



PATTERSON-KELLEY

MACH C1500/C2000

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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Boilers

Installation Date: _____



Patterson-Kelley

Harsco

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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® C1500/C2000 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 C1500/C2000 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. 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 C1500/C2000 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 and knowledgeable personnel in accordance with all applicable codes, laws, and regulations.
- The use of the term “factory-trained personnel” throughout this manual indicates Patterson-Kelley trained on this specific piece of equipment.

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

Proper training is the best protection against accidents. Operating and service personnel must be thoroughly familiar with the basic construction of the P-K MACH C1500/C2000 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 but not limited to: guards, safety labels, safety controls, interlocks, lockout devices, in place and operable.

2.4 SAFETY LABELS

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

DANGER – Used to indicate an imminently hazardous situation which, if not avoided, will result in death or serious injury. This signal word is to be limited to the most extreme conditions.

WARNING – Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.

CAUTION – Used to indicate a potentially hazardous situation which, if not avoided, may result in minor or moderate injury.

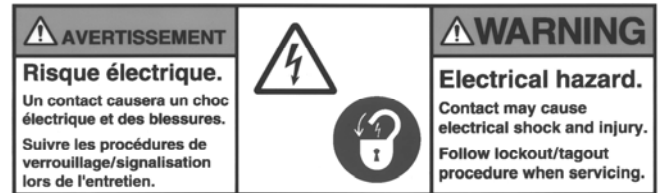
NOTICE/NOTE - NOTICE is the preferred signal word to address practices not related to personal injury. The safety alert symbol is not used with this signal word.

The safety labels shown below 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

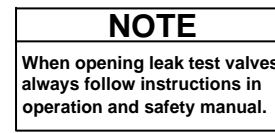
Provide a suitable location for the boiler, away from normal personnel traffic, with adequate working space, adequate clearances, proper ventilation and lighting, with a structure sufficiently strong and rigid to support the weight of the boiler, all piping, and accessories.

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 this boiler or on any electrical components.

2.5.2 Burn, Fire, and Explosion Hazards



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- Burn, fire, and explosion hazards! Installation must be in strict conformance to all applicable codes and standards including NFPA 54, ANSI Z223.1 and CSA B.149. 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 supply could result in overfiring of this or 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 blower/transition is securely fastened following any maintenance performed on them. These connections may leak gas if assembled incorrectly.
- Gas leak hazard! All threaded gas connections must be made using a pipe compound that is resistant to liquefied petroleum gas. **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.
- 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
C1500	1200
C2000	1400

- 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 3 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



General Warning

- 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.
- Fall hazard! Do not stand on any part of the boiler.
- Catch hazard! Do not wear rings, jewelry, long hair, loose clothing while working on the boiler.



3.0 INSTALLATION

WARNING!

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

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, unpack the boiler, open the front and side doors and inspect the internals of 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, or if the “Tip (N) Tell” is missing, it is likely 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 C1500/C2000 Boiler with standard components and 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 100 psig maximum operating pressure and/or 200° F maximum temperature.

Installation of the boiler must comply with the requirements of all national, state and local codes established by the authorities having jurisdiction. Authorities having jurisdiction should be consulted before installations are made.

Within the US, and in the absence of such local requirements, this boiler should be installed using 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/CSA-B149, latest edition and applicable Provincial Regulations for the class, which should be carefully followed in all cases.

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 see the Supplement for Massachusetts.

3.3 SETUP

3.3.1 Foundation and Placement

Provide a firm, level foundation, preferably of concrete.

WARNING! The wheels provided with this boiler are for positioning purposes only. When positioning this boiler, maintain positive control of it at all times. Do not attempt to move the boiler on surfaces that are not level. Failure to heed this warning could result in personal injury or death.

Lifting the front of the boiler slightly will allow the boiler to be rolled off the shipping skid onto the concrete foundation. Once in position, the wheel



bolts may be removed allowing the wheels to recess up into the boiler. The base will sit flat on the provided foundation. If the boiler is to be pulled out for maintenance, the wheels may be left attached.

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 prevent distortion of the cabinet, (twisting, etc.) in addition to leveling. Additionally there are three holes in the front and rear of the base that may be used for seismic anchoring. **Note:** The boiler may be installed on a combustible floor; however, the boiler must **never** be installed on carpeting.

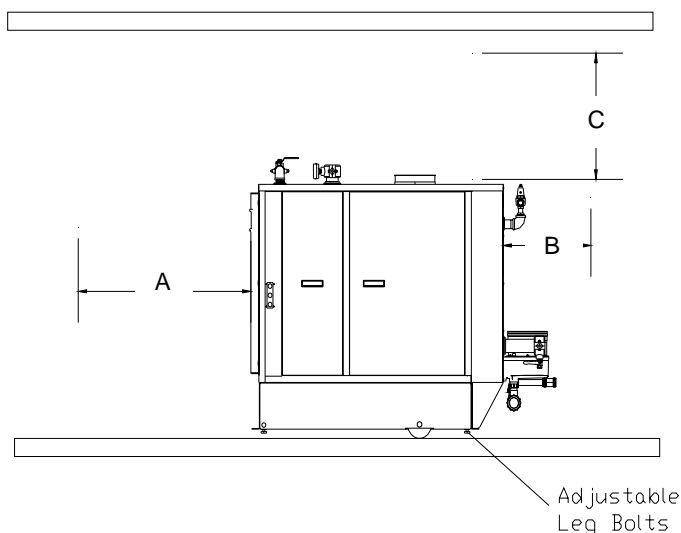
3.3.2 Clearances

If the boiler is to be installed near combustible surfaces, the minimum clearances shown in the pictures and table below must be maintained.

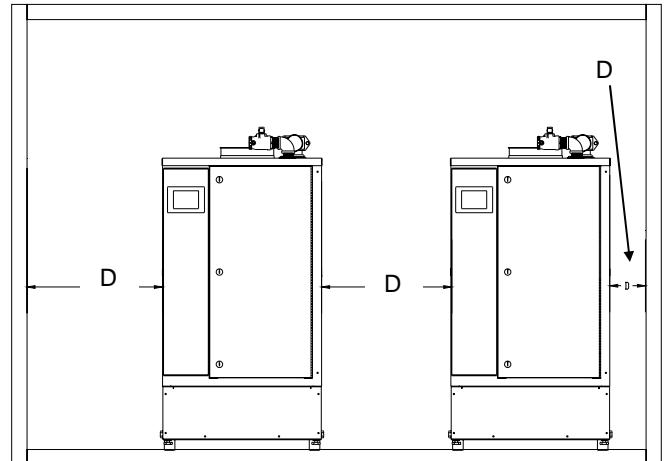
Failure to provide for the service access clearances, even with non-combustible surfaces, may cause future problems servicing the boiler.

Maintain a clearance from the vent to combustible surfaces of 18" or as specified in the vent manufacturer's listed installation instructions.

The boiler must be installed in a space large in comparison to the boiler as described in the National Fuel Gas Code, ANSI Z223.1, latest edition.



Minimum Clearances from Adjacent Walls, Ceiling, and Obstructions (shown above & below)



Type of Surface	Dimensions (inches)			
	A	B	C†	D
Combustible Surfaces Minimum Clearances	18	18	18	18
Recommended Service Clearances	30	12*	12	18**

† "C" Space required for pipes, ducts, etc. in this area above the boiler.

* Clearance depends upon exhaust vent configuration.

** Service access is required on left side of boiler to facilitate boiler maintenance. Minimum 2" clearance is required on right side. Do not put pipes, ducts, vents, etc in this space. Electrical conduit must be installed vertically so that the side doors can be opened.

CAUTION!

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

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. Each C1500/C2000 boiler

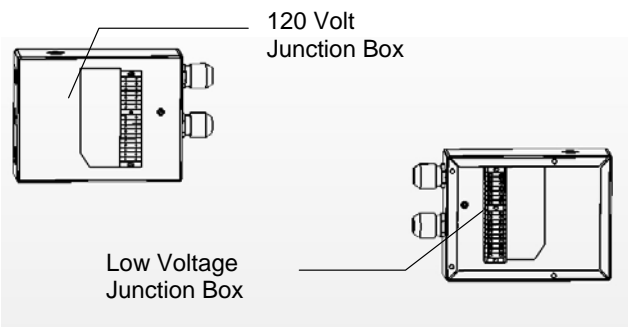


requires less than 15 amps. Before starting the boiler, check to ensure that the proper electrical service is connected to the boiler.

An external electrical disconnect (not supplied with the boiler) is required. The boiler electrical service must be installed and 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 or, in Canada, to the Canadian Electrical Code, Part I, CSA C22.1, latest edition. Conduit must be installed vertically so that the side doors can be opened.

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

Note: Refer to electrical wiring section for terminal block assignments (Section 6.1).



**Customer Connections for the Boiler
Viewed from Front of Boiler.**

3.5 COMBUSTION AIR

Note: Additional information is contained in the venting supplement “MACH-07VG”.

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, 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 9.3, 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.

3.5.1 Air Inlet Requirements

Caution.

The boiler room should not be at a negative pressure. Particular care should be taken when exhaust fans, compressors, air-handling units or other equipment may rob air from the boiler.

Combustion air may be supplied from within the building or from outdoors. The minimum required volume of the mechanical room and connected spaces is 50 cu. Ft. per 1000 Btu/hr (4.8 m³/kW). If this volume is not available, air must be taken from outdoors.

When air is supplied from inside the building, the total required volume shall be the sum of the required volume for all the appliances located in the mechanical room. Adjacent rooms furnished with fixed openings communicating directly with the mechanical room are considered part of the required volume.

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

- When rooms are on the same floor, each opening shall have an area equal to 1 square inch for each 1000 Btu/hr (2200 mm² / kW) of installed appliance input capacity, but not less than 100 square inches. One opening should be less than 12 inches above the floor and the other less than 12 inches below the ceiling. The minimum dimension of air openings shall be 3 inches.



- When rooms are on different floors, each opening shall have an area equal to 2 square inches for each 1000 Btu/hr (4400 mm² / kW) of installed appliance input capacity.

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

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

Minimum free area of the opening is;

- 1 square inch for each 3000 Btu/hr (700 mm² / kW) of installed appliance input capacity, and
- not less than the sum of the areas of all vent connectors in the room.

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

- When air is taken directly from outside the building, each opening (minimum of two, as outlined above), 1 square inch for each 4,000 Btu per hour of total boiler input is required.
- When air is taken from the outdoors through a vertical duct, 1 square inch per 4,000 Btu per hour of total boiler input is required.
- When air is taken from the outdoors through a horizontal duct, 1 square inch per 2,000 Btu per hour of total boiler input is required.

NOTE:

1. The required size of openings for combustion, ventilation and dilution air shall be based on the net free area of the opening.
2. Screens shall be not smaller than ¼”.

3. Motorized louvers shall be interlocked with the appliance so that they are proven open prior to main burner ignition and operation.

3.6 FLUE VENTING

Note: Additional information is contained in the venting supplement “MACH-07VG”.

Caution!

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

This boiler is Category IV (condensing – positive pressure) as it is defined in ANSI Z21.13/CSA 4.9, latest edition. **This boiler is not certified for use with Type "B" vent.**

The vent material must be :

- AL29-4C Stainless Steel Vent Systems listed and labeled to UL1738 *Venting Systems for Gas-Burning Appliances, Categories II, III, and IV*
- 316L Stainless Steel where certified and warranted by the vent manufacturer for venting of Category IV appliances

Vent installations shall be in accordance with Part 12, *Venting of Equipment*, of the National Fuel Gas Code, ANSI Z223.1 or Part 8, *Venting Systems and Air Supply for Appliances* of the Natural Gas and Propane Installation Code CAN/CSA-B149 current revision, or applicable provisions of the local building codes.

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



Vent design calculations should be based on a maximum of 0.44" W.C. combined frictional resistance across the air inlet duct and the stack, with a stack temperature of 185° F (gross) and a CO₂ level of 9.2% on natural gas. 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

Note: Additional information is contained in the venting supplement "MACH-07VG".

The outlet of the boiler is a metric female pipe with a gasket. It requires a male adapter that is 9.79" OD as the mating piece. This adapter should be obtained from the venting manufacturer and will be specific for this boiler. The connection from the boiler to the stack should be as direct as possible and any horizontal breaching should have an upward slope at least 1/4 inch per linear foot.

This boiler should not be connected into any portion of another mechanical draft system without consulting your venting manufacturer. This boiler shall not be connected to any part of a vent system serving a Category I appliance, nor shall a Category I appliance be connected to any part of the vent system serving this appliance.

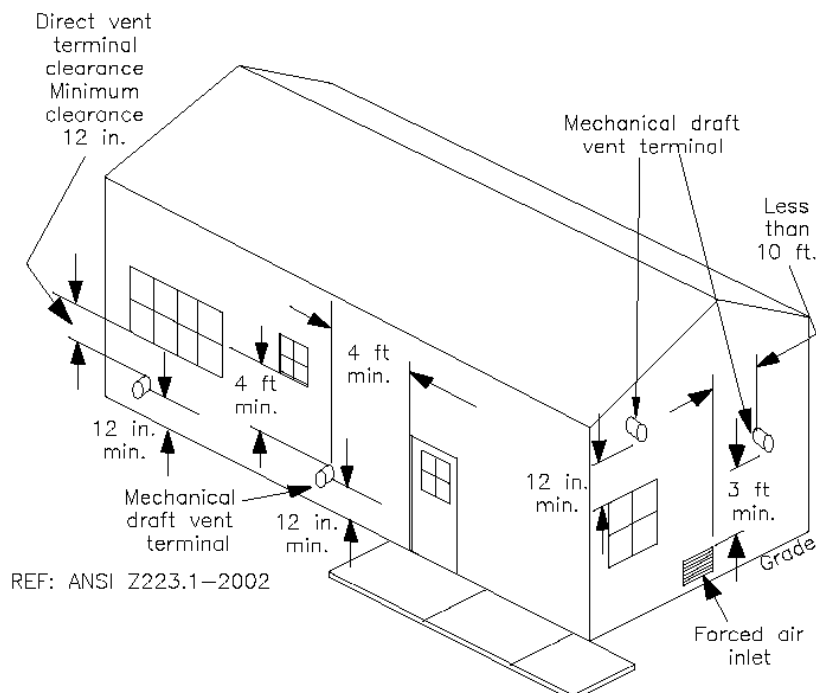
Note: If the vent is erected vertically directly from the boiler outlet, make sure that the weight of the vent is **not supported** by the boiler vent collar. **The collar is not designed to support the weight of the vent.** Structural support and spacing from combustible surfaces must be in accordance with the vent manufacturer's requirements.

3.6.3 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. All dimensions should take into account the snow line for the installation area.

WARNING!

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





3.6.4 Vertical Vent Systems

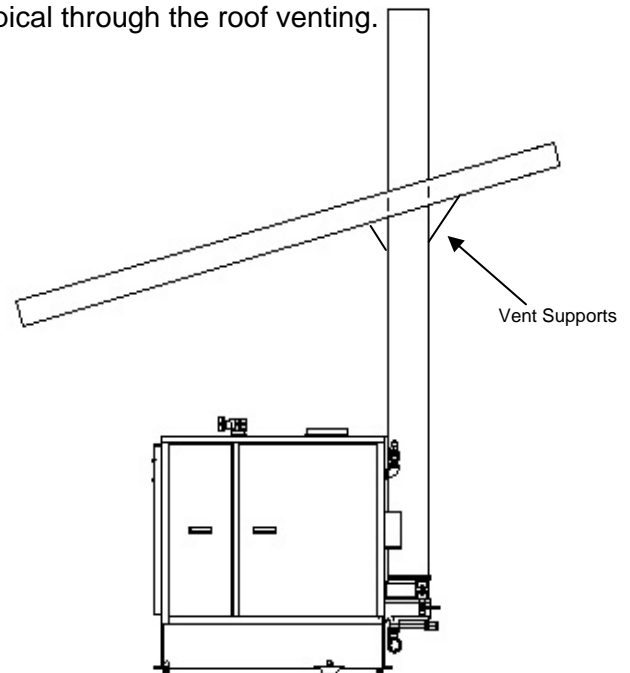
The following termination clearance requirements are for conventional, non-direct vent installations.

The vent system shall terminate at least 3 ft above a forced air inlet within 10 feet horizontally.

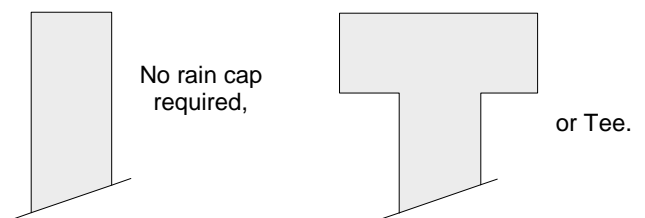
The vent system shall terminate at least 4 ft below, 4 ft horizontally from or 1 ft above any door, operable window or gravity inlet into any building. The bottom of the vent terminal shall be at least 12 in. above grade or highest expected snow line (if applicable).

The boiler vent connection is vertical and may be reduced. The stack size may be a nominal ten (10"), eight (8"), or six (6"), so long as the combined air and stack pressure resistance of 0.44" total is not exceeded. When using 10" or 8" stack, a sealed air inlet duct may also be used. When using 6" stack, the only allowable configuration is vertical without offsets (elbows, tees, etc.) which results in 0.44" or less of resistance and without a sealed air inlet.

Typical through the roof venting.

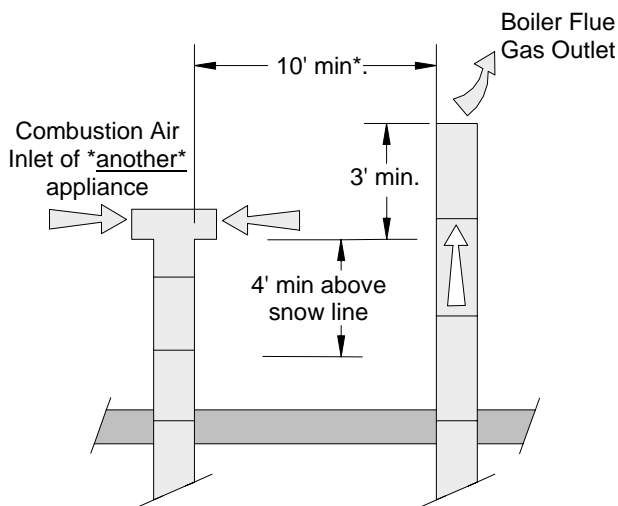


3.6.5 Vent Terminations



Vertical Vent Termination Details

The vent should extend at least four (4) 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, the vent designer must take into consideration such things as prevailing winds, eddy zones, building configurations, etc. Patterson-Kelley Co. 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.

The installation of a bird screen on the vent termination is recommended.

A rain cap is not recommended for the vent.



3.6.6. Direct Vent (Sealed Combustion) Systems

The vent terminal shall be located at least 12 in. from any air opening into a building. The bottom of the vent terminal shall be at least 12 in. above grade. Both the vent and air intake terminals must be at least 12 in. above the highest expected snow line.

Through the wall terminations shall not terminate over public walkways. Maintain a minimum clearance of 4 ft (1.22 m) horizontally from any electric or gas meter, regulator or relief equipment.

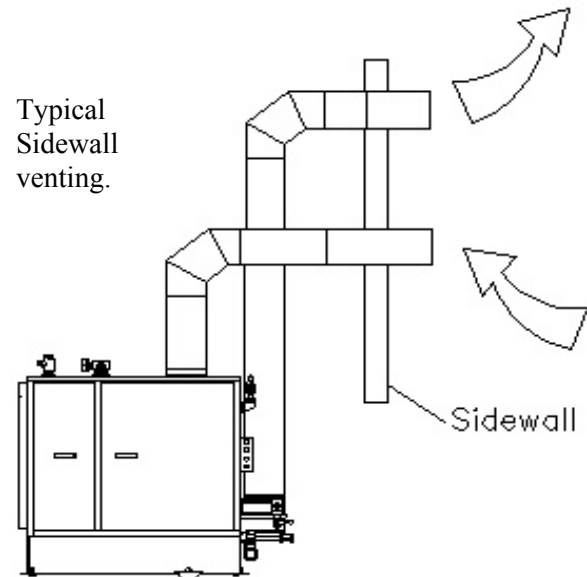
3.6.7 Sidewall Venting with Sealed Combustion

The MACH C1500/C2000 Boilers are certified for direct sidewall venting with a sidewall air inlet **only**.

Both the air inlet and the exhaust vent must terminate on the same wall of the building and must utilize the same type of termination fitting with the same orientation. Allowable termination fittings are: 90° elbows, tees, or straight vents.

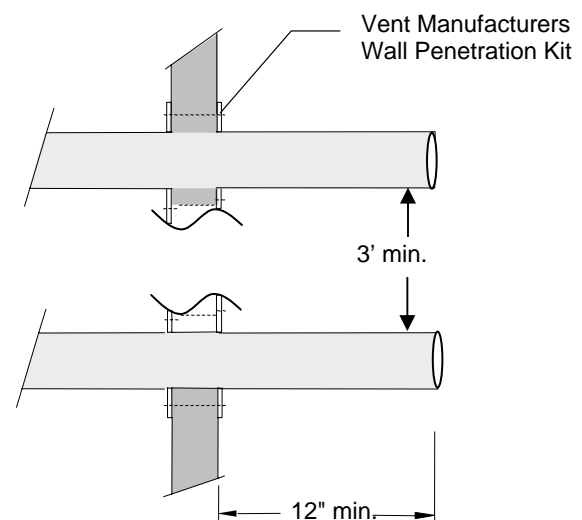
Do not install this boiler with sidewall vent and room air inlet!

The air inlet and vent must be sized so that the total pressure loss for the combined inlet and vent ducts does not exceed 0.44" w.c.. For example, if the inlet air duct loss is 0.2" w.c., the vent duct loss cannot exceed 0.24 "w.c.. The vent should be sized using a gross vent temperature of 185°F, a CO₂ level of 9.2% and the residual vent pressure loss as indicated above. The air inlet duct should be sized as indicated in paragraph 3.6.8.



Vent Installation Details

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



Sidewall Penetration Detail



3.6.8 Intake Duct Materials and Sizes:

Material: PVC, CPVC, single wall galvanized steel, or other suitable materials.

The intake duct must be sized for a pressure drop as indicated in paragraph 3.6.7 and for the SCFM as specified below.

Boiler Size	Required SCFM
1500	350
2000	467

The installation of a bird screen on the intake termination is recommended. Ensure that the screen does not become blocked with snow, ice, etc.

3.6.9 Sealing the Intake Duct

Proper sealing of the intake ductwork is necessary to prevent infiltration of air from conditioned space. Joints in PVC or CPVC must be cemented. For galvanized duct, wrap each joint and seam with adhesive aluminum tape.

3.6.10 Intake Duct Connection to Boiler

Connect the air supply duct to the 10" OD collar on the top of the boiler. Fasten the duct to the collar with sheet metal screws at 90° angles. Seal the joint.

3.6.11 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.

3.6.12 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.



3.7 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. 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.

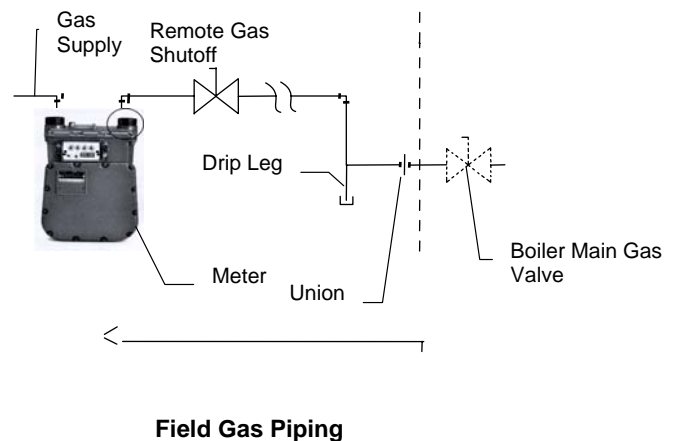
WARNING!

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."

Notice: 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., 1,500,000 Btu per hour requires about 1500 cubic feet per hour. (See "Typical Boiler Operating Conditions," Section 4.3, for more information.)

RECOMMENDED GAS PIPING INSTALLATION



Install a sediment trap (drip leg) and a union connection upstream 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, please refer to CSA-B.149, latest edition.

**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.

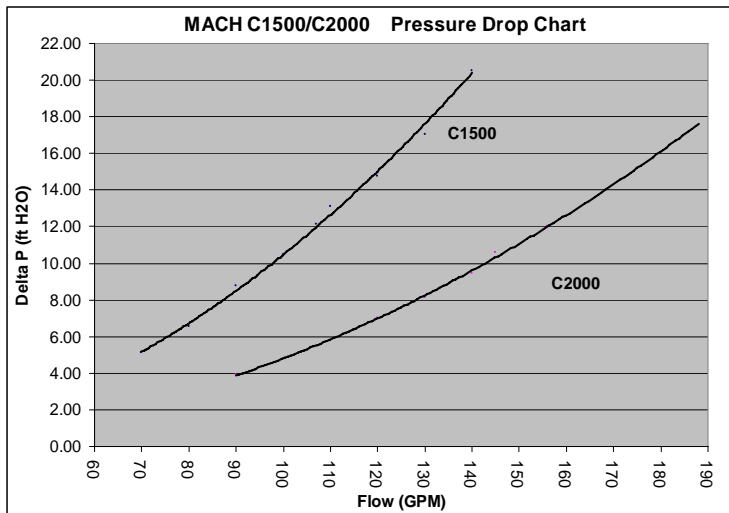
Some leak test solutions, including soap and water, may cause corrosion. These solutions should be rinsed-off with water after testing.

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.

Model	Max Flow GPM for 20°F ΔT	Min Flow GPM for 40°F ΔT	DP ft. at max flow
2000	188	94	18
1500	141	70	20

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



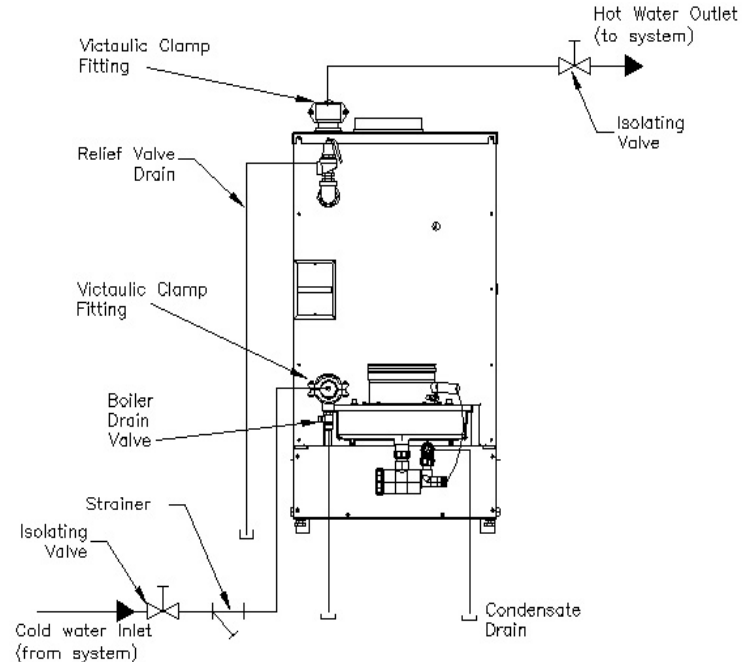
Proper flow rates may be achieved through a combination of primary and secondary flow loops. Multiple zones and pumps may result in different flow rates at different times. Consideration must be given to all possible conditions and their consequences.

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.



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 2.5" grooved connections for Victaulic Style Couplings. These coupling must be used with the EPDM Victaulic seals. Adapters from Victaulic to NPT are available from the factory. Isolating valves must be installed in both water connections for ease of service.

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

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

The 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 Piping

Each boiler is supplied with a pressure-relief valve sized in accordance with ASME requirements. Lower pressure relief valves are available, contact your Patterson-Kelley representative. 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.

CAUTION!

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 is 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 C1500/C2000 boiler heat exchanger is made of an aluminum alloy. The heat exchanger requires special water conditions to retain efficiency and function properly.

NOTE!

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

NOTE!

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 may 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 PRELIMINARY

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.

Reference Technical Bulletin regarding Glycol compositions and manufacturers

The water quality should be within the guidelines established by the American Boiler Manufacturers Association, for hydronic boilers, 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.

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, open the front door, remove the side panels 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. (refer to section 3.4)
6. Combustion air openings are not obstructed in any way and have adequate capacity. (see section 3.6.9)



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 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

MACH C1500/C2000

Test the ignition system safety shutdown as follows:

1. 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)
2. Place the boiler in operation at the high fire setting. See section 3.12.4 Gas Valve Setup and Adjustment , *Test Mode High*
3. Smoothly close the downstream manual isolation valve to reduce the gas flow and cause flame failure.
4. The display will flash **E-02** indicating a flame failure. The **E-02** lockout will remain until reset on the display.

After completing this test, turn off the boiler and open the downstream manual isolation valve and turn the boiler back on.

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 by refilling and restarting the boiler and pump. 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 02** 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

Low Gas Pressure Switch

The boiler is furnished with a low gas pressure switch. The operation of this switch must be checked by slowly closing the main gas cock while the burner is operating. The switch should shut down the main burner. 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.

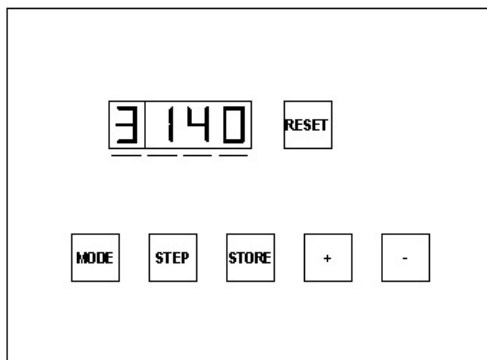


High Gas Pressure Switch

The boiler is furnished with a high pressure switch that must be checked by closing the downstream gas cock with the boiler off. When the boiler is started, it should enter its normal starting cycle and fail on high gas pressure when the automatic gas valves open. The high gas pressure switch actuation is evident when a manual reset lockout displaying **E 12** on the display panel occurs. 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



Display Panel (above) Operation of Control (below)

The MACH® C1500/C2000 boiler is equipped with a combination combustion and temperature control. This control monitors combustion and lighting of the boiler, as well as maintaining temperature of the supply water. The temperature control portion modulates the boiler to maintain the desired outlet temperature based on the selected operating configuration.

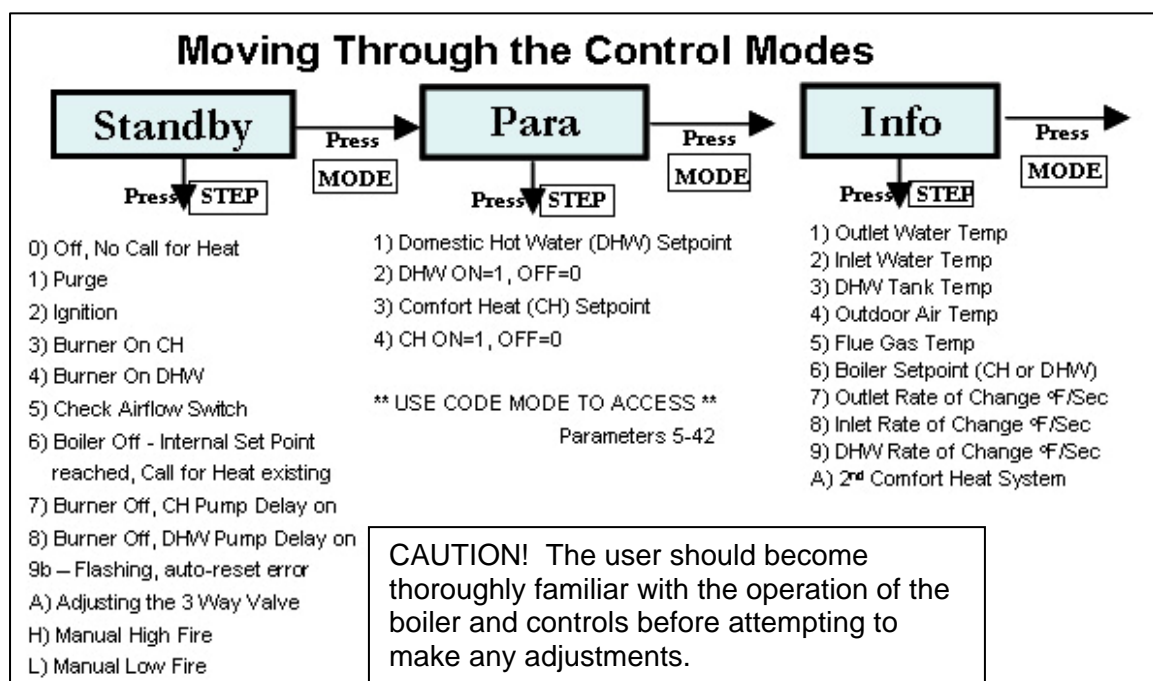
3.12.1.1 Operation of the Control

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 on 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® C1500/C2000 Boilers.

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!

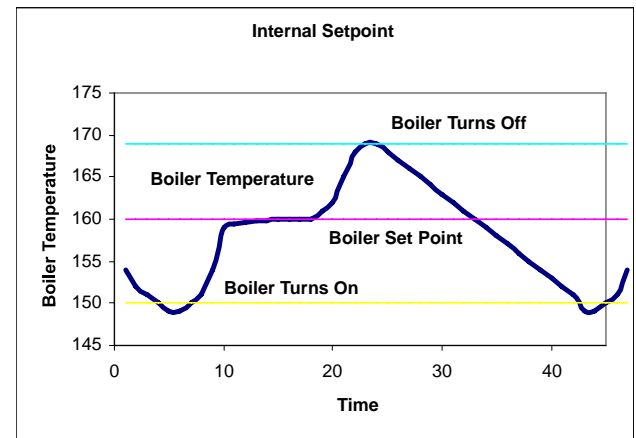
Do not modify any parameters other than those specifically mentioned.

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:

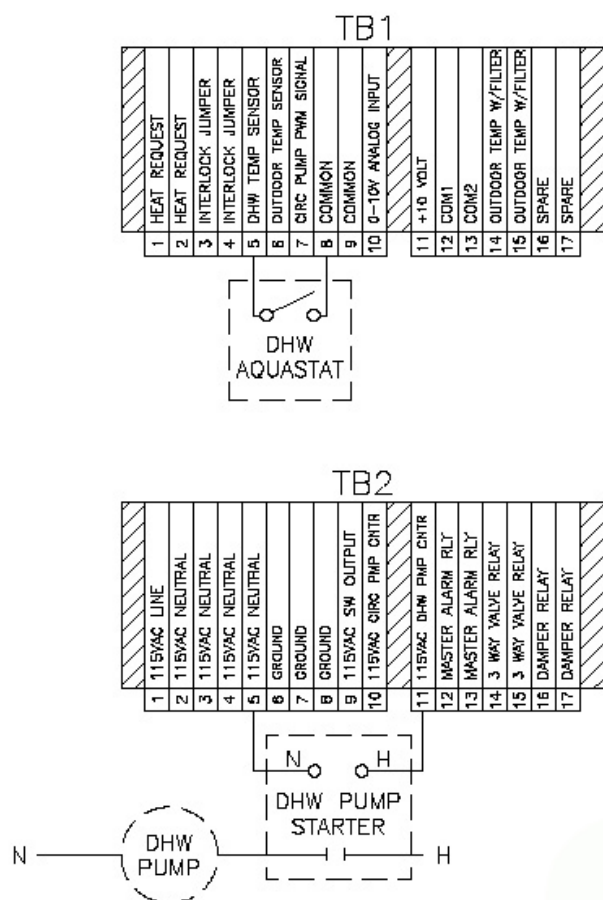
If an indirect domestic hot water (DHW) tank is connected, the DHW function of the boiler will activate when the DHW temperature controller (supplied by others) closes (Terminal 5 to 8 TB 1, refer to Section 6.1.1), indicating a call for heat from the DHW system. The parameters should be set as follows:

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

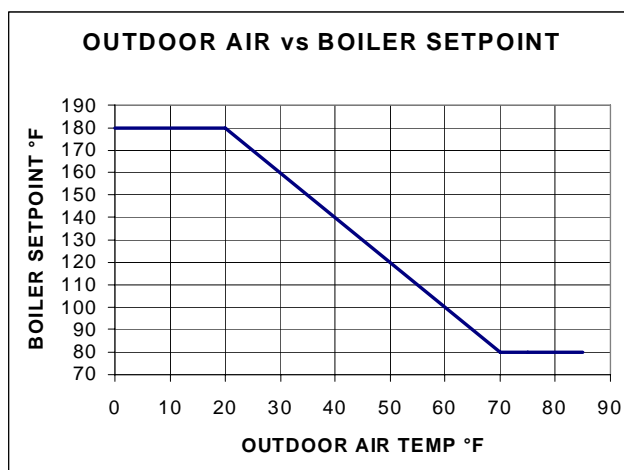
In the above example, the boiler temperature will be set to the DHW Setpoint + the DHW Setpoint Addition (140°F + 30°F = 170°F) when the DHW temperature controller indicates a call for heat from the DHW system. When the DHW system calls for heat, the Central heat pump output (Terminal 10 TB2) de-energizes 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.

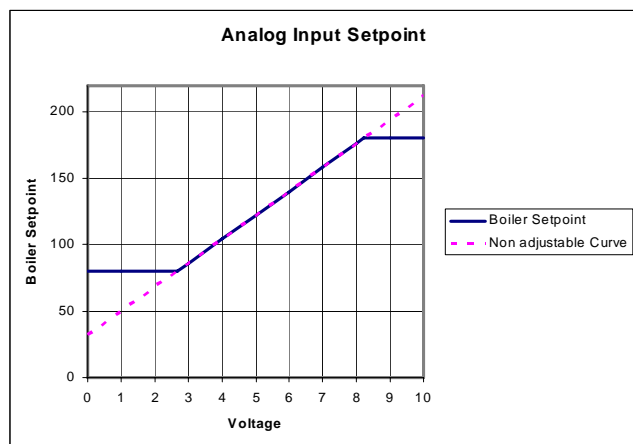
The setpoint is adjusted according to the above parameters. The boiler setpoint will be the maximum value (180° F) when the outdoor air is at or below a minimum temperature value (20° F). The boiler setpoint will be at the minimum value (80° F), when outdoor air is at or above a maximum temperature value (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:



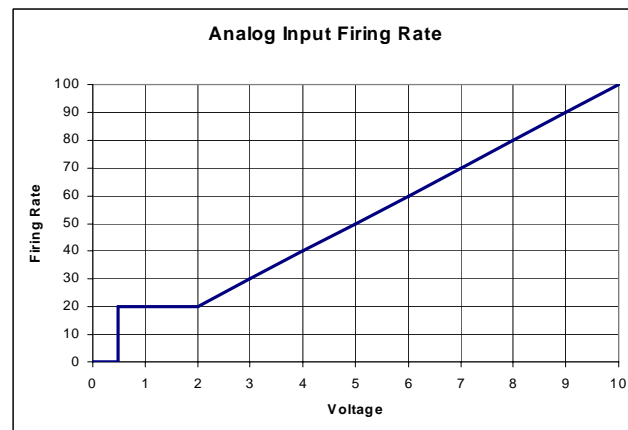
The control must be configured for a remote analog input setpoint according to the following table:

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 Burner Setup

The MACH® C1500/C2000 boilers are equipped with a Honeywell combined gas/air control and gas safety shut off control valves. The valve functions in series 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/air regulator adjusts gas flow to maintain the proper pressure at the outlet nozzle of the associated valve.

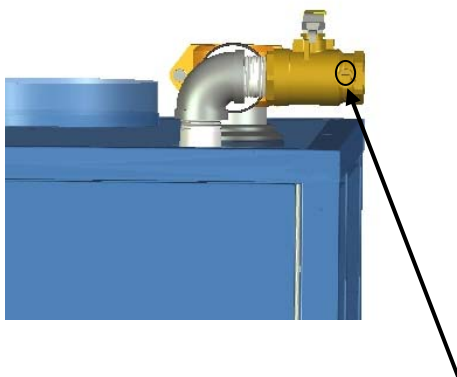


3.12.3 Gas Pressure Adjustment

Note: Adjustments shall only be performed by qualified and knowledgeable installer or service agency specifically trained and certified to perform maintenance and/or startup on the Patterson-Kelley MACH® 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.)



Gas Pressure Test Port

The supply pressure during main burner operation must be greater than the minimum indicated on the rating plate which is 3" W.C. for natural gas. Nominal gas supply pressure is 7" W.C. for natural gas. The gas pressure must not exceed 14" W.C. which is the maximum allowable pressure on the gas train components.

3.12.4 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.

3.12.5 Gas Valve Setup and Adjustment

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" W.C.

Boiler Test Mode:

The test mode should be used when checking and setting the gas safety shut off / control valves on the MACH® C1500/C2000 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.

***Adjustment:***

There must be sufficient load to operate the boiler at high fire to perform the following adjustments.

Required Tools:

TORX® T40 wrench and
3 mm hex wrench
Combustion analyzer

Start the boiler and observe proper operating parameters for the system. The combustion analyzer probe should be placed in the stack outlet to measure the combustion parameters.

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 the combustion analyzer. If combustion readings are not in accordance with Table 3-1, adjust as follows:

Remove the flat, round, blue plastic cap from the cover. Using a 3mm (or 7/64”) hex wrench, turn the adjustment screw counterclockwise to increase or clockwise to decrease gas flow and 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. Adjust the settings in small increments and allow the combustion readings to stabilize before readjusting. When desired adjustments are complete, reinstall the blue plastic cap on the cover.

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 the combustion analyzer. If combustion readings are not in accordance with Table 3-1, adjust as follows:

Remove the round metal cap on the gas regulator using a slotted screwdriver. This will expose the offset adjustment screw.

Using a TORX® T40 (or 5 mm hex), carefully adjust the low fire gas setting to achieve the CO₂ /O₂ level prescribed in Table 3-1.

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.

The offset pressure regulator is quite sensitive and adjustments should not exceed ¼ turn at a time before allowing the readings to respond and stabilize.

After proper low fire offset adjustment is made, reinstall the slotted cap on the regulator.

Following all gas valve adjustments, check for proper light-off and verify correct fuel/air mix and combustion quality throughout the entire firing range (from low to high fan speed).



C1500/C2000 Adjusting Low and High



Analyzer probe in boiler exhaust



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

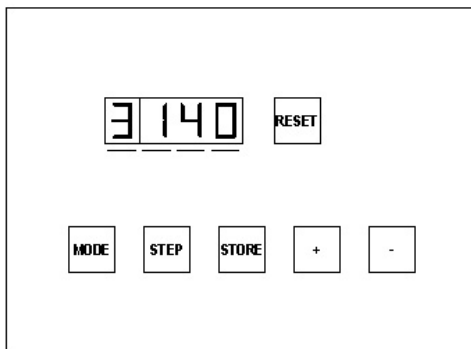
Fuel	Nominal Gas Pressure	High Fire Setting		Low Fire Setting	
		% O ₂	% CO ₂	% O ₂	% CO ₂
Natural Gas	7" W.C	4.8 ± 0.2	9.2 ± 0.1	5.0 ± 0.2	9.1 ± 0.1



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.

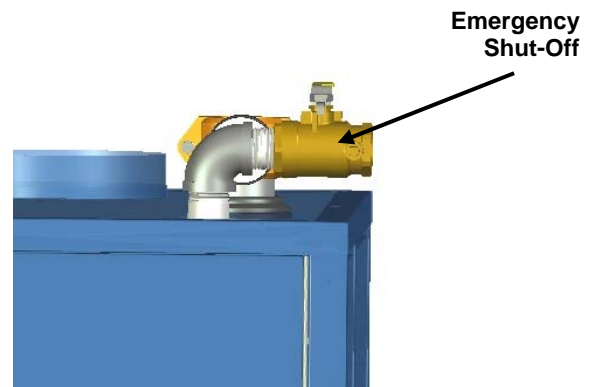
The controller will now complete the automatic firing sequence.

4.2.2 Normal Shut Down Procedures

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

4.2.3 Emergency Shut-Off

The main gas cock (at the top-front of the boiler) 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)	Total Amperage	Natural Gas (1030 Btu/cu. ft.*)	
			Gas Rate (CFH)	Output Capacity (Btu/hr)
C1500	1,500,000	Less than 15	1456*	1,440,000
C2000	2,000,000	Less than 15	1942*	1,920,000

Note: The heat exchanger is constructed and stamped for 100 psig maximum operating pressure and 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 any 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 mostly orange with a blue halo, while at low fire the burner will glow yellowish-orange.

Correct air adjustment is essential to the efficient operation of this boiler. If an adjustment in the combustion is necessary, call a qualified and knowledgeable installer or service agency who has been trained on the Patterson-Kelley MACH boilers.

5.1.3 Monthly (During Operation)

1. Test flame detection by voltage reading at the terminal strip (use 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 and knowledgeable installer or service agency who has been trained on the Patterson-Kelley MACH boilers.



5.1.4 Semi-Annually (required for boilers operated year round)

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 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 be filed for future reference.
9. Leak test gas valves. Leak test must be performed only by qualified PK certified personnel who have been trained in this procedure. This procedure is available on request from the PK Factory.

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/tagout gas supply to the boiler.
2. Lockout/tagout electrical power to the boiler.
3. Open the front door of the boiler.
4. Disconnect the two electrical connections to the blower
5. Remove the ignition electrode.
6. Remove the six screws on the bottom of the blower.
7. Remove the three nuts holding the blower outlet on the boiler casting.
8. Pull the blower w/outlet and set aside. Inspect burner gasket, replace if damaged.
9. Reaching inside the burner, carefully remove the burner. Clean using low pressure air to remove any dust or lint from the burner.
10. Reassemble, being sure to install all gaskets and seals properly.



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. In order for the boiler to start, the following limits must be satisfied:
 - a) Low water level control
 - b) High & low gas pressure switches
 - c) High temperature limit
2. When the On/Off (Main power) switch is turned on, power is provided to the boiler control, combustion blower and the gas valve relay board.
3. When the water temperature is below the control setpoint, a heat request is generated.
4. 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 to the ignition speed.
5. After the 15 second prepurge the high exhaust backpressure switch circuit is checked to ensure the air flow is within design parameters.
6. When the blower speed is within 200 rpm of the ignition fan speed, a trial for ignition period of 3 seconds is initiated. The ignition spark and the gas valves are energized.
7. The internal spark generator is de-energized after 2.7 seconds and the flame rectification system is energized. If a flame signal is detected by the control, 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.
8. The unit modulates between the low fire setting and the high fire setting to maintain the desired outlet water temp set point.
9. When the load is below the minimum firing rate 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.
10. When the water temperature is reduced by the load on the system, a heat request is again generated and repeats the cycle.



5.5 TROUBLESHOOTING

WARNING !

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

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

The MACH® C1500/C2000 boiler will display service codes to indicate some problems with the boiler.

There are two types of lockouts that the control may display. Each code will consist of a letter followed by a two digit number. A code beginning with ‘E’ indicates a manual reset lockout requiring an operator to press the reset button. A code beginning with a ‘b’ indicates an automatic reset lockout. The control will automatically attempt to restart the boiler. A listing of service codes is included in this section.

If the boiler displays an ‘E-code’ or recurring ‘b-code’, 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 gas valves and halting all boiler operations. When power is restored the boiler will restart, 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, a manual reset is required to restart the boiler, provided that all other limits are satisfied.

Low Gas Pressure

The low gas pressure switch opens when there is 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 a manual reset is required to restart the boiler, provided that all other limits are satisfied.

High Gas Pressure

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

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

**High Water Temperature**

When the boiler water has exceeded the high water temperature limit setting, the high limit switch opens and locks out. The control shows **E 02** 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 control panel reset button is pressed. Once the switches are reset, the boiler will restart provided that all other limits are satisfied.

Low Air

When there is insufficient airflow, the air switch will open, and the display panel will indicate **E 08**. Check that the burner is clean ("Cleaning the Burner," Section 5.2) and that there are no obstructions to airflow in the intake duct, exhaust vent, boiler air passageways, intake flapper box and the condensate trap. A low air indication does not necessarily mean that the low air switch is defective. The boiler will remain locked out until the control panel reset button is pressed. Once the control is reset, the boiler will restart provided that all other limits are satisfied.

Fan running and No Display

The fuse in the control may have opened and the blower will run at high speed even though the boiler is not firing. Shut off the power to the boiler and call a qualified and knowledgeable service agency.

Air Switch Closed

If the display panel indicates **b 61**, 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 alternate source of air flow (exhaust fan, induced draft fan, etc), replace the switch.

Flame Failure

In the event of a flame failure during a firing period or a trial for ignition, the main gas valves are closed and the display will indicate **E 02**. The combustion control must be manually reset and the boiler will restart provided that all other limits are satisfied.

Insufficient water flow

In the event of insufficient water flow, the outlet temperature will rise rapidly and the control may display one of the following errors: E 18, E 25, b 18, b 25, b 30. Check the water pumps, associated piping, and any strainers, valves, etc. to ensure proper flow is present. Once the flow has been re-established, any manual lockout must be reset and the boiler will restart provided that all other limits are satisfied.



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 or high temp limit tripped.
E 03	Gas Valve Relay Board error.	Electrical connection from control to GVRB open.
E 04	General lockout.	The power was lost after a lockout. The control loses the description of the lockout on power loss.
E 08	Air pressure switch open.	The air pressure switch is open. Insufficient air flow.
E 12	Limit open.	High & Low Gas Pressure, Low water cut off(s). Optional External limit
E 18	Outlet high temp.	The outlet water temperature has exceeded the internal high temperature setting.
E 19	Inlet high temp.	The inlet water temperature has exceeded the internal high temperature setting.
E 25	Outlet temp rapid change.	The outlet water temperature is increasing too fast. Indicates 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	Inlet sensor shorted.	The inlet temperature sensor is short circuited.
E 33	DHW sensor shorted.	The Domestic Hot Water 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	Inlet sensor open.	The inlet temperature sensor is indicating an open circuit.
E 38	DHW sensor open.	The Domestic Hot Water sensor is indicating an open circuit.
E 40	Flue sensor open.	The flue gas temperature sensor is indicating an open circuit.
E 52	High flue temp.	The flue temperature has exceeded the maximum allowable setting.

Note: This list is not inclusive of all possible codes. If any other error codes are displayed on the boiler, call a qualified and knowledgeable service agency.

**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 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. Indicates a 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 or external interlock jumper is open.
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.



6.0 PARTS/TECHNICAL SUPPORT

Spare parts and replacement parts can be ordered from Patterson-Kelley by calling toll free (877) 728-5351. The fax number is (570) 476-7247. Refer to the parts list shown on the assembly drawing provided in this manual. Technical information is also available at the above number and at the Patterson-Kelly website www.pkboilers.com.

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

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

6.1 SCHEMATIC DIAGRAMS

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



6.2 WIRING DIAGRAMS

6.2.1a Terminal Block Assignments – High Voltage Circuit (TB2)

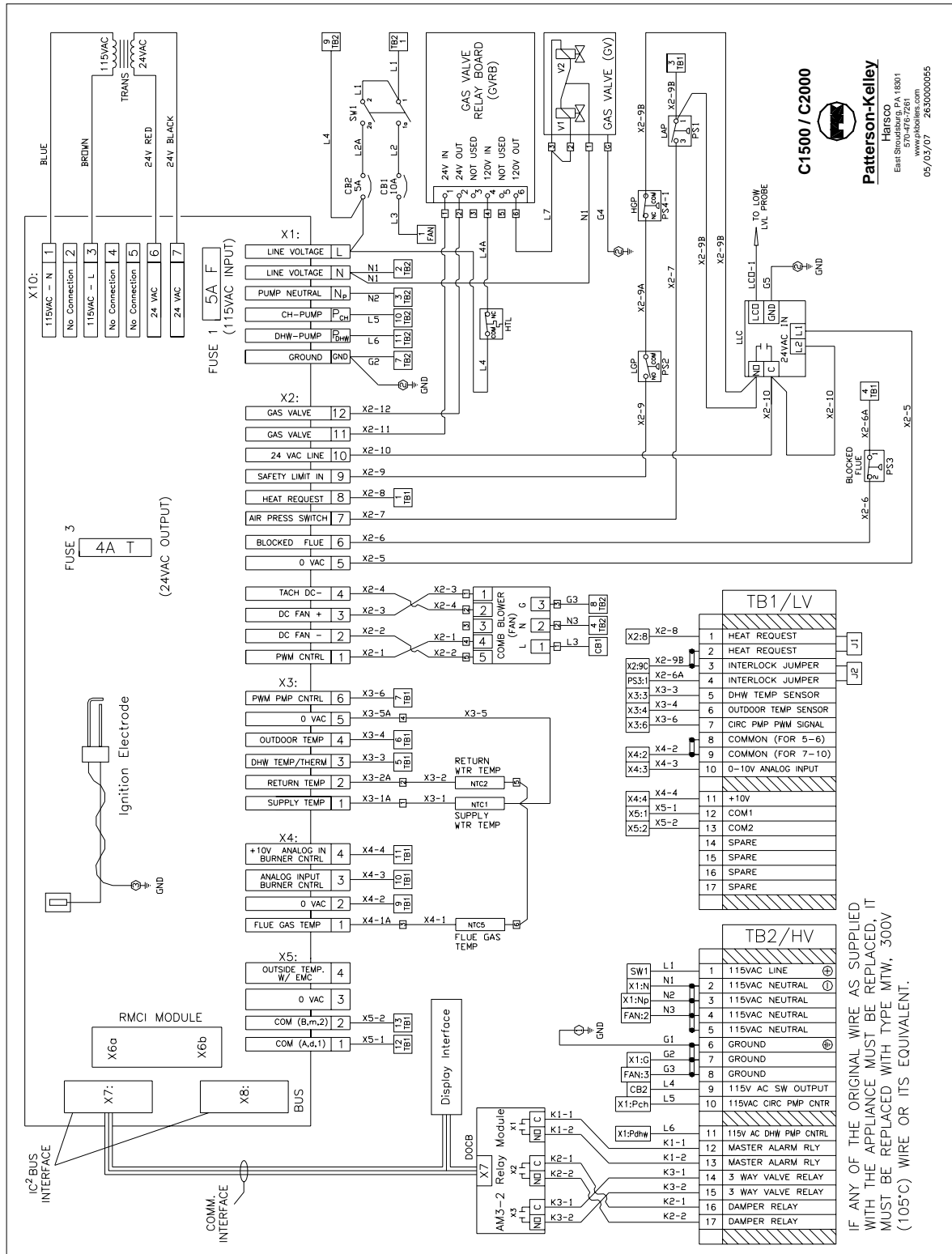
Terminal Number	Label	Description
1	115 VAC LINE	Boiler Supply Power, 115 VAC, 60 HZ, 1 ph, 8 amp
2	115 VAC NEUTRAL	
3	115 VAC NEUTRAL	Aux. Switched Output
4	115 VAC NEUTRAL	Boiler Circ. Pump
5	115 VAC NEUTRAL	DHW Circ. Pump
6	GROUND	Boiler Supply Ground
7	GROUND	Aux. Ground
8	GROUND	
9	115 VAC SW. OUTPUT	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	

**6.2.1b 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	SPARE	
15	SPARE	
16	SPARE	
17	SPARE	



6.2.2 Wiring Diagram for Series C-1500/C-2000

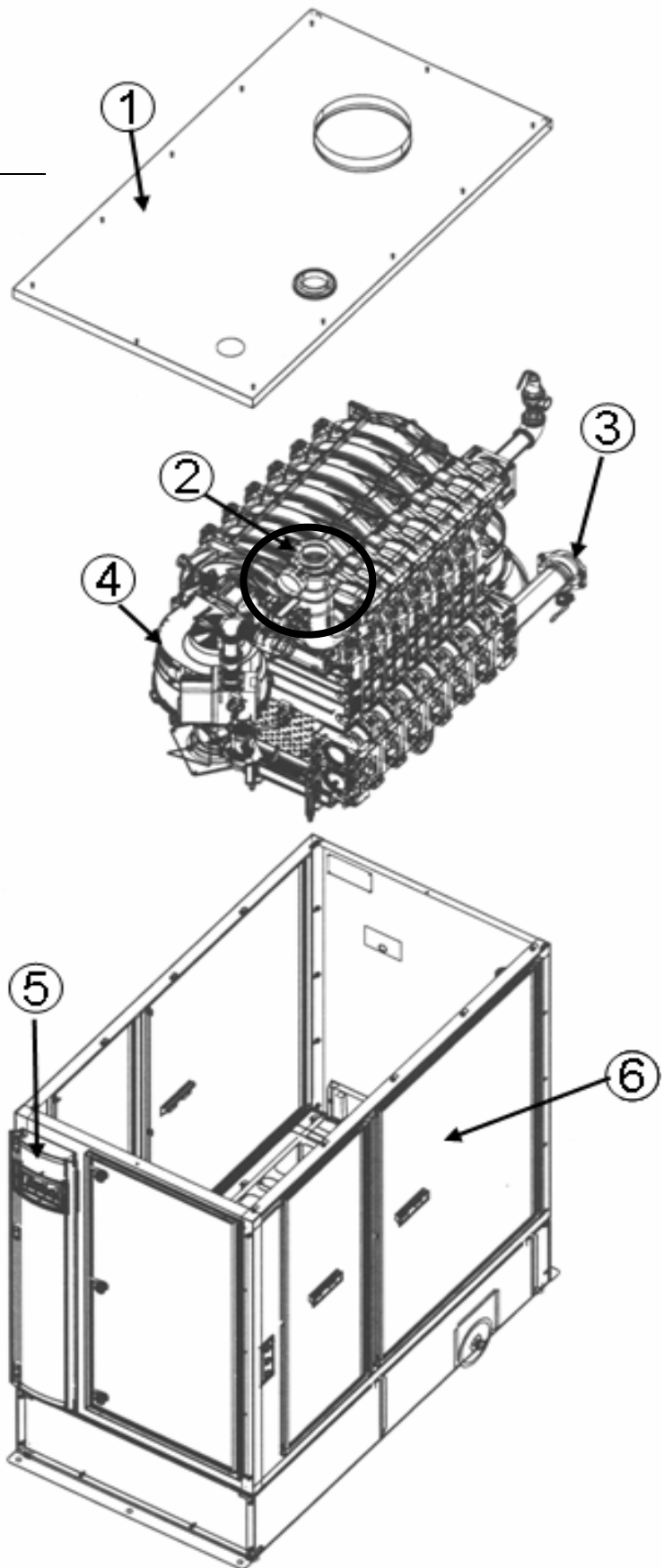




6.3 BOILER PARTS LIST

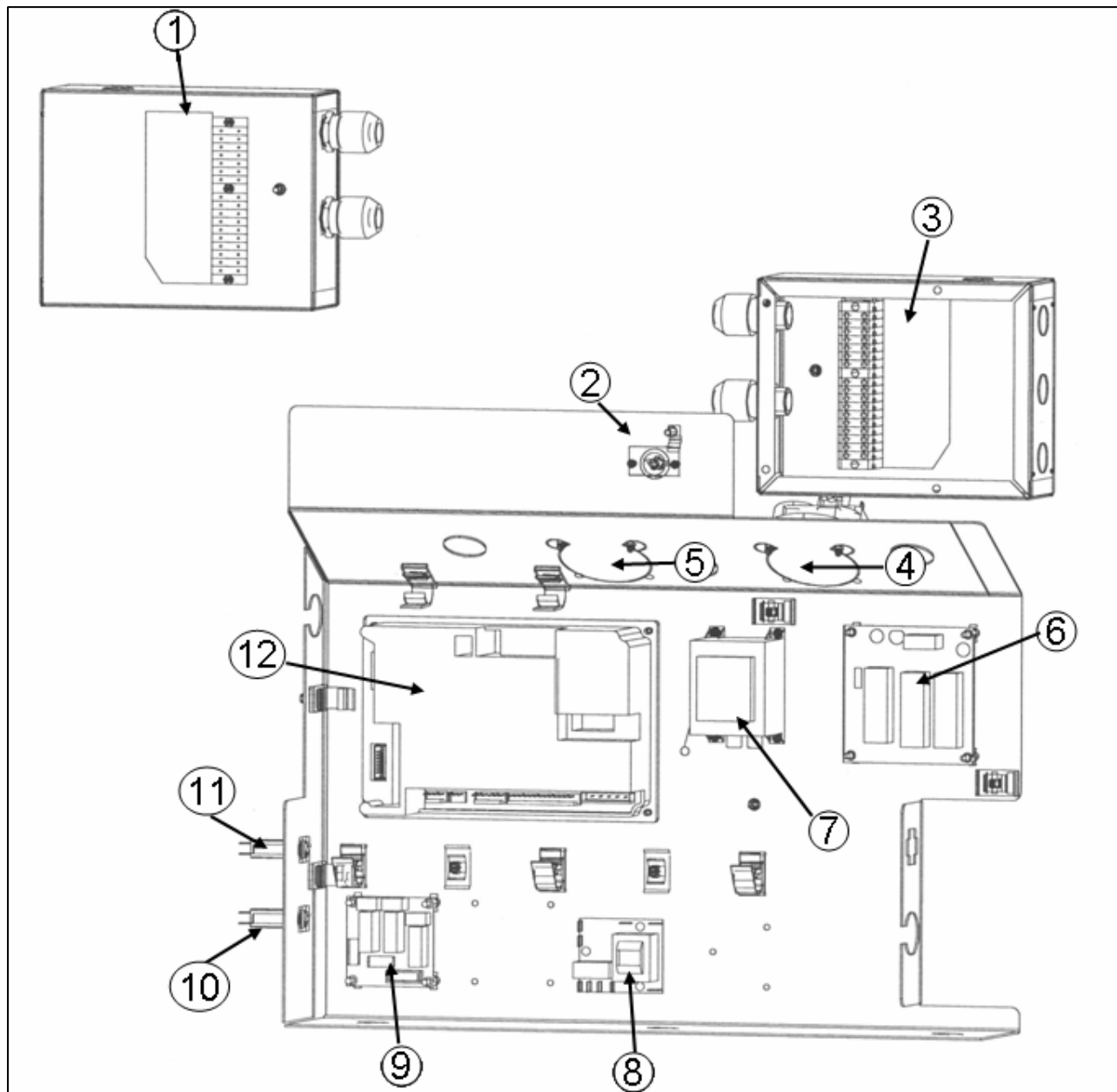
6.3.1 Main Assembly

Mark	Description
1	Cabinet Top
2	Boiler Outlet
3	Boiler Inlet
4	Blower/Burner Assembly
5	Front Control Panel
6	Cabinet





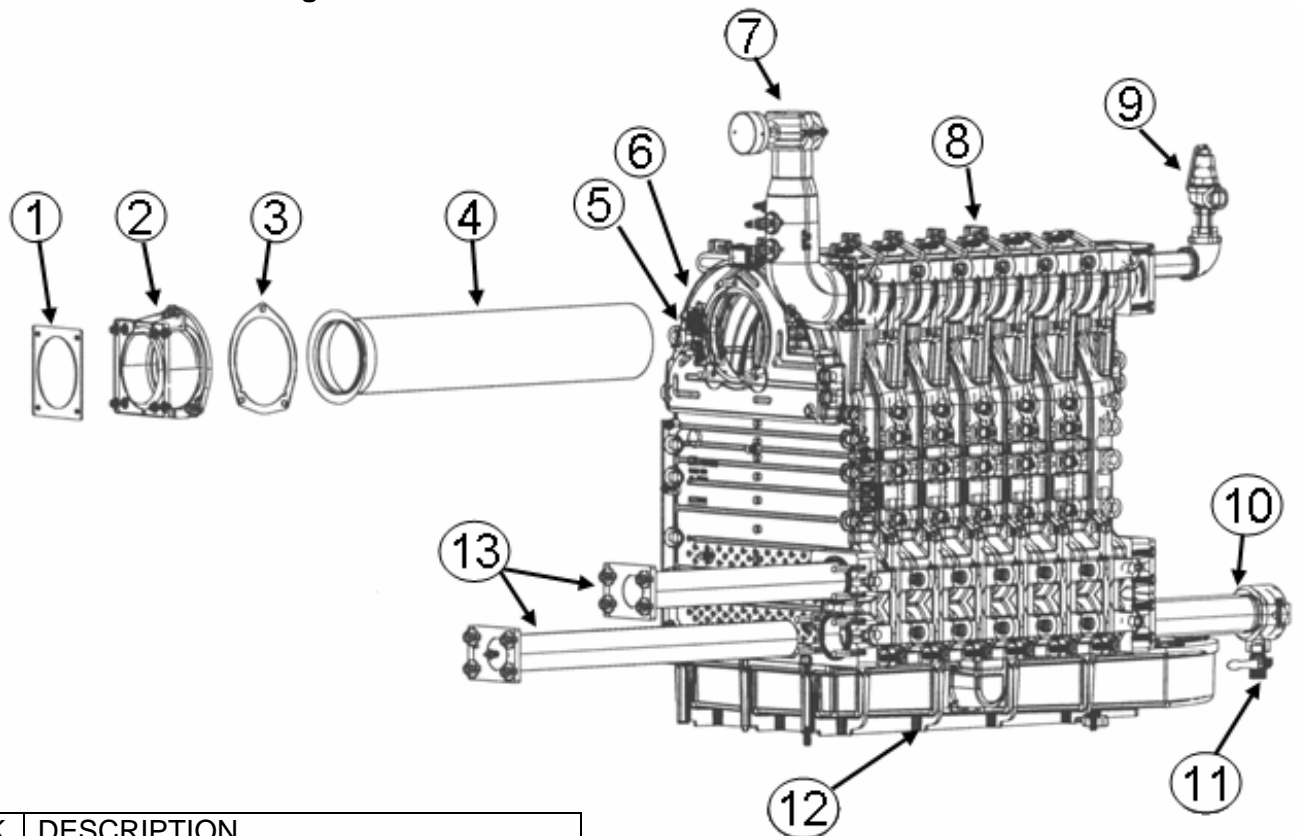
6.3.2 Control Panel



Mark	Description		
1	Terminal Block 1 (TB1) 120V	6	Gas Valve Relay Board (GVRB)
2	High Temperature Limit	7	120V/24V Transformer
3	Terminal Block 2 (TB2) Low V	8	Low Water Cut Off (LWCO)
4	Air Switch (on back)	9	AM3 Relay Board
5	High Exhaust Back Pressure Switch (HEBPS) on back	10	10 Amp Circuit Breaker
		11	5 Amp Circuit Breaker
		12	MCBA Boiler Control



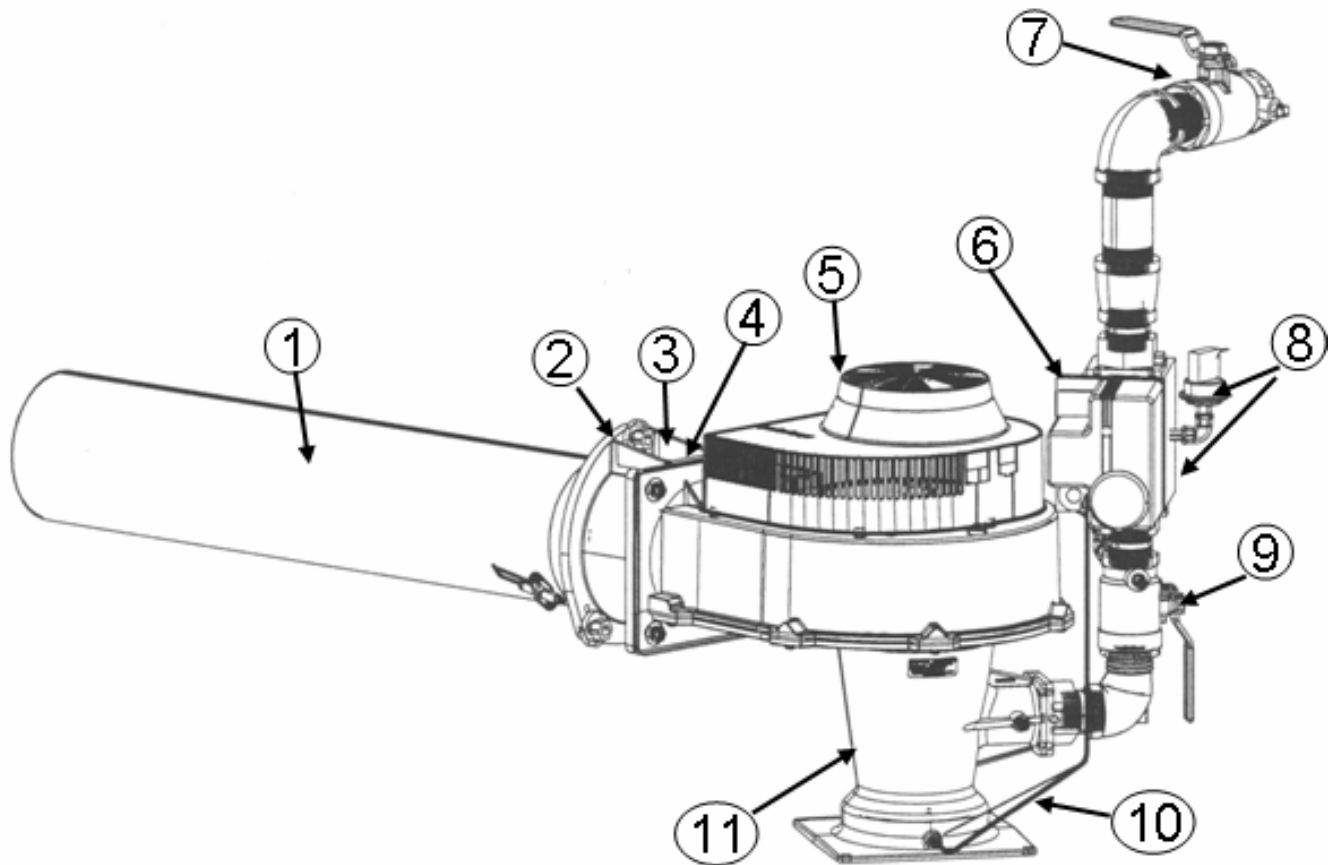
6.3.3 C1500/C2000 Heat Engine



MARK	DESCRIPTION
1	Blower Outlet Gasket
2	Blower Outlet Transition
3	Burner Gasket
4	Burner
5	Ignition
6	Sight Glass Window
7	Outlet Water Manifold
8	Heat Exchanger Sectional Castings
9	Relief Valve
10	Inlet Water Connection
11	Boiler Drain Valve
12	Condensate Collector w/Rear Drain
13	Inlet Flow Pipes



6.3.4 C1500/C2000 Gas Train



Mark	Description
1	Burner
2	Burner Gasket
3	Blower Outlet Transition Piece
4	Blower Outlet Gasket
5	Blower
6	Automatic Gas Valve
7	Main Gas Shutoff Valve
8	High & Low Gas Pressure Switches
9	Secondary Manual Shutoff Vavle
10	Gas Valve Sensing Line
11	Venturi



7.0 LIMITED WARRANTY

Patterson-Kelley**Harsco***P-K MACH Series™ Boiler*
LIMITED WARRANTY**LIMITED WARRANTY**

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

REMEDY

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

Warranty - The owner must notify the original installer of the Product and Seller (Attention: 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 the time of shipment.
- C. Any damage to the Product due to abrasion, erosion, 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.

Note: Rev. January 1, 2006





Established 1880

Patterson-Kelley**Harsco****MACH™ BOILER
FIRE-TEST REPORT**

Date: _____

Boiler Serial # _____ Model # _____

Installation: Name: _____

City: _____ State: _____ Zip: _____

Installer Name: _____ Type of Installation: _____ (Hotel, School, etc.)

Fuel: Natural Gas _____ Propane _____

Outdoor Temperature Sensor Connected Yes: ☐ No: ☐**1. Factory Fire-Test (copy from boiler label)**

	High	Low
Inlet Gas	_____ "w.c.	_____ "w.c.
Oxygen (O ₂)	_____ %	_____ %
Carbon Dioxide (CO ₂)	_____ %	_____ %
Carbon Monoxide (CO)	_____ ppm	_____ ppm
Gross Stack Temp.	_____ ° F	_____ ° F
Main Flame Signal	_____ Volts	_____ Volts

Field Fire-Test:

DATE: _____

	High	Low
Inlet Gas	_____ "w.c.	_____ "w.c.
Oxygen (O ₂)	_____ %	_____ %
Carbon Dioxide (CO ₂)	_____ %	_____ %
Carbon Monoxide (CO)	_____ ppm	_____ ppm
Nox	_____ ppm	_____ ppm
Gross Stack Temp.	_____ ° F	_____ ° F
Combustion Air Temp.	_____ ° F	_____ ° F
Stack Press. (exhaust)	_____ "w.c.	_____ "w.c.
Main Flame Signal	_____ Volts	_____ Volts
Efficiency	_____ %	_____ %
Comb. Air Pres. (intake)	_____ "w.c.	_____ "w.c.

2. Water Inlet temperature: _____ ° F

3. Water Outlet temperature: _____ ° F

4. Flow through boiler: _____ GPM

5. Operating Temperature Setpoint: _____ ° F (from internal OR external control)

6. Approximate stack lengths: Ft. Horizontal _____ Ft. Vertical _____ Flue Pipe Diameter _____

7. Incoming Electrical Power _____ Volts a.c. ☐ Less than 1 volt between neutral and ground

8. Sytem Water pH level _____

9. Comments: _____

_____Performed by: _____
(Print Name)



8.0 APPENDIX

[illegible]