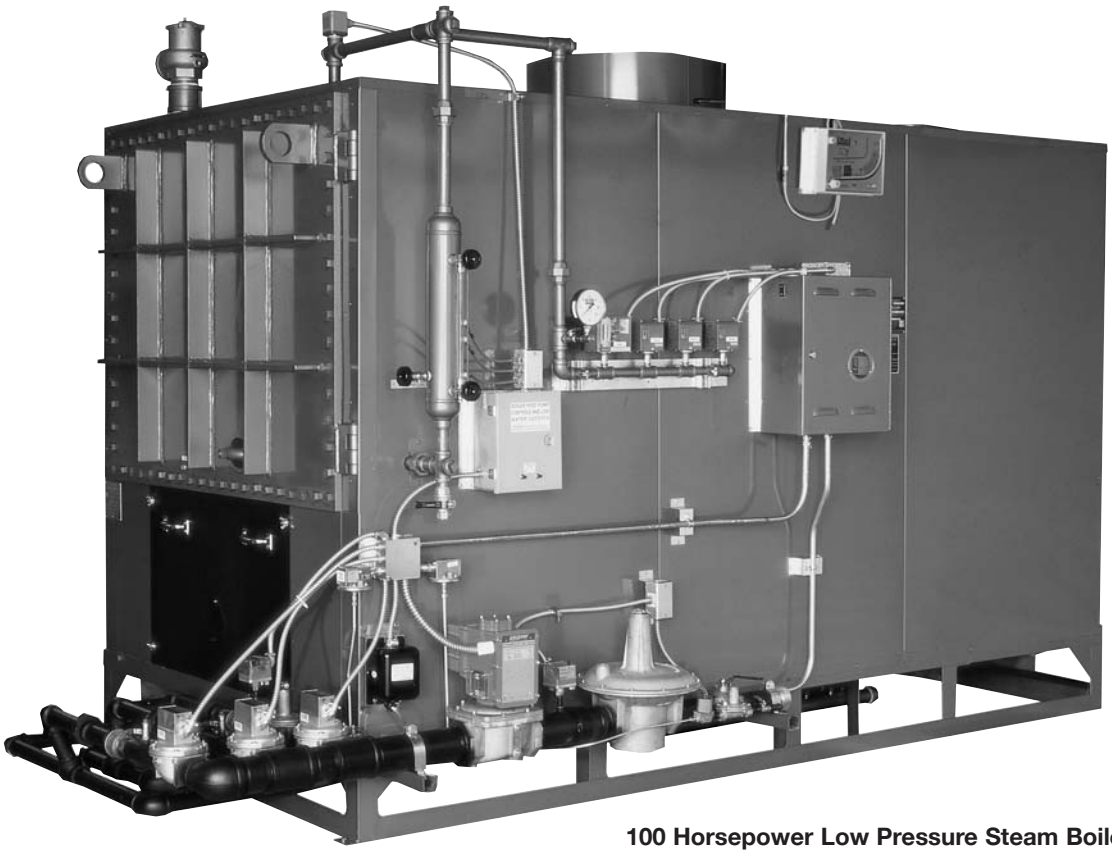
INSTRUCTION MANUAL

FOR
PROPANE **INDOOR**
ATMOSPHERIC
BOILERS



100 Horsepower Low Pressure Steam Boiler

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Read instructions carefully before proceeding with installation and operation.
Post and maintain instructions in legible condition.

11/05

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SAFETY WARNING NOTICES:

Your physical safety and the safety of others is very important. Throughout this manual we have provided safety warning notices to alert you to potential safety hazards. A safety notice will be preceded by:

DANGER ***IT MEANS:*** You CAN be **KILLED** or **SERIOUSLY HURT** if you don't follow instructions.

EQUIPMENT WARRANTY NOTICES:

When properly installed, operated and maintained, Rite Boilers can easily offer forty or more years of service. Throughout this manual we have provided equipment warranty notices to alert you to potential practices that could lead to premature repairs. An equipment warranty notice will be preceded by:

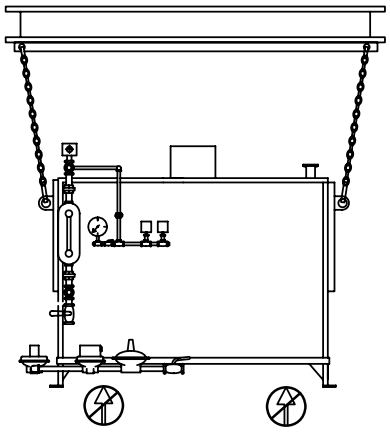
CAUTION ***IT MEANS:*** Failure to follow these instructions will void warranty and may lead to premature repairs.

RECEIVING

1. Before signing Bill of Lading, check for any signs of external damage. Be sure you have received all the pieces noted on the bill. Draft Diverters and Barometric Dampers are shipped loose.

2. **DANGER** Offload the boiler as shown in **Figure 1.** Follow safe rigging procedures and use load rated equipment.

Figure 1



CAUTION Do not forklift underneath the burner manifold(s).

3. **CAUTION** Place the boiler gently onto a firm, level surface. Hard drops may result in broken refractory.

4. Remove the firebox door attached by the four 3/8" wingnuts.

   4.1 Cut and remove the burner tie down wires.

   4.2 Be sure all the burners are in place.

   4.3 Check for any broken refractory panels. Superficial hairline cracks are part of the curing process and considered normal.

   4.4 Reinstall firebox door.

STORAGE

1. If the boiler is temporarily stored outdoors it must be completely protected from moisture by a tarp or other means.

2. Keep the Draft Diverter, Barometric Damper and any other equipment shipped loose with the boiler, otherwise they may become lost.

3. Leave plastic cap plugs in place and keep debris from entering boiler stack(s) and plumbing connections.

PLACEMENT

1. Boiler may be placed directly onto pad as shown in **Figure 1** or moved on rollers as shown below in **Figure 2**:

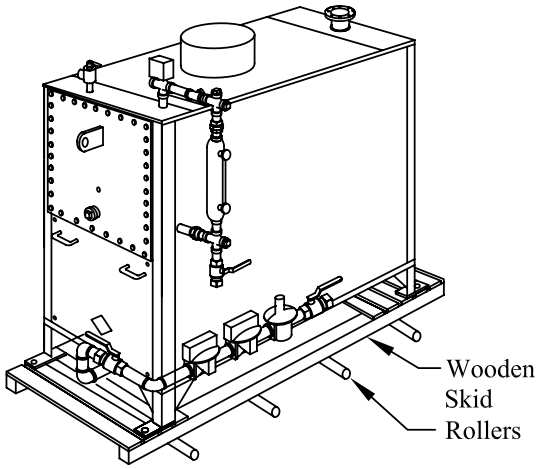


Figure 2

2. Rite Atmospheric Boilers must be installed on a level, concrete housekeeping pad or other approved non-combustible surface that has been engineered to support the boilers operating weight. If installed on an open metal grate mezzanine, cover the area under the boiler with sheet metal to prevent excess air from coming directly up into the combustion chamber.

3. If the boiler was shipped on a wooden skid, remove the skid prior to final placement on the pad.

4. When anchoring the boiler to the pad observe the following:

   4.1 Consult job specification for seismic anchorage requirements.

   4.2 If in doubt, contact your local Building & Safety Dept. or a qualified mechanical engineer for assistance.

   4.3 Refer to appropriate Rite Atmospheric brochure for boiler weights, water content and dimensions.

   4.4 Boilers not shipped on wooden skids will require anchor plates (by others).

5. When installing on a concrete pad be, sure the pad is big enough in length and width. The current minimum requirement is that the pad must extend beyond the anchor plate holes by at least six (6) times the anchor bolt diameter. (See **Figure 3** on the next page).

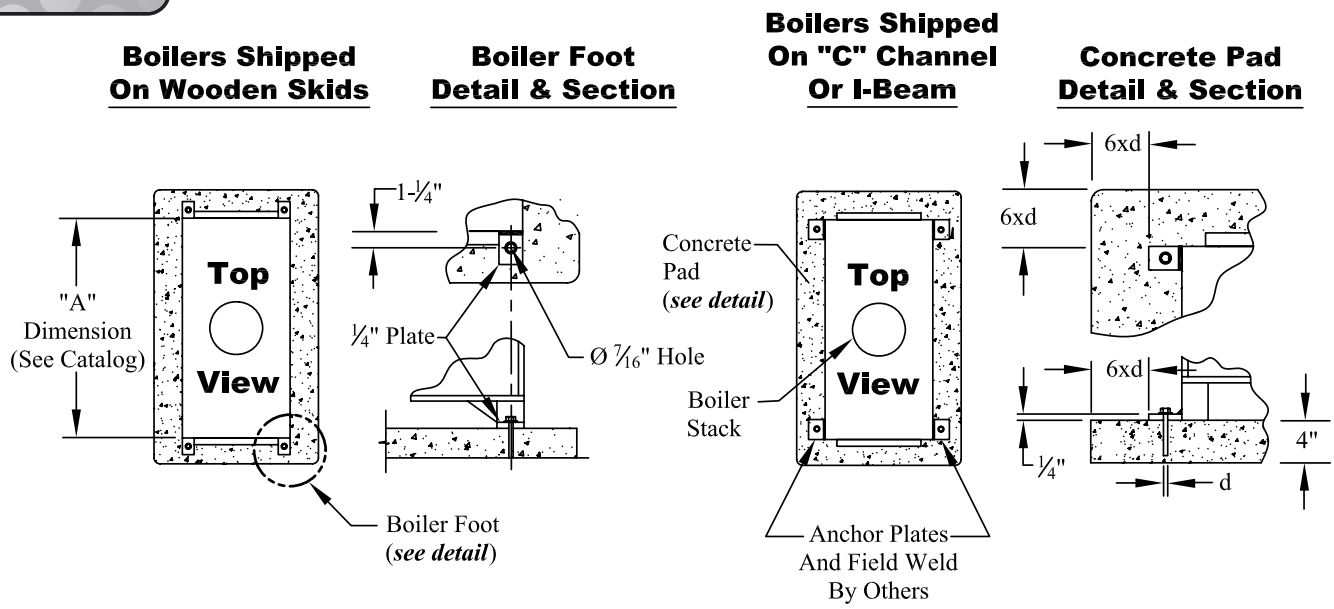


Figure 3

INSTALLATION

General

1. In most cases the installation will be carried out by a licensed contractor who must pull the required permits before starting the job. Before the boiler is started up, all the work permits must be signed off.

2. The installing contractor must carry out the work according to state and local codes which may vary from nationally recognized codes such as the Uniform Mechanical Code, Uniform Plumbing Code, National Fire Protection Agency, ASME CSD-1, National Electric Code, etc. Additional insurance requirements or job specifications may also be required. For example, it is mandatory that Section I Boilers are piped up in part by an ASME stamp holder in accordance with B31.1 of the ASME Power Piping Code.

3. Always lay out and install the largest components first. Start with the stack system and combustion air ducts, followed by the water or steam mains next and do the smallest diameter runs like water make-up and drain lines last. Plan carefully. The best installations are these where the largest components are run as straight and direct as possible.

Boiler Room Air Requirements

1. An adequate supply of fresh air is essential for safe, efficient combustion as well as ventilation of the boiler room. Because there are a number of code variations that can alter the combustion air openings minimum size requirements, it is best to reference the latest edition of the Uniform Mechanical Code hand book or consult your local Building & Safety Dept. when in doubt. Currently, a boiler in a confined space (a room having a volume less than 50 cubic feet per 1,000 BTU input rating of <u>all</u> fuel burning equipment inside) and of unusually tight construction (such as 1 hour fire-rated boiler rooms) must have the following minimum ***<u>free</u>*** air (deduct for louvers and screens) openings:

   1.1 Two vertical ducts or plenums, one within 12” of the top of the room and the other terminating 12” from the floor, each having 1 square inch of ***<u>free</u>*** opening for every 4,000 BTUH input.

   OR

   1.2 Two exterior louvered wall openings, one high and one low, each having 1 square inch of ***<u>free</u>*** opening for every 4,000 BTUH input.

   OR

   1.3 Two horizontal ducts or plenums, one high and one low, each having 1 square inch of ***<u>free</u>*** opening for every 2,000 BTUH input.

2. Doors and windows that can be closed *are not* considered to be a source for combustion or ventilation air.

3. At least two openings shall be provided: one commencing with 1 foot of the floor of the room, and the other commencing within 1 foot of the ceiling of the room.

Per 1.1 & 1.2 previous page, Example of FREE Air Opening Required.

Equipment	Btu/hr Input	Divided by 4,000	Ceiling Opening	Floor Opening
Boiler 1	4,000,000	1000	1000 inch^2	1000 inch^2
Boiler 2	3,500,000	875	875 inch^2	875 inch^2
Water Heater	225,000	56	56 inch^2	56 inch^2
Total	7,725,000	1931	1,931 inch^2	1,931 inch^2
Minimum Required FREE Air Openings			≈ 44 X 44 inches	≈ 44 X 44 inches

4. In calculating the ***free*** area openings above, the required size of the openings for combustion and ventilation air shall be based on the net free area of each opening. If the free area of a louver is known, it shall be used in calculating the size openings of the required free air specified above. If the free area is not known, it shall be assumed that:

   4.1 Fixed wood louvers will have 20-25% free air opening.
   4.2 Fixed Metal louvers will have 60-70% free air opening.
   4.3 Metal mesh screen (minimum 1/4") will have 98% free air opening.
   4.4 Blade type motorized Combustion Air Dampers (CAD) will have 95% free air opening.

5. In summary, make sure you add up **ALL** the air consuming equipment in the room and deduct the proper percentage for louver restrictions **BEFORE** arriving at the final opening sizes (high and low) required.

6. By definition, an unconfined space is where the volume of the equipment (boiler) room is at least 50 cubic feet per 1000 BTUH input of all the combustion or air consuming appliances. When this is the case, the installer should check local codes first, but in general no additional combustion air is required.

7. Where motorized combustion air dampers are used, make sure an electrical interlock (end switch) proves the dampers are fully open before the boiler is allowed to fire.

8. **DANGER** Exercise caution anytime a fan is used to exhaust air from a boiler room. Negatively pressurized boiler rooms can cause poor combustion, flame roll-out, heat damage to gas valves and electrical wiring, and carbon monoxide infiltration. Be sure the air pressure in the boiler room is the same as it is outdoors under all operating conditions.

9. **CAUTION** Determine if the boiler room is next to another equipment room and the two share a common door. If the other equipment room contains air handling equipment, boiler room's air pressure can go negative if the connecting door is left open. In such cases, a door interlock switch must be used to prevent the boiler from firing unless the connecting door is closed.

Draft Control

1. All Rite Atmospheric Boilers operate on the **natural draft** principle. This means that fan motors are not required for either combustion or to assist in forcing the products of combustion through the boiler and out the stack. Natural draft makes use of the leftover heat going up the stack to create all the draw necessary for proper operation. This not only saves electrical power and eliminates fan noise but also decreases the chance of pressurized flue gasses from escaping into an occupied room.

2. Rite Atmospheric Boilers up to 1200 mbh input are supplied with a Draft Diverter; larger units are supplied with a Barometric Damper. Where minimum headroom above the boiler does not permit the installation of a Draft Diverter, a Barometric Damper may be substituted. **CAUTION** These draft control devices must be properly installed for the boiler to maintain a Category 1 rating for use with Type B Gas Vent.

3. Boilers installed with Draft Diverters will draft approximately –.02" w.c. column when firing. There is no draft adjustment that can be made with a Draft Diverter and therefore no draft gauge is supplied. Boilers using Barometric Dampers must have the right number of washer weights to produce a draft between –.03" to –.09" w.c. when firing. Increasing the number of weights makes it harder for the damper gate to open. This results in less dilution air entering the stack, thus increasing the boiler's draft. Too much draft through the boiler is better than no draft (which can cause sooting and overheating) but keep in mind that excessively high draft reduces heat transfer efficiency.

4. Factory mounted draft gauges are standard on all boilers supplied with a Barometric Damper. The draft can be set up and monitored using this gauge. An optional flue gas thermometer for checking boiler efficiency may also be provided. See **Figure 4** below for draft control and draft measurement locations.

Stack Requirements

1. Rite Propane Fired Atmospheric Boilers are suitable for use with Type B gas vent. Type B is double wall stack, widely available from a number of different manufactures. It is relatively inexpensive, easy to install and available in 3" through 30" diameters. Type B vent is suitable for Category 1 appliances only - combustion equipment defined as having net stack temperatures less than 400° F., operating with negative draft to the stack termination and producing non-condensing flue gasses.

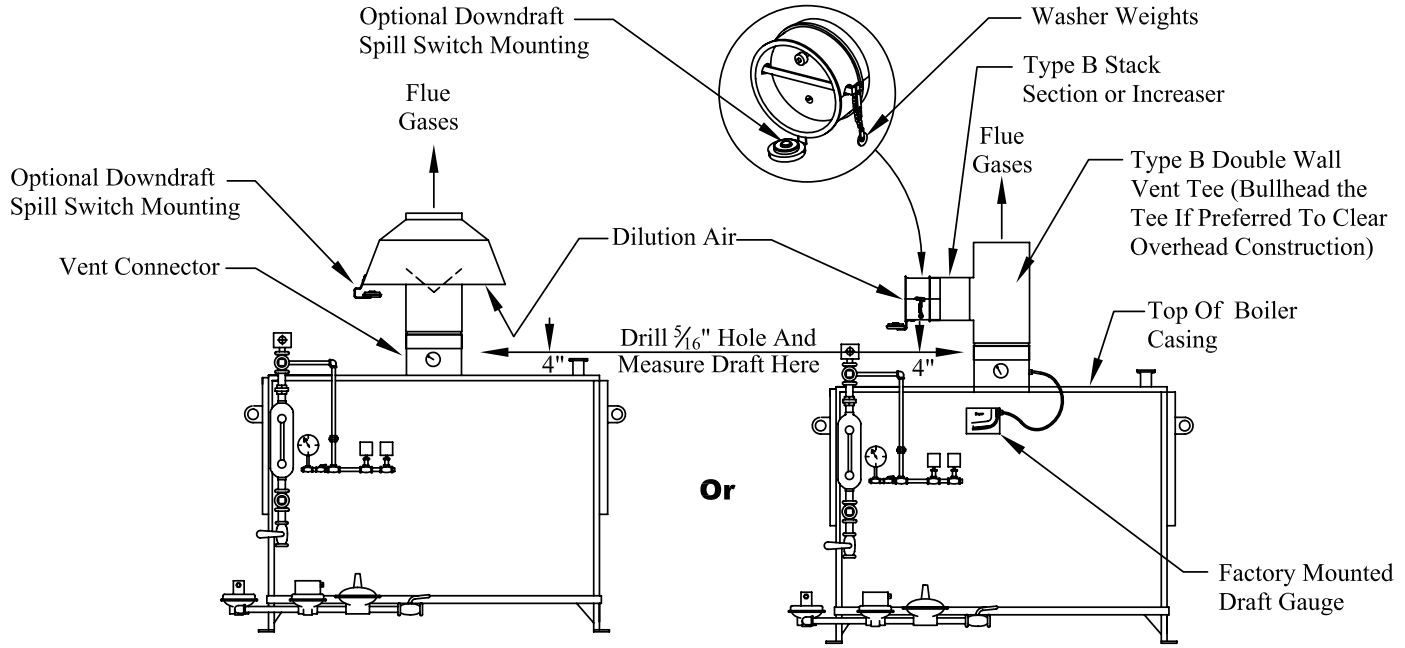
2. Refer to Type B gas vent manufacturers catalogs for detailed installation instructions. Most vent manufacturers offer free engineering support for specific job requirements as one of their selling tools. This can take the guesswork out of unconventional stack designs.

3. It is good practice to incorporate a Type B vent support plate for independent stack support and an adjustable length (telescoping) section for future boiler/stack separation. This will facilitate fireside tube cleaning should it ever be required. Terminate Type B vent stack with a B vent rain cap except in those locations where frequent high winds may necessitate a Breidert type cap.

4. **CAUTION** A horizontal stack run must not exceed 75% of the vertical stack height (NFPA 54 7.6.1d) without the addition of an engineered mechanical draft system (induced draft fan).

5. **CAUTION** Boiler installations with unavoidable negative air conditions - such as boilers located in open factories - will require engineered mechanical draft systems.

6. **CAUTION** Never reduce the boiler stack diameter without written factory approval. Stacks over 20 feet in height can sometimes reduce stack diameter requirements significantly but only after a factory engineering review and approval process.



Boiler With Draft Diverter **Boiler With Barometric Damper**

Figure 4

7. When induced draft fans are used, stack diameters are often drastically reduced. *In these cases a stack draft gauge reading should not be relied upon for assuring that the proper volume (CFM) is being exhausted.* A simple smoke test will quickly tell whether or not there is a problem. Open the firebox door peephole cover and provide a smoke source an inch or so away while the boiler is at high fire. If the smoke is gently sucked into the firebox, the draft (and CFM exhaust) is in the right range. If the smoke is rapidly sucked in, the draft (and CFM exhaust) is too high and should be adjusted lower (either by reducing the speed of the fan or adjusting the barometric damper washer weights if supplied). If the smoke is not pulled in, then not enough CFM is being exhausted. The following formulas and test can be used to verify the smoke test and help pinpoint what corrective action is required: Multiple the BTUH input by .0005 to derive the CFM that must be exhausted (eg: at 3 million BTUH input the stack must exhaust 1500 CFM). Using a feet-per-minute velocity gauge such as a Dwyer #460 take the average reading (measured by inserting a pitot tube horizontally at various depths in the stack below the draft control) and multiply by the square foot diameter of the stack. Example: an average reading of 688 feet-per-minute in a 20" diameter stack $(688 \times 3.14 \times 10^2) \div 144 = 1500$ CFM.

Clearances

1. The following minimum clearances to combustible construction from the boiler should be observed:

CLEARANCE TO COMBUSTIBLE MATERIALS

MODELS	FROM ABOVE	FROM FRONT	SIDES & REAR	VENT CONNECTOR
48W - 1250W (Water) 48S-1250S (15# Steam)	18"	48"	18"	18"
P9.5 - P250 (150# Steam) PW9.5-PW250 (Water)	48"	96"	36"	36"

2. For tube cleaning or replacement, leave an area in front of the boiler that is approximately the length of the boiler jacket and 24" or more at the rear. Codes typically require a minimum 18" clearance from the non-controls side of the boiler and 24" or more around the controls side. For tightly spaced boiler rooms, consult factory for exact minimum clearances.

3. Avoid blocking headplates with pipes or other obstructions. For boilers ordered with optional hinged headplates, leave room for the headplates to swing open. See headplate swing dimension "T" in boiler catalog.

Piping - Water Boilers

1. See recommended piping diagrams at the back of this manual, pages 41 to 44.

2. Always install the system pump so that the suction side is nearest the boiler hot water outlet. This lowers the risk of air entering the system and does not impose the system head on the boiler.

3. Rite Hot Water Boilers can be fired safely with the system pump off as long as there is water in the boiler and the low water cut-offs detect water. There is no required minimum or maximum flow rate through a Rite boiler and a flow switch is not a safety requirement.

4. **CAUTION** *Always use dielectric unions or dielectric flange kits when connecting copper pipe to the boiler to avoid galvanic electrolysis.*

5. Expansion tanks must be installed in all hot water heating systems. Tanks may be compression type or bladder/diaphragm. To properly size these tanks you must know: total system volume; supply & return water temperatures; static system pressure at the boiler; pressure reducing make-up valve setting and boiler relief valve setting. Avoid installing expansion tanks in a location prone to freezing. **CAUTION** Static system pressure at the boiler should be given to your Rite Representative before ordering a boiler and to help determine proper relief valve set pressure.

6. It is a good idea to install a relatively inexpensive water meter in the water make-up line. On closed loop heating systems it is the best way to detect system water loss early on before harmful amounts of entrained solids and oxygen are introduced into the boiler system via water make-up.

7. **CAUTION** Never let chilled water from a cooling system circulate through the boiler under any circumstances.

8. **CAUTION** Reheat systems must not allow the chilled water loop to inadvertently cool down the heating loop inside the air handler(s) to a temperature below 135˚F.

Piping - Steam Boilers

1. See recommended piping diagrams at the back of this manual, pages 45 to 49.

2. Do not reduce the steam boiler outlet nozzle size. Reducing the diameter of the pipe of the boiler's outlet nozzle to the steam main may raise steam exit velocities to the point at which water is "lifted" or carried over from the boiler into the main.

Piping - Steam Boilers *continued*

3. Use black pipe - never galvanized pipe - for steam mains and blowdown lines. Condensate return lines should be constructed of Schedule 80 pipe or Type K copper. If copper is used, be sure the fittings are silver soldered rather than soft soldered as condensate return temperatures are often at or near the soft solder melting point. Use dielectric unions or flange kits when connecting copper to steel.

4. It is a good idea to install a relatively inexpensive water meter on the make-up line to record the amount of make-up water you are using and help keep the water treatment program on track.

5. For Rite steam boilers (low and high pressure) the boiler feed pump should be sized to deliver the following GPM per boiler horsepower (BHP) at operating pressure as shown below:

   NOTE:
   - 1 BHP = 34,000 BTU output.
   - .069 x BHP = The actual GPM rate of evaporation.

Gas Piping

1. A drip leg is always recommended at or near the connection to the gas train. If an optional wye strainer is used it should have a 40 mesh screen.

Gas Piping *continued*

2. Be sure the gas supply pipe is large enough to deliver the required CFH at the inlet pressure required. If in doubt, refer to the Uniform Plumbing Code gas line sizing tables.

3. A vaporizer will be required on the pipe from the propane tank to the boiler if the pipe develops frost on the outside.

4. **CAUTION** When pressure testing a new gas line with air, be sure the boiler's main and pilot cocks are in the closed position and disconnect the union or flange connection between the main gas cock and the drip leg. This will prevent over-pressurization damage to the gas train's valves and controls.

5. Per current standards, the boiler's gas train may require that one or more separate vent lines be piped outdoors to a safe point of discharge. The main gas pressure regulator on the boiler must be vented individually unless it is factory supplied with a vent limiter installed in the vent port.

BOILER HORSEPOWER	INPUT MBH	STEAM LB/HR	RECOMMENDED GPM FEED RATE
9.5	398	328	1.5
10	419	345	1.5
12	502	414	1.5
15	628	518	1.5
20	838	690	2
30	1255	1035	3
40	1674	1380	4
50	2093	1725	5
60	2511	2070	6
70	2931	2415	7
80	3348	2760	8
100	4185	3450	10
125	5230	4313	13
150	6276	5175	15
200	8369	6900	20
225	9425	7762	23
250	10456	8625	26
275	11500	9487	28
300	12500	10350	31

Gas Piping *continued*

6. **DANGER** **DO NOT** pipe any vent lines into the combustion chamber or the stack.

7. **NOTICE** Always terminate vents away from air intakes or sources of ignition. Be sure that moisture and insects cannot enter the vent pipes. Always utilize a drip leg to keep moisture from traveling back down vent tubing and damaging the diaphragms. See **Figure 5** below:

8. **DANGER** Propane is heavier than air so it will pool on the ground and in low spots if it leaks. Propane has 2.5 times more BTU's by volume than natural gas so extreme caution must be taken that all components in the gas supply are leak free and in good working order.

Electrical

1. A 120/60/1 15 AMP circuit is required unless otherwise indicated on the boiler shop sheet.

2. When connecting power to the boiler make sure the polarity is correct and that there is less than .5 VAC between the neutral supply wire and the ground conductor.

3. **CAUTION** A good electrical ground to the boiler service connection is essential for two reasons: Poor grounding may cause the flame safeguard control to malfunction and stray voltages may cause electrolysis within the pressure vessel.

4. **CAUTION** **Electrolysis** due to poor electrical grounding and/or stray voltages passing through the boiler to ground has been known to cause severe pressure vessel damage. The problem usually goes unnoticed until a tube leak occurs and the cause turns out to be a small crater on the inside of the tube - often underneath a small and otherwise insignificant looking mud deposit. While this problem is relatively rare, it should be checked for by a skilled electrician **before** the boiler is put into service in the following manner: Using a digital multimeter with sharp probes, check for the presence of millivoltage (AC) between any bare metal spot on the pressure vessel and the building ground. A reading of 2 millivolts or less is good and no corrective action is required. If over 2 millivolts, either find the cause and correct it or install a separate ground rod dedicated to the boiler. Annual testing will show if the ground rod needs to be turned in order to break off deposits that can insulate and inhibit its grounding effectiveness.

Building Automation Systems (BAS)

1. **CAUTION** Rite Hot Water Boilers must not be operated with return water temperatures continually less than 135° F (see pages 42 - 44 for low temperature return systems). Outdoor reset controls must be carefully programmed not to reset boiler water temperatures below 135° F return.

2. **CAUTION** Care must be taken when integrating Building Automation Systems (BAS) and associated Energy Management Systems (EMS) with the boiler control circuit. BAS and EMS systems - while well intentioned - have been known to override boiler control systems and inadvertently create poor or unsafe operating conditions. EMS and BAS systems may receive information from the boiler control system but signals sent by the BAS or EMS to the boiler control system should be limited to establishing load demand and initiating start/stop sequence. *BAS and EMS systems must not be programmed to allow return water temperature to the boiler to operate below 135° F.*

3. **CAUTION** Do NOT use solid state Triac type relays to enable/disable boiler. Use only electro-mechanical or ice cube type relays. **The following operating recommendations for Rite Boilers should be part of any EMS Strategy:**

(PREFERRED)

3.1. Leave the boiler and primary loop pump on during the heating season while turning off all secondary loop pumps, air handlers, etc when heat is not required. Fuel consumption during "off hours" will be limited to boiler and primary loop piping radiant losses and these are generally small. A night temperature setback control may also be used to reduce system water temperature to 135 degrees F - the minimum recommended return water temperature. Installing an automatic stack damper can further reduce fuel consumption and protect the boiler from potentially freezing downdrafts through the stack.

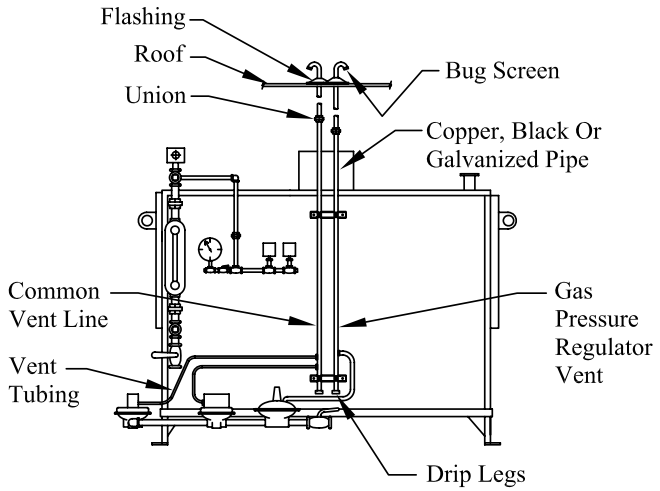


Figure 5

Building Automation Systems (BAS) *continued*

(ACCEPTABLE)

3.2 Leave the boiler on and turn the primary loop pump ***OFF***. Due to natural internal circulation, pumped water flow through a Rite Boiler is not required when firing. ***Important:*** When system heat is again required, the cool system water should be blended *slowly* back into the boiler so the boiler's water temperature doesn't fall below 135° F. This can be accomplished manually or with automatic controls.

4. While initial or infrequent cold start-ups are considered routine and will not harm the boiler - failure to follow the above strategies will cause repeated Thermal Stress Cycling. Although Rite Boilers are designed with floating heads to minimize the stresses of tube expansion and contraction, tube loosening (the "slippage" of the rolled portion of the tube in the tube sheet) **may** occur if the boiler is subjected to repeated cold start-ups or excessive on - off cycling.

Boilers owners and specifications engineers should take the following quote from the ABMA's "*Guideline for the Integration of Boilers and Automated Control Systems in Heating Applications*" into account:
"Automatic programmed de-energizing of boilers should be very closely examined. It is (also) questionable as to the real energy savings to be realized in cooling a boiler or a system on a regular basis only to reheat it in a short time later". This publication may be purchased from the American Boiler Manufacturers Association:

8221 Old Courthouse Road, Suite 207
Vienna, VA 22182
Phone: (703) 356-7172
Fax: (703) 356-4543
Web site: www.abma.com

WATER TREATMENT

1. **INITIAL CLEANING/BOILING OUT:** Every new installation will have a certain amount of cutting oil, grease, weld slag, pipe dope and other contaminants inside the system piping. Your particular job may call out a specific cleaning procedure before the boiler is put into operation. If not, and you wish to clean the system, ask your water treatment company for recommendations or use the following procedure provided you check first with local agencies regarding disposal restrictions into the sewer line.

CAUTION Remove the boiler relief valve(s) and plug or cap openings during boilout to prevent solution or contaminants from coming in contact with relief valve seats: **DANGER** Maintain strict supervision throughout boiler procedure and do not allow the boiler pressure to exceed the relief valve set pressure at any time.

1.1 Choose one of the following three chemicals at the proportions given. Preference is in the order shown: Trisodium phosphate: 1 lb. for every 50 gallons in the system. Sodium carbonate: 1 lb. for every 30 gallons in the system. Sodium hydroxide: 1 lb. for every 50 gallons in the system.

1.2 Add the chemical to the system through a bypass pot feeder for hot water systems or into the condensate return tank for steam systems making sure it is well mixed.

1.3 For hot water systems, after initial start up and refractory curing procedure has been completed, turn the pump and boiler on and run at normal operating temperatures for 3 - 4 hours. Drain the system completely and then refill with fresh water. Enough chemical should remain in the boiler and piping to make the water in the system alkaline with a pH reading between 8 and 9. ***Reinstall the relief valve(s).***

1.4 For steam systems, after initial start-up and refractory curing has been completed, operate the boiler for 3 - 4 hours at normal operating pressures after making sure the feed pump has fed the chemically treated water from the return tank into the boiler. With the boiler under low pressure, turn the boiler and feed pump off and completely blowdown the boiler and drain the return tank. Refill the return tank from the soft water supply, turn the feed pump back on and ***reinstall relief valve(s).***

2. **WATER TREATMENT FOR CLOSED HOT WATER SYSTEMS:** Your particular job may call out for chemical treatment of the heating system. Generally these chemical blends consist of corrosion inhibitors, scale and pH control. **CAUTION** Excessive concentrations of corrosion inhibitor may alter the boiler water viscosity and cause weeps or leaks where the tubes are rolled into the tubesheets. Most hot water boilers operating in a closed loop system require little or no water treatment. Keeping the system tight by introducing as little make-up water as possible is the best water treatment. Soft water make-up is not generally required. A pH level of 8.5 should be maintained. A pH level below 7 will cause an acidic attack of the boiler's pressure vessel.

3. **GLYCOL** (inhibited ethylene and propylene) reduce the film coefficient of pure water which lowers heat transfer efficiency. They should only be used when freeze protection to absolutely necessary as the following derations illustrate. For a Rite boiler operating at a typical 20˚ #T flow rate with a 10% glycol concentration by volume, derate boiler output by 5%; at 30% derate by 17% and at 50% derate by 25%. The best way to mitigate the effects of glycol on heat transfer is to significantly increase the water flow (turbulence) through the boiler (tubes). When flow rates approach 1 foot per second through the tubes, even a 50% concentration of propylene glycol should result in only a 4% loss in efficiency - but bear in mind that this will also lower the boiler #T to 2 - 4˚F. Raising the boiler operating temperature will also improve the heat transfer efficiency of glycols although to a much lesser extent than increasing water flow.

Glycol Derations:

■ Ethylene DOW SR-1™
● Propylene DOW "DowFrost"™

% BY VOLUME	Freeze Protection ˚F to: ■	●	At 20˚ #T through the boiler derate output by: ■	●	At 1 feet per second flow through the tubes - derate output by: ■	●
10%	+25	+26	5%		n/a	n/a
20%	+16	+19	11%		n/a	n/a
30%	+3	+9	17%		1.2%	1.4%
40%	-12.5	-4	21%		1.8%	2.2%
50%	-36	-23	25%		2.6%	3.6%

- Ethylene glycol is better at transferring heat than propylene glycol.
- Ethylene glycol is highly toxic if ingested. Propylene glycol is generally accepted as safer but still not intended for human consumption.
- Select a temperature rating at least 5˚F lower than expected lowest ambient temperature.
- Do not use with open-to-atmosphere type expansion tanks.
- Do not use with galvanized pipe.

Altitude Derations:

ATMOSPHERIC BOILERS: Up to 2000' above sea level, no output deration. Starting at 2500' derate 10%, @ 3000' derate 12%, @ 4000' derate 16%, and so on. Note: Glycol derations and elevation derations are not cumulative. Use only the larger of the two figures when calculating deration.

4. **WATER TREATMENT FOR STEAM BOILERS** is far more complex in that water make-up is expected because steam systems lose water. **CAUTION** ***Failure to maintain an effective water treatment program as outlined below will void warranties and lead to premature pressure vessel failure.*** There are three basic components to effective scale and corrosion prevention as follows:

4.1 **SOFT WATER MAKE-UP:** All fresh water make-up must come through a softener 100% of the time.

4.2 **BLOWDOWN:** Bottom blowdowns are required to maintain TDS (Total Dissolved Solids) levels below 2500 PPM. Always turn boiler feed pump back on immediately after a blowdown to prevent leftover solids from drying and hardening inside the boiler.

WATER TREATMENT *continued*

4.3 **CHEMICAL TREATMENT:** Use an automatic chemical metering pump to inject boiler chemicals into the boiler feed line. The metering pump should be wired in series with the boiler feed pump and the injection port (stainless steel) should be after the check valves and just before the shutoff valve installed near the boiler's feedwater inlet connection. Feeding chemicals directly into the feedwater tank is not recommended for two reasons: The chemicals can be highly corrosive to the tank's steel at the point of entry and their dispersal in the tank dilutes their effectiveness inside the boiler where they are intended.

4.4 **CAUTION** Blowdown frequency and boiler chemical blends should be recommended by a local experienced water treatment specialist. Annual or more frequent waterside inspections will confirm the effectiveness of your water treatment program. A successful program is one that keeps both scale and corrosion from occurring.

5. Some low pressure steam boilers are installed in gravity return heating systems that do not have a return tank or feed pump (see pages 48 & 49). In most of these cases there is no water treatment taking place. For these installations, use soft water make-up and install a water meter in the make-up line. Check the low water cut-offs once a month but otherwise *do not blowdown a gravity return steam heating boiler on a regular basis unless advised to do so by your water treatment specialist.*

START - UP

1. Verify that all installation permits have been signed off by inspectors prior to start-up.

2. Verify that all Installation Instructions have been followed.

3. **DANGER** Boiler start-up should be performed by a qualified boiler technician and witnessed by the operator.

4. **CAUTION** Make sure air has been bled from the natural gas supply line and that the supply pressure is within the range shown on the boiler shop sheet. A pipe tee with plug has been provided in the boiler's pilot gas line near the main gas cock for this purpose. If the supply gas pressure is over 14" w.c., make sure the boiler has been supplied with suitable high pressure regulators (main and pilot). If in doubt, consult factory ***before*** turning on the gas to the boiler.

5. **CAUTION** Make sure there is water in the boiler. For hot water boilers, make sure the system has been filled and air has been bled from all manual bleed valves.

6. For hot water boilers, verify that an expansion tank has been installed and that if a valve is installed between the tank and system *it must be open*. An elevated, compression type tank should have water in the lower third of the gauge glass when filled and vented. The air pressure in bladder/diaphragm tanks should be slightly higher than the regulated make-up water pressure and the tank should be pressurized before the boiler and system is filled with water. If the expansion tank is sized and operating properly, the boiler's pressure gauge should show a negligible increase in pressure while going from a cold start-up to operating temperature.

7. **For hot water boilers, set aquastats as labeled in the following manner:**

   OPERATOR or LOW FIRE:
   Between 155˚ F. and 230˚ F.

   MEDIUM FIRE (if used):
   5 to 10 degrees less than low fire.

   HIGH FIRE (if used):
   5 to 10 degrees less than medium or low fire.

   MODULATION (if used):
   Set so that the gas valve begins at or near low fire position every time the boiler refires on a call for heat.

   HIGH LIMIT:
   20 degrees above operator or low fire control.

8. **For low pressure steam boilers (15 PSI) set pressure controls as follows:**

   OPERATOR or LOW FIRE:
   Between 3 and 12 PSI.

   MEDIUM FIRE (if used):
   1 - 3 PSI less than low fire.

   HIGH FIRE (if used):
   1 - 3 PSI less than medium or low fire .

   MODULATION (if used):
   Set so that the gas valve begins at or near low fire position when the boiler refires on a call for steam.

   NIGHT SETBACK (if used):
   Usually 1 -2 PSI.

   HIGH LIMIT:
   13 - 14 PSI.

9. **For High Pressure Steam Boilers (M.A.W.P. 100-150 PSI) set pressure controls** using similar ratios to low pressure steam boilers. The high limit pressure control should be set at least 10 PSI less than the boiler's relief valve setting.

START - UP *continued*

10. Open boiler's main manual shutoff valve but leave the pilot cock off.

11. Open boiler's electrical panel cover (if supplied). **DANGER** Hazard of electrical shock. Avoid touching live terminals. Reset all switches marked "reset" in the panel.

12. Reset high and low gas pressure switches (if supplied) on the gas train. Reset low water cut-off control.

13. Turn the boiler's power switch on. With the pilot cock off and after a pilot trial for ignition (PTFI), the flame safeguard control should lock out on flame failure.

14. Wait 5 minutes as per the lighting and relighting instruction tag located next to the boiler's nameplate. Reset the flame safeguard control, open the pilot cock and turn the power switch back on. Once the pilot is proved, the main burners should ignite.

15. **CAUTION** Because refractory can absorb moisture even after it has cured, do not fire the boiler over 5 minutes initially. Wait 5 minutes and then increase firing time by five minutes each successive cycle for 2 hours. After that, the boiler may run continuously.

16. The cast iron burners are of a drilled, raised port, upshot design. The orifices were drilled at the factory to give the proper firing rate at your elevation. There are no air adjustments to make. Install one or more manometers or gas pressure gauges with a 0 - 15" w.c. range in the 1/4" plugged tappings located on the manifold pipes below the firebox door.

    CAUTION *Be sure the gas manifold pressure is between 10 and 11" w.c. when the boiler is firing.* If not, back off on the main gas pressure regulator until you attain the best looking flame within this range.

17. Visually check the main and pilot burner flames through the firebox door viewport. The flames should start out with bluish cones near the burner ports. The major portion of the flame should be a luminous orange-yellow with only minimal yellow tips reaching the tubes. The pilot flame should be strong and stable.

18. Use a multimeter with DCV range to check both the pilot flame signal strength and the main flame signal strength and record on start-up sheet. Fireye Micro M flame signal range is 4-10 VDC; Honeywell's RM7800 is 1.25 - 5 VDC. **CAUTION** Do not attempt to bend the flame rod into the more "visible" part of the pilot flame or you will crack the ceramic insulator. The pilot burner's visible flame represents only 10% of the total flame current being generated.

19. If the burner is other than single stage fire (on-off), be sure all the stages properly ignite or modulate. Be sure all aquastats or pressure controls respond correctly as the system heats up.

20. Check the low water cut-off(s) to verify that they will shut the burner down in the event of low water.

21. As the boiler heats up, re-tighten the headplate bolts uniformly. See page 33 for headplate bolt torque recommendations. Tighten from the centers toward the corners making sure all the bolts are moderately tight when finished. If handholes are supplied make sure the crab nut is snug as well. **CAUTION** Tightening the bolts beyond what is required to seal the headplates may reduce gasket service life.

22. Considerable condensation can occur in a cold firebox and may be observed for several minutes after start-up. Also, some sweating from the refractory may be noted. This is normal and will stop after the refractory curing process is complete (see #15 on this page) and the return water temperature climbs above 135° F.

23. For hot water boilers, check the boiler's pressure gauge with the system pump running after it has reached operating temperature. If the expansion tank was correctly sized and is working properly, the pressure should only have risen slightly from when the boiler was cold.

24. Secure the boilers electrical panel cover (if supplied) and make sure all other cover plates, enclosures and guards are place.

25. Be sure the owner receives a copy of this O & M manual along with the detailed cut sheets of all safety and operating devices furnished with this boiler as well as a copy of your start-up report (see next page for suggested start-up form).

START UP REPORT
Atmospheric Boiler

Job Site: _____ Date: _____ FSG Make & Model#: _____

Boiler Mfg.: RITE ENGINEERING & MFG. CORP. Model: _____ Water Boiler: _____

Serial #: _____ Nat. Board #: _____ Steam Boiler: _____

Combustion Analyzer Tex # _____ Year of Mfg.: _____ Ambient Temperature in Boiler Room _____ ˚F

FIRING RATE AFTER INTERMITTENT 2 HOUR OPERATION	TIME ON (minutes)	WATER TEMP. OR STEAM PSIG	GROSS STACK TEMP. ˚F	CO ppm	O2 %	CO2 %	BOILER DRAFT (inches w.c)	GAS PRESS. @ MANIFOLD (inches w.c.)	MAIN FLAME SIGNAL VDC
LOW FIRE									
MEDIUM FIRE									
HIGH FIRE									

EXPECTED FLUE GAS READINGS (TAKEN IN BOILER STACK BELOW DRAFT CONTROL):

- Gross Stack Temperature: 300˚ to 450˚F @ all firing rates.
- Draft: –.02”w.c. to –.07”w.c. @ all firing rates.
- Carbon Monoxide (CO): O to 10 ppm @ all firing rates.
- Oxygen (O_2): 6 - 8% @ high fire.
- Carbon Dioxide (CO_2): 7 - 8% @ high fire.
- Oxides of Nitrogen (NO_x): 180 ppm @ high fire.

- Size of FREE combustion air and ventilation openings into boiler room: _____
- Boiler room atmospheric pressure: _____
- Stack height and diameter: _____
- Supply voltage, polarity and ground conductor check: _____
- Electrolysis millivolt test (see page 7): _____
- Supply gas pressure to boiler: Static: _____ at Low Fire: _____ at High Fire: _____
- Pilot flame signal: _____ VDC
- Sequence of operation check (see pages 13 to 15): _____
- “Low Fire Proven” Switch short cycle test (if applicable; see page 16, #5): _____
- “Medium Fire Proven” Switch short cycle test (if applicable; see page 16, #5): _____
- Limit and Safety interlocks check: _____
- Operator control check: _____
- Pump start or feed water control check (steam boilers): _____
- Combustion air damper interlock switch check (if supplied): _____
- Induced draft fan rotation check (if supplied): _____
- Induced draft fan proving switch check (if supplied): _____
- Automatic stack damper interlock switch check (if supplied): _____
- Boiler relief valve setting: _____
- Headplate gasket leak check: _____
- The number of washer weights installed on Barometric Damper (if supplied): _____
- BAS,EMS or DDC systems integration check: _____

Owner/Contractor
Acknowledgement of Boiler Start-Up and Status

Company: _____ **Name** _____

Receipt of start up report: yes no **Receipt of Mfg O & M Manual: yes no** **Boiler secured: yes no**

Signature _____ **Date** _____

Start-Up Company _____ **Start-Up Technician’s Name** _____

Signature _____ **Date** _____

SEQUENCE OF OPERATION:

1. A "call for heat" will occur only after the following:
   (a) The boiler's power switch is "on".
   (b) The limit circuit - high limit, low water cut-off(s), high and low gas pressure switches (if used), gas valve proof of closure (if used) etc. are "made" (switch closed).
   (c) The water flow switch is made (if used).
   (d) The remote enable/disable relay is "enabled" (if used).

2. In certain installations where induced draft fans, combustion air fans, combustion air dampers or door interlocks are used, a pilot trial for ignition (PTFI) will not proceed until proving switches for these devices are "made".

3. During a PTFI, both the pilot valve and ignition transformer are energized simultaneously to produce a pilot flame. For boilers up to 2500 MBH input, the spark ignition will terminate within ten seconds but the pilot valve will remain energized (open) during the main burner-on cycle (interrupted ignition, intermittent pilot). For boilers over 2500 MBH input, both the spark and the pilot valve will be de-energized after a ten second PTFI (interrupted ignition, interrupted pilot) proving that the main flame is on.

4. A flame signal of adequate strength must be sensed during a PTFI or the flame safeguard control (FSG) will "lock-out" - preventing the main burners from coming on and requiring a manual reset of the FSG before another PTFI can occur.

5. If the pilot flame signal is sensed to be strong enough to support safe light-off of the main burners, the main fuel valve output terminal of the FSG will be energized and the boiler will commence firing. **Main flame operation will vary, depending on the number of burner manifold pipes (1, 2, 3, 4, or 5) and the firing mode (on-off, low-high-low, low-medium-high, or modulation). See Below:**

6. **One and Two Row Manifolds / On-Off Firing:** Aquastats or pressuretrolls will be labeled "high limit" and "operator". All burners should light off immediately. The main burners will shut-off when the operator set-point is reached. The FSG will not begin another PTFI until the operator control's differential is reached.

7. **One and Two Row Manifolds / Low-High-Low Firing:** Aquastats or pressuretrolls will be labeled "high limit", "low fire" and "high fire". Proven low fire start is achieved by the operation of either a slow opening gas valve or a switch labeled "low fire proven" which must sense gas pressure in the low fire manifold before allowing the high fire manifold to come on. All burners should light off within 5-10 seconds. When the high fire control's set-point is reached first, the high fire gas valve (or high-low circuit of a motorized valve actuator) will be de-energized and the boiler will return to low-fire. On single row manifolds, this is achieved by a drop in manifold gas pressure. On two row manifolds, it can be achieved the same way (using a high-low motorized valve) or by de-energizing the high fire valve (which will shut-off gas to the left hand manifold). If the boiler's temperature (or pressure) drops during low fire, high fire will re-establish itself when the high fire control's differential is reached. If the boiler's temperature (or pressure) rises during low fire, the main burners will shut-off when the low fire control's set-point is reached and the FSG will not begin another PTFI until the low fire control calls for heat again.

8. **One and Two Row Manifolds / Modulation Firing:** Aquastats or pressuretrolls will be labeled "high limit", "operator" and "modulation". All burners should light off immediately and as the modulating gas valve actuates to full open position, the firing rate will increase proportionally. As the boiler's temperature (or pressure) increases and approaches the modulation control's setpoint, the modulating gas valve will start stroking down from full open toward low fire position. The gas manifold pressure and flame height will decrease accordingly. When the boiler's temperature (or pressure) reaches the modulation control's setpoint, the modulating gas valve will be at low fire. ***Note that modulation valve actuators have a minimum/maximum low fire adjustment setting and in some cases the low fire position will need to be field adjusted for maximum low fire to insure safe lightoffs.*** The modulating gas valve will continue to proportion the amount of gas to the burners as the temperature (or pressure) in the boiler increases or decreases accordingly. If the boiler's temperature (or pressure) continues to rise after the modulating gas valve has dropped to its low fire position, the operator control's set point will ultimately be reached and the main burners will shut-off. The FSG will not begin another PTFI until the operator control's differential is reached and the modulating gas valve should reopen at its low fire position.

9. **3-Row Manifold / Low-High-Low Firing:** Aquastats or pressuretrolls will be labeled "high limit", "low fire", and "high limit". Proven low fire start is achieved by a gas manifold pressure sensing switch labeled "low fire proven". The center row of burners should light off immediately. When the low fire proven switch senses gas pressure in the low fire manifold, the switch will "make" (close) allowing the high fire gas valve to open. Within 5 to 10 seconds of the initial low fire start, all the burners should be on. When the high fire control's setpoint is reached first, the high fire valve will close and only the center row of burners will be on

(low fire). If the boiler's temperature (or pressure) drops, the high fire gas valve will open again after the high fire control's differential is reached. If the boiler's temperature (or pressure) continues to rise when the boiler is on low fire, the center row of burners will shut-off when the low fire control's setpoint is reached. The FSG will not begin another PTFI until the low fire control's differential is reached.

10. **3-Row Manifold / Low-Medium-High Fire:**
Aquastats or pressuretrolls will be labeled "high limit", "low fire", "medium fire", and "high fire". Proven low fire start is achieved by a gas manifold pressure sensing switch labeled "low fire proven". The center row of burners should light off immediately. When the low fire proven switch senses gas pressure in the low fire manifold, the switch will "make" (close), allowing the medium fire gas valve to open. This will ignite the right hand row of burners and in doing so "make" (close) the gas pressure manifold proving switch labeled "medium fire proven". The high fire gas valve will now open, igniting the left hand row of burners. All the burners are now on and the boiler is at high fire. When the high fire control's setpoint is reached first, the high fire gas valve will close, leaving the center and right hand burner manifolds on. If the temperature (or pressure) in the boiler continues to rise and the medium fire control's setpoint is reached, the medium fire gas valve will close and only the center row will remain on. Should the temperature (or pressure) in the boiler begin to fall, the medium and high fire controls will open the medium and high fire gas valves in sequence after the differential of these controls have been reached. Should the temperature (or pressure) of the boiler continue to rise after the boiler has dropped down to low fire and the low fire control's setpoint is reached, the low fire valve will close and all the burners will be off. The FSG will not begin another PTFI until the low fire control's differential is reached.

11. **3-Row Manifold / Modulation Firing:**
Aquastats or pressuretrolls will be labeled "high limit", "operator", and "modulation". Proven low fire start is achieved by a switch labeled "low fire proven" which must sense pressure in the center row manifold before allowing the gas valve that controls fuel to the two outside rows to open. All three manifolds should be firing within 5-10 seconds of the initial low fire start. As the temperature (or pressure) in the boiler rises and starts to approach the modulation control's setpoint, the modulating gas valve will start stroking down from full open toward low fire position. This will decrease the gas manifold pressure and flame height for all three rows accordingly. When the boiler's temperature (or pressure) reaches the modulation control's setpoint, the modulating gas valve will be at low fire. ***Note that modulation valve actuators have a minimum/maximum low fire adjustment setting and in some cases the low fire position will need to be field adjusted for maximum low fire in order to insure safe re-lights for boilers up to 2500 MBH input and to prevent boilers over 2500 MBH from locking out on main flame failure.*** The modulating gas valve will continue to proportion the amount of gas to all the burners as the temperature (or pressure) in the boiler increases or decreases accordingly. If the boiler's temperature (or pressure) continues to rise after the modulating gas valve has dropped to its low fire position, the operator control's setpoint will ultimately be reached and all the burners will shut-off. The FSG will not begin another PTFI until the operator control's differential is reached and the modulating gas valve should re-open at its low fire position.

12. **4-Row Manifold / Low-High-Low Firing:**
Aquastats or pressuretrolls will be labeled "high limit", "low fire", and "high fire". Proven low fire start is achieved by a gas manifold pressure sensing switch labeled "low fire proven". The two insides row of burners should light off immediately. When the low fire proven switch senses gas pressure in the low fire manifolds, the switch will "make" (close), allowing the high fire gas valve to open. Within 5 to 10 seconds of the initial low fire start, all of the burners should be on. When the high fire control's setpoint is reached first, the high fire gas valve will close, dropping the boiler back to low fire. If the boiler's temperature (or pressure) drops, the high fire gas valve will open again after the high fire control's differential is reached. If the boiler's temperature (or pressure) continues to rise when the boiler is on low fire, the two center rows of burners will shutoff when the low fire control's setpoint is reached. The FSG will not begin another PTFI until the low fire control's differential is reached.

13. **4-Row Manifold / Modulation Firing:**
Aquastats or pressuretrolls will be labeled "high limit", "operator", and "modulation". Proven low fire start is achieved by a switch labeled "low fire proven" which must sense pressure in the low fire manifolds before allowing the gas valve that controls fuel to the two outside rows to open. All four manifolds should be firing within 5-10 seconds of the initial low fire start. As the temperature (or pressure) in the boiler rises and starts to approach the modulation control's set point, the modulating gas valve will start stroking down from full open toward low fire position. This will decrease the manifold pressure and flame height for all four burner rows accordingly. When the boiler's temperature (or pressure) reaches the modulation control's setpoint, the modulating gas valve will be at low fire. ***Note that modulation valve actuators have a minimum low fire adjustment setting and in some cases the low fire position will need***

to be field adjusted for maximum low fire in order to insure safe re-lights for boilers up to 2500 MBH input and to prevent boilers over 2500 MBH input from locking out on main flame failure. The modulating gas valve will continue to proportion the amount of gas to all the burners as the temperature (or pressure) in the boiler increases or decreases accordingly. If the boiler's temperature (or pressure) continues to rise after the modulating gas valve has dropped to its low fire position, the operator control's setpoint will ultimately be reached and all the burners will shut-off. The FSG will not begin another PTFI until the operator control's differential is reached and the modulating gas valve should re-open at its low fire position.

14. **Five-Row Manifold / Low-Medium-High Firing:**
Aquastats or pressuretrolls will be labeled "high limit", "low fire", "medium fire", and "high fire". Proven low fire start is achieved by a gas manifold pressure sensing switch labeled "low fire proven". The center row of burners should light off immediately. When the low fire proven switch senses gas pressure in the low fire manifold, the switch will "make" (close), allowing the medium fire gas valve to open. This will ignite the gas manifolds to the immediate right and left of the center row and in doing so "make" (close) the gas pressure manifold proving switch labeled "medium fire proven". The high fire gas valve will now open , igniting the two outermost rows of burners. All the burners are now on and the boiler is at high fire. When the high fire control's setpoint is reached first, the the high fire gas valve will close, leaving the three middle rows on. If the temperature (or pressure) in the boiler continues to rise and the medium fire control's setpoint is reached the medium fire gas valve will close and only the center row of burners will remain on. Should the temperature (or pressure) in the boiler begin to fall, the medium and high fire controls will open the medium and high fire gas valves in sequence after the differential of these controls have been reached. Should the temperature (or pressure) in the boiler continue to rise after the boiler has dropped down to low fire and the low fire control's setpoint is reached, the low fire valve will close and all the burners will be off. The FSG will not begin another PTFI until the low fire control's differential is reached.

15. **Five Row Manifold / Modulation Firing:**
Aquastats of pressure controls will be labeled "high limit", "operator", and "modulation". Proven low fire start is achieved by a switch labeled "low fire proven" which must sense pressure in the low fire (center row) manifold before allowing the gas valve that controls fuel to the manifolds to the immediate right and left of the center row to open. When these medium fire manifolds are on, the gas pressure manifold proving switch labeled "medium fire proven" should "make" (close), allowing the high fire gas valve to open. All the burners are now on and the boiler is at high fire. As the pressure (or temperature) in the boiler rises and starts to approach the modulation control's setpoint, the modulating gas valve will start stroking down from full open toward low fire position. This will decrease the manifold pressure and flame height for all five burner rows accordingly. When the boiler's temperature (or pressure) reaches the modulation control's setpoint, the modulating gas valve will be at low fire. ***Note that modulation gas valve actuators have a minimum low fire adjustment setting and in some cases the low fire position will need to be field adjusted for maximum low fire in order to prevent FSG lockout on main flame failure due to low main flame signal strength.*** The modulating gas valve will continue to proportion the amount of gas to all the burners as the temperature (or pressure) in the boiler increases or decreases accordingly. If the boiler's temperature (or pressure) continues to rise after the modulating gas valve has dropped to its low fire position, the operator control's setpoint will ultimately be reached and all the burners will shut-off. The FSG will not begin another PTFI until the operator control's differential is reached and the modulating gas valve should re-open at its low fire position.

OPERATION, MAINTENANCE AND SERVICE

General

1. Maintaining a Boiler Log and following the recommendations in this section will help your boiler operate at peak efficiency and reduce service calls. It is impossible to cover all potential problems or questions when it comes to operation, maintenance and service. Detailed cut sheets of various components provided with your boiler O & M Manual should be referred to when necessary. Retubing and refractory replacement instructional videos are available from the factory or your representative, free of charge. Unless you are a skilled technician, we highly recommend you call one when you spot a problem rather than attempt to repair it yourself. ***Above all else, use common sense.***

2. The boiler's refractory and insulation should last many, many years provided the boiler has:
   a) *Operated with return water temperatures above 135ºF,*
   b) *not been overfired,*
   c) *operated with ample draft,*
   d) *Not subjected to negative room conditions.*
   You should not consider changing out refractory unless sections of the panels have fallen onto the burner bed or the boiler's outer jacket shows signs of heat discoloration.

3. The cast iron burners should require no maintenance for the life of the boiler. Once every few years the tops of the burners should be vacuumed clean of any incidental refractory particles and the burner ports checked for deterioration due to excess heat - the latter a sign of overfiring, negative room pressure or stack downdrafts that must be corrected. Look through the boiler's firebox door viewport when all the burners are on. Note the position of any burners that exhibit long, yellow lazy flames and then shut the boiler off. Remove only those burners and venturis and clean off the top of the brass orifices. A partially obstructed orifice will cause a lazy yellow flame.

4. Gas train components are maintenance-free controls that should last many years. Once a month you should check to see that when a call for heat has been satisfied the burners go off immediately. If your gas train was equipped with a normally open vent valve, check at least once a month that no gas is being discharged through it when the boiler is firing and that some gas is discharged only briefly when the main safety shutoff valves close.

5. **Low and medium fire short cycle test:** your boiler may be equipped with "low fire proven" or "medium fire proven" switches. They operate by sensing the gas pressure in a lower stage fire whereby the switch "makes" (closes) and allows the next stage fire to come on. A problem can occur if the switch is not set between 8 to 9" w.c. or if there is a pressure drop in the main gas supply line to the boiler. What will happen is that the high fire (or medium fire) gas valve will rapidly "click" on and off, because the opening of the valve is causing a momentary pressure drop that the switch is reacting to. After the switch "breaks" (opens), the valve closes which causes the gas pressure to rise and the switch to "make" again. To remedy this, verify how low the pressure drops that the switch is sensing with a manometer and then in order of preference: (1) lower the switch's adjustable setpoint to below this pressure (2) install a slow bleed orifice on the short-cycling valve to make it open more slowly or (3) increase the boiler's main gas pressure regulator outlet pressure until the switch holds, *but do not raise manifold pressures above 11" w.c.*. If the problem persists, contact the factory.

6. Most boiler shutdowns can be traced by referring to the boiler's wiring diagram. If your boiler is equipped with a Rite Lite Panel, it has the following lights to help you: Power On, Limits Proven, Call for Heat, Main Fuel, Flame Failure and Low Water. If your boiler is equipped with a Custom Control Panel, it may pinpoint the safety control that is off. If your boiler does not have indicating lights, remove the cover from each limit beginning with the first limit shown after the power switch per the diagram and check with a voltmeter until you find the one that is locked out (open). After correcting the problem, manually reset the switch or control. **DANGER** Electrical work should be carried out by qualified electricians only.

7. If your boiler is off due to flame failure it will be indicated on the Rite Lite Panel, the Custom Control Panel or a small LED light on the front of the flame safeguard control. Flame failure lockouts can be difficult to solve if they happen sporadically. See pages 22 - 27 for flame failure causes and remedies.

8. If you notice flue gas temperatures going up over time, it is usually an indication that the tubes need cleaning. It is neither difficult nor expensive to waterside clean a Rite Boiler and doesn't require chemicals. You will need a couple of headplate gaskets and one or two heavy duty tube brushes which can be purchased from your Rite Representative. You will need to remove the front and rear headplates, or simply swing them open if they are hinged from the factory to attain complete waterside access. Most boilers can be cleaned and put back into operation in half a day. **See steps 1-4 on the next page.**

9. The following efficiency loss due to scale in tubes applies to <u>all</u> boilers:

SCALE THICKNESS (IN INCHES)	EFFICIENCY LOSS
1/64"	4%
1/32"	8%
1/16"	12%
1/8"	18%
3/16"	27%

It pays to have a clean boiler. It pays to have a boiler that's easily cleaned!

Waterside Tube Cleaning Procedure For Rite Boilers

STEP 1

Remove (or swing open if hinged) both headplates. Install temporary splash/mud shields as shown.

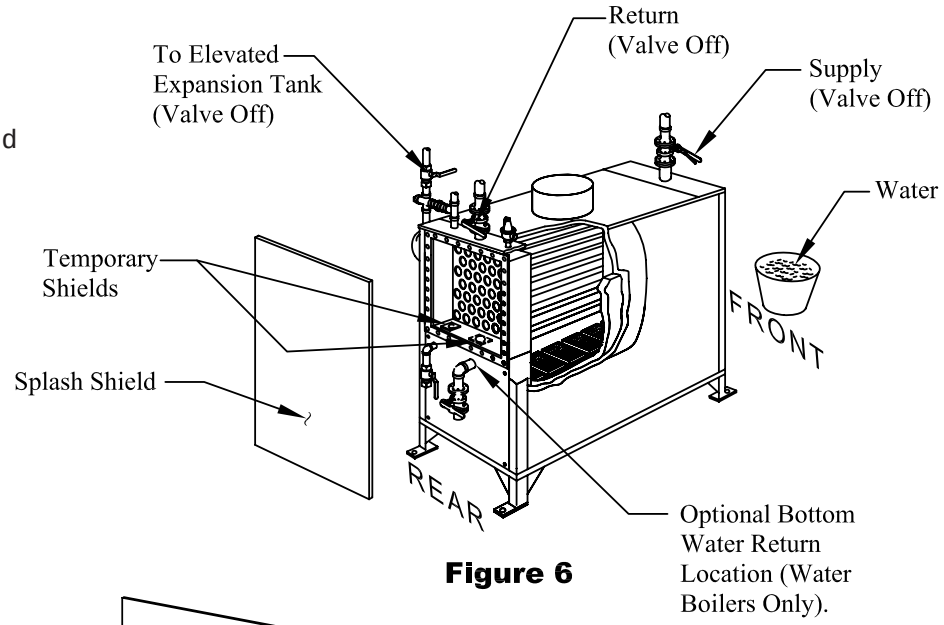


Figure 6

STEP 2

Use a standard hose with a gun type nozzle that will deliver a sharp stream of water. Begin by rinsing out the top row of tubes.

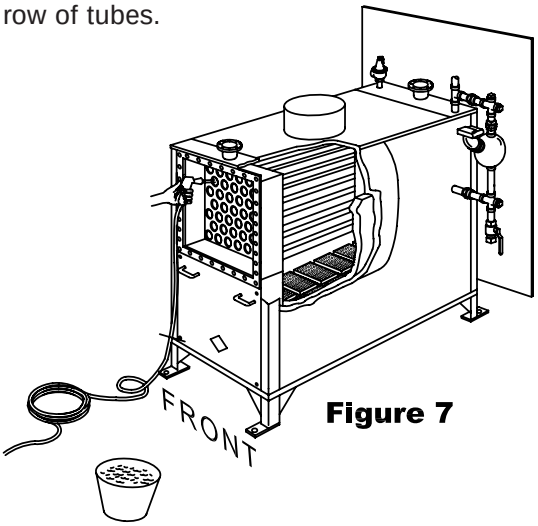


Figure 7

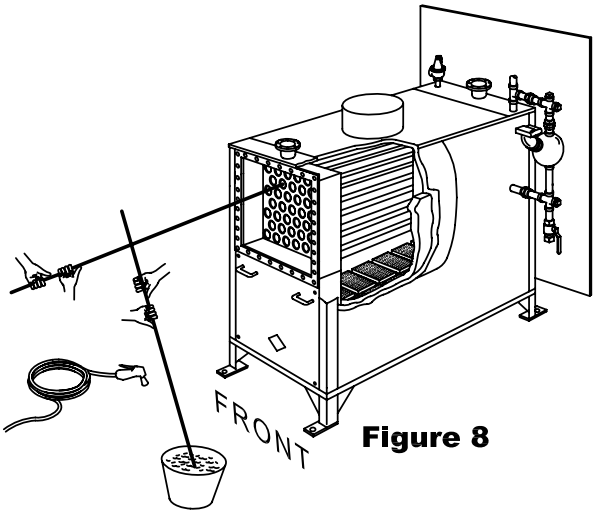


Figure 8

STEP 3

Brush out the top row of tubes, making two full passes per tube. Because mud or scale will load up the brush, dip the brush into a bucket of water after each pass. Tube brush has 1/4” female pipe thread connection. Mount onto a 1/4” pipe or 1/2” pipe using a bell reducer and 1/4” NPT nipple. The pipe handle should be approximately as long as the boiler. Where space between the boiler and an obstruction does not permit the use of a single length of pipe, use shorter threaded and coupled lengths that you can join and take apart.

STEP 4

Thoroughly rinse the top row of tubes out after brushing. Repeat this process one row at a time, top to bottom, until all tubes are clean.

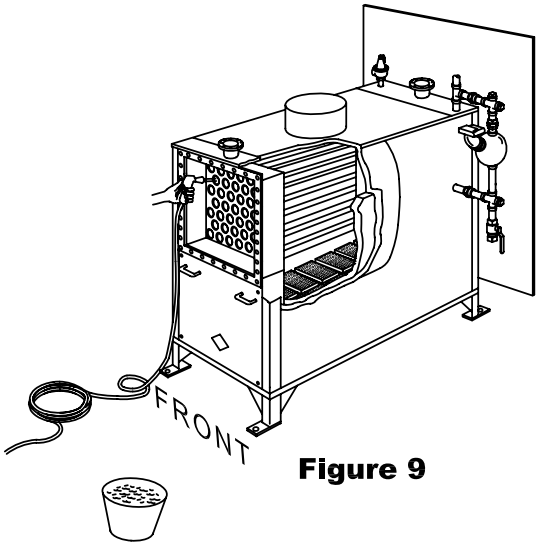
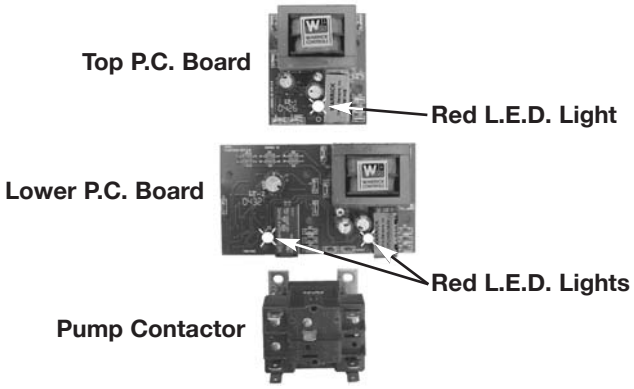


Figure 9

10. **CAUTION** **On process steam boilers it is vital to check the feedwater and low water cut off devices once a month by performing a slow steam evaporation test:** With the boiler under a light steam load and the water level between the top and middle probes on the steam column, shut off the electrical disconnect(s) to the boiler feed pump(s). Open the electrical panel marked "Boiler Feed Pump Controls and Low Water Cut-Offs" and look for a red L.E.D. light (illuminated) on the top P.C. Board and two red L.E.D. lights (right hand illuminated, left hand not illuminated) on the lower P.C. Board.



10.1 The following should happen as the water slowly drops in the gauge glass: Approximately 5 seconds after the water drops below the level of the middle probe, the left hand light on the lower P.C. Board should illuminate and the bottom relay (labeled "pump contactor") should pull in. To verify, momentarily restore pump disconnect to the "on" position and make sure the pump starts, then turn the pump disconnect off again.

10.2 When the water drops to a level approximately 1" to 1 1/2" above the bottom of the gauge glass, the top P.C. board's light should go out. This indicates the primary low water cut-off (probe is located in pipe cross on top of the header drum) senses a low water condition. This should cause the main burners to shut off. ***Temporarily jumper the automatic low water cut-off switch to bring the boiler back on.***

10.3 The water level should continue to drop slowly After the water level reaches the bottom of the glass and falls below the bottom probe on the steam column, the lower P.C. Board's right hand light should go out and the burners should shut off. Note that there are time delays of a few seconds built into both P.C. Boards so the switching action occurs shortly after the water crosses a probe in either direction. **CAUTION** ***Do not allow the boiler to keep firing if the water has disappeared from the gauge glass for longer that 15 seconds. Turn the power switch off.***

10.4 If everything works correctly as described, above, remove the temporary jumper to the automatic low water cut off and turn boiler feed pump disconnect(s) back on. When the water level rises above the bottom probe on the steam column, reset the low water cut-off push button switch. The middle P.C. Board's right hand light should come on. As the water level approaches the middle probe on the steam column, the top P.C. Board's light should come on. At this point both low water cut-offs have "remade" and the boiler should attempt a PTFI and light-off with the feed pump continuing to run. When the water level reaches the top probe, the middle P.C. Board's left hand light and the feed pump should both turn off. This completes the test.

10.5 Failure of any of the relays or controls to operate as described above requires immediate attention: Turn burner switch off and let boiler pressure drop to zero. **DANGER** Only when you are certain there is no pressure in the boiler, remove the three column probes (and the vertical probe in the front header drum by removing the entire probe housing from the pipe cross ***if*** the test proved it defective). Clean probes thoroughly using a shop cloth, wire brush or wire wheel. If there is a build-up of scale or mud on the probes, contact your water treatment company to review the water treatment program. The solution may be as simple as blowing down the steam column down more often. For process steam boilers, blowdown the column once every eight hours. For low pressure steam heating boilers, blowdown the column once a day (See page 10 for exception). Reinstall probes and corresponding "top", "middle" and "bottom" probe wires labeled accordingly. Check and repair all wiring to the P.C. Boards for loose connections, shorts or other defects. Repeat the test. If problems persist, contact the factory.

Single Channel Design(Newest design)		
Fault Code(Blinks)	Fault mode	Possible Remedies
0	NO_FAIL	
1	NOISY_SWITCH_DETECTED	For Manual Reset or Test Mode Option only. Check for faulty/intermittent switch, intermittent wiring
2	MANUAL_MODE_WRONG_RESET_STATE_ON_POWER_UP	Check for faulty or unconnected Manual Reset Switch or open circuit wiring of this switch circuit.
3	AUTO_MODE_WRONG_RESET_STATE_ON_POWER_UP	Ensure Reset 1 and Reset 2 (Reset) Terminals are unconnected.
4	STUCK_RESET_SW_INPUT_WITH_TEST_MODE_DISABLED	Check for faulty or unconnected Reset Switch or open-circuit/intermitten wiring of this switch circuit.
5	RESET_INPUT_STUCK	Check for faulty or unconnected Reset Switch or open-circuit/intermitten wiring of this switch circuit.
6	INVALID_BOARD_TYPE	Not serviceable - contact Gems factory for assistance.
7	INVALID_S26_MODE_CONFIG	Not serviceable - contact Gems factory for assistance.
8	Unused in single channel design	Not serviceable - contact Gems factory for assistance.
9	ILLEGAL_POWER_UP	Not serviceable - contact Gems factory for assistance.
10	TRIANGLE_AMPLITUDE	Not serviceable - contact Gems factory for assistance.
11	TRIANGLE_ZERO_CROSSING	Not serviceable - contact Gems factory for assistance.
12	REFERENCE_VOLTAGE_LIMITS	Not serviceable - contact Gems factory for assistance.
13	CAPTURE_EDGES_OUT_OF_RANGE	Not serviceable - contact Gems factory for assistance.
14	Unused in single channel design	Not serviceable - contact Gems factory for assistance.
15	Unused in single channel design	Not serviceable - contact Gems factory for assistance.
16	Unused in single channel design	Not serviceable - contact Gems factory for assistance.
17	Unused in single channel design	Not serviceable - contact Gems factory for assistance.
18	Unused in single channel design	Not serviceable - contact Gems factory for assistance.
19	OUT_OF_RANGE_5_VOLT	Not serviceable - contact Gems factory for assistance.
20	Unused in single channel design	Not serviceable - contact Gems factory for assistance.
21	LLCO_PROBE_BELOW_LOW_LIMIT_FAIL	Not serviceable - contact Gems factory for assistance.
22	HIGH_PROBE_BELOW_LOW_LIMIT_FAIL	Not serviceable - contact Gems factory for assistance.
23	LOW_PROBE_BELOW_LOW_LIMIT_FAIL	Not serviceable - contact Gems factory for assistance.
24	Unused in single channel design	Not serviceable - contact Gems factory for assistance.
25	Unused in single channel design	Not serviceable - contact Gems factory for assistance.
26	HP_ZERO_CROSSING	Possible excessive system noise. Ensure system wiring effecting conrol does not have noisy wire runs in wiring bundle. Contact Gems factory for assistance.
27	LP_ZERO_CROSSING	Possible excessive system noise. Ensure system wiring effecting conrol does not have noisy wire runs in wiring bundle. Contact Gems factory for assistance.
28	LLCO_ZERO_CROSSING	Possible excessive system noise. Ensure system wiring effecting conrol does not have noisy wire runs in wiring bundle. Contact Gems factory for assistance.
29	WRONG_FIRMWARE_VERSION_DETECTED	Not serviceable - contact Gems factory for assistance.
30	EEPROM_CRC_ERROR	Not serviceable - contact Gems factory for assistance.
31	RAM_EEPROM_VERIFY_ERROR	Not serviceable - contact Gems factory for assistance.
32		
33	INTERNAL_WDT_FAILURE	Not serviceable - contact Gems factory for assistance.
34	DIO_TEST_FAILURE	Not serviceable - contact Gems factory for assistance.
35	POST_RAM_TEST_FAILURE	Not serviceable - contact Gems factory for assistance.
36	PROGRAM_COUNTER_TEST_FAILURE	Not serviceable - contact Gems factory for assistance.
37	PERIODIC_RAM_TEST_FAILURE	Not serviceable - contact Gems factory for assistance.
38	POST_CPU_REGISTER_TEST_FAILURE	Not serviceable - contact Gems factory for assistance.
39	HARDWARE_COMPARATOR_FAILURE	Not serviceable - contact Gems factory for assistance.
40	DIRECT_RELAY_DRIVE_FAILURE	Not serviceable - contact Gems factory for assistance.
41	FLASH_CHECKSUM_ERROR	Not serviceable - contact Gems factory for assistance.
42	POST_FLASH_CHECKSUM_ERROR	Not serviceable - contact Gems factory for assistance.
43	PROB_MINDER_VALUES_OUT_OF_RANGE	Not serviceable - contact Gems factory for assistance.
44	WRONG_INSTRUCTION_DECODING	Not serviceable - contact Gems factory for assistance.
45	TOO_FAST_INTERRUPTS	Not serviceable - contact Gems factory for assistance.
46	TOO_SLOW_INTERRUPTS	Not serviceable - contact Gems factory for assistance.
47	LAST_FAILCODE_PLUS_1	Not serviceable - contact Gems factory for assistance.

Steam Boilers *continued*


Float Type Pump Start/LWCO

11. On a steam boiler equipped with optional float operated pump start / low water cut-offs or float operated feeder / low water cut-offs, the same slow steam evaporation test should be carried out. Prior to testing, review the control manufacturer's cut-sheets (provided with this O & M Manual) for determining normal operating levels and detailed cleaning and repair procedures.

12. On steam boilers, the gauge glass, trycock(s) and water column must be clean and in good working order at all times. Steam or water seepage around the gauge glass packing nuts will cause the glass to erode and weaken. Extra gauge glass, brass friction washers and packing gaskets should be kept on hand. Your Rite Representative can supply these items to ensure proper gauge glass length and pressure rating.

13. When replacing gauge glass, it is imperative that the water gauge valves be in near perfect alignment to prevent stress on the glass. **DANGER** Never attempt to replace the gauge glass on a boiler that is operating under pressure unless qualified to do so. Always wear safety glasses when working around gauge glass.

14. The trycock is a back up valve for verifying water level in the boiler only when the gauge glass is temporarily inoperable. It should be opened once a month to verify it is in good working order and then closed tightly. Constant leakage from the trycock can eventually cause it to plug up.

15. **CAUTION** The equalizing piping that connects the steam column to the boiler must be kept free of mud and sludge. To access and clean, remove pipe plugs in the crosses that connect the column to the boiler and rod out with a stiff wire bottle brush. The bottom equalizing pipe is generally the most susceptible to mud accumulation. The steam column itself should be checked at least once a year. Mud or sludge in the steam column is an indication that the column is not being blown down often enough.

16. On steam boilers, sometimes the feed pump is on but the water level won't rise in the sight glass until the steam pressure drops. If this happens, chances are the check valve(s) between the boiler and the pump have failed. For this reason Rite recommends two spring loaded check valves piped in series in the boiler feed line (See page 46).

17. A steam boiler that is shut off and cooling down will eventually draw a vacuum. Usually this vacuum is broken by air seeping in through the gauge glass packing gasket on the boiler's steam column. If not, the vacuum can be strong enough to pull water out of the condensate return tank and flood the boiler. A full gauge glass in the morning is an indication of this. If this causes more water carry-over than the steam main's trap can handle on restart, here are a few suggestions: 1. Install a larger capacity float & thermostatic trap at the end of the steam main. 2. Leave boiler "on" during off hours with steam stop valve closed and operating pressuretroll in night set-back mode. 3. A vacuum breaker of the proper rating can be installed by adding a tee in the boiler's control piping, but be aware that this will introduce unwanted oxygen into the boiler and may require a modification to the chemical treatment program.

18. Check steam traps regularly. Steam loss through traps that are stuck open can waste vast amounts of steam to atmosphere almost without notice. If the end of the vent pipe from the condensate return tank to outdoors is blowing a ***continuous plume*** of steam, chances are one or more traps have failed open.

Water Boilers

1. For closed hot water heating systems the most important thing to avoid is fresh water make-up. At least once a month check the discharge piping from the boiler relief valve(s) and the drain valve for any sign of leaks as well as around the boiler head gaskets, pump seal(s), valve packing(s), piping, etc. A water meter installed in the fresh water make-up line is a very cheap and simple way to tell whether or not the heating loop is losing water.

2. On hot water heating boilers, verify the following when the system is at or near operating temperature: The boiler pressure gauge should read well below the boiler's relief valve set pressure. The boiler's temperature gauge should not read below 155º F for systems operating with delta T's of 20° F or less.

3. On hot water heating boilers check the low water cut-off operation once a month. If you have a float type low water cut-off installed with *Test 'N' Check* valves, open the ball valve beneath it while the boiler is firing. The main burners should go off. Close the ball valve and manually reset the low water cut-off if required. The boiler should attempt to relight. If you have a probe type low water cut-off, hold in the "test" button for about six seconds while the boiler is firing. The main burners should go off during this time. The boiler should not attempt to relight until you push the low water cut-off reset button.

DAILY MAINTENANCE SCHEDULE:

	TYPE OF SERVICE REQUIRED	BOILER TYPE	BY WHOM	SERVICE RESPONSE	BOILER STATUS
1.	Check the water level in the boiler gauge glass.	Steam	Operator	Immediate if the water level is unusually low or not visible.	On
2.	Blowdown boiler and steam column per water treatment program recommendations. Confirm that both low water cut-offs and the pump control function properly.	Steam	Operator	Immediate if any of the water level controls fail to respond properly or if the blowdown valves or piping seem restricted or blocked.	On low fire during low demand.
3.	Check condensate return/feedwater tank for: (1) water level (2) overflow (3) make-up valve operation and tight shut-off (4) feedwater temperature (5) constant steam plume coming out of the vent pipe.	Steam	Operator	Immediate if no water in tank, otherwise A.S.A.P.	On
4.	Check chemical feed and softener systems.	Steam	Operator	A.S.A.P. if not working.	On
5.	Visually check main flame through the firebox door peep hole.	Steam Water	Operator	Identify any burners with lazy yellow flames and clean off the orifices and burners of any foreign material when scheduling permits.	On
6.	Confirm that boiler is drafting properly by checking for a slight negative draft entering the firebox door peep hole (A small amount of smoke is one way to do this).	Steam Water	Operator	Immediate if there is any indication of back pressure in the firebox.	On High Fire
7.	Check for residual main burner flames after main burners have cycled off.	Steam Water	Operator	Immediate if gas valves fail to close.	At the end of a burner “on” cycle
8.	Check for simmering or discharging relief valves.	Steam Water	Operator	Immediate if boiler pressure is within 10% of relief valve setting.	On
9.	Check boiler pressure gauge.	Steam Water	Operator	Immediate or A.S.A.P. if pressure is above normal or closer than 10-15% of relief valve set pressure	On
10.	Check boiler draft gauge.	Steam Water	Operator	A.S.A.P. if the draft reading is in the red zone.	On
11.	Check boiler stack thermometer.	Steam Water	Operator	A.S.A.P. if baseline stack temperature goes up by 40° or more.	On
12.	Check for water leakage: (1) under boiler (2) around boiler headplate gaskets (3) low water cut-off gaskets (4) pump seals (5) system piping.	Steam Water	Operator	Immediate or A.S.A.P.	On
13.	Continue to eliminate air from a new or freshly filled system.	Water	Operator	Manually vent air from high points in the system.	On or Off
14.	Check boiler return water temperature.	Water	Operator	Immediate if return is less than 135° F.	On

WEEKLY MAINTENANCE SCHEDULE:

	TYPE OF SERVICE REQUIRED	BOILER TYPE	BY WHOM	SERVICE RESPONSE	BOILER STATUS
15.	Check make-up water meter and record the number of gallons in water treatment log or boiler log.	Steam	Operator	Make sure your water treatment company receives a copy. Highlight any significant changes in water usage and investigate the cause.	On or Off
16.	Ditto	Water	Operator	Immediate if you are making up water.	On or Off
17.	Check water level in elevated compression type expansion tank.	Water	Operator	Immediate if gauge glass is full of water.	On

MONTHLY:

	TYPE OF SERVICE REQUIRED	BOILER TYPE	BY WHOM	SERVICE RESPONSE	BOILER STATUS
18.	Slow steam evaporation test (see page 18)	Steam	•Operator •Boiler Tech	Immediate if level controls fail to respond properly.	(See page 18)
19.	Probe low water cut-off test and reset check.	Water	Operator	Immediate if control does not respond to test and reset buttons	On Low Fire
20.	Blowdown float low water cut-offs that are equipped with McDonnell Miller Test ‘N’ Check valves.	Water	Operator	Immediate if low water cut-offs do not shut the burners off.	On Low Fire
21.	Check float low water cut-off that are not equipped with Test ‘N’ Check valves by externally manipulating linkages or bellows to force the float ball down (simulating low water) and then releasing in order to confirm that the float and linkages respond freely. This can be accomplished on most McDonnell Miller low water cut-offs except for #64).	Water	Operator	Immediate if the low water cut off does not shut the burners down or if the float fails to bounce back up quickly (indicating that it is sticking to mud at the bottom of the float chamber).	On Low Fire
22.	Check one complete sequence of operation (see pages 13 to 15).	Steam Water	Operator	Immediate or A.S.A.P. if actual sequence does not follow written description.	Begin at a full call-for-heat load.

AFTER THE FIRST THREE MONTHS OF OPERATION:

	TYPE OF SERVICE REQUIRED	BOILER TYPE	BY WHOM	SERVICE RESPONSE	BOILER STATUS
23.	Internal waterside inspection to check for scale, corrosion, and electrolysis, the latter sometimes indicated by reddish rust primer looking steel.	Steam Water*	•Operator •Boiler Tech •Water Treatment Company Representative	Immediate or A.S.A.P. depending on condition of tubes and header boxes.	Off
24.	Open fire box door and inspect bottom row of tubes (fireside), refractory panels (hot face side) and the burner bed.	Steam Water	•Operator •Boiler Tech	Immediate or A.S.A.P. if: (1) Rust or water marks indicate chronic condensing problems (2) Refractory deterioration indicates overheating due to draft problems (3) You discover any soot in the tube bundle (4) Any of the bottom tubes are leaking, sagging, have "blisters" or bulges.	Off
25.	Open drip/dirt legs to all vent lines. Disconnect vent lines at all diaphragm valves and switches as well as the main gas pressure regulator and NOVV if supplied.	Steam Water	•Operator •Boiler Tech	Immediate if water or moisture is discovered. These lines must be completely dry and open to atmosphere.	Off
26.	Inspect stack internally for soot near the draft control and at the stack cap.	Steam Water	•Operator •Boiler Tech	Immediate or A.S.A.P. If soot is found.	Off

ANNUAL:

	TYPE OF SERVICE REQUIRED	BOILER TYPE	BY WHOM	SERVICE RESPONSE	BOILER STATUS
27.	Follow step 23-26 above.	See above	See above	See above	Off
28.	Inspect feedwater, blowdown and equalizing valves and piping for sludge restrictions or obstructions.	Steam	•Operator •Boiler Tech	Clean or replace piping and valves as necessary.	Off
29.	Check all wye strainer screens.	Steam Water	Operator	Clean or replace as necessary.	Off
30.	Check boiler water pH with sample pulled from boiler before draining for internal inspection.	Steam Water	•Operator •Boiler Tech •Water Treatment Company Representative	Adjust with chemical treatment as required to bring into proper pH range.	Off
31.	Flush out and clean blowdown tanks and condensate return tanks.	Steam	Operator Boiler Tech	As required.	Off
32.	Open all float type low water cut-offs used on steam boilers and McDonnell MIller #64 low water cut-off on water boilers.	Steam Water	•Operator •Boiler Tech	Immediate if float bowls or float arm guides have any mud or scale buildup.	Off
33.	Check for electrolysis due to stray electrical currents or improper steel-to-copper pipe connections.	Steam Water	•Electrician •Operator	See pages 7 and 34	On
34.	Check high limit control operation.	Steam Water	Operator	Immediate if lowering high limit setting to pressure or temperature reading in boiler does not cause burners to shutdown and high limit to lockout.	On low fire
35.	Check high limit control, operator control and pressure/temperature gauge for nominal accuracy.	Steam Water	•Operator •Boiler Tech	Immediate if the controls and pressure/temperature gauge are not within reasonable accuracy of each other.	On
36.	Replace gauge glass and glass packing gaskets on steam column.	Steam	•Operator •Boiler Tech		Off
37.	Replace gauge glass and glass packing gaskets on elevated compression type expansion tanks.	Water	Operator	Do only if expansion tank has become waterlogged during the year.	Off
38.	Lubricate (if necessary) and do amperage test on all pump and fan motors associated with boiler system.	Steam Water	•Operator, •Boiler Tech •Electrician	A.S.A.P. If full load amperage draw is higher than motor name-plate rating, check motor starter contacts for wear and replace as necessary.	Off
39.	If supplied, check normally open vent valve on boiler gas train for proper operation.	Steam Water	•Operator •Boiler Tech	Immediate if NOVV stays open when boiler is firing.	Firing
40.	Check that washer weights have remained in place on barometric dampers (if supplied).	Steam Water	Operator	Replace weights if they have fall-en off. Recheck draft when finished.	On or Off
41.	Relief valve test: With boiler pressure at 75% of relief valve set pressure- use relief valve lever to manually open the valve. Leave open about 5 seconds and then close again. **DANGER:** Relief valve discharge piping must be piped to a safe point of discharge. Ear and eye protection is recommended for this test.	Steam Water	Boiler Tech	Immediate if valve fails to open or if water or steam is not discharged under pressure. If valve fails to reseat tightly, open a few more times to dislodge any foreign material on the valve seat. Replace valve if it does not reseat.	On
42.	Check draft gauge calibration (if supplied).	Steam Water	Operator	Temporarily remove plastic tubing to draft gauge's "to stack" port. If red gauge oil does not return to "O", try adjusting it with the zero set knob. Extra gauge oil and instructions are located in cavity behind the gauge and accessible by unfastening the gauge from its metal standoff.	On

* The 3 month internal inspection may be waived for water boilers provided they are opened up after one year. Subsequent inspections are discretionary but should not be more than 5 years apart.

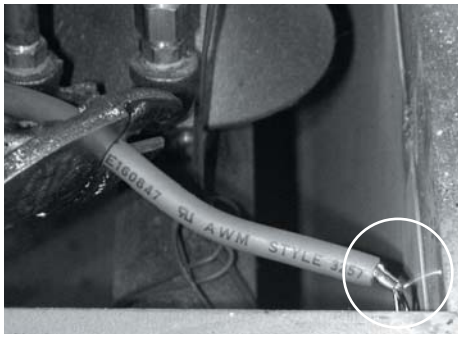
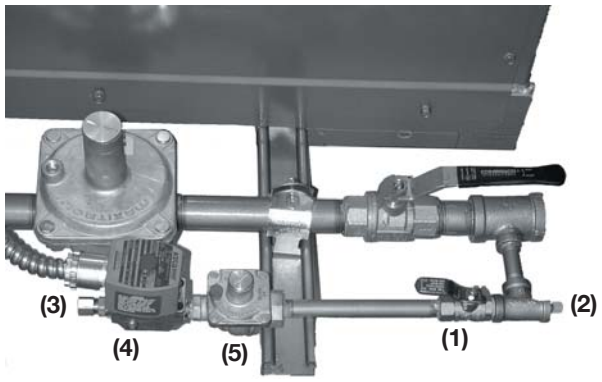
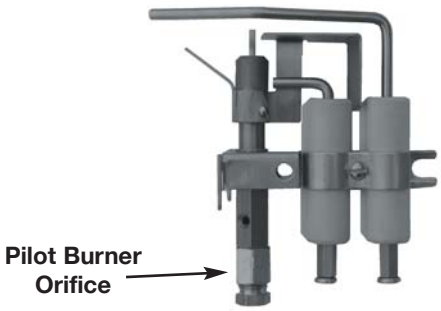
TROUBLESHOOTING

DANGER **TROUBLESHOOTING SHOULD BE CARRIED OUT BY QUALIFIED PERSONNEL ONLY**

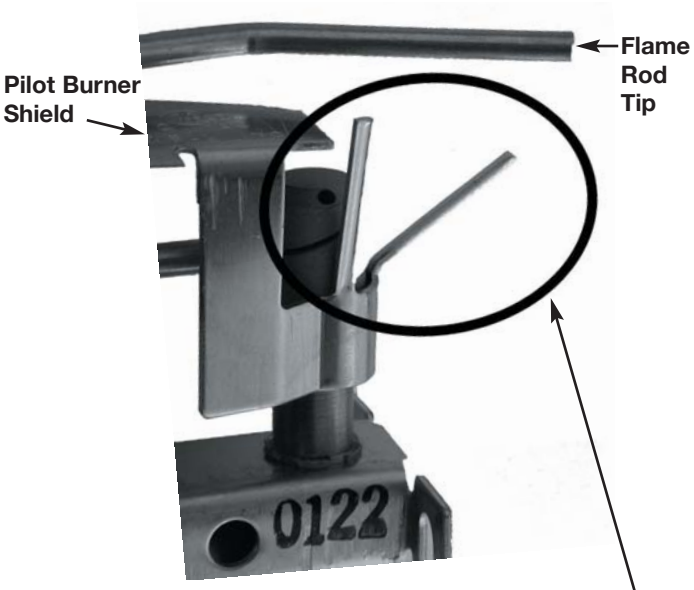
SECTION I. FLAME SAFEGUARD CONTROLS

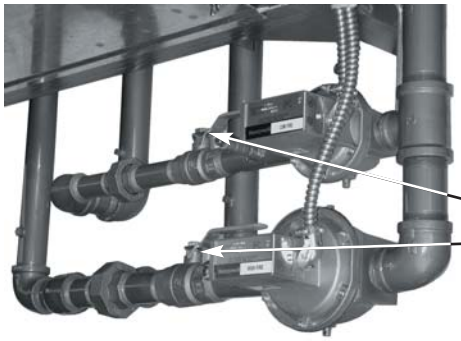
SEE APPROPRIATE FSG BULLETIN FOR MORE COMPLETE OPERATION & TROUBLESHOOTING INFORMATION.

PROBLEM	CAUSE / REMEDY
1. On FSG, the top light does not come on: 	1. Circuit breaker or fuse to the boiler is off. 2. Boiler power switch is off. 3. On Fireye FSG's the limit circuit must be "made" and there must be a call for heat (power on terminal 7 of wiring sub base) otherwise all the lights will be off except for a brief flash sequence once every minute (or when the reset button is pressed) to indicate that the control is in standby mode.
2. FSG does not sequence to PTFI (Pilot Trial for Ignition). The second light down does <u>not</u> come on:     Honeywell FSG Run/Test switch (On boilers over 2500 MBH) Fireye FSG Run/Check switch (On boilers over 2500 MBH)	1. One or more of the limit switches are not "made" (closed). Correct problem and then manually reset the switch(es). 2. The operator or low fire control is not calling for heat. 3. Boiler control circuit fuse (if provided) is blown. 4. Building Automation System (if used) is not calling for heat. 5. FSG "run-check" or "run-test" switch is in the "check" or "test" position (on boilers over 2500 MBH input only). 6. C.A.D. end switch, draft fan proving switch or supply air fan proving switch (if used) are not "made". Fireye FSG's "AIR FLOW" LED will flash indefinitely on boilers with inputs up to 2500 MBH; over 2500 MBH the blinking will stop after 10 minutes and the FSG will lock out on flame failure.
3. These lights come on but there is no ignition spark at the pilot burner:    Ignition Transformer	1. Make sure primary side of ignition transformer is getting 120 VAC during PTFI. If not, check wiring to the primary side. If wiring is good, the FSG is probably bad. 2. Test the ignition transformer 6000V secondary output by removing the ignition wire from the pilot burner ignition electrode and checking for high voltage spark as shown in the top photograph on page 23:

PROBLEM	CAUSE / REMEDY
3. Honeywell “Pilot” light is on. Fireye “PTFI” light is on but there is no ignition spark at the pilot burner (continued from previous page):	3. If ignition transformer tests good, the ignition wire may be defective. Temporarily substitute another wire (12-14 AWG solid or stranded TFFN is fine for a one-time test) in its place. If pilot sparks, replace substitute wire with a new ignition wire.
 High Voltage Spark	4. If ignition wire is good and still no spark, check ignition electrode ceramic insulator for cracks or wetness. If cracked, replace ignition electrode (P/N 133445A); If wet, dry out with a small propane torch, Check the arc gap between the ignition electrode and the pilot burner tip - it should be between 1/16” to 3/32” inch.
	5. On Fireye FSG’s only, the replaceable chassis fuse may be blown. The LED’s will illuminate in the following manner to indicate a blown fuse: “OPR CTRL” “PTFI” and “FLAME” lights will be on, the “AIR FLOW” light will be off and the “ALARM” light will be flashing. Before replacing the fuse, check for shorts in the wiring or to the coils of the pilot valve, ignition transformer or the main fuel valves.
4. During PTFI there is ignition spark but no pilot flame:	1. Make sure air has been bled from the gas supply line. 2. Make sure the manual pilot gas cock (**1**) is open. 3. Check the gas pressure to the pilot line at the 1/4” tee test port (**2**) and make sure it is within the range required on the boiler shop sheet. 4. During PTFI, check for gas flow by disconnecting the aluminum tubing (**3**) at the pilot valve outlet. If there is no gas flow: a) Check to see if the pilot valve (**4**) is receiving 120 VAC (if not, the FSG may be bad or the wiring from the FSG’s pilot terminal sub base to the pilot valve may be faulty). b) The pilot valve may be defective c) The pilot regulator (**5**) vent port may be plugged and not allowing the regulator to operate properly. 5. Check the aluminum pilot tubing for kinks, breaks or obstructions. 6. Check the pilot burner orifice for blockage or corrosion.
	
	

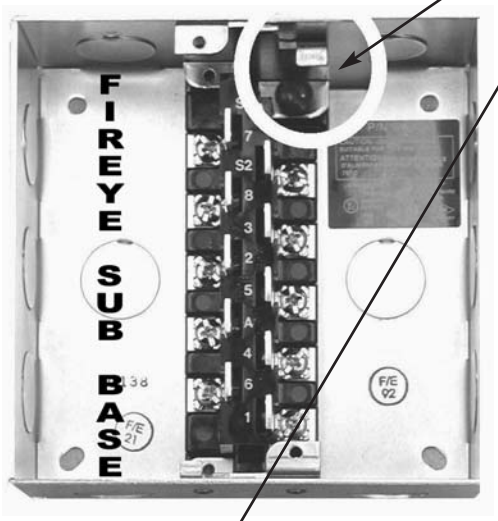
PROBLEM	CAUSE / REMEDY
5. During PTFI there is a pilot flame but the fourth light down does not come on:	1. Using a multimeter (or the FSG's optional display annunciator if so equipped) make sure the pilot flame signal strength is in the proper range. If not: a) Check the gas pressure at the pilot burner (it should be between 3" and 8" w.c.). b) Check the wire from the flame rod terminal to the FSG sub base for defects or poor bonding at the points of connection. c) Check the bare copper ground wire from the FSG sub base to the boiler frame for breaks or poor bonding.
	2. With the power switch off, make sure there is no continuity between the flame rod terminal on the FSG sub base ("S2" for Fireye and "F" for Honeywell) and ground. Continuity can be caused by carbon filaments between the flame rod and pilot shield due to a lazy yellow pilot flame (defective pilot burner orifice), cracked flame rod wire insulation, a wet or cracked flame rod ceramic insulator or flame rod contact with the pilot burner shield.
	3. Turn the power switch on and temporarily interrupt the limit circuit so there is no call for heat. On Fireye FSG, measure voltage between S1 and S2 using the brass eyelets on the side of the chassis. Voltage should be about 270 VAC. Zero voltage indicates a grounded flame rod circuit; partial voltage indicates a partially grounded circuit such as can be caused by carbon filaments or a wet ceramic insulator. Remove the flame rod wire from S2. If voltage between S1 and S2 remains zero or significantly less than 270 VAC, the Fireye FSG chassis is probably defective. For Honeywell, follow the same procedure except measure voltage between "F" (flame rod) and "G" (ground). Honeywell uses a lower impressed voltage than Fireye, about 195 VAC, otherwise the same test principles apply.
	4. Make sure the pilot burner grounding forks are both intact as shown.
	5. Make sure the pilot flame carries around to the front of the pilot burner (toward the tip of the flame rod).
	6. F.S.G. amplifier module may be defective.
	7. The main gas pressure regulator vent or vent line may be plugged, blocked or corroded shut, causing the regulator not to open.
	8. One of the downstream manual gas valves (leak test cocks) may be closed.
	9. Supply gas pressure exceeds main gas pressure regulator's maximum inlet pressure, causing it to lock up.

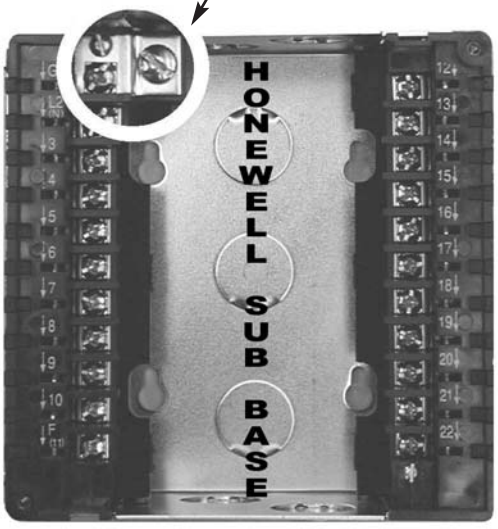




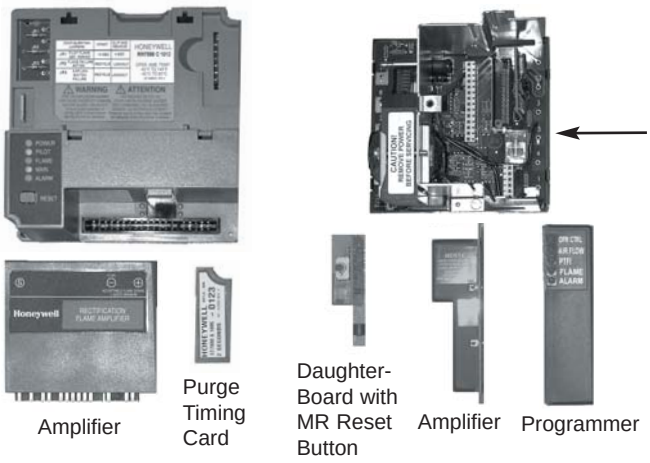
3-Row Manifold/Low-High-Low Firing shown above

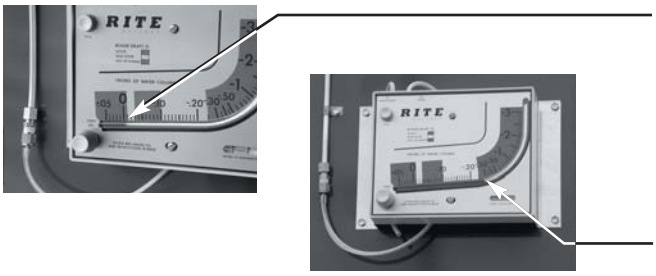
PROBLEM	CAUSE / REMEDY
5. During PTFI there is a pilot flame but the main flame does not come on (continued from previous page):	10. If one or more of the automatic safety shut-off gas valves is failing to open, a) check for 120 VAC to valves, b) check that the bleed vent port or vent line on diaphragm type SSOV is not plugged, blocked or corroded shut. 11. On modulation firing boilers over 2501 MBH input, increase the modulating valve actuator's low fire adjustment to its maximum low fire setting.
6. Intermittent flame failure requiring manual reset of FSG:	1. Poor electrical ground. Verify that a solid earth ground wire has been brought to the F.S.G.'s sub base earth grounding screw. 2. Wrong electrical polarity: Check that the 120 VAC supply hot leg goes to the burner switch and that the neutral leg (L2) has less than .5 VAC potential to earth ground. 3. Transient voltage problems with the main power supply. To verify, run a temporary ground wire from the pilot burner to the F.S.G. sub base earth grounding screw. 4. Power supply less than 102 VAC or greater than 132 VAC. 5. Ambient temperature at the F.S.G. is over 140 degrees F or less than -40 degrees F. 6. Pilot valve is sticking open after a burner firing cycle and creating a false flame signal during standby. Honeywell's "MAIN" and "ALARM" LED lights will be on. Fireye's "FLAME" LED light will be on for 60 seconds and then default to "AIRFLOW" light and flashing "ALARM" light. 7. Energy Management System's enable-disable relay is "Triac" type (i.e., voltage leaks through before relay contacts fully make). Replace with "ice cube" or similar definite purpose relay. 8. VFD (variable frequency drive) motors are operating nearby. Install a power line "noise" filter (such as Corcom 10VS1 or Schaffner FN 660-16-03) at the supply side of the boiler's power-on switch.

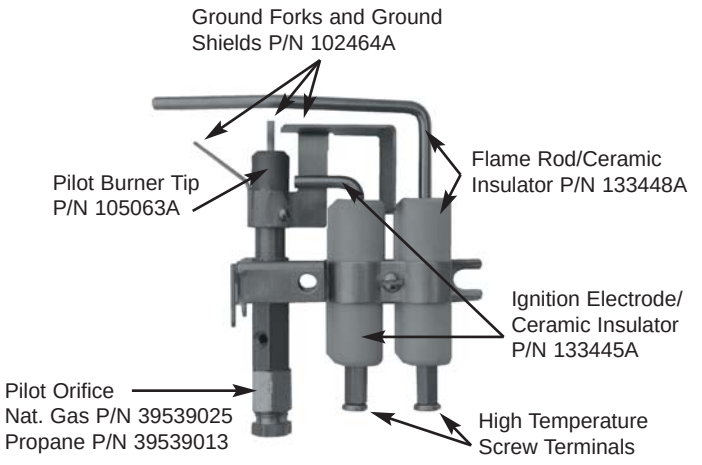




6. Intermittent flame failure requiring manual reset of FSG (continued from previous page):







(Q179A Pilot Burner Detail)

9. Fluttering draft proving switch. If an Induced Draft Fan is used, be sure the draft proving switch is properly installed and calibrated so that the switch does not "flutter" on and off.

10. Gas pressure "droop". Make sure the gas supply piping to the boiler is properly sized to prevent the gas pressure from decreasing below minimum supply requirements when the boiler and any other gas burning equipment connected to the same meter are on line. This can be checked by installing a gas pressure gauge of the proper range at the gas train's supply gas pressure test port and seeing if the pressure drops appreciably between static and flow conditions. Make sure the propane supply line doesn't frost (freeze). If so, a vaporizer will be required.

11. Intermittent F.S.G. control component failure. The best way to check this is if there is a second boiler operating nearby with the exact same F.S.G. control. Swap the controls and see if the problem stays with the boiler or follows the control. If the problem follows the control, you may then want to swap the F.S.G.'s control modules to further pinpoint the defective component. If you do not have another F.S.G. to swap, check with a local authorized Honeywell or Fireye distributor to see if they can bench test the unit.

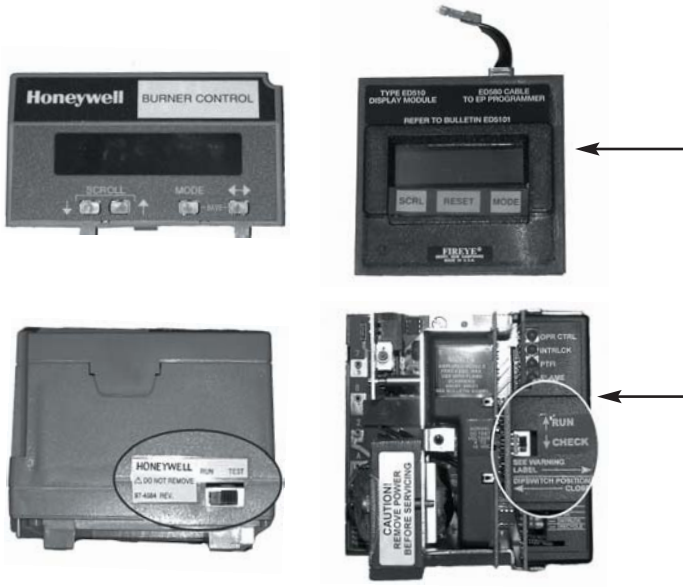
12. A poor main or pilot flame can lead to deterioration of flame ionization and thus a weak flame signal. Typical causes of this are temporary negative boiler room pressure conditions or stack downdrafts.

13. Too high a draft can pull the flame off the flame rod. Check draft gauge and draft control to assure that draft is not over –.1" w.c., especially on boilers with vertical stacks over 40 feet tall or operating with an induced draft fan.

14. Pilot burner flame rod or ignition ceramic insulators are getting wet due to tube leak from above. Repair tube leak. If intermittent problems always occur during morning restarts, program the energy management system to intermittently bring on the boiler two or three times a night to keep the firebox warm and help prevent the ceramic insulators from picking up moisture.

PROBLEM	CAUSE / REMEDY

6. Intermittent flame failure requiring manual reset of FSG (continued from previous page):



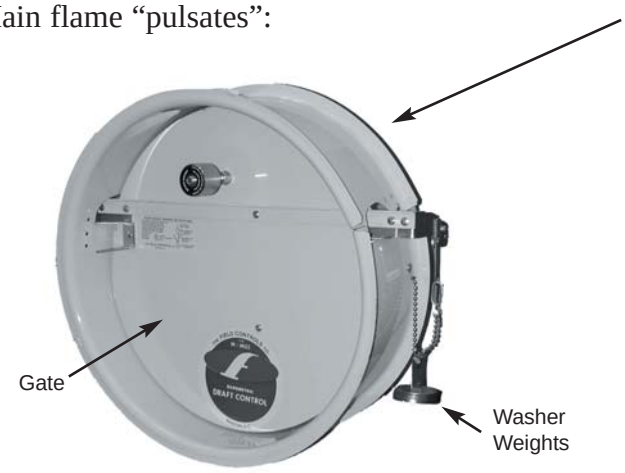
15. F.S.G. control sub base is defective. In some rare cases, there have been hidden defects in the F.S.G. sub base. If all else fails, the F.S.G. sub base should be changed out (see page 25).

16. The following F.S.G. plug-in diagnostic display module will provide flame signal read-out as well as other useful burner monitoring and troubleshooting information: Fireye: ED510, and Honeywell: S7800A1001.

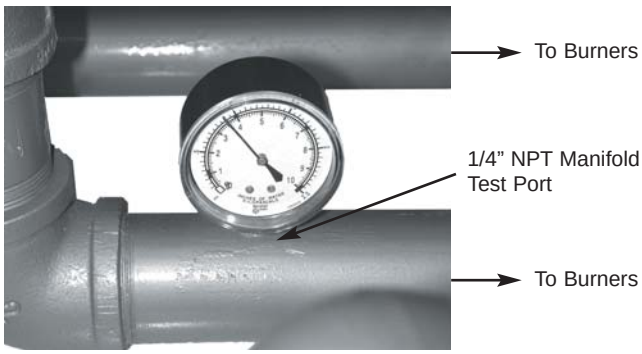
17. On boilers over 2500 mbh input it can be helpful to put the F.S.G.'s "run-check or "run-test" switch to the "check" or "test" position to "hold" the FSG at that point in its sequence - especially for checking pilot signal strength and steadiness.

SECTION II. MAIN FLAME

1. Main flame "pulsates":



Barometric Damper



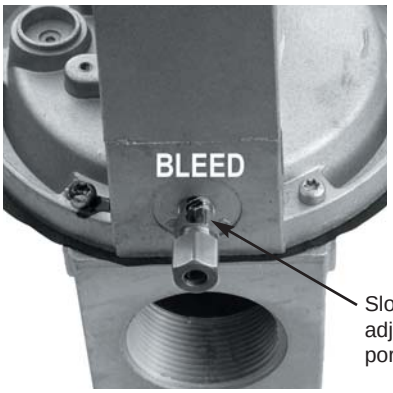
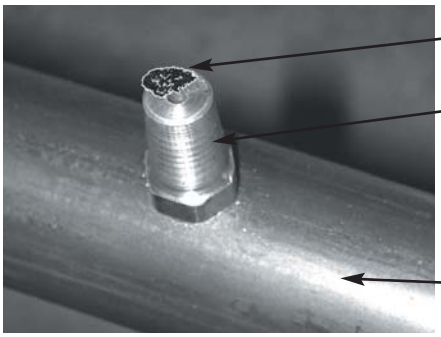
1. Barometric damper or draft diverter is not installed.

2. Barometric damper is installed too far away from the boiler. Install damper in stack tee as close to the boiler as possible (see page 4, **figure 4**).

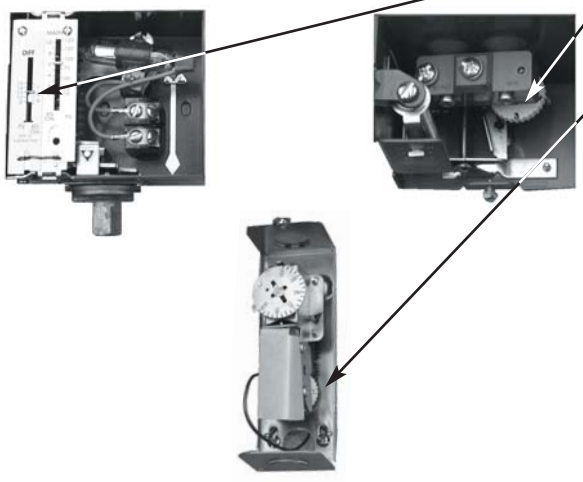
3. Barometric damper is installed in a Tee or collar that doesn't provide enough offset, causing the bottom of the damper gate to get caught in the stack's exhaust flow while operating.

4. Barometric damper gate is not opening up enough. Remove some washer weights.

5. Faulty main gas pressure regulator or regulator at the gas meter. Verify using a 0-15" w.c. gauge or manometer at manifold test ports. If the gauge fluctuates, then a gas pressure regulator upstream may be defective.

PROBLEM	CAUSE / REMEDY
2. Main flame rolls out from under boiler base:  	1. Boiler room under negative pressure condition. 2. Blocked or restricted stack or stack cap. 3. Tube bundle sooted. 4. Diaphragm gas valve(s) opening too fast. Install slow opening bleed orifice in bleed port to solve momentary rollouts when one or more of the gas burner manifolds light off.
3. Lazy yellow main flame:  	1. Not enough combustion air (refer to the installation section of this manual). 2. Main burner brass orifice opening is partially blocked by debris. 3. Boiler overfiring. Make sure manifold gas pressure does not exceed 11” w.c. 4. Main burner orifices oversized. New orifices of smaller drill size may be required.

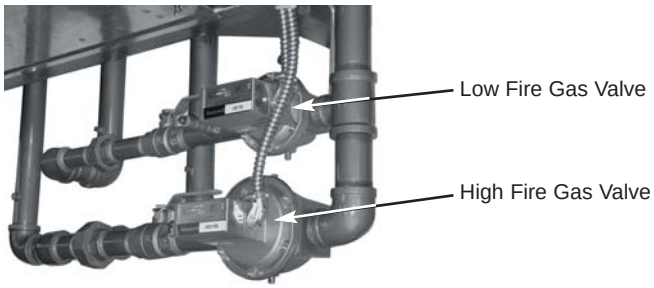
SECTION III. GAS VALVE AND BURNER OPERATION

1. Boiler cycles on/off too frequently: 	1. On steam boilers, adjust the differential setpoint higher. 2. On water boilers, replace aquastats with fixed differentials to adjustable type. 3. Check energy management system’s remote start/stop relay. 4. Check sequence of operation (see pages 13-15) to make sure the burners have returned to low fire long before a call for heat has been satisfied.

PROBLEM	CAUSE / REMEDY

2. High fire (or medium fire) gas valve short cycles (clicks on-off-on-off continuously):

1. Low or medium fire proven switch is "dropping out" when high or medium fire gas valve opens. (See page 16, paragraph 5 for remedy).



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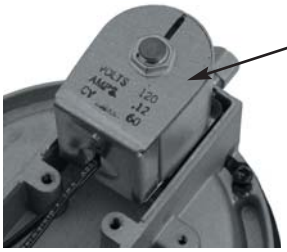
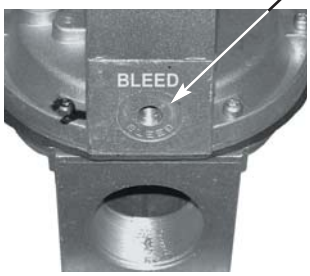
3. Diaphragm gas valve does not open when energized:





1. Coil defective. Replace with new coil (part #116931) for all Honeywell V48A valves.
2. Bleed port is plugged, blocked or corroded shut.
3. Valve defective. Replace.

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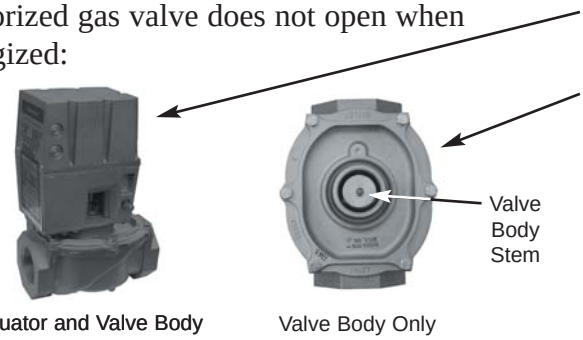
4. Solenoid gas valve does not open when energized:

1. Coil defective. For Honeywell V4295A valves, replace with new coil (see chart below).

Valve Size (inch)	Type	Coil Part Number 120 Vac, 50/60 Hz	
		2 psi	5 psi
3/8, 1/2	N.C.	BBA51302	BBA51302
3/4	N.C.	BBA51302	BBA51314
1	N.C.	BBA51302	BBA51309
1-1/4	N.C.	BBA51303	BBA51310
1-1/2	N.C.	BBA51301	BBA51310
2	N.C.	BBA51304	BBA51311
2-1/2	N.C.	BBA51305	N/A
3	N.C.	BBA51306	N/A
3/4, 1	N.C.	BBA51307	N/A
1-1/4	N.C.	BBA51308	N/A

2. Valve defective. Replace.

PROBLEM	CAUSE / REMEDY
5. Motorized gas valve does not open when energized:  Actuator and Valve Body Valve Body Only	1. Check actuator for leaking hydraulic oil fluid. 2. Remove actuator and make sure valve body stem is not jammed and can be forced down against closing spring pressure. 3. Replace actuator or valve body as required.

6. Safety shut-off gas valves fail to close completely when de-energized:

Valve Leak Test (see Figure 10 on next page)

This is a test for checking the closure tightness of a gas safety shutoff valve. It should be performed by qualified personnel during the initial startup of a burner system, or whenever the valve or valve bonnet is replaced. It is recommended that this test also be included in the scheduled inspection and maintenance procedures. For a periodic inspection test, follow steps ***1-12 below and refer to figure 10 on page 31.***

1. Shut the burner power switch off.

2. Close the downstream leak test cock “E”

3. Open manual gas shutoff cock “A”

4. Remove the plug from the petcock “F” and connect the test apparatus.

5. Submerse the 1/4” tubing vertically 1/2” into a jar of water.

6. Slowly open test petcock “F”.

7. When the rate of bubbles coming through the water stabilizes, count the number of bubbles appearing during a ten second period. Each bubble appearing during a ten second period represents a flow rate of approximately .001 CFH (23.32 cc/hr).

8. If the leakage rate for the SSOV “B” does not exceed the allowable rate, close the test petcock “F” and reinstall plug.

9. Temporary hot-wire SSOV “B” to the open position.

10. Use test petcock “G” to test SSOV “C” in the same manner.

11. If the leakage rate for SSOV “C” does not exceed the allowable rate, close the test petcock “G” and reinstall plug.

12. Rewire all valves and wiring to pre-test conditions and check the burner gas train operation for at least two complete firing sequence.

To Meet U.S. requirements, leakage must not exceed the following values:

V48A Pipe Size *(in)*	Allowable Leakage *(cc/hr NatGas)*	Number of Bubbles per 10sec *(Nat Gas)*
3/4"	332.5	8
1"	377.5	9
1-1/4" & 1-1/2"	552.5	13
2" & 2-1/2"	812.5	20

V5055 Pipe Size *(in)*	Allowable Leakage *(cc/hr)*	Number of Bubbles per 10sec *(Nat Gas)*
3/4, 1, 1-1/4, 1-1/2	573	14
2, 2-1/2, 3	940	24
4	1254	33

V4295A Pipe Size *(in)*	Allowable Leakage *(cc/hr)*	Number of Bubbles per 10sec *(Nat Gas)*
3/8" & 1/2"	235	6
3/4" & 1"	241	6
1-1/4 & 1-1/2"	444	11
2"	532	14
2-1/2”	629	16
3	768	20

NOTE: For international leak test requirements, contact the office of the appropriate approval agency.

Gas Safety Shutoff Valve Leak Test

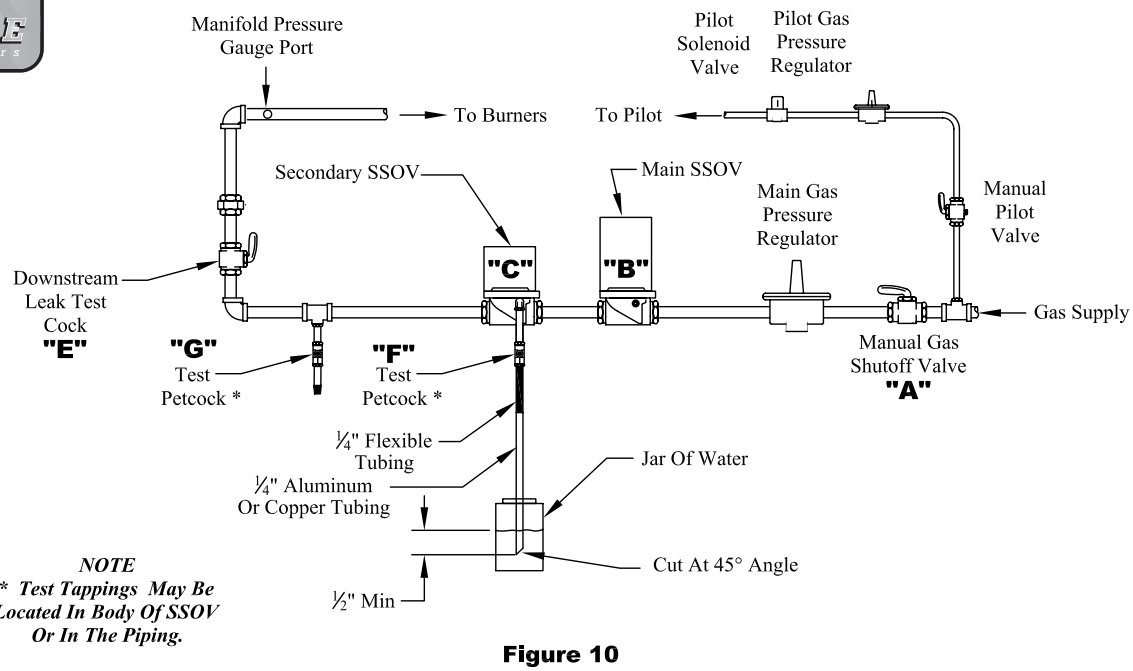
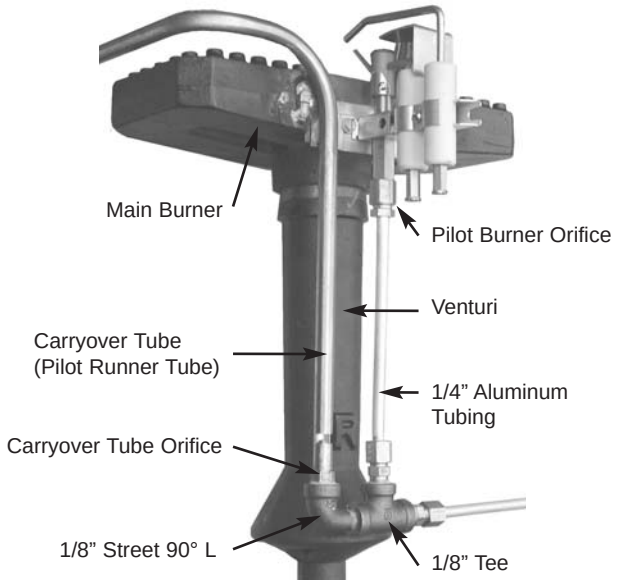
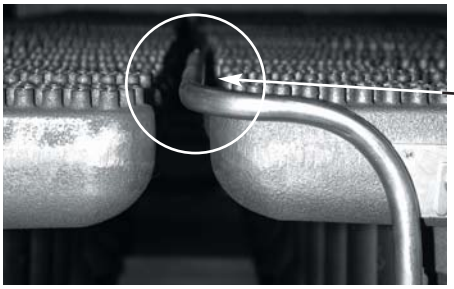


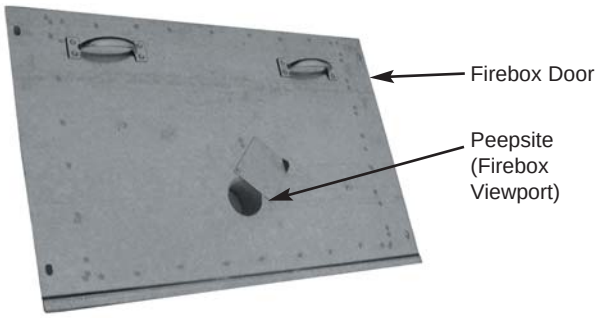
Figure 10

PROBLEM	CAUSE / REMEDY
7. Carry-over tube prematurely burns out: 	1. Adjust carry-over tube location so it is not being impinged on by the main burner flame. 2. Check the draft and burner input. An overheated firebox will cause carry-over tube burnout. 
8. Burner heads "pop off" the venturi tubes.	1. An overheated firebox from poor draft or excessive BTU input can cause manifold pipes to distort and change burner spacing. Fix the draft or input problem first and then grind the burner spacer tips where necessary in order to reinstall the burners on venturis.
9. Burner heads are warped and/or burner ports are "mushroomed".	1. Poor draft. 2. Boiler room air pressure is going negative. 3. Boiler is overfiring.

PROBLEM	CAUSE / REMEDY

SECTION IV. DRAFT OR HIGH STACK TEMPERATURE

1. Not enough draft: Positive pressure at firebox door peepsight opening when firing and/or draft gauge is reading positive pressure in stack:



1. Tube bundle (heat exchanger) sooted.
2. Boiler room is under negative pressure.
3. Washer weights have fallen off barometric damper.
4. Downdraft condition due to wind or poor stack termination location. If winds are a constant problem, consider replacing standard stack cap with Breidert type.
5. Boiler is condensing.
6. Improper stack design such as long horizontal run or stack diameter reduction.

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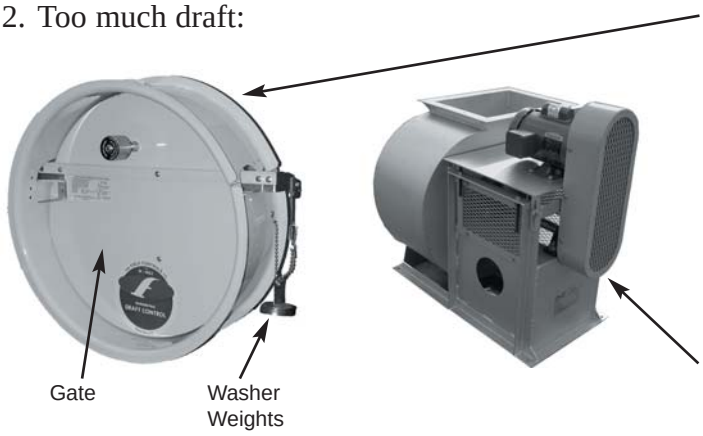
2. Too much draft:



1. Excess washer weights on Barometric Damper keeps the gate from opening and lowering the draft through the boiler.
2. Stack is over 25’ tall and with Barometric Damper wide open, the draft is still too high. Increase the damper size or add a second Barometric Damper in the stack.
3. Induced draft fan (if used) R.P.M. too high. Reduce fan speed.

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3. High stack temperature. Over 400˚F net or 500˚F gross - except high pressure steam or high temperature hot water boilers which will have higher stack temperatures due to higher fluid saturation temperatures.

1. Excessive draft.
2. Boiler tubes require internal waterside cleaning.
3. Boiler tubes sooted (external).
4. Boiler overfiring.
5. Glycol in system (water boilers only) will result in higher operating stack temperatures than systems without glycol (see page 9).

SECTION V. WATER LEAKS

1. Headplate gasket leak

Typical headplate cap screw markings, ASME SA grade, and recommended final torque values:

5/8”-11 N.C. Thread
SA 307B
Final torque to 50 foot pounds.

5/8”-11 N.C. Thread
SA 325-1
Final torque to 100 foot pounds.

5/8”-11 N.C. Thread
SA 354BD-1
Final torque to 100 foot pounds.

3/4”-10 N.C. Thread
SA 307B
Final torque to 85 foot pounds.

3/4”-10 N.C. Thread
SA325-1
Final torque to 160 foot pounds.

3/4”-10 N.C. Thread
SA354BD-1
Section IV Boilers: Final torque to 180 foot-pounds.
Section I Boilers: Final torque to 200 foot-pounds.

1. Make sure the boiler flange and headplate gasket mating surfaces are clean and not pitted or wire-drawn.

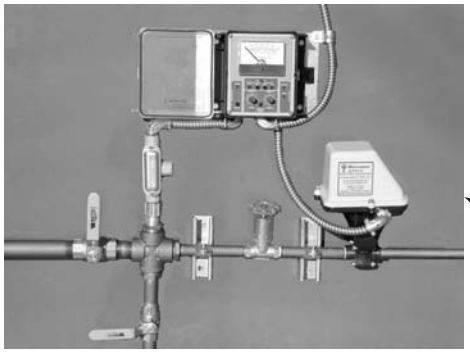
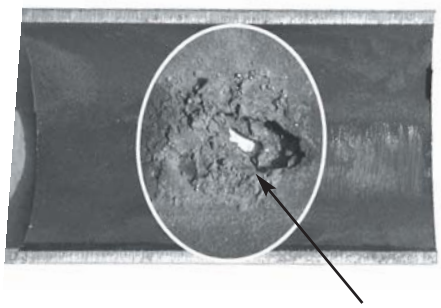
2. Use new authorized factory gaskets as supplied without additional sealant.

3. Use new or like new cap screw bolts with undamaged threads, lubricated with anti-seize rated for 1800˚F.

4. Make sure threaded thru-holes in header box flanges are not galled or damaged. To “chase” threads, use 5/8”-11 or 3/4”-10 hand tap with H5 ground thread limits. Bolts should go in finger tight until the bolt heads engage the headplates.

5. Tighten cap screws starting from the centers and working towards the corners. After finger tightening all the bolts, use a torque wrench and tighten to half their final torque values (see left). Next, use the same pattern to tighten all the bolts to the final torque value given. Last, go around the entire headplate making sure the bolts are evenly torqued.

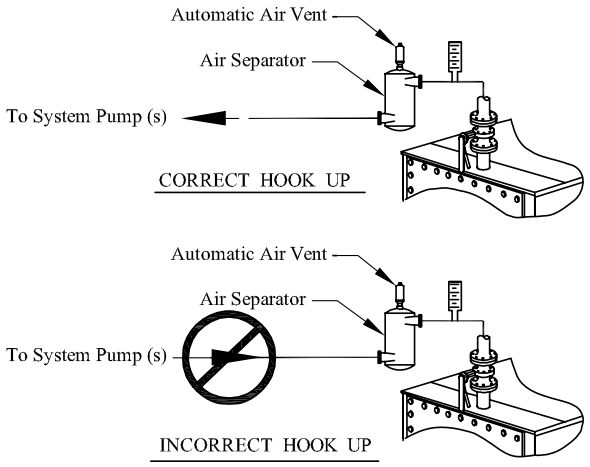
6. After bringing boiler up to operating pressure/temperature, re-torque all bolts to final settings again.

PROBLEM	CAUSE / REMEDY
2. One or more boiler tubes leak at the tubesheet(s):	1. Boiler may have been dry-fired. Tubes that are sagging or warped must be replaced. If tubesheets are warped and cannot be re-straightened, the entire heat exchanger may have to be replaced. Identify and correct the cause of the dry-fire before putting the boiler back into service. 2. Boiler may be located on an open-grate mezzanine that is allowing large amounts of relatively cool air directly into the combustion chamber. If the boiler is operating at low fire for extended periods of time, this can cause some tubes to expand while others contract, leading to tube loosening. Fix by: a) installing sheet metal under the boiler (see page 1) or b) re-orificing the boiler for reduced BTU input and resetting the aquastats in order to keep the medium and high fire manifolds "on" during the run cycle.
3. One or more boiler tubes leak above the burner bed, usually from the bottom or second row. (External wastage from long term leakage is usually visible): 	1. Problem is usually a long term overheated area of the tube caused by a buildup of mud or lime deposits. Replacement of leaking tube(s) is required. Find cause of the water makeup before putting boiler back into service and make appropriate repairs. 2. For steam boilers operating with water make-up, find out why the water treatment program - especially the bottom blowdown, water softening and chemical treatment - has not been more successful at reducing scale. 3. Consider installing an automatic timed surface blowdown system to reduce scale. They can pay for themselves in energy savings in as little as 6 months.
4. Water Boiler: one or more tubes leak from above the second row:  Sectioned boiler tube showing underdeposit corrosion. (Enlarged for clarity).	1. The problem might be due to longterm overheating from internal scale but the higher up in the tube bundle the less likely a tube burnout becomes. Check the boiler water pH before you drain the boiler. It should be at or near 8.5. If below 7, the water is acidic and is eating the steel. 2. Test for electrolysis due to stray voltage and correct as necessary (see page 7 paragraph 4).

PROBLEM	CAUSE / REMEDY
4. Water Boiler: one or more tubes leak from above the second row (continued from previous page):	3. If copper piping was used on *any of the lines* to the boiler, make sure dielectric flange kits (or unions) are installed and working to keep the copper (cathode) isolated from the steel (anode). Note that a copper ground rod used to fix stray voltage electrolysis *will not solve* a galvanic electrolysis (dissimilar metals) problem even though galvanic electrolysis will also show up as AC millivoltage.
5. Steam Boiler: One or more tubes leak from above the second row:	1. The problem might be due to longterm overheating from scale (easily confirmed by visual evidence) but the higher up in the tube bundle the less likely a tube burnout becomes. Check the boiler water pH before draining the boiler. It should be between 10 and 11.5. If below 7, the water is acidic and is eating the steel. 2. Remove the leaking tube(s) and section the tube near the failure. If the tube that failed came from below the normal water line, it could be due to oxygen corrosion or carbonic acid. Oxygen corrosion will appear as pitting in the steel, while carbonic acid attack will appear as channeling or grooving. 3. If the tube failed above the water line, it is usually the result of oxygen corrosion. Reasons include: a) Not enough oxygen scavenger in the chemical treatment. b) Boiler is frequently shut down at night or over weekend - causing a vacuum as it cools and sucking in oxygen laden air through the gauge glass packing gaskets. c) Out-of service oxygen corrosion due to improper boiler lay-up (see page 39).
6. One or more tubes have “split” or ruptured during cold weather shutdown:	1. Indicates that water in boiler reached freezing temperature. To help prevent this from occurring again: a) Install an automatic stack vent damper in the stack. b) Maintain enough glycol in the system (hot water boilers only) to stay above the freeze point. c) Leave the boiler and the system pump(s) on.

SECTION VI - Miscellaneous Water Boiler Problems

1. Water boiler “knocks or bangs” when firing:

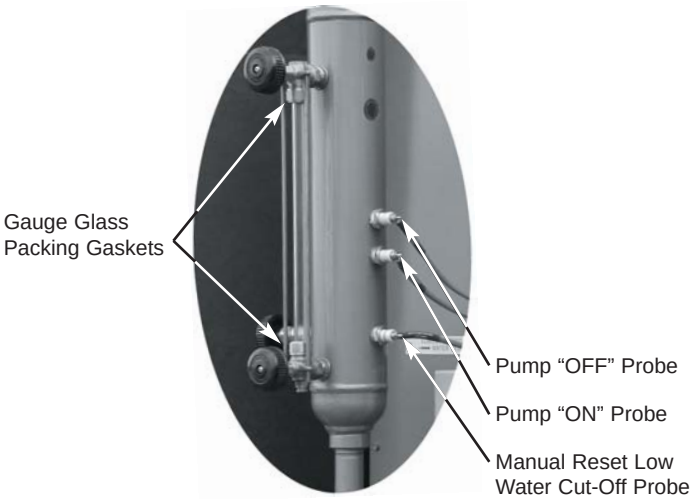


1. The problem is almost always air in the system. Make sure automatic air vents are installed and working. Try manually bleeding air from high points in the system. If an air separator is installed, make sure it has a functional automatic air vent. Make sure boiler pH is 8.5. If you can’t eliminate the air by any other means, try adding liquid dishwasher soap to the system (1 cup for small systems; 1 quart for larger systems) but not if the system has glycol in it.

2. System pressure may be to low. If the operating temperature is above the boiling point, make sure the boiler pressure exceeds the equivalent steam pressure at that temperature to avoid flashing to steam.

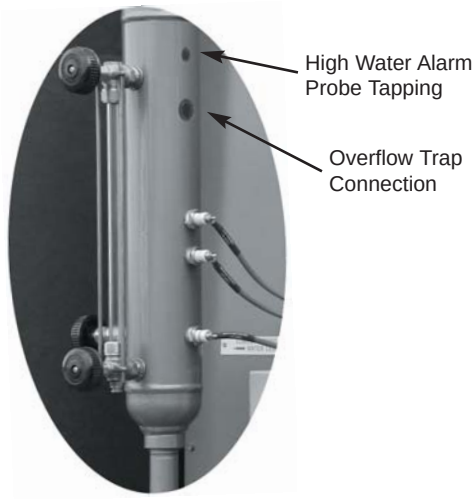
SECTION VII - Miscellaneous Steam Boiler Problems

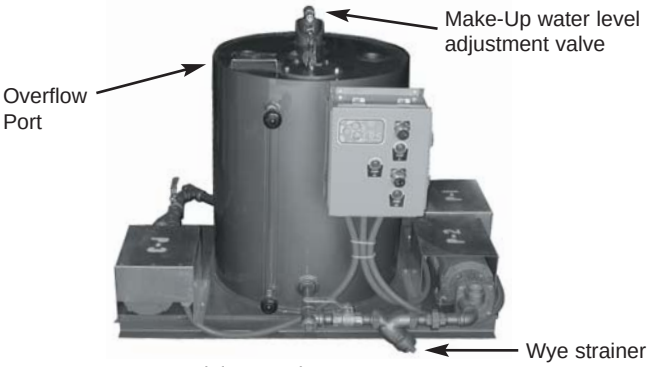
1. Flooded gauge glass:



1. If this occurs only after the boiler has been turned off and cooled down, it’s due to the boiler drawing a vacuum and pulling water out of the condensate return/feedwater tank. Adding a vacuum breaker on to the boiler external piping can solve this problem, but also creates another problem as well: by introducing air into the boiler, you are introducing oxygen into the boiler which will require more chemical treatment (especially oxygen scavengers) to compensate. As an alternative, consider leaving the boiler “on” in a night or weekend “set back” mode (1-2 psi) with the boiler stop valve closed.

2. If flooded glass occurs when the boiler is operating, see if the boiler feed pump is running. →

PROBLEM	CAUSE / REMEDY
1. Flooded gauge glass (continued from previous page):  	If the feed pump system is designed to run continuously and multiple boilers are fed by individual electrically operated valves, see if the valves are energized open. In either case, if there is a call for water when there shouldn't be, you will have to troubleshoot the feed pump circuit until you find the problem. If solenoid feed valves are used, there might be foreign material under the seat preventing a tight shut-off. 3. If two or more boilers are piped in battery, make sure that the swing check valve (low pressure steam only) is closing tightly to prevent steam in the main header from condensing back into the boilers that are off line. On high pressure steam boilers piped in battery, the same thing can occur through the spring loaded check valves or the stop/check valves from each boiler's steam supply. On low pressure steam boilers piped in battery, it is often more economical and just as effective to install a steam trap just above the level in the boiler where the feed pump normally cuts off in lieu of installing a large swing check valve. See page 46 for recommended steam boiler battery piping.
2. Steam boiler off on low water:	1. Follow steps in slow steam evaporation test (see page 18).
3. "Slow" feedwater pump. Water level in gauge glass starts to rise only after pressure in boiler drops:	1. Check valve(s) in feed water line have failed and boiler water has reached pump volute where it's flashing to steam. Replace or repair check valves (see page 46 for recommended check valve type and location). 2. Check feed pump discharge pressure with a gauge and make sure it is above boiler operating pressure. If not, on Burks pumps only, try adjusting impeller clearance. 3. Feedwater tank temperatures over 200° F may be causing steam vapor lock in pump volute. Lower feedwater temperature to 180° - 190° F.

PROBLEM	CAUSE / REMEDY
4. Feedwater pump sluggish under most operating conditions:  Triplex Feedwater System shown	1. Feed pump wye strainer screen is clogged. 2. Feedwater inlet port at the boiler is partially blocked by scale or sludge. 3. Feedwater pumps “vortexing” due to low Net Suction Positive Head (NSPH). Raise make-up water level in tank without reaching the 1” overflow port.
5. Water carryover (“wet steam”):	1. Reducing the steam stop valve size and associated piping from the steam outlet nozzle can raise steam exit velocities out of the boiler and cause water lift. The exception to this is on larger high pressure steam boilers where stop/check valves are almost always sized smaller than the boiler outlet nozzle. 2. Instantaneous high steam demand. Correct by using slower opening valves such as motorized ball type in lieu of solenoid snap-acting type valves to feed steam equipment. 3. Boiler water T.D.S. levels above 2500 ppm will promote water carry-over. Lower T.D.S. level. 4. Make sure the steam main is properly pitched and trapped at the end. Make sure the risers from the steam main come off at or near the top of the pipe.
5. Not enough steam:	1. Boiler not sequencing to high fire (see pages 13-15). 2. One or more steam traps have failed open, causing steam to continually blow by the traps. A steady plume of steam coming out of the condensate return tank vent line is a telltale sign of this; normal trap operation will be indicated by wisps of steam coming out the vent as various traps open intermittently. 3. Boiler is undersized for the load. Fix this problem by purchasing another Rite Boiler.

Removing Boilers From Service (Lay-up)

1. There are two types of lay-ups: short term and long term. A short term lay-up could be considered anywhere from a few weeks up to the 3 to 6 month warm season that comfort heating boilers are off-line. A long term lay-up could be considered any time period longer that 6 months. The two main goals of short and long term lay-ups is to prevent corrosion (oxygen or acidic) from attacking the boilers waterside steel surfaces and to prevent freeze-ups if the boiler is layed-up wet (full of water).

2. A wet lay-up is generally recommended for short term removal from service for two reasons: the boiler can be brought back on-line relatively quickly and it is also less labor intensive than a "dry" (no water in the boiler) lay-up. If the boiler to be layed-up wet in potentially freezing weather, add glycol to the boiler and system in concentrations recommended on page 9, or consider laying the boiler up dry instead. To combat corrosion in a wet lay-up, it is common to add a blend of oxygen scavenging and corrosion inhibiting chemicals to the boiler and system, but it is highly recommended that you do so only under the guidance of a local water treatment company in your area.

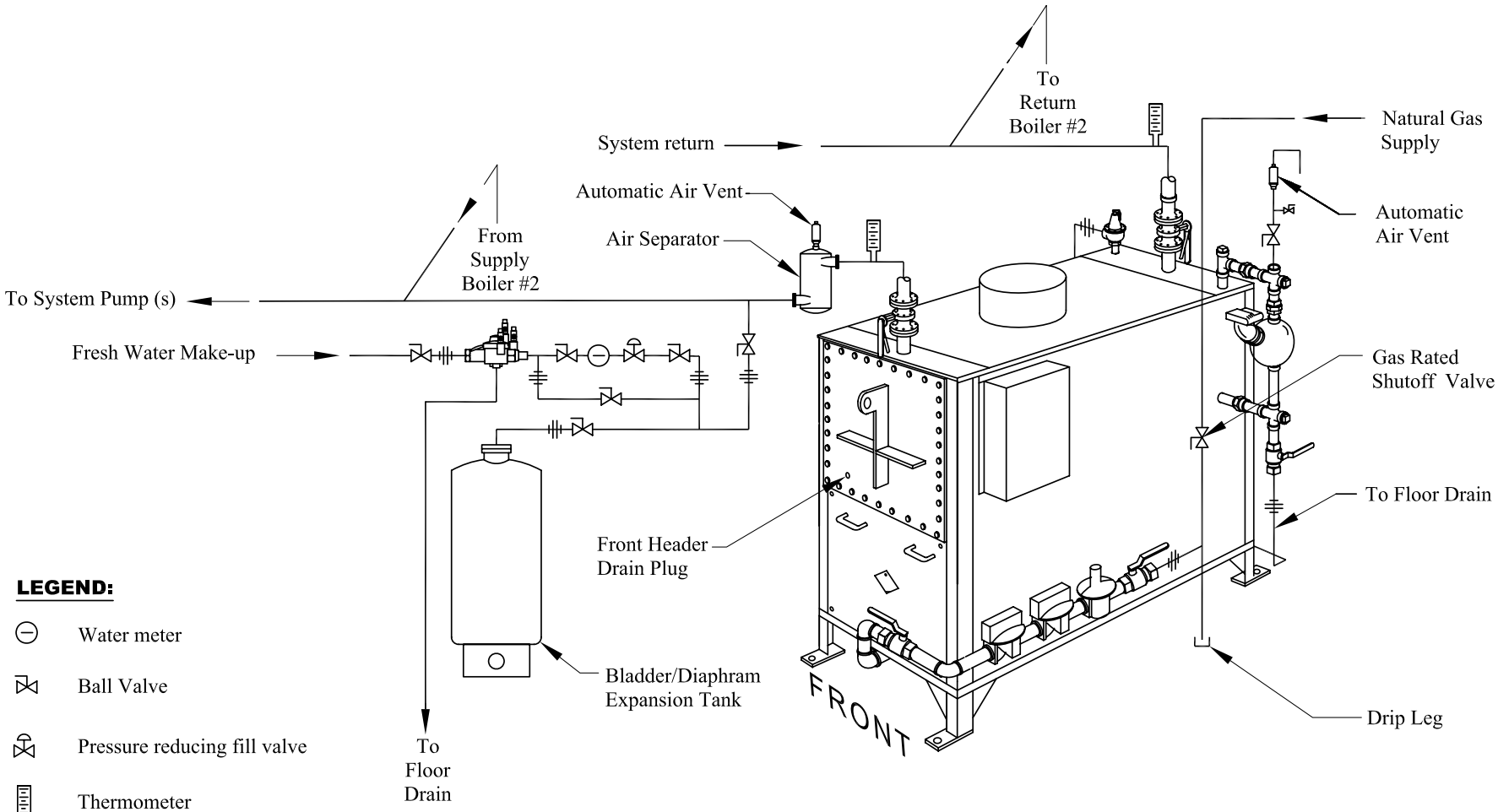
3. While wet lay-ups of water boilers are fairly straight forward because the boiler and system are full of water and all the air has been vented out of the system, steam boilers are another matter. Steam boilers normally operate with a water line approximately 2/3 full. Steam boilers *must not* be layed-up in this manner because the air in the upper portion of the boiler will attack the exposed steel above the water line. Steam boilers must therefore be completely flooded up to the steam outlet's stop valve. The water used to flood the boiler should be softened and chemically treated. Returned condensate from the system is ideal for this purpose. The boiler should also be kept under slight pressure (3 to 5 p.s.i.) to prevent air (oxygen) from entering the boiler. Again, it is prudent to follow recommendations from your water treatment company when laying up a steam boiler wet. Their recommendations may include weekly testing of the water for maintaining pH levels above 8 and sulfite (oxygen scavenging) residual. Test results should be a minimum of 20 ppm sodium sulfite (as SO_3) and 400 ppm phenolphthalein alkalinity (as $CaCO_3$). In some cases they may recommend nitrogen blankets for your particular installation.

4. In a dry lay-up, you must be sure that the water is not only drained from the boiler, but from all external boiler piping as well. This includes low water cut-off float bowls and the anti-siphon line to the steam boiler pressuretrolls. After draining all the water out of the boiler with the water temperature between 120-135°F, remove the headplates. Next, the boiler tubes should be thoroughly brushed clean to remove any mud or sludge that could promote underdeposit corrosion (see page 17 and the bottom of page 34). Thoroughly dry all waterside surfaces using a warm air fan, towels, etc. Place quick lime (not hydrated) or commercial grade silica gel on elevated non-metallic trays inside each header box. If you are in an area subject to warm humid air, reinstall the headplates. Consult your desiccant supplier or water treatment company regarding the best type and amount of desiccant to use for your area. Generally, 5 lbs. of quick lime or 8 lbs. of silica gel should be used for every 30 BHP. Open the headplates up every 1-2 weeks to check results. In some cases, nitrogen blankets are used in dry lay-ups but always exercise caution when working nitrogen in confined spaces as pure nitrogen does not support life.

GLOSSARY

ABMA	American Boiler Manufacturers Association
Aquastat	A water temperature controller.
ASME	American Society of Mechanical Engineers
BAS	Building Automation System
BHP	Boiler Horsepower (1BHP = 34,000 BTU Output)
BTU(H)	British Thermal Unit (per hour)
CFH	Cubic feet per hour.
CFM	Cubic feet per minute.
Combustion Efficiency	Boiler efficiency based on flue gas analysis.
CSD-1	ASME code for boilers (Control Safety Devices).
DDC	Direct Digital Control
Delta T or #T	The temperature difference between a boiler's hot water supply and return.
Differential	The number of degrees or the amount of pressure below an aquastat's or pressuretroll's cut-out setpoint at which the control will automatically reset back on.
EMS	Energy Management System
FSG	Flame Safeguard Control
FM	Factory Mutual (Insurance)
GPH	Gallons per hour
GPM	Gallons per minute
HGPS	High Gas Pressure Switch
HTHW	High Temperature Hot Water (Section 1 Boilers)
High Pressure Steam	Steam pressure over 15 psi.
IRI	Industrial Risk Insurers (Insurance) (Recently bought out by GE Gap which currently accepts CSD-1 requirements.)
LFPS	Low fire pressure switch.
Low Pressure Steam	Steam pressure at or under 15 psi.
LWCO	Low Water Cut-Off
MAWP	Maximum Allowable Working Pressure
MBH	One thousand BTU's.
MFPS	Medium Fire Proven Switch
Millivolt	One thousandth of a volt.
Motorized Gas Valve	A fluid powered or hydromotor SSOV.
MR	Manual Reset
NB	National Board
NBBI	National Board of Boiler and Pressure Vessel Inspectors
NOVV	Normally Open Vent Valve
NOx	The fusion of oxygen and nitrogen molecules during the combustion process.
PFEP	Pilot Flame Establishing Period
pH	A measure of the acidity or alkalinity of a solution.
PPM or ppm	Parts Per Million
Pressuretroll	A steam pressure controller.
PSI (G)	Pounds Per Square Inch (Gauge)
PTFI	Pilot Trial For Ignition
Reheat Systems	Hot water systems that are used to raise the temperature of dehumidified chilled air up to human comfort levels.
Section I Boiler	An ASME Code Boiler stamped for over 15 psi (steam) or over 160 psi or 250° F (water).
Section IV Boiler	An ASME Code Boiler stamped for a maximum 15 psi (steam) or up to 160 psi or 250° F (water).
Short Cycling	Excessive or rapid on-off operation.
Static Pressure	The pressure inside a boiler caused by the height of the column of water in the system above it (1 psi = 2.3 feet).
SSOV	Electrically controlled gas valves. (Safety shut-off valves)
TDS	Total Dissolved Solids
Thermal Stress Cycling (Thermal Shock)	Pressure vessel stresses created by heating and cooling cycles.
UL 795	Underwriters Laboratories Boiler Code
VAV	Variable Air Volume (Boxes)
VAC	Alternating Current Voltage
VDC	Direct Current Voltage
W.C. or w.c.	Inches Water Column (28" w.c. = 1 psi)
WSHP	Water Source Heat Pump

Rite Hot Water Boilers
Suggested Piping Diagram For Closed Hydronic Heating System
Featuring Conventional 135° To 235° F Return Water Temperature



LEGEND:

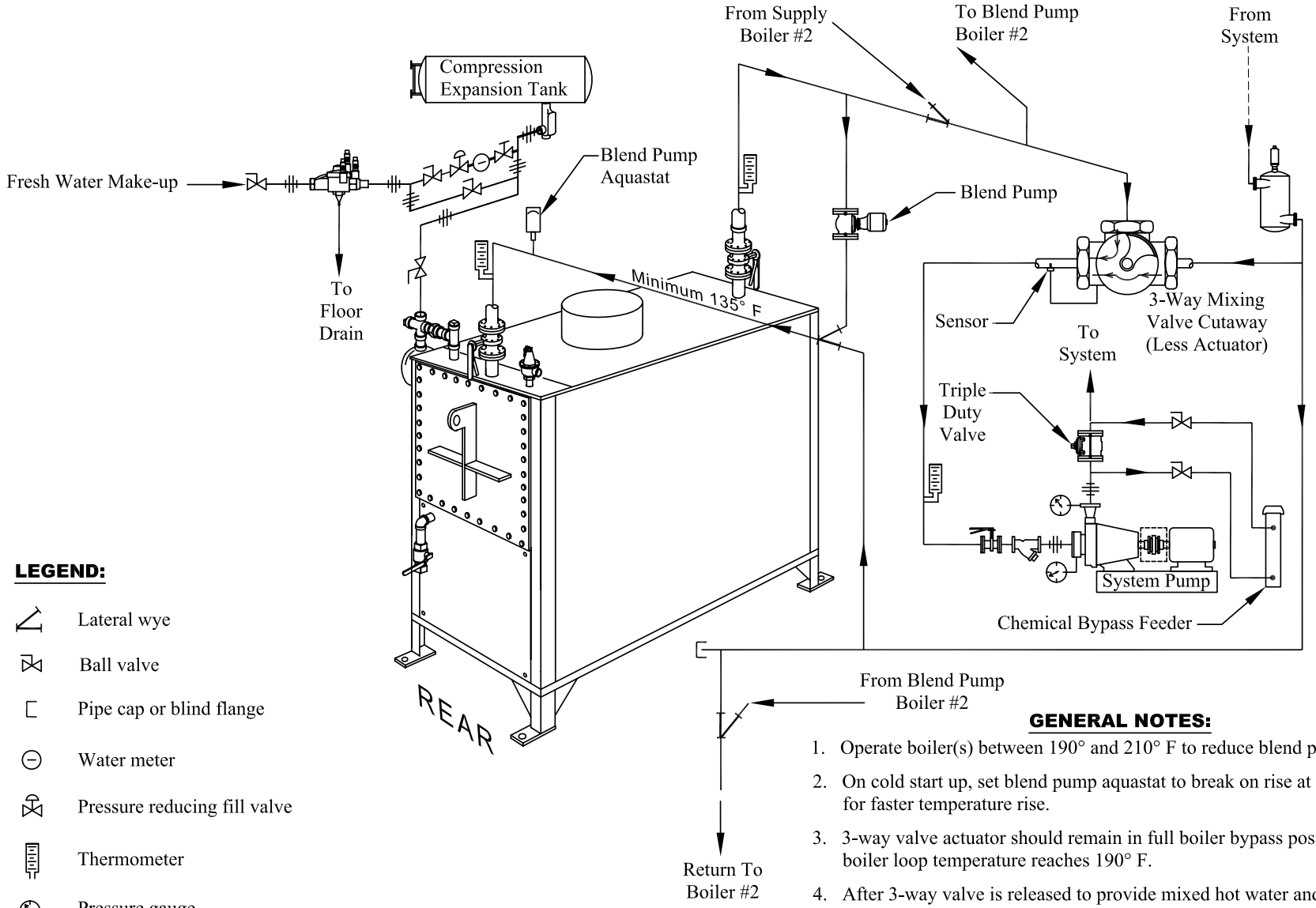
- Water meter
- Ball Valve
- Pressure reducing fill valve
- Thermometer
- Threaded Pipe Cap Or Plug
- Union or Flange
- Reduced Principal (R.P.) Backflow Preventer

GENERAL NOTE:

This system may be used with a factory installed boiler indoor/outdoor temperature reset control provided the control is programmed to never return less than 135° F to the boiler.

Figure 11

Rite Hot Water Boilers
Suggested Piping Diagram For Closed Hydronic Heating System
Featuring 3-Way Valve For System Temperature Reset And Blend Pump For Boiler Protection



LEGEND:

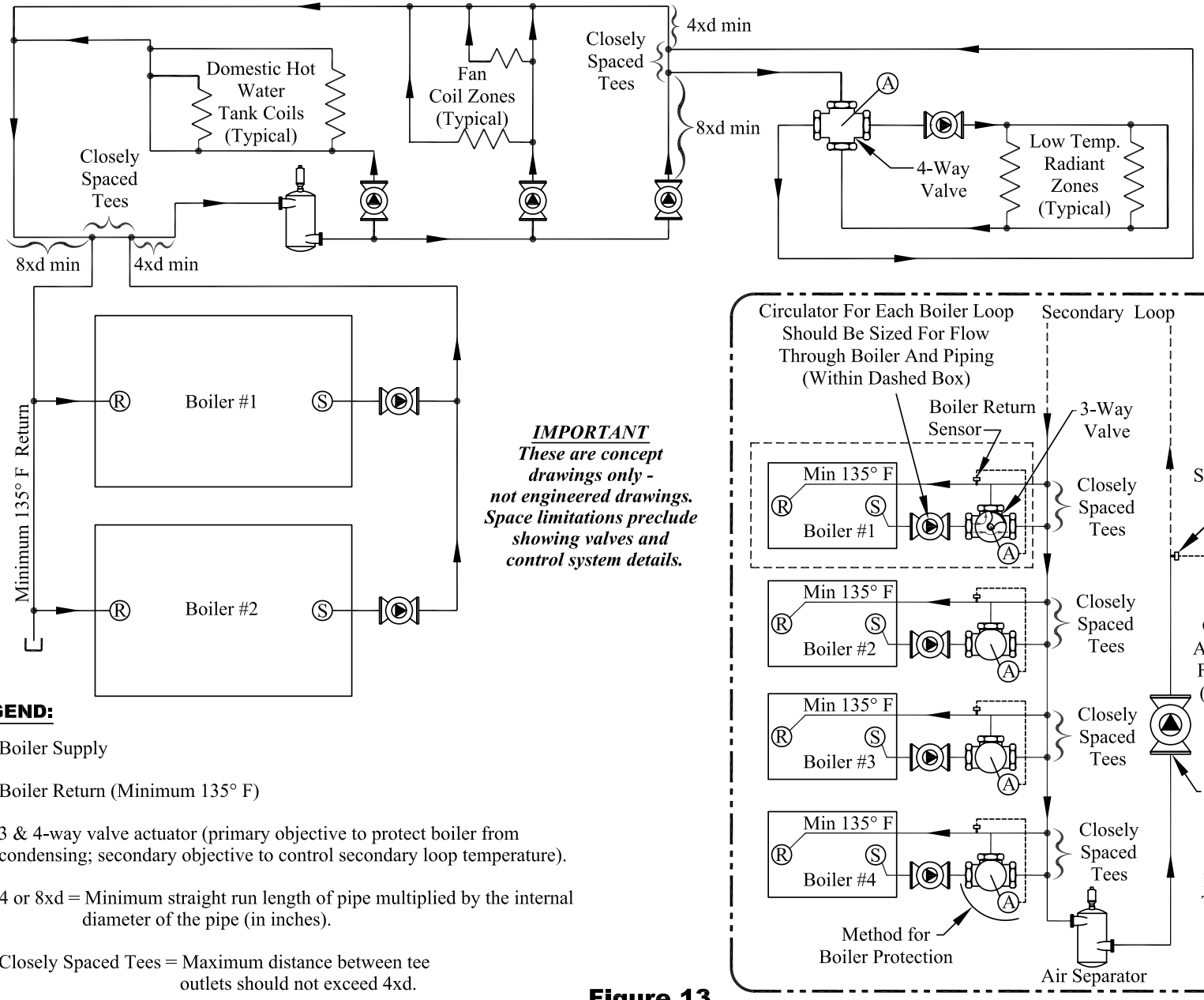
- Lateral wye
- Ball valve
- Pipe cap or blind flange
- Water meter
- Pressure reducing fill valve
- Thermometer
- Pressure gauge
- Reduced principal (R.P.) backflow preventer

Figure 12

GENERAL NOTES:

1. Operate boiler(s) between 190° and 210° F to reduce blend pump size.
2. On cold start up, set blend pump aquastat to break on rise at 190° F for faster temperature rise.
3. 3-way valve actuator should remain in full boiler bypass position until boiler loop temperature reaches 190° F.
4. After 3-way valve is released to provide mixed hot water and the system temperature approaches set point, reset the blend pump aquastat to 145° F to conserve energy. Aquastat differential should be set at 10° F.
5. "Condensing" flow through a standby boiler can be prevented by closing either the supply or return valve (see butterfly valves shown on boiler).

Rite Hot Water Boilers
Suggested Piping Diagram For Closed Hydronic Heating System
Featuring Primary-Secondary Piping With 3 & 4-Way Valves



IMPORTANT
These are concept drawings only - not engineered drawings. Space limitations preclude showing valves and control system details.

LEGEND:

Ⓢ Boiler Supply

Ⓡ Boiler Return (Minimum 135° F)

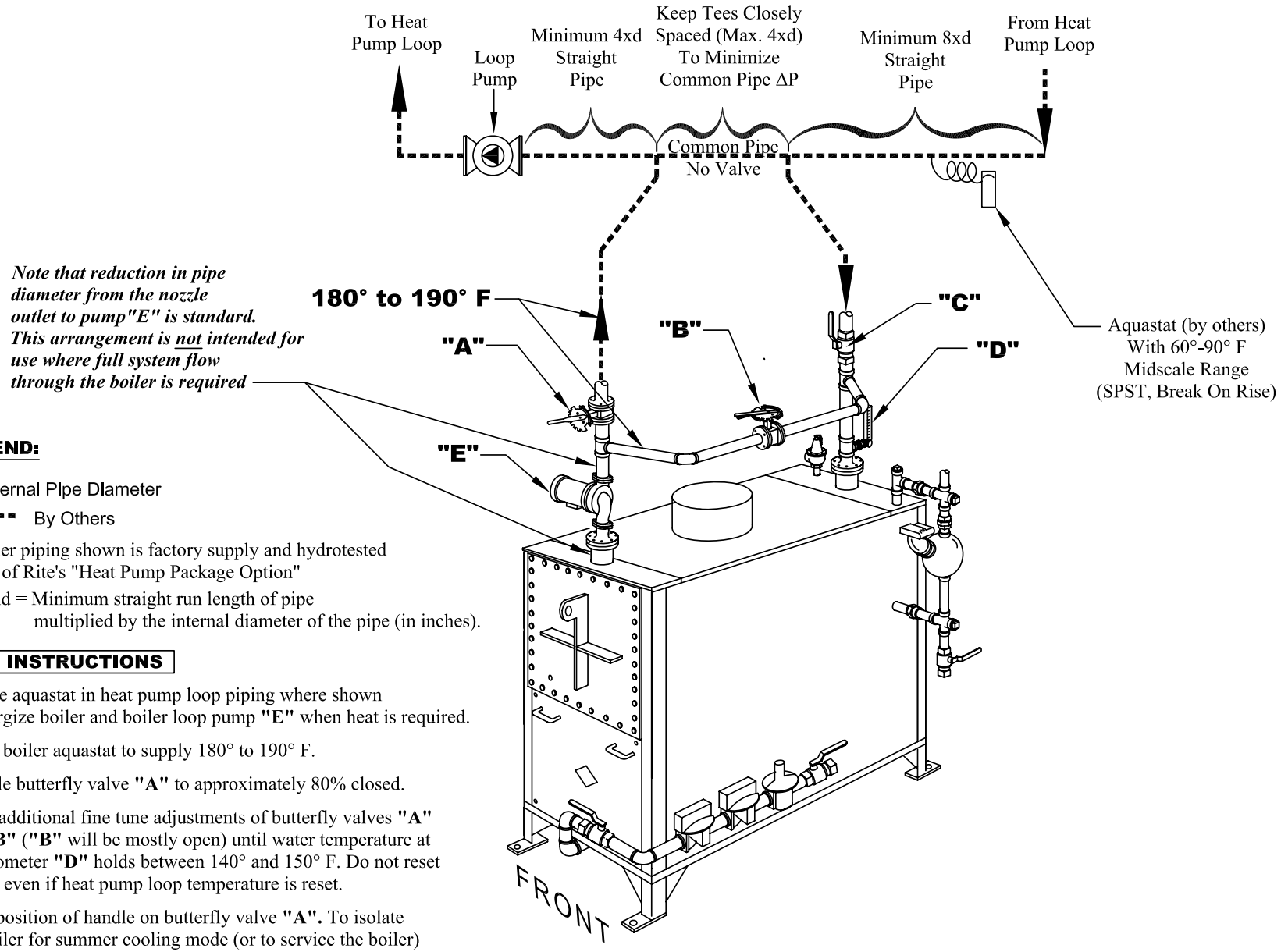
Ⓐ 3 & 4-way valve actuator (primary objective to protect boiler from condensing; secondary objective to control secondary loop temperature).

4 or 8xd = Minimum straight run length of pipe multiplied by the internal diameter of the pipe (in inches).

Closely Spaced Tees = Maximum distance between tee outlets should not exceed 4xd.

Figure 13

Rite Water Heating Boilers Heat Pump Package
Suggested Piping For 60° To 90° F Water Source Heat Pump Systems*Only*



LEGEND:

d = Internal Pipe Diameter

------ By Others

All other piping shown is factory supply and hydrotested as part of Rite's "Heat Pump Package Option"

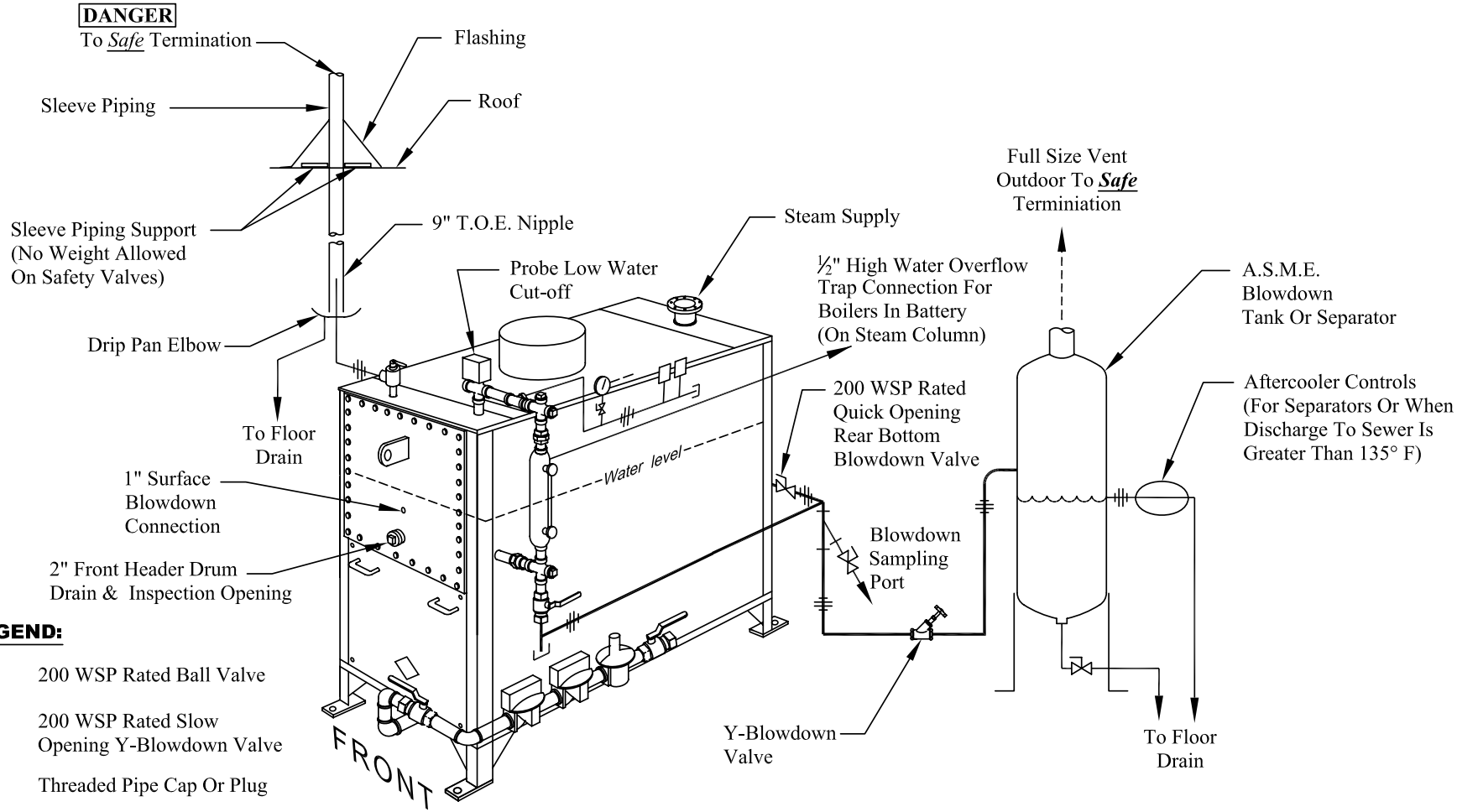
4 or 8xd = Minimum straight run length of pipe multiplied by the internal diameter of the pipe (in inches).

SET-UP INSTRUCTIONS

1. Provide aquastat in heat pump loop piping where shown to energize boiler and boiler loop pump **"E"** when heat is required.
2. Set up boiler aquastat to supply 180° to 190° F.
3. Throttle butterfly valve **"A"** to approximately 80% closed.
4. Make additional fine tune adjustments of butterfly valves **"A"** and **"B"** (**"B"** will be mostly open) until water temperature at thermometer **"D"** holds between 140° and 150° F. Do not reset valves even if heat pump loop temperature is reset.
5. Mark position of handle on butterfly valve **"A".** To isolate the boiler for summer cooling mode (or to service the boiler) simply close valves **"A"** and **"C".** To restore to heat mode, return **"A"** to marked position and open **"C"** fully.

Figure 14

Rite Steam Boilers
Suggested Piping For High Pressure Steam Boilers (150 psi)
Featuring Blowdown & Safety Relief Valve Piping



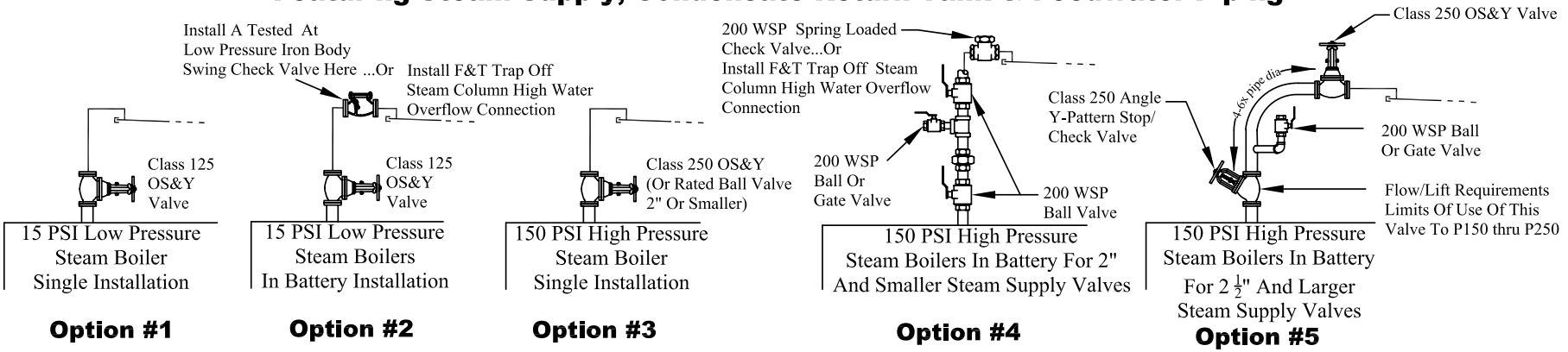
LEGEND:

- 200 WSP Rated Ball Valve
- 200 WSP Rated Slow Opening Y-Blowdown Valve
- Threaded Pipe Cap Or Plug
- Boiler Normal Water Line
- Schedule 80 Pipe & 300# Malleable Or Forged Steel Fittings
- Union or Flange
- Safety Relief Valve

Figure 15

Rite Steam Boilers

Suggested Piping For Low & High Pressure Steam Boilers
Featuring Steam Supply, Condensate Return Tank & Feedwater Piping



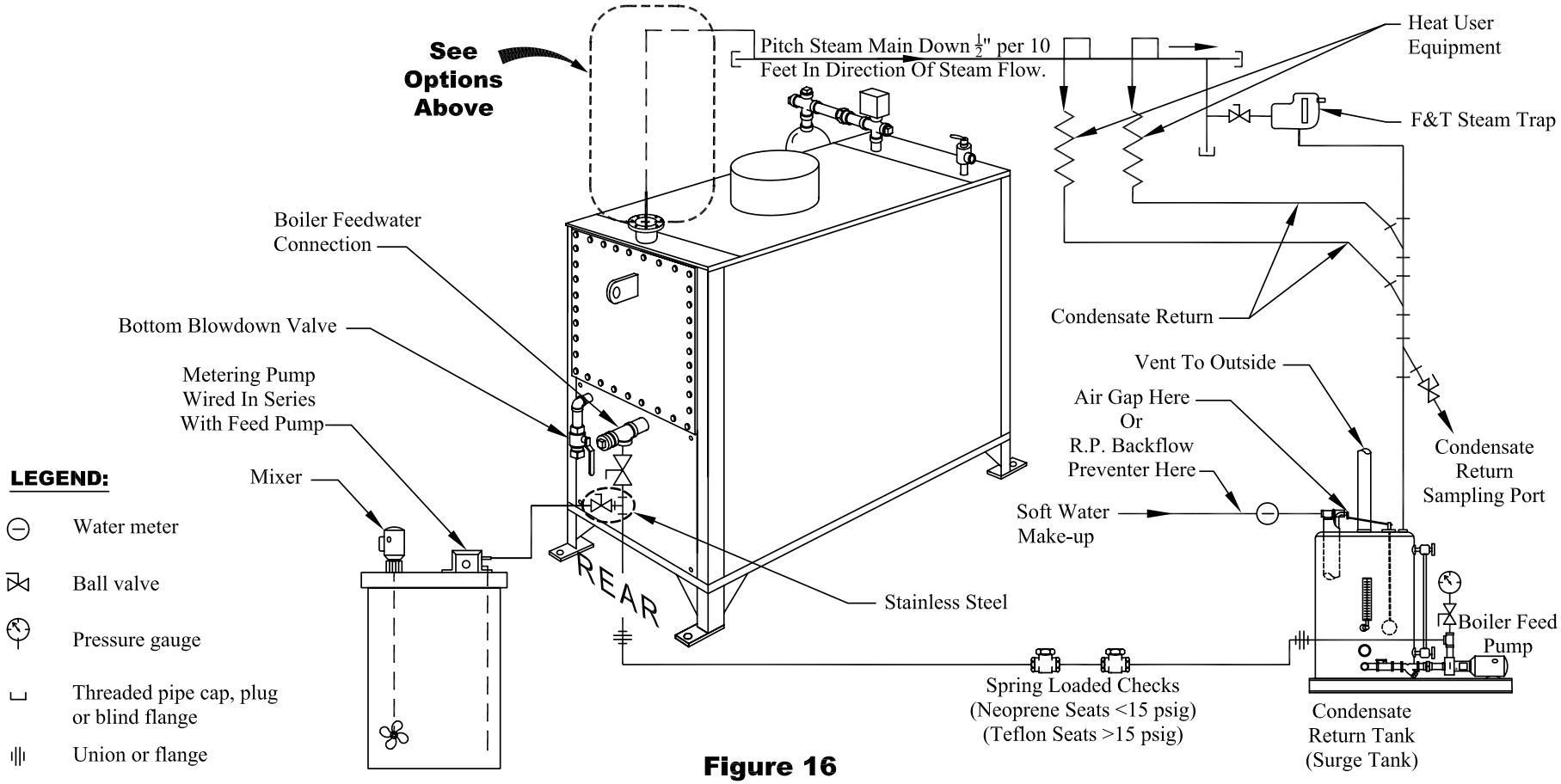
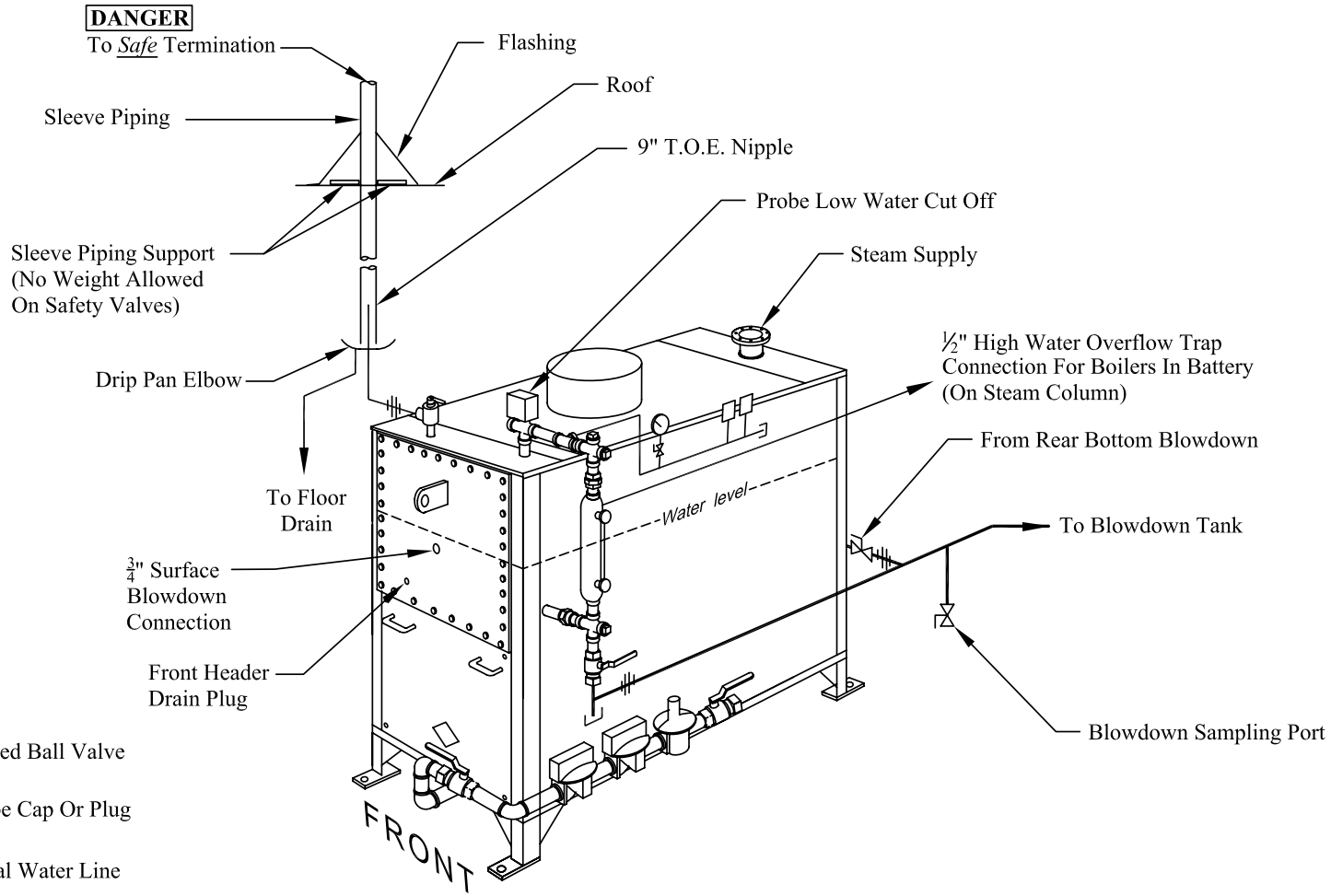


Figure 16

Rite Steam Boilers
Suggested Piping For Low Pressure Steam Boilers (15 psi)
Featuring Blowdown & High Water Overflow Valve Piping

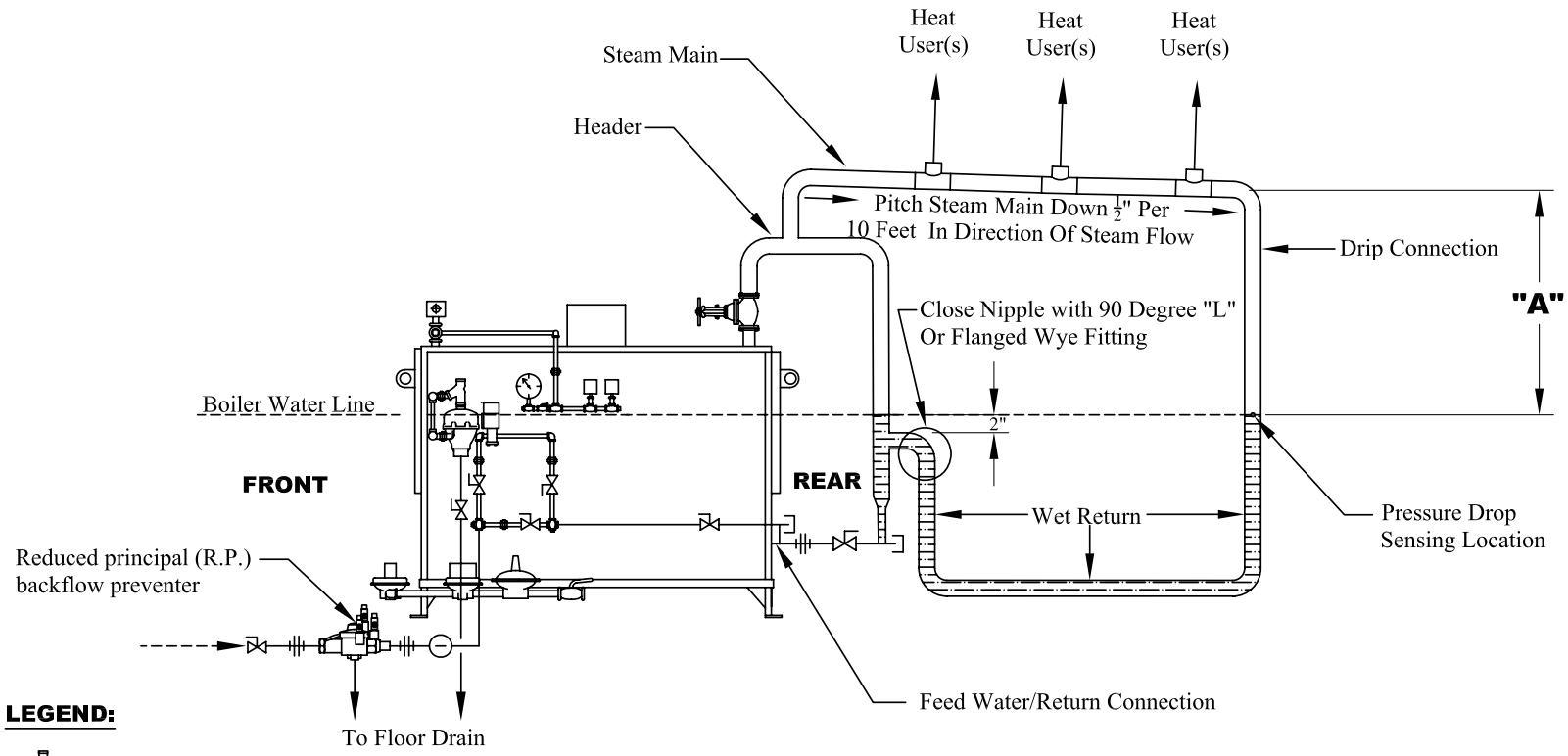


LEGEND:

- 150 WSP Rated Ball Valve
- Threaded Pipe Cap Or Plug
- Boiler Normal Water Line
- Schedule 80 Pipe & 300# Malleable Or Forged Steel Fittings
- Union or Flange
- Safety Relief Valve

Figure 17

Rite Steam Boilers
Suggested Piping For Low Pressure Steam Boilers (15 psi)
One Pipe System, Wet Gravity Return, With Hartford Loop



LEGEND:

- Combination water feeder/low water cutoff
- Water meter
- 150 WSP rated ball valve
- 125 WSP rated OS&Y stop valve
- Threaded pipe cap or plug
- Union or Flange
- Boiler pressure gauge

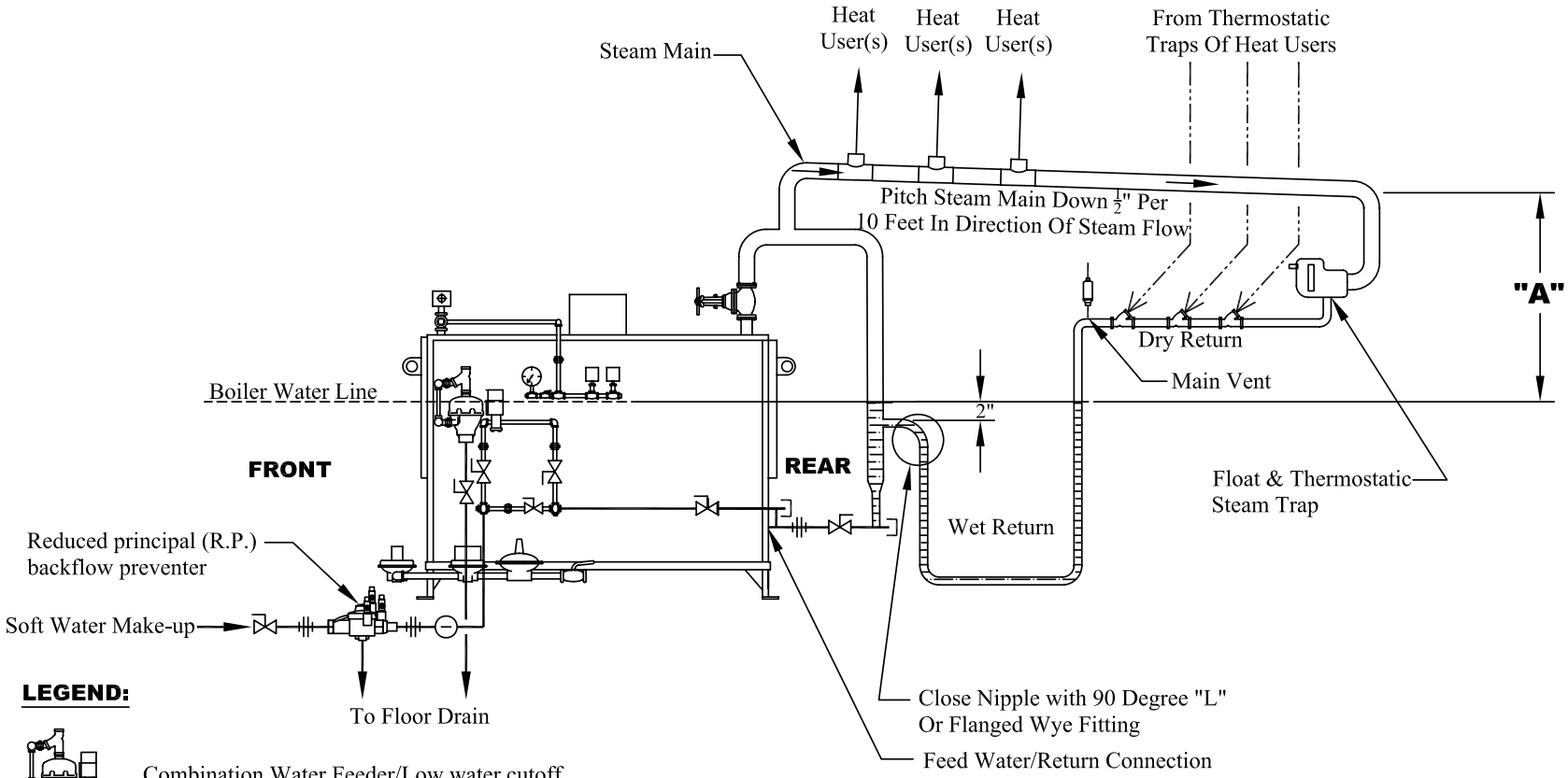
NOTE:

To prevent the steam pressure boiler from pushing the wet return back up into the steam main and to provide enough head in the wet return line to maintain the boiler water line - dimension **"A"** is important. If the pressure drop through the piping system is designed for ⅛ psi, then the minimum **"A"** dimension is 18". If the pressure drop is closer to ½ psi then the minimum "A" dimension is 28". The pressure drop is the difference between the boiler gauge pressure and the pressure at the pressure drop sensing location when the boiler is steaming.

Figure 18

Rite Steam Boilers

Suggested Piping For Low Pressure Steam Boilers (15 psi)
Featuring A Two Pipe System With Wet Gravity Return And Hartford Loop
For Extremely Low Boiler Operating Pressures (½ to 1 psi, see note)



LEGEND:

- Combination Water Feeder/Low water cutoff
- Water meter
- 150 WSP rated ball valve
- 125 WSP rated OS&Y stop valve
- Threaded pipe cap
- Union or Flange
- Boiler pressure gauge

NOTE:

"A" Dimension is critical on two pipe system with gravity return. Unlike one pipe systems where the boiler pressure is equalized throughout the system loop (minus only the pressure drop), steam traps used on a two pipe systems prevent the system pressure from helping push the condensate (wet return) back into the boiler. The column of water in the wet return pipe must therefore be high enough to overcome and fill against the boiler operating pressure. Using this system, a boiler operating at 10 psig would need an **"A"** dimension of ***23 feet***.

Figure 19

25 Year Non Pro-rated Thermal Shock Warranty

Rite engineering & Manufacturing Corp. warrants its Boilers against pressure vessel cracks and broken welds caused by thermal stress cycling (“thermal shock”) for a period of 25 years from the date of manufacture. The Warranty - non pro-rated - is limited to the replacement or repair of the pressure vessel when such damage is determined by Rite Engineering or an authorized Rite Representative to have occurred during normal operation*. The Warranty shall not cover damage due to freezing, dry firing, or excessive scale build-up. The Warranty is limited to damage to the boiler itself and expressly excludes all other consequential damage.

25 Year Non Pro-rated Tube Erosion Warranty

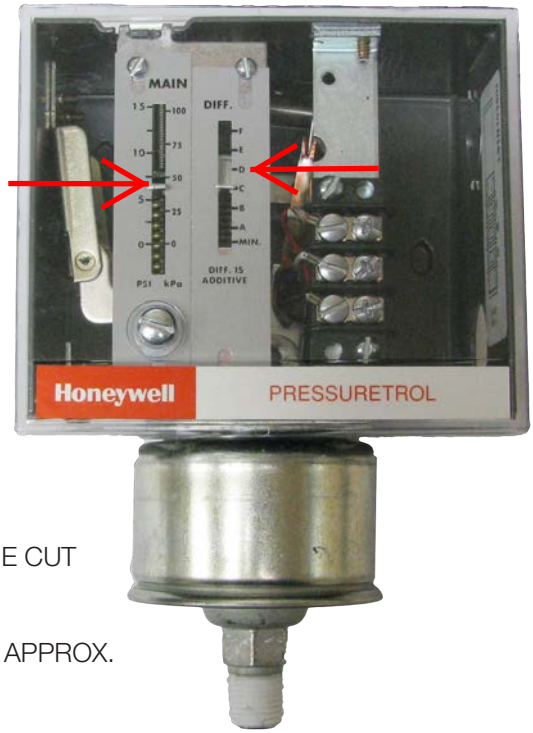
Rite Engineering & Manufacturing Corp. warrants its Boilers against waterside tube erosion for a period of 25 years from the date of manufacture. Waterside tube erosion - defined as the result of scrubbing action caused by high velocity water flow through a limited number of boiler tubes such as copper finned - will not occur to Rite Boilers because of our greater number of tubes and low pressure drop heat exchanger construction. The Warranty shall not cover damage due to oxygen, electrolysis or acidic corrosion. The Warranty is limited to damage to the boiler itself and expressly excludes all other consequential damage.

Additional Warranty Coverage

Rite Engineering & Manufacturing Corp. warrants its Boilers against defective parts and poor workmanship for a period of 18 months from date of shipment or 12 months from date of start-up - whichever occurs first. Controls, valves and instruments made by other manufacturers and installed on Rite Boilers are generally covered by the same warranty period. Misuse, neglect or exposure shall not be considered grounds for warranty claims. In no case shall Rite Engineering be held liable for any consequential damage including product loss, freight or replacement labor.

**Operating instructions specific to limiting thermal stress cycling may be found on pages 7 and 8 of this instructional manual.*

SETTING THE L91B 1035 PRESSURETROL



SETTING THE L91B 1035 PRESSURETROL

L91B MAIN SCALE SETTING IS SET AT APPROX. ½ OF THE CUT OUT SETTING ON THE PA404A.
(EACH LINE EQUALS APPROX. 2.5PSI)

L91B DIFFERENTIAL SCALE EACH LETTER REPRESENTS APPROX. 1.8 PSI INCREASE IN DIFFERENTIAL.
(A TO B = 1.8, A TO C = 3.6, A TO D = 5.4)

THE TOTAL OF MAIN PLUS DIFF. MUST BE LESS THAN THE SETTING ON THE PA404A.

EXAMPLE: PA404A SETTING IS 12PSI

L91B
MAIN SCALE SET AT ½ OF 12 = APPROX. 6.25
(HALF WAY BETWEEN 5 AND 7 ON THE SCALE)
DIFF. SCALE IS SET AT LETTER D
(1.8+1.8+1.8 = 5.4)
TOTAL IS 6.25 + 5.4 = 11.65 WHICH IS LESS THAN 12 PSI ON THE PA404A.

WARNING:

THE PRESSURETROL SETTINGS FOR MODULATION FOR HIGH FIRE OR LOW FIRE CANNOT EXCEED THE UPPER OR LOWER RANGE OF THE PA404A CONTROL SETTINGS. (A VALUE LESS THAN 0 (ZERO) IS NOT ALLOWED).

EXAMPLE:

IF THE PA404A IS SET AT 9PSI
THEN THE L91B MAIN WOULD BE SET AT 4.5
BUT THE DIFFERENTIAL CAN ONLY BE SET AT C MARK SINCE
4.5 + (1.8+1.8) = 8.1 PSI LESS THAN 9 PSI
4.5 – (1.8+1.8) = .9 PSI GREATER THAN 0 PSI

4.5 – (1.8+1.8+1.8) = -0.9 PSI <u>NOT ALLOWED IF IT WAS D</u>

CHECKING THE CORRECT OPERATION OF THE MODULATING PRESSURETROL AND THE MOTORIZED VALVE.

AS THE PRESSURE IN THE BOILER LOWERS FROM THE SET POINT ON THE PA404A, THE MOTORIZED VALVE WILL BEGIN TO MODULATE OPEN TO HIGH FIRE POSITION AND THE OHM READINGS WILL INCREASE ON AN OHM METER CONNECTED BETWEEN THE W AND B TERMINALS IN THE L91B.

AS THE PRESSURE INCREASES THE OHM READINGS WILL DECREASE ON THE METER AND THE MOTORIZED VALVE WILL MODULATE CLOSED TO A LOW FIRE POSITION.

MID RANGE OHM READINGS ARE ABOUT 140 OHMS AT APPROX. 6.25 PSI PRESSURE.

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