



MULTI-PASS HORIZONTAL BOILER

MPH SERIES

**INSTALLATION,
OPERATION and
MAINTENANCE MANUAL**

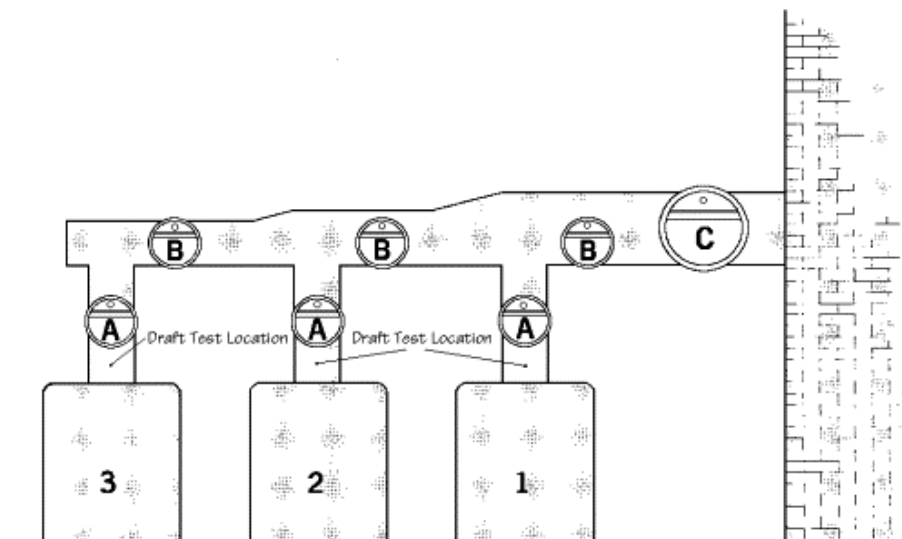
**COLUMBIA BOILER COMPANY
POTTSTOWN, PENNSYLVANIA**

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IMPORTANT

1. Read and familiarize yourself with this installation, operation, and maintenance manual before installing, operating, or servicing your boiler.
2. All cover plates, enclosures, and safety devices must be installed at all times except while performing maintenance and service.
3. Only trained service technicians should do any work on your boiler.
4. All state and local codes take precedence over any recommendations given in this manual.
5. Columbia Boiler performed testing on the MPH boiler line using specific makes and models of burners. Should you choose to supply your own burner, please contact the burner manufacturer to confirm compatibility with the MPH boiler design.
6. A barometric damper or draft regulator may be required on MPH installations. A draft regulating device is required on all multiple boiler installations where the boilers utilize common breaching. One regulator is required per boiler. Regulators can be installed in each individual boiler breach (Location A) or in the common breach, just upstream of each connection between the boiler breach and the common breach. (Location B) One regulator (Location C) is not acceptable.



Courtesy Field Controls

LIMITED PARTS WARRANTY

The Columbia Boiler Company (hereinafter Columbia) warrants the burner components and controls installed on its boiler/burner units to be free from defects in material and workmanship under normal use and service for 12 months from the date of installation or 18 months from the date of manufacture, whichever date occurs first, and is subject to warranty approval by the manufacturer of the specific components. This warranty does not extend to equipment subjected to misuse, neglect, accident or improper installation. Equipment which is defective in material or workmanship and is removed within 12 months from the date of installation will be repaired or replaced as follows:

- a. Motors, fuel units, controls, and transformers should be sent for repair or replacement to an authorized service point or distributor of the manufacturer of such component when reasonably available in Customer's locality.
- b. Where such local service is not available with respect to the above listed components, or where other components are involved, such defective equipment should be returned after receiving authorization from your dealer, freight prepaid, to the Columbia Boiler Co., 390 Old Reading Pike, Pottstown PA 19464. The use of the Columbia returned goods form is mandatory when returning defective material.
- c. Columbia is not responsible for any labor cost for the removal and replacement of equipment.
- d. Equipment which is repaired or replaced will carry a warranty equal to the unexpired portion of the original equipment warranty.
- e. If inspection by Columbia does not disclose any defect covered by this warranty, the equipment will be repaired or replaced at the expense of the Customer, and Columbia's regular charges will apply.

THIS WARRANTY IS LIMITED TO THE PRECISE TERMS SET FORTH ABOVE, AND PROVIDES EXCLUSIVE REMEDIES EXPRESSLY IN LIEU OF ALL OTHER REMEDIES. ALL IMPLIED WARRANTIES, INCLUDING BUT NOT LIMITED TO ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OR USE, ARE EXCLUDED. IN NO EVENT WILL COLUMBIA BOILER CO. BE LIABLE FOR ANY INCIDENTAL OR CONSEQUENTIAL DAMAGES OF ANY NATURE. Columbia neither assumes nor authorizes any person to assume for Columbia any other liability or obligation in connection with the sale of this equipment. Columbia's liability and Customer's exclusive remedy being limited to repairs or replacement as set forth above.

March 10, 1997

INTRODUCTION

Series MPH Modified Scotch Boiler

The Columbia Multi-Pass Horizontal (MPH) boiler is a modified scotch boiler designed for hot water, and/or low pressure steam applications. The pressure vessel is available as a welded pipe boiler or a rolled tube boiler. These units are manufactured to the specifications set forth by Section IV of the ASME Boiler and Pressure Vessel Code. Boilers are inspected and stamped for conformity to requirements of the National Board of Boiler and Pressure Vessel Inspectors. All boilers are designed to be fired using No. 2 fuel oil, and/or natural, manufactured, or liquid propane (LP) gas, and are powered by standard AC electrical service.

Columbia MPH hot water and low pressure steam boilers are typically shipped knocked down (unassembled), but are also available factory packaged. All boilers are furnished with a burner and boiler trim (the jacket is factory installed). Boiler trim consists of the operating and limit controls, pump control and/or low water cut off (LWCO) controls, and a safety valve. Factory packaged boilers are fully assembled and test fired.

SERVICE POLICY

Steam and hot water boilers are routinely serviced by the installer or another boiler maintenance company. Occasionally the service technician may be unable to determine the cause of the problem. In this situation, the dealer or service organization should contact the selling distributor for help.

Should the problem persist, the distributor will contact the sales representative for assistance. Depending on the extent of the problem, the representative may request technical assistance from the factory.

If the problem cannot be resolved by the representative, the representative or serviceman should contact the Technical Service/Engineering Department at the factory. The following information will be needed. It is essential that this information be available to assure prompt service.

Boiler Model and Size (HP) _____

Boiler Serial Number _____

Boiler National Board Number _____

Date Installed _____

Burner Type and Model _____

Primary Burner Control Type _____

Installer's Name _____ Phone (____) _____

Address _____

Distributors Name _____ Phone (____) _____

Address _____

Sales Representative _____ Phone (____) _____

Address _____

Specific Problem - Detailed

INSTALLATION

BEFORE BEGINNING INSTALLATION, CAREFULLY STUDY THESE INSTRUCTIONS AND ALL CHARTS, DRAWINGS, AND DIAGRAMS SHIPPED WITH THE BOILER.

Installation must follow all state and local code requirements, Fire and Underwriters regulations, and standard plumbing practices. The electrical installation shall be in accordance with the National Electrical Code.

Remove all boiler components from packaging and inspect prior to assembly to ensure that damage has not occurred in shipping.

BOILER ROOM

Locate the boiler in a well lit area on a noncombustible, level floor. Make available a convenient water supply and allow adequate drainage, including unobstructed floor drains, for flushing and filling the boiler. Provide sufficient make-up air for combustion at all times. See section on "Combustion Air" later in this manual. Power the boiler using a properly rated electrical service. Include fused disconnects for control circuits, blower motor circuits, and feed pump circuits that require a motor contactor or motor starter relay.

Where possible, place the boiler on a 3 inch concrete pad. Allow adequate clearance between the boiler and any walls or obstructions to permit inspection and service on burner, boiler piping, controls, or combustion vent.

DO NOT install exhaust fans in or near the boiler room. Exhaust fans consume available make-up air during burner operation. More importantly, when the boiler cycles off, exhaust fans pull hot flue gases back through the burner causing burner parts to deteriorate, and possibly fail. Maintain a positive pressure in the boiler room at all times. Refer to the combustion air section of this manual for additional information.

Do not allow your boiler room to become a storage room.

VENTING

Locate the boiler as close as possible to the chimney or other approved exhaust vent. Attach all flue piping to the round flue connection and make each connection secure. The flue pipe should not be inserted beyond the inside wall of the chimney.

DO NOT REDUCE THE SIZE OF THE FLUE OUTLET OR FLUE PIPING.

Columbia Boiler recommends the use of galvanized "B" Type vent for stack connections suitable for temperatures to 550F. The flue pipe should be pitched upward at least 1/4" per foot of run. Avoid the use of tees, sharp bends, and long horizontal runs. Install a draft regulator if required. See page 4 for draft regulator installation on multiple boilers with common breaching.

All Columbia boiler models utilize a pressure fired burner and need only to be properly vented. For situations where unusual conditions may exist, consult the factory for proper venting.

COLUMBIA BOILER COMPANY OF POTTSTOWN SHALL NOT BE HELD LIABLE FOR DAMAGE TO THE BOILER CAUSED BY INCORRECT VENT CONDITIONS AND/OR INSUFFICIENT BURNER MAKEUP AIR.

JACKET ASSEMBLY

The jacket for the MPH boiler is factory installed and should not have to be removed for installation of the boiler.

BURNER MOUNTING

If the burner is to be installed on site, first apply a gasketing material between the burner flange and the burner mounting plate to seal the burner. Use a non-asbestos fiber rope, or a wet insulating material for a gasket, as shown in Figure 2. Wet insulation is the preferred gasketing material because it compresses into a flat gasket which conforms to and fills any and all voids. Secure the burner in the boiler using the four bolts supplied with the burner. See the Burner Section of this manual for proper electrical wiring, and fuel supply piping.

Note: All factory packaged boilers use a wet insulation material as a gasket.

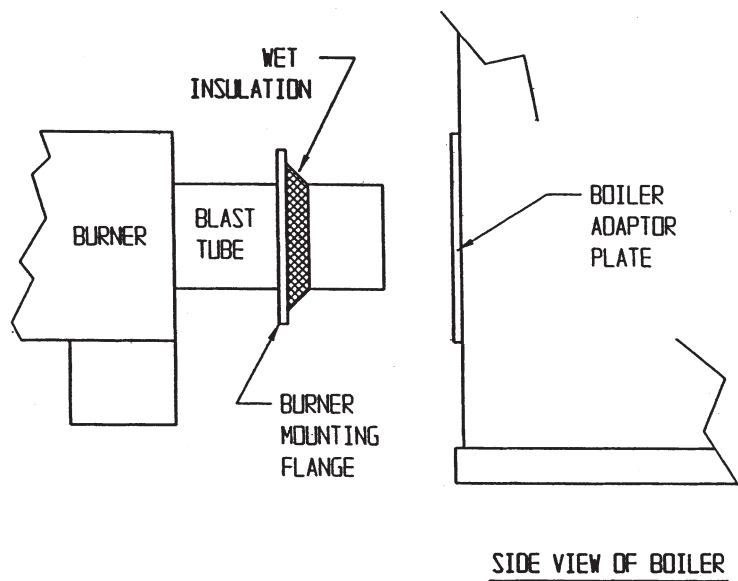


Figure 1

BOILER CONNECTIONS

Drains

All Columbia Boiler MPH units have (2) 1-1/4" drains. These are located in the front and rear of the boiler below the fire chamber. Install a pipe nipple and ball valve in a least one for use as a drain. If a drain is not needed, plug it by using the proper size nipple and a pipe cap. DO NOT use a pipe plug.

Low Water Cut-Offs

All Columbia boilers are supplied with at least one low water cut-off (LWCO) as standard equipment. Some boiler applications may require a secondary LWCO. The standard equipment is as follows:

Hot Water Boilers - *McDonnell & Miller 750-MT-120 Probe Type Low Water Cut-Off with Remote Sensor* - Thread the Remote Sensor into the 3/4" NPT fitting located on top of the boiler. Mount the Control Box near the top of the side jacket panel.

Steam Boilers - *McDonnell & Miller Model 157 Low Water Cut-Off/Pump Control* - Install this device into the 1" NPT welded couplings found on the top and either side of the boiler. Only two of the three 1" NPT will be used. The 157 can be piped to either side of the boiler.

Secondary Low Water Cut-Offs

Secondary LWCO's may be required to meet local codes or CSD-1 requirements. A Warrick 26C1D1C Probe Type Low Water Cut-Off is used in steam applications to meet CSD-1 requirements and is also standard on steam units. Thread the remote sensor into the 1/2" NPT fitting located on top of the boiler using a 1/2" x 3/8" bushing. See Table 1. for proper probe rod length. Mount the control box to a side jacket panel on the boiler.

LENGTH OF PROBE ROD IN "MPH" SERIES BOILERS				
BOILER MODEL	MPH 30/40	MPH 50/60	MPH 70/80	MPH 90/100
ROD LENGTH	14"	14"	14"	12"

TABLE 1

Other secondary LWCO's include combination LWCO / Water Feeders. These devices are typically connected externally using an equalizing line, and piped into the available 1" NPT fittings found in boiler top, and left side or front. Most commonly used combination units are *McDonnell & Miller 42 Series Pump Controls and Low Water Cut-Off* or *McDonnell & Miller No. 247-2 Feeder Combination*. For piping diagram, see the List of Figures on the Table of Contents Page of this manual.

NOTE:

Mount a combination unit so the low water cut-off line on the device is approximately 3 inches above the lowest permissible water level plate found on the left side jacket panel of the boiler. This point is also the center line of the 2" opening on the left side of the boiler.

Water Gauge

The water gauge is piped into the (2) 1/2" NPT fittings located on the M & M 157. During operation, the boiler's water level should always be above the Lowest Permissible Water Level. Hot water boilers do not require a Water Gauge.

Pressure Controllers

Low pressure, 15 PSI controls are supplied with steam units only. These controls consist of an Operating Control and a Safety Limit. An additional operating control may also be supplied for burners that function with low-high-low operation. Pipe the Pressure Controls and the 30 PSI Steam Gauge using the supplied steam syphon to the 1/2" NPT fittings on the front of the boiler.

Aquastat Controllers®

Aquastat® Controllers are used to regulate boiler water temperature. Columbia supplies an Operating Control and a Safety Limit Aquastat® with all hot water boilers and water heaters. An additional Operating Aquastat® may also be supplied for burners that function with low-high-low operation and/or steam boilers using an optional coil. Aquastat®'s are mounted in the 3/4" NPT fittings located on the front of the boiler.

Safety Valve / Relief Valve

All safety or relief valves are located in the rear center fitting on top of the boiler. A 15 PSI Steam Safety Valve is supplied for steam boiler and water heater applications. A 30 PSI Water Relief Valve is used for hot water applications. The MPH 90/100 steam boiler will have two Safety Valves. All safety and relief valves should be safely piped away from the boiler without reducing the valve's outlet port size.

Steam

Pipe the steam lines to the largest fitting or flange located on top of the boiler. Pipe the hot water supply to the largest fitting or flange located on the top of the boiler.

Hot Water Connections

Use the fittings located on either side in the lower front of the boiler for the hot water return from the system. Hot water applications also require the use of an expansion tank in the system piping, to compensate for fluctuations in the water volume during heating and cooling cycles.

NOTE: Do not use lower rear fittings for returns.

Feed Water Supply

Virtually any unused port on the heat exchanger can be used for the feed water supply. In situations where make up water is needed, the water supply must be treated before it enters the boiler to prevent the formation of scale, and to protect the boiler surfaces from the corrosive effects of oxygenated water. Water treatment and a water treatment program must be adhered to, or the life of the boiler will be effected. If a Condensate Return / Feedwater Tank is used, connect the feedwater source to the float valve on the tank. Return to the section on water treatment later in this manual.

Boilers with Coils

When ordered with coils, boilers are shipped with the coil(s) assembled to the coil plate(s), and mounted in the boiler. MPH boilers 30 thru 80 HP can be furnished with one or two coils.

When making coil connections for twin coil units, manifold indirect water piping using copper tubing and fittings connected in parallel. Pipe the outside coil openings together for cold water inlets, and the inside coil openings for hot water outlets. If necessary, temper the hot water supply by using a mixing valve. Connect the hot water outlet source and a cold water supply line to a mixing valve, to temper the hot water supply to the proper temperature requirements for process equipment.

Whenever boilers are supplied with one or two coils, the coils must be covered by a minimum of two inches of water, during normal operation, to allow proper heat transfer through the coil. Adjust all LWCO piping to keep the coil(s) submerged in the event of a low water situation.

FUEL CONNECTIONS

OIL SUPPLY PIPING

Connect burner to oil supply. Refer to fuel unit manufacturer literature for piping, connections, lift and tank installation. If such information is unavailable use the following guidelines:

Fuel supply “level with” or “above” burner: A single stage fuel unit connected to the fuel supply with a single supply line is the most common type of installation for these conditions. Manual venting of the fuel oil is usually required on initial start up. Failure to vent air could result in air lock/oil starvation.(One Pipe)

Fuel supply below the level of the burner: Use a single stage fuel pump in lift conditions of up to 10 feet and a two stage pump when lift exceeds 10 feet. Both conditions require the use of a return line which purges the fuel pump of air, returning it to the fuel tank. The “by-pass” plug **must be inserted** into the fuel pump when installing a return line. (Two Pipe)

Fuel line installation: Consult the burner section of this manual for oil line type and sizing requirements for proper operation. The size of oil lines is extremely important for proper operation. Continuous lengths of heavy wall copper tubing are recommended and should be installed under the floor whenever possible. Fuel lines should not chaff the appliance or building structure.

All oil feed lines must be air tight. Use as few fittings as possible when assembling the oil lines. Compression fittings allow more of a chance for air to be introduced into the oil supply and are NOT recommended for use. The slightest air leak, usually caused by loose fittings or bad gaskets, can cause poor starts, smoky starts, sooting of burner parts, inefficient operation, and a dangerous combustion condition. Always install fittings in accessible locations.

WARNING:

TEFLON® TAPE SHOULD NEVER BE USED WITH ANY OIL LINE CONNECTIONS. THE USE OF TEFLON® TAPE ON BURNER COMPONENTS OR OIL SERVICE LINES WILL VOID MOST BURNER WARRANTIES.

A vacuum test should be done on all installations to ensure that all fittings are tight and the oil lines are of proper size. Suction vacuums must be held to acceptable limits. This is available with the pump information supplied with the burner.

Fuel line valve and filter: (Not supplied) Install two high quality shutoff valves in accessible locations on the oil supply line. Locate one close to the tank and the other close to the burner ahead of the filter. Some filters come with built-in shutoff valves. Install a generous capacity filter inside the building between the fuel tank shutoff and burner.

For additional information consult the burner section of this manual.

GAS SUPPLY PIPING

Contact your local gas company to ensure that adequate gas service is available, and to review applicable installation codes for your area.

The minimum gas supply pressure required by the burner is seven inches water column for all Power Flame MPH Series burners. The maximum gas supply pressure to the Power Flame burner is fourteen inches water column. Gas pressure greater than fourteen inches water column will require an additional gas pressure regulator to prevent damage to the primary gas regulator. Gas pressure below the minimum will cause combustion efficiency problems and should be avoided if possible. Low gas pressure may also prevent the boiler from obtaining the desired input rate, which will cause the boiler to be unable to produce the desired output. Consult the factory if your gas supply pressure is not in the recommended range, or for pressure requirements for other burner manufacturers.

Use the following tables to determine the size of the main gas line required for the boiler that is being installed. First determine the required input volume of gas needed at the gas manifold, then determine the correct pipe size for the length of run needed.

REQUIRED INPUT - CUBIC FEET OF GAS PER HOUR

GAS TYPE	MPH 30	MPH 40	MPH 50	MPH 60	MPH 70	MPH 80	MPH 90	MPH 100
NATURAL	1260	1680	2100	2520	2940	3360	3780	4200
PROPANE	495	659	824	989	1153	1318	1483	1647

CAPACITY OF PIPE - CUBIC FEET OF GAS OER HOUR AT 0.2" W.C. PRESSURE DROP

Equivalent Length (ft)	1"	1-1/4"	1-1/2"	2"	2-1/2"	3"	4"
10	425	725	1170	2360	4300	6250	12800
20	300	520	800	1700	3000	4500	9300
30	250	425	690	1400	2500	3750	7500
40	210	360	560	1200	2100	3200	6400
50	190	325	500	1100	1900	2850	5800
60	180	300	480	1000	1800	2300	4800
80	150	260	410	850	1550	2000	4200
100	135	230	370	750	1375	1680	3500
150	110	190	300	600	1100	1200	2750
200	75	165	260	540	950	1000	2000
Fitting	Equivalent Lengths of Standard Pipe in Feet for Listed Fittings						
Std. Tee	5.5	7.5	9.0	12.0	13.5	15	20
Std. Elbow	2.7	3.7	4.5	5.5	6.1	8	11

Vent lines, if required, are to be run outside the building, stopping clear of windows or fresh air intakes. The vent should terminate in a way that will not allow the possibility of water, dirt, insects, animals, and other matter from entering and clogging the vent pipe.

Gas lines should be tested for leaks using a soap solution. Your gas company may wish to witness this test. **Do not** exceed the maximum pressures allowed by the valve train.

Additional gas piping information is included in the burner section of this manual.

COMBUSTION AIR

It is essential that provisions are made for a fresh supply of outside air into the boiler room to insure complete combustion, proper boiler efficiency, and a clean fire. Sufficient makeup air also helps prevent nuisance shut-downs due to excessive combustion byproduct build-up on burner parts. Outside air may be provided through ducts, fixed louvers or motorized louvers.

A rule of thumb for calculating fresh air openings to the outside is 63 sq. in. for every 100,000 BTUH gross output, or 21 sq. in. per boiler horsepower. The result of the above calculation is expressed as free area, meaning no restrictions of any kind. If louvers or screens are used over combustion air openings, calculate the percentage of free area to allow for these restrictions.

Do not have exhaust fans in the immediate proximity of the boiler room **if at all possible**, as they will cause a reversal of draft through the boiler when the burner is cycled off. This draft reversal draws heat from the combustion chamber back through the burner. This heat will deteriorate burner components prematurely, and eventually, burner operation will fail. The boiler room should experience a positive pressure when the burner is not firing.

In situations where a boiler room experiences a negative pressure, use a direct air intake. A direct air intake uses an adapter over the burner fan intake housing to draw in outside air through duct work, from an external source. Consult burner manufacturer for parts and availability.

REQUIRED BOILER MAKE-UP AIR

	BTU INPUT	OPENING MIN. SQUARE INCHES	SQUARE HOLE SQUARE HOLE (APPROXIMATE)	ROUND PIPE ROUND PIPE (APPROXIMATE)
MPH 30	1,260,000	630	26 X 26	30
MPH 40	1,680,000	840	30 x 30	34
MPH 50	2,100,000	1050	34 X 34	38
MPH 60	2,520,000	1260	36 X 36	40
MPH 70	2,940,000	1470	40 x 40	42
MPH 80	3,360,000	1680	42 X 42	46
MPH 90	3,780,000	1890	44 X 44	50
MPH 100	4,200,000	2100	46 X 46	52

CLEANING AND FILLING A NEW STEAM BOILER

Note: The following procedures are for steam boilers only.

In order to minimize the corrosive effects of raw water oxidation on the boiler, the water must be heated to at least 180F immediately after entering the boiler, in order to drive off the corrosive dissolved gases. This applies to all water - whether from a well, a spring, or from the local municipal water system.

The oil and grease that accumulate in a new steam boiler can usually be washed out by either procedure.

A. Skimming:

Since oil floats on water, skimming removes these oils from the water surface.

1. The 1" tapping on the back of the boiler can be used for skimming the water surface. Install a ball valve and piping to a nearby drain.
2. Fill the boiler to the normal waterline.
3. With the boiler firing slowly open the ball valve installed at the skimmer port on the back of the boiler.
4. Add water to the boiler at a rate that will allow the boiler to maintain a water temperature between 180-200 F. **Note do not add too much water so that the water level rises above the skimmer tapping.**
5. Continue to allow water to flow from the skim tapping until it appears to be oil free.
6. Once the water appears to be oil free, close the ball valve. The ball valve and piping to the drain can be left in place or removed is so desired. If the skimming piping is to be removed the water level must be lowered so that the piping can be removed safely. After the skimming piping is removed plug the 1" fitting and fill the boiler back to it's proper water operating level.

B. Cleaning Compound:

1. Fill the boiler to the normal waterline.
2. Remove the safety valve.
3. Provide a boilout compound of caustic soda and trisodium phosphate in the proportions of 2-1/2 lbs. of each chemical per 120 gallons of water.

CAUTION: USE CARE IN HANDLING THESE CHEMICALS. THE CAUSTIC SODA IS EXTREMELY CORROSIVE TO SKIN AND CLOTHING. DO NOT PERMIT EITHER THE DRY MATERIAL OR THE CONCENTRATED SOLUTION TO CONTACT SKIN OR CLOTHING.

BOILER MODEL	EQUAL AMOUNTS CAUSTIC SODA AND TRISODIUM PHOSPHATE
MPH 30	3 lbs. 7 oz
MPH 40	4 lbs. 9 oz
MPH 50	5 lbs. 6 oz
MPH 60	6 lbs. 14 oz
MPH 70	7 lbs. 10 oz
MPH 80	8 lbs. 11 1/3 oz
MPH 90	10 lbs. 13 oz
MPH 100	10 lbs. 13 oz

4. Mix the chemicals with water and pour into the boiler through the safety valve opening.
5. Replace the safety valve.
6. Start the firing equipment.
7. Boil the water for at least five hours.
8. Stop the firing equipment.
9. Drain the boiler to a location where hot water can be discharged safely.
10. Wash the boiler thoroughly using a hose with sufficient pressure.
11. Fill the boiler to the normal waterline.
12. Add boiler water treatment as prescribed by a water treatment specialist.
13. Boil or bring water temperature to at least 180°F immediately.
14. The boiler is ready to put into service or on standby.

OPERATING THE BOILER

NOTE: Whether the boiler was purchased knockdown or factory packaged test fired, each boiler must be "set up" for the conditions on location. Improper combustion settings may cause the burner to operate erratically, resulting in boiler shutdowns, lost time, and unnecessary service expenses.

PRE-START CHECKS AND INFORMATION

A new or relocated boiler should not be put into service until it has been inspected by an authorized inspector for the jurisdiction or the insurance company, and the required certificates have been issued.

Whenever a new boiler is placed in service, operating data should be recorded and saved for future reference. This information is extremely valuable for diagnosing problems if abnormal operation occurs. Record all operating parameters such as pressures, stack temperatures, oxygen or carbon dioxide levels, flows, draft, motor amps, damper positions, and interlock set points. A burner start up and test information sheet has been included at the end of this section for your convenience.

All cover plates, enclosures, and safety devices must be installed at all times during operation and should only be removed while performing maintenance and/or service.

The fuel supply should not be turned on until the combustion chamber has been vented and the pilot light (if gas ignited) checked for proper operation.

All drain valves including blowdown valves for steam boilers, water column drain valves, gauge glass drain valves, and gauge cocks should be closed.

The safety/relief valves should be inspected externally to see that they are free to operate, and that the discharge piping and drain piping are open to the atmosphere, and free to expand without imposing a load on the safety valve bodies. Make sure the safety valve is piped to a safe location to prevent injury.

The boiler feed pump(s) for steam applications should be checked to ensure that they are ready for service. Check the data on rating plates of all electrical equipment to be certain the electrical characteristics match those of the electric supply to which they are connected.

Before attempting start-up, carefully study the instructions included in the burner section of this manual.

It is important to have the proper test equipment in order to adjust the combustion and pilot if equipped. Those items that may be required include a manometer, micro ammeter, multimeter, vacuum gauge, 0-300 PSI pressure gauge, carbon dioxide or oxygen analyzer, carbon monoxide tester, smoke gun, and stack thermometer.

STARTING THE BOILER

WARNING: NEVER OPERATE A BOILER WITHOUT BEING SURE IT IS FILLED WITH WATER AND THAT PROPER WATER TREATMENT CHEMICALS HAVE BEEN ADDED.

Allow the boiler to fill with water to its normal operating level.

Supply power to the boiler disconnects.

NOTE: The burner will not operate when the boiler has reached its normal water level, until the reset button on the manually reset, probe type, low water cutoff is pushed.

NOTE: **Combustion efficiency must be checked at this time.** See the burner manufacturer's instructions for correct settings and more detailed information.

Follow the adjustment procedures outlined in the burner section of this manual to set up the burner for proper operation.

STOPPING THE BOILER

To stop the boiler turn the main disconnect to the OFF position.

BURNER START UP AND TEST INFORMATION

For a new boiler start up, or for troubleshooting an existing installation, the following information is essential for effective service assistance.

Boiler Model _____ Serial No. _____ N.B. No. _____
 Burner Model _____ Invoice No. _____ Serial No. _____
 Installation Name _____ Start Up Date _____
 Start Up Contractor _____ Phone No. _____
 Name of Technician Performing Start Up _____
 Fuel Type: Natural Gas LP Gas Fuel Oil (#2) Other _____

Gas Firing

Gas Pressure At Train Inlet Burner In Off Position _____ "W.C.	Flame Signal Readings Pilot _____	Stack Outlet Test Point Draft Low Fire _____ "W.C. High Fire _____ "W.C.
Gas Pressure At Train Inlet High Fire _____ "W.C.	CO2 Low Fire _____ High Fire _____	Over Fire Draft Low Fire _____ "W.C. High Fire _____ "W.C.
Gas Pressure At Main Orifice Low Fire _____ "W.C. High Fire _____ "W.C.	CO Low Fire _____ High Fire _____	Net Stack Temperature Low Fire _____ °F High Fire _____ °F
Gas Pressure At Pilot Orifice _____ W.C.	Measured Input Rate - BTU/HR Low Fire _____ BTU/HR High Fire _____ BTU/HR	

Oil Firing

High Fire Vacuum Reading At Oil Pump Inlet _____ "H.G.	CO2 Low Fire _____ High Fire _____	Stack Outlet Test Point Draft Low Fire _____ "W.C. High Fire _____ "W.C.
Oil Nozzle Supply Pressure Low Fire _____ PSI High Fire _____ PSI	Bachrach Scale Smoke Number Low Fire _____ High Fire _____	Net Stack Temperature Low Fire _____ °F High Fire _____ °F
Firing Rate - GPH Low Fire _____ High Fire _____	Over Fire Draft Low Fire _____ "W.C. High Fire _____ "W.C.	

Operational Check of Controls

Operating Limit _____ <input type="checkbox"/>	Aux LWCO _____ <input type="checkbox"/>	Flame Safeguard _____ <input type="checkbox"/>
Safety Limit _____ <input type="checkbox"/>	Low Gas Pressure _____ <input type="checkbox"/>	Ignition Failure _____ <input type="checkbox"/>
Low Water Cut Off _____ <input type="checkbox"/>	High Gas Pressure _____ <input type="checkbox"/>	Flame Failure _____ <input type="checkbox"/>
Motor Amps _____ <input type="checkbox"/>	Damper Position _____ <input type="checkbox"/>	Interlock Set Points _____ <input type="checkbox"/>

Comments

CONTROL DESCRIPTIONS

STEAM BOILERS

Pressure Controllers

All Columbia steam boilers are controlled by both operating Pressure Controllers. Both devices are adjustable. These switches open when pressure reaches the main scale set point value, cycling the boiler off.

The operating Pressure Control also has an adjustable differential feature. Differential settings values are subtractive from the main scale set point value, indicating the change in pressure for when the boiler will re-fire. Always adjust the differential set point above the required steam pressure for the system. Make the differential value as large as possible to prevent short cycling.

The safety limit Pressure Control does not have an adjustable differential, and has a manual reset feature. The safety limit Pressure Control breaks the control circuit if the operating Pressure Control becomes inoperable, and steam pressure continues to climb. The burner will not start until the excessive pressure situation is corrected and the reset button is pushed.

Adjust the safety limit value higher than the operating limit under normal operating conditions. This setup allows the operating control to function properly and reduces the need to reset the control circuit constantly. Set the safety limit value less than the error margin of the safety relief valve, so the Pressure Control can safely control boiler pressure. Make set point value adjustments by turning the adjusting screws found on top of the Pressure Control casing.

For additional information on either controllers see the Publication following this booklet.

Low Water Cut-offs

Low water cut-offs safely control boiler operation in the event of a low water condition. The standard LWCO's for steam applications is a *McDonnell & Miller #157*, and the *Warrick 26C1D1C* probe type LWCO. Other optional equipment used in place of, or in addition to, one of the aforementioned LWCO's includes water feeders and combination LWCO/ feeders, which is required to meet csd-1 code requirements.

The *McDonnell & Miller #157* is a LWCO and pump control. The low water switch opens in a low water condition. In the same instance, the *McDonnell & Miller #157* has an extra set of contacts that close with a drop in water level activating the water feeder(pump). This control is mounted on the left or right side of the boiler using the 1" tappings found in the side and on top of the boiler, as part of an equalizing line.

A Warrick 26C1D1C "Probe" type LWCO is used only as a Secondary low water cut-off device. Its primary function is to protect the boiler against low water situations where the primary LWCO fails to break the control circuit. The probe mounts in the top head of the boiler and has a rod length lower than that of the primary LWCO. This relay must be manually reset if power is interrupted to the control circuit for any reason. During operation, if the water level falls below the probe rod, the energized circuit breaks, causing the relay to open, disconnecting power to the burner. Restore the water level to the normal operating level, then manually reset the control to resume operation.

For additional information on the appropriate Low Water Cut-Off, see the LWCO cut sheets following this booklet.

Safety Valve

Safety valves shall be piped so that any discharge cannot cause injury to people or damage to property. The discharge piping must be supported so that the weight of the piping is not transmitted to the safety valve body. The weight supported by the valve outlet should not exceed that of a drip pan elbow. Installations requiring long discharge piping should not be connected directly to the safety valve. Refer to Drawing PL-049 in the Appendix.

Always maintain a proper operating gap between the set pressure of the safety valve and the maximum operating pressure of the boiler.

If the valve discharges on its own, contact a qualified service technician to determine the cause. This may be an indication of equipment or system malfunction.

HOT WATER BOILERS

Aquastat® Controllers

All Columbia water boilers and indirect water heaters are controlled by both operating and safety limit Aquastat® Controllers. The safety limit should always be adjusted higher than the operating limit under normal operating conditions. If for any reason the water temperature would exceed the operating limit and not trip the control, the safety limit should break the circuit to the burner.

The operating Aquastat® consists of an adjustable thermostatic control and separate temperature sensing immersion well. The immersion well mounts either in the boiler's coil plate or in the 3/4" tappings on rolled tube units. Adjust the indicating dial to set the maximum operating temperature. The differential wheel setting is subtractive from the operating limit indicating the re-fire temperature. This differential set point should be adjusted above the required water temperature for the system. The differential wheel can be adjusted for 3 to 5F .

The safety limit like the operating Aquastat®, consists of an adjustable thermostatic control and separate temperature sensing immersion well. This controller has a manual reset switch which must be depressed in the event that the operating circuit reached and shut off on safety.

For additional information on either controllers, see the Publication following this booklet.

Low Water Cut-off

Hot water boilers utilize the *McDonnell & Miller 750-MT-120 Probe Type Low Water Cut-Off* with Remote Sensor. The 750-MT-120 has a test feature that allows this control to meet CSD-1 requirements. Similar to the Warrick 26C1C1C, this control breaks the control circuit in the event of a low water condition and must be manually reset once the proper water level is restored.

For additional information on the *McDonnell & Miller 750-MT-120 Probe Type Low Water Cut-Off with Remote Sensor* see *McDonnell & Miller Bulletin MM-212(A)* and *Installation and Maintenance Instructions MM-213(C)*.

Relief Valve

Relief valves are a safety devices to relieve boiler water pressure. Like safety valves, relief valves should be piped so any discharge cannot cause injury to people or damage property. See the "Safety Valve" description in the Control Descriptions, Steam Boiler section of this booklet.

MAINTENANCE

RECORD KEEPING

All manufacturers' literature, spare parts lists, operating and maintenance procedures should be maintained in the boiler room at all times. A log book should also be provided to record maintenance work, inspections, and other performance test results.

General

Clean the boiler and heating surfaces whenever required. The frequency of the cleaning required to maintain the boiler at peak efficiency will be determined only by frequent inspections. It cannot be predicted. Your operating conditions might be different from your neighbors'.

When in doubt - check it out.

WARNING: DISCONNECT ALL INCOMING ELECTRICAL POWER BEFORE SERVICING THE BOILER. USE EXTREME CAUTION AROUND BOILER PIPING THE LOW WATER CUT OFFS, SINCE THEY MAY BE VERY HOT.

The life of your boiler will be determined by the level of care given it by those who are responsible for maintenance. A log of the following items should be maintained in the boiler room at all times.

Daily Boiler Check & Maintenance List

1. Water Level Controls and Cut Offs are operating normally.
2. Instrument and equipment settings are normal.
3. Gauge glass is clean. If leaks are detected, replace glass, gaskets, and brass washers immediately. When replacing gauge glass use only 5/8" O.D. Pyrex® red line, high pressure, high temperature, glass tubing, with fire polished ends. See gauge glass maintenance section for proper method when installing this gauge glass.
4. Boiler water at proper operating level.
5. Blow down boiler as instructed under BLOWDOWN if required by application.

Remember, the life of your boiler is drastically reduced by sludge, scale, and corrosion. By proper treatment of the boiler water and systematic blow down procedures your boiler will provide years of service.

Weekly Boiler Check & Maintenance List

1. Check flame failure detection system.
 - A. Gas boilers: Close fuel supply to pilot and main gas and check shut down timing.
 - B. Oil boilers: Remove cad cell leads and check shut down timing.
2. Check fuel valves; Open limit switch and make aural and visual check.
3. Check ignition system flame signal.

Monthly Boiler Check & Maintenance List

1. Test all fan interlocks.
2. Check main burner safety shut off valve(s) for operational closure.
3. Oil fired; check fuel pressure interlocks when provided.
4. Gas fired; check high and low fuel pressure switches.
5. Flue or stack dampers; make visual inspection for proper operation.
6. Inspect heating surfaces for cleanness.

Semiannual Boiler Check & Maintenance List

1. Inspect burner components; Refer to burner manufacturers' instructions.
2. Check the flame failure system components; Refer to the burner section of this manual.
3. Check piping and wiring of all interlocks and shut off valves.
4. Internal boiler plate inspection. Remove hand-hole assemblies; use new gaskets when replacing covers.

Annual Boiler Check & Maintenance List

1. Check operating Pressure Control or Aquastat® Controller.
2. Check high limit Pressure Control or Aquastat® Controller.
3. Test safety valves.
4. Remove the Low Water Cut Off and clean inside casting.
5. Oil fired - clean/replace oil filters or strainers if equipped
6. Oil fired - replace ignition electrodes if equipped.
7. Gas pilots - conduct pilot turndown test.
8. Gas fired - replace ignition and flame rods.
9. Gas fired - check drip leg/strainer.
10. Oil fired - check for refractory hold in.
11. Check Automatic Change Over Control if equipped.
12. Gas fired - perform valve leakage test.

Gauge Glass - Not required on hot water boilers only.

The water gauge glass must be kept clean. Dirt on, or in, the glass may be mistaken for the water level. Do not allow steam or water to leak from the water glass, as this may effect the accuracy of the level indication. Leaking of the gauge glass will also reduce the wall thickness of the glass to the point where it may explode.

WARNING: DO NOT OPERATE THE BOILER WITHOUT THE GAUGE GLASS PROTECTOR INSTALLED. NEVER ATTEMPT TO WORK ON THE GAUGE GLASS WHILE THE BOILER IS UNDER PRESSURE. ALWAYS CLOSE GAUGE VALVES PRIOR TO TIGHTENING GASKETS ON WATER LEVEL GAUGE GLASS. SERIOUS INJURY COULD RESULT.

Gauge Glass Replacement Instructions:

1. Make absolutely certain that the new water level gauge glass is 5/8"O.D. and is the correct length glass tubing with fire polished ends.
2. Close gauge glass valves.
3. Remove gauge glass protector.
4. Remove the old glass, gaskets, brass washers, and brass nuts. Be sure threads on the gauge valves are clean.
5. Install brass nuts, brass washers, and gaskets on each end of the gauge glass.
6. Insert glass tube into top gauge valve and lower the glass tube into the bottom gauge valve which contains a seat. Then raise glass 1/16". Do not allow glass to rest directly on the valve.
7. Hand tighten the lower glass nut and then the upper nut. While tightening these nuts, be sure to keep the red line opposite the viewing side.
8. With a wrench, snug up the bottom nut and then the top nut.
9. **Replace gauge glass protector.**
10. Open gauge glass valves fully. Failure to completely open the gauge glass valves renders the ball check safety feature inoperative.
11. Without pressure on boiler and with gauge valves closed, snug up the bottom nut and then the top nut with a wrench, after 1 day of operation.

Blowdown

Perform blowdown procedures on boilers that require make-up water such as steam boilers. Hot water boiler are closed loop systems that recirculate the same water. These boilers should require minimal make-up water.

Blowing down the boiler is done to remove excess total dissolved solids. The actual amount of blowdown should be determined through boiler water analysis, done by a water treatment specialist. Until an analysis of your boiler water is made, the following guidelines should be used.

Blow down the boiler after firing equipment has been shut down for the evening. Allow boiler water to settle for approximately 10 minutes. Then open blowdown valve at a pressure between 5 and 10 psi for 30 seconds then close. Use this same procedure with the low water cut off blow-down ball valve. Then go back to the boiler blowdown valve, open and close the valve, very fast, two more times. Repeat this procedure with the low water cut off valve. This will rid the boiler of most precipitated sediment. **DO NOT EMPTY THE BOILER OF ALL ITS WATER.**

WATER TREATMENT

Proper treatment of make-up water and boiler water is necessary to prevent scale, or other deposits, and corrosion within the boiler. The absence of adequate external and internal treatments can lead to operational upsets or total boiler failure. Where a choice is available, pretreatment external to the boiler is always preferred and more reliable than treatment within the boiler.

Obtain, and follow, Instructions for feedwater treatment, prepared by a competent feedwater chemist. Do not experiment with homemade treatment methods or compounds.

Representative samples of feedwater and boiler water must be analyzed frequently to ensure that they are in specification. The following terms and guidelines are to be used in conjunction with the advice of a water treatment specialist.

Recommended Guidelines for Boiler Water Treatment

ANALYSIS	RECOMMENDED RANGE	COMMENTS
pH	10-11	Low pH promotes corrosion
Total Alkalinity	200-700 ppm	Low; promotes corrosion
Phosphates	30-100 ppm	Prevents scale formation
Total Hardness	0-50 ppm	Prevents scale formation
Chlorides	60-200 ppm	A measure of proper blow down
Total Dissolved Solids	2000 ppm Maximum	High solids may cause surging
Sulfites	20-30 ppm	A good oxygen scavenger
Specific Conductance	< 700 micro ohms cm	A measure of proper blowdown
Oxygen	< .007 mg/liter	Prevents corrosion and pitting

ppm = parts per million

Use proper water treatment **to prevent the buildup of scale** on the boiler. After scale has built up on the walls of the boiler it is almost impossible to remove it from the boiler. The introduction of acids into the pressure vessel is thoroughly discouraged, since virtually any solution that will chemically attack the scale will also attack the boiler metal.

pH

The pH value of the boiler water is a number between zero and fourteen. Values below seven are acidic, seven is neutral, and values above seven are alkaline.

The pH factor is the most important factor influencing scale formation and the corrosive tendencies of boiler water. The pH should be maintained between a minimum of 10.5, and a maximum of 11.0 to prevent acidic corrosion of boiler tubes and plates, and to provide for the precipitation of scale forming salts before scale is deposited.

Below a pH of 5.0 the water is acidic enough to dissolve the steel boiler plates. Under these conditions the steel gradually becomes thinner and thinner until its destruction. At a pH between 5 and 9.4 pitting of shell plates will occur at a rate depending on the amount of dissolved oxygen in the boiler.

Dissolved Oxygen

Dissolved oxygen is caused by the solubility of atmospheric oxygen into the supply water. Aeration of the city water supply is frequently used to remove other noxious gasses. Efficient aeration results in saturation of the water with oxygen.

The majority of corrosion problems are directly related to the quantity of dissolved oxygen in the boiler water. Elimination of the corrosive effect of dissolved oxygen can be accomplished both directly or chemically.

Direct or mechanical removal of dissolved oxygen is accomplished through the use of a deaerator or by heating the water to a temperature above 180°F. Heating the water can be done with a preheater or a sparge tube installed in the return system.

Chemical deaeration is done through the introduction of specific chemicals in the boiler to react with the oxygen. The dissolved oxygen content should be maintained at a minimum but at no time should it exceed 0.007 mg/l.

Sulfites

Sodium sulfite is generally used for the chemical removal of dissolved oxygen within the boiler water. To assure the rapid and complete removal of the oxygen entering the boiler feedwater system the concentration of sulfite in the boiler must be maintained at a minimum of 20 PPM. (parts per million)

Solids

Solids can be broken up into two categories: suspended solids, and dissolved solids. Suspended solids are those which can be removed by filtration, while dissolved solids are in solution with the water. The best test for the determination of solids content of the boiler water is through a conductance test.

The conductance value of boiler water varies by the various ionized salts present. The conductance can be used to measure the total dissolved solids in the boiler water and to serve as an accurate means for the control of solids through the use of blowdown.

Another test which is sometimes used as a gauge of solids is to measure the chloride present in the boiler water. The ratio of chlorides in the boiler water to that of the feed water can be used as a means to determine the amount of blowdown required. The chloride test is unsuitable for feedwater with low incoming concentrations and the concentrations in the feedwater must be averaged over time for accuracy.

High boiler solids will lead to foaming, priming, surging and carry over. These problems can be overcome by proper, daily blowdown of the boiler.

Alkalinity

The alkalinity of boiler water should be sufficiently high enough to protect shell and plates against acidic corrosion, but not high enough to produce carryover. A minimum value for alkalinity for adequate protection is 200 PPM.

High boiler alkalinity, which is in excess of 700 PPM. should be avoided. Values higher than this can lead to embrittlement of the steel.

Phosphates

Phosphates are used to react with calcium hardness in the boiler water. In order for this reaction to take place it is important to maintain a pH at a minimum value of 9.50. It is desirable to keep the concentration of phosphates in the water to 30-50 PPM in order for complete reaction of the phosphates with the calcium hardness entering the boiler through the feedwater.

Hardness

The hardness of water is caused by calcium and magnesium ions which will vary greatly throughout the country depending on the source of the water.

In boilers the hardness of the water can cause the formation of scale and sludge or mud. The hardness must be removed in the makeup water to the return system. Total hardness should not exceed 50 PPM.

Oils

Every effort should be made to prevent oils from getting into the boiler water. Oil causes foaming, or combines with suspended solids to form a sludge which can cause the overheating of boiler plates. If oil does get into the boiler, the boiler should be taken out of service immediately, and thoroughly cleaned.

