START-UP AND OPERATION
WATER BOILERS

WARNING:

IMPROPER SERVICING AND START-UP OF THIS EQUIPMENT MAY CREATE A POTENTIAL HAZARD TO EQUIPMENT AND TO OPERATORS OR PERSONS IN THE BUILDING.

SERVICING AND START-UP MUST BE DONE ONLY BY FULLY TRAINED AND QUALIFIED PERSONNEL.

CAUTION:

BEFORE DISCONNECTING OR OPENING ANY FUEL LINE, OR BEFORE CLEANING OR REPLACING PARTS OF ANY KIND TAKE THE FOLLOWING PRECAUTIONS:

Turn OFF the main fuel shutoff valves, including the pilot gas cock if applicable. If the burner is a multiple fuel type, shut OFF all fuel supplies.

Turn OFF all electrical disconnects to the burner, boiler and any other equipment or systems electrically interlocked with the burner or boiler.

All cover plates, enclosures, and guards must be in place at all times except during maintenance and servicing.

2.1 FIRING RATE ADJUSTMENT - ATMOSPHERIC GAS UNITS

2.1.1 The following procedures must be followed carefully before putting the boiler in operation. Failure to do so will present severe hazards to equipment, operating personnel and building occupants.

2.1.2 ADJUST PILOT BURNER
Carefully follow the instructions on the Lighting Instructions sheet in the boiler manual for the proper adjustment of the pilot burner. This is absolutely essential before attempting to adjust the main burner.

2.1.3 ADJUST BOILER INPUT(S)
The boiler input must be adjusted for both maximum and minimum input values which are listed on the boiler nameplate on the boiler. First adjust the maximum input rating using the method described in the Lighting Instructions in the Boiler Manual. Refer to the following information for the adjustment of the minimum input. To determine which firing rate system is used, see the boiler Equipment List and Wiring Diagram.

2.1.4 ADJUST BOILER MINIMUM INPUT
After setting the correct maximum input as described in the Lighting Instructions, proceed to adjust the minimum input as outlined below. This applies only to those boilers which are designed and equipped for two-stage (High/Low/Off) firing or modulation. On those boilers which are equipped for ON/OFF firing only, no minimum input adjustment is required. NOTE: the low firing rate input is adjustable only on boilers equipped with two-stage or modulating motorized gas valves (V4055, V9055, or AH4 actuators) or with motor-operated modulating butterfly gas valves. The other two-stage firing systems (VR850 or VR852 combination valves or dual diaphragm valve type by-pass systems) have a non-adjustable minimum input rate.

NOTE

THE LOW FIRE ADJUSTMENT SHOULD RESULT IN A GAS PRESSURE ON THE BURNER MANIFOLD EQUAL TO 1" WATER COLUMN FOR NATURAL GAS AND 3" FOR PROPANE GAS.

2.1.5 MINIMUM INPUT ADJUSTMENT - COMBINATION GAS VALVES (VR850 OR VR852)

The minimum input on these gas valves is NOT adjustable. The maximum input must be properly set as outlined in Lighting Instructions. See the manufacturer's instructions on the VR850 or VR852 included in the Boiler Manual for further information.

2.1.6 MINIMUM INPUT ADJUSTMENT - DUAL DIAPHRAGM GAS VALVE HIGH/LOW BY-PASS SYSTEM

The minimum input on this control system is NOT adjustable. The maximum input must be properly set as outlined in Lighting Instructions. This system consists of two V48A (120 volt coil) or two V88A (24 volts coil) diaphragm gas valves which are piped in parallel. The minimum input is controlled by an orifice plug installed in a coupling in the by-pass piping (low fire valve piping) sized for approximately 1" w.c. manifold pressure at low fire natural gas (2" w.c. if propane gas). When the high fire gas valve is not activated, gas flows only through the bypass piping. When the high fire gas valve is activated, gas will flow though both valves achieving full input.

2.2 FIRING RATE ADJUSTMENT - GAS METER READINGS

2.2.1 CHECKING BURNER INPUT

The burner input rate can be checked by taking readings from the gas meter. Please note checking the rate with a meter is the only way to be sure of input. Manifold readings are only an approximate value and may vary from unit to unit.

In order to obtain accurate data, there must be no other appliances using gas from the same meter while the burner input rate is being checked. The test hand on the meter should be timed for several revolutions. The input rate in cubic feet per hour is calculated from this timing. The method is described in the Lighting Instructions. If the meter is not calibrated for gas temperature and pressure, correction factors must be applied to determine correct rate in SCFH (standard cubic feet per hour). Consult the National Fuel Gas Code (ANSI Z223.1, NFPA 54) or the local gas utility for further information. Refer to Table 2.2A for correction factors for the gas pressure at the meter. Refer to Table 2.2B for the gas temperature correction factors.

Table 2.2A - Pressure Correction		Table 2.2B - Temperature Correction	
Gas Pressure at Meter	Correction Factor	Gas Temp. at Meter	Correction Factor
7" w.c.	1.017	40 □F	0.920
14" w.c.	1.034	50 □F	0.902
21" w.c.	1.051	60 □F	0.885
1 psig	1.061	70 □F	0.868
2 psig	1.136	80 □F	0.852
5 psig	1.340	90 □F	0.836

2.3 SAFETY SHUT-OFF DEVICES (FLAME SUPERVISION)

2.3.1 FLAME SUPERVISORY SYSTEM

The boiler is equipped with a flame supervisory system, either the Thermocouple type (such as a combination gas valve or a pilotstat) or electronic type (such as the RA890, or RM7895). The purpose of this device is to detect the main or pilot flame, depending on the type of device, and control the gas valves accordingly. The device must be checked for proper operation. See Lighting Instructions in the Boiler Manual for the correct procedure. The flame supervisory system must be tested to assure that it will shut off the main gas valves in case of a flame loss. In addition to the information given in Lighting Instructions, operating sequence and troubleshooting information may be found in the manufacturer's instructions in the Boiler manual.

2.3.2 AUTOMATIC (ELECTRIC) IGNITION SYSTEMS

On boilers equipped with automatic electrically ignited pilots, follow the procedures described in Lighting Instructions and test the controls for proper operation.

2.4 LIMIT CIRCUIT CUT-OUT TEST

2.4.1 PROTECTIVE DEVICES

All operating and limit controls, and low water cutoffs must be tested for proper operation.

2.4.2 WATER TEMPERATURE OPERATING CONTROL

The water temperature in the boiler is regulated by the Boiler Operator. This is a temperature control which senses the water temperature and turns the boiler on and off accordingly. This control must be operationally tested. Turn the temperature setting on the control to a temperature less than the boiler temperature (as shown on the boiler temperature gauge). The control should turn the boiler off. Restore the control setting to normal. The boiler should cycle on.

2.4.3 OUTDOOR RESET CONTROLS

Some boiler control systems also include an outdoor reset control. This control increases the boiler operating temperature with a decrease in outdoor air temperature, and decreases the boiler operating temperature with a rise in the outdoor temperature. For gas fired boilers, it is essential that the minimum operating temperature of the boiler never drop below 130□F, even at 70□F outdoor temperature. Reference Section 3.4. Also refer to the literature on the outdoor reset control for further information.

2.4.4 HIGH LIMIT CONTROL

At least one additional temperature control is provided as the high limit control. It is set at a temperature above the operator to act as a back-up should the operator fail. The high limit control must be operationally tested. With the boiler operating, decrease the temperature setting of the Limit Control below the current temperature of the boiler. The boiler should cycle off. Restore the high limit control setting to normal (pushing the reset button if it is a manual reset type). The boiler should now cycle on.

2.4.5 POOL TEMPERATURE CONTROL

On swimming pool heating boilers, an additional temperature control is installed with its sensing bulb in the pool circulation line (sensing the water temperature coming from the pool) to cycle the boiler, so as to control the pool water temperature. Test this control by reducing the temperature of the control below the temperature of the pool water. The boiler should cycle off. Restore the setting of the control and the boiler should cycle on.

2.4.6 COIL LIMIT CONTROL

On indirect water heating boilers, an additional temperature limit control is installed to limit the temperature leaving the heat exchanger. It must be tested in the same manner as the boiler High Limit control.

2.4.7 LOW WATER CUT-OFF(S)

Most boiler are supplied with at least one float or electric probe type control, designed to sense the level of the water in the boiler. It operates to shut off the boiler if the water level drops below its

sensing level. The low water cut-off controls must be operationally tested by manually lowering the boiler water level (by opening the drain valve). The boiler should cycle off when the water level drops below the control point of the low water cut-off. When the water level is restored, the boiler should cycle back on. Depress the manual reset button of devices which require manual reset in order to restore the boiler to operation. Carefully read the enclosed literature on the low water cut-off controls, particularly installing, operating and servicing.

2.4.8 COMBINATION LOW WATER CUT-OFF & FEEDER

The low water cut-off/feeder supplied with some boilers serves as a low water cut-off (see above) and also causes make-up water to be added to the boiler, should the water level drop below its control point. This type of control must be operationally tested as described in Section 2.4.1 and also to assure that the make-up water is introduced as needed. Carefully read the enclosed literature on the Low Water Cut-off controls, particularly installing, operating and servicing.

2.4.9 OTHER CONTROLS

Additional controls, as required for the particular installation, may also be provided. Refer to the literature on these devices included in the Boiler Manual. All such devices must be operationally tested to assure reliable operation of the boiler and system.

2.5 RECOMMENDED DRAFT AND COMBUSTION READINGS

ATMOSPHERIC GAS-FIRED BOILERS					
BOILER SERIES	DRAFT AT BOILER OUTLET (i.w.c.)	CO_2 @ HIGH FIRE	O_2 @ HIGH FIRE	CO (ppm)	SMOKE NO.
F	-0.01 TO -0.04	7.5 TO 8.5 %	5.0 TO 7.5 %	< 400	0
CL	-0.02 TO -0.04	7.5 TO 9.0 %	4.8 TO 7.5 %	< 400	0
K	-0.02 TO -0.06	8.0 TO 9.5 %	4.0 TO 6.7 %	< 400	0

FORCED DRAFT GAS FIRED BOILERS					
BOILER SERIES	DRAFT AT BOILER OUTLET (i.w.c.)	CO_2 @ HIGH FIRE	O_2 @ HIGH FIRE	CO (ppm)	SMOKE NO.
D	-0.01 TO -0.04	7.5 TO 9.5 %	4.0 TO 7.5 %	< 400	0
HED	-0.01 TO -0.04	7.5 TO 9.5 %	4.0 TO 7.5 %	< 400	0
CL	0.0 TO -0.04	8.5 TO 10.0 %	3.2 TO 5.0 %	< 400	0
HECL	0.0 TO -0.06	8.5 TO 10.0 %	3.2 TO 5.0 %	< 400	0
RV & RW	+0.50 TO -0.10	9.0 TO 10.0 %	3.2 TO 5.0 %	< 400	0
AB	+0.25 TO -0.06	9.0 TO 10.0 %	3.2 TO 5.0 %	< 400	0

FORCED DRAFT OIL FIRED BOILERS					
BOILER SERIES	DRAFT AT BOILER OUTLET (i.w.c.)	CO_2 @ HIGH FIRE	O_2 @ HIGH FIRE	CO (ppm)	SMOKE NO.
D	-0.01 TO -0.04	10.0 TO 12.0 %	4.0 TO 7.2 %	< 400	0
CL	0.0 TO -0.04	10.0 TO 12.0 %	4.0 TO 7.2 %	< 400	0
RV & RW	+0.50 TO -0.10	11.5 TO 12.5 %	3.7 TO 5.0 %	< 400	0
AB	+0.25 TO -0.06	11.5 TO 12.5 %	3.7 TO 5.0 %	< 400	0

NOTE: THE VALUES FOR CO_2 AND O_2 ARE SHOWN FOR HIGH FIRE ONLY. THE VALUES FOR LOW FIRE OR MID RANGE WILL GENERALLY BE LOWER, PARTICULARLY FOR ATMOSPHERIC GAS-FIRED BOILERS. DRAFT SHOULD BE MEASURED APPROXIMATELY 24" FROM TOP OF BOILER, BEFORE ANY DRAFT CONTROL.

2.5.1 DRAFT ADJUSTMENT - ATMOSPHERIC GAS BOILERS

Refer to Section 1.8.6 for the adjustment method for barometric dampers. Adjust the damper so as to yield a draft which results in values of CO_2 and CO within the allowable limits listed above in the appropriate table.

Draft adjustments are generally not required for boilers which are equipped with draft diverters. The diverter must be installed without modification. Combustion readings are required, however, to assure that the boiler operation is both safe and efficient.

Draft measurement should preferably be made with an inclined tube manometer. If a draft gauge is not available, check to be sure the flue gases are being carried up the venting system by passing a lighted taper or match around the edge of the draft hood relief opening (or barometric). If the venting system is operating correctly, the match flame will be drawn toward the draft hood relief opening. Otherwise the products of combustion will tend to push the flame and extinguish it.

CAUTION

IF THE PRODUCTS OF COMBUSTION ARE BEING EMITTED INTO THE ROOM (VENTING SYSTEM NOT OPERATING CORRECTLY), THE BOILER MUST NOT BE OPERATED UNTIL PROPER ADJUSTMENTS OR REPAIRS ARE MADE TO ASSURE ADEQUATE DRAFT THROUGH THE VENTING SYSTEM.

2.5.2 DRAFT ADJUSTMENT -FORCED DRAFT BOILERS

Draft adjustments are generally not necessary on forced draft boilers. The draft must be measured as part of the start-up procedure. The measured draft at the boiler flue should fall within the recommended range specified in the appropriate table.

On some installations, the draft may be excessive due to a high chimney. In these cases, the draft should be adjusted to within the recommended range specified in the appropriate table above.
This may be done using a barometric damper, a restrictor, or a locking quadrant damper. Such devices must be installed and adjusted by a qualified technician.

2.5.3 COMBUSTION ADJUSTMENTS - FORCED DRAFT BURNERS

Refer to the separate burner manual for the procedures for burner adjustments. The burner must be adjusted for a smooth lightoff. Combustion parameters should be within the appropriate range specified in the above table. In no case should the level of CO or the smoke spot reading be allowed to exceed the recommended limit.

2.6 OPERATING INSTRUCTIONS

2.6.1 FAMILIARIZATION WITH MANUAL(S)

The user of the boiler must familiarize himself with this manual (and the burner manual for those units which are forced draft) to be sure he is prepared to operate and maintain the boiler properly.

The operating instructions should be kept in the pocket in the boiler for F Series boilers or adjacent to the boiler for all others.

READ THE MANUAL BEFORE ATTEMPTING A START UP.

2.7 MAINTENANCE SCHEDULE

2.7.1 POSTING SCHEDULE

Post a maintenance schedule in accordance with the recommendations in this manual. A copy of a typical schedule is included in this manual.

CARE AND MAINTENANCE
WATER BOILERS

CAUTION:

- The boiler area should be kept free of combustible materials, gasoline and other flammable liquids.
- The boiler and venting system must be kept free of obstructions of the air louvers and draft hood relief openings.
- The following procedures must be conducted as outlined to assure safe operation of the boiler.
- All cover plates, enclosures, and guards must be in place at all times, except during maintenance and servicing.

3.1 CLEANING THE BOILER AND SYSTEM - NEW SYSTEMS

PRE-BOIL OUT FLUSHING OF SYSTEM

Much of the dirt and contamination in a new hot water system can be flushed out before the boil out of the system. First, flush the system of waste with clear water. The boiler and circulating pumps must be isolated through the successive zones of the system to waste, carrying chips, dirt, pipe joint compound, etc. with it. Follow with a chemical flush. The removal of pipe chips and other debris from the system before opening the isolation valves to the boiler and pumps will help to protect this equipment from damage by such debris.

In combination with system contamination, bacteria from ground water boiler water may produce objectionable odors, sometimes resembling natural gas. It is important to keep these fumes from air intakes which would distribute them throughout the building.

BOIL OUT PROCEDURE

The boil out of the boiler and system is neither difficult nor expensive. The chemicals needed for cleaning are readily available. Trisodium phosphate, and sodium hydroxide (lye) are the most commonly used chemicals. Use only one type of solution in the system. The amount of chemical required will vary according to conditions, but one pound per fifty gallons of water is suggested.

Fill the system with this solution, venting all air. Then, with the circulating pump running, bring the system to design or operating temperature. After circulating water for two to three hours, the system should be drained completely, and refilled with fresh, softened water. Usually enough of the cleaning solution will adhere to the piping to result in an alkaline solution satisfactory for operation. A pH reading between 7 and 8 is preferred. If necessary, to increase the pH, a small amount of cleaner may be added.

IMPORTANT

The boil out procedure outlined must be performed by, or under the direct supervision of, a qualified technician. The chemicals used present a hazard of burns and physical injury if mishandled. Always use suitable face mask, goggles, protective gloves and garments when handling caustic chemicals. Do not permit the chemical to come into contact with skin or clothing. Always follow the safety precautions on the container's label. Add chemicals slowly and in small amounts to prevent excessive heat and agitation.

DRAINING THE SYSTEM

A clean neutral hot water system should not be drained, except for an emergency or when unavoidable for servicing of equipment. See Section 3.3 for water treatment required when refilling.

3.2 REPLACEMENT BOILER INSTALLATIONS: PROTECTION AGAINST CORROSION & SEDIMENT

CLEAN OR REPLACE ALL SYSTEM PIPING AND HEATING UNITS

Arrange for chemical or mechanical cleaning of the entire system. A chemical treatment company should be consulted for the proper means of any chemical cleaning.

Replace any piping considered to be deteriorated beyond safe or cleanable condition.

Flush the system clean, being certain to isolate the boiler.

DO NOT FLUSH THE SYSTEM THROUGH THE BOILER.

NOTE: For some old systems, there is a reluctance to clean the piping because of possible leaks occurring in badly corroded lines. Should the customer refuse cleaning, it is necessary to install filtration equipment. Install either a fibrous filter or a centrifugal filter in the boiler return piping. This will collect and remove sediment from the system.

A booster pump may be required to overcome the additional pressure drop introduced in the line by the filter. When filling the system, provide chemical treatment as outlined in Section 3.3.

CAUTION

Failure to properly clean the system or to install mechanical sediment removal equipment can result in tube blockage and severe corrosion plus damage to pumps, controls, and air removal devices.

Inspect, repair as necessary, or replace system air control devices.

Install gauge glasses on air expansion tanks and install a tank fitting in the system connection to the tank.

Install a strainer in boiler return piping.

3.3 BOILER WATER TREATMENT

PURPOSE OF WATER TREATMENT

Water treatment is required for satisfactory operation of the boiler. It must be devised to prevent depositing of scale and corrosion from acids, oxygen and other such harmful elements that may be in the water supply.

A qualified water treatment chemist should be consulted and the water systematically treated.

OBJECTIVES

The basic objectives of water treatment are:

1. Prevent the accumulation of scale and deposits in the boiler.
2. Remove dissolved gases from the water.
3. Protect the boiler against corrosion.
4. Maintain the highest possible boiler fuel efficiency.
5. Decrease the amount of boiler down time from cleaning.

CONTINUOUS MONITORING REQUIRED

Water treatment should be checked and maintained whenever the boiler is operating. The boiler operator should be sure that the boiler is not operating for long periods without proper water treatment.

It should be noted that water boilers may well need chemical treatment for the first filling plus additional periodic chemical treatment, depending on system water losses and the makeup requirements.

Water treatment may vary from season to season or over a period of time. Therefore, the water treatment procedure should be checked not less than four times a year, and possibly more frequently as the local water conditions may indicate. All water introduced into the boiler should be softened and should include an oxygen scavenger like sodium sulfite. This is required to remove dissolved oxygen from the water.

Dissolved oxygen will cause severe boiler tube corrosion.

DRAINING AND REFILLING THE BOILER & SYSTEM

If the system is drained and then refilled, chemical treatment is essential to treat the raw water. Use only clean, softened water.

3.4 EXTERNAL "FIRE-SIDE" CLEANING

PURPOSE

Carbon (soot) is an insulator and is corrosive. The heating surface of a boiler must be kept free from soot accumulation to keep the boiler operating at its highest efficiency and to avoid damage from corrosion.

SOOT REMOVAL

If the yearly inspection of the boiler tube surfaces reveals a build-up of either soot or rust (usually due to condensation), the tubes should be thoroughly brushed. (Tube cleaning brushes are available from Bryan Steam) To inspect and, if necessary, clean the tube surfaces and flue collector, first remove the tube access panels. Examine the exterior of the tubes for evidence of soot or rust. Using a flashlight, carefully look between the tubes. There should be an unobstructed opening between all tubes, and the top surfaces of the tube must be free from soot accumulation. Also inspect the interior of the flue collector. Brush or vacuum the soot from all surfaces. Be sure to cover atmospheric burners with a protective cover during cleaning to prevent soot from falling into them.

If the buildup of soot is appreciable, the flue gas venting system must be thoroughly inspected internally as well, and cleaned as necessary.

IMPORTANT

If either soot or condensation is apparent, a boiler service technician should be consulted. The presence of soot indicates poor combustion and possibly hazardous boiler operation. Failure to do so may result in fire, explosion potential, or asphyxiation. A combustion test and burner adjustments should be undertaken at once.

Rust on the tubes indicates that boiler operating temperatures are too low. The set point of the boiler operating control must be no less than 130□F for natural gas or propane firing and 170□F for oil fired boilers. Boilers equipped with outdoor reset must also follow these limits.

3.5 SUGGESTED MAINTENANCE SCHEDULE

DAILY

1. Make visual inspection of gauges, monitors, and indicators and record readings in boiler log.

2. Make visual check of instrument and equipment settings against factory recommended specifications.

3. Check operation of float type low water cutoffs to ensure control is functioning. The lower piping connections of float type level controls should have a suitable blowdown valve piped into a proper drain. This valve should be opened periodically to allow any sludge accumulated in the control to be flushed out. On closed loop water heating systems this should not be often required. Consult manufacturer's instructions.

WEEKLY

1. On units equipped with firing rate control, verify it is functioning correctly by adjusting control and observing if input changes accordingly.

2. Make visual inspection of igniter and pilot flame. For an atmospheric unit, confirm pilot flame is as shown in this manual (Section 1.9) and that the main burners light off correctly (smoothly) and that the flame is clean and normal. For units with a power burner, check pilot flame signal strength as specified in burner manual.

3. Check pilot and main fuel valves for correct operation. Open limit switch - make audible and visual check - check valve position indicators and check fuel meters, if supplied.

4. Confirm boiler area is free of combustible materials and that there is nothing obstructing air openings, draft hood relief openings, etc.

5. Check combustion safety controls for flame failure and flame signal strength as specified in manufacturer's instructions located at the back of this manual for atmospheric units or in the burner manual for units equipped with a power burner.

6. Check all limit controls as specified in Section 2.4 of this manual.

7. Check float low water cutoff as described above.

MONTHLY

1. Make visual inspection of linkage and proper operation of flue, vent, stack, or outlet dampers. Check draft as specified in Section 2 of this manual.

2. Check float low water cutoff as described above.

3. For those units equipped with a power burner, check low draft, fan, air pressure and damper position interlocks as specified in burner manual.

4. Check high and low gas pressure interlocks. Refer to manufacturer's instructions for correct procedure.

5. Check high and low oil pressure interlocks. Refer to manufacturer's instructions for correct procedure.

ANNUALLY

1. Perform leakage tests on pilot and main gas or main oil fuel valves as specified in manufacturer's instructions.

2. Check operating control, high limit, low fire start control, and low water cutoff as specified in manufacturer's instructions.

4. For units equipped with power burners, check air atomizing interlock, fuel valve interlock switch, purge switch, burner position interlock, and fuel changeover control, as specified in burner manual.

6. The boiler should be checked at least yearly by the local gas utility company. Particular attention should be paid to the pilot burner safety devices. The pilot burner should be checked to ensure that prompt ignition of all burners occurs as the gas valve opens. Refer to Section 1.9.

7. The flue gas passages and the exterior surfaces of the boiler tubes should be inspected at least annually. Any accumulation of soot or debris should be thoroughly cleaned out.

8. If the yearly inspection of the boiler tube surfaces reveals a build-up of soot (carbon) or rust, the tubes surfaces should be thoroughly brushed. Failure to do so may result in fire or asphyxiation hazards.

9. The boiler pressure vessel and piping should be checked annually.

10. Check combustion safety control for pilot turndown and hot refractory hold-in as specified in manufacturer's instructions.