next page
for parts listing.



Mark	Description
1	Gasket Blower to Burner Hood
2	Burner Hood
3	Inside Burner Hood Gasket
4	Outside Burner Hood Gasket
5	Burner
6	Burner Flange With Insulation
7	Sight Glass
8	Seal Sight Glass
9	Sight Glass Holder
10	Exhaust Pipe Lip Ring
11	Exhaust Manifold
12	Inspection Cover Gasket
13	Inspection Cover
14	Gasket (Header Gasket)
15	Boiler Outlet / Supply Manifold
16	Boiler Inlet / Return Manifold
17	Condensate Trap
18	Manifold Mounting Plate
19	Thermistor (Temperature Sensor)



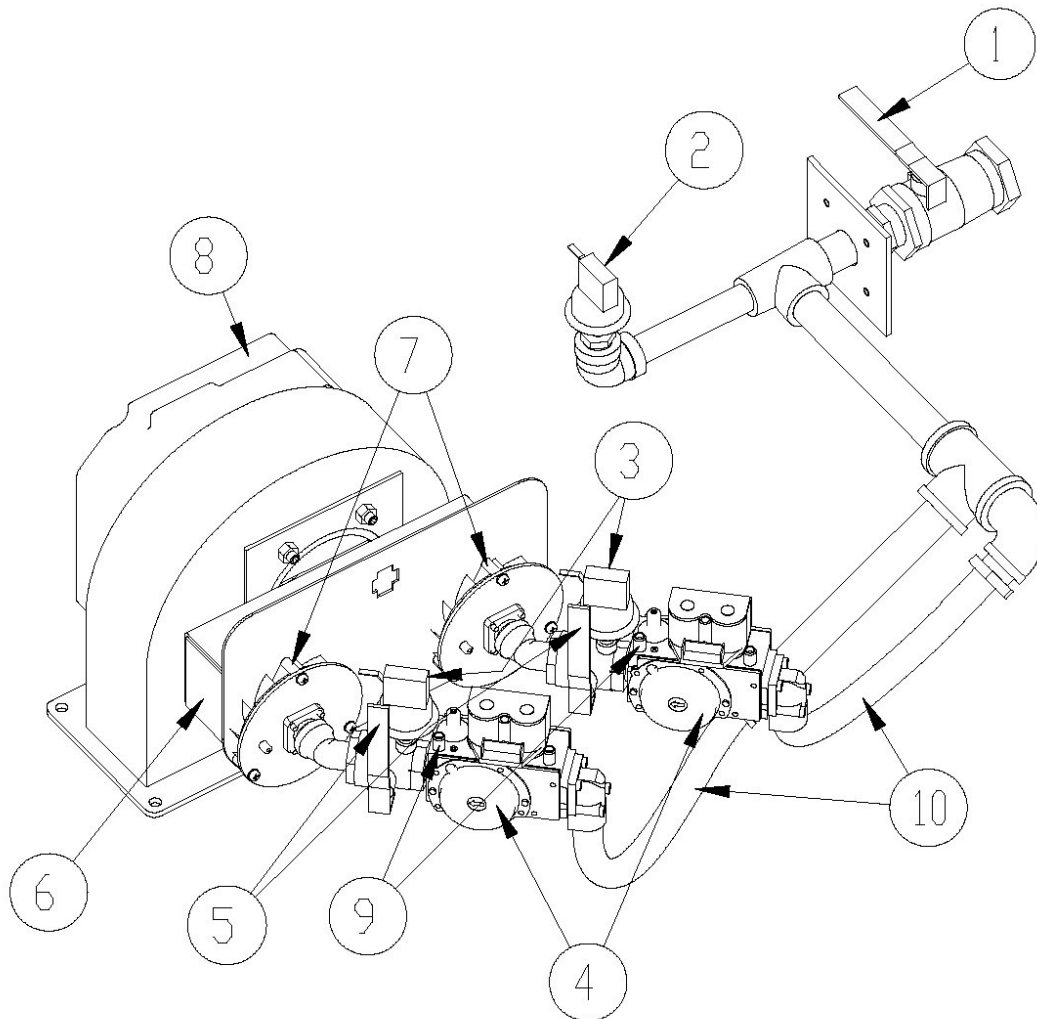
6.2.5 Series C-300 Boiler Gas Train



Mark	Description
1	Main Gas Shut-off Valve
2	Low Pressure Gas Switch
3	Gas Safety Shut-off/Control Valve
4	Air/Gas Manifold
5	Swirlplate
6	Blower
7	Gas Leak Test Port
8	Flex Hoses w/ Gas Valve Adaptors



6.2.6 Series C-450 Boiler Gas Train



Mark	Description
1	Main Gas Shut-off Valve
2	Low Pressure Gas Switch
3	High Pressure Gas Switch
4	Gas Safety Shut-off/Control Valve
5	Gas Manifold Shut-off Valve
6	Air/Gas Manifold
7	Swirlplate
8	Blower
9	Gas Leak Test Port
10	Flex Hoses with Gas Valve Adapters



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") 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 (1) 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., P.O. 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 at of the time of shipment.
- C. Any damage to the Product due to abrasion, erosion, corrosion, deterioration, abnormal temperatures or the influence of foreign matter or energy.
- D. The design or operation of owner's plant or equipment or of any facility or system of which any Product may be made a part.
- E. The suitability of any Product for any particular application.
- F. Any failure resulting from misuse, modification not authorized by Seller in writing, improper installation or lack of or improper maintenance.
- G. Equipment furnished by the owner, either mounted or unmounted, or when contracted for by the owner to be installed or handled.
- H. Leakage or other malfunction caused by:
 - 1. Defective installations in general and specifically, any installation which is made:
 - a. in violation of applicable state or local plumbing housing or building codes,
 - b. contrary to the written instructions furnished with the unit
 - 2. Adverse local conditions in general and, specifically, sediment or lime precipitation in the tubes and/or headers or corrosive elements in the atmosphere.
 - 3. Misuse in general and, specifically, operation and maintenance contrary to the written instructions furnished with the unit, disconnection, alteration or addition of components or apparatus, not approved by Seller, operation with fuels or settings other than those set forth on the rating plate or accidental or exterior damage.
- I. Production of noise, odors, discoloration or rusty water.
- J. Damage to surrounding area or property caused by leakage or malfunction.
- K. Costs associated with the replacement and/or repair of the unit including: any freight, shipping or delivery charges, any removal, installation or reinstallation charges, any material and/or permits required for installation, reinstallation or repair,



charges to return the boiler and or components. Seller's liability under this warranty shall not in any case exceed the amount paid for the Product found to be defective.

THIRD PARTY WARRANTIES

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

SEVERABILITY

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

NO OTHER WARRANTIES

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

8.0 APPENDIX

[illegible]



Parameter Settings for MCBA 14C 10XX Controls

No.	Description	Lower Limit	Upper Limit	MACH 300 PK Factory Setting for MCBA 14C1028		MACH 450 PK Factory Setting for MCBA 14C1036		Installed MCBA Parameter Settings
				NG	LPG	NG	LPG	
	End User Settings							
1	Setvalue for DHW	Water Storage Tank: 68 F	Water Storage Tank: 158 F	140	140	140	140	
2	DHW system	0 = off		0	0	0	0	
		1 = on						
		2 = off+ pump continuous						
		3 = on+ pump continuous						
3	CH system	0 = off		1	1	1	1	
		1 = on						
		2 = off+ pump continuous						
		3 = on+ pump continuous						
4	Setpoint or Maximum Setpoint (OAR)	68 F	182	180	180	180	180	
	Service Settings							
5	Minimum Setpoint, Outdoor Air Reset (OAR)	60 F	140 F	80	80	80	80	
6	Minimum outdoor temp (OAR)	-4 F	50 F	20	20	20	20	
7	Maximum outdoor temp (OAR)	59 F	77 F	70	70	70	70	
8	Frost protection, at OA Temp	-22 F	50 F	32	32	32	32	
9	Correction, Outdoor Air Sensor	-9 F	9 F	0	0	0	0	
10	CH shutdown setpoint temp (OAR)	32 = off						
		34 F	140 F	32	32	32	32	
11	Booster time	0 = no booster		0	0	0	0	
		1 minute	30 minutes					
12	Outdoor Air Offset	0 F	144 F	0	0	0	0	
13	Maximum fanspeed CH (hundreds)	10	70	60	57	56	54	
14	Maximum fanspeed CH (units)	00	99	00	00	00	00	
15	Maximum fanspeed DHW (hundreds)	10	70	60	57	56	54	
16	Maximum fanspeed DHW (units)	00	99	00	00	00	00	
17	Minimum fanspeed (hundreds)	5	70	16	20	12	20	
18	Minimum fanspeed (units)	00	99	00	00	00	00	
19	Ignition fanspeed (hundreds)	5	70	35	35	25	25	
20	Postpumptime CH	0 = 10 Seconds		1	1	1	1	
		1 Minute	99 Minutes					
21	Postpumptime DHW	0 Seconds	30 (*10.2 seconds)	3	3	3	3	
22	CH modulation hysteresis On	0 F	36 F	10	10	10	10	
23	CH modulation hysteresis Off	0 F	18 F	10	10	10	10	
24	DHW modulation hysteresis On	-9 F	54 F	10	10	10	10	
25	DHW modulation hysteresis Off	-9 F	54 F	10	10	10	10	



No.	Description	Lower Limit	Upper Limit	MACH 300 PK Factory Setting for MCBA 14C1028		MACH 450 PK Factory Setting for MCBA 14C1036		Installed MCBA Parameter Settings
				NG	LPG	NG	LPG	
26	DHW detection hysteresis On	-9 F	54 F	5	5	5	5	
27	DHW detection hysteresis Off	-36 F	54 F	5	5	5	5	
28	Restart delay CH (*10.2 seconds)	0 seconds	30 (*10.2 seconds)	3	3	3	3	
29	Restart delay DHW (*10.2 seconds)	0 seconds	30 (*10.2 seconds)	3	3	3	3	
30	Restart delay DHW to CH	0 = switch with burner On		3	3	3	3	
		1 (*10.2 seconds)	30 (*10.2 seconds)					
31	Difference T1-T2 for modulating back	9 F	72 F	46	46	46	46	
32	RMCI address	-1 = RMCI Off		-1	-1	-1	-1	
33	Setvalue addition for DHW, Parameter 1	0 F	(194- par 1) F or 54 F	30	30	30	30	
34	CH Heat Request Type			00	00	00	00	
	(1st digit) 2nd CH-circuit	0X = 2nd CH-circuit off		X	X	X	X	
		1X = 2nd CH-circuit slave						
		2X = 2nd CH-circuit master						
		3X = 2nd CH slave, Tset depends on potmeter						
		4X = 2nd CH master, Tset depends on potmeter						
		5X = 2nd CH- circuit slave,during DHW						
		6X = 2nd CH- circuit master, during DHW						
		7X = 2nd CH slave, during DHW,Tset depends on potmeter						
		8X = 2nd CH master, during DHW,Tset depends on potmeter						
	(2nd digit) CH Heat Request Type	X0 = Room Thermostat		X	X	X	X	
		X1 = Outside Temperature						
		X2 = 0 - 10 V on MCBA: Capacity						
		X3 = 0 - 10 V on MCBA: Temperature						
		X4 = 0 - 10 V on AM4: Capacity						
		X5 = 0 - 10 V on AM4: Temperature						
		X6 = +/- Control						
35	DHW			13	13	13	13	
	Type (2nd digit)	X0 = Instant water heater with NTC3						
		X1 = Instant water heater without NTC3						
		X2 = Storage tank with NTC3						
		X3 = Storage tank without NTC3		X	X	X	X	
		X4 = Instant water heater+NTC3+anticondensation						
		X5 = Instant water heater +anticondensation						
		X6 = Storage tank+NTC3+anticondensation						
		X7 = Storage tank+anticondensation						
		X8 = Plate heat						



No.	Description	Lower Limit	Upper Limit	MACH 300 PK Factory Setting for MCBA 14C1028		MACH 450 PK Factory Setting for MCBA 14C1036		Installed MCBA Parameter Settings
				NG	LPG	NG	LPG	
		exchanger						
		X9 = External heat request (by RMCI)						
	DHW 3 Way Vlv or Pmp (1st digit)	0X = 3 way valve normally open						
		1X = Hot water pump		X	X	X	X	
		2X = 3 way valve normally closed						
36	Manual fanspeed	-1 = off		-1	-1	-1	-1	
37	PWM-level CH-pump:			41	41	41	41	
38	Hold boiler water DHW only	32 = off						
		34 F	176 F	32	32	32	32	
39	Max Setpoint, 2nd CH-circuit	50 F	176 F	100	100	100	100	
40	Min Setpoint, 2nd CH-circuit	50 F	140 F	50	50	50	50	
41	Hysteresis 2nd CH-circuit	34 F	86 F	14	14	14	14	
42	Low/off Cycle			00	00	00	00	
		X0 = Off		X	X	X	X	
		X1 = On						
	Special pump CH / DHW	0X = CH: normal pump function		X	X	X	X	
		DHW: normal pump function						
		1X = CH: pump off						
		DHW: normal pump function						
		2X = CH: normal pump function						
		DHW: 5 second pump delay						
		3X = CH: pump off						
		DHW: 5 second pump delay						