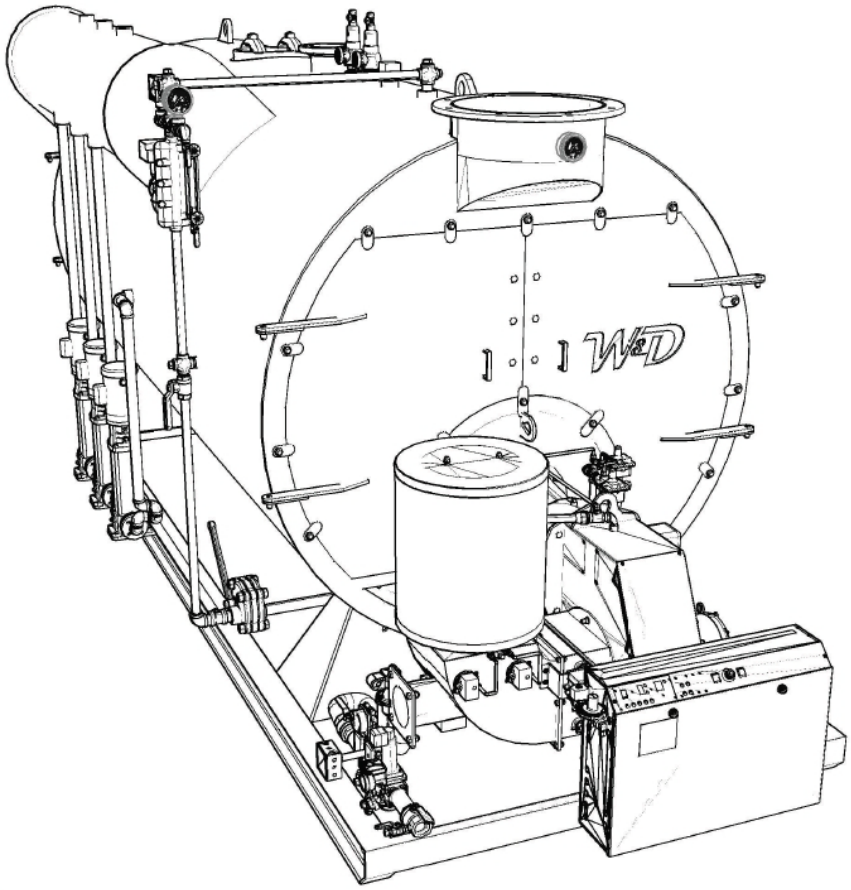
CAPABLE &
DEPENDABLE SINCE 1921

INSTALLATION AND OPERATING INSTRUCTIONS FOR W&D SCOTCH BOILERS



PLEASE READ BEFORE STARTING INSTALLATION OR OPERATION

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Table of Contents

Boiler Language

Arch	The refractory at the rear of the boiler that forms the top of the turn box.
ASME Code	A set of rules developed by the American Society of Mechanical Engineers that governs the minimum construction specifications of boilers and pressure vessels. It has been adopted by boiler manufacturers and users as a standard for safety and quality.
Baffle	A steel trough used to disperse boiler feedwater as it enters the boiler. It prevents cooler feedwater from contacting directly with hot return tubes.
Blower	A mechanical device used to force air though a boiler for combustion.
Blowdown Separator	A baffled tank used to separate the steam and water and kill the pressure so that the steam may be vented and the water drained to the sewer.
Boiler	A pressure vessel used to transfer heat energy to a usable medium such as water.
Boiler Tubes	A passage for products of combustion and hot gases used to heat water in Fire Tube Boilers.
Breeching	The metal box at the stack end of the boiler that collects the flue gases from the tubes for removal by the stack.
Burner	A device used to properly mix air and fuel and cause the chemical reaction of combustion and the attendant release of heat energy.
Check Valve	A device which allows flow in only one direction.
Compression Gauge Cock	A manual valve located on the water column of the boiler trim which is used to determine the location of the water level without the use of the gauge glass. Two or more compression gauge cocks are used together. If steam emerges from one and water emerges from the other, then the water level is between the two compression gauge cocks. They should be opened only when there is no water glass.
Contractor	Normally an electrically operated switch used to relay single phase power to an electric motor or other similar load.
Donut	A ring of refractory material located in the boiler furnace that is used to stabilize furnace pressure.
Daft Door	An air register used to control the volume of combustion air entering the furnace.
Dry Pan	A steel plate located under the steam nozzle to prevent water from splashing into the steam nozzle and being carried out into the steam distribution system.
Electrontic Control	A safety device which controls the sequence of operation of the burner. The general sequence of operation of most electronic controls is first to establish and prove that a pilot flame is present and then to allow the main volume of fuel to flow to the burner.

Feed Pump	A water pump used to inject water into the boiler.
Firetube	A primary combustion furnace of the boiler.
Gas Pressure	The force per square inch exerted by the gaseous fuel which causes flow through the burner when the control valves are opened.
Gas Pressure Regulator	A mechanical device which can control the gas pressure by using an opposing spring pressure.
Gauge Glass	A glass tube that will withstand pressure that allows the level of water in a boiler to be visible.
Handholes	Openings provided in the boiler pressure vessel that allow ordinary maintenance of the boiler pressure vessel, including cleaning, inspection and tube removal. Handhole openings are usually a 3" x 4" oval opening.
Head	The flat ends of the boiler pressure vessel or the tube sheets into which the return tubes are rolled and beaded.
Ignition Transformer	An electrical device which makes available electrical energy in a form which can cause a spark to ignite the burner fuel.
Inspection Door Plug	A refractory access opening in the rear door of the boiler which allows access to the combustion area for inspection without opening the rear door.
Jacket	A metal covering placed over the boiler insulation for appearance and protection of the insulation.
Load	The output required of the boiler.
Magnetic Starter	An electrically operated switch that relays three-phase power 10 an electric motor or other similar load.
Main Gas Valve	An electrically operated valve which controls the flow of the main volume of gas to the burner
Manhole	An opening in the boiler pressure vessel to allow ordinary maintenance and inspection of the boiler pressure vessel.
Millboard	A board made of ceramic fiber material which is used to line the front breaching.
Non-Return Valve	A main steam shut-off valve provided with a built-in check valve.
Peep Sight	An observation port provided in the burner front and the rear door of the boiler for visual check of burner flame.
Pilot	A small gas flame used to ignite the main volume of fuel. Also known as the pilot gas burner assembly.
Pilot Gas Valve	An electrically operated valve used to control the flow of gaseous fuel to the pilot burner.
Refractory	A material which will withstand high temperatures. Boiler refractories usually should withstand temperatures in excess of 2,600° F.

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Scanner	An electronic device used to convert ultra-violet, visible, or infra-red light into an electronic signal that can be used by an appropriate electronic control to prove the existence of a flame within a boiler furnace.
Shell	The cylindrical outer portion of the boiler pressure vessel into which all of the external openings are welded.
Stack	The vent used to remove the combustion gases from the boiler furnace to the outside atmosphere.
Transformer	An electrical device used to change one alternating current voltage into another alternating current voltage.
Tri-Cock	A manual valve located on the water column of the boiler trim which is used to determine the location of the water level without the use of the gauge glass. Two or more tri-cocks are used together. If steam emerges from one alone and water emerges from the other, then the water level is between the two tri-cocks. They should be used only when there is not water glass.
Heatmizer	Bent metal straps engineered to break up smooth flow through the return tubes, thus making the flow turbulent, thereby allowing more hot gases to come in contact with the return tube surfaces and causing an increase in heat transfer to the boiler water.
Turn-Box	The area at the rear of the boiler that allows the combustion gases from the firetube to flow to the return tubes.
Vertical Check Valve	A device which allows flow in only one direction, and may be installed in piping running vertically.
Water Column	A Vertical tubular member connected at its top and bottom to the steam and water space respectively of a boiler, to which the water gauge, compression gauge cocks, high and low level alarms and fuel cutoff may be connected.
Water Treatment	The method used to render the available raw water useful and safe for boiler operation. The Object of water treatment is to remove impurities which would form harmful scale deposits, or excess oxygen which would corrode metal surfaces within the boiler.
W&D	A sign of quality and service-initials and trademark of Williams & Davis Boilers. The appearance of "W&D" on a boiler or related equipment signifies the highest obtainable standard of craftsmanship accrued for over 70 years of boiler manufacturing and service.

Boiler Sizing

Boilers are sized according to the amount of useful heat they make available. Heat is measured in BTU's (British Thermal Units) One BTU is defined as the amount of heat required to raise the temperature of one pound of water one degree Fahrenheit.

Below are some of the relations required in boiler sizing:

One boiler horsepower equals:

a. 33,475 BTU per hour output.
b. 34.5 pounds steam per hour output.
c. 9.81 Kilowatts input

One mechanical horsepower equals:

a. 33,000 foot-pounds per minute
b. 2,546 BTU per hour

One electrical horsepower equals:

a. One mechanical horsepower
b. .746 Kilowatts

One Kilowatt equals:

a. 1,000 watts
b. 1.34 mechanical horsepower
c. 3,415 BTU per hour
d. 44,236.5 foot-pounds per minute

To determine the size required, add up the requirements of each individual piece of equipment and then add at least 10% to the total requirement.

Laundry & Dry Cleaners

Machine Boiler	Horsepower*	Machine	Boiler Horsepower
Adjusta-Form	2.00	Yoke Press	.50
Body & Bosom Press	1.00	2-roll, 120” Ironer	3.80
Collar & Cuff Press	1.00	3-head Puff Iron	.25
Handy Ironer, 54”	1.20	30” x 42”	2.50
Ironing Board	.25	40” Press	1.00
Sleever	.50	52” Press	1.50
Spotting Board	.33	Water gal	
		100 degree rise in one hour	2.50

**Approximate figures. Manufacturer’s Data be used when available*

Feed Mill

1 boiler HP per 1″ of roll
½ boiler HP per one horsepower of Pellet Mill

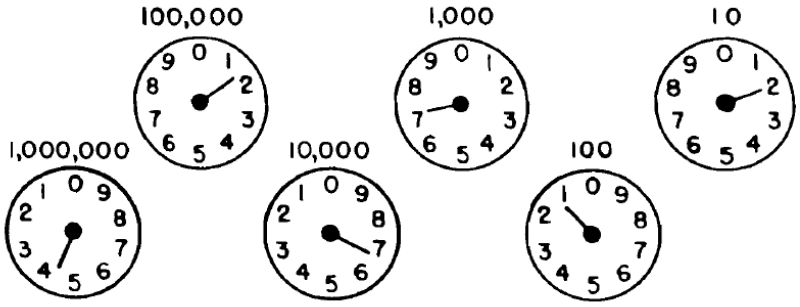
Fuel

Natural Gas

Domestic and Commercial distribution pressure – 4 oz.
Industrial distribution pressure ranges up to 30psi and occasionally higher.

Natural gas is metered by the gas company primarily to determine the volume of gas that is consumed for the purpose of charging their customers. The meter may also be used to determine the volume of gas required by individual pieces of equipment used by a customer. It is important, therefore, for the customer to understand how to read a meter.

The most common type of meter has a series of dials that rotate in opposite directions and record the volume of gas used in multiples of ten. One dial measures each cubic foot. The next dial measures each 10 cubic feet and so on until the last dial usually records each 100,000 cubic feet on small domestic meters.



The reading in *Figure* 1, above, would be 416,712 cubic feet. As gas is used, the reading becomes larger To obtain the volume of gas consumed over a period of time, the reading taken at the beginning of the period is subtracted from the reading taken at the end of the period.

To establish the volume of gas being used by a particular piece of equipment, first turn off all other equipment. Make sure the equipment being tested is set for maximum input. Monitor the 10 cubic foot dial for one minute and count the cubic feet consumed by the equipment. To obtain the BTU input each hour, multiply first by 60 min/hour and then by 1,000 BTUIft.]

When pressures above 4 oz. are present through the meter, a correction factor must be applied to the volume read at the meter. The exact correction factors can be obtained from the gas service company. An approximation can be made, however, using the following formula:

$$\text{Correction Factor} = \frac{(pressure\ at\ meter\ in\ psi) + 15}{15}$$

The correction factor is then applied to the volume read.

EXAMPLE:

Pressure at meter =30 psi
Volume read at meter =90 cubic feet per minute

$$\text{Correction Factor} = \frac{30+15}{15} + \frac{45}{15} = 3.0$$

Corrected cubic feet per minute =90 x3.0 = 270 cubic feet per minute.
BTU per hour =270 x 60 x 1000 = 16,200,000 BTU hour.

Propane

Propane is manufactured gas that is supplied in a liquid form in pressurized storage tanks. As the pressure is relieved by demand, the liquid boils to a gas and can be used in a way similar to natural gas. Propane is heavier than Natural gas. Its specific gravity is 1.53, as compared to 0.61 for Natural gas. The heating value of propane is 2500 BTU/ff' as compared to 1000 BTU/fP for Natural gas

Propane is normally used where distribution lines for Natural gas are not available. It is also used as a stand-by fuel for some dual fuel burner systems.

Propane, when used in the quantity required to fire most boilers, requires vaporization. Vaporization is achieved by a device very similar to a hot water heater. Propane liquid is piped through the vaporizer and is heated and boiled to insure that dry vapor only is used at the burner head.

If vapor from the storage tank alone is used, two things occur. First, when the flow rate becomes high, liquid propane will be carried through the piping to the burner along with the vapor. The liquid will vaporize as it passes through the burner orifices and will result in more propane being burned than design calls for. Second, propane contains impurities. These impurities consist of a small percentage of heavier compounds left after refining and of oil introduced during each pumping and handling required to distribute and store propane. These Impurities are left in the tank as the propane vapor is removed for use. The result is that the tank must be blown down and cleaned periodically.

Vaporization allows the use of propane liquid from the bottom of the storage tank. A vaporizer of adequate size will add enough heat to the liquid propane to deliver dry gas from the pressure regulator at the vaporizer. By taking liquid from the bottom of the storage tank the heavier substances are used in acceptable quantities, and no accumulation occurs in the storage tank.

Properties of Propane

Pounds per gallon	4.24	Vapor Pressure	
Cubic feet gas per gallon liquid	36.20	@ 0° F	28 psi
Cubic feet per pound	8.50	@ 10° F	122 psi
BTU per gallon	91,800	@ 100° F	190 psi
BTU per cubic pound	21,600	Specific Gravity gas	1.53
BTU per cubic foot	2,530	Specific Gravity liquid	0.511
Dew point	-45° F	Gallons per hour per boiler horsepower	0.5
		Cubic feet per hour per boiler horsepower	18.0
		Gallons storage per boiler horsepower	25.0

Oil

Oil for use as boiler fuel comes in several grades. The two most commonly encountered are NO.2 and NO.6 oil. NO.2 oil is a light, refined oil that requires no preheat or other special handling. NO.6 oil is a heavy oil with a high viscosity. NO.6 oil requires preheating and special handling.

Properties of Fuel Oil

No.	No. 1	No. 2	No. 4	No. 5 No preheat	No. 5 Preheat	No. 6
BTU/gal.	136,000	139,000	145,000	148,000	149,000	152,000
BTU/lb.	19,000	19,500	19,200	19,000	18,950	18,800
Lb./Ga.	6.9	7.1	7.6	7.8	7.9	8.1
cfm air gal.	22.43	22.90	24.00	24.76	24.96	25.74

WATER SUPPLY & TREATMENT

All fresh water available from natural sources in the entire world today will require varying degrees of treatment prior to use in a boiler. The impurities in fresh water are many, and each requires special attention. Solids in the form of minerals, chemicals, and organic material are all found in so-called fresh water and all have a different effect on the internal surfaces of a boiler.

WATER TREATMENT

The treatment of feedwater and the conditioning of boiler water are beyond the control of this Company. This Company does not assume the responsibility for water treatment and does not make specific recommendations for control purpose.

The successful operation of boilers depends upon a rigid control of feedwater and operating variables to assure freedom from scale formation and corrosion of water and steam-contacted surfaces of the boiler.

This control is very important in lower pressure boilers and becomes increasingly magnified at intermediate and higher pressure operation.

Scale formation in boilers is prevented by providing a good make-up water to the feedwater system and by avoiding condensate contamination.

Corrosion of metal surfaces in contact with water and steam constitutes the major maintenance expense to the power industry. The condensate and feedwater must be free of dissolved corrosive gases and the pH of the water must be properly adjusted to prevent the attack of metal surfaces.

The oxygen content in the feedwater must be reduced to low levels by effective deaeration in the condenser and in deaerating heaters. Care must be taken to prevent the introduction of air into heater drips which may be added directly to the feedwater system without deaeration. Minimum forced boiler outage time has been realized where the oxygen content has been reduced and held below 0.01 PPM. It is important to maintain a chemical reducing environment in the boiler and chemicals such as sulfite and hydrazine have. been used effectively to achieve this.

The pH of the feedwater must be controlled to prevent the dissolution of the iron and copper alloys in the pre-boiler system. These form corrosive products when introduced into the boiler and will contribute to the corrosion of boiler steam generating surfaces. Oxides of iron and copper may permit the diffusion of boiler water to the heated surfaces of the unit and cause locally high concentrations the heated surfaces of the unit and cause locally high concentrations of boiler water salines that result in the attack of the tube metal.

The pick-up metals from pre-boiler surfaces can be minimized by the addition of volatile alkaline chemicals that raise the pH of the feedwater. Ammonia and various amines, added to maintain a pH range of 8.8 - 9.2 have produced the best results.

Close control of solids in the boiler water must be established. The presence of oil, grease, high alkalinity, or other foam-inducing solids cannot be tolerated.

Boiler feed water treatment by a competent company will result in the prevention of scale and deposits, removal of dissolved gases *(free oxygen),* protection against corrosion, elimination of carry-over of water with steam prevention of caustic embrittlement, reduction of boiler *down-time,* production of the best boiler efficiency and reduction of fuel and maintenance costs.

Electrical Supply

Several voltages are encountered in boiler work. The most common are 24, 110 220 single phase; 220 three phase and 440 three phase. In some parts of the country 550 volt, three phase, is being used. 24 volts is normally used for thermostatic and other open-type controls where human contact is most likely. 24 volts is usually obtained from a step-down transformer from 110 volts. 110 volts is normally used for the operating controls. 110 volts is normally obtained from one line of a 220 volt single phase source, but is also available directly from a 220 volt, three phase, source. When the primary source is 440 volt, three phase; or 550 volt, three phase, a step-down transformer from the higher voltage to 110 volts is required. 60 Hertz is the standard in the United States, while 50 hertz is found in numerous foreign countries.

Local Codes

Boiler Codes vary from state to state and from city to city within a state. It is impossible, therefore, to anticipate the exact requirements in a particular location. Normally a new installation would require a building inspection, electrical inspection. The exact requirements for a particular location can be obtained from the city hall, if it is an urban location, or from the State government, if it is a rural location.

Installation Instructions

PERMITS and CODES

Permits for installation should be obtained before work is started. Local installation codes should be followed to prevent delays in installation or possible added expense for rework.

BOILER LOCATION and SUPPORT

The location for the boiler should be determined well in advance of the equipment arrival in order to allow adequate time to provide adequate utilities for the boiler location. Every boiler location requires:

1. Fuel
2. Water
3. Fresh Air
4. Stack
5. Electrical Power
6. Floor Drainage.
7. Steam Distribution
8. Condensate Return
9. Boiler Support
10. Clearance for maintenance
11. Clearance for tube replacement

RECOGNIZING THE POTENTIAL EXISTS TO CONTAMINATE YOUR POTABLE WATER SUPPLY SYSTEM(S) FROM BOILER INSTALLATIONS, IT IS RECOMMENDED THAT PROVISIONS TO PREVENT CONTAMINATION FROM YOUR BOILER INSTALLATION BE CONSIDERED.

Installation Check List

Pre-Installation

1. Boiler Location
2. Clearance for installation and maintenance
3. Support Pad
4. Stack outlet through roof
5. City water to boiler room
6. Natural Gas Supply
    a. Meter Size
    b. Meter Pressure
    c. Pipe size to boiler room
    d. Pressure available at boiler room
7. Propane Gas Supply
    a. Storage Capacity
    b. Vaporizer Capacity
    c. Pipe Size to boiler room
    d. Pressure available at boiler room

Installation

1. Boiler Level
2. Clearance for maintenance and local code compliance
3. Stack
4. Make-up City water
    a. To return tank
    b. To boiler
5. Fuel Supply
6. Blow-down
7. Electrical
8. Steam Supply
9. Condensate Return
10. Ventilation

Operating Instructions

READ BEFORE STARTING BOILER:

A. Boiler/Burner Inspection Check Before Start-up:
    1. Check for completed installation. (See Pre-Installation Check List.)
    2. Turn off all electrical switches and disconnects.
    3. If necessary, bleed air from gas supply line. Do not depend on odor to detect gas presence. Purge through gas pilot line.
    4. Close all gas supply valve.
    5. Close steam supply valve.
    6. Close all blow-down valves.
    7. Check boiler refractories for shipping damage.
    8. Check tightness of piping connections on boiler trim.
    9. Check for loose or broken electrical connections.
    10. Note any damage caused during installation and correction and correct before start-up.
    11. Remove shipping bolts from rear of skids. (Size 100 and Larger)

B. Boiler/Burner Preparation before Start-Up:

1. Open valves at top and bottom of the water column gauge glass.
2. Open city water valve to condensate return tank and check function
3. Open pump suction line valve.
4. Open pump discharge line valve.
5. Remove ¾" shipping plug from McDonnell-Miller water level control and replace with ¾" pipe plug.
6. Check supply voltage.
7. Turn on main power disconnect and check pump rotation.
8. Fill boiler with water to normal operating level. Use either city water make-up or pump. Turn pump off, if return tank goes dry.
9. The following list of data is pertinent to the boiler/burner start-up and should be carefully studied **BEFORE** commencing start-up:

    a. Boiler/Burner Manual
    b. Boiler/Burner Material List
    c. Boiler/Burner Wiring Diagram
    d. Boiler/Burner Flame Safeguard Bulletin

Flooded Weights of W&D Boilers
Scotch Marine

Size	Wt. (lbs.)
10	2225
15	2850
20	3875
25	4775
30	6265
40	7015
50	10030

Size	Wt. (lbs.)
60	11980
80	16100
100	18940
125	21300
150	25400
175	29320
200	31370

Size	Wt. (lbs.)
250	37460
300	44600
350	51500
400	57000
500	73000
600	79650
700	86300

Concrete Pads

The boiler support should be a concrete pad with enough steel reinforcement to support the weight of the boiler and the amount of water required to operate the boiler.

Size	L W	Thick
10	5' 6" x 3' 0"	4"
15	7' 0" x 3' 0"	4"
20	7' 0" x 3' 6"	4"
25	8' 0" x 3' 6"	4"
30	7' 6" x 4' 0"	4"
40	8' 6" x 4' 0"	4"
50	9' 0" x 5' 0"	5"

Size	L W	Thick
60	10' 6" x 5' 0"	5"
80	11' 6" x 5' 6"	5"
100	13' 0" x 5' 6"	5"
125	10' 6" x 5' 0"	5"
150	13' 0" x 6' 6"	6"
175	14' 0" x 6' 6"	6"
200	16' 0" x 7' 6"	6"

Size	L W	Thick
250	17' 0" x 7' 6"	6"
300	19' 0" x 8' 6"	6"
350	19' 0" x 9' 0"	6"
400	19' 0" x 9' 0"	6"
500	22' 6" x 9' 0"	6"
600	23' 0" x 9' 6"	6"
700	24' 0" x 9' 6"	6"

Gas Supply

Gas Pressures Required (Natural Gas)

Size	CFH Gas	Min.	Max.
10	450	4 oz.	8 oz.
15	680	4 oz.	8 oz.
20	900	4 oz.	1 psig
25	1150	4 oz.	1 psig
30	1350	4 oz.	1 psig
40	1680	4 oz.	1 psig
50	2100	4 oz.	1 psig
60	2520	4 oz.	1 psig
80	3360	8 oz.	1 psig
100	4200	8 oz.	1 psig

Size	CFH Gas	Min.	Max.
125	5250	5 psig	30 psig
150	6300	5 psig	30 psig
175	7350	5 psig	30 psig
200	8400	2 psig	30 psig
250	10500	2 psig	30 psig
300	12600	3 psig	30 psig
350	14700	3 psig	30 psig
400	16800	5 psig	30 psig
500	21000	10 psig	30 psig
600	25200	10 psig	30 psig

If the gas pressure available for your equipment does not fall within the limits given in this chart, notify the gas service company. If the gas company service cannot provide the prescribed pressure, the equipment will require modification for proper operation.

If the gas meter servicing the boiler also services other equipment, the requirements of the other equipment will have to be added to the capacity shown in the chart for your equipment in order to establish the capacity required from the gas meter.

GAS SUPPLY PIPE SIZES FROM METER TO BOILER

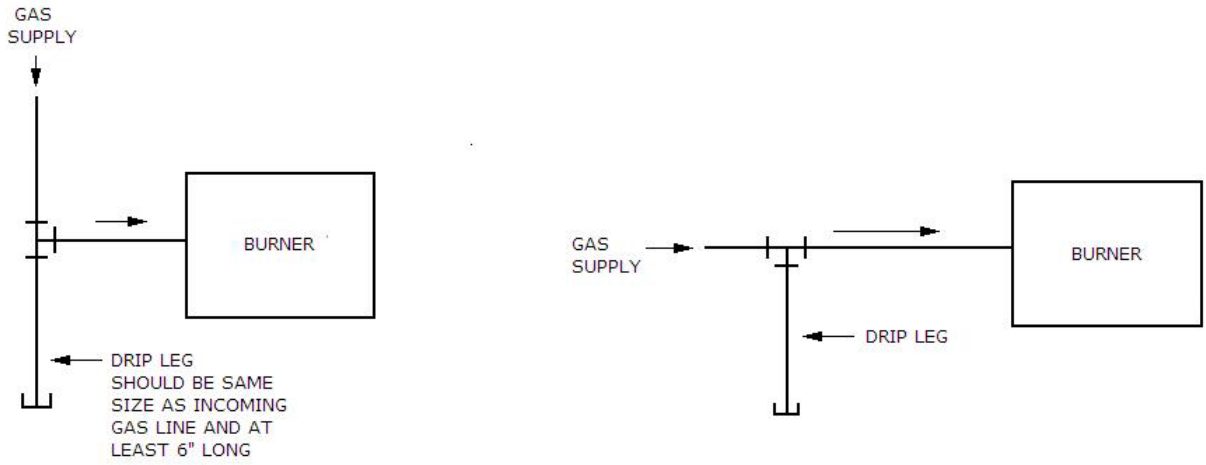
Boiler Size	Distance from Meter							Min. Gas Pressure
	30’	50’	100’	200’	300’	400’	500’	
10	1”	1-1/4”	1-1/4”	1-1/2”	1-1/4”	2”	2”	4 oz.
15	1-1/4”	1-1/4”	1-1/2”	2”	2”	2”	2”	4 oz.
20	1-1/4”	1-1/2”	2”	2”	2”	2”	2-1/2”	4 oz.
25	1-1/2”	2”	2”	2”	2-1/2”	2-1/2”	2-1/2”	4 oz.
30	1-1/2”	2”	2”	2-1/2”	2-1/2”	2-1/2”	2-1/2”	4 oz.
40	2”	2”	2”	2-1/2”	2-1/2”	3”	3”	4 oz.
50	2”	2”	2-1/2”	2-1/2”	3”	3”	3”	4 oz.
60	2”	2”	2-1/2”	3”	3”	3”	3”	4 oz.
80	2”	2”	2-1/2”	3”	3”	3”	3”	8 oz.
100	2”	2”	2-1/2”	3”	3”	3”	3”	8 oz.
125	2”	2-1/2”	2-1/2”	3”	3”	4”	4”	5 psig
150	2”	2”	2-1/2”	2-1/2”	3”	3”	3”	5 psig
175	2-1/2”	2-1/2”	2-1/2”	3”	3”	3”	3”	5 psig
200	2-1/2”	2-1/2”	2-1/2”	3”	3”	3”	4”	2 psig
250	2-1/2”	2-1/2”	3”	3”	3”	4”	4”	2 psig
300	3”	3”	3”	3”	4”	4”	4”	3 psig
350	3”	3”	3”	4”	4”	4”	4”	3 psig
400	3”	3”	3”	3”	3”	3”	4”	5 psig
500	3”	3”	3”	3”	4”	4”	4”	10 psig
600	3”	3”	3”	4”	4”	4”	4”	10 psig

Add 5' to length for every elbow or equivalent fitting between meter and boiler.

PIPING

Always apply pipe dope to the *male* threads of the pipe, and **NEVER** to the *female* threads of the fitting. No galvanized pipe or fittings should be used on gas or steam.

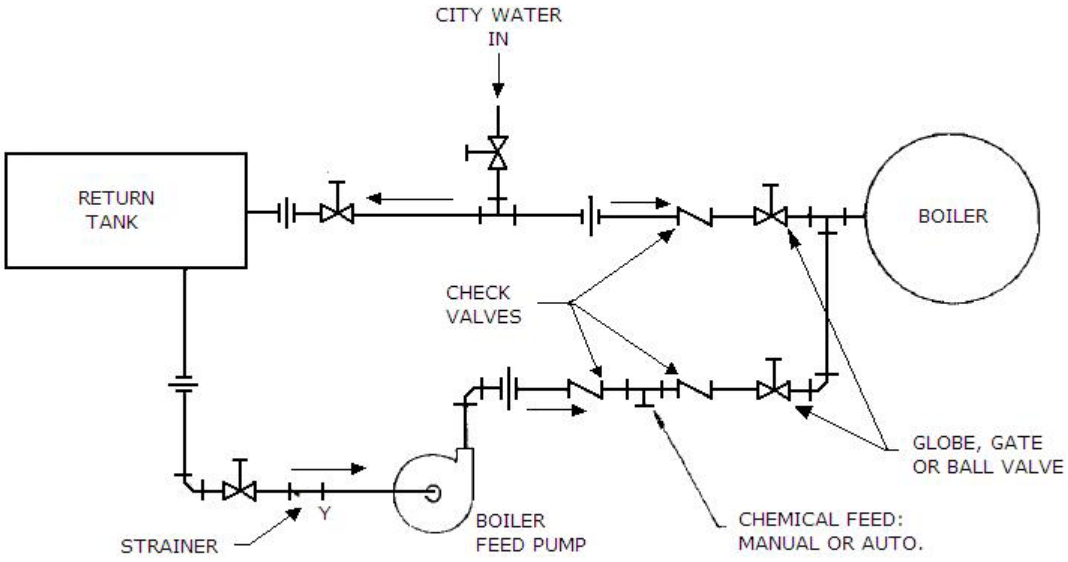
Drip Leg Installation:



(CORRECT) FIGURE 2 (INCORRECT)

WATER SUPPLY

All check valves and shut all valves must be steam service rated.



CHEMICAL FEED

Manual:

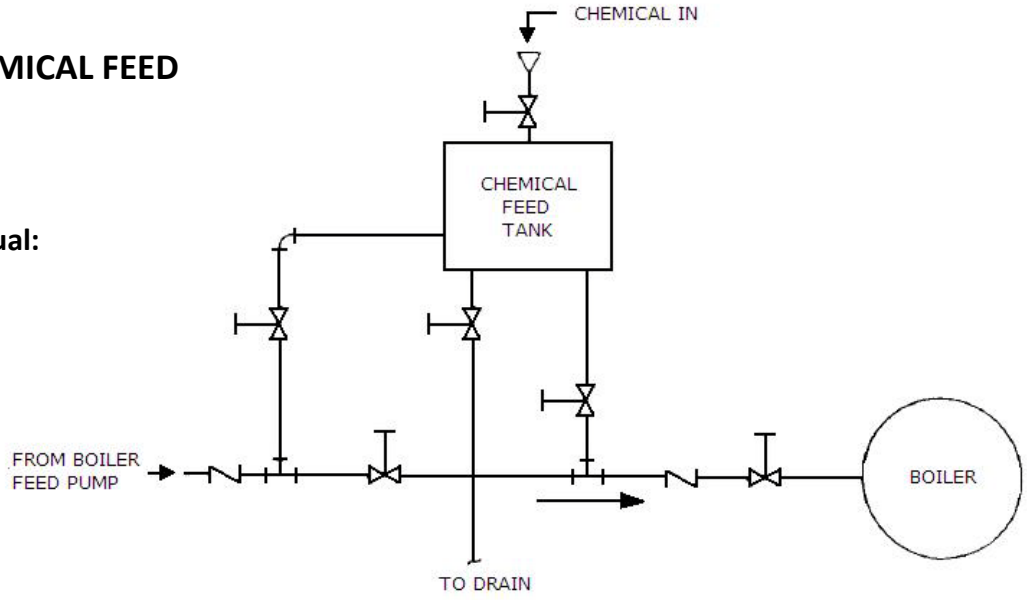


FIGURE 4

Chemical Feed, continued
Automatic:

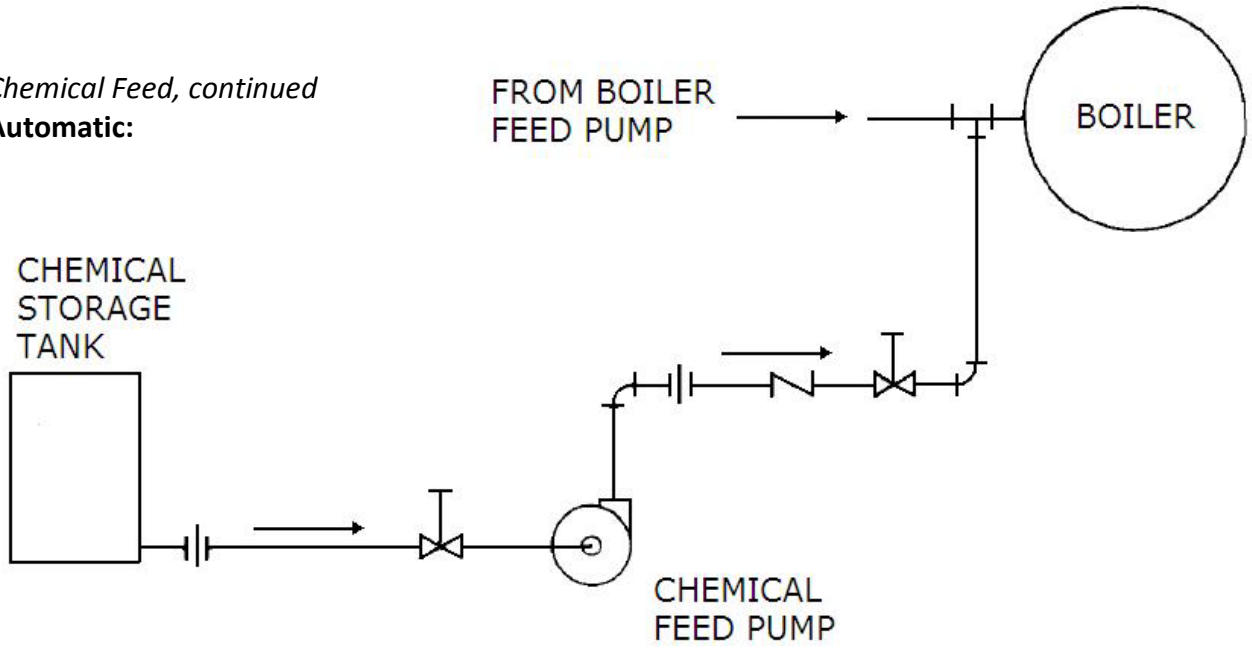


FIGURE 5

ELECTRICAL SUPPLY

Every boiler requires 110V, 60HZ power supply for boiler control.

FUSED ELECTRICAL SERVICE APPROXIMATE REQUIREMENTS

AMPS

Boiler Size	Boiler Burner Motor			Boiler Feed System				Oil Pump		
	110-1Φ	220-3Φ	440-3Φ	110-1Φ	220-1Φ	220-3Φ	440-3Φ	110-1Φ	220-3Φ	440-3Φ
10	10			15	10			15		
15	10			15	10			15		
20	10			15	10			15		
25	10			15	15	15	15	15		
30	10			15	15	15	15	15		
40	30			20	25	15	15	15		
50	30				30	15	15	15		
60	30				40	20	15		10	15
80		20	15			30	15		10	15
100		20	15			45	25		10	15
125		20	15			45	25		10	15
150		20	15			70	35		10	15
175		20	15			70	35		10	15
200		30	15			90	45		10	15
250		30	15			90	45		10	15
300		30	15			90	45		10	15
350		45	25			125	60		10	15
400		45	25			125	60		10	15
500		90	45			175	80		10	15
600		125	60			175	80		10	15
700		125	60			175	80		10	15

STACK

Stack diameter should be the same as the outlet diameter of the boiler being installed.

STACK DIAMETERS

Boiler Size	Stack Size	Boiler Size	Stack Size	Boiler Size	Stack Size
10	8”	60	12”	250	20”
15	8”	80	16”	300	24”
20	10”	100	16”	350	24”
25	10”	125	18”	400	24”
30	10”	150	20”	500	24”
40	12”	175	20”	600	24”
50	12”	200	20”	800	24”

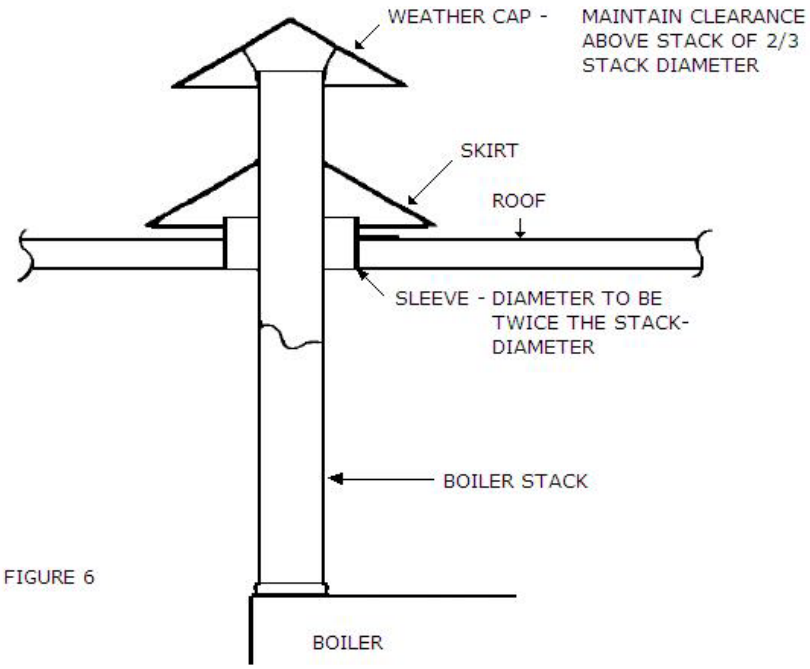


FIGURE 6

BLOWDOWN

The boiler blowdown lines should be piped together into a blowdown separator as shown below.

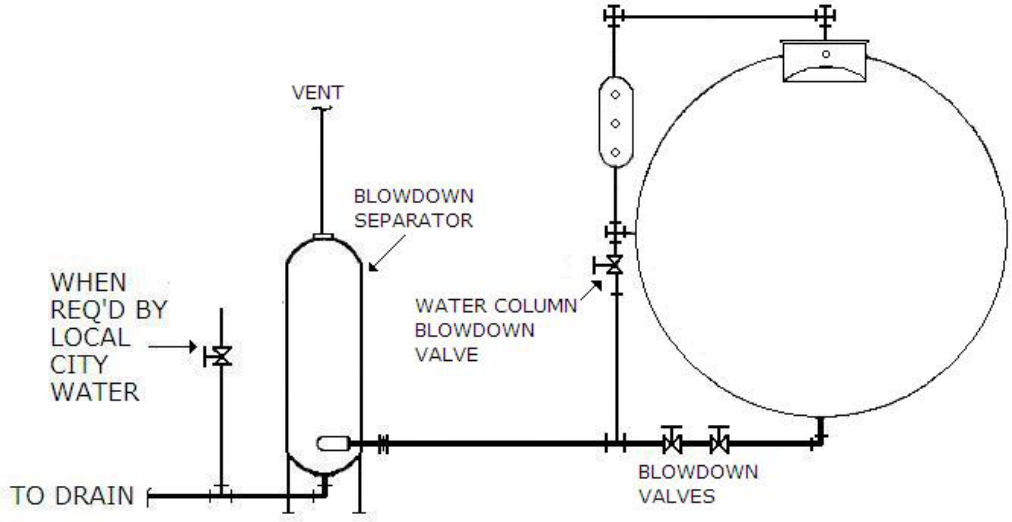
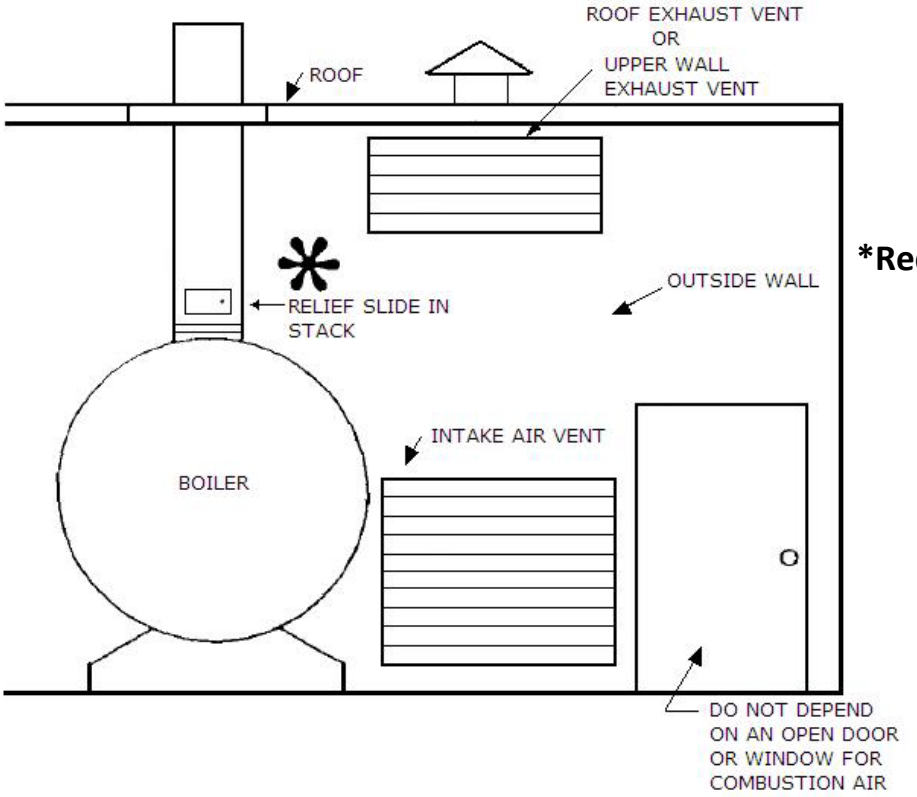


FIGURE 7

Schedule 80 pipe recommended.
Do Not reduce Blow-Down Line!

BOILER ROOM VENTILATION & COMBUSTION AIR

Most boiler and combustion controls operate erratically above an ambient temperature of *125* ^{0} F. Adequate ventilation should be provided at the upper area of the boiler room wall or roof to allow the escape of hot air from the boiler room. Forced ventilation is acceptable with the precaution that the powered exhaust does not starve the boiler of combustion air. An opening must be provided in the lower area of the boiler room wall to allow the influx of fresh air needed for ventilation and combustion.



***Required, if stack is over 10' high.**

Before slack is installed, a 4" x 8" opening with a slide cover is to be placed in the stack.

The amount of slide opening for correct burner operation will have to be set with proper combustion metering equipment.

Intake grills should be located on outside walls' when possible in order to eliminate possible interference from exhaust equipment located in adjacent buildings. If powered exhaust equipment is employed, allow at least one square inch for each 3 cfm of rated capacity of exhaust equipment in addition to the area required for combustion air.

MINIMUM INTAKE GRILLE SIZES
for Combustion Air Only

Boiler Size	Grille Area	Grille Dim.
10	128 in^2	8” x 16”
15	128 in^2	8” x 16”
20	128 in^2	8” x 16”
25	128 in^2	8” x 16”
30	128 in^2	8” x 16”
40	256 in^2	8” x 32”
50	256 in^2	8” x 32”
60	256 in^2	8” x 32”
80	512 in^2	16” x 32”
100	512 in^2	16” x 32”

Boiler Size	Grille Area	Grille Dim.
125	512 in^2	16” x 32”
150	640 in^2	16” x 40”
175	640 in^2	16” x 40”
200	960 in^2	24” x 40”
250	960 in^2	24” x 40”
300	1344 in^2	24” x 56”
350	1344 in^2	24” x 56”
400	1536 in^2	24” x 64”
500	2048 in^2	32” x 64”
600	2304 in^2	32” x 72”

***Based on .015 in W.C. drop across grille with approx 400 fpm Velocity thru grille.**

SAFETY VALVE DISCHARGE LINES

Discharge lines from the safety relief valve should be supported so as to remove any strain on the relief valve. Safety relief valves will not support the weight of a steel discharge line. Do not reduce the outlet size of the relief valve. If long runs of pipe are required to the discharge line outside the boiler room, larger pipe must be used. If the discharge line is to be vertical, a drip panel should be employed to prevent water from standing in the discharge line. Since a column of water has weight, it will cause a pressure against the relief valve, thus making the relief valve discharge at a higher pressure.

SAFETY RELIEF VALVES

The primary purpose of safety valves is to prevent excessive pressure in the boiler. Safety relief valve(s) furnished by W&D are sized to comply with the latest applicable Code (ASME, National Board, USCG, ABS, etc.) requirements for which the boiler was designed.

Safety valves are normally located on the shell and are factory ·set" and ·sealed" by the valve manufacturer. The warranty is IMMEDIATELY VOIDED if the seals are broken. Therefore, DO NOT ALLOW anyone to attempt to adjust or reset the relieving pressure. There should be no obstructions at the safety valve inlets or outlets.

Safety valve relieving pressures conform with the maximum allowable working pressure stamped on the boiler shell (150 PSIG), as the safety valve's purpose is to protect the boiler, not the distribution system nor connected equipment. When boilers having different design pressures are connected into a common header, special code regulations become effective.

Safety valve discharge capacities are stamped on the valve label by the valve manufacturer for the -, relieving pressure at which the safety valve has been set. Changes in the relieving pressure will result in a change in the valve capacity and, in many instances; safety valves reset to a lower pressure may not be adequate to meet minimum code requirements. Therefore safety valve substitutions should not be made without first communicating with W&D.

A pipe wrench **MUST NOT BE USED** to install a safety valve. This type wrench squeezes the valve body and often causes the valve(s) to weep. Warranty replacement WILL NOT BE MADE for such damage. Always use an adjustable end wrench tor safety valve installations.

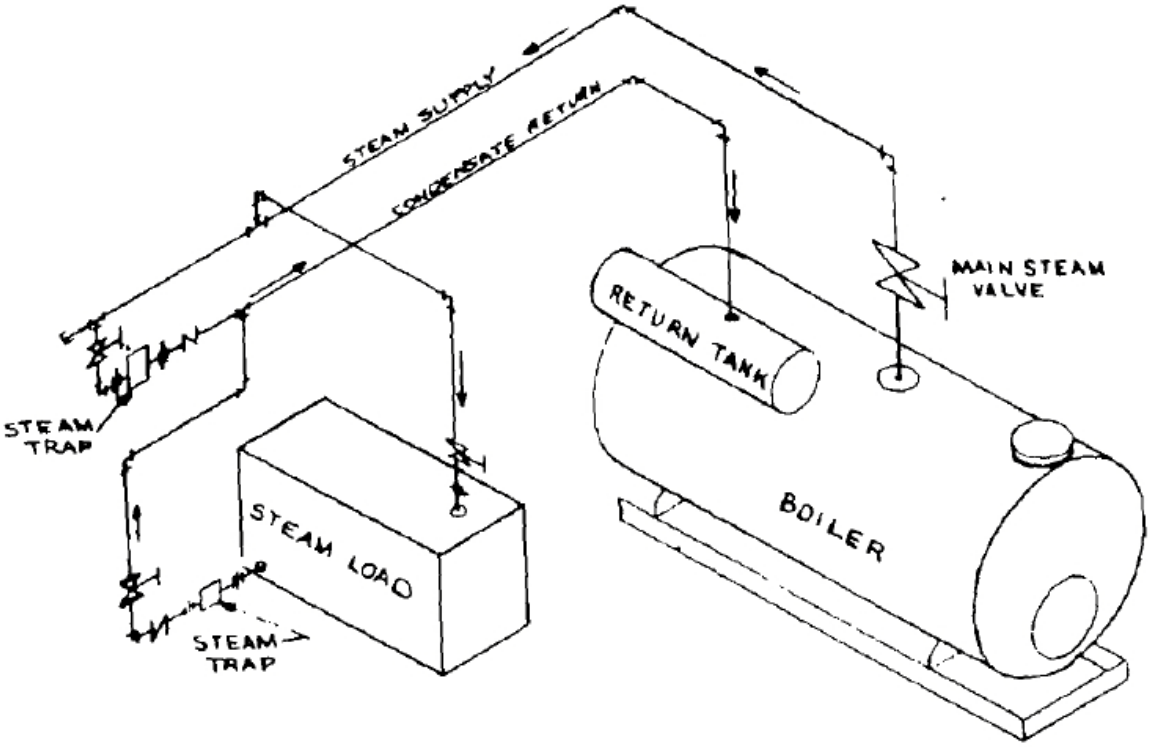
Safety valve discharge piping shall have an internal area equal to or greater than the aggregate internal area of the valve outlets piped into them. The weight of the discharge piping MUST BE INDEPENDENTLY SUPPORTED and must NOT rest on the safety valve body.

Safety valve bodies are equipped with a drain tapping which shall not be plugged, but should have discharge piping run to a point where the accumulated condensate will not drain onto the boiler.

STEAM SUPPLY and CONDENSATE RETURN

The main steam valve may be either a gate valve or a steam-rated globe valve. Each piece of equipment should be provided with a steam shut-off valve and a condensate trap. A condensate trap is not necessary, if the steam is used directly during a process. The end point of each main steam supply line and each branch supply line should be trapped to maintain dry steam to the equipment and to prevent water hammering in supply pipes. The valves used in the condensate return lines must also be steam service rated valves. Steam and condensate lines should always be insulated, because the losses by radiation must be replaced by additional input.

TYPICAL LOAD PIPING



BLOW-OFF VALVES

One (1) slow opening valve and one (1) quick opening valve may be used, or the valve assembly may consist of two (2) slow opening valves. A slow opening valve requires at least five full turns to completely open. A quick opening valve is usually lever actuated.

All valves shall be temperature/pressure rated and shall be equivalent to the M.A.D.P. stamped on the boiler. Blow-off piping between the boiler and the second valve, whether screwed or welded, should be at least Sch.BO and all fittings shall be steel.

Blow-off valves & piping are subject to water hammer shock and extremes can be momentarily induced by improper operation of the valves. ALWAYS OPERATE THE LEVER OPERATED VALVE VERY SLOWLY.

The data on blowdowns should be recorded. The frequency and duration are best determined from a chemical analysis of the boiler water. Since the water treatment system varies for each plant, a competent authority on water conditioning should be engaged to prescribe suitable feedwater treatment from analysis of the water supply and to furnish the necessary instructions for blowing down. If this is not practical, the boiler should be blown down at least once every 24 hours, however, W&D recommends blowdown once at least every 8 hours, or more often if the feedwater is of inferior quality or the amount of make-up is large.

The use of the boiler bottom blow-off valves should be restricted to periods of moderate steaming rates and preferably very low combustion rate. The bottom blow should always be used to free a boiler of sediment when the boiler is being cutoff.

MAINTENANCE

DAILY:

1. Blowdown boiler at least twice every 8 hour period in use. On high pressure boilers, it is recommended the boiler be blown-down at 15-25 PSIG if possible. Blow down as follows:

   a. Open the first valve from the boiler
   b. Open the second valve from the boiler
   c. Allow boiler to blow down until the pump turns on and the burner cuts off.
   d. Close the second valve from boiler.
   e. Wait for pump to turn off, then repeat steps b, c and d at least three times.
   f. Close the valve from boiler.

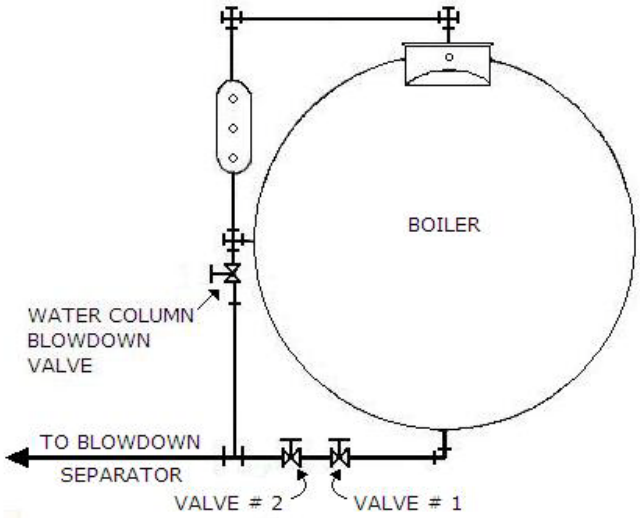


FIGURE 16

2. Blowdown water gauge glass to keep free of scale obstructions. See item 5 weekly.
3. Blowdown the water column and level control, and check that the pump starts and the low water cut-off operates in the proper sequence, at least twice every 8 hour period.

WEEKLY:

1. Check flame safety system for proper operation
2. Check ignition wires and replace if brittle or cracked
3. Clean scanner tube with a soft cloth and detergent. Wipe completely dry.
4. Visually check burner condition and flame appearance
5. On 80 HP and larger, gauge glass valves should be closed and reopened to maintain freedom of the ball check mechanism. The ball check mechanism is to prevent steam and water from spraying from the water column in case of gauge glass blow-out.

90 DAY:

1. Avoid excessive "popping" of the safety/relief valve as even one opening can provide a means for leakage. Safety/relief valves should be operated only often enough to assure that they are in good working order.
2. Blow-out steam gauge and pressure switch line slowly at 15 to 20 psig.
3. Remove all handhole and man hole plates for internal Inspection of scale and corrosion conditions, scrape clean internal seating surface and plate surface. **Wash the boiler thoroughly,** especially the rear tube sheet and top of furnace. Install only new gaskets. Replace leaking gaskets

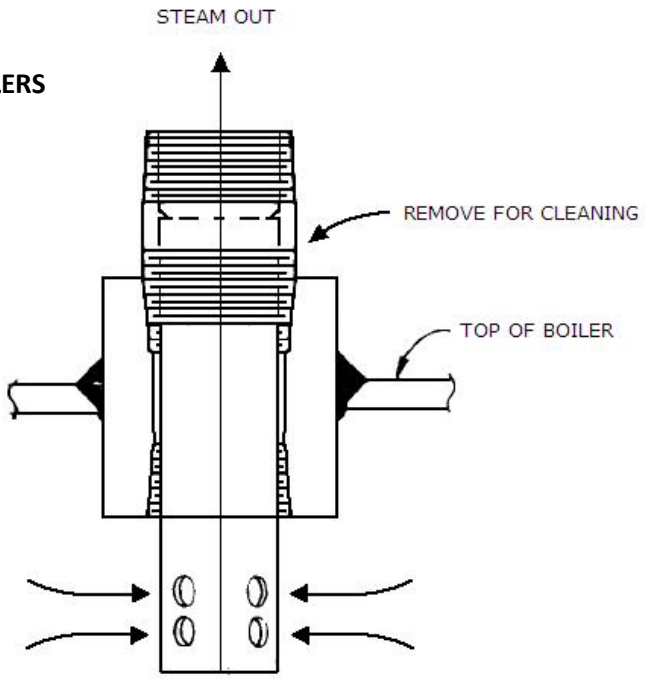
immediately to prevent wire drawing of the seating surface.

4. Remove plugs on feed line and water column connections and clean out fittings into boiler shell.
5. Inspect tubes for cleanliness and leaks.
6. Repack leaky valve stems.
7. Replace water gauge glass as necessary for good visibility of water level.
8. Clean pump suction strainer.
9. Clean lint and dust from blower wheel blades.
10. Check and clean airway to pilot. This may be done easily by pushing a hacksaw blade or similar piece of material through the opening several times. Low pressure air may be used.

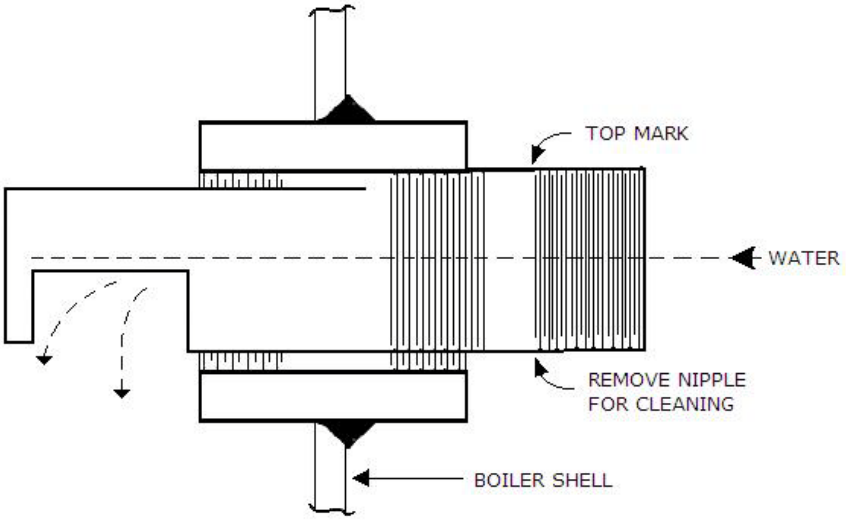
YEARLY:

1. Call inspector for annual inspection.
2. Remove water level control float and clean float bowl.
3. Remove secondary low water cut-off probe and check for corrosion.
4. Clean Steam Dry Pan on Vertical Tubeless Boiler. Clean Boiler Feed Filling, be sure to install "Top" as stamped on nipple.

STEAM DRY PIPE
FOR VERTICAL TUBELESS BOILERS



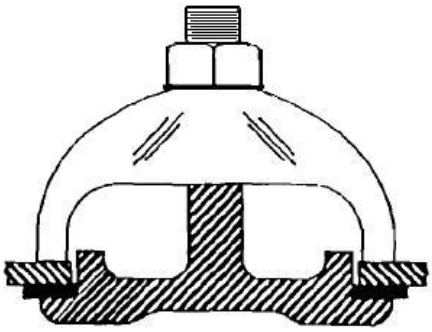
BOILER FEED FITTING



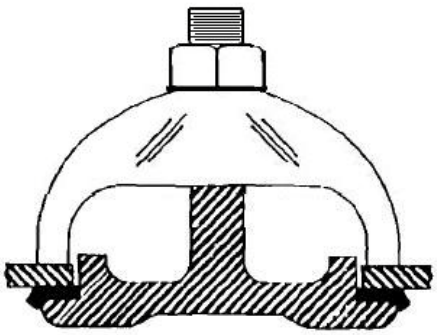
REPLACING HANDHOLE & MANHOLE GASKETS

1. Match-mark the plate(s), the hole and the top edge so the plate can be reinstalled in the same position in the same opening.
2. Remove old gasket and thoroughly clean the surface on the inside of the boiler, and on the plate, using a scraper, wire brush, or grinder, if necessary. Extreme care should be taken not to undercut the gasket surfaces.
3. Carefully center the gasket on the plate. DO NOT use any grease, lubricant nor adhesive. Center the plate in the opening so the gasket-bearing surface is even all around.
4. After plate is in boiler and gasket is in place, set crab and tighten nut only enough to provide a snug fit. Make it hand-tight, then snug with wrench about *1/4* turn. DO NOT COMPRESS excessively.
5. If gasket leaks while pressure is being built up, tighten only enough to stop leakage. *Never tighten more than necessary to prevent leakage.* Excessive tightening may shorten life of gasket.

GASKET INSTALLATION ILLUSTRATION



(CORRECT)
CORRECT PRESSURE ON GASKET



(INCORRECT)
NEVER OVER-COMPRESS
GASKET AS SHOWN

Leakage of boiler manhole/handhole gaskets is not only an unsightly nuisance, but can develop into a serious maintenance problem unless promptly corrected. Even small or intermittent leaks cause a general deterioration of adjacent boiler and manhole/handhole plate surfaces. As the corrosion progresses, the metal parts will be wire-drawn.

If the plate *&/or* boiler surface has been corroded by leak(s), they may be too irregular to fit, or there may be insufficient gasket surface area left to make a tight joint. If so, repairs must be made. The boiler surface may be built up by a certified welder and ground flush. It is generally more economical to install a new handhole plate rather than attempt to repair the old one.

Gasket leaks are sometimes caused by excessive use of boiler compounds. Such leaks are identified by a crusty formation of "beards· around the plate. The concentration of water treatment chemical should be checked and if too high, the boiler should be drained, washed & refilled. and enough water added to bring it within the recommended range. All gaskets should be replaced with special attention given to cleaning surfaces.

When boilers have been cleaned, new gaskets should be installed before the boiler is placed back in service.

DO's & DON'Ts:

1. 1.ALWAYS promptly and permanently stop the gasket leak.
2. Always replace manhole & handhole plates in the same opening, and in the same position. Match-mark the plate, the opening and the top edge before removing.
3. Always use new gaskets. Do not try to reuse an old gasket even in the same opening.
4. Frequently check manhole plate bolts for tightness.
5. Do NOT use a long-handled wrench, nor try to tighten a bolt when boiler is under full steam pressure. A joint rupture can result in serious scalding.
6. Do not allow boiler insulation to cover any handhole openings.

COMMON CAUSES OF GASKET LEAKAGE:

1. Use of old gaskets that have lost their flexibility.

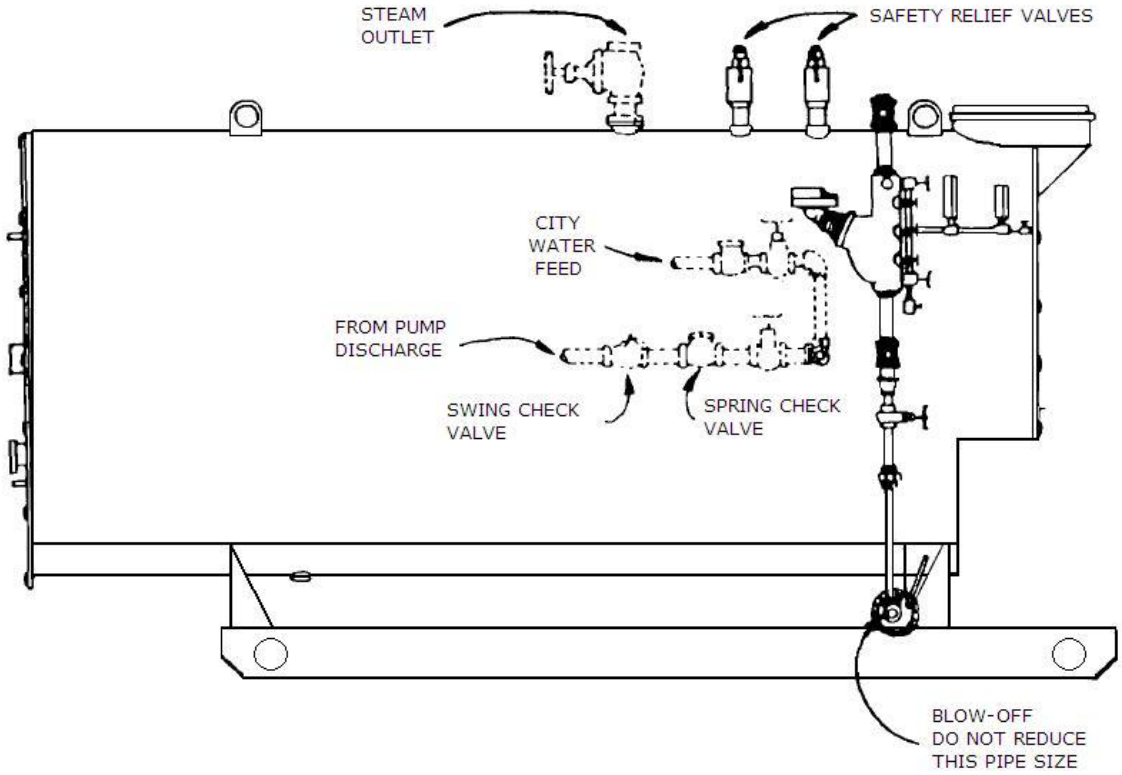
2. Improper positioning of gasket on the plate &/or location of the plate in the opening.

3. Loose bolts.

4. Rough, wire-drawn, scaled or pitted surfaces of the plate &/or boiler surface.

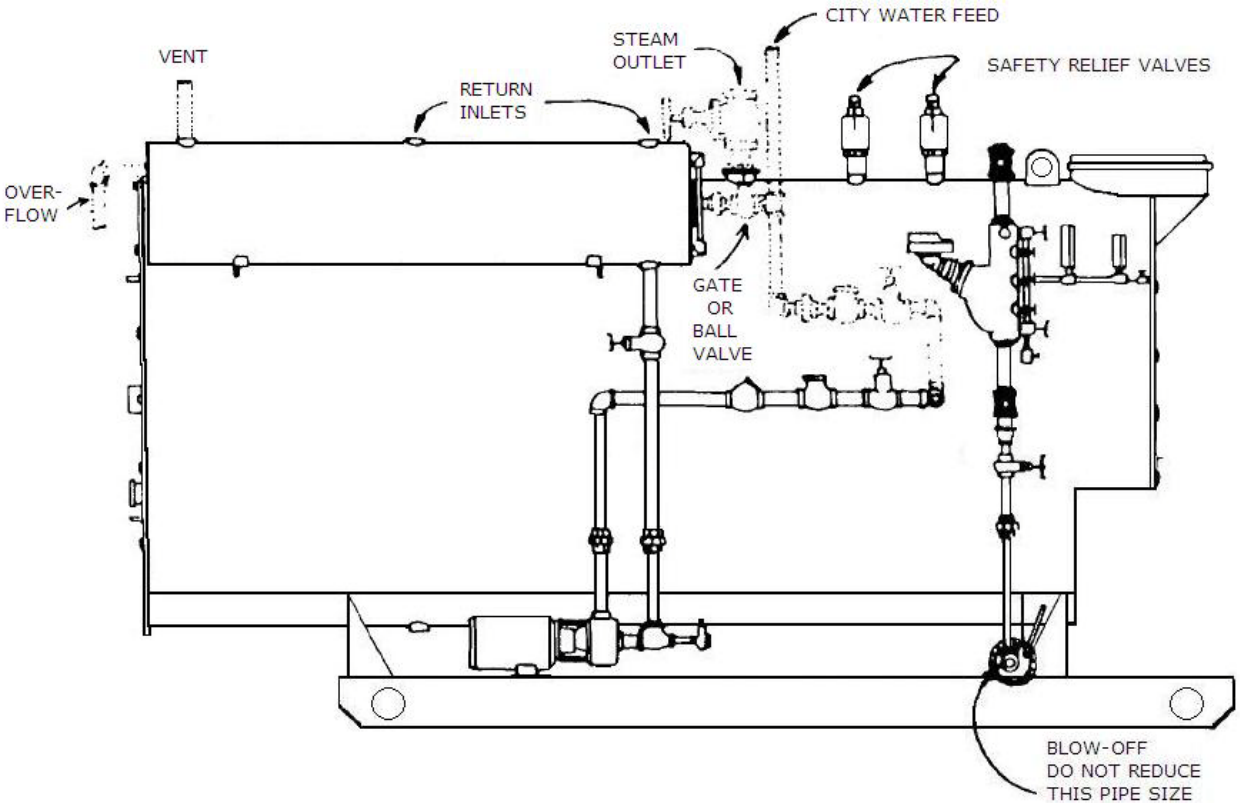
5. Excessive use of boiler compounds resulting in high caustic concentrations of boiler water.

6. Use of handhole or manhole crabs as lugs for jacks or levers, or for attachment of hooks or slings for pulling or lifting.



SCOTCH MARINE BOILER WITHOUT BOILER FEED SYSTEM

DOTTED PIPING & FITTINGS SUPPLIED BY CUSTOMER



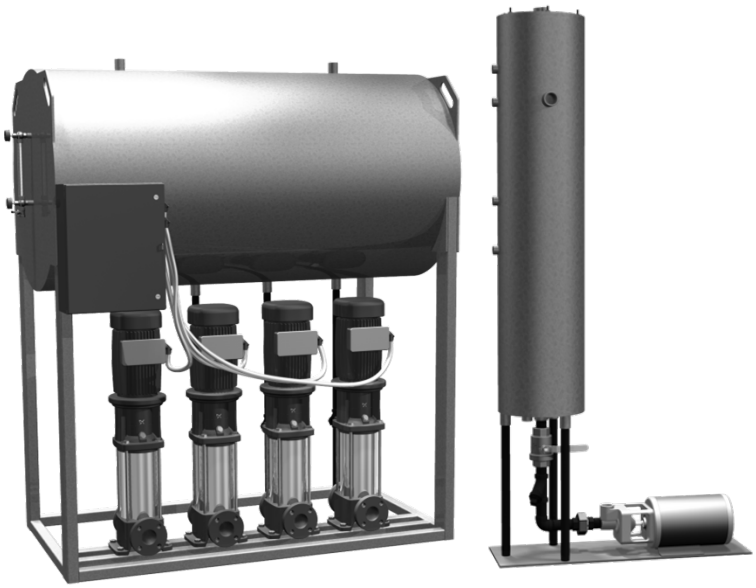
SCOTCH MARINE BOILER WITH MODEL "B" BOILER FEED SYSTEM DOTTED PIPING & FITTINGS SUPPLIED BY CUSTOMER

STEAM TABLE

Gauge Pressure Lb./Sq. In.	Temp.˚F	Volume Cu. Ft./lb.	Total Heat Above 32˚F		
			In 1 Lb. Water	Latent Heat	Total 1 Lb. Steam
0	221.0	26.80	180.1	970.3	1150.4
1	215.5	25.13	183.6	968.1	1151.7
2	218.7	23.72	186.8	966.0	1152.8
3	221.7	22.47	189.8	964.1	1153.9
4	224.5	21.35	192.7	962.3	115.0
5	227.3	20.34	195.5	960.5	1156.1
6	229.9	19.42	198.2	958.8	1157.0
7	232.4	18.58	200.7	957.2	1157.9
8	234.9	17.81	203.2	955.6	1158.8
9	237.2	17.11	205.6	954.1	1159.7
10	239.5	16.46	207.9	952.5	1160.4
11	241.7	15.86	210.1	951.1	1161.2
12	243.8	15.31	212.2	949.7	1161.9
13	245.9	14.79	214.3	948.3	1162.6
14	247.9	14.31	216.4	946.9	1163.3
15	249.8	13.86	218.3	945.6	1163.9
16	251.7	13.43	220.3	944.3	1164.6
17	253.6	13.03	222.2	943.0	1165.2
18	255.4	12.66	224.0	941.8	1165.8
19	257.1	12.31	225.7	940.6	1166.3
20	258.8	11.98	227.5	939.5	1167.0
21	260.5	11.67	229.2	938.3	1167.5
22	262.2	11.37	230.9	937.2	1168.1
23	263.8	11.08	232.5	936.1	1168.6
24	265.4	10.82	234.1	935.0	1169.1
25	266.9	10.56	235.6	934.0	1169.6
30	274.1	9.45	234.0	928.9	1171.9
35	280.7	8.45	249.8	924.2	1174.0
40	286.8	7.82	256.0	919.8	1175.8
45	292.4	7.20	261.8	915.7	1177.5
50	297.7	6.68	267.2	911.8	1179.0
55	302.7	6.23	272.4	908.1	1180.5
60	307.3	5.83	277.2	904.6	1181.8
65	311.8	5.49	281.8	901.3	1183.1
70	316.4	5.18	286.2	898.0	1184.2
75	320.1	4.91	290.4	894.8	1185.2
80	323.9	4.66	294.4	891.9	1186.3
85	327.6	4.44	298.2	899.0	1187.2
90	331.2	4.24	301.9	886.1	1188.0
95	334.6	4.06	305.5	883.3	1188.8
100	337.9	3.89	308.9	880.7	1189.6
105	341.1	3.74	312.3	878.1	1190.4
110	344.2	3.59	315.5	875.5	1191.0
115	347.2	3.46	318.7	873.0	1191.7
120	350.1	3.34	321.7	870.7	1192.4
125	352.9	3.23	324.7	868.3	1193.0

STEAM TABLE

Gauge Pressure Lb./Sq. In.	Temp.˚F	Volume Cu. Ft./lb.	Total Heat Above 32˚F		
			In 1 Lb. Water	Latent Heat	Total 1 Lb. Steam
130	355.6	3.12	327.6	865.9	1193.5
135	358.3	3.02	330.4	863.7	1194.1
140	360.9	2.93	333.1	861.5	1194.6
145	363.4	2.84	335.8	859.3	1195.1
150	365.9	2.76	338.4	857.2	1195.6
155	368.3	2.68	340.9	885.0	1195.9
160	370.6	2.61	343.4	853.0	1196.4
165	372.9	2.54	343.9	850.9	1196.8
170	375.2	2.47	348.3	848.9	1197.2
175	377.4	2.41	350.7	846.9	1197.6
180	379.5	2.35	353.0	845.0	1198.0
185	381.6	2.30	355.2	843.1	1198.3
190	383.7	2.24	357.4	841.2	1198.6
195	358.8	2.19	359.6	839.2	1198.8
200	387.8	2.14	361.8	837.5	1199.3



BOILER FEED SYSTEMS

BLOW-DOWN SEPARATORS