TW 1319

INSTALLATION MANUAL

MODULATIC WATERTUBE BOILERS

VAPOR POWER INTERNATIONAL

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1. GENERAL

1.1 The Vapor Power Modulatic boiler is a forced circulation watertube boiler that employs a small volume water coil as the heat exchange element and a vertical combustion and exhaust system. It is equipped with all the necessary operating and safety controls, feedwater pump, and steam separator. Assembly, electrical wiring, fire testing, and factory adjustments are complete.

1.2 Most models of the packaged Modulatic boiler (4748 excepted) are mounted on a flat steel deck plate which in turn mounted on a wooden shipping skid. The 4748 model and others built as specialties are mounted on a heavy structural steel base. Either method of mounting is designed to facilitate handling during shipment or installation.

1.3 This manual contains many helpful suggestions and recommendations for the proper installation of piping, wiring, stack arrangements, and various other factor which should be considered for a good installation. A well planned installation is essential to achieve maximum efficiency, ease of maintenance, and extended service life from boiler.

1.4 Figure 20 (page 35) illustrates a typical boiler installation of a unit which may be fired with either gas or oil.

2. UNLOADING

2.1 The Vapor Power Division recommends that experienced riggers handle the boiler when it is unloaded from its carrier and moved to the site of installation. Be sure that the equipment to be used can handle the weight of the boiler. Usually, a lift truck of adequate capacity, if available, is all that is necessary to handle the boiler.

2.2 Table 1 lists the various basic Modulatic boiler models and their approximate shipping weights.

APPROXIMATE SHIPPING WEIGHT

Boiler Model No.	Boiler Horsepower	Approximate Shipping Weight
4605	18	1500 Lbs.
4611	40	4000 Lbs.
4617	65	4200 Lbs.
4626	100	5300 Lbs.
4636	125	5900 Lbs.
4742	150	7200 Lbs.
4748	200	7700 Lbs.

Table 1

2.3 Vapor Power cannot be responsible for damage caused in transit. Uncrate your boiler when you receive it. Make any claims for damages to the carrier within the allowable time limit. Inspect the boiler again after the riggers have moved it into place so that any damage claims may be filed against them at this time. Notify Vapor Power immediately should a part be damaged so that a replacement can be obtained before start-up.

2.4 If your Modulatic has a flat deck plate, guard against bending it during handling. It is advisable to keep the shipping skid attached until you are ready to make the installation permanent. Removal of the belt guard will protect it from damage when the shipping skid is removed.

2.5 When moving the boiler or raising it, be sure that slings or jack are not attached to the piping, or apply stress to the boiler casing, controls, or accessories. Never raise the boiler from one corner only, be sure it is always lifted evenly.

2.6 Lifting eyes are provided in the boiler casing to facilitate servicing. These may also be used to lift the boiler when removing the shipping skid. Some models have only two front lifting eyes and may be raised by attaching a sling or hoist to a heavy pipe or solid bar inserted through the two openings in the stack. One of these openings may contain a stack switch or thermometer which must be removed before inserting the bar or pipe.

2.7 When openings are provided in the mounting skids, solid bars or heavy pipe may be inserted through them for lifting. Use spreader bars to prevent the sling from causing damage to the boiler when lifting.

3. **INSTALLATION**

3.1 Local authorities and your insurance company have jurisdiction over the installation of the boiler, related equipment and stack. They should be consulted before the installation is started, and any permits needed should be obtained.

3.2 Many insurance companies require boiler installations to be in accordance with the National Fire Protection Association (NFPA). Listed below are two of the applicable standards.

3.2.1 Standards for "Gas Piping and Gas Appliances in Buildings" is contained in pamphlet NFPA No. 54.

3.2.2 Standards for "Installation of Oil Burning Equipment" is contained in pamphlet NFPA No. 31.

3.2.3 Other applicable standards should be consulted as necessary. These may be determined by contacting the NFPA office in Boston, MA.

3.3 Consult your gas company regarding inlet gas pressure and capacity (CFM).

4. MOUNTING

4.1 If your boiler has a flat deck plate for a base it should be permanently mounted on a concrete pad approximately 4 inches high to provide elevation for protection.

4.2 If your boiler has a structural steel base, no special masonry support is necessary, except the boiler must be level. Make sure the base is in contact with the floor at all points. Use shims and grout with stiff cement to level the boiler as necessary.

4.3 The boiler must be level for all installations whether temporary or permanent.

4.4 The boiler must be mounted on a floor of noncombustible material that is pitched toward a sewer to provide for drainage.

4.5 Secure the boiler with bolts through the mounting holes in the boiler base. Bolts should be at least 1/16" smaller in diameter than the mounting holes to allow for tolerances in the bolt and mounting hole locations.

5. CLEARANCE

5.1 There must be sufficient clearance around and above the boiler for convenient servicing, and to meet code minimum requirements.

5.2 Three feet clearance on all sides of the boiler are generally recommended for convenient servicing. Four feet clearance should be allowed when the area is to be used as an aisle.

5.3 The boiler is disassembled from the top. A structural member capable of supporting at least 1000 pounds should be installed above the boiler to which a hoist can be installed as illustrated in Figure 1. At least four feet clearance above the boiler is required for this service operation.

5.4 If any of the boiler room walls are of combustible material, the National Fire Protection Association requires minimum clearances as shown in their Pamphlets
No. 31 and 54.

NOTE: The National Fire Protection Association code requires a fire resistance rating for boiler and boiler room walls, floor and ceiling. See the code for this rating.

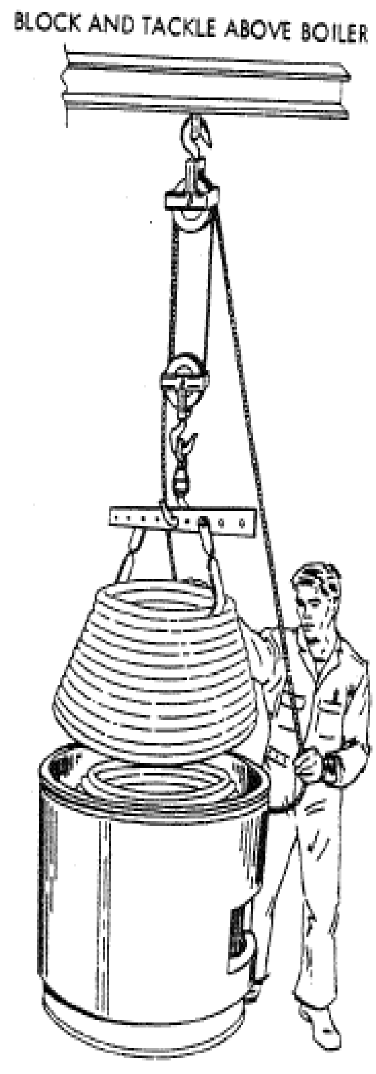


Figure 1, Boiler Servicing

6. COMBUSTION AND VENTILATION AIR REQUIREMENTS

6.1 Make sure the boiler room is properly ventilated. Accumulation of hot air (125°F. max.) near the boiler can cause overload elements to trip, relay malfunctions and other component failures. Lack of adequate combustion air and/or dusty air conditions, which can disrupt the boiler blower air flow, can result in smoke.

6.2 The number and size of air supply vent openings, as required by the National Fire Protection Association (NFPA) numbers 31 and/or 54, depends upon the type of fuel used and the type of enclosure in which the boiler is to be located. The <u>total free area</u> of the openings is based upon the <u>total gallons per hour input</u> for oil (Table 9) of the <u>total BTU per hour input</u> for gas (Table 10) for all boilers and appliances located within the enclosure. For example NFPA 31, for oil burning equipment, states that for boiler rooms adjacent to outside walls where combustion air is provided by natural ventilation from the outside, there shall be a permanent air supply inlet having a <u>total free area</u> of no less than 10 square inches per gallon per hour of total input rating. For a model 4636 boiler, fuel oil consumption at high fire is 38 gallons per hour (Table 9). <u>Total free area</u> = 38 x 10 - 380 square inches. For gas burning equipment NFPA 54 states that for a confined boiler room with all air supplied from outdoors, there will be two permanent openings, one commencing twelve inches from the top and one commencing within twelve inches from the bottom of the enclosure. <u>Each opening</u> to have a <u>minimum free area</u> of one square inch per 4000 BTU per hour of total input rating. For example, a gas fired model 4636 requires 5400 standard cubic feet per hour at high fire (Table 10). Assuming a 1000 BTU per standard cubic foot heating value; <u>total free area</u> = (5400 x 1000 x 2) divided by 4000 = 2700 square inches or 1350 square inches per opening.

6.3 If blowers are used to supply sufficient air to the boiler room, vent openings may not be required if such devices are approved by the authority having jurisdiction. If the air supply is dependent upon a blower, an interlock switch should be provided to prevent the boiler from firing if the blower fails.

6.4 Vent openings must be increased to compensate for the blocking effect of louvers, screens, guards and filters. For example, NFPA states that for an opening having metal louvers a free area of 75% may be assumed. The total free areas obtained in paragraph 6.2 must be increased thus, 380 divided by .75 = 507 square inches and 1350 divided by .75 = 1800 square inches to obtain the area of the wall opening.

6.5 The wall openings must also be increased to compensate for the cubic feet per minute of air being removed from the room by exhaust fans. The increase will be dependent upon the capacity of the fans.

6.6 A method of heating the boiler room, water piping, and the system equipment should be provided in the event the boiler is shut down and the ambient temperatures are below freezing.

7. STACK INSTALLATION - EXHAUST GASES

7.1 The recommended installation is to have the stack supported independent of the boiler and run straight up to the outside with drainage provided at the bottom. The boiler stack is brought into the main stack, not less than 45° above horizontal.

7.2 A vertical stack should extend through the roof and have provisions for drainage. The boiler should not be used to support the weight of the stack. (See Figure 2)

7.3 All stacks should be at least 5 feet above any adjacent wind obstructions and not less than 10 feet above the roof.

7.4 All stacks shall be provided with a drawband connection to the boiler for ease of boiler repair.

NOTE: Insulated on the stack should be installed so that it will not be destroyed when taken apart at the drawband.

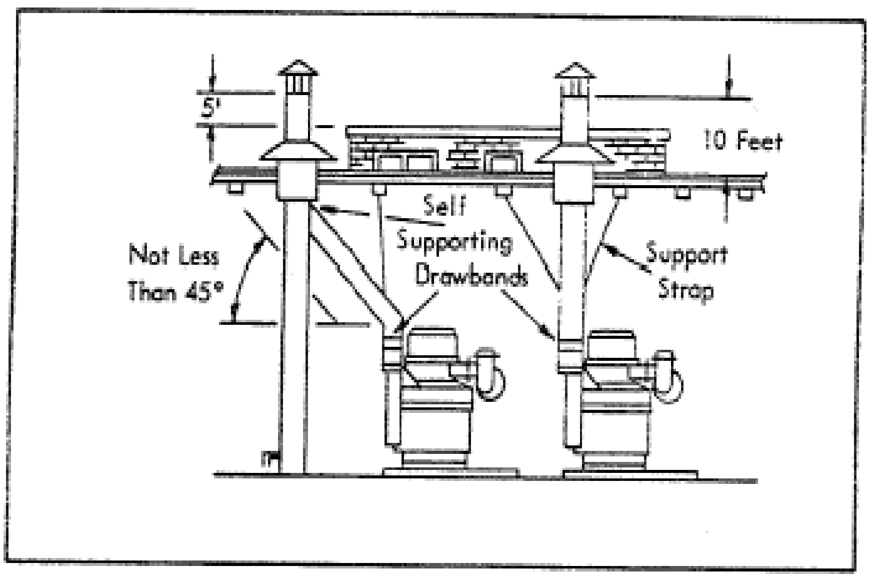


Figure 2, Recommended Stack Installation

7.5 The Vapor Power boiler is fired with a forced draft supplied by its own blower, therefore, the stack installation need add no draft through the boiler. However, the stack should be of sufficient size to provide free discharge of exhaust gases without back pressure. <u>Stack draft should not exceed -0.3 inches of water column</u> when the boiler is operating at high fire and the stack temperature has reached a steady value.

7.6 The Building Code Standards of the National Fire Protection Association require that where a metal stack passes through a combustible roof, such roof shall be guarded by a metal sleeve or thimble extending not less than nine inches above and below the roof, and providing not less than eighteen inches clearance on all sides of the stack.
(See Figure 3)

STACK REQUIREMENTS

Boiler Model No.	Stack Area (Sq. In.)	Stack Diameter (In. O.D.)
4605	50	8-1/8
4611	76	10
4617	76	10
4626	130	13
4636	130	13
4742	173	15
4748	250	18

Table 3

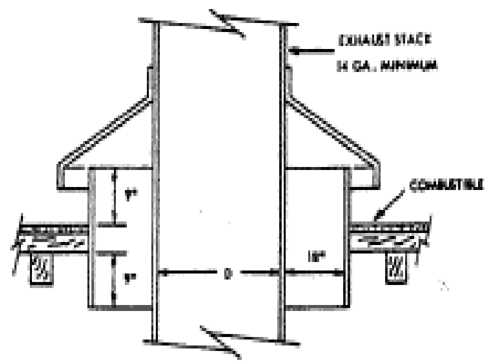


Figure 3, Smoke Stack Installation Through Combustible Roof

7.7 Horizontal runs should be pitched up 1/4 inch per foot, and the diameter of the pipe should be increased 5% over the preceding pipe diameter at each 10 foot interval in the horizontal run. A 10% increase in pipe diameter over the preceding diameter must be made at each elbow. (See Figure 4) Horizontal runs should be provided with a clean out door. Round stacks and breeching are preferred.

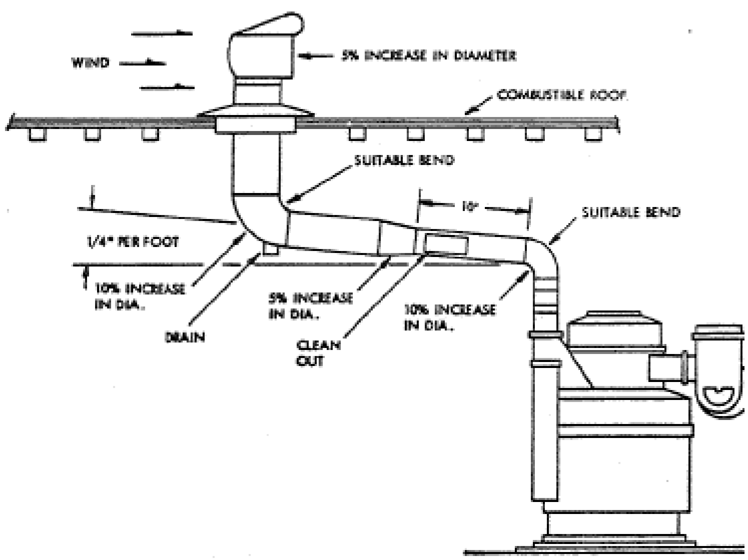


Figure 4, Stack Installation With Horizontal Run

7.8 The stack should be designed with the required bracing, or hangers to be self-supporting. (See Figure 2) A section of the stack should be removable to permit inspection for corrosion and soot buildup. An inspection door or panel may be inserted if removal of a section of the stack will be difficult. The minimum recommended material thickness for stacks and breeching is 14 gauge.

7.9 The stack should be protected against down drafts, back drafts, and rain with a simple flat or cone-shaped cap. (See Figure 5) Make sure the area between the cap and stack is at least equal to the area of the stack. Protect all steel work from corrosion.

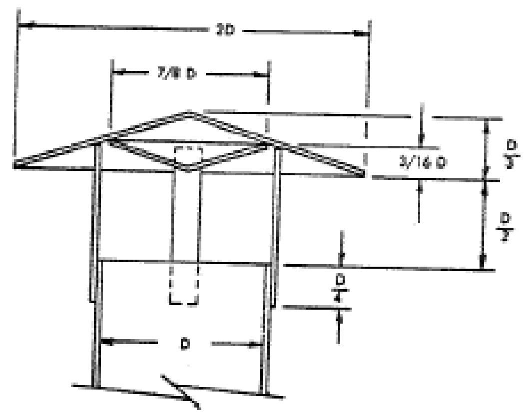


Figure 5, Stack Rain Cone

7.10 In areas where unusually high draft conditions prevail a method of reducing the draft is necessary. An orifice, barometric damper or adjustable damper must then be installed in the exhaust stack to reduce the draft to the limits indicated in paragraph 7.5.

7.11 The ideal draft regulator is an electric or hydraulic automatic positioning type. These regulators maintain a constant draft on the boiler under all variances of boiler firing rates and atmospheric conditions.

7.12 When it is necessary to increase draft from what is available the height of the stack must be increased or an induced draft fan installed in the exhaust system.

7.13 If more than one boiler is to be connected to a single main stack, the cross sectional area of the main stack must be equal to, or greater than, the sum of the areas of all connecting stacks.

7.14 In cold climate regions and/or regions of high humidity, a shutoff damper must be installed in each stack. When closed, the shutoff damper will prevent the boiler coils from freezing or sweating by outside air that is drawn into the boiler when it is shutdown. This is applicable to a boiler installation with multiple stacks or an installation with a single stack in a building with depressed atmospheric pressure.

8. STEAM OUTPUT

8.1 An adequate supply of water must be available to operate the boiler. Table 4 indicates the equivalent evaporation rates of various boiler models rated from and at 212°F.

8.2 Actual evaporation rates or steam output, depend upon the feedwater (water entering the boiler) temperature and the boiler operating pressure. To determine your actual evaporation refer to Figure 6 and follow the example below.

If you have a 100 BHP boiler operating at 100 psig with 120°F feedwater, enter Figure 6 at the 100 psig point and proceed upward until that grid intersects the curve for 120°F feedwater. Read the scale at left which indicates an actual evaporation of 30.4 pounds of steam per boiler horsepower. Multiplying by 100 BHP equals 3040 pounds of steam. This means that the actual evaporation for a 100 BHP boiler operating at 100 psig is 3040 pounds of steam per hour.

EQUIVALENT EVAPORATION RATES

Boiler Model	Boiler Horsepower	Evaporation, Lbs/Hr (From and At 212°F)
4605	18	620
4611	40	1380
4617	65	2240
4626	100	3450
4636	125	4312
4742	150	5175
4748	200	6900

Table 4

9. FEEDWATER SYSTEM

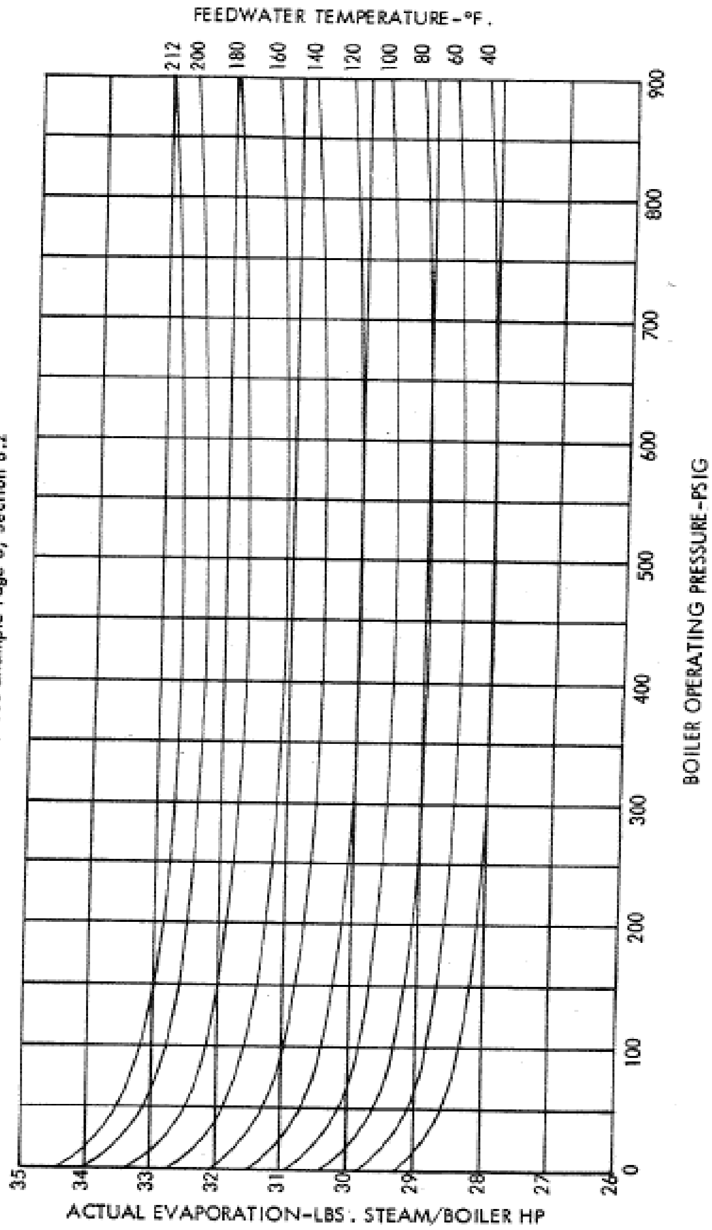
9.1 Feedwater Supply

9.1.1 The feedwater supply (or make-up) tank should be large enough to hold a sufficient quantity of water for a few minutes operation (approximately 20) when large amounts of condensate from the system cannot be returned. Table 5 indicates the recommended feedwater reserve quantities and tank sizes for the various boiler sizes.

9.1.2 When sizing the feedwater supply tank the condensate capacity of the system should be considered. The feedwater tank should also be large enough to accommodate the quantity of condensate being returned after a boiler a system shutdown plus the expansion that will occur on startup when the feedwater is heated.

FACTORS OF EVAPORATION

NOTE: See Example Page 8, Section 8.2



RECOMMENDED FEEDWATER RESERVES & TANK SIZES

Boiler Model	Boiler H.P.	Feedwater Reserve Quantities (Gallons)	Feedwater Tank Size (Gallons)
4605	18	30	80
4611	40	55	100
4617	65	100	210
4626	100	140	210
4636	125	175	300
4742	150	210	430
4748	200	275	510

Table 5

9.1.3 When a float valve is used to control admittance of incoming make-up water, it should be sized large enough to permit flow equivalent to the full boiler output capacity. It is also good practice to install a bypass line, with shutoff valve, around the automatic float valve.

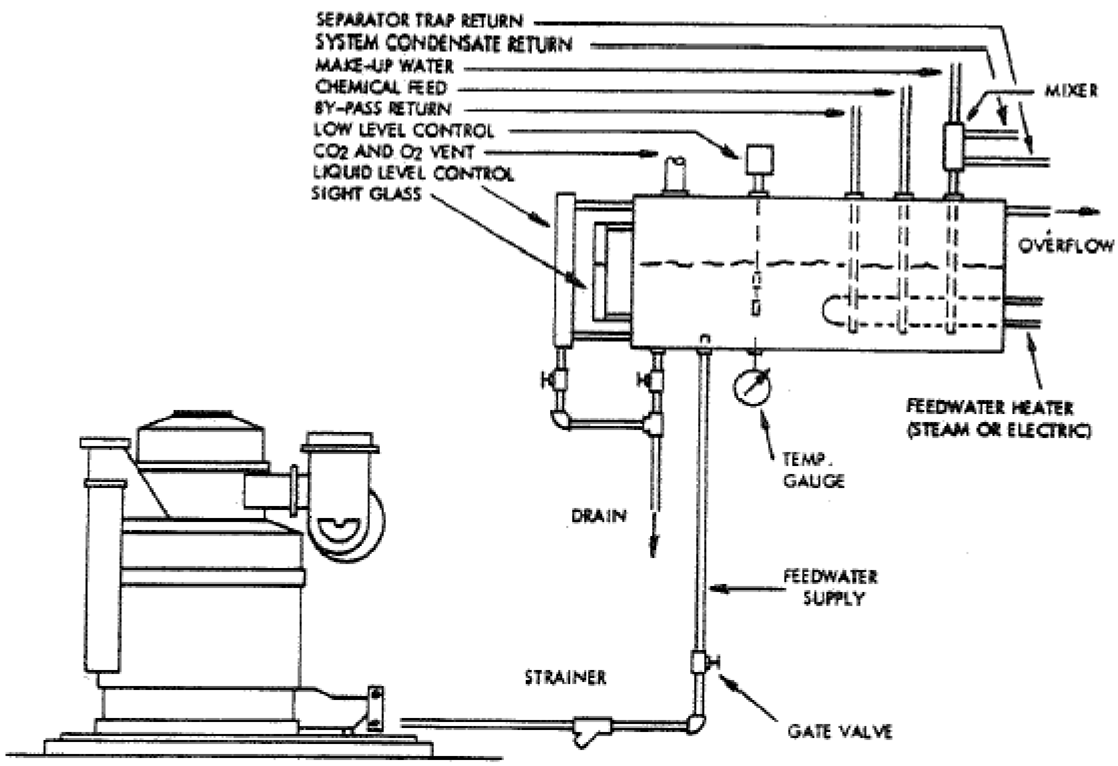


Figure 7, Water Tank Installation (See Page 35)

9.1.4 It is not good practice to connect the boiler feed pump directly to a water main. The pump inlet should be connected to a feedwater supply (or make-up) tank which will serve as a reservoir for the softened make-up water, system return condensate, boiler steam separator trap return condensate, boiler feedwater pump bypass water return, and after treatment chemicals. Figure 7 illustrates a typical water tank installation.

9.1.5 A gate shutoff valve should be installed in the line between the feedwater supply tank and the boiler feedwater strainer so that the strainer can be cleaned and the pump serviced without draining the tank.

9.1.6 In some systems, commercial deaerators are installed to remove oxygen and other undesirable gases from the feedwater by deaeration. In such cases the commercial deaerator apparatus will usually serve as a feedwater supply reservoir, also.

9.1.7 Not all of the water pumped through the boiler is evaporated. The unevaporated water is collected in the steam separator. A substantial portion of this water is returned to the feedwater supply tank through a steam trap mounted on the boiler. The remainder is blown out as sludge to the sewer. A pressure gauge and shutoff valve should be connected to the trap outlet piping to serve as a flow indicator. When the boiler is operating properly the pressure will rise and fall with each trap cycle. Open the valve only to check the trap operation. The trap should cycle about 5 to 7 times per minute.

9.1.8 The water pump relief valve connection should be piped to a sewer or a sump.

9.1.9 When piping a single boiler installation with lines not exceeding 100 feet in length, use pipe sizes no smaller than those listed in Table 6. For multiple boiler installations and/or lines exceeding 100 feet in length a corresponding increase in pipe size must be made to compensate for the increased flow rates and pipe restriction due to length. If this is not done correctly a booster pump may have to be added later.

BOILER WATER CONNECTIONS

Boiler Model No.	Feedwater Inlet Connection (Inch)(NPT)	Bypass Return (Inch)(NPT)	Separator Condensate Return (Inch)(NPT)	Fill Test Valve (Inch)(NPT)	Water Pump Relief Valve (Inch)(NPT)
4605	1 1-1/2*	1/2	1/2	3/8	1/2
4611	1-1/4 1-1/2*	3/4	1/2 & 3/4*	1/2	1/2
4617	1-1/4 1-1/2*	3/4	3/4	1/2	1/2
4626	1-1/2 1-1/2*	3/4	3/4 & 1*	1/2	1/2 & 1*
4636	1-1/2 1-1/2*	3/4	1	1/2	1/2
4742	2 2 *	3/4	1	1/2	1/2
4748	2 2 *	3/4	1	1/2	1/2 & 1*

Table 6

* For boilers designed at 900 psig maximum working pressure.

NOTE: Table 6 connection sizes are typical for boilers with designed maximum working pressures to 900 psig. However, consult the installation drawing for your unit to obtain specific sizes.

9.1.10 The fill test valve connection should be piped to a sewer or sump. However, since this valve is only used to determine that the boiler coils are filled with water prior to being fired, the exit should be clearly visible so that the boiler operator can observe the water flow.

9.1.11 Vapor Power does not recommend a boiler feedwater temperature for continued operation low enough that will permit the exhaust gases to fall below 220°F. This feedwater temperature is approximately 120°F. Lower feedwater temperatures will allow water vapor in the exhaust gases to condense on the coil surface and boiler casing surfaces with resultant corrosion loss. Also, low feedwater temperatures allow more oxygen and carbon dioxide to remain in solution i.e., 120°F water can hold 6 ppm O_2, 150°F water can hold 4.3 ppm O_2, etc.

9.1.12 When pumping feedwater at elevated temperatures it is necessary to maintain a positive head of water on the suction side of the feedwater pump. This is done by elevating the feedwater supply (or make-up) tank or by using a booster pump. Table 7 indicates the recommended minimum suction head requirements for various water temperatures when the boiler installation is at various altitudes.

NOTE: Water temperature in excess of 200°F will reduce pump packing life.

* MINIMUM SUCTION HEAD REQUIRED
TO PUMP HOT WATER (Feet H_2O)

Altitude Feet	Temperature - °F			
	195	200	210	220
Sea Level	6	8	14	15
2000	8	10	16	17
4000	10	13	19	20
6000	12	15	21	22
8000	14	17	23	24

Table 7

* When a feedwater pump inlet shut-off solenoid valve is used add 1 additional foot to minimum head requirements.

9.2 Feedwater Treatment

9.2.1 Every boiler made today is subject to premature failure if its water is not properly treated for scale and corrosion prevention. Consult a reliable water treatment company before the boiler is installed. It is the responsibility of the boiler owner to see that the feedwater to the boiler is continuously free of scale formers and corrosion potentials.

This can best be done by setting up a water treatment system and program under the guidance of a reliable water treatment company. The treatment and program should be based entirely on a complete analysis of the raw water and the needs of the boiler and the users system. A daily log should be set up and maintained to show the important properties of the boiler waters as the result of the specified water treatment. The water treatment company and user should be responsible for periodically examining the log for correct procedures and acceptable water conditions. The boiler manufacturer cannot be held accountable for the adverse results of scale or corrosion. (See Figures 11 and 12 for sample log sheets)

NOTE: Your water treatment consultant should recognize this boiler as a once-through type which means that the most important water is the water about to enter the heat exchanger coils, and not the concentrated water in the steam separator. A special valve has been placed on the boiler feedwater pump for obtaining a sample of this water for analysis. (See Figure 8)

9.2.2 Water treatment for any boiler has two main functions: the first being prevention of scale on the inside tubing walls; the second being the prevention of corrosion of the tubing walls, other boiler parts, and the users system.

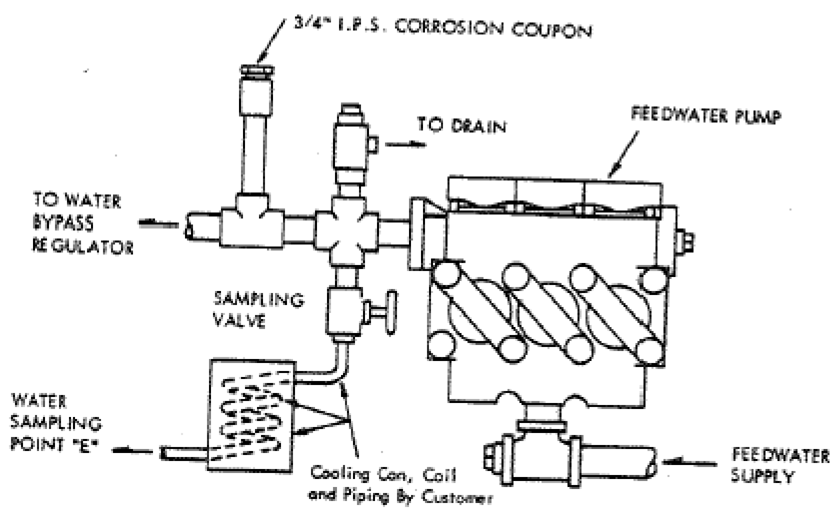


Figure 8, Typical Pump Piping

9.3 Prevention of Scale on Heat Exchanger Walls

NOTE: Boiler tubing scale cannot only reduce the tubing life, but it also reduces heat transfer efficiency. Your boiler was tested and rated with clean boiler tubing.

9.3.1 Water hardness indicates the amount of the two principle scale formers, namely, calcium and magnesium. They form scale with the carbonates ($Ca\ CO_3$), the hydroxides ($Mg(OH)_2$), the sulfates ($Ca\ SO_4$), and the silicates ($Ca\ Si\ O_2$). Their removal via a softener eliminates these types of scale formation, but silica can form a very troublesome scale without calcium or magnesium.

9.3.2 Another type of scale that must be taken into account is formed from dissolved iron. Similar to the other scales, it forms in the hottest region of the system which is the boiler heat exchanger tubing. Like calcium sulfate and silicate, it cannot be readily removed once formed. For these reasons, calcium, magnesium, sulfate, dissolved silicate, and dissolved iron must be measured in the raw water to the plant. Once measured, the water treatment consultant can pass judgment on whether the amounts warrant certain treatments for either their removal or reduction.

9.3.3 Scale forming ingredients are removed by many different methods, but the two most common ones are the sodium zeolite softener or the demineralizer with certain types of after treatment. The after treatment takes care of any hardness that occasionally gets through the softening equipment.

9.3.4 For normally encountered water, sodium zeolite softener has proven to be one of the better methods of removing calcium and magnesium hardness. It also slightly raises the alkalinity (pH) in the softened water which helps to protect the system from corrosion.

9.3.5 The size of the softener is determined by the amount of hardness to be removed, the required flow rate, the total flow desired between regenerations, and the use factor. The latter must be taken into account if operation were to be 24 hours per day for five to seven days per week. Twin softeners would be necessary so that while one was handling the water load, the other would be regenerating. Make certain that a knowledgeable water consultant takes all of these items into account for the sizing calculations.

9.3.6 If dissolved silica appears in the raw water analysis, ask your water treatment company whether the amount warrants the use of a demineralizer instead of a zeolite softener. They are best suited to answer this question since a combination of their proprietary compounds, other chemicals present, and operating conditions permit vary levels of dissolved silica. A demineralizer will remove calcium, magnesium, and silica as well as many other ions, e.g., sulfate, chloride, nitrate, etc. In effect, the total dissolved solids are reduced.

9.3.7 A certain amount of silica can be tolerated and kept from precipitating out in the boiler coils by control of other properties, i.e. zero calcium, zero magnesium, high pH, and small amounts of phosphate. This should be checked out with the chemists associated with your water treatment company. As with the softener, demineralizer sizing must be carefully considered.

9.3.8 Some water treatment companies list 3 ppm of dissolved iron as possibly being harmful. Others allow more or less depending on their experience with this species. They should be consulted for the allowable amount and a recommended treatment if it is exceeded. Some companies recommend phosphates while others recommend lignins. Remember that dissolved iron can not only be coming in with the raw water, but large amounts may be coming in with improperly treated return condensate. Periodic checks should be made on this water especially if its pH is below 8.

9.3.9 Chemical aftertreatments are added to the feedwater to take care of any small amounts of hardness that may pass through the softeners or demineralizer. Some examples of aftertreatment are: (a) Phosphates, (b) Carbonates, (c) Chelants, (d) Polymers, (e) Combinations of above. Consult your water treatment representative for the best method compatible with the boiler and your system. Note that chemical aftertreatment without softening is not satisfactory. The rate of scale buildup is reduced, but it is not eliminated.

NOTE: When conditions are such that scale due to calcium and magnesium hardness forms in the coils, washing with an inhibited acid is necessary. Complete washout instructions are available in other Vapor Bulletins. There is no known washout procedure for silica scale.

9.4 Prevention of Boiler Corrosion

9.4.1 Oxygen corrosion and acidic corrosion (low pH) are the two types that must be prevented. As stated previously, sodium zeolite softened water leaves a slight protective alkalinity. However, in most cases it is necessary to add a caustic with the aftertreatment to increase the pH of the feedwater to within the range of 9.0 to 10.0. This will prevent acidic corrosion and inhibit oxygen corrosion. It will not eliminate oxygen corrosion, just slow it down. The only way to stop oxygen corrosion is to reduce oxygen to zero.

9.4.2 Addition of caustic soda (Na OH) or soda ash ($Na_2\ CO_3$) are two ways of increasing the pH of boiler feedwater. The caustic soda increases the pH immediately by increasing the OH anion. The soda ash must wait until heat causes it to break down to form the OH anion.

$$Na_2\ CO_3 + H_2O \xrightarrow{\text{Heat}} CO_2 \overset{\text{Gas}}{\uparrow} + Na\ OH$$

The problem with the soda ash reaction is the formation of CO_2 gas which if not allowed to escape in the feedwater tank will pass through the boiler with the steam. Corrosion of the condensate system could be the result. Dissolved iron would find its way back to the feedwater tank. This effect has already been discussed. Note that the soda ash reaction could take place in the boiler heat exchanger rather than the feedwater tank. For sure, the CO_2 gas would find its way into the condensate system. Sufficient neutralizing amines would have to be added to the boiler feedwater to compensate for this new amount of CO_2 gas.

9.4.3 The two gases, dissolved oxygen (O_2) and dissolved carbon dioxide (CO_2), must be eliminated from the feedwater. The best method of accomplishing this elimination is through a well designed deaerator. If this is impossible or impractical, a well designed feedwater tank or condensate receiver is the next best thing. It must heat the boiler feedwater to from 205°F to 210°F and be vented so that the O_2 and CO_2 can easily escape to the atmosphere. See Figure 9 for an acceptable feedwater tank design. Even at 205°F to 210°F, some O_2 will remain in solution. (See Figure 10). This remaining O_2 must be removed by using an oxygen scavenger such as catalyzed sodium sulfite or hydrazine. The O_2 scavenger must be added to the feedwater tank at a point where it will intercept the new waters entering the tank. This is shown in Figure 9. It must have sufficient residence time (preferably in the tank) to react with any dissolved oxygen before it can do any damage to the tank, the piping, or the boiler. For this reason catalyzed sodium sulfite is preferred over uncatalyzed sodium sulfite or hydrazine. It reacts much faster than either of these. Catalyzed sodium sulfite contributes to total dissolved solids, creates sulfates with the oxygen, and cannot be used over 600 psi. These possible problems can be resolved by the water treatment company, Hydrazine does not contribute to TDS.

NOTE: The effect of sulfite or hydrazine treatment is judged by the residual amount remaining in the boiler feedwater. It is recommended that oxygen be also measured at the same point. There are economical, easy to use instruments now on the market that will accurately measure oxygen.

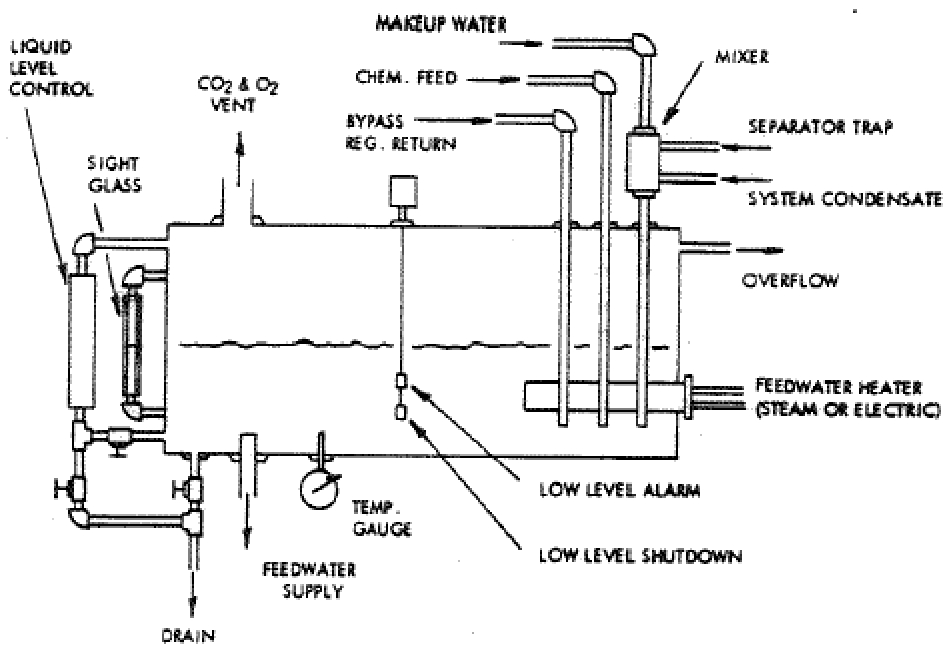


Figure 9, Recommended Feedwater Tank Design

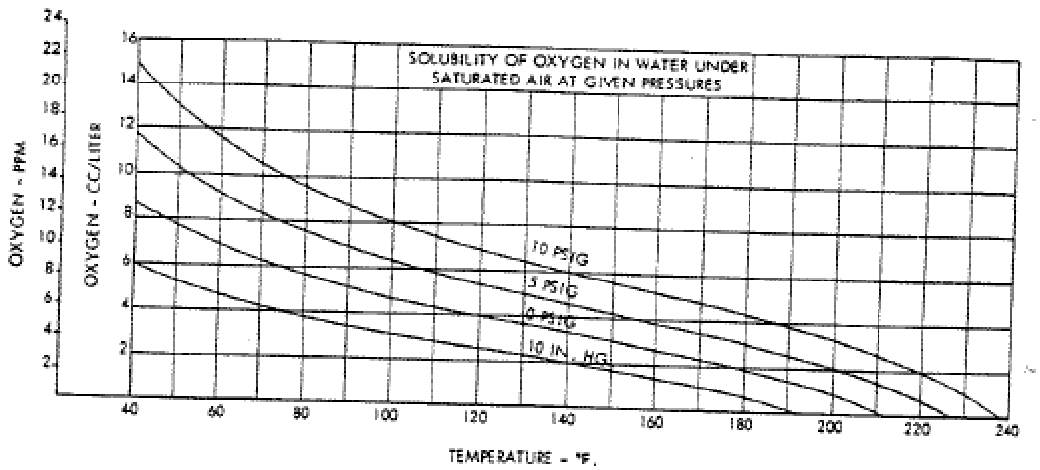


Figure 10

9.4.4 Even if all of the CO_2 is driven off in the heated feedwater tank, more will be generated in the boiler from the bicarbonates. This CO_2 will go off with the steam and create carbonic acid in the condensate lines. Neutralizing and/or filming amines are added to the feedwater preferably downstream of the feedwater tank. They also go off with the steam and either coat the piping with a protective film or neutralize the carbonic acid before it can damage the steel jackets and pipes.

NOTE: Volatile amines in the feedwater tank may be driven off with the oxygen and carbon dioxide; hence, they should be entered downstream of feedwater tank.

9.4.5 As a further more positive check, corrosion coupons should be inserted in the boiler feedwater line and in the condensate return line. These can be obtained from your water treatment company. See Figures 8 and 20 for locations.

9.5 Water Sampling

9.5.1 Figure 20 shows five sampling points for water analysis. Of course, the raw water sample is taken and analyzed before prescribing any water treatment. (Point "C", Figure 20) It should be checked at least once a year thereafter to see if it is changing.

9.5.2 The softened water sample is taken at point "D" in Figure 20. The analysis of this water checks the softener operation before a malfunction causes the feedwater tank to be loaded with either hard water or water high in chloride. The benefits of catching a small hardness leak before it gets out of hand needs no explanation. Chlorides greater than the raw water amount indicates that the softener regeneration time is too short.

9.5.3 The most important water relative to the boiler is the water about to enter the boiler coils. This is shown as point "E" in Figure 20. Changes in water treatment must be based upon an analysis of this water and not upon water in the steam separator or accumulator. (See Table 8)

BOILER FEEDWATER REQUIREMENTS
(Required at Sampling Point "E" Page 35)

WATER PROPERTY	PREFERRED RANGE
Total Hardness (CaCO3)	0.0 ppm **
pH	8-9.5
Sulfate (as SO_4)	0-50 ppm
Total Alkalinity ("M") $CaCO_3$)	150-400 ppm
Partial Alkalinity ("P") $CaCO_3$)	Greater than 1/2"M" ppm
Hydrate Alkalinity ("O") $CaCO_3$)	(2 "P" minus "M") ppm
Carbon Dioxide (CO_2)	0 ppm
Oxygen (O_2)	0 ppm
Sulfite (SO_3)	25-50 ppm
Total Dissolved Solids	Less than 850 ppm
Silica (SiO_2)	0-5.5 ppm
Iron (Dissolved)	0-1 ppm

Table 8

* Consult with water treatment company.

** A temporary hardness of 5 ppm can be tolerated for five days. Periodically check pump discharge pressure, under identical conditions, to gauge amount of scaling. Pump discharge pressure of 50 psig over original pressure indicates the coils should be acid washed.

9.5.4 The most important water relative to the system load is the return condensate. (Point "F", Figure 20) If it has low pH or high dissolved iron, corrosion is taking place. If the total dissolved solids or chlorides are high, carryover may be taking place. Also the system may be leaking process material into the condensate line.

9.5.5 The steam separator water sampling point is also shown in Figure 20 at point "G". Relatively speaking, it is the least important water of all. It has passed through the boiler and a large portion of it will be sent to the sewer. Some is trapped back to the feedwater tank. This returned water has unused chemicals and heat which could be put to use in the feedwater. That is its only importance. It is analyzed for what it is sending back to the feed tank.

9.6 <u>Water Analysis</u>

9.6.1 The Vapor Company relies heavily on the purchaser of the boiler to employ the services of a reliable and knowledgeable water treatment company. We specify only these required water properties that we are certain of, and leave the more complex conditions to the water chemist. For instance, water treatment companies state that setting limits on soluble silica depends on many parameters that only a water chemist can specify. As a result, Vapor must rely on these people to determine whether the amount encountered in the raw water requires the use of demineralizers rather than zeolite softeners. The same thing can be said for dissolved iron.

9.6.2 Since the boiler <u>feedwater</u> is the most important water, Vapor`s comments are centered on this water. The desired total dissolved solids are from 350 to 400 ppm, but satisfactory operation can be achieved at up to 850 ppm.

9.6.3 Desired hardness is zero, but temporary hardnesses of 5 ppm have not altered efficient operation. Correct after treatment can easily handle 5 ppm hardness.

9.6.4 We would like the pH to be between 9 and 10 with 9.0 preferred. If phosphates are used in the treatment program they tend to get sticky below 9.6. Also, we know that the bicarbonates will increase the pH by 1 to 1.5 when they decompose under heat. This depends upon the permissible alkalinities in the feedwater. Here again is a place for the water treatment company to contribute their expertise. If the alkalinity is such that the pH reaches 12 at the boiler outlet caustic embrittlement can take place. The threads in threaded connections can be eaten out with resultant steam leaks.

9.6.5 Without reservations, the dissolved oxygen and carbon dioxide should be zero. Correspondingly the excess sulfite should be 20-30 ppm. See Table 8 for recommended limits on feedwater properties.

NOTE: See Figures 11 and 12 for typical water and boiler operation log sheets. They should be used at least once per day. Blank log sheets may be found in your Instruction Manual.

DAILY BOILER LOG

COMPANY________ LOCATION________ BOILER TYPE________ STARTUP DATE________

Boiler No.	Units							
Date	—							
Time	—							
Data Taken By	—							
Timer	Hours							
Servo Pin No.	—							
Water Pump Press.	PSIG							
Steam Press Panel/Header	PSIG	/	/	/	/	/	/	/
CTC-Inner Temp/Press	°F / PSIG	/	/	/	/	/	/	/
CTC-Lower Temp/Press	°F / PSIG	/	/	/	/	/	/	/
Stack Temp	°F							
Feed Water Temp	°F							
Oil Press (Servo)	PSIG							
H_2O Pump Speed	RPM							
Water Meter Reading	Gal							
Boiler Trap Cycles	Times/Min							
Boiler Blowdown	Sec/Min	/	/	/	/	/	/	/
PROBLEM / ADJUSTMENT								

VAPOR CORPORATION, CHICAGO, IL

Figure 11

DAILY LOG OF WATER CONDITIONS AT ____________ IN ____________ BOILER TYPE ____________
WATER TREATMENT CO. ____________ TYPE CHEMICALS ____________ DATE START ____________
COMMENTS

WATER OUT OF SOFTENERS

Date/Time	Units	Limits	/	/	/	/	/	/
Soft No./pH	—	—	/	/	/	/	/	/
Chloride	ppm Cl	0-50						
Hardness	ppm $CaCO_3$	0						
Make-up Flow	Gal/Min	—	/	/	/	/	/	/

WATER INTO BOILER COILS

Boiler No./By	—	—	/	/	/	/	/	/
Hardness	ppm $CaCO_3$	0-Trace						
pH	—	8-9.5						
'P' Alkalinity	ppm $CaCO_3$	80-220						
'M' Alkalinity	ppm $CaCO_3$	150-400						
'O' Alkalinity	ppm $CaCO_3$	1-20						
Sulfite (Hydrazine)	ppm SO_3 (ppm Hyd)	25-50 (1-2)						
Chloride	ppm Cl	0-50						
Feedwater Temp	°F.	200-210						
Oxygen	ppm O_2	0.0						
TDS (Conductivity)	ppm (Micromho/cm)	850 (1300)						
Dissolved Iron	ppm Fe	0-1						
Corrosion Coupon	No./Date Applied	—	/	/	/	/	/	/

BOILER SEPARATOR, ACCUMULATOR WATER OR WATER OUT OF BOILER COILS

TDS (Conductivity)	ppm (Micromho/cm)	8500 (11000)						
pH	—	10-11.5						

CONDENSATE RETURN WATER LOCATED AT

TDS (Conductivity)	ppm (Micromho/cm)	0-15 (0-27)						
pH	—	7.5-8.5						
Corrosion Coupon	No./Date Applied	—	/	/	/	/	/	/

VAPOR CORPORATION CHICAGO, IL

Figure 12

10. FUEL SUPPLY

10.1 Oil and Combination Fired Boilers

NOTE: Combination units being fired on gas require oil to operate boiler controls.

10.1.1 Select a supply tank of adequate capacity using Table 9 and paragraph 10.1.2.

10.1.2 The following method may be used to determine the minimum size of the fuel tank.

If you have a Model 4626 boiler it will burn 30 gallons of No. 2 fuel oil per hour (at high fire). For an eight hour day and seven days a week, you will need 8 x 30 x 7 = 1680 gallons of fuel per week. We recommend a tank that will hold a minimum of two weeks supply.

NOTE: Before selecting the size of your oil storage tank check with your fuel oil supplier to find the most economical quantities in which to order, as it could be a major factor in determining the tank size.

FUEL CONSUMED, GATE VALVE AND FUEL LINE SIZES

Model Size	Fuel Consumed at High Fire using No. 2 Fuel Oil (Gallons/Hour)	Fuel Suction Line (NPT)(Inch)	Fuel By-Pass Line (NPT)(Inch)
4605	5.5	1/2	1/2
4611	12	3/4	1/2
4617	20	3/4	1/2
4626	30	3/4	1/2
4636	38	3/4	1/2
4742	47.5	3/4	1/2
4748	60	1	3/4

Table 9

10.1.3 Install the fuel tank outside if possible (underground is preferred and as near to the boiler as codes permit. Many local codes designate particular locations. Keep suction lines as short and as free of fittings as possible. (See Figure 13)

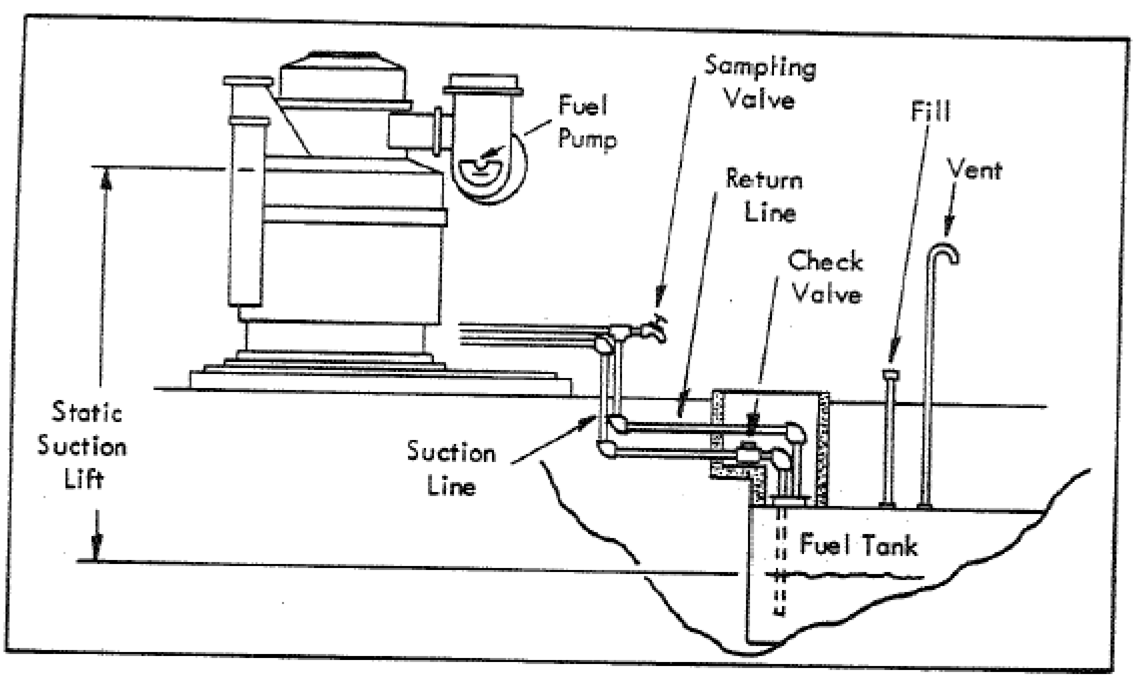


Figure 13, Underground Fuel Tank Installation

10.1.4 If you use a floor mounted or an overhead tank; install a shut-off valve in the suction line ahead of the strainer to facilitate removal for cleaning. (See Figure 14)

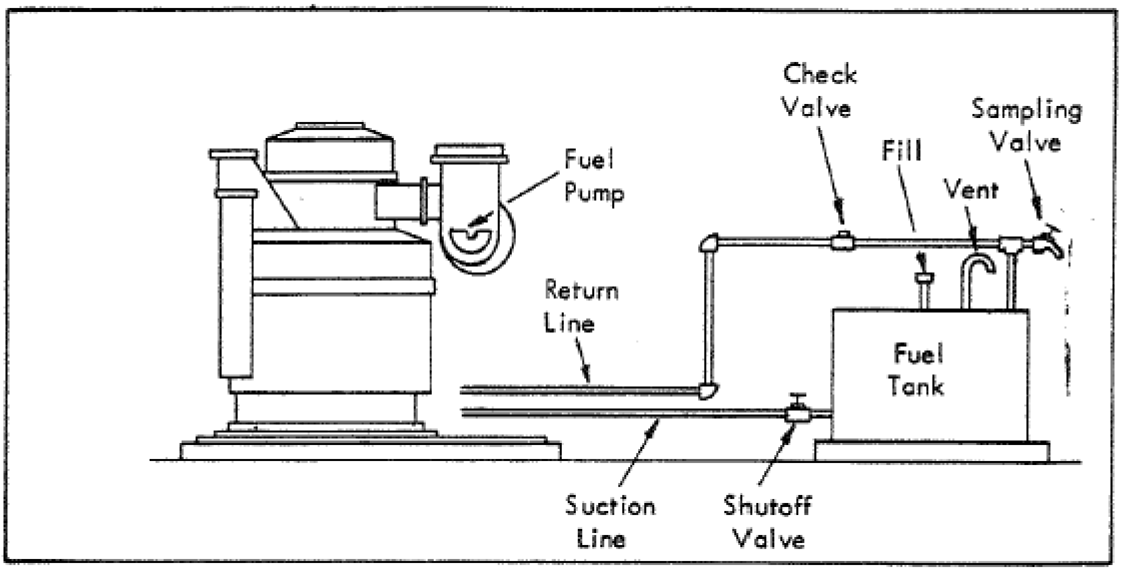


Figure 14, Fuel Tank Installation

10.1.5 Use only gate valves in the fuel piping lines to minimize resistance in the fuel piping system.

10.1.6 If your fuel tank requires heating because of freezing temperatures; install a steam heating coil in the tank.

CAUTION: ***Do not install any steam heating coil operating at a pressure of more than 15 psig in a fuel oil tank.***

10.1.7 Place a sampling tee and valve in the fuel return line and install a vent pipe in the fuel supply tank. (See Figures 13 and 14, also the typical boiler installation drawing, Figure 20.)

10.1.8 See OSHA standards for vent requirements versus size of tank required.

10.1.9 The fuel pump delivers fuel at a constant rate despite the amount burned, so it is important to size fuel suction and return lines properly. Size the return line so there is no back pressure; refer to Table 9. These line sizes cover only a single boiler installation with lines not longer than 100 feet in length. For multiple boiler installation and/or lines exceeding 100 feet in length a corresponding increase in pipe size must be made to compensate for the increased flow rates or pipe restriction due to length.

10.1.10 The return line should always be piped back to the supply tank and never to the suction side of the fuel pump. Return line back pressure should not exceed 10 psig at the boiler, which includes the static head pressure if the fuel tank is elevated.

10.1.11 If the dynamic suction lift (static suction lift + friction loss of pipe and fittings) exceeds 15 feet of water at the customer connection to the boiler it will be necessary to install a fuel transfer pump. The pump must be located between the main tank and customer connection to the boiler and have a capacity of 160 gallons per hour per boiler. (10 gallons per hour for model 4605)

CAUTION: ***Do not put more than 25 psig to the inlet of the boiler fuel pump. Pressure over 25 psig will damage the fuel pump seal. Do not operate fuel pump without oil or it will be damaged.***

10.1.12 Some customers prefer to remotely install the boiler fuel pump (and bypass relief valve) as a method of overcoming the suction lift problem. This practice is acceptable provided a check valve is installed in the pump discharge line to the boiler as close to the pump as possible.

10.1.13 Boiler installations under the jurisdiction of I.R.I. (formerly F.I.A.) or F.M. require additional equipment. The standard Vapor Power Boiler Fuel Oil Piping conforms to I.R.I. and F.M. requirements. The exceptions to the standard piping are shown in Figure 15.

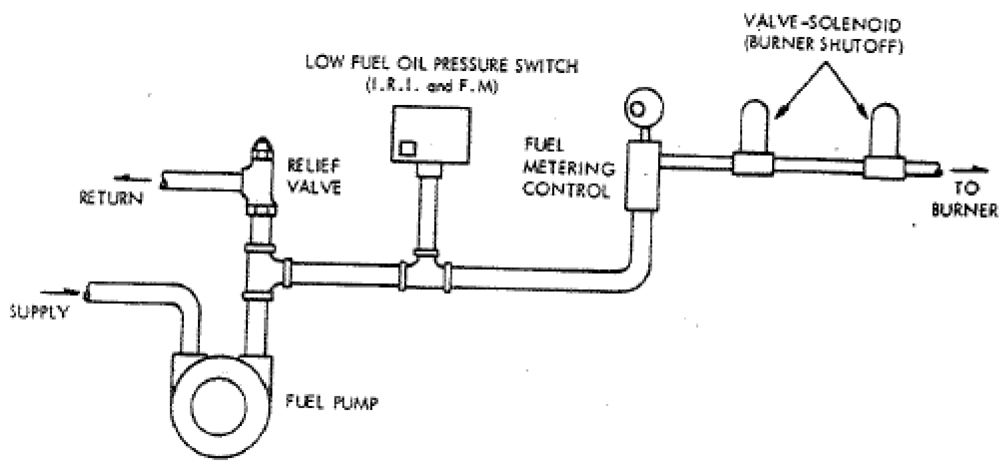


Figure 15, Fuel Oil Piping I.R.I. and F.M.

10.2 <u>Gas Fired Boilers</u>

10.2.1 The size of your gas line is determined by the gas pressure at the meter, the resistance of the pipe and fittings to gas flow and the volume of gas flow to the burner in cubic feet per hour. Vapor Power Modulatic boilers require 1 psig <u>(except for Model 4605 which requires 6 in. W.C.)</u> of regulated gas pressure at high fire <u>at the boiler customer connection</u>. Your local gas company can help you to determine the proper size of piping you will require.

10.2.2 When installing the gas regulators and piping be sure to observe all regulations of the National Fire Protection Association and all local regulations that may apply.

10.2.3 Gas flow requirements for Vapor Power boilers, main burner customer connection sizes, and gas pressures required at the customer connection are listed in Table 10.

GAS CONSUMED & GAS LINE CONNECTION REQUIREMENTS

Boiler Model No.	High Fire Gas Flow Req'd. (SCFH)*	Customer Main Gas Connection (NPT)(Inch)	Customer Conn. Main Gas Press. At High Fire
4605	770	1-1/4	6 In. W.C.
4611	1720	2	1 psig
4617	2800	2	1 psig
4626	4300	2	1 psig
4636	5400	2	1 psig
4742	6800	2	1 psig
4748	8600	3	1 psig

Table 10

* Based on heat value of 1000 BTU/standard cubic foot.

NOTES:
1. Gas Flow required will change with BTU content of gas.
2. Consult your gas pressure regulator manufacturer (Reliance, Fisher or equivalent) for size and type required for your specific application.
3. Regulators must be adjustable above and below 1 psig or 6 inch W.C. for a 4605.

10.2.4 If your main line gas pressure is less than that required at the boiler customer connection, install a gas booster as close to the boiler as possible. We recommend (if local codes permit) a Roots-Connersville booster with a built-in bypass valve. When ordering a booster, specify the following:

a. Inlet pressure (main gas line pressure).

b. Outlet pressure sufficiently in excess of the required pressure at the boiler to maintain that required pressure at the boiler.

c. Gas flow rate (see Table 10), also specify type of gas and BTU content.

NOTE: Due to heat of compression it is best to cycle booster off when the boiler cycles off.

10.2.5 When ordering a gas regulator, specify data from Table 10 for your model size, your main gas line pressure and standard trim for natural gas (0.60 specific gravity).

NOTE: Two regulators in series may be required to obtain accurate regulation and to meet local codes.

10.2.6 The selected gas regulator(s) may be installed anywhere between the meter and the boiler, but must be located upstream of gas line safety equipment. Wherever the regulator is located, it must be capable of supplying the required pressure at the boiler connection. Figures 16, 17, 18, and 20 illustrate a gas pressure regulator.

NOTE: If a sensor line is required, it shall be connected downstream from the regulator at least five(5) pipe diameters. The connection must also be at least five(5) pipe diameters downstream or two(2) diameters upstream from any valve, elbow or other restriction.

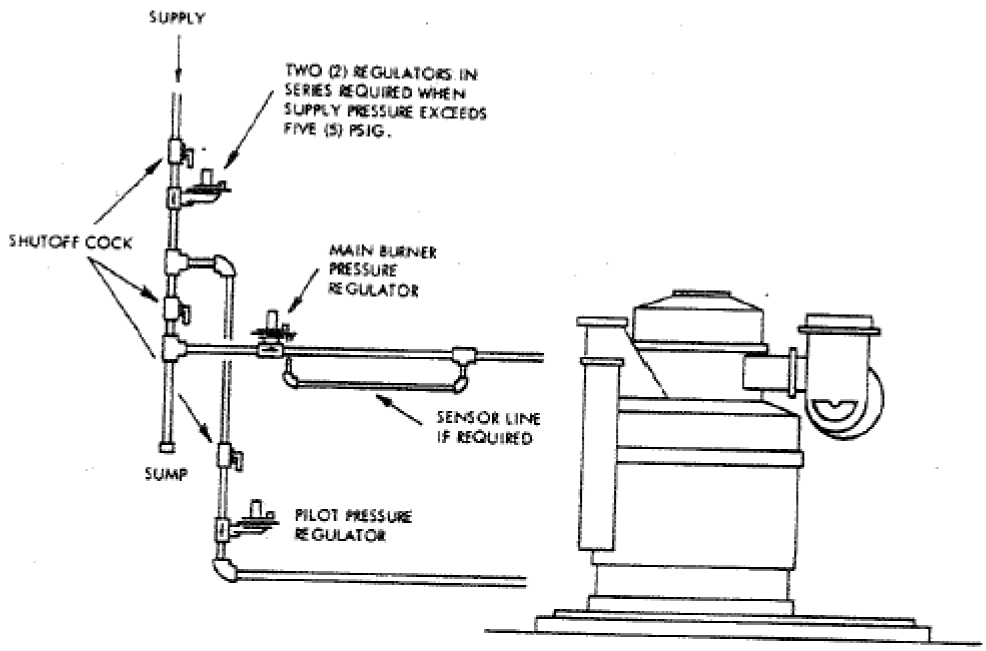


Figure 16, Gas Regulator Installation

10.2.7 Boiler installations under jurisdiction of I.R.I. or F.M. require additional gas equipment than what is normally supplied. Figure 17 illustrates the piping arrangements for I.R.I., Figure 18 for F.M. equipment.

10.2.8 Install a manual shutoff cock in the line between the meter and the gas pressure regulator.

10.2.9 Install a sump trap to collect residual moisture and oil in the gas line. The trap should be located between the main regulator and manual shut off cock.

CAUTION: In all instances concerning gas pressure regulators, boosters, reducers, piping, etc., consult with your local gas supply company. Follow their recommendations and preferences; also follow the codes for gas fired equipment as set down by the AGA and the National Fire Protection Association.

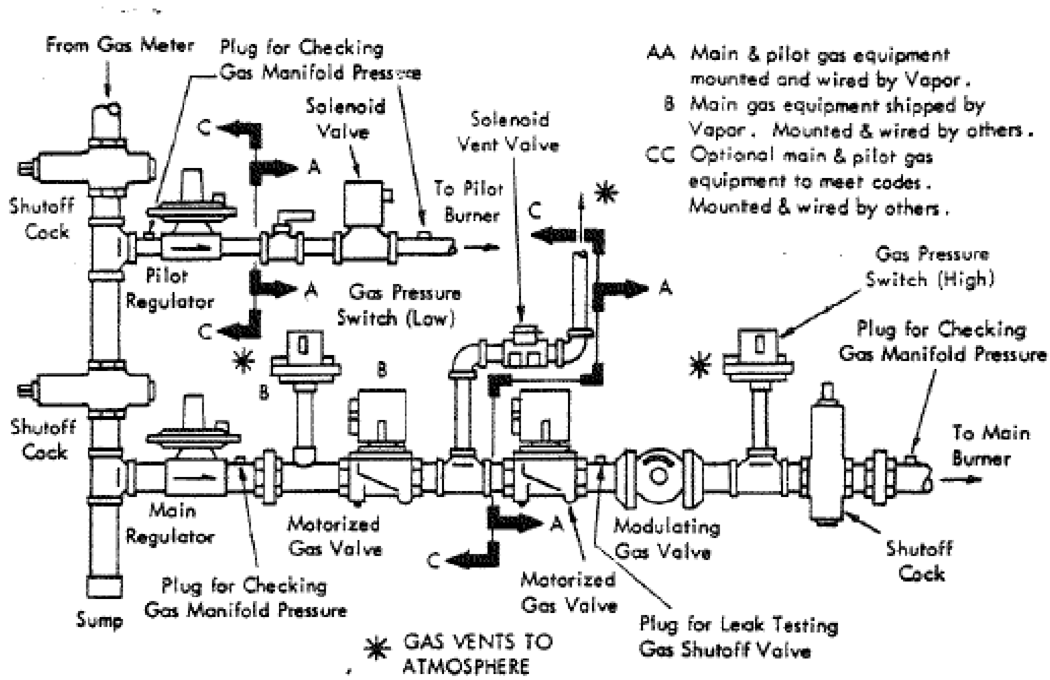


Figure 17, Piping For I.R.I.

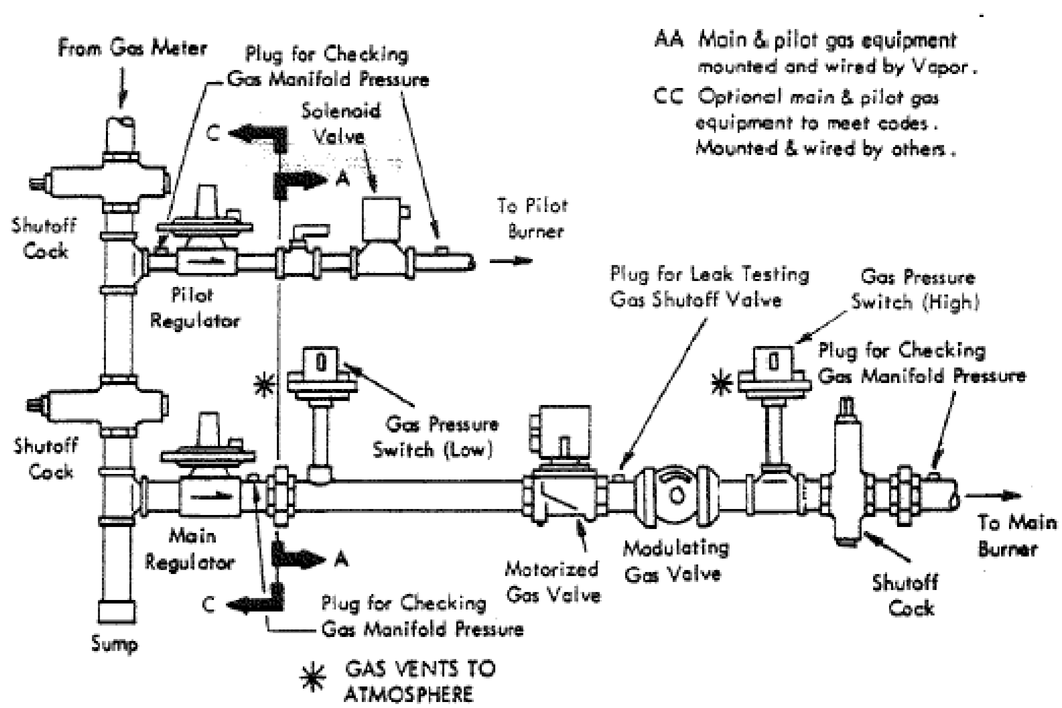


Figure 18, Piping For F.M.

NOTES:

1. Install the I.R.I. or F.M. equipment within ten pipe diameters of the customer connection on your heater. Install the selected gas pressure regulator upstream of the I.R.I. or F.M. equipment.

2. A separate pilot burner regulator and a separate main burner regulator must be installed for each boiler when multiple installations are made.

3. Combination fired models must meet the codes for both gas and oil fired types. All instructions given above for oil and gas fired boilers apply to the combination fired models.

11. PILOT BURNER GAS REQUIREMENTS

11.1 All standard oil, gas and combination oil/gas fired boilers use gas pilots. Oil fired units used in marine installations are direct spark ignited and, therefore, not fitted with gas pilot burners. Liquid petroleum gas (LPG) may also be used for pilots.

11.2 Natural gas pilots may be either interrupted or constant, requiring 4 inches W.C. gas pressure. All LPG pilots require 11 inches W.C. pressure. These pressures are required at the pressure tap located on the boiler.

11.3 All units fitted with gas pilot burners have a 3/8 inch NPT pilot gas connection.

11.4 The pilot gas regulator may be installed anywhere between the meter and the main gas regulator and must be capable of supplying the required pressure at the heater connection. Figures 16, 17, 18, and 20 illustrate a gas pressure regulator installation.

11.5 A number 1203 series Reliance Industrial Regulator or equivalent (Vapor Power No. 46621193-21) may be used as the pilot line gas pressure regulator. It has a 3/4 by 3/4 inch NPT body to provide a gas flow of at least 40 standard cubic feet per hour (based on 1090 BTU natural gas) when gas line inlet pressure is between 2 to 125 psig.

12. COMPRESSED AIR REQUIREMENTS (OIL FIRED BOILERS)

12.1 If your boiler is oil fired, or combination oil/gas fired type, it will require compressed air at the burner nozzle for fuel atomization. Table 11 indicates the pressure and cubic feet per minute of free air required for your particular model.

FUEL ATOMIZING AIR REQUIREMENTS

Model Size	Air Flow Required (SCFM)	Air Pressure Required At High Fire (PSIG)	Boiler Connection (NPT)(INCH)
4605	None (pressure) (atomized)	--	--
4611	5	40	1/4
4617	5	40	1/4
4626	10	70	1/4
4636	10	70	1/4
4742	10	70	1/4
4748 (oil fired)	9	40	1/2
4748 (comb. oil and gas)	10	70	1/2

Table 11

13. **POWER SUPPLY REQUIREMENTS**

NOTE: Your boiler is factory wired to comply with the National Electrical Codes. Connect your power line in accordance with the national and local electric codes.

13.1 It is important that you use the proper size wire to bring the electrical power to the boiler. There should be no more than 3% voltage drop in the feeder line.

13.2 There must be a remote fusible disconnect switch installed for the boiler main power supply and no other load should be connected to this switch.

13.3 Use moisture resistant insulated wire, with a 100°C rating for high temperature service.

13.4 All electrical connections, between the boiler and the building wiring shall conform to the National Electrical Code, USAS STD. C1-1968 and NFPA No. 70-1968 when no other local electrical codes apply.

13.5 Electrical wire sizes supplying electrical power to the boiler may vary according to the drive motor horsepower required by the boiler and the voltage supply available. Different steam operating pressures require different size motors for the boiler. Table 12 indicates the different horsepower size motors that may be used as well as the minimum wire size required for various voltages.

DRIVE MOTORS AND FEEDER LINE SIZES

Boiler Model	Boiler Design Maximum Working Pressure (PSI)	Boiler Drive Motor Horsepower	Minimum Wire Size (AWG Copper Wire) (See Note 1)		
			230V.	460V.	575V.
4605	15 - 600 900	1-1/2 2	14 14	14 14	14 14
4611	15 - 600 900	3 5	14 14	14 14	14 14
4617	15 - 600 900	5 7-1/2	14 8	14 14	14 14
4626	15 - 300 600 - 900	7-1/2 10	8 6	14 10	14 12
4636	15 - 300 600 900	7-1/2 10 15	8 6 4	14 10 8	14 12 10
4742	15 - 300 600 - 900	10 15	6 4	10 8	12 10
4748	15 - 300 600 - 900	15 20	4 2	8 6	10 8

Table 12

NOTES: 1. Wire sizes in Table 12 are minimum sizes to carry the current for the boiler, only when line lengths do not exceed 150 feet. As line lengths increase, corresponding wire size increases may be necessary to prevent excessive voltage drop.

2. Table 12 values are typical for single boiler installations having designed maximum working pressures up to and including 900 psig. For boilers having designed maximum working pressures of 1000 psi and above consult the installation drawings for your specific unit to obtain motor horsepower sizes.

13.6 The proper fusing for the boiler remote main power disconnect switch is also important. Table 13 indicates the KVA draw for various size motors.

13.7 Check the boiler test sheet for rated voltage. Low voltage will result in reduced blower and pump speed. Motors will operate satisfactorily if the voltages shown in Table 13 vary no more than ± 10% at rated frequency of 60 hertz. Motors will also operate satisfactorily if the combination of ± 10% variation in voltage and frequency occurs, providing the frequency variation does not exceed 5%.

KVA DRAW FOR VARIOUS MOTORS & VOLTAGES

Motor H.P.	230 V., 460 V., 575 V.	
	Running Draw (KVA)	Locked Rotor Draw (KVA)
1	2.2	9.1
2	3.5	16.3
3	4.6	22.2
5	6.8	36.6
7-1/210	9.6	53.3
15	11.9	65.2
20	17.4	96.3
25	22.2	124.9
30	27.8	153.5
40	32.6	187.0
	42.1	249.1

Table 13

NOTE: All motors shown are 3 phase, induction type squirrel-cage.
All values shown include 0.750 KVA for control panel draw.

$$\text{Amps} = \frac{\text{KVA X 1000}}{\text{1.73 X Volts}}$$

Ref. for AMP values; NEC 1968, NFPA 370-1968,
USAS C1-1968, Pp,70-243 AND 70-244

13.8 When line voltages are not exactly the same on all phases, unbalanced currents will flow in the stator windings. A small voltage unbalance can increase the temperature rise and current, at operating speed, by 6 to 10 times the voltage unbalance. A 3-1/2% voltage unbalance can cause a 25% increase in temperature rise. For example, if line voltages are measured at 230 VAC, 225 VAC, and 220 VAC, the average line voltage is 225 VAC. The maximum deviation from average is 5 volts. The percent unbalance equals 225 divided by 5 x 100 = 2.22%. The increase in temperature rise is 2 times the percent unbalance squared or $2(2.22)^2$ = 9.9%. To avoid motor damage, notify the power company of voltage unbalance so the situation may be corrected.

14. **STEAM PIPING**

14.1 Your steam service line should be as large as, or larger than, the outlet connection on the boiler. If possible, use a steam reservoir or header that will act as an accumulator to compensate for a rapid pressure drop due to a sudden demand for steam or pressure surge when the steam is abruptly shut off.

14.2 Where multiple boilers are installed, the steam lines should be sized to carry the total steam flow and should be adequate to handle the system equipment involved.

14.3 Steam lines should be insulated to conserve heat and to protect personnel from possible burns.

14.4 Where condensate may collect in the steam lines, traps should be installed to prevent "water logging" the system.

14.5 All steam piping must be properly secured and anchored to prevent any strains on equipment and boiler connections.

14.6 To enable the boiler to be tested (combustion adjustment, etc.), it is necessary that provisions be made for discharge of steam, which the system cannot accommodate. This is usually done by connecting a blowoff line from the boiler outlet piping to the atmosphere.

14.7 The blowoff line should be large enough to relieve the full boiler output at the lowest operating pressure. The end of the line should discharge to a point of maximum safety.

14.8 A shutoff valve which can be used to throttle the boiler discharge must be installed in the blowoff line at a point which is easily accessible.

15. SAFETY VALVE PIPING

15.1 Individual discharge pipes must be installed to carry away the blowoff from each safety valve. Support these pipes to prevent any stress upon the safety valve.

15.2 Discharge pipes must not be rigidly connected to safety valves. Clearances should be provided to allow for expansion. A drip pan elbow installed similar to the illustration in Figure 19 will provide clearances and also prevent the accumulation of steam condensate from flooding the safety valve outlet and subsequently freezing or other wise restricting flow. The drain must discharge to an open sewer. Do not connect to blowdown piping.

15.3 Safety valve discharge pipes must have an unobstructed path, that is, no valves or series of pipe fittings between the safety valve and the atmosphere. Also, the discharge pipe shall not be smaller than the safety valve outlet.

15.4 Locate all safety valve discharges so that they clear all working areas and platforms. Usually the discharge pipe is installed to exit vertically.

15.5 Do not install a discharge pipe to exit horizontally if it contains any bends or elbows.

15.6 Table 14 lists typical boiler steam and safety valve discharge connection sizes for the various model boilers.

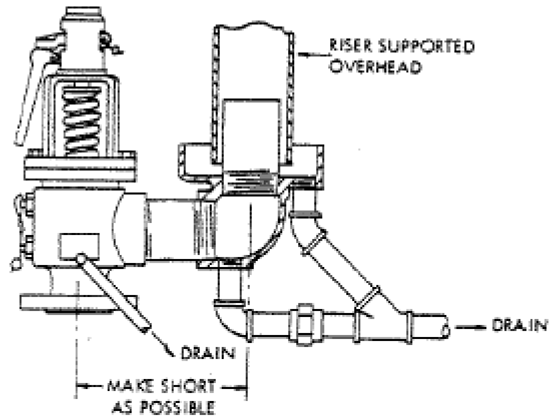


Figure 19, Typical Safety Valve Piping

BOILER STEAM CONNECTION SIZES

Boiler Model	Boiler Design Max. Working Pressure (PSI)	Steam Outlet	Safety Valve Outlet
4605	15 300-900	4" x 150# ANSI Flange 1-1/2 Inch NPT	2 Inch NPT 1 Inch NPT
4611	15 300-600 900	4" x 150# ANSI Flange 1 Inch NPT 1-1/2 Inch NPT	2 Inch NPT 1 Inch NPT 1 Inch NPT
4617	15 300-600 900	6" x 15# ANSI Flange 1-1/2 Inch NPT 1-1/2 Inch NPT	3 Inch NPT 1-1/2 Inch NPT 1-1/4 Inch NPT
4626	15 300-600 900	6" x 150# ANSI Flange 1-1/2 Inch NPT 1-1/2 Inch NPT	3 Inch NPT 1-1/2 Inch NPT 1-1/4 Inch NPT
4636	15 300 600 900	6" x 150# ANSI Flange 2 Inch NPT 2 Inch NPT 2 Inch NPT	3 Inch Npt 1-1/2 INCH NPT 1-1/2 INCH NPT
4742	15 300 600 900	6" x 150# ANSI Flange 2 Inch NPT 2 Inch NPT 2 Inch NPT	3 Inch NPT 1-1/2 Inch NPT 1-1/2 Inch NPT 1-1/4 Inch NPT
4748	15 300 600-900	6" x 150# ANSI Flange 2-1/2 Inch NPT 2-1/2 Inch NPT	3 Inch NPT 2-1/2 Inch NPT 1-1/2 Inch NPT

Table 14

NOTE: Table 14 values are typical sizes only. Consult the installation drawing for your unit to obtain specific sizes and to determine the number of safety valves required.

16. BLOWDOWNS

16.1 Separator Blowdown

16.1.1 Boiler steam separators are equipped at the bottom with a blowdown valve for blowing out accumulations of sludge deposits that are collected there. It is important to remove these deposits periodically, otherwise they will be carried back to the feedwater supply tank and increase the total dissolved solids recommended for satisfactory operation.

16.1.2 Local codes and ordinances may require that the blowdown be piped into a receiver tank or a blowdown separator. The boiler installer should determine details of what is required.

16.1.3 When piping the separator blowdown, the line size should be at least as large as the separator connection (see Table 15). Use a minimum number of fittings to keep the line restriction as low as possible.

16.1.4 The size of the blowdown receiver should be determined by the amount of blowdown from the boiler. Blowdown rates depend upon local raw water properties, the amount of make up water needed, the condition of the system return condensate, and the amount of feedwater treatment chemicals added. It therefore cannot be predicted precisely. Blowdown rates over 10% of the boiler evaporation rate are usually considered excessive.

16.1.5 In some installations it has been advantageous to install a tee, a sump leg, and a metering type shutoff valve in the line from the boiler steam separator trap to the feedwater supply tank. When feedwater total dissolved solids control is troublesome, "bleeding" away water through the metering valve can be an advantageous alternative to increasing the frequency of separator blowdown. (See Figure 20)

16.1.6 An optional separator blowdown valve may be automatically operated. These valves require a pneumatic or hydraulic pressure of 40-150 psig (fluid temperature not to exceed 175°F) for operation.

16.2 Coil Blowdown

16.2.1 Each boiler is equipped with a connection for coil blowdown. The purpose of the coil blowdown is to allow reverse flow of fluid through the coils which are most prone to precipitate and collect solids from the boiler water.

16.2.2 Coil blowdown lines should also be piped to a blowdown receiver, separator or point of maximum safety. Lines for coil blowdown should be independent of any other lines.

16.2.3 When piping the coil blowdown, the line sizes should be at least as large as the boiler connection (see Table 15). Use a minimum number of fittings to keep the line restriction as low as possible.

BOILER BLOWDOWN CONNECTIONS

Boiler Model	Boiler H.P.	Coil Blowdown Connection (NPT)(Inch)	Separator Blowdown Connection (NPT)(Inch)
4605	18	3/4	1
4611	40	3/4	1
4617	65	1	1
4626	100	1	1
4636	125	1	1
4742	150	1	1
4748	200	1	1

Table 15

NOTES: 1. Table 15 values are typical sizes. However, consult the installation drawing for your unit to obtain specific sizes.

2 If line lengths exceed 100 feet from the boiler connection to the point of discharge a corresponding increase in line size must be made to compensate for the increased restriction due to length.

17. NEW UNIT STORAGE

17.1 Should your new Vapor Power boiler arrive on the job site before the system is ready to accept it, place it in a protected area. It should not be located in an area where workmen will climb on it or can bump into it with heavy equipment.

17.2 As discussed in paragraph 2.3, uncrate and inspect the unit for damage in transit or unloading. Once inspected, the unit should be recovered. Tie the covering down to prevent it from blowing off. This will protect the unit from dirt and possible pilferage.

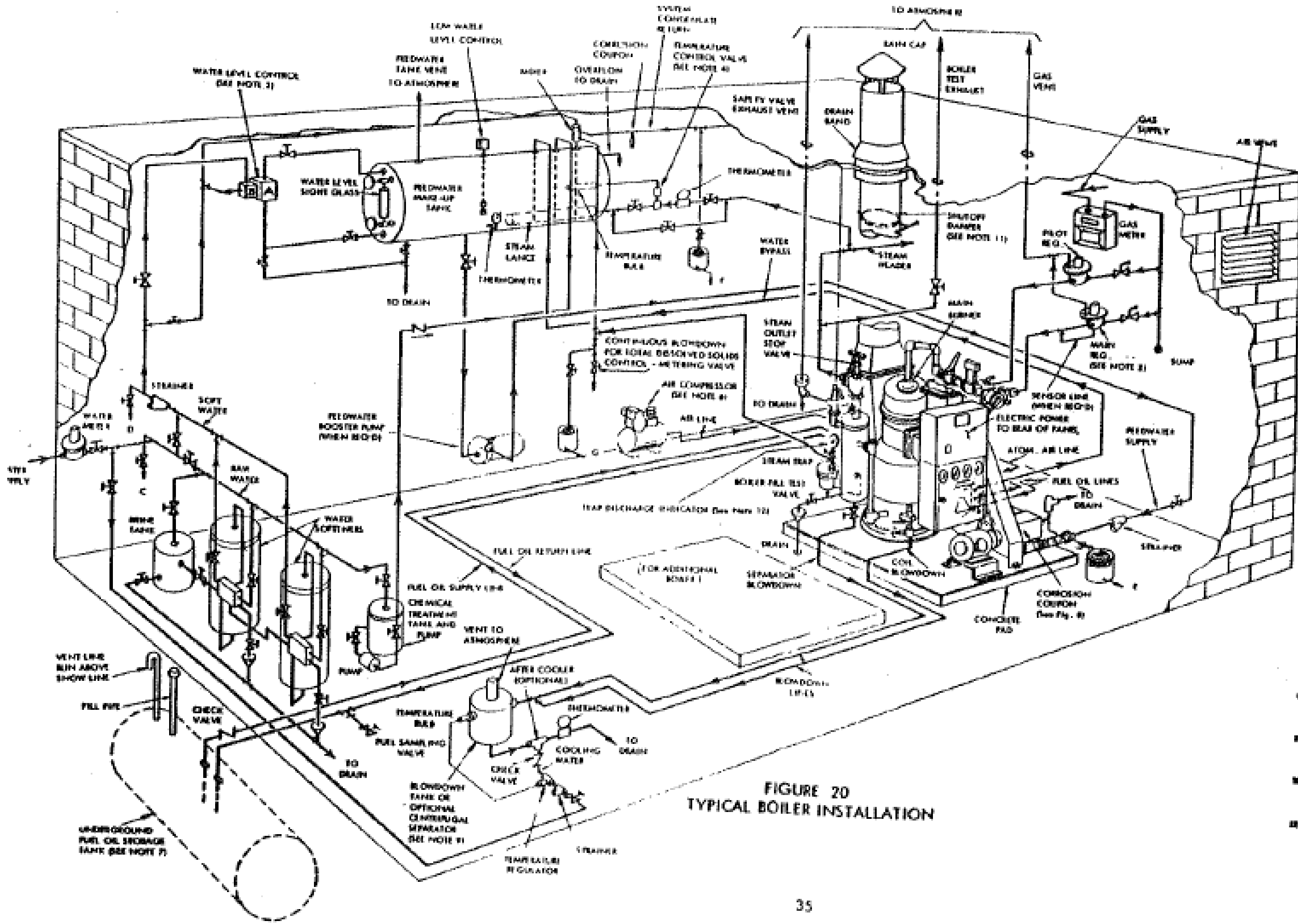


FIGURE 20
TYPICAL BOILER INSTALLATION

NOTES:

1. CONNECTION LOCATIONS ON THIS DRAWING ARE SHOWN DIAGRAMMATICALLY. FOR ACTUAL LOCATIONS REFER TO CUSTOMER CONNECTION DRAWING FOR BOILER.

2. GAS PRESSURE REGULATOR SHOULD BE LOCATED AT LEAST 10 DIAMETERS FROM ANY ELBOW. IF A PRESSURE SENSOR LINE IS USED, IT SHOULD BE LOCATED AT LEAST 10 DIAMETERS DOWNSTREAM OF MAIN REGULATOR AND AT LEAST 5 DIAMETERS UPSTREAM FROM ANY RESTRICTION (ELBOW, TEE, ETC.)

3. WATER LEVEL CONTROL (A) MAY BE MECHANICAL OR ELECTRICAL. IF ELECTRICAL PART "A" WILL BE A SWITCH MECHANISM AND PART "B" WILL BE AN ELECTRICALLY OPERATED WATER ADMISSION.

4. FOR DE-AERATION OF THE FEEDWATER, IT SHOULD BE HEATED TO 200°F. BY THE RETURN SYSTEM OR FEEDWATER HEATER SHOULD BE SUPPLIED.

5. WHEN FM OR FIA CONTROLS ARE SPECIFIED, SEE BOILER PIPING DIAGRAM FOR PIPING DETAILS.

6. COMPRESSED AIR IS REQUIRED FOR FUEL ATOMIZATION WHEN UNIT IS OIL FIRED OR WHEN USED FOR AUTOMATIC PNEUMATIC BLOWDOWN.

7. FUEL OIL STORAGE TANK AND PIPING MUST BE INSTALLED IN COMPLIANCE WITH LOCAL CODES. KEEP CHECK VALVE IN SUCTION LINE.

8. GAS PILOT IS STANDARD ON ALL UNITS. LPG MAY BE USED ON STRAIGHT OIL-FIRED UNITS.

9. CENTRIFUGAL SEPARATOR MAY BE USED INSTEAD OF BLOWDOWN TANK. AFTER-COOLER WITH TEMPERATURE CONTROLLED WATER ADMISSION VALVE, STRAINER, CHECK VALVE AND THERMOMETER ARE ALSO OPTIONAL EQUIPMENT, FOR USE WHERE LOCAL CODES REQUIRE THIS.

10. INDIVIDUAL VENT LINES ARE RECOMMENDED. WHEN LINES ARE MANIFOLDED, PIPE AREA MUST BE EQUAL OR LARGER THAN SUM OF AREAS OF INDIVIDUAL VENT PIPES.

11. DAMPER SHOULD BE INSTALLED IN COLD CLIMATES TO PREVENT COILS FROM BEING FROZEN BY COLD AIR DRAWN IN WHEN BOILER IS SHUT DOWN.

12. A STEAM PRESSURE GAUGE OF A SUITABLE RANGE MAY BE INSTALLED WITH A SHUTOFF VALVE TO BE USED AS A STEAM TRAP TEST INDICATOR.

13. RECOMMENDED LOCATIONS FOR WATER SAMPLING (SEE SECTION 7.3) ARE:

C. RAW WATER
D. SOFT WATER
E. BOILER FEED*
F. RETURN CONDENSATE
G. SEPARATOR (TRAP)

* THESE POINTS MUST BE COOLED TO CONDENSE VAPOR