Spraymaster® Deaerator
Boilermate® Deaerator

Operation, Maintenance, and Parts

750-183

TO: **Owners, Operators and/or Maintenance Personnel**

This operating manual presents information that will help to properly operate and care for the equipment. Study its contents carefully. The unit will provide good service and continued operation if proper operating and maintenance instructions are followed. No attempt should be made to operate the unit until the principles of operation and all of the components are thoroughly understood.

It is the responsibility of the owner to train and advise not only his or her personnel, but the contractors' personnel who are servicing, repairing, or operating the equipment, in all safety aspects.

Cleaver-Brooks equipment is designed and engineered to give long life and excellent service on the job. The electrical and mechanical devices supplied as part of the unit were chosen because of their known ability to perform; however, proper operating techniques and maintenance procedures must be followed at all times.

Any "automatic" features included in the design do not relieve the attendant of any responsibility. Such features merely free him of certain repetitive chores and give him more time to devote to the proper upkeep of equipment.

It is solely the operator’s responsibility to properly operate and maintain the equipment. No amount of written instructions can replace intelligent thinking and reasoning and this manual is not intended to relieve the operating personnel of the responsibility for proper operation. On the other hand, a thorough understanding of this manual is required before attempting to operate, maintain, service, or repair this equipment.

Operating controls will normally function for long periods of time and we have found that some operators become lax in their daily or monthly testing, assuming that normal operation will continue indefinitely. Malfunctions of controls lead to uneconomical operation and damage and, in most cases, these conditions can be traced directly to carelessness and deficiencies in testing and maintenance.

The operation of this equipment by the owner and his operating personnel must comply with all requirements or regulations of his insurance company and/or other authority having jurisdiction. In the event of any conflict or inconsistency between such requirements and the warnings or instructions contained herein, please contact Cleaver-Brooks before proceeding.

Cleaver-Brooks

Operation, Maintenance, and Parts Manual
Spraymaster® Deaerator
Boilermate® Deaerator
Deaerator and Surge Controls

Please direct purchase orders for replacement manuals to your local Cleaver-Brooks authorized representative

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Section 1

Deaerators

1.1 GENERAL

The Spraymaster and Boilermate Deaerators (Figures 1-1 and 1-2) are designed to operate with steam generation plants, or wherever oxygen-free water is required.

Boiler feedwater usually contains two harmful dissolved gases; oxygen and carbon dioxide. The purpose of deaeration is to remove these gases before they are liberated in the boiler. This reduces corrosion in the boiler, steam lines, condensate lines, and heat transfer equipment.

The deaerator conditions feedwater so that it has less than 0.005 CC oxygen per liter. This is termed “zero oxygen” and is the practical limitation of current chemical testing equipment. Carbon dioxide is, for all practical purposes, eliminated. Water delivered to the boiler is pre-heated.

Deaerators are designed to operate on steam from the boiler, exhaust steam, or both. If exhaust steam is currently going to waste, it may be used in the deaerator — reducing the fuel expense of the plant approximately 1% for each 10 °F rise in boiler feedwater temperature.

Figure 1-1. Spraymaster® Deaerator

Figure 1-2. Boilermate® Deaerator

NOTE: Exhaust steam must be free of oils and other contaminants, be of continuous supply, and at the required pressure. Care must be taken to avoid problems with the equipment from which steam is extracted.

1.2 DESCRIPTION AND PRINCIPLES OF OPERATION

The basic principle of deaeration is as follows. The supply water enters the deaerator through a spring-loaded, self-cleaning nozzle, which sprays it into a steam-filled primary heating and vent concentration section. Here, the water temperature is raised to within 2° or 3° of steam temperature and virtually all the gases are released. Typical configurations are shown in Figure 1-4; a typical two-tank deaerator system is shown in Figure 1-5.

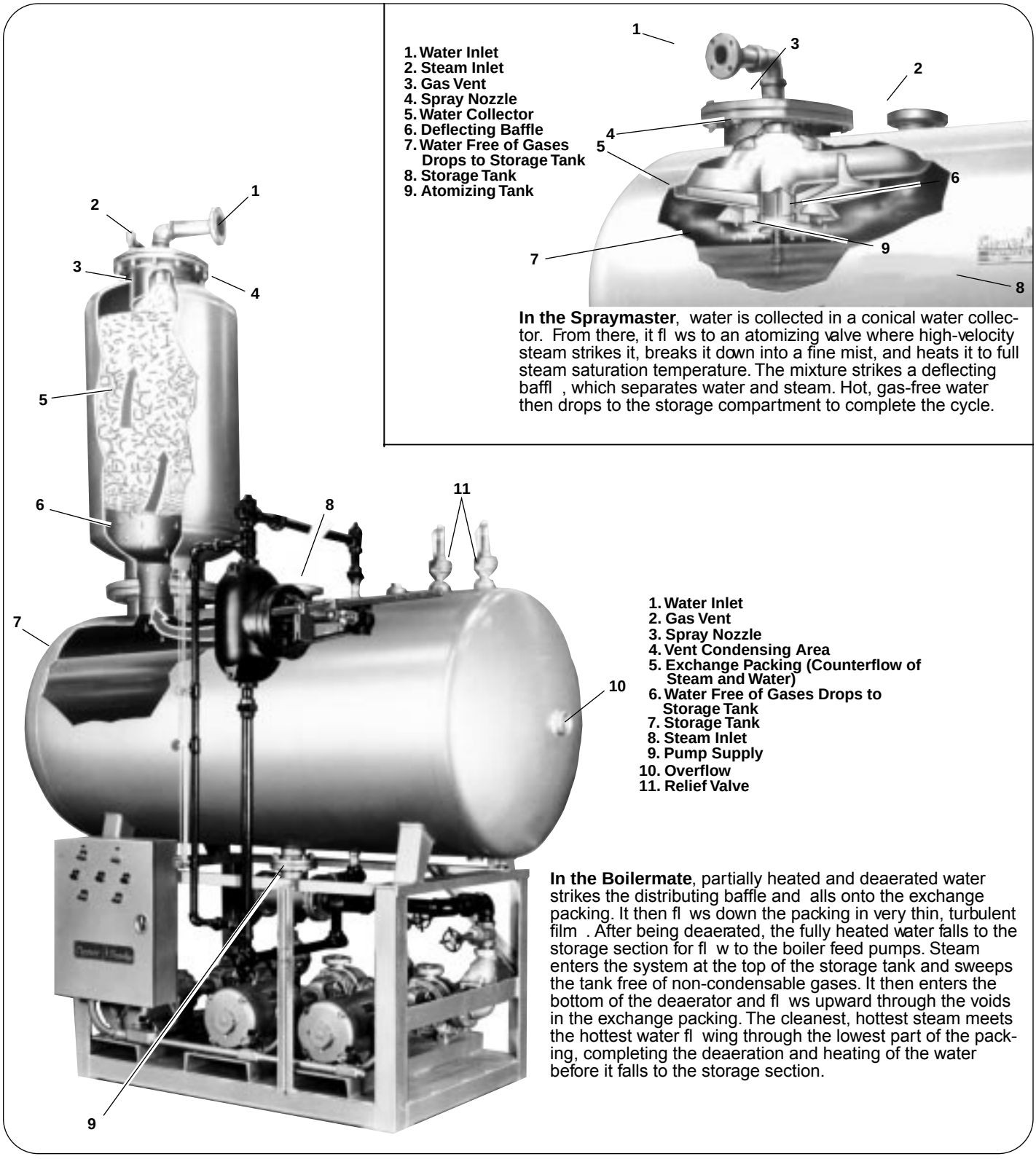


Figure 1-3. Deaerator Operation

1.2.2 Spraymaster Deaerator

A typical Cleaver-Brooks Spraymaster Deaerator is shown in Figure 1-3, which illustrates a packaged type deaerator tank mounted on a stand or legs of appropriate height, and includes all operating controls and boiler feed pump(s), assembled and piped.

Cleaver-Brooks also supplies deaerator tanks for installation with pumps and stands provided by others. Generally, accessories such as relief valves for the tank, steam pressure reducing valve, float-operated make-up water control valve, and an overflow drainer are provided with the deaerator tank, because their sizing is critical to proper operation.

The tank is a 50 psig ASME vessel containing an 11" x 15" manhole, and fitted with a 0-60 lb pressure gauge, a 50 – 300 °F thermometer, and a water level gauge glass (or glasses).

The main deaerating portion is located internally and consists of a water collector and steam atomizing valve. Built into a flange on the top of the tank is a spring-loaded spray nozzle inlet water assembly that includes an automatic vent valve and a manual vent valve. The various components are identified in Figures 1-6 and 1-7.

NOTE: To prevent damage during shipment, the steam atomizing valve in those models using the counterbalance is fastened in the closed position as shown in Figure 1-8. The retaining spacer and nut must be removed prior to operation. The manhole cover must be opened for this removal.

The spray nozzle assembly for the SM-7 Deaerator is slightly different than that illustrated in Figure 1-3, but the principle is identical. On this size, the entire deaerator assembly is removable from the flange in the top of the tank. See Figure 1-9.

The principle of operation is identical for either design.

1.2.3 Boilermate Deaerator

The Boilermate Deaerator (Figure 1-3) consists of:

1. Deaerator Column
2. Storage Tank
3. Accessories

The deaerator column is a 50 psig ASME steel shell with a stainless steel liner on the vertical water contact surface.

The standard column includes an automatic vent valve, manual vent valve, spring-loaded spray nozzle for variable flow rate, stainless steel distribution baffle, assembly gasket and bolts, and column packing.

The tank is a 50 psig ASME vessel containing an 11" x 15" manhole, and fitted with a 0-60 lb pressure gauge, a 50 – 300 °F thermometer, water level gauge glass (or glasses), and an overflow pipe.

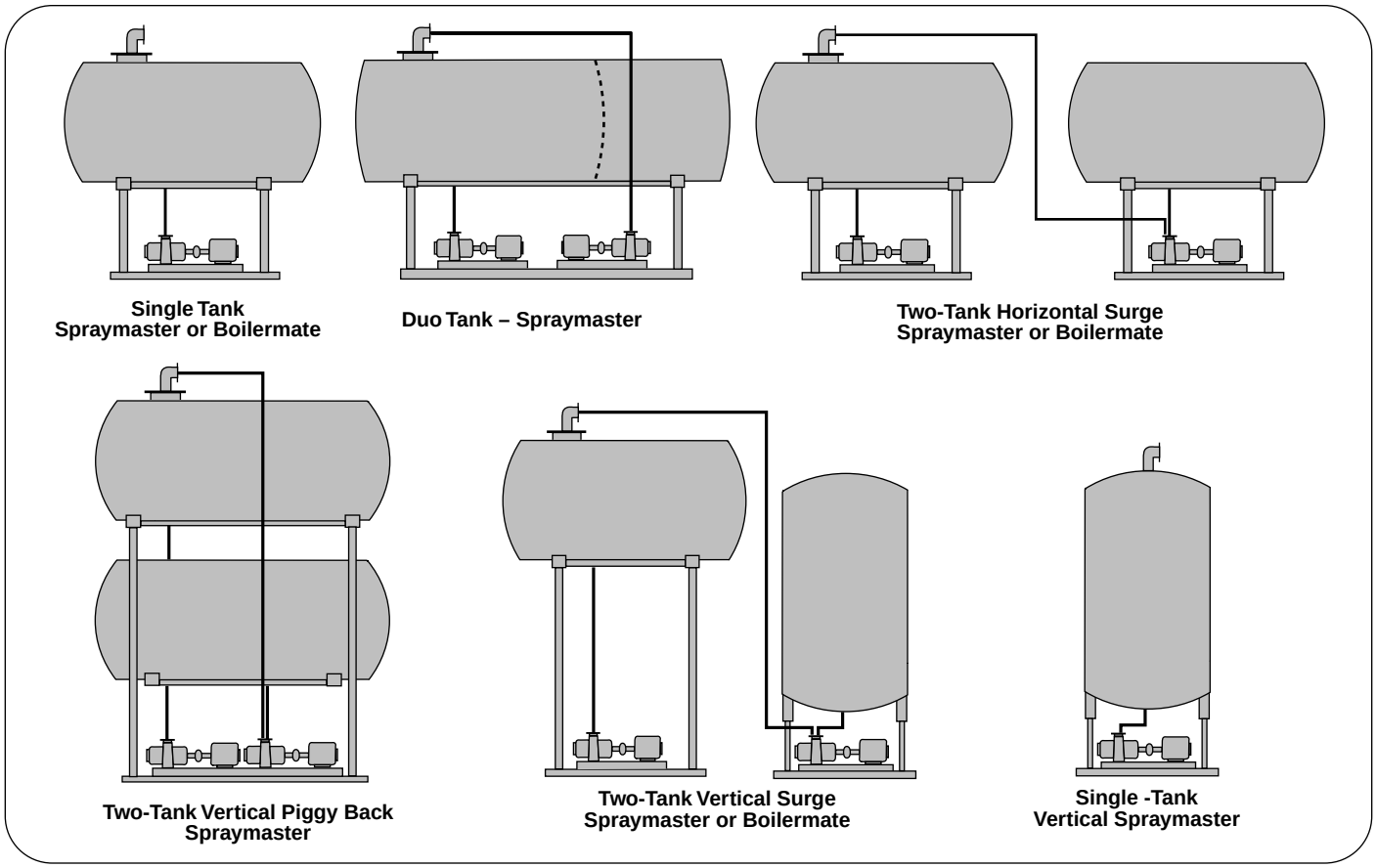


Figure 1-4. Typical Deaerator Configurations

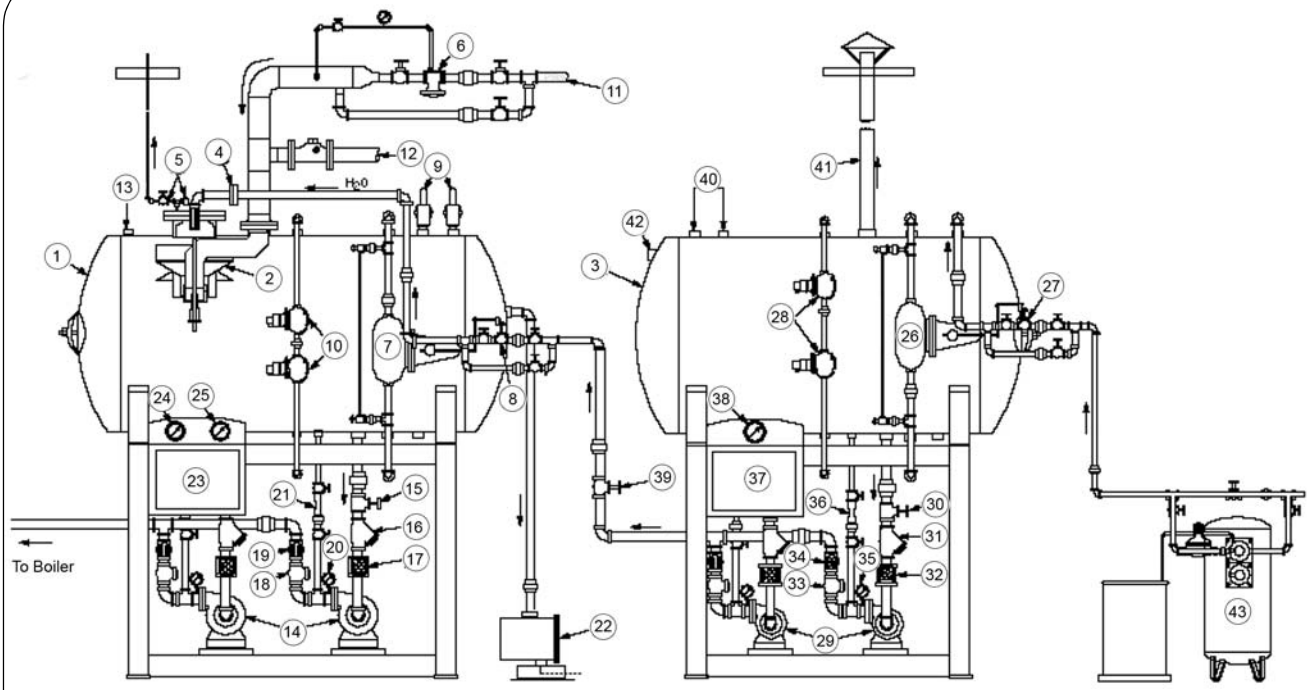


Fig 1-5. Typical Two-Tank System

1. Deaerator Storage Tank
2. Spraymaster Deaerator
3. Surge Tank
4. Deaerator Water Inlet
5. Deaerator Manual & Automatic Vent
6. Steam Pressure Reducing Valve
7. Deaerator Water Level Float Cage
8. Deaerator Inlet Control Valve
9. Steam Relief Valve
10. Hi-Lo Water Alarms
11. Steam Supply
12. Exhaust Steam Supply (if any)
13. High Temperature Condensate Returns (over 227°F) (limited to 30% maximum of the deaerator total load or should be returned to surge tank)
14. Boiler Feed Pumps (BFP)
15. BFP Suction Shut Off Valve (one per pump)
16. BFP Suction Strainer (one per pump)
17. BFP Suction Flexible Hose (one per pump)
18. BFP Discharge Check Valve (one per pump)
19. BFP Discharge Shutoff Valve (one per pump)
20. BFP Discharge Pressure Gauge (one per pump)
21. BFP Bypass Orifice (one per pump - required on continuous operating pumps)
22. Overflow Drainer
23. Control Panel
24. Deaerator Pressure Gauge
25. Deaerator Temperature Gauge
26. Make-up Water Float Cage
27. Make-up Water Inlet Valve
28. Surge Tank Hi-Lo Water Alarms
29. Surge Transfer Pumps
30. Transfer Pump Suction Shutoff Valve (one per pump)
31. Transfer Pump Suction Strainer (one per pump)
32. Transfer Pump Suction Flexible Hose (one per pump)
33. Transfer Pump Discharge Check Valve (one per pump)
34. Transfer Pump Discharge Shutoff Valve (one per pump)
35. Transfer Pump Discharge Pressure Gauge (one per pump)
36. Transfer Pump Bypass Orifice (one per pump)
37. Control Panel
38. SurgeTemperature Gauge
39. Transfer Pump Control Valve
40. Condensate Returns
41. SurgeTank Vent
42. Surge Tank Overflow
43. Water Softener (as required)

Two-Tank System description of operation (refer to Figure 1-5)

Surge Tank Supply
The surge tank receives returning condensate and supplements raw makeup water only if necessary to maintain desired operating level. Ideally, raw water makeup should first pass through a water softener, as shown. Condensate and makeup water mix into a blend temperature as determined by the percentage of each. The surge tank is vented to atmosphere. It is recommended that the tank have a protective lining.

Deaerator Supply
When the deaerator needs additional water to maintain the proper level, the makeup valve opens and the continuous operating transfer pump supplies the needed amount. The pumps are equipped with recirculation orifices to permit continuous operation when the makeup valve is closed. Note that two transfer pumps are shown - one serving as a standby. Both transfer pumps have shutoff valves, strainers and flexible connectors at the suction side. A control valve regulates the flow to the deaerator within its capacity limits.

Pressure Regulation
A steam pressure reducing valve controls steam for heating incom- ing water at the deaerator from its surge tank blend temperature to sat- uration temperature. Normally, the deaerator operates at 5 psig; exiting boiler feedwater is 227°F.

Boiler Feed
Boiler feed pumps are equipped with shutoff valves, strainers and flexible connectors in the suction lines. They operate intermittently or continuously, depending on pump and boiler operating requirements.
A bypass orifice in the pump discharge line is recommended when pumps are in continuous operation and a tight shutoff may be encountered. A relief valve in the pump discharge line is recommended when pumps are in intermittent operation and a tight shutoff may be encountered.

Return Lines
When condensate return water is 227°F or above, it is returned directly to the deaerator storage tank. Any condensate below 227°F must be deaerated.

Turbine Exhaust Steam
Exhaust steam from turbines or other sources can be tied in downstream of the pressure reducing valve using a check valve to prevent back-feeding steam for utilization in the feedwater heating and deaerating processes. Exhaust steam should not exceed the requirements for deaeration.

Venting
Released dissolved oxygen and carbon dioxide gases - along with a negligible steam loss of approximately one tenth of 1% - are vented out of the roof of the deaerator.

Protective Controls
High-low alarm and low water pump cut off controls can be provided on both the deaerator and surge tanks.

Single Tank Operation
In the event a surge tank is not required, returning low temperature condensate is pumped directly to the deaerator water inlet connection. Only when required, additional raw makeup water is supplied through the float-operated makeup valve.

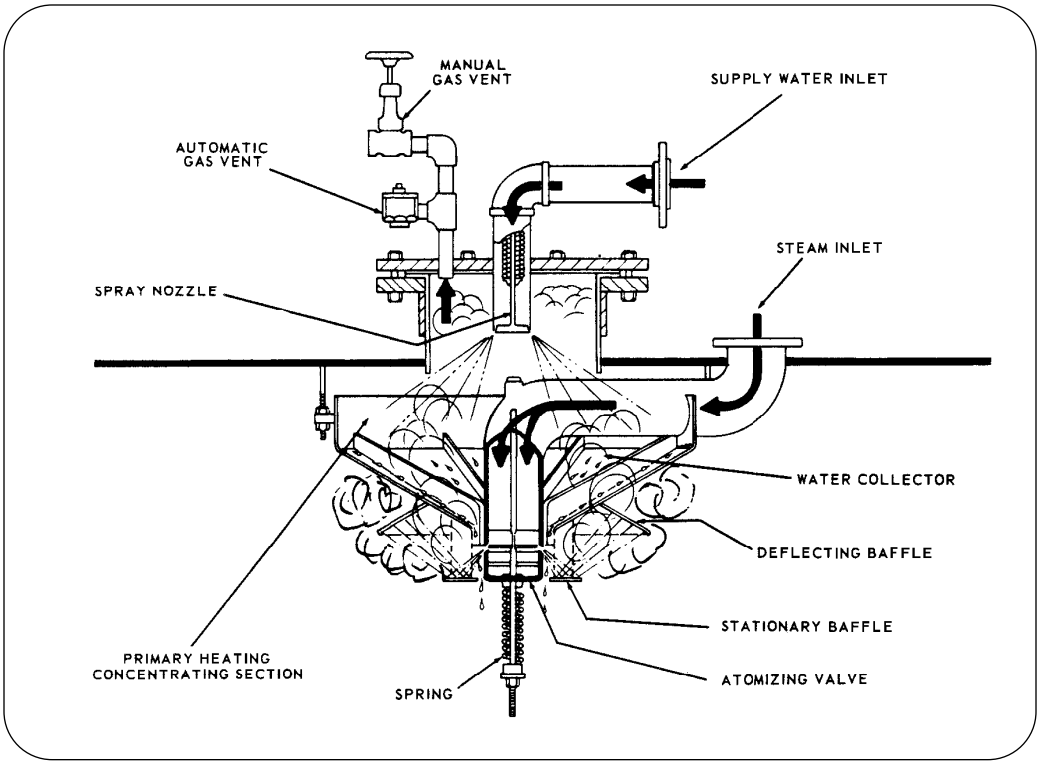


Figure 1-6. Spraymaster Deaerator With Spring Loaded Atomizing

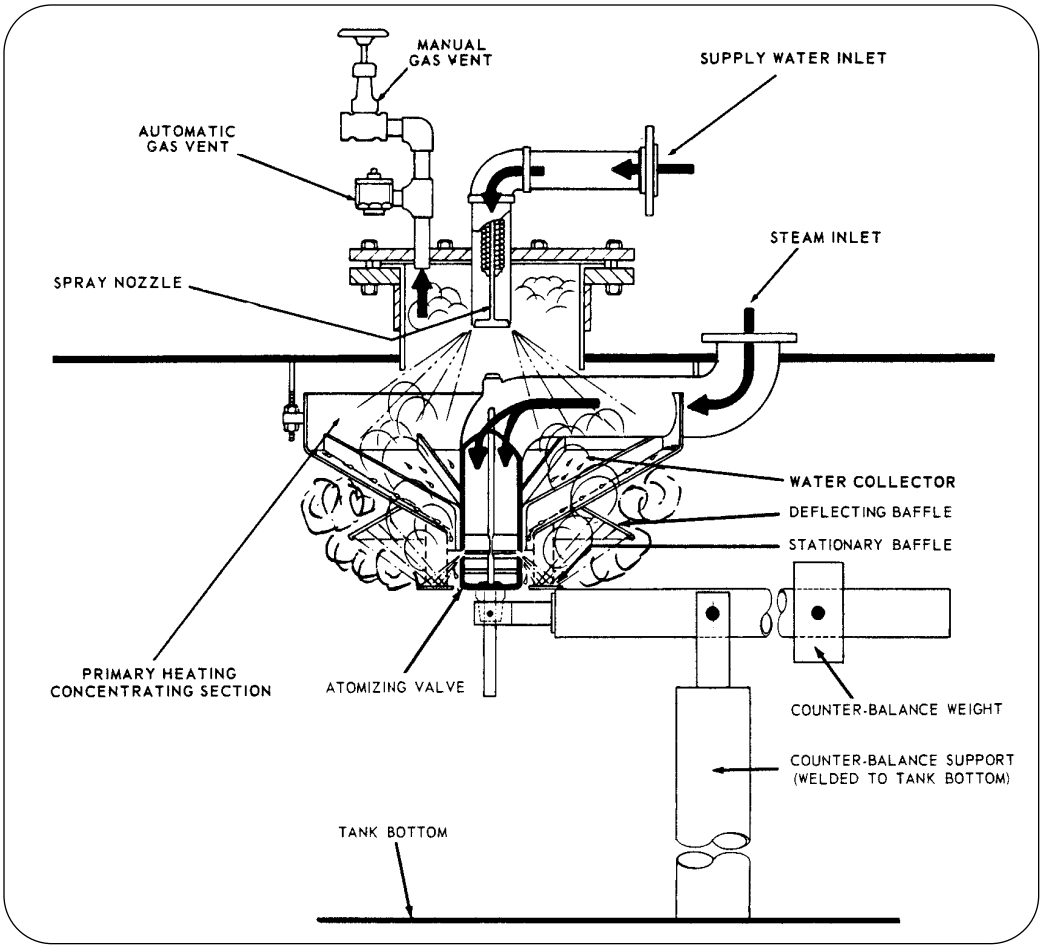


Figure 1-7. Spraymaster Deaerator with Counterbalance Steam Atomizing

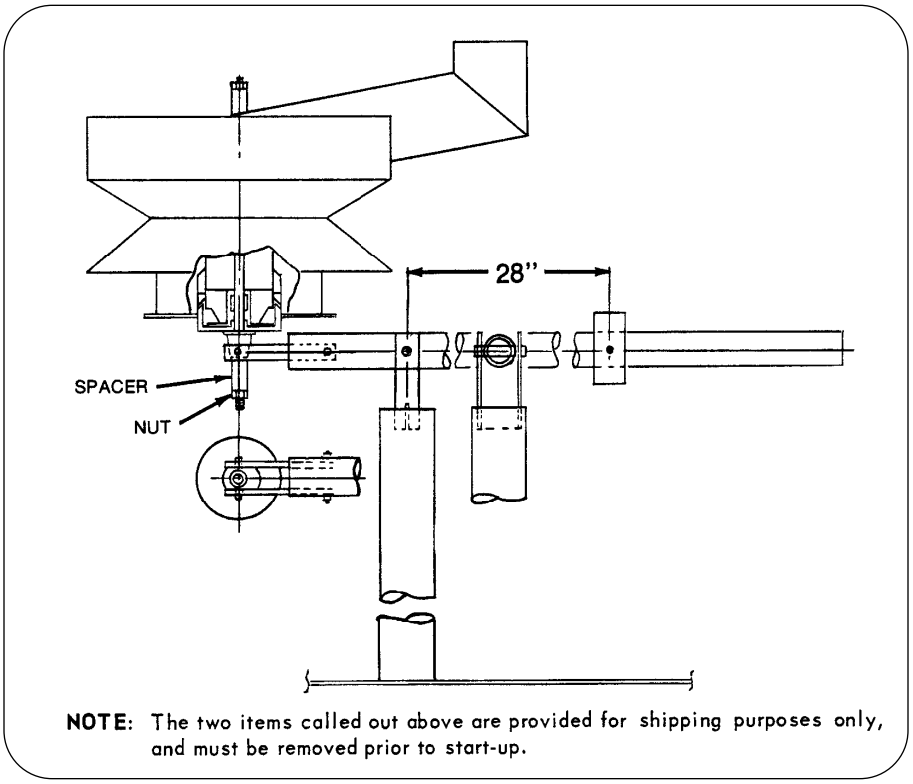


Figure 1-8. Shipping Configuration for Units Equipped with a Counterbalance System

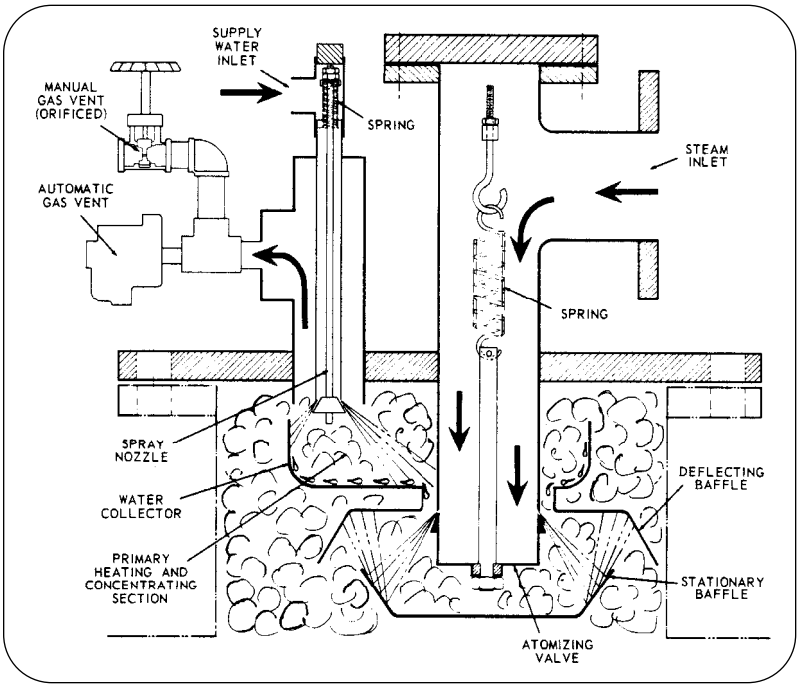


Figure 1-9. Model SM-7 Spraymaster Deaerator

Accessories generally provided with the assembly are relief valve(s) for the tank, overflow drainer, steam pressure reducing valve, and float-operated make-up water control valve.

1.3 SYSTEM LAY-OUT

1.3.1 General

Two typical system lay-outs are described in plan "A" (Figure 1-10) and plan "B" (Figure 1-11).

Note that in either case the minimum water pressure requirement is 10-12 lbs, and that the recommended steam pressure within the deaerator storage tank is 5 psig.

If water exceeds 1 part per million of hardness, a water softener is recommended.

All supply water to the deaerator, with the exception of uncontrolled condensate return, must be limited to the maximum capacity of the deaerator, whether the source is a condensate pump, a transfer pump, or a city water supply. This is usually accomplished by manual adjustment of a control valve in the transfer pump discharge line. ***This adjustment is of extreme importance to proper operation.***

Some of the larger Spraymaster deaerators contain two (2) spray units in a single tank. To assure proper flow of water to each spray nozzle, balancing cocks with pressure gauges should be installed in the symetrically branched supply lines.

Recommended steam piping configurations for various deaerator models are shown in Figures 1-12 thru 1-15.

1.3.2 Plan A (Figure 1-10)

Under normal operating conditions, the make-up water will be automatically combined with the condensate to maintain water in the storage tank at the correct level. Makeup water will only enter the system when there is insufficient condensate return.

If high pressure (high temperature) returns are less than 25-30% of the deaerator rating, they may be returned directly to the deaerator storage tank. High pressure trap returns are defined as being at a temperature greater than the normal operating temperature of the deaerator.

> NOTE: If high pressure retur ns exceed this amount, they should not be introduced directly into the deaerator tank.

The overflow drain shown in Figure 1-10 may be omitted if feedwater consists of 100% makeup.

1.3.3 Plan B (Figure 1-11)

In Figure 1-11 the high pressure returns, low pressure returns, and cold water makeup are collected in the surge tank. The output of the transfer pump is adjusted through a control valve to prevent flooding of the deaerator storage tank.

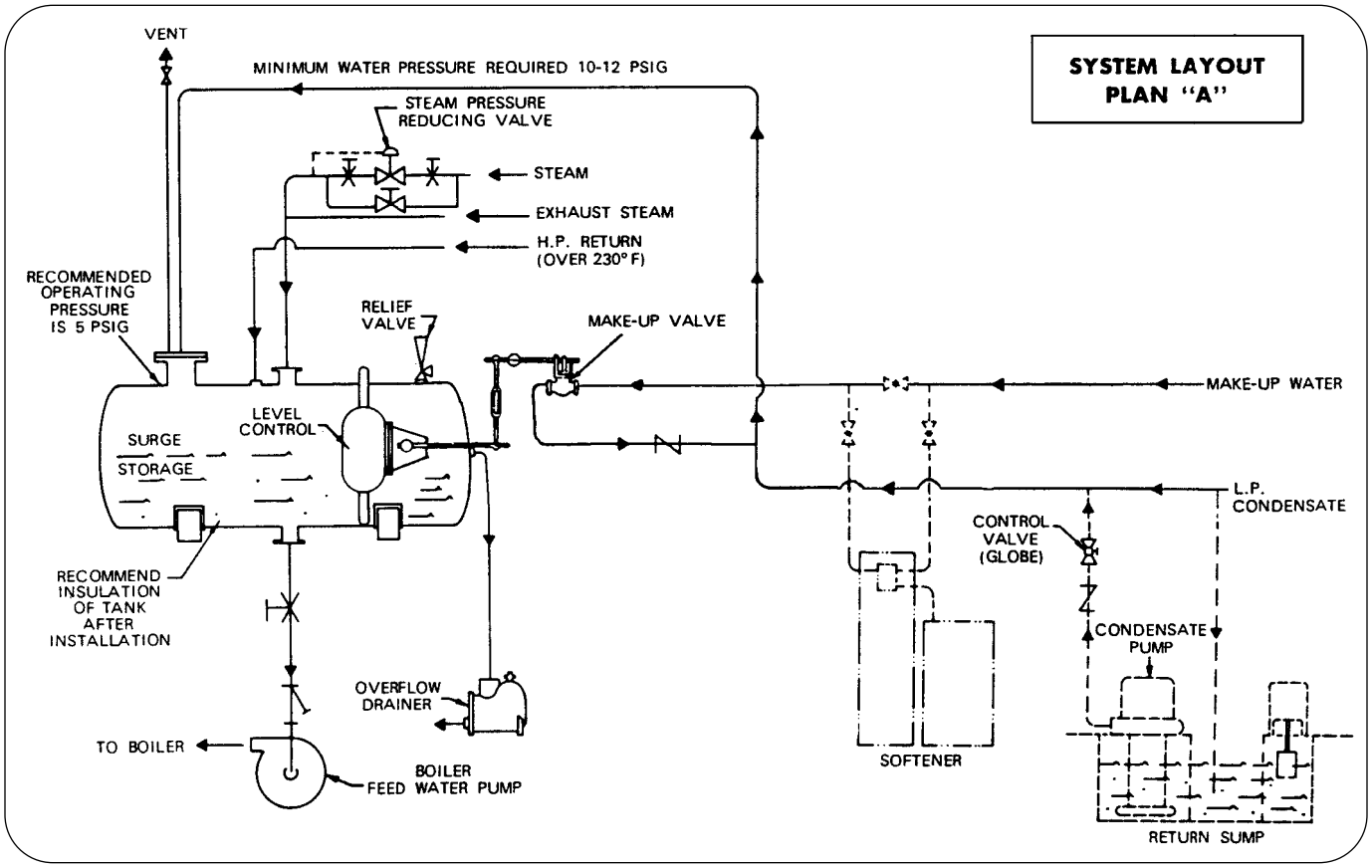


Figure 1-10. System Layout – Plan A

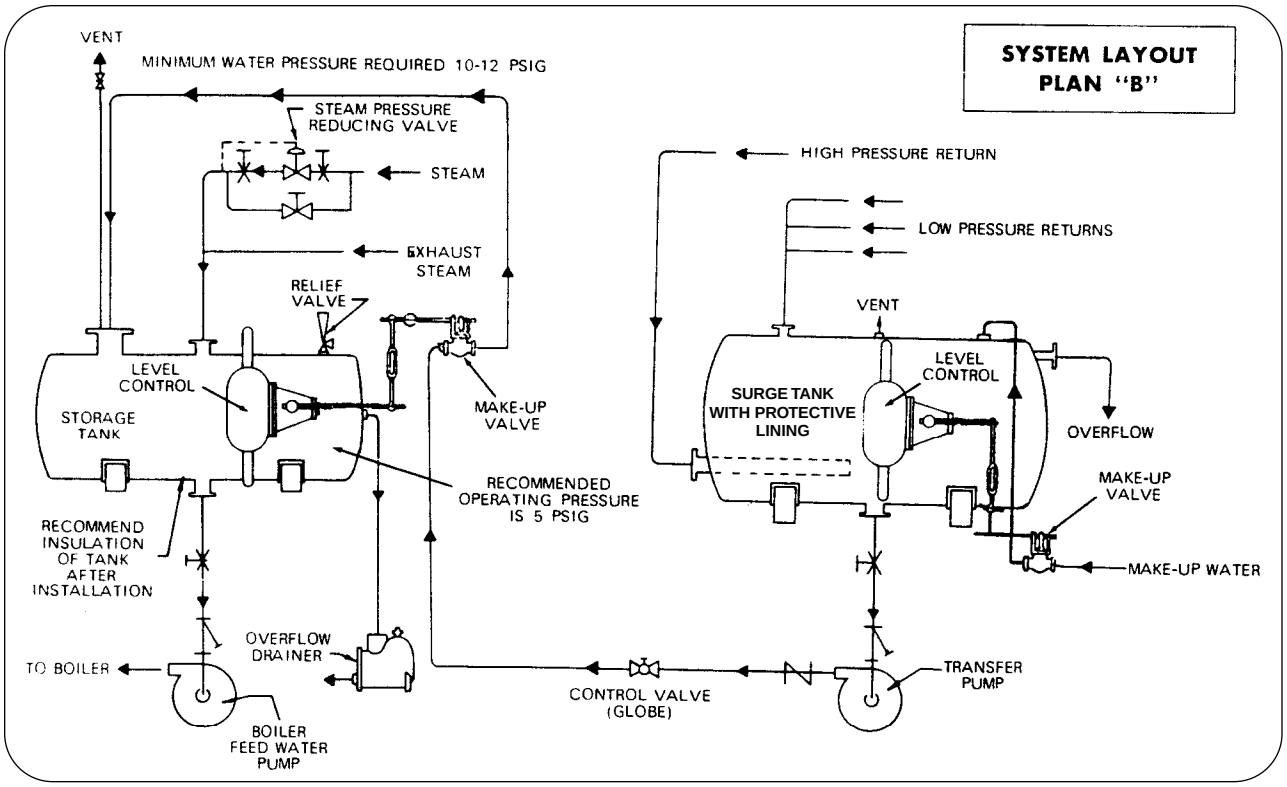
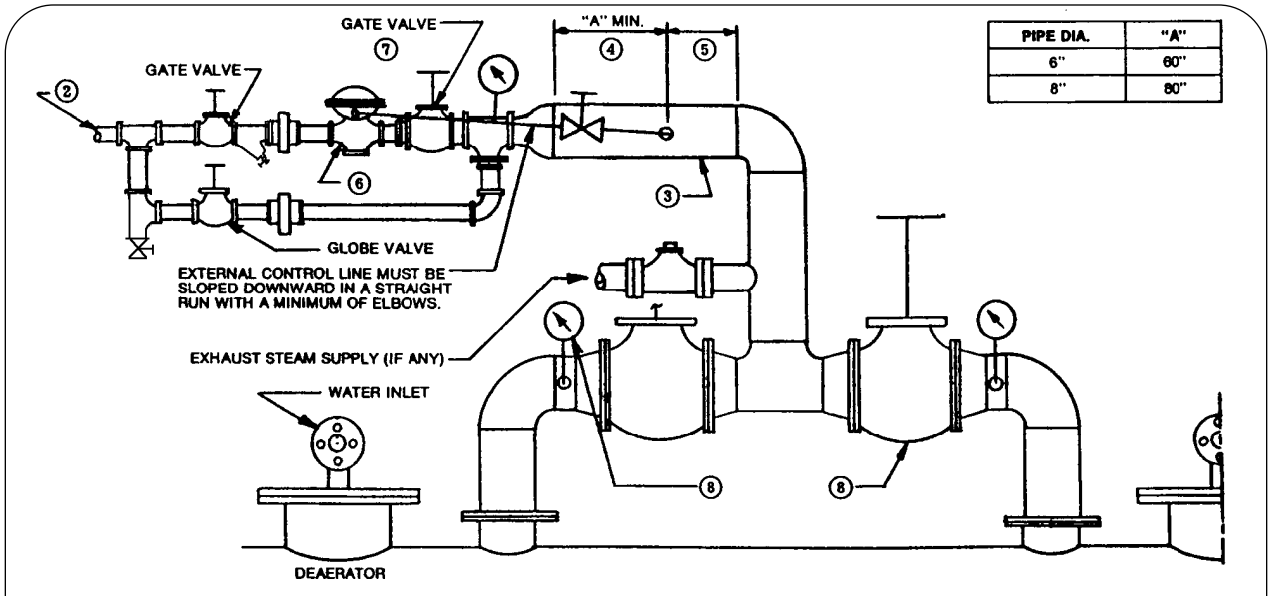


Figure 1-11. System Layout – Plan B



1. STEAM PIPING SHOWN ON THIS DRWAING IS NOT FURNISHED BY CLEAVER-BROOKS UNLESS IT IS PART OF THE CONTRACT.

2. SUPPLY PIPING TO PRESSURE REDUCING VALVE ASSEMBLY TO BE SIZED FOR REQUIRED INLET PRESSURE AT REGULATOR.

3.DISCHARGE PIPING FROM PRESSURE REDUCING VALVE MUST BE SAME SIZE AS STEAM INLET, WITH PIPE EXPANSION AS CLOSE TO PRESSURE REDUCING VALVE AS POSSIBLE.

4. CONTROL LINE MUST BE AT LEAST 10 PIPE DIAMETERS DOWNSTREAM OF LAST FITTING.

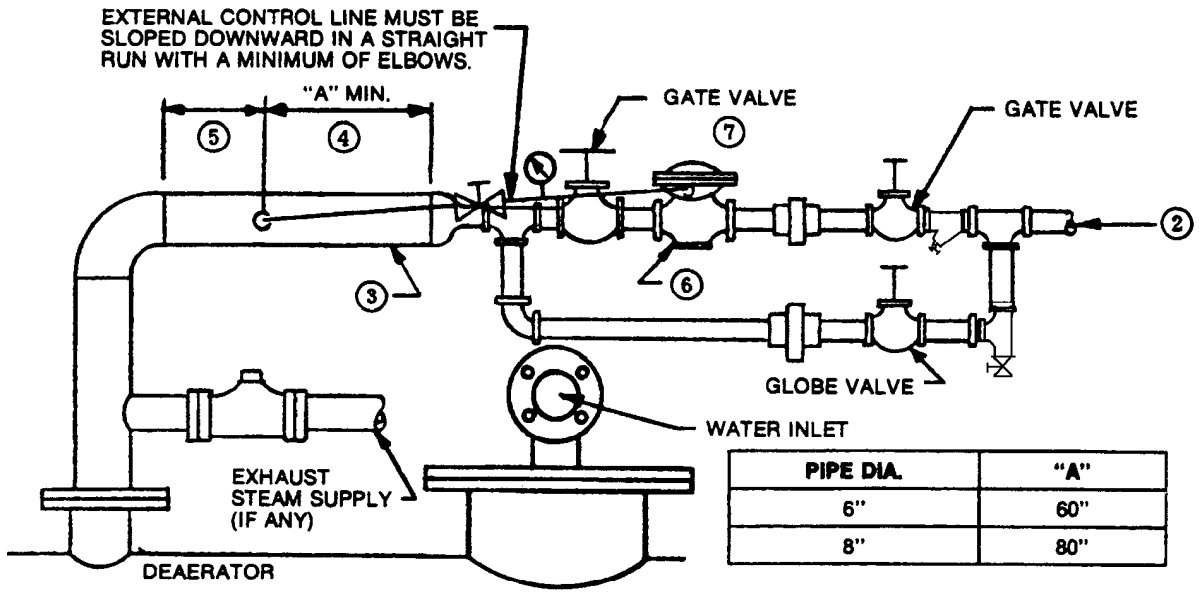
5. EXTERNAL CONTROL LINE MUST BE 18" MINIMUM FROM ELBOW DUE TO TURBULENCE.

6. REGULATOR MUST BE THE HIGHEST POINT IN PIPING TO AVOID TRAPPING CONDENSATE.

7. GATE VALVE MUST BE PROPRTIONATELY SIZED BETWEEN PRESSURE REDUCING VALVE AND DEAERATOR STEAM INLET SIZES; I.E., 2" PRESSURE REDUCING VALVE AND 6" STEAM LINE USE AT LEAST A 4" VALVE.

8. PROVIDE BALANCING COCKS WITH PRESSURE GAUGES FOR EACH BRANCH LINE.

Figure 1-12. Steam Piping for Double Inlet Spraymaster Deaerators



PIPE DIA.	"A"
6"	60"
8"	80"

1. STEAM PIPING SHOWN ON THIS DRWAING IS NOT FURNISHED BY CLEAVER-BROOKS UNLESS IT IS PART OF THE CONTRACT.

2. SUPPLY PIPING TO PRESSURE REDUCING VALVE ASSEMBLY TO BE SIZED FOR REQUIRED INLET PRESSURE AT REGULATOR.

3.DISCHARGE PIPING FROM PRESSURE REDUCING VALVE MUST BE SAME SIZE AS STEAM INLET, WITH PIPE EXPANSION AS CLOSE TO PRESSURE REDUCING VALVE AS POSSIBLE.

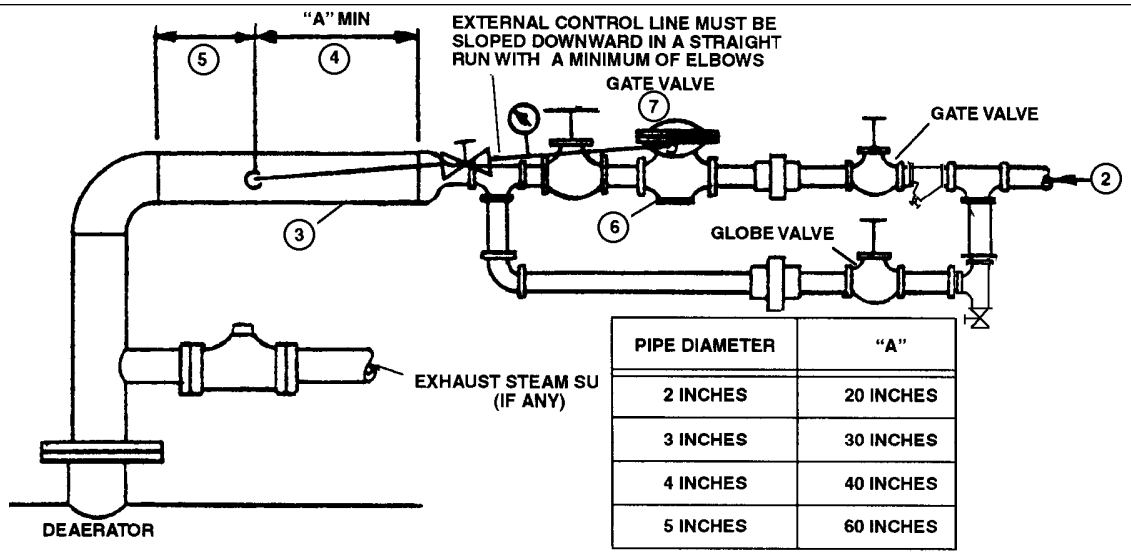
4. CONTROL LINE MUST BE AT LEAST 10 PIPE DIAMETERS DOWNSTREAM OF LAST FITTING.

5. EXTERNAL CONTROL LINE MUST BE 18" MINIMUM FROM ELBOW DUE TO TURBULENCE.

6. REGULATOR MUST BE THE HIGHEST POINT IN PIPING TO AVOID TRAPPING CONDENSATE.

7. GATE VALVE MUST BE PROPRTIONATELY SIZED BETWEEN PRESSURE REDUCING VALVE AND DEAERATOR STEAM INLET SIZES; I.E., 2" PRESSURE REDUCING VALVE AND 6" STEAM LINE USE AT LEAST A 4"VALVE.

Figure 1-13. Steam Piping for Spraymaster Deaerators



PIPE DIAMETER	"A"
2 INCHES	20 INCHES
3 INCHES	30 INCHES
4 INCHES	40 INCHES
5 INCHES	60 INCHES

1. STEAM PIPING SHOWN ON THIS DRWAING IS NOT FURNISHED BY CLEAVER-BROOKS UNLESS IT IS PART OF THE CONTRACT.

2. SUPPLY PIPING TO PRESSURE REDUCING VALVE ASSEMBLY TO BE SIZED FOR REQUIRED INLET PRESSURE AT REGULATOR.

3.DISCHARGE PIPING FROM PRESSURE REDUCING VALVE MUST BE SAME SIZE AS STEAM INLET, WITH PIPE EXPANSION AS CLOSE TO PRESSURE REDUCING VALVE AS POSSIBLE.

4. CONTROL LINE MUST BE AT LEAST 10 PIPE DIAMETERS DOWNSTREAM OF LAST FITTING.

5. EXTERNAL CONTROL LINE MUST BE 18" MINIMUM FROM ELBOW DUE TO TURBULENCE.

6. REGULATOR MUST BE THE HIGHEST POINT IN PIPING TO AVOID TRAPPING CONDENSATE.

7. GATE VALVE MUST BE PROPRTIONATELY SIZED BETWEEN PRESSURE REDUCING VALVE AND DEAERATOR STEAM INLET SIZES; I.E., 2" PRESSURE REDUCING VALVE AND 6" STEAM LINE USE AT LEAST A 4"VALVE.

Figure 1-14. Steam Piping for Boilermate Deaerator

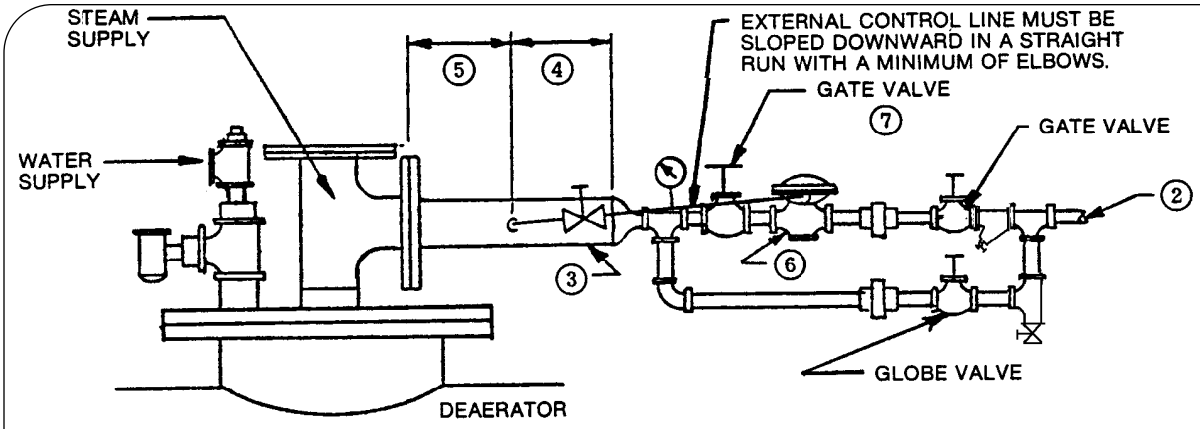


Figure 1-15. Steam Piping for Spraymaster Model SM-7 Deaerator Only

1.4 OPERATING INSTRUCTIONS

1.4.1 Installation

This manual contains information on typical accessory equipment such as water controls and steam reducing valves. Some installations may use specialized controls not covered in this manual. In such cases, refer to the Manufacturer's literature. Familiarize yourself with the instructions for the particular items furnished.

Installation should conform to the manufacturer's prints supplied for the system. Check all piping for proper connections. Check all valves and controls to be sure they are installed with proper direction of flow.

Refer to Figures at the end of this section for appropriate piping arrangements of controls.

IMPORTANT: The steam pressure reducing valve should be installed as near as practical to the deaerator tank. Installation should be made in accordance with instructions of the valve manufacturer. The downstream piping MUST be the same size as the tapping in the tank. The external control line MUST be installed to agree with the manufacturer's recommendation. These recommendations will ensure the correct volume of steam supplied to the deaerator.

The manual vent valve supplied with the deaerator has an orifice of a predetermined size drilled in its gate; since it is used for continuous venting, the discharge should be piped to atmosphere with no obstructions or resistance. The piping must at least be the same size as the valve. See Table 1-1 for valve and orifice sizes.

⚠ CAUTION

Do not substitute or replace the manual vent valve. If there is any doubt, verify that the valve has a drilled gate prior to placing the unit into operation.

The automatic vent valve may be piped to the outside, although it does not necessarily have to be. This valve provides a faster means of venting at startup, or should there be a sudden build up of gases.

NOTE: In the Boilermate Deaerator, the packing (stainless steel rings) should be carefully dumped onto the support grid, being careful to prevent damaging the grid. Be sure to achieve a uniform distribution to maximize efficiency and thoroughness of deaeration.

⚠ CAUTION

Wear suitable gloves when handling the rings to prevent cuts from sharp edges.

1.4.2 Water Pumps

If a "packaged" type system was provided, the height of the deaerator storage tank above the boiler feed pumps will have been predetermined to obtain proper NPSH (Net Pump Suction Head); this height must be adhered to.

If a deaerator storage tank only was supplied by Cleaver-Brooks and the pumps by others, the tank must be mounted at a proper height above the pumps to avoid flashing and cavitation. The pump manufacturer's recommendations must be followed.

Continuously operating centrifugal pumps must have a by-pass orifice in the discharge line ahead of the check valve. This orifice is shipped loose with all centrifugal pumps and should be installed in the manner shown in Figure 1-17.

Turbine pumps should be protected by a relief valve in the discharge line when they operate against a feed water valve on the boiler.

Because of the various makes and models of pumps utilized with a deaerator, it is not practical to provide specific instructions in this manual. The manufacturer's literature provided with the pump should be referred to. It provides instructions for proper mounting, piping, and alignment; these recommendations should be followed.

When pumps are provided by Cleaver-Brooks as a part of the deaerator, care is taken to assure proper installation and alignment. It is extremely important, however, that alignment be rechecked prior to operation. A flexible coupling does not correct or compensate for any misalignment between the pump and the motor. Paragraph 1.4.3 deals with coupling alignment.

There are general instructions applicable to all pumps. Most of these are listed in the various manufacturer's literature, but they are worth repeating.

- Do not run the pump unless it is filled with liquid.
- Protect the pump from foreign particles, chips, scale, etc., using a suitable strainer installed in the suction line as near as possible to the pump.
- Suction and discharge piping must aline and not be forced into position when assembling to a pump. All piping must be supported to assure that no stresses or strains are transmitted to the pump.
- Verify that all discharge piping is open at start-up.
- In general, do not introduce boiler feed compound through a feed pump.
- Lubricate all bearings in accordance with manufacturer's instructions. Remember that over greasing is harmful.
- When packed stuffing boxes are employed, adjustment will be required. Follow the manufacturer's recommendation. Do not over-tighten. Adjust the packing only while the pump is running. Some leakage is required for lubrication and 40 to 60 drops per minute should not be considered excessive.
- Be sure that the pump shaft turns freely by hand. If it does not, some corrective action is required.
- Be sure wiring is connected for correct rotation as marked on the pump casing. In some cases, the flexible coupling insert on a pump provided by Cleaver-Brooks is removed prior to shipment. It is tied to the coupling along with a precautionary tag advising that motor rotation be established and verified. Incorrect rotation of some types of pumps can cause serious pump damage.
- Check rotation by momentarily energizing the motor starters.

1.4.3 Flexible Coupling Alignment

Alignment of the pump and motor through the flexible coupling is of extreme importance for trouble free operation. Check coupling alignment frequently and replace the coupling insert as required. Keep the coupling guard in place.

The most commonly used tools for checking alignment are a straightedge and a thickness gauge.

Table 1-1. Vent Valve Sizes

Spraymaster Deaerator Size	Boilermate Column SIze	Valve Size	Orifice Size
SM7	8 & 12	1/2"	1/8"
SM15	16	3/4"	3/16"
SM30-45	20 & 24	3/4"	1/4"
SM70	30	1"	3/8"
SM100	36	1-1/2"	3/8"
SM140	42	2"	7/16"

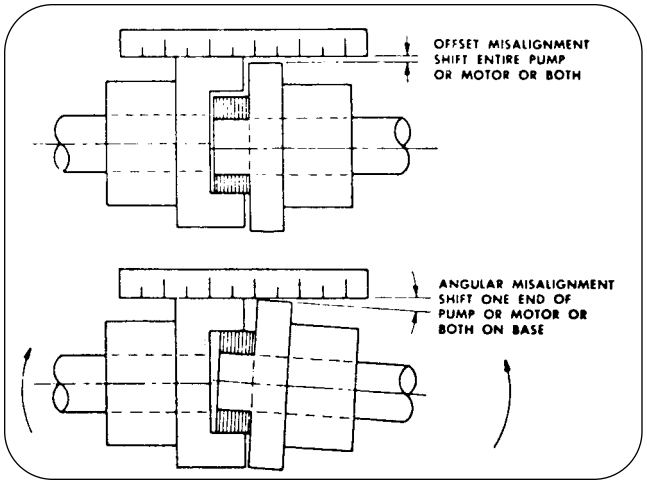


Figure 1-16. Flexible Coupling Alignment

The coupling must be checked for both parallel (offset) alignment and angular (gap) alignment. Parallel misalignment occurs when shaft axes are parallel but not concentric (see Figure 1-16). Angular misalignment is the reverse situation - shaft axes concentric but not parallel.

Align the coupling following instruction sheets provided with the pump. If instructions are not available, the following procedure may be used.

Checking parallel alignment, both horizontal and vertical, can be accomplished by laying a straightedge across the coupling halves and checking with a thickness gauge to obtain the amount of misalignment. This check should be performed on top of the coupling, and at least at one 90° interval. If possible, checking at four 90° intervals is best. A useful hint is to hold a flashlight behind the straightedge so that any gap can readily be seen.

Shim stock of appropriate thickness and area is then used under either the feet of the pump or the motor to establish parallel alignment 0.008" tolerance is generally a permissible limit.

After parallel alignment is established, check for angular alignment. This is done by checking the gap between coupling halves.

Set the spacing between the halves at one point by using a thickness gauge and then rotate the coupling slowly by hand to be sure that the halves are the same distance apart at all points. Adjust to obtain proper gap by loosening the hold-down bolts and shifting either the pump or the motor as required. Generally, lightly tapping on either the front or rear legs is all that is needed to obtain lateral adjustment. Rear legs may require shimming for vertical correction. Tighten the hold-down bolts after adjustments are made.

Calipers can also be used to check angular alignment. Measure the overall distance of the outer ends of the coupling halves at 90° intervals. Shift the pump or motor, as required, so that the ends of the coupling are equal distance apart at all points. The coupling will then have proper angular alignment.

Remember that alignment in one direction may alter the alignment in another. Recheck thoroughly both angular and parallel alignment procedures after making any alteration.

A properly aligned coupling will last a long time and will provide trouble-free mechanical operation.

1.4.4 Initial Startup

Open the gauge glass shut-off cocks and the vent cock on the drainer. The manual vent valve may be opened to provide faster venting. Open the valves in the supply line to the steam pressure regulator and close the by-pass valve.

If the boiler is empty and will be filled from this tank, close the pump discharge shut-off valve. Be sure that the pump is turned off**.**

Start water flow, but at a controlled rate so that capacity of the deaerator is not exceeded.

> **NOTE:** All supply water to the deaerator must be limited to the maximum capacity of the deaerator whether the source be from a condensate pump, a transfer pump, or a city water supply. This is usually accomplished by manual adjustment of a control valve in the discharge line. ***This adjustment is of extreme importance to proper operation.***

The turnbuckle linking the level regulator to the make-up valve must be adjusted to close the valve at the proper water level. Refer to Figures 1-18 and 1-19 to determine the desired water level for the particular size tank.

When the correct water level is reached, open the pump valves and start the feed water pump to fill the boiler. Observe the water level during this process to assure that the pump does not run dry.

Fire the boiler and bring it up to operating pressure in accordance with good practice and the boiler manufacturer's recommendations.

When normal operating pressure is obtained, adjust the steam pressure reducing valve to provide 5 psig within the tank. See adjustment procedures.

Close the vent cock on the drainer when steam begins to flow from it.

If the manual vent valve was opened, it should now be closed to provide the desired rate of venting. The orifice in the valve gate will provide a predetermined and sufficient vent rate.

⚠ CAUTION

Be sure that the orifice ent valve supplied with the unit is installed. Damage to the equipment could result.

1.4.5 Operation and Adjustments

For deaeration to occur, it is necessary to raise the temperature of the incoming water to a point where oxygen and carbon dioxide are released from the water. This is accomplished by spraying the water into a steam filled chamber and through a spray of high velocity steam.

Suitable deaeration will take place if the operating pressure within the tank is maintained at 5 psig and 227° F.

> **NOTE**: 227° F is the saturation temperature of steam at 5 psig. Although operation is possible

with steam pressures ranging from 2 to 15 psig, 5 psig is the recommended operating pressure.

There are relatively few adjustments required. However, it is important that these adjustments be made under normal load conditions.

It is necessary to control the volume of water entering the deaerator in relation to the inlet water temperature and to stay within the heat limitation of the steam flow. Failure to maintain the desired operating pressure and temperature can generally be attributed to either too much inlet water or too little steam.

The modulating make-up valve size is predicated on the total load and the inlet water pressure. This determines the maximum flow capacity (GPM) at a given supply pressure. (See Table 1-2.) When the valve is sized on the basis of accurate data, it will be close to, or slightly above, the maximum requirement. Depending upon conditions, it may be necessary to throttle the flow of water to the make-up valve. This requires a control valve (globe type) or possibly a pressure reducing valve. This valve may be provided with the system, or it may be provided by others.

Table 1-2. Modulating Make-Up Valve Capacity

VALVE SIZE INCHES	CV	CAPACITY IN GPM (see notes)						
		INLET PRESSURE (PSI)						
		25	30	40	50	60	70	100
McD-M #51-S (with integral float) (see notes)								
3/4	–	5	7	9	11	13	15	17
Warren 377 Level Control with Warren 326L Lever Valve								
3/4	7.7	27	33	43	52	58	64	80
1	10.1	32	39	50	60	67	75	93
1-1/4	19.3	63	77	100	118	134	148	184
1-1/2	25	80	97	125	149	168	186	232
2	40	126	155	200	238	269	298	370
Warren 377 Level Control with Warren 322L Level Valve								
2-1/2	78	250	305	390	460	530	575	710
3	110	350	425	555	650	740	–	–
4	220	710	850	–	–	–	–	–

Notes:

1. McDonnel Miller #51-S maximum body rating is 35 psi. Deaerator relief valve to be set at 35 psi. Use same selection as 50 psi setting. Make up side Temperature Rating 70°F maximum (do not use on Deaerator of two tank system).

2. Capacities are based on 15 psi back pressure from water spray nozzle including deaerator operating pressure of 5 psi. Valves used for make-up on atmospheric tanks will fl w slightly more water.

3. Specific GPM and PSI when orde ing.

4. Same sizing chart applies for emergency make-up valves. The difference is the external float controllers p ysical location.

5. Valves are suitable for temperatures up to 300°F.

6. Valves 1” thru 2” Warren No. 326L, bronze body with balanced piston, stainless steel seating surfaces and screwed ends.

7. Valves 2-1/2” thru 4” are Warren No. 322L, Q.O. port with cast iron bodies and 125# flanged connection .

8. External float controller used is Warren No. 377 with 8” S.S. float

Table 1-3. Pneumatic Make-up Valve

VALVE BODY SIZE INCHES	CV	ACTUATOR USED NO.	CAPACITY IN GPM (SEE NOTES)							SHIPPING WEIGHT WITH CONTROLLER LBS
			INLET WATER PRESSURE (PSI)							
			25	30	35	40	45	50	60	
1/2	4.1	30	13	16	18	20	22	24	28	195
3/4	8.2	30	26	32	37	42	46	49	56	195
1	12.7	30	41	50	58	65	71	77	87	200
1-1/2	22.2	30	72	88	101	113	124	134	152	230
2	50.0	40	161	198	228	255	280	302	342	275
2-1/2	77.7	40	251	307	355	397	434	467	533	290
3	104.0	45	336	411	475	531	581	628	712	315

Notes:
1. Capacities are based on 15 PSI back pressure from spray nozzle including a Deaerator operating pressure of 5 PSI. Valves used for make-up on atmospheric tanks will fl w slightly more water.
2. Specify GPM and PSI when ordering.
3. Same sizing chart applies to emergency make-up valves. The difference is the physical location of the level controller.
4. Control valve is globe type with proportional control and with spring-opposed diaphram actuator arranged for 3-15 PSIG operating pressure. Controller is proportional type sensing the level of the liquid in the tank using a 14 inch diplacer and produces a standard pneumatic output signal. (Valve normally open on loss of air.)
5. All make-up valves 2” and smaller have screwed NPT connections.
6. All make-up valves 2-1/2” and larger are ANS1 125 lb. flange connection .
7. Valves are suitable for water temperatures up to 410°F.
8. All valves are Fisher model 657EZ except for the 2-1/2” size which is 657ES.
9. Valves are cast iron body with hardened stainless steel trim and TFE packing.
10. Controller is a Fisher model 2500-249.

When throttling is necessary, an initial adjustment made when the boiler, or boilers, are operating at capacity is normally sufficient. Manually adjust the control valve so that a fairly stable water level will be maintained under the maximum load. The make-up valve will modulate to maintain a relatively constant level under other load conditions.

Always observe the water level in the gauge glass and make any necessary re-adjustment to maintain the desired level.

If the flow of “cool” water is too great, it will quickly condense the incoming steam making it difficult to maintain the desired pressure and temperature.

If the flow is insufficient, due to over-throttling the control valve, or from lower than anticipated water pressure, it is possible for low water to occur. This can cause pump cavitation – possibly damaging the pump – and eventual boiler shut down.

When the water flow is established under normal load conditions, adjust the steam pressure regulator to maintain a 5 psig pressure within the tank. Adjustment should be performed in accordance with the recommendation of the regulator manufacturer.

Once the unit has leveled out under normal operating conditions and the liquid level control is operating automatically, operation is essentially automatic. No further adjustments should be required unless there is a change in operating conditions. Log book recording of all pressures and temperatures on a daily basis will alert operating personnel to deviations and the need for adjustments.

If adjustments to make-up or steam flows are necessary during normal operation, make the adjustments smoothly in small increments in order to maintain a good heat balance.

Normally there are no re-adjustments required when beginning from a cold start, for example after a week-end shut down.

For a normal shut down, such as a week-end, it is usually only necessary to secure the necessary supply, drain, or shut-off valves and the pumps. Depending upon the installation, it may be advisable to turn off the boiler feed pump during this shut down and to close the pump discharge valve. This wi11 help prevent any vacuum caused by the cooling boiler water from pulling water from the deaerator, or from draining water from an elevated tank to equalize water levels between the boiler and the tank, or to possibly flood the boilers.

Before resuming operation, verify that all valves are returned to their normal operating position.

Depending upon conditions, ambient temperature, length of shut down, etc. the water temperature in the deaerator tank may have cooled considerably. Because of the advantage of feeding hot deaerated water to the boiler as soon as possible, it may be desirable to speed up heating of the water more quickly than normal operation will accomplish. This can be done as soon as steam is available by manually operating the drain valve to dump water so that make-up water and steam will enter. Care must be taken not to overload the system or to starve the pump. When the desired operating temperature and pressure are obtained be sure to tightly shut the drain valve.

During shut downs, especially seasonal or extended periods, chemical treatment of the water in the deaerator is required. Your feedwater consultant's recommendations regarding the use of an oxygen scavenger should be followed.

1.5 MAINTENANCE

Cleaver-Brooks equipment is designed, engineered, and built to provide long life and excellent service on the job. Good operating practices and conscientious maintenance and care will obtain efficiency and economy from their operation and contribute to long years of performance.

A well planned maintenance program avoids unnecessary down time or costly repairs, promotes safety, and aids boiler code and local inspectors. An inspection schedule with a listing of procedures should be established. It is recommended that a boiler room log, or record, be maintained. Recording of daily, weekly, monthly and yearly maintenance activities provides a valuable guide and aids in obtaining economies and length of service from Cleaver-Brooks equipment.

Even though the deaerator has electrical and mechanical devices that make it operate automatically, these devices require systematic and periodic maintenance. Any "automatic" features do not relieve the operator from responsibility, but rather free him of some repetitive chores, providing time to devote to maintenance.

Only trained and authorized personnel should be permitted to operate, adjust or repair the boiler and its related equipment.

Good housekeeping helps maintain a professional appearing boiler room. The boiler room should be kept free of all material and equipment not necessary to the operation of the boiler or heating system.

Alertness in recognizing unusual noises, improper gauge reading, leaks, etc., can make the operator aware of a developing malfunction, permitting prompt corrective action that may prevent extensive repairs or unexpected down time. Any steam, water or fuel leaks should be repaired as soon as they are noticed. These are wasteful as well as hazardous. Include in the program preventive maintenance measures such as regularly checking the tightness of connections, locknuts, setscrews, packing glands, etc.

Insurance regulations or local laws may require a periodic inspection of the pressure vessel by an authorized inspector.

Inspections of this type are usually, though not necessarily, scheduled for periods of normal boiler down time such as an off season. This major inspection can often be used to accomplish maintenance, replacements, or repairs that cannot easily be done at other times. This also serves as a good basis for establishing a schedule for annual, monthly, or other periodic maintenance programs.

While this inspection pertains primarily to the waterside and fireside surfaces of the boiler, it provides an excellent opportunity for detailed inspection and checking of all components of the system including piping, valves, pumps, gaskets, softener, etc. Comprehensive cleaning, spot painting or re-painting, and the replacement of expendable items, should be planned for and taken care of during this time. Any major repairs or replacements that may be required should also, if possible, be coordinated with this period of boiler shutdown.

Replacement spare parts, if not on hand, should be ordered sufficiently prior to shutdown.

Water and steam passing through the deaerator are normally of high purity. The necessity for cleaning should be infrequent. The internal parts of the spray nozzle, the steam atomizing valve, and the water collector are constructed of stainless steel and normally require no maintenance or cleaning. Nevertheless, the interior of the tank and the spray assembly should be inspected at least annually for any evidence of corrosion, scaling or other damage.

In the event there is an accumulation of sediment, sand, gravel, etc. in the bottom of the tank, it should be removed, analyzed, and an effort made to eliminate the source.

Should scale be present, the method of cleaning, either mechanical or chemical, will be governed by the composition of the scale and its location. If cleaning is required, it is suggested that the cleaning problem be referred to a company that is versed in this type of cleaning. They will be able to determine the composition of the scale and will select the proper chemicals to be employed in the cleaning process.

Periodic checks for water softness should be maintained. If hardness exceeds three grains per gallon, a water softener should be used to prevent build up of mineral deposits on the internal parts of the deaerator.

The water spray nozzle is of the self-cleaning type. Clogging or wearing seldom occurs, however, it is a possibility that should be checked in the event problems are encountered. This is a spring-loaded valve and it is factory pre-set. Should disassembly or adjustment become necessary, tighten the spring with the spray disc closed, compressing it 3/16". Be sure that the jam nut locks tightly against the adjusting nut.

NOTE: For the Spraymaster only!

Spring compression for the steam atomizing valve (on deaerators so equipped) is factory set and does not normally require alteration. If possible, this dimension should be rechecked when the deaerator is installed, and again prior to operation since the adjusting nuts may have vibrated loose during shipment or installation. It should be rechecked during an internal inspection or if any problem is encountered. The compressed spring length is as follows:

6" diameter valve	*6" ± 1/8"*
8" diameter valve	*7-5/8" ± 1/8"*

The lock nut on the top end of the valve rod should fit tightly against the steam duct so the valve seat is held in the proper position

Some models are equipped with a counter-balanced, rather than a spring-loaded steam atomizing valve. (See Figure 1-7). This type of valve should be periodically inspected for any evidence of scale build up that might prevent tight closing or freedom of movement. The counter weight is located 28" from the fulcrum and normally requires no adjustment.

The spray assembly for the Model SM-7 Deaerator is constructed in accordance with Figure 1-9. Access to the adjusting nuts on the springs is through a plug on the water valve and a flange on the steam valve. The tension setting of the steam valve spring should be sufficient to just close the valve against a 20 lb weight. The compression adjustment of the water valve spring should permit it to just close against a 1 pound weight.

Float-operated controls should be blown down or drained routinely to assure against build up of sediment that may interfere with their function. It is suggested that the heads be removed for visual inspection during the annual boiler inspection. At the same time, remove the pipe plugs from the tees or crosses to verify that the cross connecting piping is clean and free of obstructions. Controls must be mounted in a plumb position for proper performance. Determine that piping is vertically aligned after shipment and installation, and throughout life of equipment.

The water gauge glass should be kept clean. Check while cool for etching thinning or damage. If any deterioration is found, replace glass immediately to avoid the possibility of breakage in service. The glass should be replaced periodically as part of the maintenance program. Always use new gaskets when replacing a glass. Do not over tighten water gauge glass fittings. Check try-cocks and gauge cocks for freedom of operation and clean as required. Proper alignment of gauge glass cocks is essential to prevent mechanical strain on the glass.

Check and clean all drain valves.

Strainers in all lines should be cleaned at regular intervals determined by conditions and usage.

Refer to the Manufacturer's literature for service recommendations on the particular components.

Table 1-4. Overflow Drainer Capacity

WARREN TYPE 313	
Drainer Size	**Capacity in lb/hr**
1"	10,000
2"	45,000
3"	78,500
4"	138,000
6"	293,000
Based on differential of 5 psi	

Table 1-5. Steam Table

STEAM TABLE	
GAUGE PRESSURE LB/SQ IN.	**TEMPERATURE °F**
0	212.
1	215.5
2	218.7
3	221.7
4	224.5
5	227.3
6	229.9
7	232.4
8	234.9
9	237.2
10	239.5
11	241.7
12	243.8
13	245.9
14	247.9
15	249.8

Table 1-6. General Information, Single Tank Deaerator (Spraymaster Only)

Model No.	Rating lb/hr	Gallons to Overflow 10 Minute Storage	Tank Size	Gallons to Overflow 5 Minute Storage	Tank Size
SM7	7,000	230	36" x 6"0"	–	–
SM15	15,000	300	48" x 8"0"	–	–
SM30	30,000	600	54" x 10"0"	300	48" x 8’0"
SM45	45,000	900	60" x 11’1"	450	48" x 10’8"
SM70	70,000	1,400	66" x 14"10"	700	54" x 11’6"
SM100	100,000	2,000	72" x 16’7"	1,000	60" x 12’0"
SM140	140,000	2,800	84" x 15’4"	1,400	66’ x 14’10"
SM200	200,000	4,000	96" x 15’9"	2,000	72’ x 16’7"
SM280	280,000	5,600	108" x 16"8"	2,800	84" x 15’4""

Table 1-7. General Information, Duo-Tank Deaerator (Spraymaster Only)

Model No.	Rating lb/hr	Gallons to Overflow 10 Minute Storage	Tank Size
SM7 D	7,000	230/160	36" x 9’0"
SM15 D	15,000	300	48’ x 11’6"
SM30 D	30,000	600	54" x 15’0"
SM45 D	45,000	900	60" x 17’3"
SM70 D	70,000	1,400	66" x 22’8"
SM100 D	100,000	2,000	72" x 26’0"
SM140 D	140,000	2,800	84’ x 25’0"
SM200 D	200,000	4,000	96’ x 26’3"
SM280 D	280,000	5,600	108’ x 28’4"

NOTES:
Duo-Tank Deaerators have a 10 minute storage capacity in each section.
200 and 280 Models use two internal sprays.

Table 1-8a. Steam Pressure Reducing Valve Capacity (Spence With Pilot Operator)

AVERAGE INLET MIX TEMPERATURE	STEAM REQUIRED AS % OF TOTAL OUTPUTCAPACITY (2)
200°F	4%
150°F	8%
100°F	12%
50°F	16%

Note:
High pressure steam must be reduced to less than 15 PSIG for a standard deaerator to function properly. The steam pressure reducing valve (PRV) regulates the fl w of steam according to the deaerator load, and holds a constant operating pressure (5 PSIG recommended) on the system. The successful operation of the deaerator requires that the capacity of the PRV be carefully matched to the load required. The following steps will enable you to select a PRV of appropriate size:

STEP 1: Determine the peak output capacity of the deaerator, i.e. maximum pumping rate out of the deaerator during normal operation, and the steam supply pressure from the boiler.
STEP 2: Estimate the average inlet mix temperature of all input streams, i.e. cold make-up, low temperature returns and high temperature returns (Mix temp = (fl w 1 x temp + fl w 2 x temp + fl w 3 x temp) / total fl w). NOTE: Consult the local Cleaver-Brooks Representative if average mix temperature is greater than 210°F.
STEP 3: Refer to Table 1-8 to determine "Percentage Steam Required" to heat the inlet water to 227°F (5 PSIG). Interpolate if necessary.
STEP 4: Multiply the "Percentage Steam Required" obtained above times the peak output capacity from Step 1. The result is the required capacity for the PRV. Refer to the selection chart.

EXAMPLE:
- 40,000 lb/hr peak total capacity
- 125 PSIG Operating Pressure
- 50% returns @ 180°F = 90°F
- 50% make-up @ 60°F = 30°F
- Mix temperature is 120°F, from Table 1 approximately 10% steam required
- 40,000 lb/hr x 10% = 4,000 lb/hr steam
- From the selection chart choose a 1-1/2" valve with inlet pressure of 125 PSIG and capacity of 4,730 lb/hr

INLET PRESSURE PSIG	1/2	3/4	1	1-1/4	1-1/2	2	2-1/2	3	4
250	1,265	2,435	3,970	6,360	8,930	13,985	19,845	33,380	49,165
200	1,030	1,980	3,230	5,175	7,265	11,380	16,150	27,160	40,005
150	790	1,520	2,480	3,970	5,575	8,730	12,390	20,840	30,700
125	670	1,290	2,100	3,370	4,730	7,405	10,510	17,680	26,040
100	550	1,060	1,725	2,765	3,885	6,080	8,630	14,515	21,380
75	420	805	1,315	2,105	2,955	4,630	6,570	11,050	16,275
50	310	600	975	1,560	2,190	3,430	4,870	8,185	12,060
25	190	365	595	955	1,345	2,105	2,985	5,025	7,400
12**	-	280	430	690	1,005	1,610	2,490	3,515	5,235
Shipping Weight Spence ED	21	25	30	40	50	69	107	137	242
Shipping Weight Spence E2D	-	28	29	40	46	60	80	108	145

All Models are SPENCE with 2-15 spring

Notes:
1. Steam Capacities are based on pressure reduction to 5 PSIG. Consult the local Cleaver-Brooks Representative if high deaerator operating pressures are required.
2. All valves above 25 PSIG inlet pressure are Spence Type ED (Full Port). Valves 1/2" thru 2", screwed ends, 2-1/2" thru 4", 250 lb flanged Pilot and Spring control delivery range is 2 to 15 PSI.
3. Spence, Type E2D used for low pressure of 12 PSIG. Valves 3/4" thru 2", screwed ends, 2-1/2" thru 4" 125 lb flanged NOTE: Max inlet pressure is 15 PSIG.
4. For inlet pressure above 250 PSIG, cast steel valves are available. Consult the local Cleaver-Brooks Repersentative for details.

Table 1-8b. Safety Valve(s) Required (Spence with Pilot Operator)

	PRV SIZE (in)								
PRV SIZE (in) Press (psig) PRV- INLET	1/2	3/4	1	1-1/4	1-1/2	2	2-1/2	3	4
250	1@1-1/2	1@2	1@1-1/4 1@2	2@1-1/2 1@2	3@2	2@2-1/2	1@2-1/2 1@3	3@3	1@4N 2@4P
200	1@1-1/4	1@2	2@1-1/2	2@2	1@1-1/2 2@2	1@3	2@2-1/2	3@2-1/2	1@2-1/2 3@3
150	1@1-1/4	1@1-1/2	1@2	1@1-1/4 1@2	2@2	3@2	2@2-1/2	2@3	1@2-1/2 2@3
125	1@1	1@1-1/2	1@2	2@1-1/2	1@1-1/2 1@2	1@1-1/2 2@2	1@3	1@2-1/2 1@3	3@2-1/2
100	1@1	1@1-1/4	1@1-1/2	1@2	1@1-1/2 1@2	2@2	3@2	2@2-1/2	2@3
75	1@3/4	1@1-1/4	1@1-1/2	1@2	1@2	1@1-1/2 1@2	2@2-1/2 1@2	2@2-1/2	2@2-1/2
50	1@3/4	1@1	1@1-1/4	1@1-1/2	1@2	2@1-1/2	1@1-1/2 1@2	3@2	2@2-1/2

Example: Having selected a 1-1/2 PRV at 200 PSIG max. inlet pressure, relief valve(s) required from the table are:
One (1) 1-1/2 inch valve and Two (2) 2 inch valves.

Notes:
1. All relief valves are selected for vessel design maximum pressure of 50 psig. Consult with consult the local Cleaver-Brooks Represe-natative if different settings are required.
2. These safety valve selections are based on standared catalogued pressure reducing valves indicated. Contact the local Cleaver-Brooks Representative if non-standard PRV's are used.
3. Consult the local Cleaver-Brooks Representative for safety valve size in the presence of significant high tempe ature returns.
4. Bypass valves installed in PRV piping must be sized to not exceed relief valve capacity.

Table 1-9. Steam Pressure Reducing Valve Capacity (Fisher With Pilot Operator)

AVERAGE INLET MIX TEMPERATURE	STEAM REQUIRED AS% OF TOTAL OUTPUTCAPACITY (2)
200°F	4%
150°F	8%
100°F	12%
50°F	16%

Note:
High pressure steam must be reduced to less than 15 PSIG for a standard deaerator to function properly. The steam pressure reducing valve (PRV) regulates the fl w of steam according to the deaerator load, and holds a constant operating pressure (5 PSIG recommended) on the system. The successful operation of the deaerator requires that the capacity of the PRV be carefully matched to the load required. The following steps will enable you to select a PRV of appropriate size:

STEP 1: Determine the peak output capacity of the deaerator, i.e. maximum pumping rate out of the deaerator during normal operation, and the steam supply pressure from the boiler.
STEP 2: Estimate the average inlet mix temperature of all input streams, i.e. cold make-up, low temperature returns and high temperature returns (Mix temp = (fl w 1 x temp + fl w 2 x temp + fl w 3 x temp) / total fl w). NOTE: Consult the local Cleaver-Brooks Representative if average mix temperature is greater than 210°F.
STEP 3: Refer to Table 1-9 to determine “Percentage Steam Required” to heat the inlet water to 227°F (5 PSIG). Interpolate if necessary.
STEP 4: Multiply the “Percentage Steam Required” obtained above times the peak output capacity from Step 1. The result is the required capacity for the PRV. Refer to the selection chart.

EXAMPLE:
• 40,000 lb/hr peak total capacity.
• 125 PSIG Operating Pressure
• 65% returns @ 180°F = 117° F
• 35% make-up @ 60°F = 21° F
• Mix temperature is 138°F, from Table 1 approximately 9% steam required
• 40,000 lb/hr x 9% = 3,600 lb/hr steam
• From the selection chart choose a 1-1/2” valve with inlet pressure of 125 PSIG and capacity of 4,140 lb/hr

INLET PRESSURE PSIG	VALVE SIZE	1/2 92C	3/4 92C	1 92B	1-1/2 92B	2 92B	2-1/2 92S	3 92B	4 92B
250				4,460	7,820	13,000		27,200	37,300
200				3,610	6,480	10,700		21,900	29,500
150		400	740	2,770	5,000	8,220	11,900	16,700	23,600
125		390	730	2,310	4,140	6,950	10,000	13,900	19,600
100		370	710	1,900	3,400	5,710	8,500	11,500	16,100
75		370	590	1,500	2,510	4,610	6,000	9,080	10,900
50		250	440	1,080	1,830	3,300	4,180	6,500	8,960
25		200	280	660	1,060	2,060	1,000	3,800	4,940

Notes:
1. Steam Capacities are based on pressure reduction to 5 PSIG. Consult the local Cleaver-Brooks Representative if higher deaerator operating pressure are required.
2. “Percentage Steam Required” in Table 1-9 includes the contribution of deaerating steam condensate to the total load.
3. For inlet pressure above 250 PSIG, cast steel valves are available. Consult the local Cleaver-Brooks Representative for details. For inlet pressure below 25 PSIG consult the local Cleaver-Brooks Representative for details.

Table 1-9b. Safety Valve Requirements (Fisher with Pilot Operated)

	PRV SIZE (in)							
PRV SIZE (in) Press (psig) PRV- INLET	1/2	3/4	1	1-1/2	2	2-1/2	3	4
250	1@1-1/4	1@1-1/2	1@2 1@1/2	2@2	3@2	2@3 1@2	1@4P 1@2 1@1-1/2	2@4P
200	1@1	1@1-1/4	2@2	1@2 1@1-1/2	2@2 1@1-1/2	2@3	2@3	1@4P 2@2
150	1@3/4	1@1	2@2	1@2 1@3/4	2@2	3@2	1@2-1/2 2@2	2@3 1@1/2
125	1@3/4	1@1	1@1-1/2	2@2	1@2 1@1-1/2	2@2 1@1-1/4	1@3 1@1-1/2	1@3 2@2
100	1@3/4	1@1	1@1-1/2	2@2	1@2 1@1-1/4	2@2	2@2 1@1-1/2	1@2-1/2 1@2 1@1-1/2
75	1@1/2	1@3/4	1@1-1/4	1@1-1/2	1@2 1@1/2	1@2 1@1-1/4	2@2 1@1/2	2@2 1@1-1/2

Example: Having selected a 2 inch PRV at 200 PSIG max. inlet pressure, relief valve(s) required from the table are: Two (2) 2 inch valves and One (1) 1-1/2 inch valve.

Notes:

1. All relief valves are selected for vessel design maximum pressure of 50 psig. Consult with the local Cleaver-Brooks Representative if different settings are required.
2. These safety valve selections are based on standared catalogued pressure reducing valves indicated. Contact the local Cleaver-Brooks Representative if non-standard PRV's are used.
3. Consult the local Cleaver-Brooks Representative for safety valve size in the presence of significant high tempe ature returns.
4. Bypass valves installed in PRV piping must be sized to not exceed relief valve capacity.

Table 1-10a. Steam Pressure Reducing Valve Capacity (Fisher With Pneumatic Type)

AVERAGE INLET MIX TEMPERATURE	STEAM REQUIRED AS% OF TOTAL OUTPUTCAPACITY (2)
200°F	4%
150°F	8%
100°F	12%
50°F	16%

Note:
High pressure steam must be reduced to less than 15 PSIG for a standard deaerator to function properly. The steam pressure reducing valve (PRV) regulates the fl w of steam according to the deaerator load, and holds a constant operating pressure (5 PSIG recommended) on the system. The successful operation of the deaerator requires that the capacity of the PRV be carefully matched to the load required. The following steps will enable you to select a PRV of appropriate size:
STEP 1: Determine the peak output capacity of the deaerator, i.e. maximum pumping rate out of the deaerator during normal operation, and the steam supply pressure from the boiler.
STEP 2: Estimate the average inlet mix temperature of all input streams, i.e. cold make-up, low temperature returns and high temperature returns (Mix temp = (fl w 1 x temp + fl w 2 x temp + fl w 3 x temp) / total fl w). NOTE: Consult PWS Sales if average mix temperature is greater than 210°F.
STEP 3: Refer to Table 10a to determine “Percentage Steam Required” to heat the inlet water to 227°F (5 PSIG). Interpolate if necessary.
STEP 4: Multiply the “Percentage Steam Required” obtained above times the peak output capacity from Step 1. The result is the required capacity for the PRV. Refer to the selection chart.
EXAMPLE:
• 40,000 lb/hr peak total capacity
• 150 PSIG Operating Pressure
• 65% returns @ 180°F= 117° F
• 35% make-up @ 60°F = 21° F
• Mix temperature is 138°F, from Table 1 approximately 9% steam required
• 40,000 lb/hr x 9% = 3,600 lb/hr steam
• From the selection chart choose a 1” valve with inlet pressure of 150 PSIG and capacity of 3,740 lb/hr

Inlet Press PSIG	Valve Body Size	1"			1-1/2"	2"	2-1/2"	3"	4"
	Orifice Si e	1/2"	3/4"	1	1-1/2	1-1/2	2-7/8"	3	4
		Inst. Air Req’d							
		3 – 15			6 – 30				
300		2100 Size 30	4500 Size 30	7000 Size 30	12500 Size 34	30000 Size 45	45000 Size 70		
275		1900 Size 30	4000 Size 30	6500 Size 30	11000 Size 34	28000 Size 45	42000 Size 70		
250		1750 Size 30	3750 Size 30	5900 Size 30	10000 Size 34	25000 Size 45	38000 Size 70		
225		1600 Size 30	3400 Size 30	5300 Size 30	9300 Size 34	23000 Size 45	35000 Size 70	44000 Size 70	
200		1400 Size 30	3100 Size 30	4800 Size 30	8500 Size 34	20500 Size 45	27000 Size 70	44000 Size 70	
175		1250 Size 30	2700 Size 30	4200 Size 30	7400 Size 34	18000 Size 45	27000 Size 70	35000 Size 70	
150		1100 Size 30	2350 Size 30	3700 Side 30	6500 Size 34	15500 Size 45	23500 Size 45	30000 Size 70	
100		940 Size 30	1950 Size 30	3000 Size 30	5500 Size 34	13000 Size 45	20000 Size 45	26000 Side 45	42500 Size 70
75		740 Size 30	1600 Size 30	2500 Size 30	4500 Size 34	11000 Size 40	16500 Size 45	21000 Size 45	35000 Size 70
55		580 Size 30	1200 Size 30	1900 Size 30	3400 Size 34	8400 Size 40	12500 Size 45	16000 Size 45	27000 Size 70
50		420 Size 30	900 Size 30	1400 Size 30	2300 Size 34	6000 Size 40	9000 Size 45	11500 Size 45	19000 Size 70

NOTES:
1. Steam capacities are based on pressure reduction to 5 PSIG. Consult the local Cleaver-Brooks Representative of higher deaerator operating pressures are required.
2. “Percentage steam required” in Table 10a includes the contribution of deaerating steam condensate to the total load.
3.Consult the local Cleaver-Brooks Representative if inlet pressures exceeds 300 PSIG or is lower than 50 PSIG.

Table 1-10b. Safety Valve Selection Requirements
(For FISHER pneumatically operated PRV's).

	PRV SIZE (in)							
PRV SIZE (in) Press (psig) PRV- INLET	1" 1/2	1" 3/4	1" 1	1-1/2" 1-1/2	2" 1-1/2	2-1/2" 2-7/8	3" 3	4" 4
300	1@1-/12	1@2 1@1/2	1@2 1@1-1/2	3@2	2@4(N) 1@1-1/4	2@4(P) 1@2		
250	1@1-1/2	1@2	1@2 1@1-1/4	2@2 1@1-1/4	2@3 1@1-1/4	2@4(P)		
200	1@1-1/4	1@2	1@2 1@3/4	2@2	1@4(N) 2@2	2@3 1@2	2@4(P)	
150	1@1-1/4	1@1-1/2	1@2	1@2 1@1-1/2	1@2-1/2 1@2 1@1-1/2	2@3	2@4(N) 1@1-1/4	
125	1@1-1/4	1@1-1/2	1@2	1@2 1@1-1/2	1@2-1/2 1@2 1@1-1/2	2@3	2@4(N) 1@1-1/4	
100	1@1	1@1-1/2	1@2	1@2 1@1-1/4	3@2	1@3 2@2	3@3 1@1-1/2	2@4(P) 1@1
75	1@1	1@1-1/4	1@1-1/2	1@2 1@1/2	2@2 1@1-1/2	1@2-1/2 2@2	2@2-1/2 1@1-1/2	1@4(P) 2@2-1/2

Example: Having selected a 1" PRV at 200 PSIG max. inlet pressure, relief valve(s) required from the table are: One (1) 2 inch valve and One (1) 3/4 inch valve.

Notes:

1. All relief valves are selected for vessel design maximum pressure of 50 psig. Consult with the local Cleaver-Brooks Representative if different settings are required.
2. These safety valve selections are based on standared catalogued pressure reducing valves indicated. Contact the local Cleaver-Brooks Representative if non-standard PRV's are used.
3. Consult the local Cleaver-Brooks Representative for safety valve size in the presence of significant high tempe ature returns.
4. Bypass valves installed in PRV piping must be sized to not exceed relief valve capacity.
5. After selecting the pressure reducing valve, locate the quantity and size of relief valves required opposite the maximum inlet pressure.
6. Maximum inlet pressure is the safety valve set pressure on the boiler or header, not the operating pressure.

1/2 through 2 inch valves are Kunkle Fig. 6010 or equal.

2- 1/2 through 4 inch valve is Kunkle Fig. 252 with N-orifice or P-o ific .

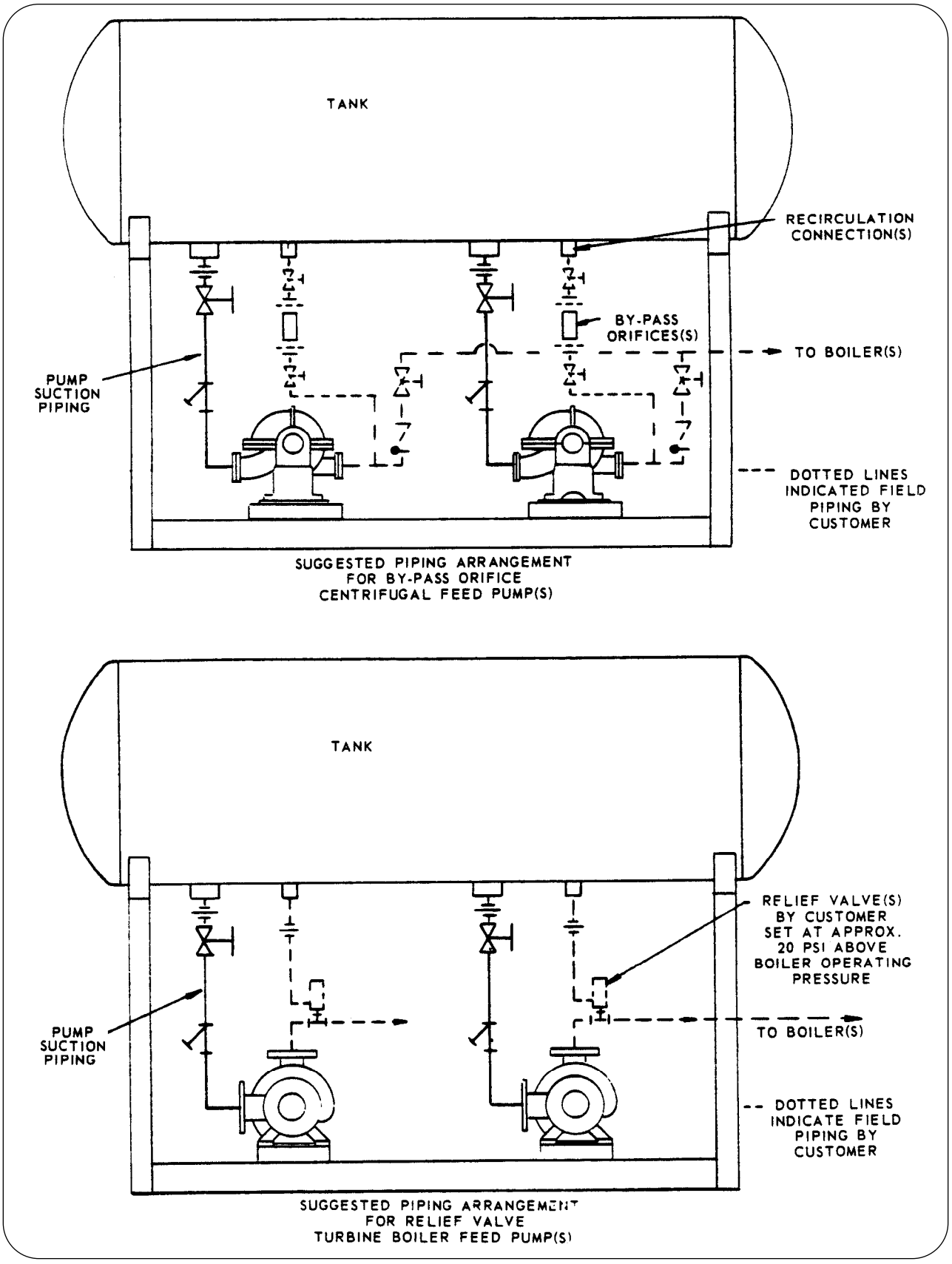


Figure 1-17. Suggested Piping Arrangement for Boiler Feed Pump

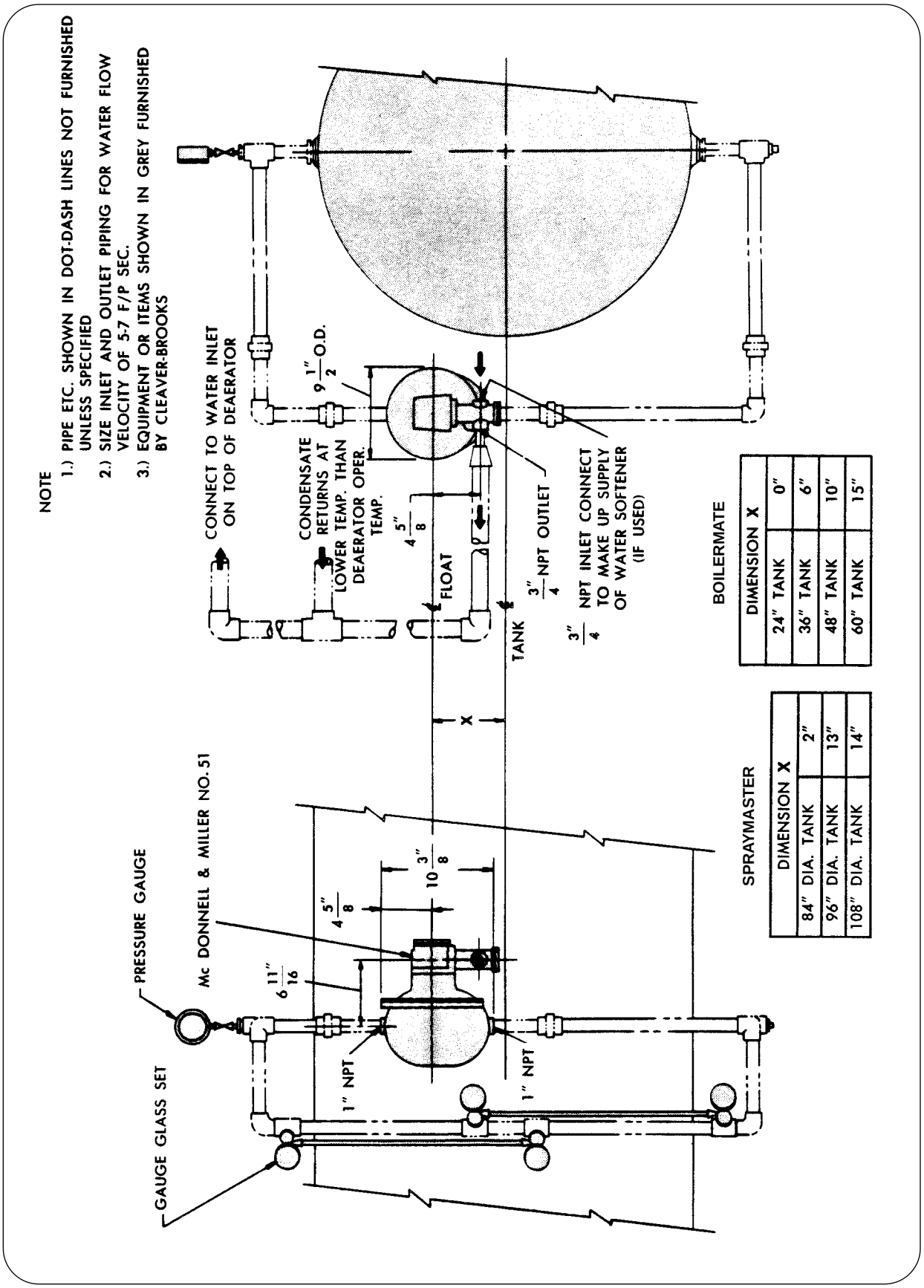


Figure 1-18. Make-Up Valve Arrangement for Spraymaster or Boilermate Storage Tanks (McDonnell & Miller No. 51)

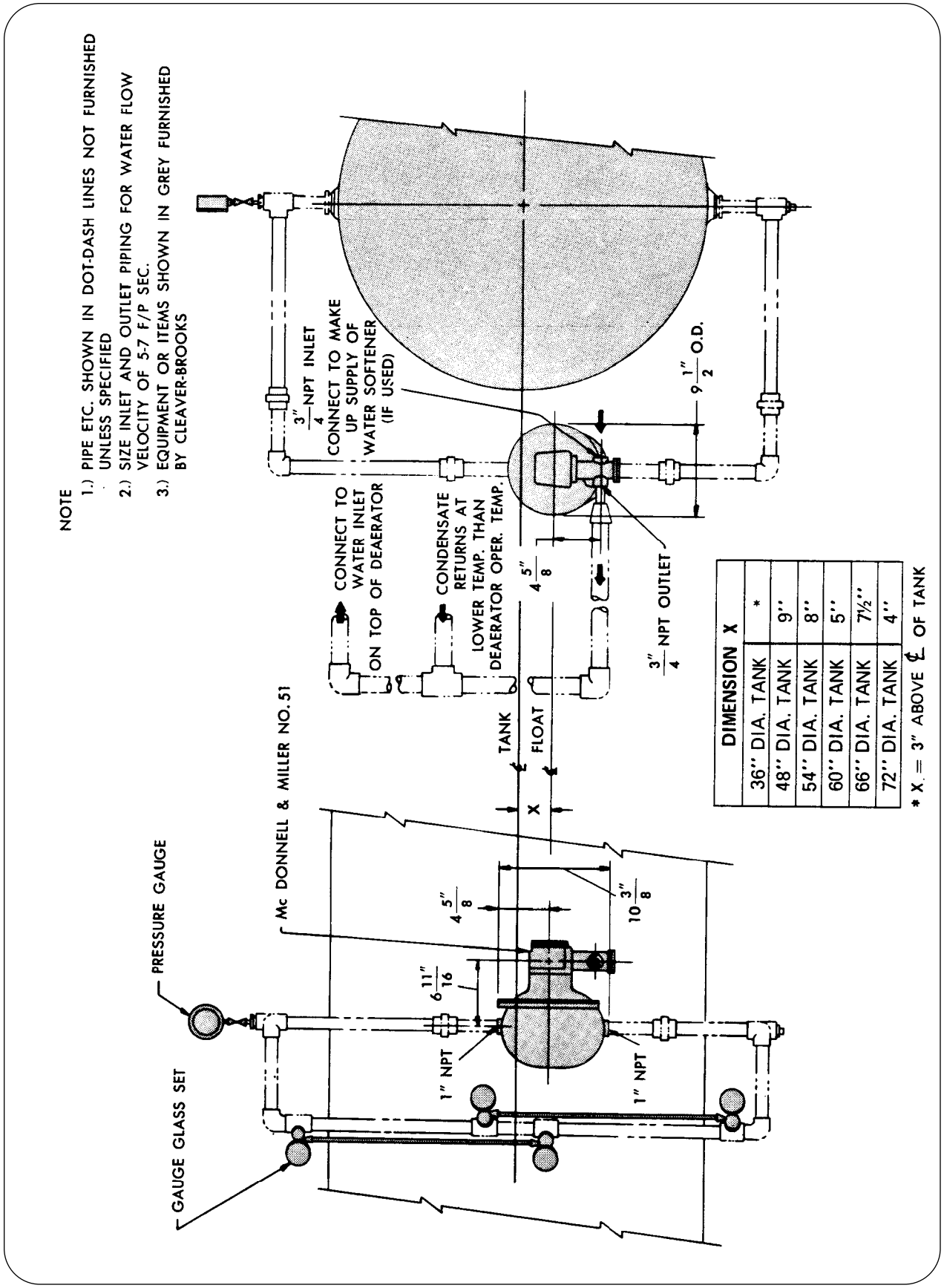


Figure 1-19. Make-Up Valve Arrangement for Spraymaster Storage Tanks (McDonnell & Miller No. 51)

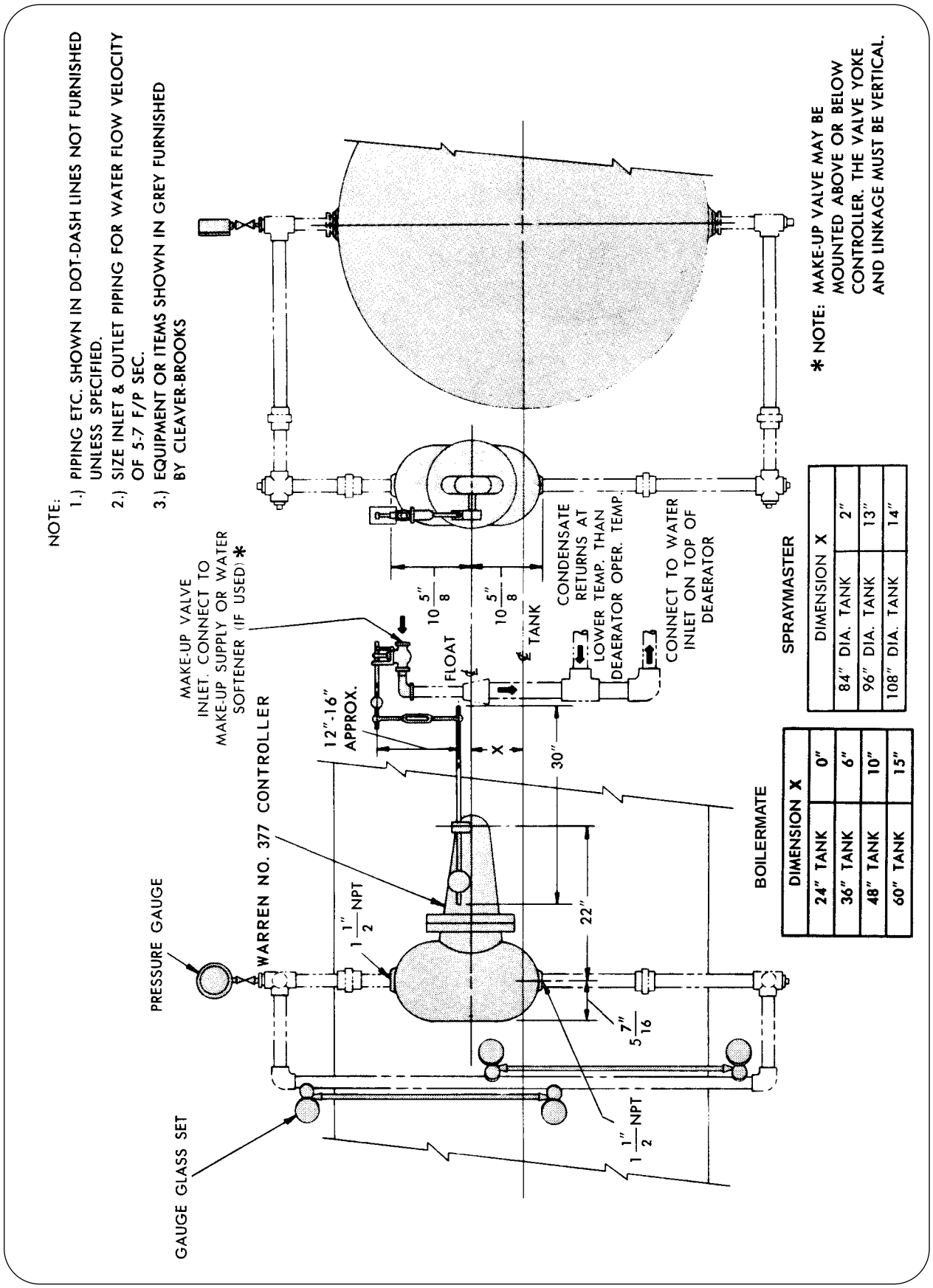


Figure 1-20. Make-Up Valve Arrangement for Spraymaster or Boilermate Storage Tanks (Warren 326L & 322L Valve with No. 377 Controller)

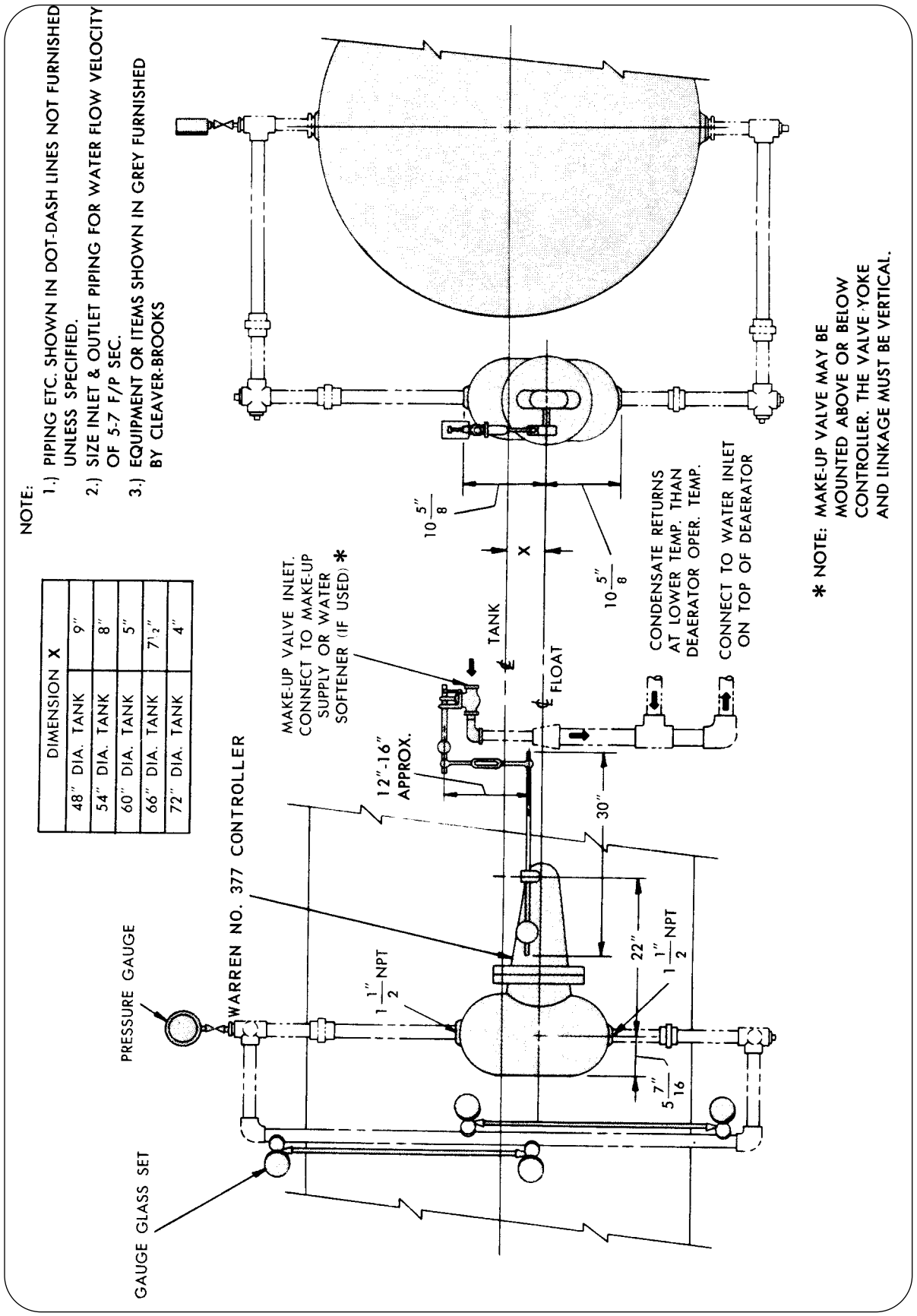


Figure 1-21. Make-Up Valve Arrangement for Spraymaster Storage Tanks (Warren 326L & 322L Valve with No. 377 controller)

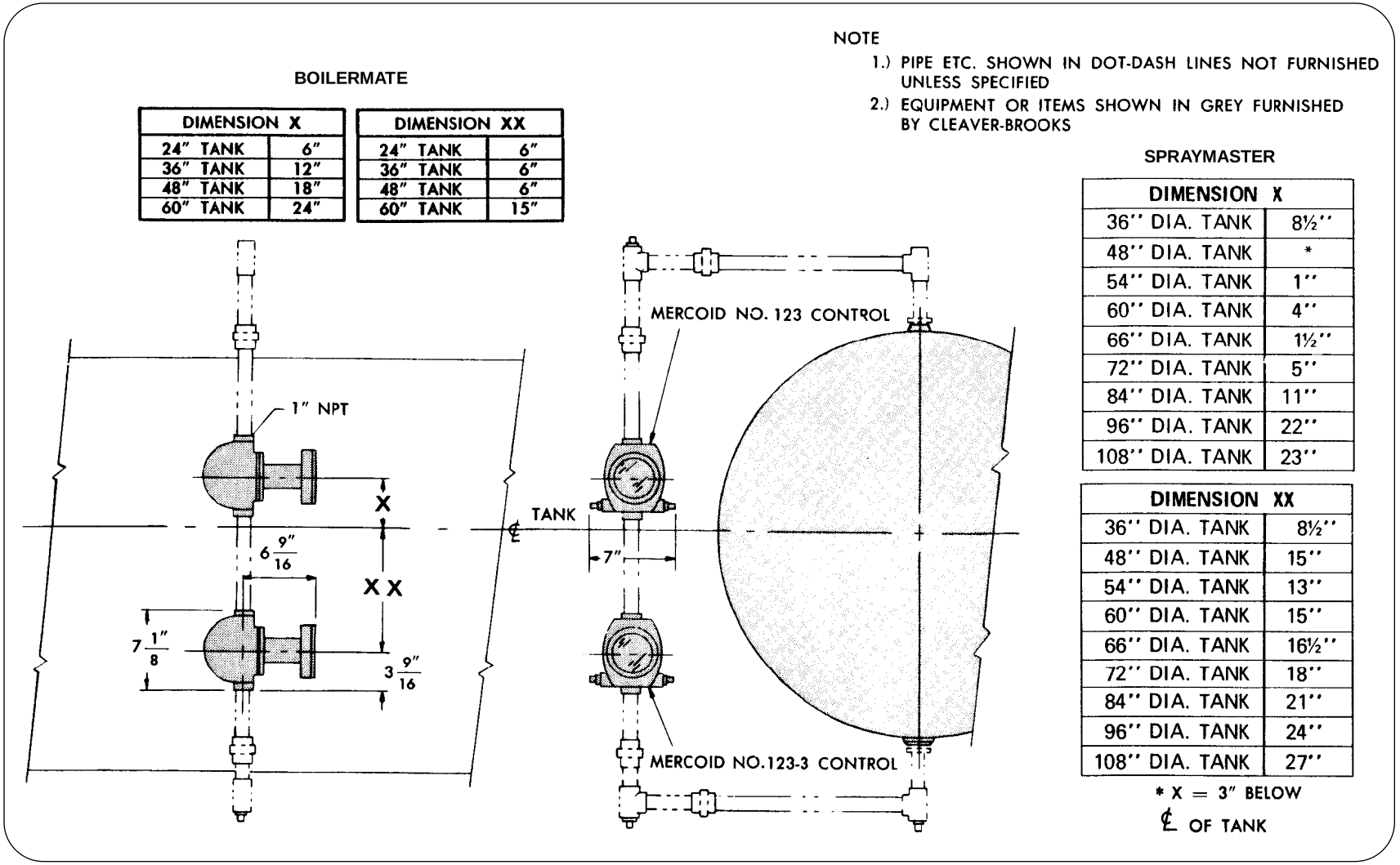


Figure 1-22. High and Low Alarm Control Arrangement for Spraymaster or Boilermate Storage Tanks (Mercoid or McDonnell Miller 64)

Section 2
Pressure Reducing Valves

START-UP AND SETTING

On pressure reducing valves such as the type ED, use a by-pass to fill the delivery system and raise pressure to slightly below normal required. Close the pilot by releasing compression on the adjusting spring. See Figure 2-1. Open the 1/4" control pipe valve, crack the outlet stop valve, the crack inlet stop valve, and blow down the strainer.

⚠ CAUTION

Never open a reducing valve without positive indication that the high side is clear of condensate.

Open the inlet stop valve and gradually compress the adjusting spring until the valve opens and takes control at the desired pressure. Alternately choke down on the by-pass and open the outlet stop valve until the regulator is on the line, See individual instructions for other pilots.

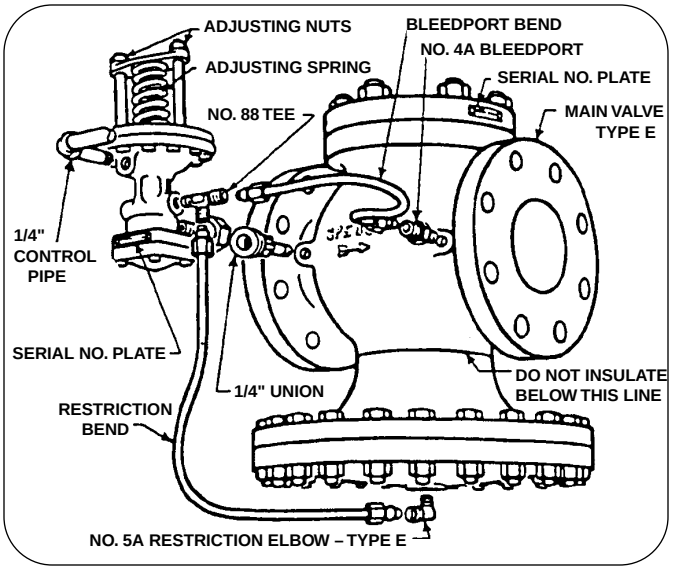


Figure 2-1.Type ED Valve

HYDROSTATIC TEST PROCEDURE

Install the pilot according to instructions. Fully compress the pilot spring and open the inlet and outlet stop valves before filling the system. Slowly fill the system from the inlet or high pressure side of the regulator. Bleed off trapped air. Slowly develop test pressure up to the 300 psig maximum. If a higher pressure is required, contact the factory first. Test pressures may cause normally acceptable leakage at the diaphragm joint. Consult the factory for hydrostatic testing of other types of regulators.

TROUBLE SHOOTING (See Figure 2-1)

Failure to Open, or Sagging Delivery Pressure

1. Adjusting spring on the pilot may have been tampered with.
2. Initial pressure may be down due to a partially closed supply valve, clogged strainer, or other obstruction.
3. Orifice in No. 5A restriction elbow may be plugged. No. 4A bleedport fitting may have been omitted and an open coupling substituted.
4. Control pipe may be plugged. Most likely points of obstruction are at the shutoff valve and the entrance to the delivery main.
5. Main diaphragm may be broken. Test with air or water before dismantling.

Failure to Close, or Over-Riding Delivery Pressure

1. Adjusting spring on the pilot may have been tampered with.
2. Orifice in bleedport No. 4A may be plugged.
3. By-pass valve may be leaking.
4. On pressure regulators such as the ED, the main valve or pilot may be held open by foreign matter in the seat. To determine which valve leaks, first close the stop valve and 1/4" control pipe valve. Then remove the bleedport bend so that the pilot will exhaust to atmosphere. Crack the inlet stop valve. Steam will issue from No. 8B tee. Release compression on the adjusting spring to see if the pilot closes tight. Open and close it several times to wash the seat. Steam blowing back from the bleedport means that the main valve disc is held open by foreign matter. Steam may

wash the obstruction from the seat if the valve is made to open wide. This can be accomplished, even at light loads, if the control point is beyond the outlet stop valve. Reassemble the bleedport bend and place the regulator in operation. Then, slowly open and close the outlet stop valve.

MAINTENANCE

Inspection

Under normal conditions, complete dismantling at regular intervals is not recommended. A valve kept relatively free of dirt will function for years with minimum attention.

After the first few days of operation and twice a year, the following should be checked.

1. Inspect for dirt collected at bleedport No. 4A and restriction elbow No. 5A (see Figure 2-1).
2. Inspect all joints for leakage. Keep bolts tight. Never allow a leak to persist.

Notes:

Section 3

Parts

Table 3-1. Standard Spraymaster Parts

PART NO.	DESCRIPTION	USAGE
851-284	Glass, Gauge, 5/8" x 61-7/8"	108" Dia
853-115	Gasket, 5/8" Gauge Glass	2 per Glass
853-618	Gasket, Manhole, 11" x 15"	
825-281	Set, Water Gauge	
850-50	Gauge, Pressure, 4-1/2", 0-60 lbs, Bottom Connector	
850-583	Gauge, Pressure, 4-1/2", 0-60 lbs, Back Connector	
937-669	Thermometer, 0-250°F, 4" Stem	
937-660	Thermometer, 50-300°F, 4-1/2" Dial, 5 ft Capillary	
937-662	Thermometer, 50-300°F, 4-1/2" Dial, 20 ft Capillary	
934-322	Valve, Auto -Vent, 1/2"	
817-161	Control, Water Level, McDM-51-B	
817-187	Control, Water Level, McDM-51-B-S	

Table3-2. Standard Boilermate Parts

PART NO.	DESCRIPTION	USAGE	
853-115	Gasket, 5/8" Gauge Glass	2 per Glass	
853-618	Gasket, Manhole, 11" x 15"		
825-281	Set, Water Gauge		
853-913	Gasket, Flange, 8" ID		
853-914	Gasket, Flange, 12" ID		
853-915	Gasket, Flange, 14" ID		
853-916	Gasket, Flange, 16" ID		
853-917	Gasket, Flange, 18" ID		
853-918	Gasket, Flange, 20" ID		
850-50	Gauge, Pressure, 4-1/2", 0-60 lbs. Bottom Connector		
850-583	Gauge, Pressure, 4-1/2", 0-60 lbs, Back Connector		
937-669	Thermometer, 0-250°F, 4" Stem		
937-660	Thermometer, 50-300°F, 4-1/2" Dial, 5 ft Capillary		
934-322	Valve, Auto-Vent, 1/2"		
817-161	Control, Water Level, McDM-51-8		
914-238	Packing Rings, Stainless Steel	Qty	Column Size cu-ft
		8	0.7
		12	1.6
		16	3.0
		20	5.0
		24	8.0
		30	12.0
		36	18.0
		42	29.0

MODEL NUMBER EXPLANATION

Table 3-3. Spray Head (194-72) SM-6 and SM-7

ITEM	QTY.	PART NO.	DESCRIPTION
1	1	934-322	Valve, Auto Vent (Replaces 940-1321)(Air)
2	1	194-42	Valve, Manual Vent (Air)
3	2	869-61	Nut, Hex No. 10-24
4	1	13-174	Cap, Spring
5	1	82-77	Spring
6	1	939-65	Spacer, 3/8" OD x 3/4" Lg (994-7416)
7	2	869-61	Nut, Hex No. 10-24
8	1	67-553	Hook, Spring
9	1	82-76	Spring
10	1	903-164	Pin, Roll
11	1	853-710	Gasket, Flange 14" ID x 17-3/4" OD, 1/16" Thk
12	1	194-74	Valve, Atomizing
13	1	194-71	Guide Valve - nod
14	1	952-122	Lock Washer, 3/8" SS
15	1	869-35	Nut, Hex 3/8" - 16 SS
16	1	194-90	Valve Stem, Water Inlet
17	1	853-543	Gasket, Flange 3-1/2" ID x 5-3/8" OD, 1/16" Thk
18	1	63-68	Stationary Baffl

NOTE: here is no old or new style on this model.
Notice the water and steam inlet construction.

Table 3-4. Hinged Manways (Spraymaster) - 50#

DEAERATOR MODEL - 50#	ITEM 1	ITEM 2	ITEM 3	SIZE
SM15 thru SM70	656-6203	141-777	853-1003	28"
SM100	656-6202	141-810	853-1002	32"
SM140	656-5923	141-743	853-1004	36"

For use on 50# design pressure Sprymaster deaerators only.

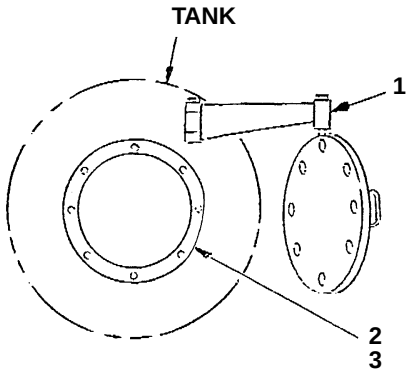


Table 3-5. Manhole Cover Assemblies

ASSEMBLY PART NO.	COVER		YOKE		BOLT		NUT		WASHER	
	PART NO.	REQ.	PART NO.	REQ.	PART NO.	REQ.	PART NO.	REQ.	PART NO.	REQ.
11" x 15" Manhole Cover and Yoke Assembly										
821-192 (Std)	821-191	1	953-40	1	868-778	1	869-320	1	952-132	1
821-188	821-187	1	953-50	2	868-366	2	869-65	2	952-124	2
12"x 16" Manhole Cover and Yoke Assembly (Standard)										
821-271	821-207	1	953-50	2	868-366	2	869-65	2	952-288	2

Table 3-6. Pressure Reducing Valves (Fisher 92 Series)

DESCRIPTION	FISHER #92 PART NO.	CURRENT FISHER REPLACEMENT PART NO.	APPROXIMATE WEIGHT
1/2" Fisher PRV	940-1448	918-505	12 lbs
3/4" Fisher PRV	940-1329	918-507	23 lbs
1" Fisher PRV	940-1449	918-512	23 lbs
1-1/4" Fisher PRV	940-1355	Call Factory for Replacement	-
1-1/2" Fisher PRV	940-1427	918-513	42 lbs
2" Fisher PRV	940-1447	918-514	55 lbs
2-1/2" Fisher PRV	940-1611	918-516	67 lbs
3" Fisher PRV	940-1612	918-517	115 lbs
4" Fisher PRV	940-1618	918-518	165 lbs
6" Fisher PRV	940-1617	Call Factory for Replacement	-

NOTE: The above chart is only for standard Cleaver-Brooks specified deae ator pressure reducing valves.

Table 3-7. Pressure Reducing Valves (Spence ED Series)

DESCRIPTION	PART NO.	APPROXIMATE WEIGHT
1/2" Spence PRV	940-4904	24 lbs
3/4" Spence PRV	940-4339	28 lbs
1" Spence PRV	940-4905	33 lbs
1-1/4" Spence PRV	940-4722	43 lbs
1-1/2” Spence PRV	940-4077	53 lbs
2” Spence PRV	940-3298	77 lbs
2-1/2" Spence PRV	940-4906	92 lbs
3" Spence PRV	940-4907	120 lbs
4" Spence PRV	940-3976	210 lbs
5" Spence PRV	940-4450	290 lbs

NOTE: The above chart is only for standard Cleaver-Brooks specified deae ator pressure reducing valves.

Table 3-8. Pressure Reducing Valves (Spence E2D Series)

DESCRIPTION	PART NO.	APPROXIMATE WEIGHT
3/4" Spence PRV	940-4919	28 lbs
1" Spence PRV	940-3321	29 lbs
1-1/4" Spence PRV	940-4358	40 lbs
1-1/2" Spence PRV	940-2740	46 lbs
2" Spence PRV	940-2885	67 lbs
2-1/2" Spence PRV	940-2859	80 lbs
3" Spence PRV	940-3390	108 lbs
4" Spence PRV	940-3357	145 lbs
5" Spence PRV	940-4069	195 lbs
6" Spence PRV	940-3303	260 lbs

NOTE:
The above chart is only for standard Cleaver-Brooks specified deae ator pressure reducing valves.

Table 3-9. Valve Sets for Gauge Glass

DESCRIPTION	PART NO.
Valve Set with Ball Valve (Obsolete)	825-216
Valve Set (Standard)*	825-281
Ball Valve (Standard)*	941-55
Valve Set with Ball Valve (Special)	825-317

*Use one of each when replacing Part Number 825-216.

Table 3-10. Overfl w Drainer (Steam Trap)

DESCRIPTION	PART NO.	APPROXIMATE WEIGHT
OFD, 1" NPT Warren #313	817-2040	60 lbs
OFD, 2" NPT Warren #313	817-2041	75 lbs
OFD, 3" FLG Warren #313	817-1910	125 lbs
OFD, 4" FLG Warren #313	817-1554	150 lbs
OFD, 6" FLG Warren #313	817-1663	200 lbs
OFD, 1" NPT Fisher #38 (Obsolete)	817-673	65 lbs
OFD, 1-1/2" NPT Fisher #38 (Obsolete)	817-769	110 lbs
OFD, 2" NPT Fisher #38 (Obsolete)	817-666	120 lbs
OFD, 3" NPT Fisher #38 (Obsolete)	817-671*	No Longer Mfg.

*Replace with 3" Warren #313 (Part No. 817-1910), but note that piping will have to be modified to fi

Table 3-11. Make-Up Controls (Float Cages)

DESCRIPTION	PART NO.
Float Cage, Fisher #220-C 1-1/2" (Obsolete)	817-672
Float Cage, Warren #337 1-1/2"	817-2012
Float Cage, Clayton CFC 2A-1 1"	817-205
Float Cage, Fisher #2500-249 1-1/2"	817-1523
Float Cage, Fisher #2500-249-S1 1-1/2"	817-1815

Note: These float cages are used with ma e-up valves. The float cage detects water level and the make-up valves lets water in.

Table 3-12. Lever Operated Warren Valve

DESCRIPTION	PART NO.
Valve Lever Operated Warren 326L 1/2"	940-05724
Valve Lever Operated Warren 326L 3/4"	940-05725
Valve Lever Operated Warren 326L 1"	940-05726
Valve Lever Operated Warren 326L 1-1/4"	940-05727
Valve Lever Operated Warren 326L 1-1/2"	940-05728
Valve Lever Operated Warren 326L 2"	940-05729

Table3-13. Make-Up Controls (Lever Operated Make-Up Valves) (Fisher 171L)

DESCRIPTION	PART NO.	APPROXIMATE WEIGHT	DESCRIPTION*	PART NO.
Make-Up Valve, Lever Operated 1/2"	940-3539	8 lbs	Repair Kit for 171L 3/8" thru 3/4"	797-04052
Make-Up Valve, Lever Operated 3/4"	940-3540	8 lbs	Repair Kit for 171L 3/8" thru 3/4"	797-04052
Make-Up Valve, Lever Operated 1"	940-3541	8 lbs	Repair Kit for 171L 1"	797-04053
Make-Up Valve, Lever Operated 1-1/4"	940-3542	19 lbs	Repair Kit for 171L 1-1/4" and 1-1/2"	797-04054
Make-Up Valve, Lever Operated 1-1/2"	940-3543	25 lbs	Repair Kit for 171L 1-1/4" and 1-1/2"	797-04054
Make-Up Valve, Lever Operated 2"	940-3544	30 lbs	Repair Kit for 171L 2"	797-04055

* Kits include O-ring, seat ring, pilot valve assembly, packing, piston rinr, and expander.

Table 3-14. Make-Up Controls (Lever Operated Make-Up Valves) (Fisher 670EK)

DESCRIPTION	PART NO.
Make-Up Valve, Lever Operated 1" NPT	940-4894
Make-Up Valve, Lever Operated 1-1/2" NPT	940-4474
Make-Up Valve, Lever Operated 2-1/2" FLG	940-5193
Make-Up Valve, Lever Operated 3"	940-4278
Make-Up Valve, Lever Operated 4"	940-4320

Table 3-15. Make-Up Controls (Lever Operated Make-Up Valves) (Fisher 608EK)

DESCRIPTION	PART NO.
Make-Up Valve, Lever Operated 2-1/2" FLG	940-4697
Make-Up Valve, Lever Operated 3" FLG	940-4781
Make-Up Valve, Lever Operated 4" FLG	940-4580

Table 3-16. Make-Up Controls (Diaphragm Operated Make-Up Valves) (Fisher 657ES)

DESCRIPTION	PART NO.
Make-Up Valve, Diaphragm Operated 1/2" NPT	940-4520
Make-Up Valve, Diaphragm Operated 3/4" NPT	940-4632
Make-Up Valve, Diaphragm Operated 1" PT	940-4081
Make-Up Valve, Diaphragm Operated 1-1/2" NPT	940-3849
Make-Up Valve, Diaphragm Operated 2" NPT	940-4660
Make-Up Valve, Diaphragm Operated 2-1/2" FLG	940-4555
Make-Up Valve, Diaphragm Operated 3" FLG	940-4684

NOTE: Shown is a typical 657 diaphragm actuator mounted on an ES valve.

Table 3-17. Deaerator Retrofit arts

PART NO.	MODEL USED	DESCRIPTION
194-72	SM7	Steam/Water Inlet Assembly
277-116	SM15	Water Inlet Assembly
277-117	SM30 - SM45	Water Inlet Assembly
277-118	SM70	Water Inlet Assembly
277-119	SM100 - SM200 (2 ea.)	Water Inlet Assembly
277-120	SM140 - SM280 (2 ea.)	Water Inlet Assembly
295-109	SM15, 30, 45, 70, 100 & 200	Spring Loaded Valve Assembly
295-111	SM140 & SM280	Spring Loaded Valve Assembly
97-221	SM15, 30, 45 & 70	Cone Assembly
97-222	SM100 & 200 (2 ea.)	Cone Assembly
97-239	SM140 & 280 (2 ea.)	Cone Assembly
656-6203	SM15 - SM70 28"	Hinged Manway with Gasket and Hardware - 50#
656-6202	SM100 - SM200 32"	Hinged Manway with Gasket and Hardware - 50#
656-5923	SM140 - 200 & 280 36"	Hinged Manway with Gasket and Hardware - 50#
141-777	SM15 - SM70 28"	Tank Flange - 50#
141-810	SM100 - 200 & 280 32"	Tank Flange - 50#
141-743	SM140 - 200 & 280 36"	Tank Flange - 50#
797-4039	All Models	Engineering Calculations

When retrofiting the deae ator to a davited manway, please use these part numbers related to the model.

Table 3-18. Spray Nozzle Assembly or Water Inlet Assembly (SM-15 thru SM280)

MODEL NUMBER	WATER INLET ASSEMBLY PART NO.
SM-15	277-116
SM-30	277-117
SM-45	277-117
SM-70	277-118
SM-100	277-119
SM-140	277-120
SM-200	277-119 (2 Required)
SM-280	277-120 (2 Required)

NOTE: The water inlet assembly does not change from old style to new style. Only the steam inlet assembly changed from spring loaded to counter balanced. The next fi e pages shows a parts break down of the water inlet assemblies.

Table 3-19. Boilermate Support Grid for Column

SUPPORT GRID SET REPLACEMENT PART NO.	COLUMN MODEL NO.	NUMBER OF PIECES THAT MAKE UP A SUPPORT GRID SET
530-256	8	2
530-257	12	2
530-258	16	2
530-259	20	2
530-260	24	2
530-261	30	3
530-262	36	3
530-263	42	4

NOTE: The reason a support grid comes in pieces instead of a complete circle is for installation purposes.

Table 3-20. Boilermate Liner for Column

LINER PART NO.	COLUMN MODEL NO.	LENGTH OF LINER
102-47	8	25-9/16"
102-50	12	28"
102-51	16	29-1/4"
102-52	20	30-1/4"
102-53	24	32-1/4"
102-54	30	34-1/4"
102-55	36	36-1/4"
102-56	42	38-1/4"

Table 3-21. Boilermate Gaskets for Column

COLUMN MODEL NO.	WATER INLET GASKET	STEAM INLET GASKET
8	Was 853-913 replaced by 853-974	Was 853-914 replaced by 853-976
12	Was 853-914 replaced by 853-976	Was 853-914 replaced by 853-976
16	Was 853-913 replaced by 853-974	Was 853-914 replaced by 853-976
20	Was 853-914 replaced by 853-976	Was 853-914 replaced by 853-976
24	Was 853-914 replaced by 853-976	Was 853-914 replaced by 853-976
30	Was 853-914 replaced by 853-976	Was 853-916 replaced by 853-978
36	Was 853-914 replaced by 853-976	Was 853-917 replaced by 853-979
42	Was 853-915 replaced by 853-977	Was 853-918 replaced by 853-980

Table 3-22. Boilermate Bare Column Only

BARE COLUMN PART NO.	COLUMN MODEL NO.	NOMINAL DIMENSIONS
172-388	8	8" dia. x 41" Lg
172-387	12	12" dia x 43" Lg
172-3885	16	16" dia x 53-1/2" Lg
172-386	20	20" dia x 56" Lg
172-387	24	24" dia x 59-1/4" Lg
172-388	30	30" dia x 64" Lg
172-389	36	36" dia x 70-1/4" Lg
172-390	42	42" dia x 73" Lg

NOTE: Bare column only is the shell with grid support and liner. This does not include water inlet assembly, gaskets, packing, plug or data nameplate.91-121

Table 3-23. Boilermate Column Type Deaerator Water Inlet Valve Parts

COLUMN MODEL	WATER INLET ASSEMBLY	MANUAL VENT VALVE	SPRING	DISC	SPRING CAP 2 REG.	NUT (JAM) 2 REQ.	AUTO VENT VALVE
8	277-139	194-42	82-50	91-122	13-167	869-370	934-322
12	277-146	194-42	82-24	91-121	13-86	869-370	934-322
16	277-116	194-44	82-107	91-109	13-86	869-370	934-322
20	277-117	194-43	82-52	91-110	13-160	869-209	934-322
24	277-117	194-43	82-52	91-110	13-160	869-209	934-322
30	277-118	194-46	82-20	91-111	13-160	869-209	934-322
36	277-119	194-45	82-21	91-112	13-160	869-209	934-322
42	277-120	194-49	82-21	91-113	13-160	869-209	934-322

Table 3-24. Spraymaster Gasket for Water Inlet

MODEL NUMBER	WATER INLET GASKET
SM-15	Was 853-913 replaced by 853-974
SM-30	Was 853-914 replaced by 853-976
SM-45	Was 853-914 replaced by 853-976
SM-70	Was 853-914 replaced by 853-976
SM-100	Was 853-914 replaced by 853-976
SM-140	Was 853-915 replaced by 853-977
SM-200*	Was 853-914 replaced by 853-976
SM-280*	Was 853-915 replaced by 853-977

*Requires 2 if replacement in both water inlet assemblies is needed.

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