Spraymaster Signature *Series*

Deaerator Operation, Maintenance and Parts

750-223
04/2012

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

Spraymaster *Signature* Series
Deaerator Operation, Maintenance and Parts

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

Manual Part No. 750-223
04/2012

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Section 1
Operation and Service

A. Deaerators

General

The Spraymaster Signature Deaerator (**Figure 1-1**) is designed to operate with steam generation plants, or wherever oxygen-free water is required.

Figure 1-1 Spraymaster *Signature* Deaerator

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 oxidation 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. Through this process, the deaerator also provides preheated water to the boiler increasing thermal efficiency.

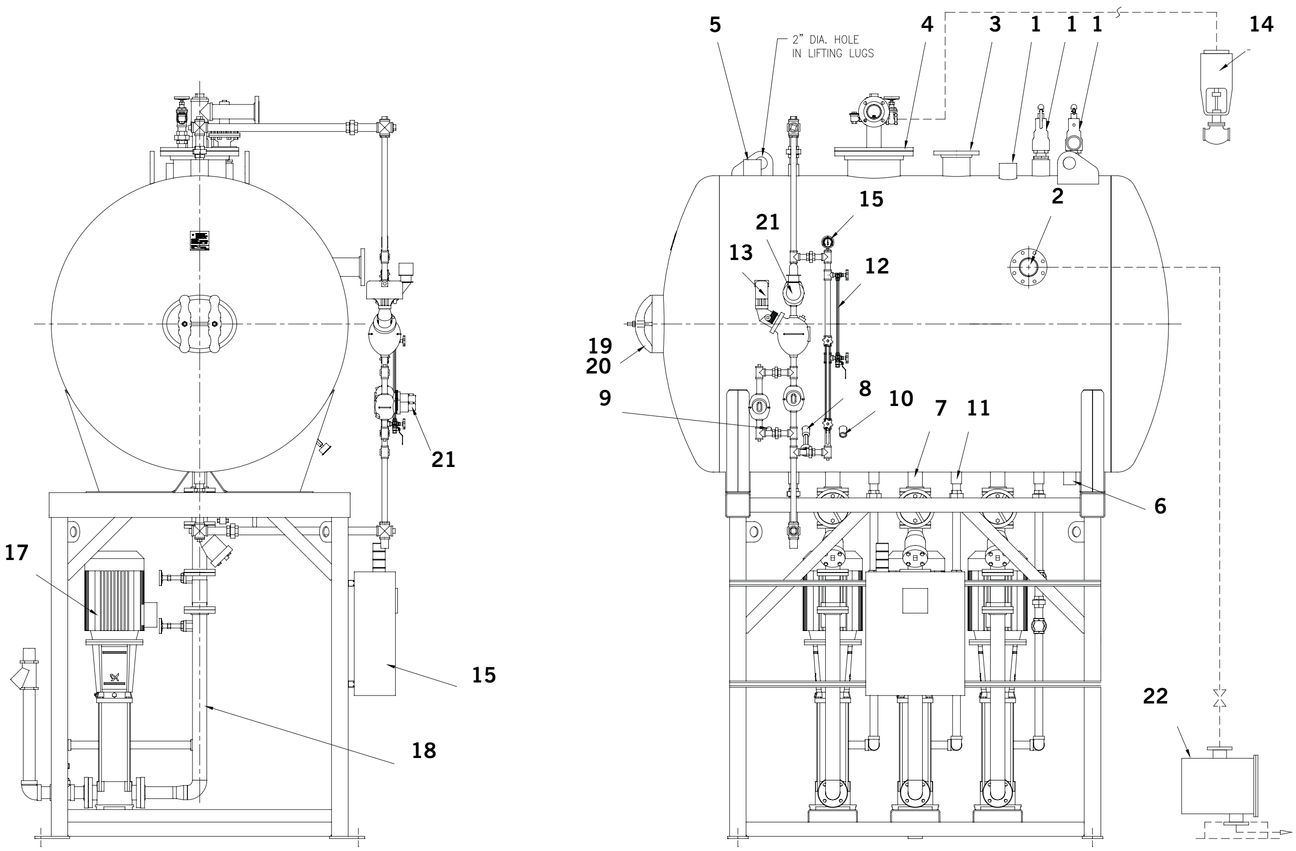
Figure 1-2 Spray Head

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

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.

Figure 1-2 illustrates the location of the spray cone assembly in relation to the vessel. The majority of deaeration occurs within this spray-cone assembly

Model No.	Rating lb/hr	Gallons to Overflow (Min.) 10 Minute Storage	Tank Size (inches)
SS7	7,000	260	48 x 75
SSP15	15,000	415	48 x 115
SSP30	30,000	610	54 x 117
SSP45	45,000	1105	66 x 121
SSP70	70,000	1,400	72 x 123
SSP100	100,000	2,485	84 x 152



CONNECTIONS AND TRIM								
1	Relief Valve Size / Quantity	Contact Your Local Cleaver-Brooks Authorized Representative						
2	Overflow Size	3" NPT	3" NPT	3" NPT	3" NPT	4"-150# FF	4"-150# FF	4"-150# FF
3	Steam Inlet Size	6"-150# FF	6"-150# FF	6"-150# FF	6"-150# FF	6"-150# FF	6"-150# FF	6"-150# FF
4	Water Inlet Size	8"-150# FF	8"-150# FF	8"-150# FF	12"-150# FF	12"-150# FF	12"-150# FF	12"-150# FF
5	High Temperature Return Size	1 1/2" NPT	2" NPT	2" NPT	2" NPT	3" NPT	3" NPT	3" NPT
6	Drain Size	2" NPT	2" NPT	2" NPT	2" NPT	2" NPT	2" NPT	2" NPT
7	Suction Size	2.5" NPT	2.5" NPT	2.5" NPT	2.5" NPT	3"-150# FF	3"-150# FF	4"-150# FF
8	Thermometer	3/4" NPT	3/4" NPT	3/4" NPT	3/4" NPT	3/4" NPT	3/4" NPT	3/4" NPT
9	Sample	1/2" NPT	1/2" NPT	1/2" NPT	1/2" NPT	1/2" NPT	1/2" NPT	1/2" NPT
10	Chemical Feed	1" NPT	1" NPT	1" NPT	1" NPT	1" NPT	1" NPT	1" NPT
11	Recirculation	1.5" NPT	1.5" NPT	1.5" NPT	1.5" NPT	1.5" NPT	1.5" NPT	2" NPT
12	Gauge Glass Assembly							
13	Level Controller	1.5" NPT	1.5" NPT	1.5" NPT	1.5" NPT	1.5" NPT	1.5" NPT	1.5" NPT
14	Make-Up Valve							
15	Pressure Gauge	1/4" NPT	1/4" NPT	1/4" NPT	1/4" NPT	1/4" NPT	1/4" NPT	1/4" NPT
16	Control Panel	Per Design	Per Design	Per Design	Per Design	Per Design	Per Design	Per Design
17	Feed Pump/Motor	Per Design	Per Design	Per Design	Per Design	Per Design	Per Design	Per Design
18	Suction Piping	Per Design	Per Design	Per Design	Per Design	Per Design	Per Design	Per Design
19	Manway Size - SSP 15-70	12" x 16"	12" x 16"	12" x 16"	12" x 16"	12" x 16"	12" x 16"	N/A
20	Manway Size - SSP 100	N/A	N/A	N/A	N/A	N/A	N/A	14" x 18"
21	Level Alarms	1" NPT	1" NPT	1" NPT	1" NPT	1" NPT	1" NPT	1" NPT
22	Overflow Drainer	Per Design	Per Design	Per Design	Per Design	Per Design	Per Design	Per Design

Figure 1-4 Component Location

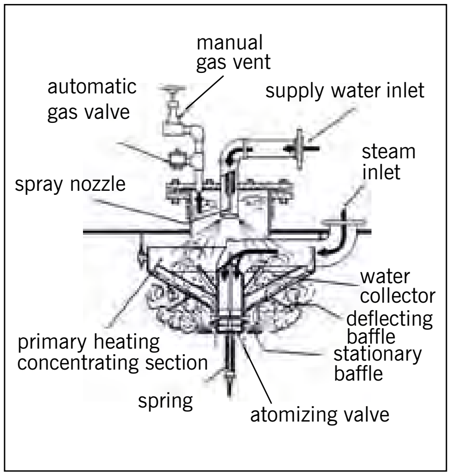


Figure 1-5 Spray Head Components

Figure 1-6 Spray Head Installed

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 to atmosphere through the gas vent valves.

Spraymaster Deaerator

A typical Cleaver-Brooks Spraymaster Signature Deaerator is shown in **Figure 1-1**, which illustrates a packaged type deaerator tank mounted on a stand 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. Standard components in the package include such items as relief valves for the tank, steam pressure reducing valve, 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 elliptical 12" x 16" manway, and fitted with a 0-60 lb pressure gauge, a 50 – 300 °F thermometer, 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 **Figure 1-5**. An actual spray cone assembly is shown in **Figure 1-6**. The assembly is all stainless steel.

System Lay-Out

General

Two typical system lay-outs are described in plan “A” (**Figure 1-7**) and plan “B” (**Figure 1-8**). Note that in either case the minimum supply 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*. The make-up water must be modulated into the deaerator and must not exceed the deaeration capacity of the model.

The recommended steam piping configurations for various deaerator models are shown in **Figure 1-7** thorough **Figure 1-9**.

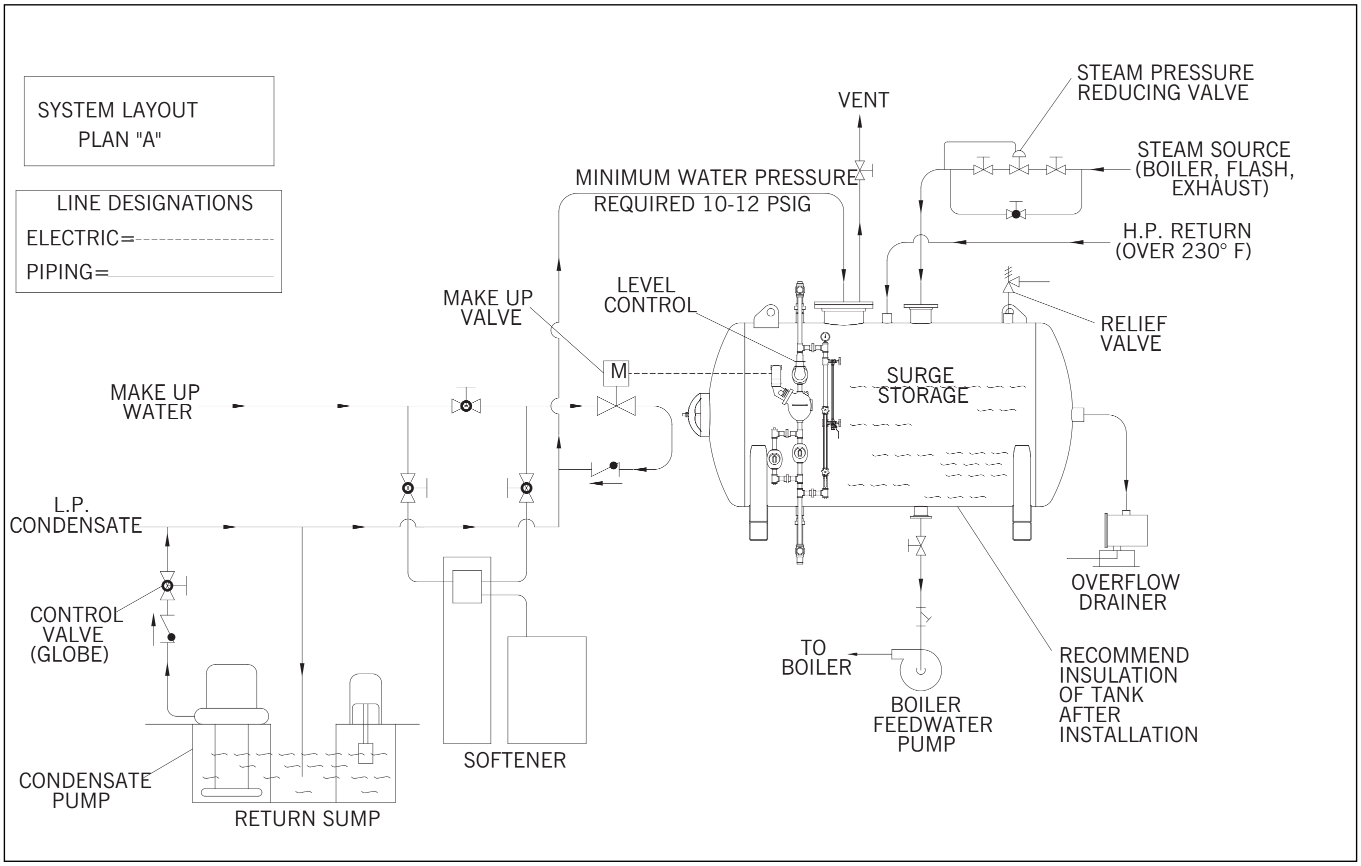


Figure 1-7 System Layout - Plan A

Plan A (Figure 1-7)

Under normal operating conditions, the make-up water will be automatically combined with low or medium temperature 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 or in excess of 230 F.

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

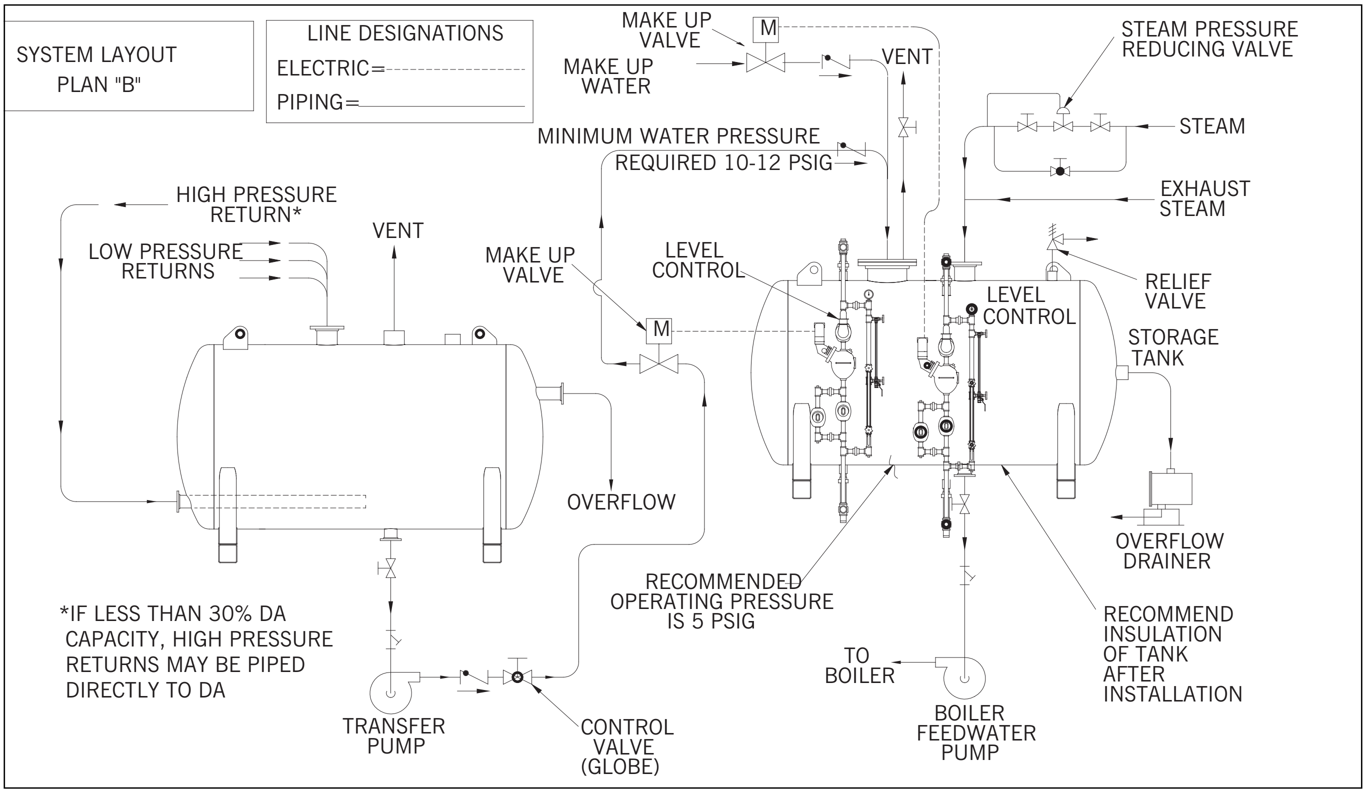
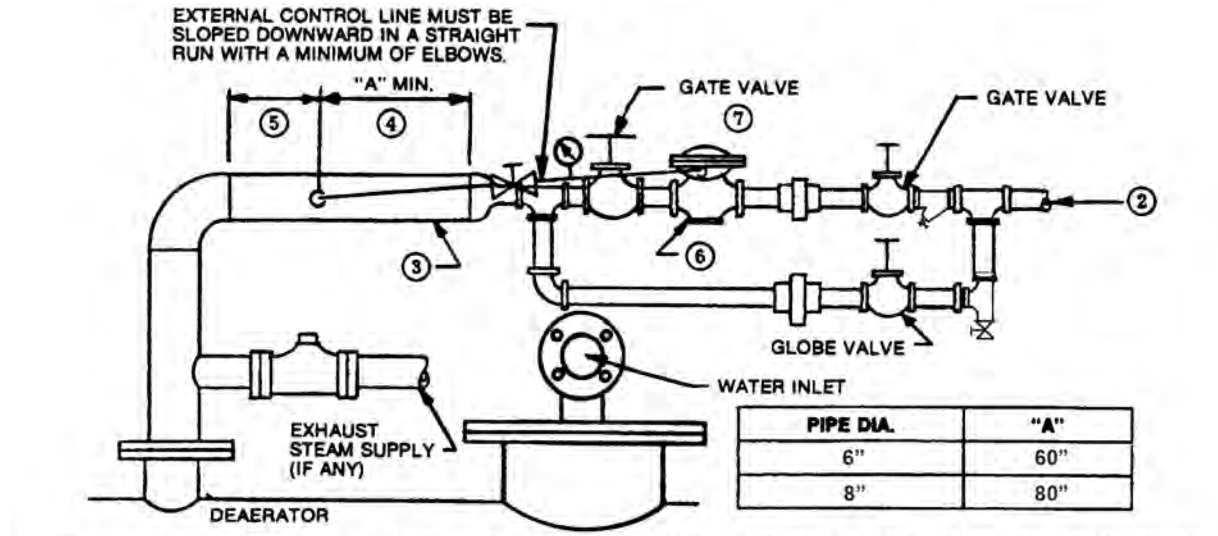


Figure 1-8 System Layout - Plan B

Plan B (Figure 1-8)

In this layout the high pressure returns and low pressure returns 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.

If high pressure returns are less than 30% of the deaerator capacity, they may be returned directly to the deaerator.



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

1. STEAM PIPING SHOWN ON THIS DRAWING 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 PROPORTIONATELY SIZED BETWEEN PRESSURE REDUCING VALVE AND DEAERATOR STEAM INLET SIZES; I.E., 2" PRESSURE REDUCING VALVE AND 6i STEAM LINE USE AT LEAST A 4" VALVE.

Figure 1-9 Steam Piping for Spraymaster Deaerators

B. Operating Instructions

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.

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.

Table 1-1 Vent Valve Sizes

Spraymaster Signature Deaerator Size	Valve Size	Orifice Size
SS7	1/2"	1/8"
SS15	3/4"	3/16"
SS30-45	3/4"	1/4"
SS70	1"	3/8"
SS100	1-1/2"	3/8"

Continuous venting of the deaerator through the predetermined orifice valve is absolutely necessary for proper operation. Never replace this manual valve with a valve providing tight shutoff. Contact your authorized Cleaver-Brooks representative for more information. The piping must be the same size as the valve. See Table 1-1 for valve and orifice sizes.

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 should there at be a sudden build up of gases.

⚠ Caution

Do not substitute or replace this valve. If there is any doubt, verify that the valve has a drilled gate prior to placing the unit into operation. The valve is normally in the closed position and vents a continuous flow of steam and gases through the orifice drilled into the gate.

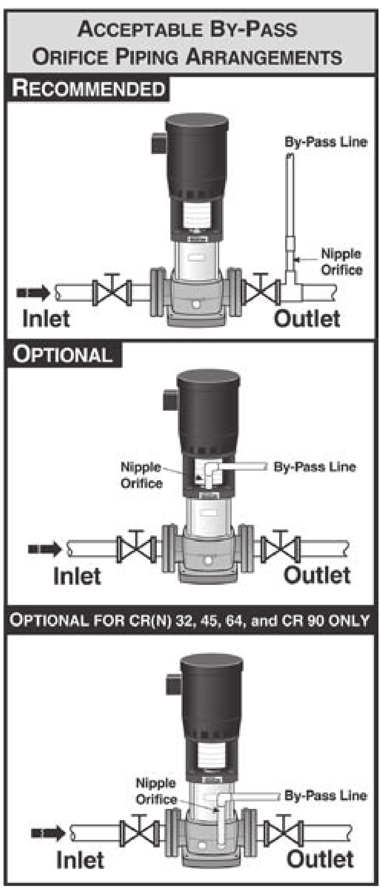


Figure 1-10

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; this height must be adhered to and should never be lowered.

C. General Pump Operation

Discharge piping

Pipe, valves and fittings should be at least the same diameter as the discharge pipe or sized in accordance with good piping practices to reduce excessive fluid velocities and pipe friction losses. Pipe, valves and fittings must have a pressure rating equal to or greater than the maximum system pressure. It is recommended that the discharge piping be pressure checked to at least the maximum pressure the pump is capable of generating or as required by codes or local regulations. Operating pressure of the vessel must also be taken into consideration.

Whenever possible, avoid high pressure loss fittings, such as elbows or branch tees directly on either side of the pump. The piping should be adequately supported to reduce thermal and mechanical stresses on the pump. Good installation practice recommends the system be thoroughly cleaned and flushed of all foreign materials and sediment prior to pump installation. Furthermore, the pump should never be installed at the lowest point of the system due to the natural accumulation of dirt and sediment. If there is excessive sediment or suspended particles present, it is advised a strainer or filter be used. Grundfos recommends that pressure gauges be installed on inlet and discharge flanges or in pipes to check pump and system performance.

Check valves

A check valve may be required on the discharge side of the pump to prevent the pump's inlet pressure from being exceeded. For example, if a pump with no check valve is stopped because there is no demand on the system (all valves are closed), the high system pressure on the discharge side of the pump will "find" its way back to the inlet of the pump. If the system pressure is greater than the pump's maximum inlet pressure rating, the limits of the pump will be exceeded and a check valve needs to be fitted on the discharge side of the pump to prevent this condition.

Bypass

A bypass should be installed in the discharge pipe if there is any possibility the pump may operate against a closed valve in the discharge line. Flow through the pump is required to ensure adequate cooling and lubrication of the pump is maintained. Elbows should be a minimum of 12” from the orifice discharge to prevent erosion.

D. Electrical

All electrical work should be performed by a qualified electrician in accordance with the latest edition of the National Electrical Code, local codes and regulations.

> **⚠ Caution**
>
> The safe operation of this pump requires that it be grounded in accordance with the national electrical code and local governing codes or regulations.

Motor

Grundfos CR pumps are supplied with heavy-duty 2-pole (3600 RPM nominal), ODP or TEFC, NEMA C frame motors selected to rigid specifications.

E. Motor Protection

1. Single-Phase Motors:

With the exception of 10 HP motors which require external protection, single-phase CR pumps are equipped with multi-voltage, squirrel-cage induction motors with built-in thermal protection.

2. Three-Phase Motors

CR pumps with three-phase motors must be used with the proper size and type of motor-starter to ensure the motor is protected against damage from low voltage, phase failure, current imbalance and overloads. A properly sized starter with manual reset and ambient- compensated extra quick trip in all three legs should be used. The overload should be sized and adjusted to the full-load current rating of the motor. Under no circumstances should the overloads be set to a higher value than the full load current shown on the motor nameplate. This will void the warranty. Overloads for auto transformers and resistant starters should be sized in accordance with the recommendations of the manufacturer. Three phase MLE motors require only fuses as a circuit breaker. They do not require a motor starter.NOTE: Standard allowable phase imbalance difference is 5%.

F. Starting the Pump the First Time

Priming

To prime the pump in a closed system or an open system where the water source is above the pump, close the pump isolation valve(s) and open the priming plug on the pump head. See **Figure 1-11**, **Figure 1-12**, and**Figure 1-13**. Gradually open the isolation valve in the suction line until a steady stream of airless water runs out the priming port. Close the plug and securely tighten. Completely open the isolation valves. For pumps with Cool-Top, see **Table 1-4**.

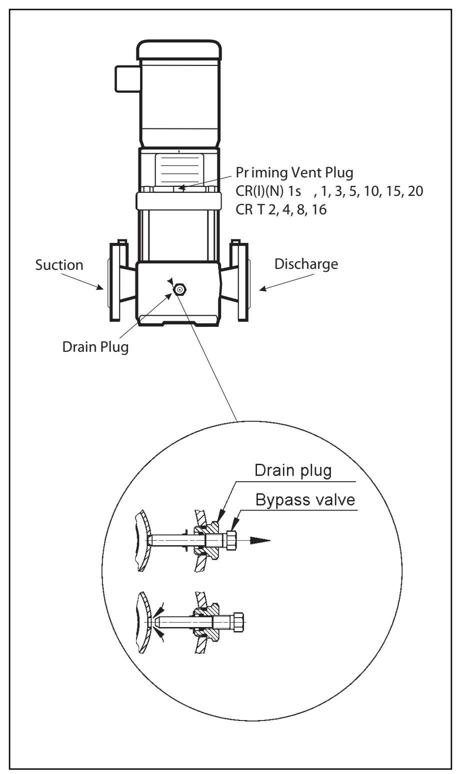


Figure 1-11 Drain Plugs

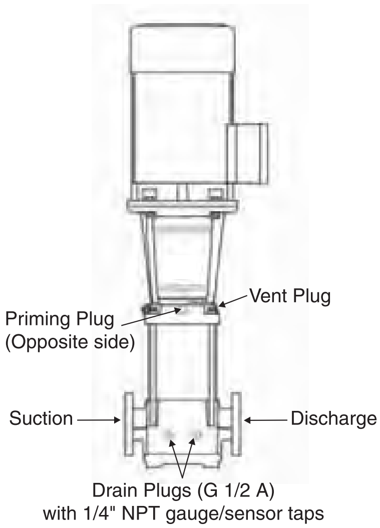


Figure 1-12 Drain Plugs

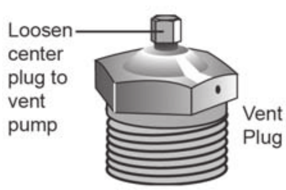


Figure 1-13 Vent Plug

> **⚠Caution**
>
> Motors should not be run unloaded or uncoupled from the pump at any time; damage to the motor bearings will occur.

In open systems where the water level is below the pump inlet, the suction pipe and pump must be filled and vented of air before starting the pump. Close the discharge isolation valve and remove the priming plug. Pour water through the priming hole until the suction pipe and pump are completely filled with water. If the suction pipe does not slope downward from the pump toward the water level, the air must be purged while being filled. Replace the priming plug and securely tighten.

1. Switch power off.
2. Check to make sure the pump has been filled and vented.
3. Remove the coupling guard and rotate the pump shaft by hand to be certain it turns freely.
4. Verify that the electrical connections are in accordance with the wiring diagram on the motor.
5. Switch the power on and observe the direction of rotation. When viewed from the top, the pump should rotate counter-clockwise (clockwise for CRN-SF).
6. To reverse the direction of rotation, first switch OFF the supply power.

7. On three-phase motors, interchange any two power leads at the load side of the starter. On single-phase motors, see connection diagram on nameplate. Change wiring as required.8. Switch on the power and again check for proper motor rotation. Once rotation has been verified, switch off power again. Do not attempt to reinstall the coupling guards with the motor energized. Replace the coupling guard if the rotation is correct. After guards are in place the power can be reapplied.

Note: CR, CRI, CRN 1s to 5: For these pumps, it is advisable to open the bypass valve (**Figure 1-11**) during start-up. The bypass valve connects the suction and discharge sides of the pump, thus making the filling procedure easier. When the operation is stable, the bypass valve must be closed.

REMINDER: Do not start the pump before priming or venting the pump (**Figure 1-13**). Never operate the pump dry.

Operating Parameters

CR multi-stage centrifugal pumps installed in accordance with these instructions and sized for correct performance will operate efficiently and provide years of service. The pumps are water-lubricated and do not require any external lubrication or inspection. The motors may require periodic lubrication as noted in the following Maintenance Section.

Under no circumstances should the pump be operated for any prolonged periods of time without flow through the pump. This can result in motor and pump damage due to overheating. A properly sized relief valve should be installed to allow sufficient water to circulate through the pump to provide adequate cooling and lubrication of the pump bearings and seals.

Pump Cycling

Pump cycling should be checked to ensure the pump is not starting more than: 20 times per hour on 1/3 to 5 HP models

15 times per hour on 7 1/2 to 15 HP models

10 times per hour on 20 to 60 HP models

Rapid cycling is a major cause of premature motor failure due to increased heat build-up in the motor. If necessary, adjust controls to reduce the frequency of starts and stops.

Boiler-feed installations

If the pump is being used as a boiler-feed pump, make sure the pump is capable of supplying sufficient water throughout its entire evaporation and pressure ranges. Where modulating control valves are used, a bypass around the pump must be installed to ensure pump lubrication (see “Minimum Continuous Duty Flow Rates”).

Freeze Protection

If the pump is installed in an area where freezing could occur, the pump and system should be drained during freezing temperatures to avoid damage. To drain the pump, close the isolation valves, remove the priming plug and drain plug at the base of the pump. Do not replace the plugs until the pump is to be used again. Always replace the drain plug with the original or exact replacement. Do not replace with a standard plug. Internal recirculation will occur, reducing the output pressure and flow.

Motor Inspection

Inspect the motor at regular intervals, approximately every 500 hours of operation or every three months, whichever occurs first. Keep the motor clean and the ventilation openings clear. The following steps should be performed at each inspection:

1. Check that the motor is clean. Check that the interior and exterior of the motor is free of dirt, oil, grease, water, etc. Oily vapor, paper, pulp, textile lint, etc. can accumulate and block motor ventilation. If the motor is not properly ventilated, overheating can occur and cause early motor failure.

2. Use an Ohmmeter (“Megger”) periodically to ensure that the integrity of the winding insulation has been maintained. Record the Ohmmeter readings. Immediately investigate any significant drop in insulation resistance.

3. Check all electrical connectors to be sure that they are tight.

⚠ Warning

Do not touch electrical connections before you first ensure that power has been disconnected. Electrical shock can cause serious or fatal injury. Only qualified personnel should attempt installation, operation, and maintenance of this equipment.

Motor Lubrication

Electric motors are pre-lubricated at the factory and do not require additional lubrication at start-up. Motors without external grease fittings have sealed bearings that cannot be re-lubricated. Motors with grease fittings should only be lubricated with approved types of grease. Do not over-grease the bearings. Over greasing will cause increased bearing heat and can result in bearing/motor failure. Do not mix petroleum grease and silicon grease in motor bearings.

Bearing grease will lose its lubricating ability over time, not suddenly. The lubricating ability of a grease (over time) depends primarily on the type of grease, the size of the bearings, the speed at which the bearings operate and the severity of the operating conditions. Good results can be obtained if the following recommendations are used in your maintenance program. It should also be noted that pumps with more stages, pumps running to the left of the performance curve, certain pump ranges may have higher thrust loads. Pumps with high thrust loads should be greased according to the next service interval level.

If pump is fitted with a bearing flange that requires grease, see the stickers on either the bearing flange or coupling guards for proper grease type and greasing schedule.

Motor Lubrication Schedule (for Motors with Grease Nipples)

New motors that have been stored for a year or more should be regreased.

Table 1-2 Motor Lubrication Schedule

NEMA/(IEC) Frame Size	Standard Severe Interval	Severe Service Interval	Extreme Service Interval	Weight of Grease to Add Oz./(Grams)	Volume of Grease to Add In^3/(Teaspoons)
Up through 210 (132)	5500 hrs.	2750 hrs.	550 hrs.	0.30 (8.4)	0.6 (2)
Over 210 through 280 (180)	3600 hrs.	1800 hrs.	360 hrs.	0.61 (17.4)*	1.2 (3.9)*
Over 280 up through 360 (225)	2200 hrs.	1100 hrs.	220 hrs.	0.81 (23.1)*	1.5 (5.2)*
Over 360 (225)	2200 hrs.	1100 hrs.	220 hrs.	2.12 (60.0)*	4.1 (13.4)*

Procedure

⚠ Caution

To avoid damage to motor bearings, grease must be kept free of dirt. For an extremely dirty environment, contact Grundfos, the motor manufacturer or an authorized service center for additional information. Mixing dissimilar grease is not recommended.

1. Clean all grease fittings. If the motor does not have grease fittings, the bearing is sealed and cannot be greased externally.
2. If the motor is equipped with a grease outlet plug, remove it. This will allow the old grease to be displaced by the new grease.
3. If the motor is stopped, add the recommended amount of grease. If the motor is to be greased while running, a slightly greater quantity of grease will have to be added.

Note: If new grease does not appear at the shaft hole or grease outlet plug, the outlet passage may be blocked. At the next service interval the bearings must be repacked. Add grease SLOWLY taking approximately one minute until new grease appears at the shaft hole in the end plate or grease outlet plug. Never add more than 1-1/2 times the amount of grease shown in the lubrication schedule.

4. For motors equipped with a grease outlet plug, let the motor run for 20 minutes before replacing the plug.

G. Preventative Maintenance

At regular intervals depending on the conditions and time of operation, the following checks should be made:

1. Pump meets required performance and is operating smoothly and quietly.
2. There are no leaks, particularly at the shaft seal.
3. The motor is not overheating.
4. Remove and clean all strainers or filters in the system.
5. Verify the tripping of the motor overload protection.
6. Check the operation of all controls. Check unit control cycling twice and adjust, if necessary.
7. If the pump is not operated for unusually long periods, the unit should be maintained in accordance with these instructions. In addition, if the pump is not drained, the pump shaft should be manually rotated or run for short periods of time at monthly intervals.
8. To extend the pump life in severe duty applications, consider performing one of the following actions:
    - Drain the pump after each use.
    - Flush the pump, through system, with water or other fluid that is compatible with the pump materials and process liquid.
    - Disassemble the pump liquid components and thoroughly rinse or wash them with water or other fluid that is compatible with the pump materials and process liquid.

If the pump fails to operate or there is a loss of performance, refer to the Troubleshooting Section (**Table 1-4**).

H. Motor Replacement

If the motor is damaged due to bearing failure, burning or electrical failure, the following instructions detail how to remove the motor for replacement. It must be emphasized that motors used on CR pumps are specifically selected to our rigid specifications.

Replacement motors must be of the same frame size, should be equipped with the same or better bearings and have the same service factor. Failure to follow these recommendations may result in premature motor failure.

Disassembly

1. Turn off and lock out power supply. The power supply wiring can not be safely disconnected from the motor wires.
2. . Remove the coupling guards.

CR 1s, 1, 3, 5, 10, 15, and 20: do not loosen the three shaft seal securing allen screws.

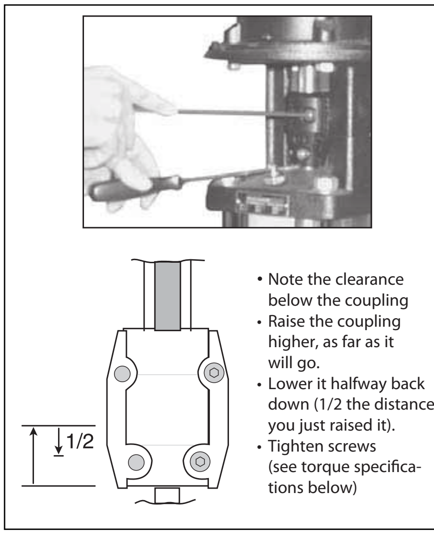


Figure 1-14

Torque Specifications CR(I)(N) 1s, 1, 3, 5, 10, 15, and 20CRT 2, 4, 8, and 16	
Coupling Bolt Size	Min. Torque Specifications
M6	10 ft-lbs.
M8	23 ft-lbs.
M10	46 ft-lbs.

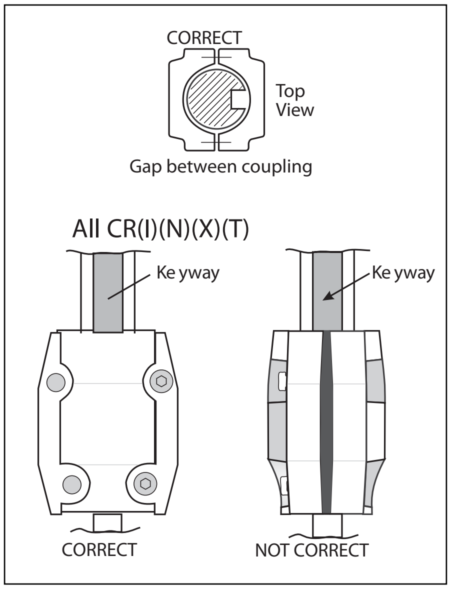


Figure 1-15

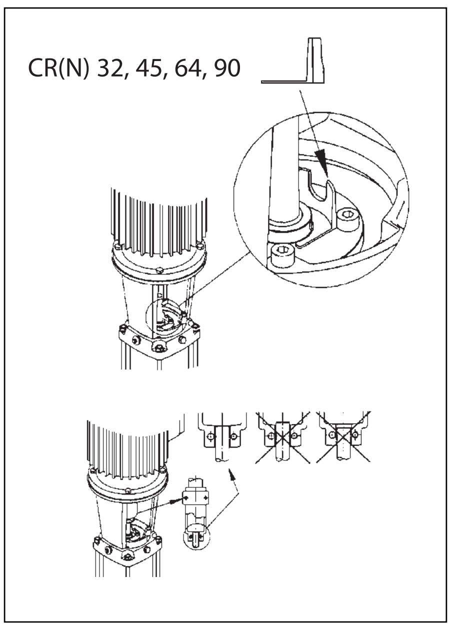


Figure 1-16

3. Using the proper metric Allen wrench, loosen the four cap screws in the coupling. Completely remove coupling halves. On CR1s-CR20, the shaft pin can be left in the pump shaft. CR(N)32, 45, 64 and 90 do not have a shaft pin.
4. With the correct size wrench, loosen and remove the four bolts which hold the motor to the pump end.
5. Lift the motor straight up until the shaft has cleared the motor stool.

Assembly

1. Remove key from motor shaft, if present, and discard.
2. Thoroughly clean the surfaces of the motor and pump end mounting flange. The motor and shaft must be clean of all oil/ grease and other contaminants where the coupling attaches. Set the motor on the pump end.
3. Place the terminal box in the desired position by rotating the motor.
4. Insert the mounting bolts, then diagonally and evenly tighten. For 3/8” bolts (1/2 to 2 HP), torque to 17 ft.-lbs., for 1/2” bolts (3 to 40 HP) torque to 30 ft.-lbs., and for 5/8” bolts (50 - 60 HP) torque to 59 ft.-lbs.
5. CR 1s, 1, 3, and 5:

Insert shaft pin into shaft hole. Reinstall the coupling halves onto shaft and shaft pin. Reinstall the coupling screws and leave loose. Check that the gaps on either side of the coupling are even, and that the motor shaft keyway is centered in the coupling half, as shown in **Figure 1-15**. Tighten the screws to the correct torque.

CR 10, 15 and 20:

Insert shaft pin into shaft hole. Insert plastic shaft seal spacer beneath shaft seal collar. Reinstall the coupling halves onto shaft and shaft pin. Reinstall the coupling screws and leave loose. Check that the gaps on either side of the coupling are even and that the motor shaft key way is centered in the coupling half, as shown in **Figure 1-15**. Tighten the screws to the correct torque. Remove plastic shaft seal spacer and hang it on inside of coupling guard.

CRT 2, 4, 8 and 16:

Reinstall coupling halves. Make sure the shaft pin is located in the pump shaft. Put the cap screws loosely back into the coupling halves. Using a large screwdriver, raise the pump shaft by placing the tip of the screwdriver under the coupling and carefully elevating the coupling to its highest point (**Figure 1-14**). Note: the shaft can only be raised approximately 0.20 inches (5mm). Now lower the shaft half way back down the distance you just raised it and tighten the coupling screws (finger tight) while keeping the coupling separation equal on both sides. When the screws are tight enough to keep the couplings in place, then torque the screws evenly in a criss-cross pattern.

CR(N) 32, 45, 64 & CR90:

Place the plastic adjustment fork under the cartridge seal collar (see **Figure 1-16**).

Fit the coupling on the shaft so that the top of the pump shaft is flush with the bottom of the clearance chamber in the coupling (see **Figure 1-16**).

Lubricate the coupling screws with an anti-seize and lubricating compound. Tighten the coupling screws (finger tight) while keeping the coupling separation equal on both sides and the motor shaft keyway centered in the coupling half as shown in **Figure 1-14**.

When the screws are tight enough to keep the couplings in place, then torque the screws evenly in a crisscross pattern.

Torque coupling screws to 62 ft.-lbs. Remove the adjustment fork from under the cartridge seal collar and replace it to the storage location (see **Figure 1-17**).

6. Check to see that the gaps between the coupling halves are equal. Loosen and readjust, if necessary.
7. Be certain the pump shaft can be rotated by hand. If the shaft cannot be rotated or it binds, disassemble and check for misalignment.
8. Prime the pump.
9. Follow the wiring diagram on the motor label for the correct motor wiring combination which matches your supply voltage. Once this has been confirmed, reconnect the power supply wiring to the motor.
10. Check the direction of rotation, by bump-starting the motor. Rotation must be left to right (counter-clockwise) when looking directly at the coupling.
11. Shut off the power, then re-install the coupling guards. After the coupling guards have been installed the power can be turned back on.

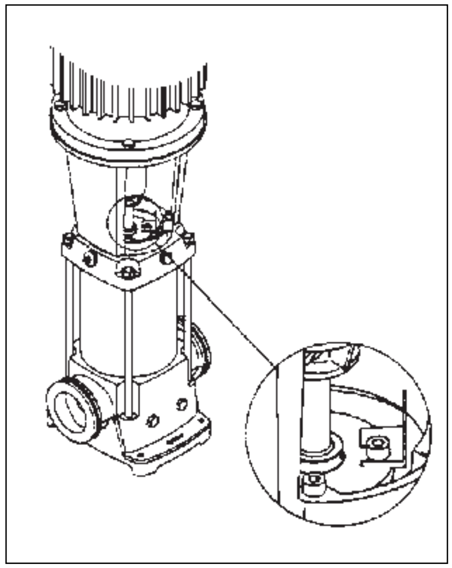


Figure 1-17

> ⚠ **Warning**
>
> When working with electrical circuits, use caution to avoid electrical shock. It is recommended that rubber gloves and boots be worn, and metal terminal boxes and motors are grounded before any work is done. for your protection, always disconnect the pump from its power before handling.

Table 1-3 Preliminary tests

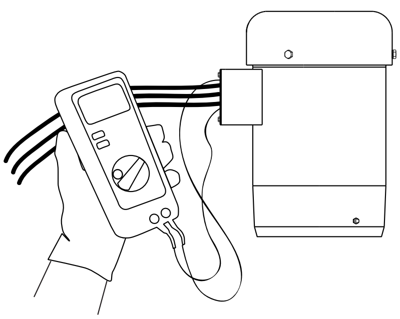
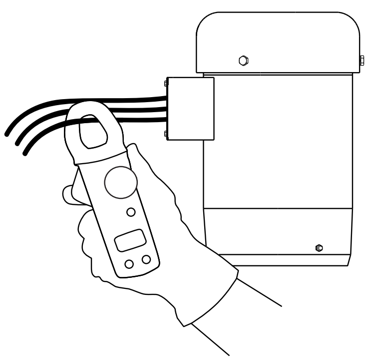
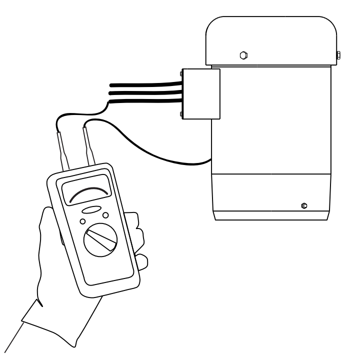
Supply voltage	How to measure	What it means
	Use a voltmeter, (set to the proper scale) measure the voltage at the pump terminal box or starter. On single-phase units, measure between power leads L1 and L2 (or L1 and N for 115 volt units). On three-phase units, measure between: • Power leads L1 and L2 • Power leads L2 and L3 • Power leads L3 and L1	When the motor is under load, the voltage should be within ±10% of the nameplate voltage. Larger voltage variation may cause winding damage. Large variations in the voltage indicate a poor electrical supply and the pump should not be operated until these variations have been corrected. If the voltage constantly remains high or low, the motor should be changed to the correct supply voltage.
Current measurement	**How to Measure**	**What it Means**
	Use an ammeter, (set on the proper scale) to measure the current on each power lead at the terminal box or starter. See the motor nameplate for amp draw information. Current should be measured when the pump is operating at constant discharge pressure.	If the amp draw exceeds the listed service factor amps (SFA) or if the current imbalance is greater than 5% between each leg on three-phase units, check the following: 1. Burned contacts on motor starter. 2. Loose terminals in starter or terminal box or possible wire defect. 3. Too high or too low supply voltage. 4. Motor windings are shorted or grounded. Check winding and insulation resistances. 5. Pump is damaged causing a motor overload.
Insulation Resistance	**How to Measure**	**What it Means**
	Turn off power and disconnect the supply power leads in the pump terminal box. Using an ohm or mega ohm meter, set the scale selector to Rx 100K and zero adjust the meter. Measure and record the resistance between each of the terminals and ground.	Motors of all HP, voltage, phase and cycle duties have the same value of insulation resistance. Resistance values for new motors must exceed 1,000,000 ohms. If they do not, motor should be repaired or replaced.

Table 1-4 Diagnosing specific problems

Problem	Possible cause	Remedy
The pump does not run	1. No power at motor.	Check for voltage at motor terminal box. If no voltage at motor, check feeder panel for tripped circuits and reset circuit.
	2. Fuses are blown or circuit breakers are tripped.	Turn off power and remove fuses. Check for continuity with ohmmeter. Replace blown fuses or reset circuit breaker. If new fuses blow or circuit breaker trips, the electrical installation, motor and wires must be checked.
	3. Motor starter overloads are burned or have tripped out.	Check for voltage on line and load side of starter. Replace burned heaters or reset. Inspect starter for other damage. If heater trips again, check the supply voltage and starter holding coil.
	4. Starter does not energize.	Energize control circuit and check for voltage at the holding coil. If no voltage, check control circuit fuses. If voltage, check holding coil for shorts. Replace bad coil.
	5. Defective controls.	Check all safety and pressure switches for operation. Inspect contacts in control devices. Replace worn or defective parts or controls.
	6. Motor is defective.	Turn off power and disconnect wiring. Measure the lead to lead resistances with ohmmeter (RX-1). Measure lead to ground values with ohmmeter (RX-100K). Record measured values. If an open or grounded winding is found, remove motor and repair or replace.
	7. Defective capacitor. (Single-phase motors)	Turn off power and discharge capacitor. Check with ohmmeter (RX-100K). When the meter is connected to the capacitor, the needle should jump towards 0 ohms and slowly drift back to infinity. Replace if defective.
	8. Pump is bound.	Turn off power and manually rotate pump shaft. If shaft does not rotate easily, check coupling setting and adjust as necessary. If shaft rotation is still tight, remove pump and inspect. Disassemble and repair.
The pump runs but at reduced capacity or does not deliver water	1. Wrong rotation	Check wiring for proper connections. Correct wiring.
	2. Pump is not primed or is airbound.	Turn pump off, close isolation valve(s), remove priming plug. Check fluid level. Refill the pump, replace plug and start the pump. Long suction lines must be filled before starting the pump.
	3. Strainers, check or foot valves are clogged.	Remove strainer, screen or valve and inspect. Clean and replace. Reprime pump.
	4. Suction lift too large.	Install compound pressure gauge at the suction side of the pump. Start pump and compare reading to performance data. Reduce suction lift by lowering pump, increase suction line size or removing high friction loss devices.
	5. Suction and/or discharge piping leaks.	Pump runs backwards when turned off. Air in suction pipe. Suction pipe, valves and fittings must be airtight. Repair any leaks and retighten all loose fittings.
	6. Pump worn.	Install pressure gauge, start pump, gradually close the discharge valve and read pressure at shutoff. Convert measured pressure (in PSI) to head (in feet): (Measured PSI x 2.31 ft./PSI = _____ ft.). Refer to the specific pump curve for shutoff head for that pump model. If head is close to curve, pump is probably OK. If not, remove pump and inspect.
	7. Pump impeller or guide vane is clogged.	Disassemble and inspect pump passageways. Remove any foreign materials found.
The pump runs but at reduced capacity or does not deliver water	8. Incorrect drain plug installed.	If the proper drain plug is replaced with a standard plug, water will recirculate internally. Replace with proper plug.
	9. Improper coupling setting.	Check/reset the coupling.

Pump cycles too much	1. Pressure switch is not properly adjusted or is defective. 2. Level control is not properly set or is defective. 3. Insufficient air charging or leaking tank or piping. 4. Tank is too small. 5. Pump is oversized.	Check pressure setting on switch and operation. Check voltage across closed contacts. Readjust switch or replace if defective. Check setting and operation. Readjust setting (refer to level control manufacturer's data). Replace if defective. Pump air into tank or diaphragm chamber. Check diaphragm for leak. Check tank and piping for leaks with soap and water solution. Check air to water volume. Repair as necessary. Check tank size and air volume in tank. Tank volume should be approximately 10 gallons for each gpm of pump capacity. The normal air volume is 2/3 of the total tank volume at the pump cut-in pressure. Replace tank with one of correct size. Install pressure gauges on or near pump suction and discharge ports. Start and run pump under normal conditions, record gauge readings. Convert PSI to feet (Measured PSI x 2.31 ft./PSI = _______ ft.) Refer to the specific pump curve for that model, ensure that total head is sufficient to limit pump delivery within its design flow range. Throttle pump discharge flow if necessary.
Fuses blow or circuit breakers or overload relays trip	1. Low voltage. 2. Motor overloads are set too low. 3. Three-phase current is imbalanced. 4. Motor is shorted or grounded. 5. Wiring or connections are faulty. 6. Pump is bound. 7. Defective capacitor (single-phase motors). 8. Motor overloads at higher ambient temperature than motor.	Check voltage at starter panel and motor. If voltage varies more than ±10%, contact power company. Check wire sizing. Cycle pump and measure amperage. Increase heater size or adjust trip setting to a maximum of motor nameplate (full load) current. Check current draw on each lead to the motor. Must be within ±5%. If not, check motor and wiring. Rotating all leads may eliminate this problem. Turn off power and disconnect wiring. Measure the lead-to-lead resistance with an ohmmeter (RX-1). Measure lead-to-ground values with an ohmmeter (RX-100K) or a megaohm meter. Record values. If an open or grounded winding is found, remove the motor, repair and/or replace. Check proper wiring and loose terminals. Tighten loose terminals. Replace damaged wire. Turn off power and manually rotate pump shaft. If shaft does not rotate easily, check coupling setting and adjust as necessary. If shaft rotation is still tight, remove pump and inspect. Disassemble and repair. Turn off power and discharge capacitor. Check with ohmmeter (RX-100K). When the meter is connected to the capacitor, the needle should jump towards 0 ohms and slowly drift back to infinity. Replace if defective. Use a thermometer to check the ambient temperature near the overloads and motor. Record these values. If ambient temperature at motor is lower than at overloads, especially where temperature at overloads is above +104×F (+40×C), ambient-compensated heaters should replace standard heaters.

I. High Water Alarm
Series 63 McDonnell & Miller Maintenance Instructions

Warning

To prevent electrical shock, turn off the electrical power before making electrical connections.

This low water cut-off must be installed in series with all other limit and operating controls installed on the deaerator. After installation, check for proper operation of all of the limit and operating controls, before leaving the site.

Failure to follow this warning could cause electrical shock, an explosion and/or a fire, which could result in property damage, personal injury or death.

Electrical Wiring

TOOLS NEEDED: One (1) flathead screwdriver.

Cover Removal and Installation Procedure

Using a flathead screwdriver, remove the one

(1) screw that secures the switch cover.

Place the cover on the switch housing and, using a flathead screwdriver, tighten the one

(1) screw to approximately 2 ft-lb. (2.6 Nm).

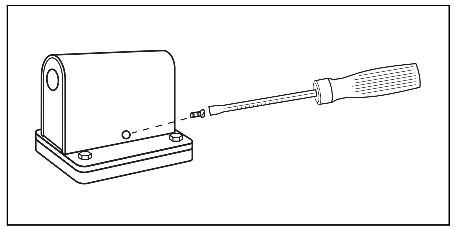


Figure 1-18 Cover Removal

a. The No. 2 switch can be positioned with the conduit opening facing toward or away from the float chamber. These are the only positions in which the switch will function properly.

See drawing at right.

b. On initial fill-up, push the 2M manual reset button after the proper water level is reached to energize the burner. If a low water condition occurs and the water level has been restored, push the reset button to energize the burner.

c. Follow the wiring diagrams below to wire the No. 2 Switch. Terminals C and NC are the low water cut-off switch. Terminals C and NO are alarm switch. If the electrical load exceeds the rating of the switch, use an auxiliary relay or motor starter.

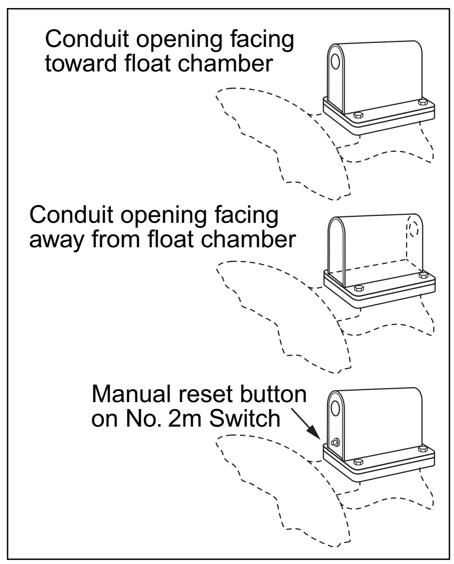


Figure 1-19

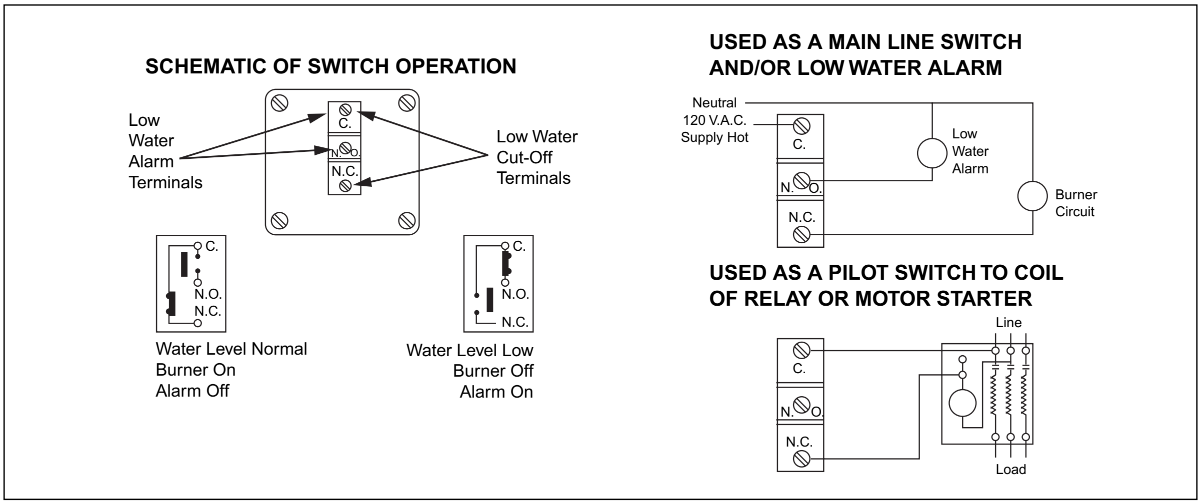


Figure 1-20

Testing

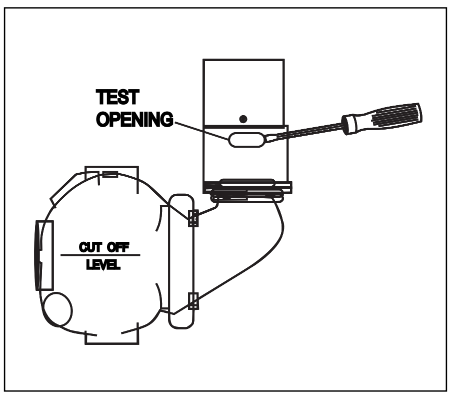


Figure 1-21 MM 63 Testing

Control can be tested on a deaerator by gently inserting a screwdriver or similar tool in the test opening below the switch (see drawing) and lifting linkage to cause float to drop, thereby simulating a low water condition.

Troubleshooting

Table 1-5 Problem:

1. Burner does not shut off on low water.	
a. **Cause:** Float chamber is loaded with mud or sediment.	b. **Cause:** Contacts are fused together. **Test:** Remove switch and operate manually to verify proper switch operation.
Test: With water level below the control check if terminals C and N.C. are open. If not, remove switch and manually test if terminals C and N.C. can be opened.	**Solution:** Replace switch. Check electrical load and make sure it is within the ratings of the switch.
Solution: Open float chamber and clean. At this time, check for a build-up of scale or sediment between corrugations of the bellows.	

Maintenance Schedule:

- blowdown control as follows when the deaerator is in operation:

Steam:

- Daily if operating pressure is above 15 psi.
- Weekly if operating pressure is below 15 psi.

Hot Water:

- Quarterly
- **Disassemble and inspect annually. Replace the low water cut-off if it is worn, corroded, or if components no longer operate properly.**
- **Inspect the float chamber and equalizing piping annually. Remove all sediment and debris.**
- **Replace head mechanism every 5 years.** More frequent replacement may be required when severe conditions exist such as rapid switch cycling, surging water levels, and use of water treatment chemicals.
- **We recommend head mechanism replacement when the switch(es) no longer operate properly.** If you choose to replace the switch(es), order the proper McDonnell & Miller replacement switch or switch assembly and follow the Repair Procedure provided.

Note: More frequent blowdown may be necessary due to dirty water and/or local codes.

PROCEDURE:

1. blowdown the low water cut-off when the water level is at its normal level and the burner is on. **Slowly** open the blowdown valve until it is fully open and observe the water level fall in the gauge glass. Close the valve after verifying that the pump contacts have closed and the burner shuts off. If this does not happen, immediately shut off the deaerator and correct the problem.

⚠ Caution

To prevent serious personal injury from steam pipe blowdown, connect a drain pipe to the control opening to avoid exposure to steam discharge. Failure to follow this caution could cause personal injury.

J. Low Water Alarm and Low Water Cutout

Series 64 McDonnell & Miller Maintenance Instructions

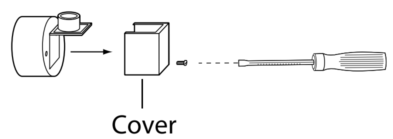


Figure 1-22 Electrical Cover

Warning

To prevent electrical shock, turn off the electrical power before making electrical connections. Failure to follow this warning could cause electrical shock, an explosion and/or a fire, which could result in property damage, personal injury or death.

Cover

Using a flathead screwdriver, remove the one (1) screw that secures the switch cover.

Switch Operation

The No. 11 switch can be identified by a black terminal panel. The switch contains two (2) single pole single throw switches to control the water feeder and the low water cut-off. The low water cut-off switch is between terminals marked ì1î and ì2î. A second switch is located between terminals marked ì3î and ì4î.

This can be used to operate a low water alarm or a McDonnell & Miller electric water feeder.

NOTE: Connect hot wire to terminal marked (2) ahead of all controls. See **Figure 1-24** for control operation. See **Figure 1-26**-**Figure 1-28** for proper application wiring.

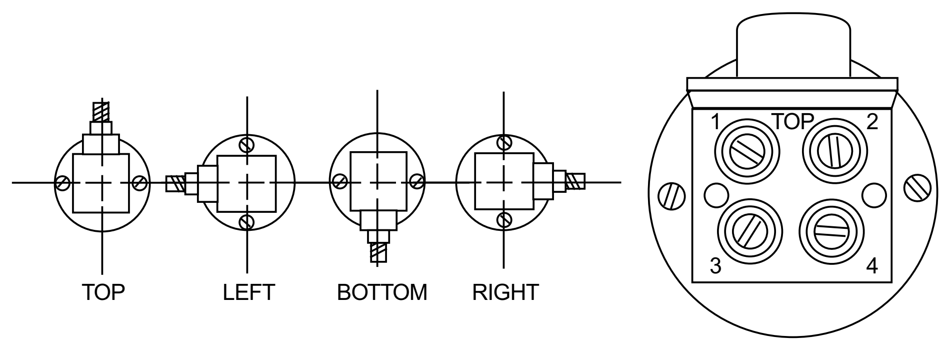


Figure 1-23 Switch Orientation

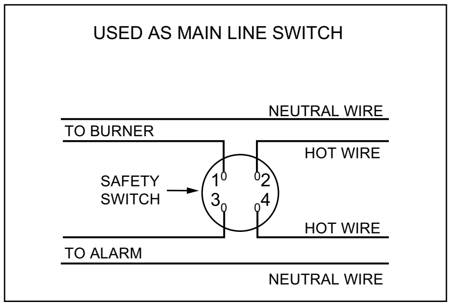


Figure 1-25

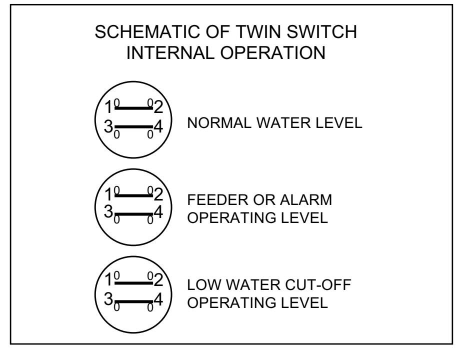


Figure 1-24

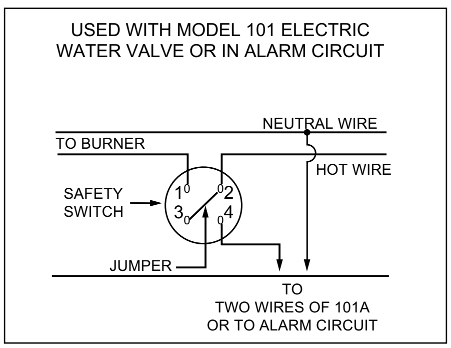


Figure 1-27

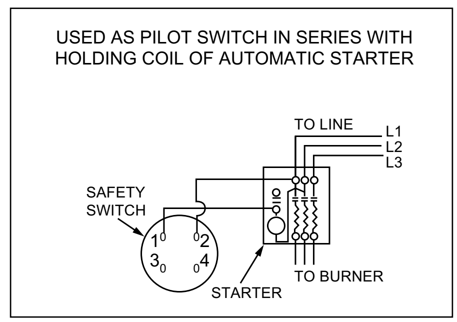


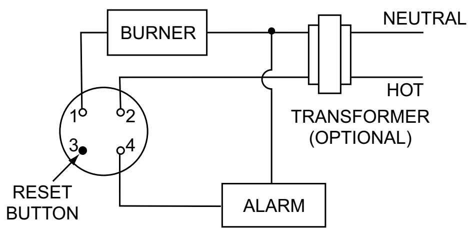
Figure 1-26

Model 64A-M For use on 24 or 120 VAC systems requiring manual reset on low water cut-off.

⚠ CAUTION

Do not electrically connect water feeder to Model 64A-M. This model includes a manual reset feature, failure to follow this caution could result in boiler flooding and property damage.

WIRING SCHEMATIC



SWITCH SCHEMATIC

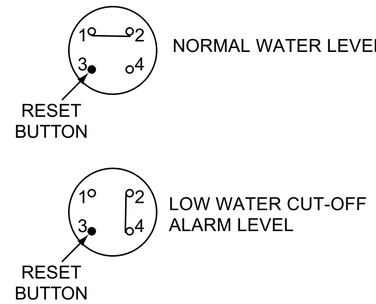


Figure 1-28

Place the cover on the switch housing and, using a flathead screwdriver, tighten the one (1) screw to approximately 2 ft•lb (2.6 N•m).

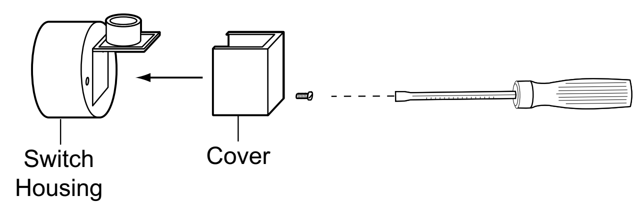


Figure 1-29 Replace Cover

Maintenance Schedule:

- blowdown weekly during heating season.
- Open up float chamber and clean annually.

More frequent cleaning may be necessary if there are high make-up water requirements or poor local water quality.

Replace control every 10 years.

Troubleshooting

Problem:

1. Burner does not shut off on low water.

a. **Cause:** Float chamber is loaded with mud or sediment.

Test: With water level below the control check if terminals 1 and 2 are open. If not, remove switch and manually test if terminals 1 and 2 can be opened.

Solution: Open float chamber and clean. At this time, check for a build-up of scale or sediment between corrugations of the bellows.

b. **Cause:** Contacts are fused together.

Test: Remove switch and operate manually to verify proper switch operation.

Solution: Replace switch. Check electrical load and make sure it is within the ratings of the switch.

2. Electric water feeder does not shut off.

a. **Cause:** Build-up of scale or sediment between corrugations of the bellows.

Test: With water level above the control, check if terminals 3 and 4 are open. If not, remove switch and manually test to verify terminals 3 and 4 can be opened.

Solution: Open float chamber and replace or clean the bellows.

b. **Cause:** Contacts are fused together.

Test: Remove switch and operate manually to verify proper switch operation.

Solution: Replace switch. Check electrical load and make sure it is within the ratings of the switch.

K. Water Level Control

Series 93/193 McDonnell & Miller Low Water Cut-Off/ Pump Controller

Wiring Diagrams

Note: The following diagrams are provided for reference only. If available, manufacturers wiring diagrams should always be followed to connect the device being operated.

Caution

To prevent electrical shock, turn off the electrical power before making electrical connections.Failure to follow this warning could cause electrical shock, an explosion and/or a fire, which could result inproperty damage, personal injury or death.

Red switch terminals 1 and 2 are for burner circuit contacts, terminals 3 and 4 are for the low level alarm circuit contacts.

Blue switch terminals 3 and 4 are for feeder/pump control contacts, terminals 1 and 2 are for high level alarm circuit contacts.

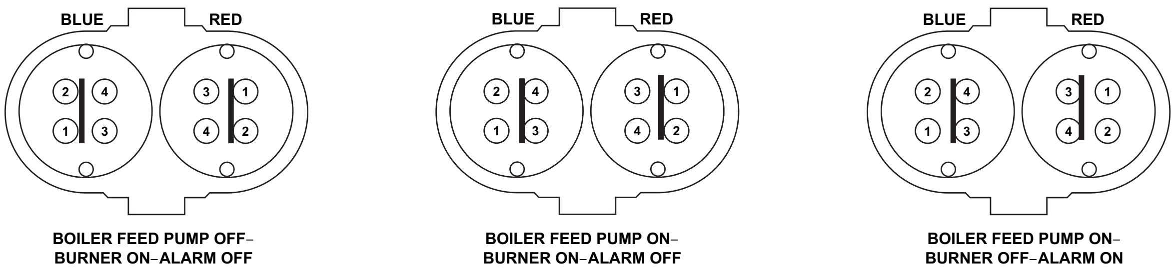


Figure 1-30

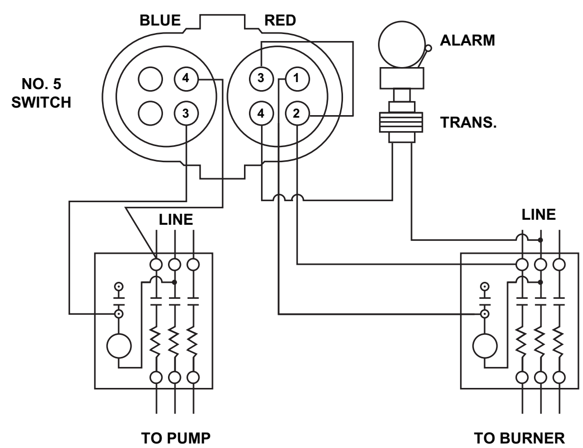


Figure 1-31

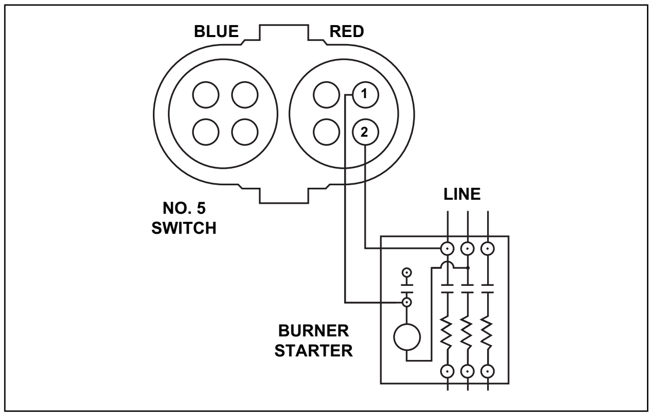


Figure 1-32 Low Water Cut-Off Only

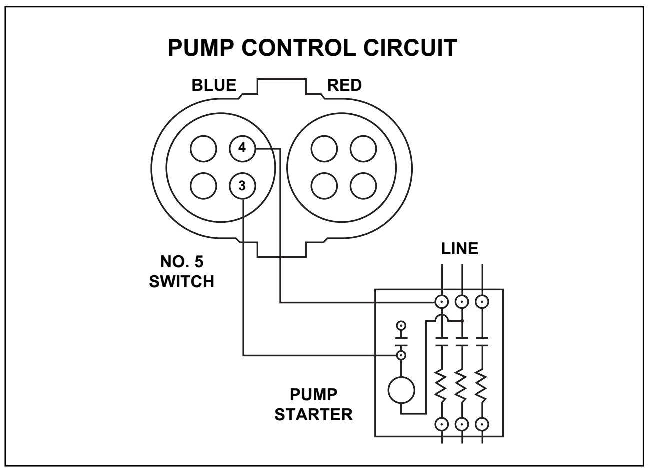


Figure 1-33 Pump Control Only

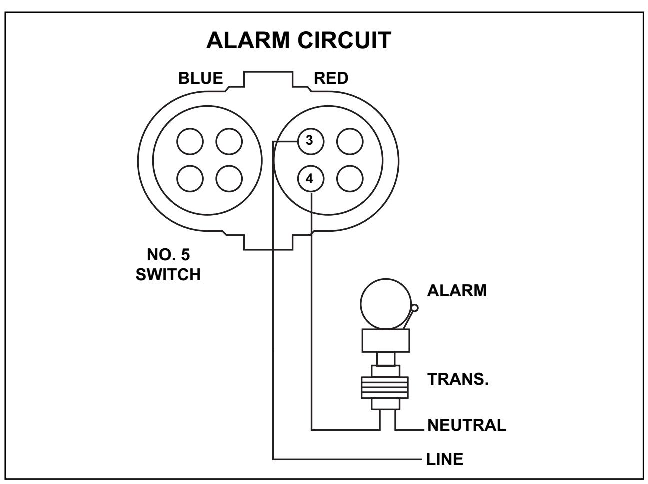
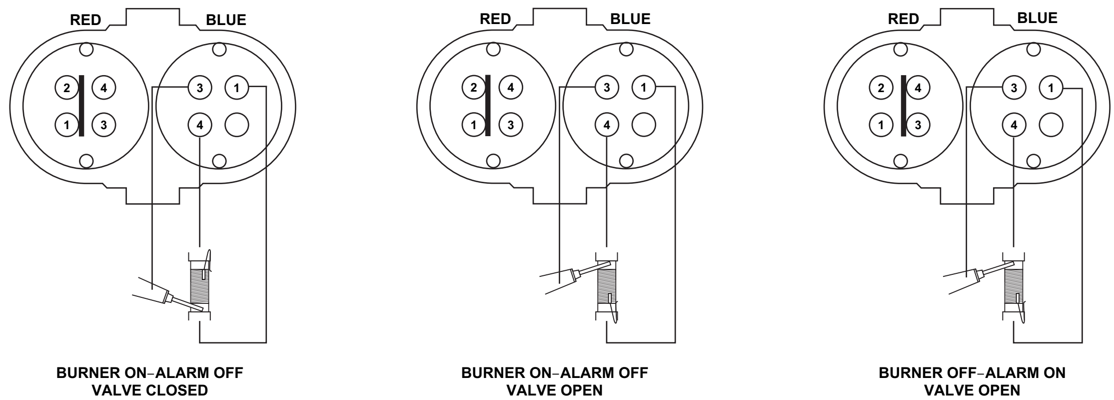


Figure 1-34 Low Water Alarm Only

Red terminals 3 and 4 are the burner circuit contacts, terminals 1 and 2 are the low level alarm circuit contacts.

Blue terminal 3 is the common contact, terminals 1 and 4 are the output contacts.



NOTE: The 7B switch is a 135 ohm potentiometer slide wire control for use with an electric valve operator with the same rating.

Figure 1-35 Series 93/193 or 94/194 with 7B or 7B-M

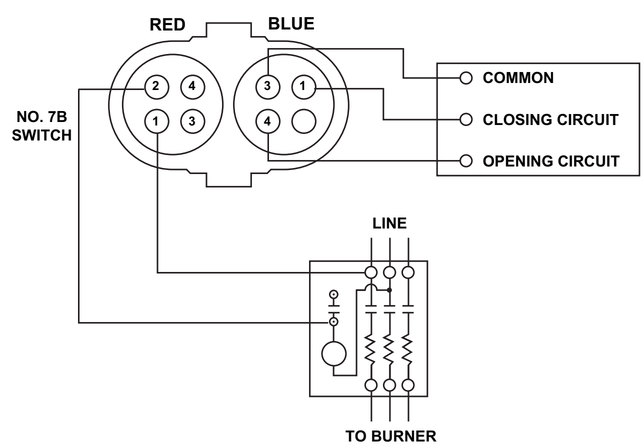


Figure 1-36 Proportional Control, Low Water Cut-Off and Alarm

Maintenance Schedule:

- **blowdown daily when the deaerator is in operation.** Control should be blown down daily to flush accumulation of sediment from float chamber and verify operation of switches.
- **Remove head assembly and inspect waterside components annually.** Replace head assembly if any of the internal components are worn, corroded or damaged or if control no longer operates properly.
- **Inspect the float chamber and equalizing piping annually.** Remove all sediment and debris.
- **Replace head mechanism every 5 years.** More frequent replacement may be required when severe conditions exist such as rapid switch cycling, surging water levels, and use of water treatment chemicals.
- **Replace unit every 15 years.** More frequent replacement may be required when severe conditions exist.

Procedure:

blowdown the control when the water level is at its normal position and the burner is on. **Slowly** open the blowdown valve until it is fully open and observe the water level fall in the gauge glass. Close the valve after verifying that the pump contacts have closed and the burner shuts off. If the pump does not turn on and burner turn off when water level is lower, immediately shut off power to the pump and deaerator and correct the problem.

⚠ Caution

To prevent serious personal injury from steam pipe blowdown, connect a drain pipe to the control opening to avoid exposure to steam discharge. Failure to follow this caution could cause personal injury.

Troubleshooting

Erratic operation of the control is the most common symptom that occurs. Erratic operation can be defined as pump and/or burner switches not switching at proper levels. Refer to the following list of items to check if the control is not operating properly.

1. Float Ball is Crushed

Crushed floats are typically caused by improper blowdown. Drain piping from blowdown valve to drain should be checked for proper pitch and the blowdown procedure followed when blowing down the control. Purchase and install a new float ball after investigating and correcting the problem.

2. Float Ball is Filled with Water

The seam weld on the float can sometimes deteriorate. This can be caused by the type of chemical treatment used in the deaerator. While this is a rare occurrence, the chemical treatment supplier should be consulted to determine if a reaction could occur. Purchase and install a new float ball after investigating and correcting the problem.

3. Float Arm Springs are Bent

The pivot springs located on either side of the float rod should be flat and straight. If they become bent, the usual cause is mishandling of the unit during installation or improper blowdown. The control should never be picked up by the float ball or allowed to hang from the bowl by the float. Drain piping from blowdown valve to drain should be checked for proper pitch and the blowdown procedure followed when blowing down control. Purchase and install new control or head mechanism after investigating and correcting the problem.

4. Switch Contact Springs Broken

The contact springs can break if the electrical rating is exceeded. Purchase and install new switch assembly or head mechanism after investigating and correcting the problem.

5. Switch Contact Springs Misaligned

Misalignment of the contact arms is usually associated with damage to the control during shipment or installation. Purchase and install new switch assembly or head mechanism after investigating and correcting the problem.

6. Internal (Wetted) Parts Dirty

The internal parts can operate improperly if dirt, scale or rust is allowed to build. This condition can be a result of not blowing down the control as recommended and/or improper boiler water chemical treatment. Purchase and install new control or head mechanism after investigating and correcting the problem.

L. 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.

Notice

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.*

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.

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.

Be sure that the orifice vent valve supplied with the unit is installed.

M.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. 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.

When throttling is necessary, an initial adjustment made when the deaerator is 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 deaerator 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 will 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.

N. 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.

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 that the valve seat is held in the proper position

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.

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	

O. OVERFLOW TRAP

Deaerators, tanks with steam blankets, produce additional liquid as the steam condenses. The 313 Overflow Trap traps and relieves this condensate and overflow without the steam blanket escaping. Buoyancy of its float ball provides force to operate internal valve assembly to relieve condensate and overflow to drain. Features steel chamber, brass/bronze internal valve, 316 stainless steel float ball. Sizes 1” through 2” with NPT connections, and 3î through 6î with 150FLG Large end cover provides easy access to internal valve assembly.

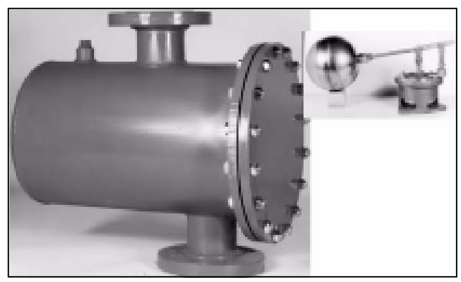


Figure 1-37 Warren Controls 313 Overflow Trap

Operation

As condensate/overflow enters the overflow trap the level of the liquid in the float chamber increases. For small amounts of liquid the float ball lifts the pilot assembly away from the piston disc and the liquid is relieved through the hole in the center of the piston disc. For large volumes of liquid the piston disc lifts off its seat in the valve body. The liquid then passes under the piston disc to the drain.

Installation

The overflow trap should be installed in an upright position.

Maintenance

The inlet and outlet of the overflow trap must be kept unblocked. The internal valve assembly must be kept free of debris, deposits, and dirt. The internal valve assembly should move freely.

Section 2

Pressure Regulator Installation and Operation

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Pressure Regulator Installation and Operation

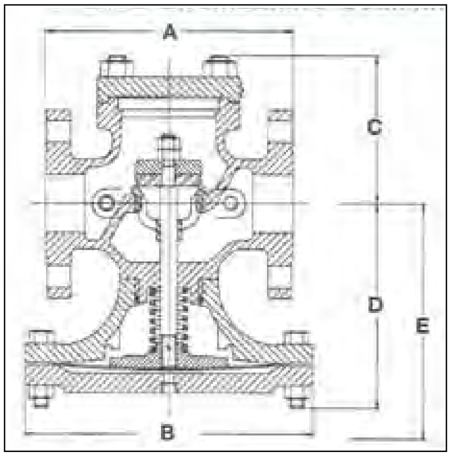


Figure 2-1 Type E Main Valve

A. Type E Main Valve

The Type E Main Valve is of normally closed, single seat design featuring packless construction, balanced metal diaphragms and protected main spring.

CAST IRON RATINGS (Maximum Inlet Conditions)

Valve Ends Pressure (Temperature)

- ANSI NPT Screwed............250 PSIG.................(450×F)
- ANSI 125 Flanged...............125 PSIG.................(450×F)
- ANSI 250 Flanged...............250 PSIG.................(450×F)

CAST STEEL RATINGS (Maximum Inlet Conditions)

Valve Ends Pressure (Temperature)

- ANSI NPT Screwed............300 PSIG.................(600×F)ü
- ANSI 150 Flanged..........150 PSIG..............(600×F)
- ANSI 300 Flanged...............300 PSIG.................(600×F)ü
- ANSI 600 Flanged...............600 PSIG.................(600×F)ü

DIMENSIONS (inches) **AND WEIGHTS** (pounds)

SIZE	FACE TO FACE DIMENSIONS A ANSI NPT	A ANSI 125,150	A ANSI 250	A ANSI 300	A ANSI 600	OTHER DIMENSIONS B	C	C ANSI 600	D	E	APPROX. WT. ANSI NPT	ANSI 125	ANSI 150	ANSI 250	ANSI 300	ANSI 600
⅜	4¾	—	—	—	—	5⅛	2⅝	—	5½	7⅜	14	—	—	—	—	—
½	4¾	—	—	—	6	5⅛	2⅝	2¾	5½	7⅝	14	—	—	—	—	20
¾	4¾	—	—	—	6⅜	5⅛	2⅞	3⅛	5½	7⅛	18	—	—	—	—	28
1	5⅜	5½	6	6½	6¼	7	3⅜	4¼	6½	8⅜	23	24	26	27	31	32
1¼	6½	6¾	7¼	7⅝	7¼	7⅛	4⅛	4⅜	6½	9⅛	33	36	37	40	41	45
1½	7¼	6⅞	7⅜	8	8	8⅜	4⅜	5⅛	7⅛	9⅜	43	45	47	51	55	58
2	7½	8½	9	10¼	10¼	9⅛	5⅛	5⅜	7⅜	11¼	62	67	73	72	78	83
2½	—	9⅜	10	11½	11¼	10⅝	5⅜	7½	8⅝	12¼	—	92	95	100	100	130
3	—	10	10¾	12¼	12¼	11¾	6⅜	9⅛	9¼	14⅜	—	110	125	130	140	175
4	—	11½	12½	12½	14½	14¾	7⅜	10⅜	11⅛	18½	—	200	210	235	230	310
5	—	13⅜	14½	14½	16½	16⅝	8¼	12½	12⅛	20⅜	—	260	255	315	310	490
6	—	15¼	16	16	17⅜	19⅝	10	13⅜	14⅛	22⅝	—	385	425	455	470	655
8	—	19	20	20	21⅝	22½	11½	15⅜	17¼	27⅜	—	657	700	735	710	1070
10	—	23⅜	25	25	—	28	13⅜	—	23⅜	36¼	—	1260	1240	1430	1300	—
12	—	26½	28	28	—	30	15¼	—	25⅜	41½	—	2070	2060	2145	2140	—

RATED FLOW COEFFICIENTS (Cv)

SEAT FACTOR	REGULATOR SIZE ⅜	½	¾	1	1¼	1½	2	2½	3	4	5	6	8	10	12
Full	1.5	2.8	5.4	8.8	14.1	19.8	31	44	74	109	165	248	444	706	1113
Full 75 %	—	2.1	4.0	6.6	10.6	14.8	23.3	33	56	82	177	186	333	530	835
Full 50 %	—	1.4	2.7	4.4	7.0	9.9	15.5	22	37	55	86	124	222	353	557
Normal	.66	1.5	4.8	7.5	10.4	14.6	17.6	24	43	78	115	161	249	377	631
Normal 75 %	—	—	—	—	—	—	—	19	33	58	87	114	187	283	474
Normal 50 %	—	—	—	—	—	—	—	12	22	35	58	78	125	189	316

Figure 2-2 Dimensions and Weights

Operating Principle

The regulator is operated by initial steam or fluid pressure. It is normally closed, being held so by initial pressure on the disc and by an internal main spring. When the pilot is opened (see pilot instructions), initial pressure flows through the pilot to the 8B tee. Bleedport 4A restricts the flow and pressure builds under the diaphragm and opens the main valve. The 5A steadies the operation of the regulator.

Delivery pressure feeds back through the control pipe to the pilot diaphragm. As this pressure approaches a balance with the thrust of the adjusting spring, the pilot throttles the loading pressure. In turn, the main valve takes a position established by the loading pressure where just enough steam flows to maintain the set delivery pressure.

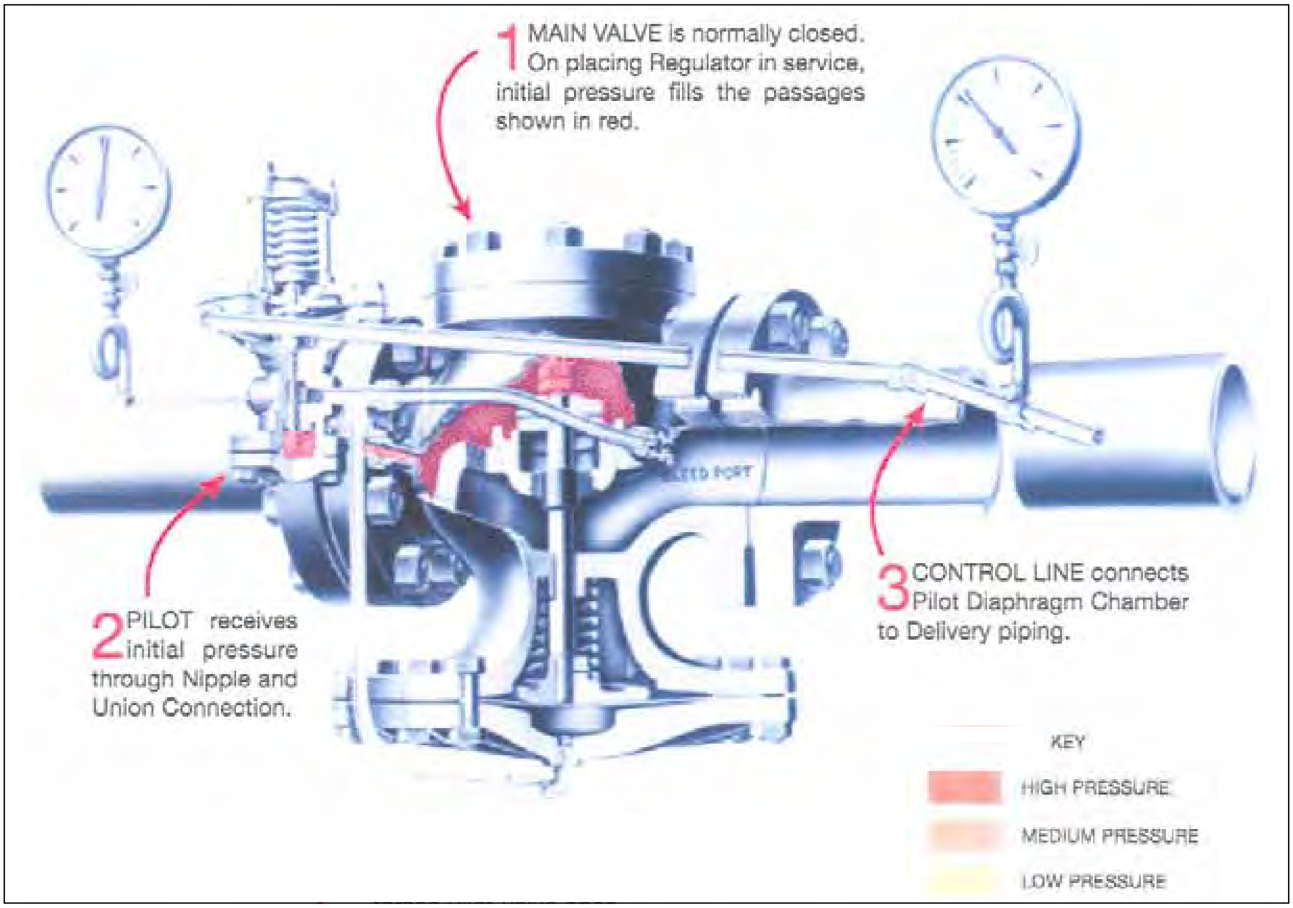


Figure 2-3 The Operating Cycle of a Spence Pressure Regulator

Figure 2-3and 2-4 illustrate the operation of a SPENCE Pilot Operated Regulator describing the successive steps in the mechanical cycle of the Regulator.

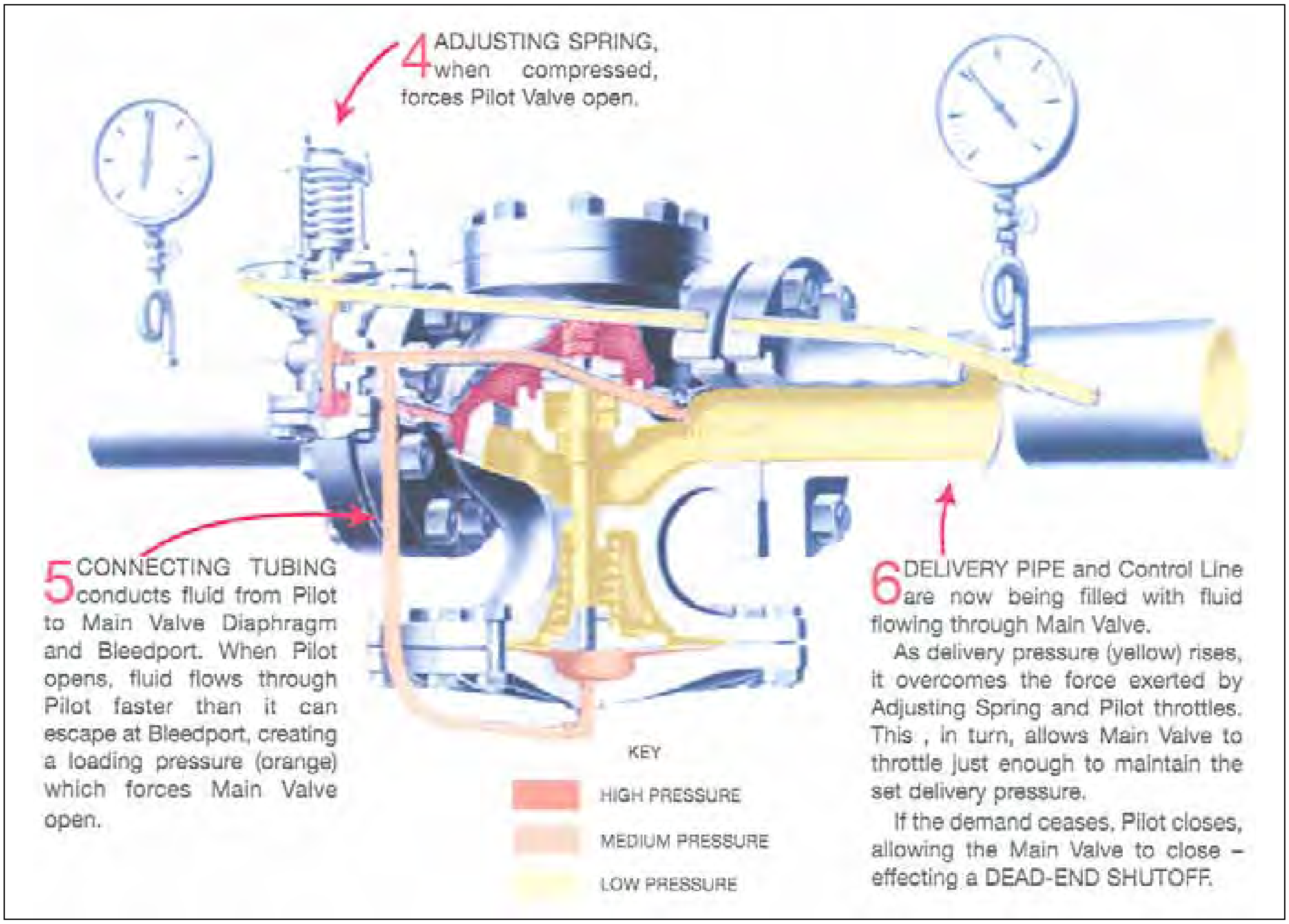


Figure 2-4 The Operating Cycle of a Spence Pressure Regulator

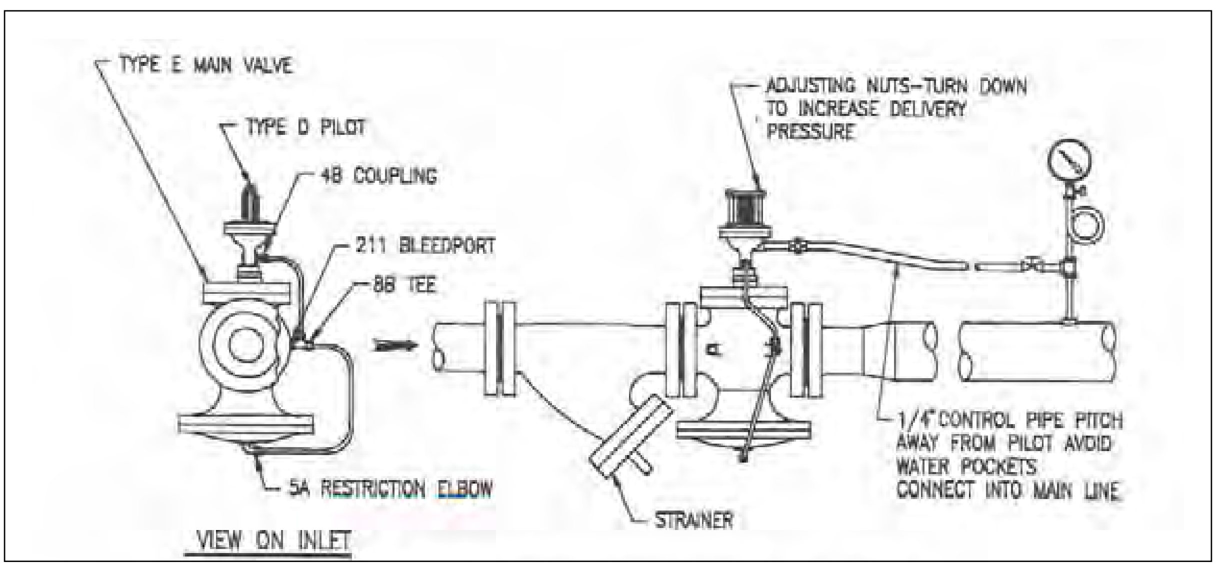


Figure 2-5 Installation of Integrally Mounted Pilot

B. Installation

1. Planning

Locate the valve in a straight run of horizontal pipe. Allow headroom above the valve for access through the blind flange.

Provide clearance for stem withdrawal underneath. Prevent water hammer and erratic operation by installing traps to provide proper drainage before and after the valve and before secondary PRV or control valve. Avoid damaging effects of scale and dirt in pipe lines by using a strainer. Provide a 3-valve by-pass to facilitate inspection without interrupting service.

To eliminate excessive noise and erratic regulation with steam and other compressible fluids, enlarge the delivery pipe size to effect a reasonable flow velocity at the reduced pressure. A tapered transition is recommended. If possible, avoid a sharp turn close to the regulator outlet and a bull-headed tee connection to the low pressure main.

Install initial and delivery pressure gages to indicate performance. If the pressure rating of the delivery system or connected equipment is less than the initial steam pressure, provide a safety valve.

2. Main Valve

Flush the piping system thoroughly to clear it of welding beads, scale, sand, etc. Mount the main valve with diaphragm chamber down and arrow on body pointing in the direction of flow.

Screwed end valves should be mounted in unions.

3. Pilot

Mount the pilot on either side of the main valve by means of 1/4" nipple and union provided. Make this connection the the 1/4" pipe tap at the inlet of the main valve. Screw No. 4A bleedport fitting into the 1/8" pipe tap at the outlet of the main valve body. Note bleed orifice in this fitting - vital to operation of regulator.

Screw No. 8B tee into 1/8" pipe tap in pilot. Select tap facing downstream.

Screw No. 5A elbow containing restriction orifice into 1/8" pipe tap on underside of main valve diaphragm chamber. If the initial pressure or pressure drop is less than 15 psi, a No. 5B open elbow is used.

Connect tubing bends and any condensation chamber fittings.

4. Control Pipe (if required)

Use 1/4" pipe for this line which connects the pilot diaphragm chamber to the desired point of pressure control. Take the control at a point of minimum turbulence. Avoid control immediately at the valve outlet or after a turn. When the delivery pipe expands in size, select a spot at least 4 pipe diameters beyond the point of

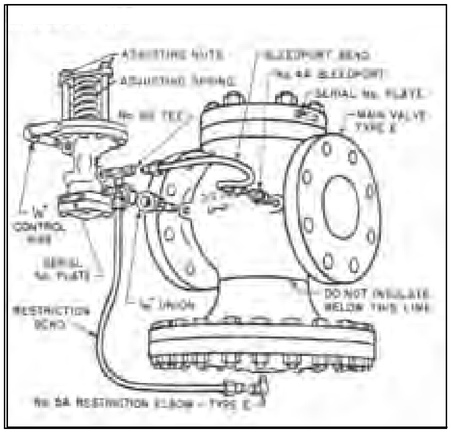


Figure 2-6

enlargement. Pitch away from pilot to avoid erratic operation and excessive fouling. Eliminate water pockets.

Locate delivery pressure gage in control pipe to show pressure actually reaching pilot diaphragm.

C. Start-up and Setting

On pressure reducing valves like the ED, use by-pass to fill the delivery system and raise pressure to slightly below normal required. Close pilot by releasing compression on adjusting spring. Open 1/4" control pipe valve. Crack outlet stop valve. Crack inlet stop valve. Blow down strainer.

⚠ Caution

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

Open inlet stop valve and gradually compress adjusting spring until the valve opens and takes control at desired pressure.

Alternately choke down on the by-pass and open outlet stop valve until the regulator is on the line. See individual instructions for other pilots.

1. Hydrostatic Test Procedure

Install pilot according to instructions. Fully compress pilot spring and open inlet and outlet stop valves before filling system.

SLOWLY fill system from inlet or high pressure side of regulator. Bleed off trapped air. *SLOWLY* develop test pressure up to *300 PSIG MAXIMUM*. If a higher pressure is required **CONTACT FACTORY FIRST**.

Test pressures may cause normally acceptable leakage at the diaphragm joint. Consult factory for hydrostatic test for other types of regulators.

D. Troubleshooting

Failure To Open Or Sagging Delivery Pressure

1. Adjusting spring on pilot may have been tampered with.

2. Initial pressure may be down due to 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 shutoff valve and entrance to 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 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 like the ED, the main valve or pilot may be held open by foreign matter in seat. To determine which valve leaks, first close stop valve and 1/4" control pipe valve.

Then remove bleedport bend so pilot will exhaust to atmosphere. Crack inlet stop valve. Steam will issue from No. 8B tee. Release compression on adjusting spring to see if pilot closes tight. Open and close several times to wash seat.

Steam blowing back from bleedport means 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 bleedport bend and place regulator in operation. Then, slowly open and close outlet stop valve.

E. 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.

2. Inspect all joints for leakage. Keep bolts tight. Never allow a leak to persist.

Dismantling Main Valve

Connect a source of air or water pressure which can be adjusted by hand to the No. 5A restriction elbow. Apply pressure to jack valve open and prevent stem from turning while removing stem nuts. Usually 50 to 60 psi will suffice. Use penetrating oil on the threads.

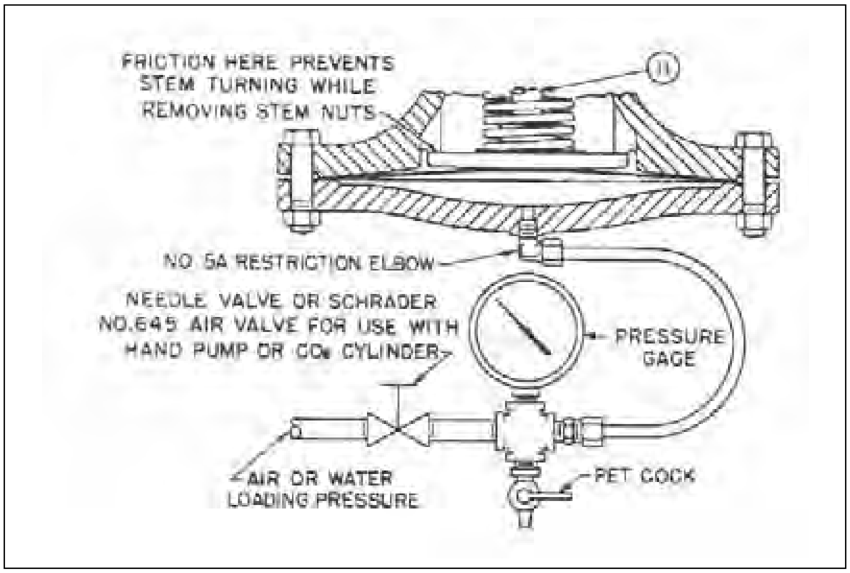


Figure 2-7 Diaphragm Cross Section

Replacing Seat Rings

These joints should be made up with Copaltite, Permatex or equal high temperature gasket compound. Remove old compound from body and seat ring with a wire brush. Apply new compound sparingly to both parts, threads and shoulders. Let stand until tacky before assembling.

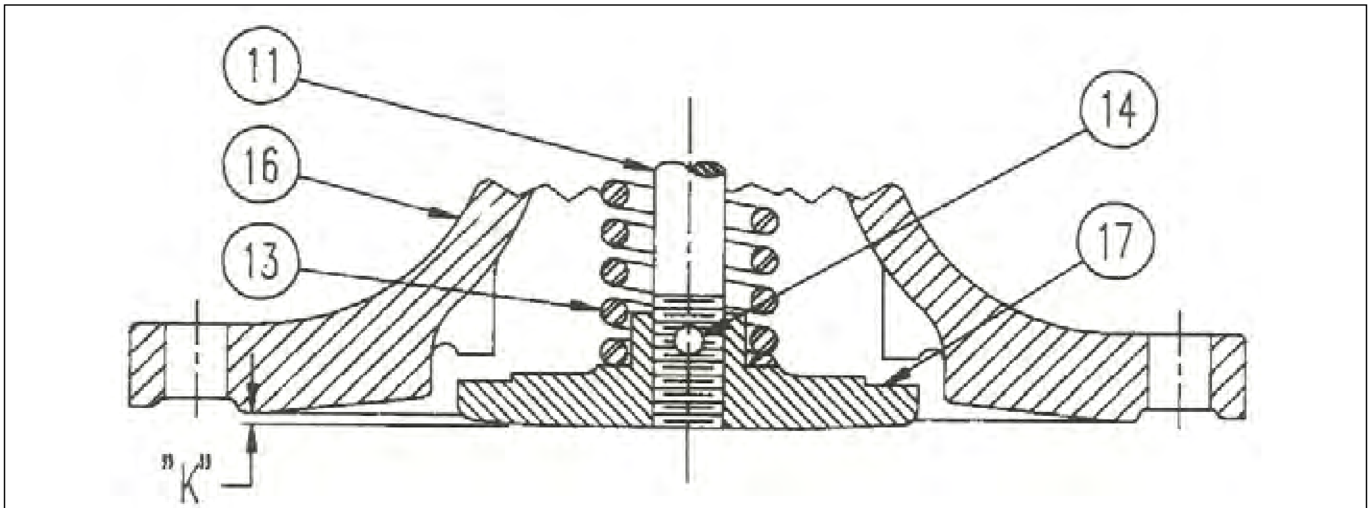


Figure 2-8 Diaphragm Stem Cross Section

Grinding In

Seats and discs should never require more than the lightest touch up with very fine (400 grit) grinding compound. Heavy grinding will produce galling, wider seating surface and a groove in the disc, all of which tend to cause leakage. Reface a damaged surface before attempting to grind it in. Grind sparingly.

Main stem (11) is slotted for rotation with a screwdriver, Valve spring (13) is omitted from the assembly during grinding. Slip the stem into its normal position. apply compound to the disc, place it on the stem and tighten with one stem nut. After grinding, disassemble and clean all parts.

Valve Setting

Valve setting is gaged at K to establish correct stem length and diaphragm position. Dimension K is supplied with each replacement stem. For metal diaphragm valves, K is cast on the upper face of pressure plate (17) (Fig. 2-8). To install new stem (11), fasten disc (7) firmly on stem with stem nut. Insert stem and disc assembly in valve and screw on pressure plate (17). Omit spring (13) for this operation. Hold disc on seat and adjust position of pressure plate until valve setting K is reached. Push pressure plate against stops in base (16). Remove disc, drop out pressure plate and stem, drill and insert dowel pin (14) to lock the joint. Grind off stem projection flush with face of pressure plate.

VALVE SIZE	TYPE E HOOD (K)	TYPE E TOTAL
3/8	1/32	3/32
1/2	3/64	7/64
3/4	3/64	1/8
1	1/16	5/32
1-1/4	5/64	3/16
1-1/2	3/32	7/32
2	7/64	1/4
2-1/2	1/8	9/32
3	9/64	3/8
3-1/2	5/32	11/32
4	3/16	13/32
5	7/32	1/2
6	9/32	19/32
8	11/32	3/4
10	7/16	31/32
12	9/16	1-1/4

Figure 2-9 Valve Size

When ordering parts, it is essential that the valve type, size, service and serial number be stated.

Select part by item number, but order by part number. Specify complete part number when ordering.

ITEM NO.	PART NAME	MATERIAL
1	Stud	Steel
2	Nut	Steel
3	Blind Flange	Cast Iron
4	*Gasket	Non-Asbestos
5	*Stem Nut	Steel
6	Muffling Plate	Cast Iron
7	*Disc	Stainless Steel
8	*Seat Ring	Stainless Steel
9	Pipe Plug 1/4"	Steel
10	Pipe Plug 1/8"	Steel
11	*Stem	Stainless Steel
12	NPT Body	Cast Iron
	125 Body	Cast Iron
	250 Body	Cast Iron
13	*HP Spring	Steel
	LP Spring	Steel
14	*Dowel Pin	Steel
15	Diaphragm Bolt	Steel
16	Base	Cast Iron
17	*Pressure Plate	Cast Iron
18	Diaphragm Nut	Steel
19	Hood	Cast Iron
20	*Diaphragm	Stainless Steel
	Repair Kit - High Pressure	
	Repair Kit - Low Pressure	

Figure 2-10 Parts List

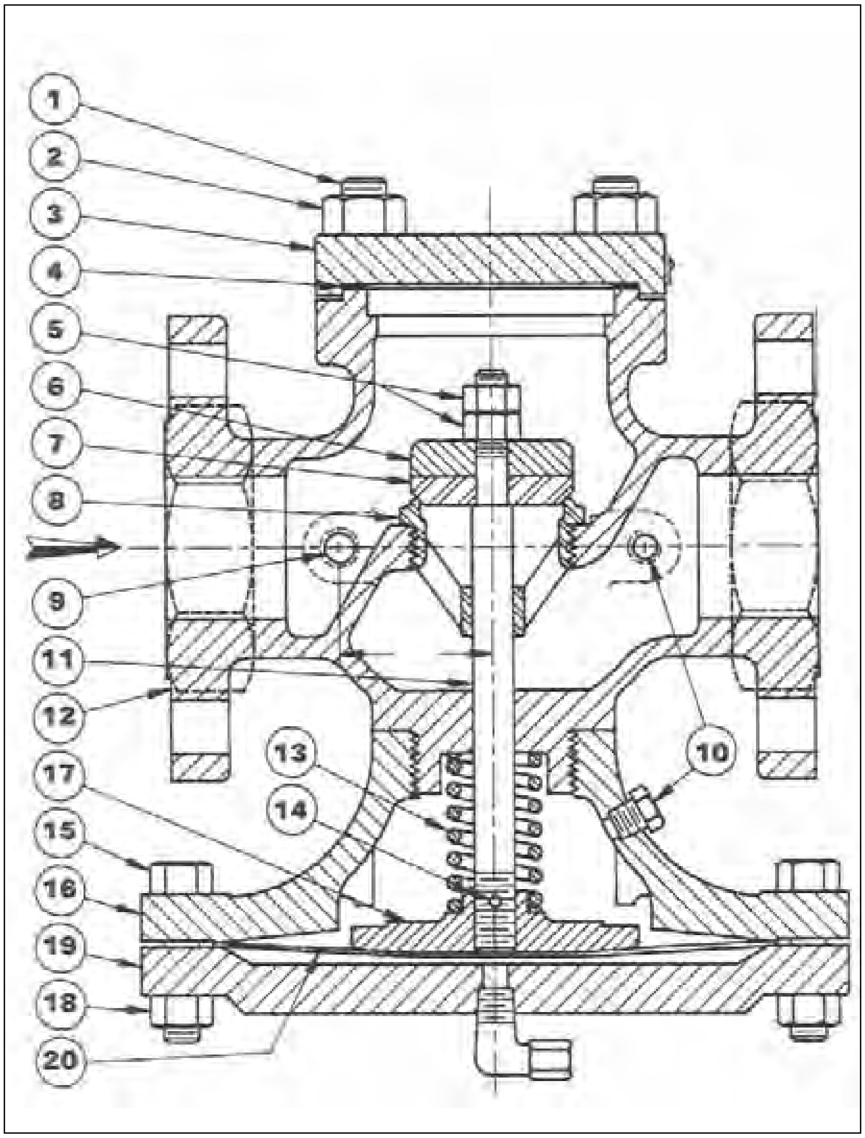


Figure 2-11 Valve Components

Section 3
Type D Pressure Reducing Pilot

A. Type D Pressure Reducing Pilot

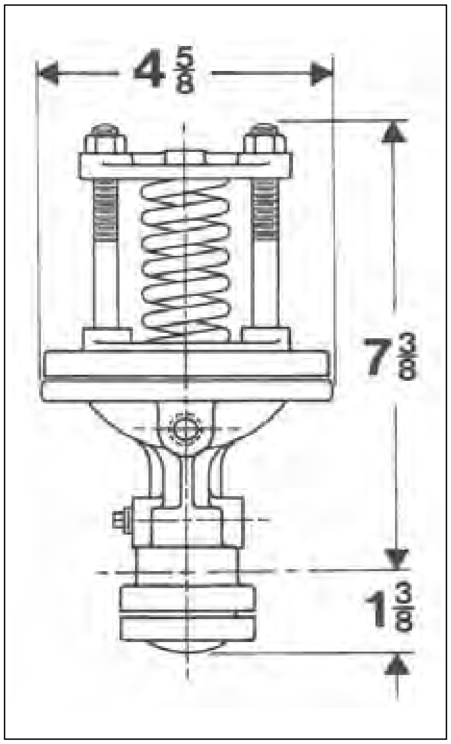


Figure 3-1 Standard D Pilot

The combination of a Type D pilot and a Spence Type E or Type C main valve produces a Spence Pressure Regulator. This regulator will reduce a steady or varying initial pressure to a constant, adjustable delivery pressure.

The Type D pilot is spring loaded. Normal accuracy of regulation is ±1 psi. The adjustable range of delivery pressure is governed by the choice of adjusting spring as shown in Table 1.

RATINGS (Maximum Inlet Conditions)

Construction Pressure (Temperature)

- Cast Iron............................250 PSIG.................(450×F)
- Cast Bronze........................300 PSIG.................(500×F)
- Cast Steel...........................600 PSIG.................(750×F)

Table 3-1

PRESSURE RANGE (PSIG)	ADJUSTING SPRING - Item 4	
	WIRE DIA. (Inch)	COLOR
3-20*	**3/16**	Aluminum
5-5-*	**1/4**	Orange
10-100	**5/16**	Green
20-150	**11/32**	Black

*With Vacuum Spring Assembly, minimum range is 30 inches Hg; maximum is reduced by 15 PSIG.

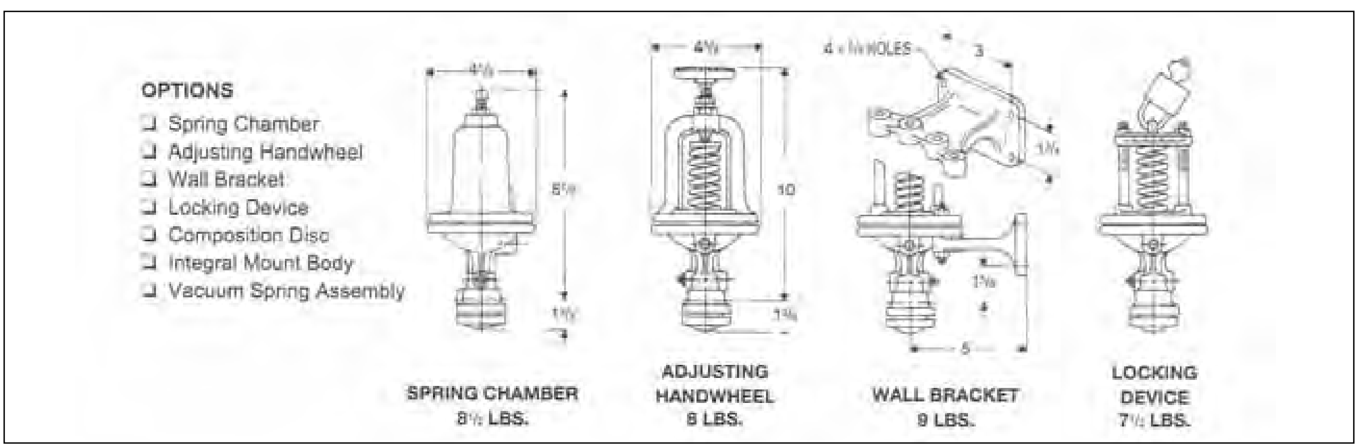


Figure 3-2 Pressure Reducing Pilot Options

B. Maintenance

(Brackets refer to item number; see Figures and Table 3-2)

Dismantling

1 - Release adjusting spring (4) compression.

2 - Remove diaphragm nuts (15) and lift off cowl (6). Lift out diaphragm assembly (7, 16 & 17).

3 - Disassemble diaphragm assembly by removing diaphragm screw (7) from pressure plate (16).

4 - Remove blind flange bolts (23) and take off blind flange (14). Remove screen (20) and gasket (13).

5 - Hold the pusher plate (8) and remove stem nuts (22). Lift out stem assembly (8 & 19) and valve spring (9). The disc (21) will drop off.

6 - If the seat ring (11) requires replacement, remove it from pilot body with a socket wrench.

Assembly

1 - Reassemble the pilot in the reverse of the procedure described above.

2 - When replacing diaphragms, apply sealing compound (Copaltite or equal) sparingly to the shoulder of the diaphragm screw (7). For steel pilots only, apply sealing compound to the diaphragm flange of the pilot body.

3 - When replacing gaskets, be sure that any serrated sealing surfaces are cleaned of old gasket material.

Inspection

1 - Examine the seat and disc sealing surfaces for nicks or other signs of damage by pipeline debris. Slight imperfections may be removed by lapping the surfaces together. Otherwise, the seat and disc must be replaced.

2 - Examine the stem for a build-up of pipeline contaminants or erosion. Remove any build-up with a wire brush and polish with very fine crocus cloth. Work carefully to avoid bending the stem.

Lapping Operations

Lap sparingly using 500 grit lapping compound and light pressure. Heavy grinding may cause galling, wide sealing surfaces and a grooved disc. all of which tend to produce leakage.

After the sealing surfaces are lapped in, disassemble and clean all parts.

Seat, Disc And Stem Replacement

1 - Clean the body threads of old sealing compound using a wire brush. Apply new sealing compound (Copaltite or equal) to the

shoulder of seat ring. Let stand until tacky before installing in pilot body.

2 - Lap in stem to disc joint with lapping compound.

3 - Secure disc (21) to stem (19) with a stem nut (22). Insert this assembly into pilot body (omit valve spring).

4 - Apply lapping compound to the disc and lap in the seat to disc joint. The stem is slotted for rotation with a screwdriver.

5 - Screw pusher plate (8) on stem (19). Holding disc against its seat, adjust the pusher plate so that dimension C = 11/64" (See Figure 1). A gage (part number 05-02416-00) is supplied with each repair kit.

6 - Remove stem nut, being careful not to disturb the pusher plate adjustment, and lift stem out the top of the pilot. Grind off stem Projection B flush with upper surface of the pusher plate.

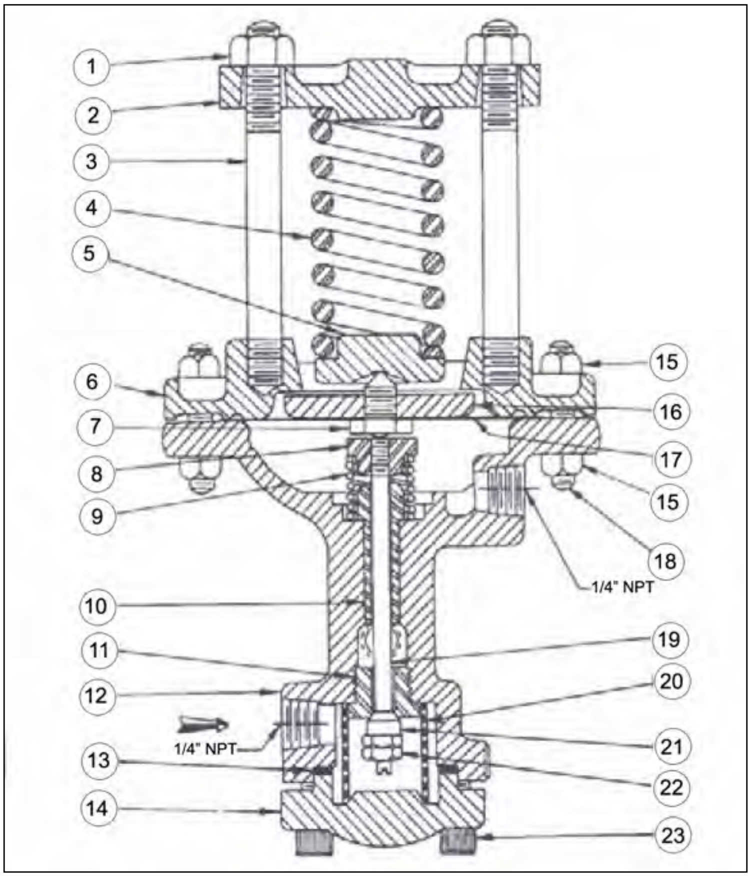


Figure 3-3 Type D Pressure Reducing Cross Section

Table 3-2

ITEM NO.	PART NAME	MATERIAL	REMARKS
1	Adjusting Nut	Steel	
2	Spring Yoke	Iron	
3	Standard	Steel	
4	Adjusting Spring	Steel	
5	Spring Button	Steel	
6	Cowl	Cast Iron	Iron & Bronze Body
7	Diaphragm Screw	Steel	
8	Pusher Plate	Steel	
9	Valve Spring	Inconel	
10	Bushing St.	Steel	
11	Seat Ring	Seco Metal	
12	Body, Bushing, Plug	Cast Iron	
	Body, Bushing, Plug	Bronze	
	Body, Bushing, Plug	Steel	
13	Gasket	Blugard	Iron & Bronze Body, Non-Asbestos
	Gasket	Flexitalic	Steel Body, Non-Asbestos
14	Blind Flange	Cast Iron	
	Blind Flange	Bronze	
	Blind Flange	Steel	
15	Diaphragm Nut	Steel	Iron & Bronze Body
	Diaphragm Nut	Steel	
16	Pressure Plate	Steel	
17	Diaphragm St.	Steel	
18	Diaphragm Bolt	Steel	
	Diaphragm Stud	Steel	
19	Stem St.	Steel	
20	Screen St.	Steel	
21	Disc	Seco Metal	
22	Stem Nut	Steel	
	Stem Nut	Brass	
23	Blind Flange Bolt	Steel	
	Blind Flange Bolt	Steel	
	Repair Kit	Cast Iron Pilot	
	Repair Kit	Steel Pilot	

7 - Reinsert stem into pilot body. Install disc and stem nut. Check dimension C and, if correct, lock the adjustment by prick punching

the thread at several points. Work carefully to avoid bending the stem.

8 - Scrape away burs raised by prick punching. Upper surface of pusher plate must be smooth and flat.

9 - Check that valve travel A = 3/64". This need not be exact. Stem should move smoothly. Binding indicates a bent stem.

10- Remove stem nut and disc; withdraw stem. Install stem with valve spring disc and both stem nuts in place.

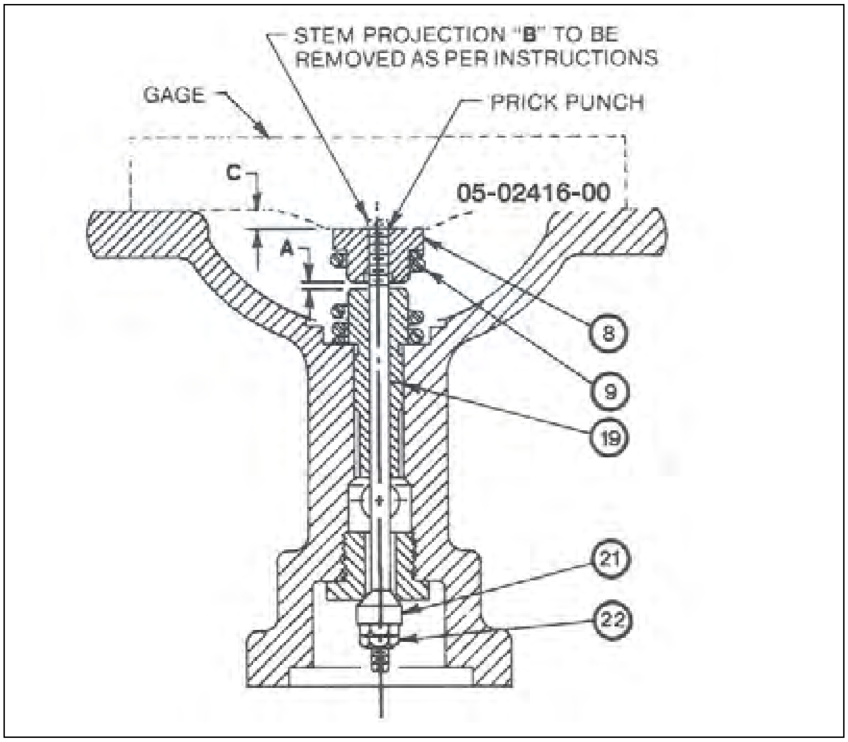


Figure 3-4 Travel Setting

Section 4

Siemens Flowrite EA599 & VF59 Series

A. Description

The Flowrite EA 599 Series SKB/C/D62UA Electronic Valve Actuator requires a 24 Vac supply and receives a 0 to 10 Vdc or a 4 to 20 mA control signal to proportionally control a valve. This actuator is designed to work with Flowrite VF 599 Series valves and Siemens Building Technologies, Inc. standard valves with a 3/4-inch (20 mm) stroke.

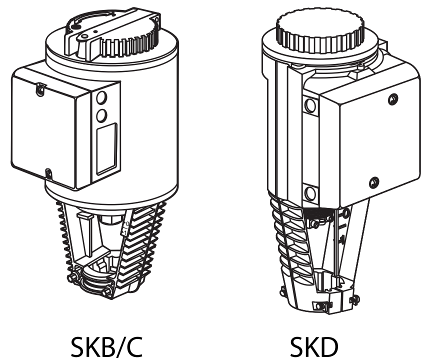
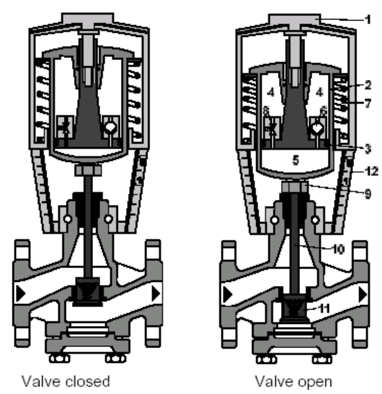


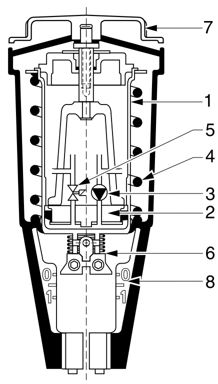
Figure 4-1 Electronic Valve Actuators

B. Valve Details



1. Manual Adjuster
2. Pressure Cylinder
3. Piston
4. Reservoir
5. Pressure Chamber
6. Pump
7. Return Spring
8. Bypass Valve
9. Coupling
10. Valve Stem
11. Inner Valve
12. Position Indicator (0 to 1)

Figure 4-2 SKB/C Valve Parts



1. Pressure cylinder
2. Piston
3. Oscillating pump
4. Return spring
5. Bypass valve
6. Valve stem retainer
7. Manual override knob
8. Position indicator

Figure 4-3 SKD Valve Parts

C. Standard Operation

The actuator accepts a 0 to 10 Vdc or a 4 to 20 mA control signal. The actuator mounted on a valve produces a stroke proportional to the input signal. When power is turned off or in the event of a power failure, the actuator spring returns the valve to its normal position.

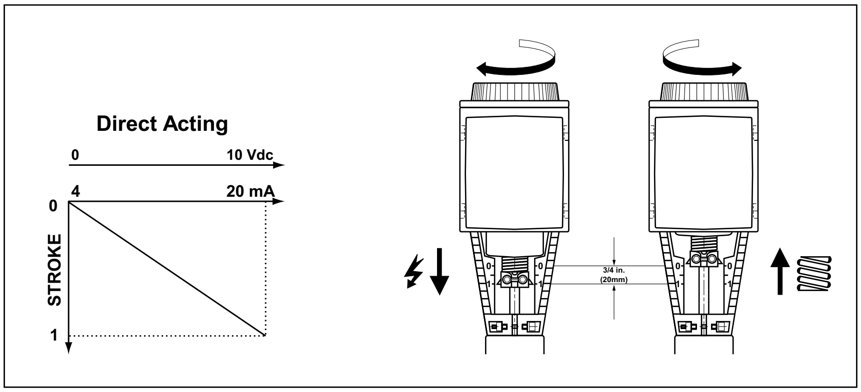


Figure 4-5 SKD Valve Stem Travel Indication

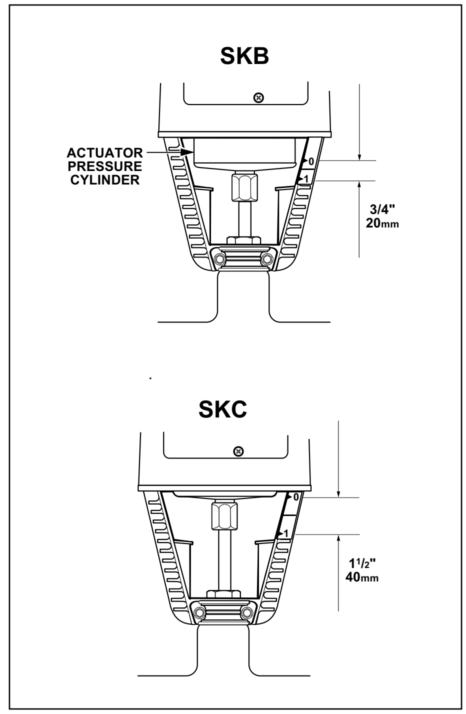


Figure 4-4 SKB/C Valve Stem Travel Indication

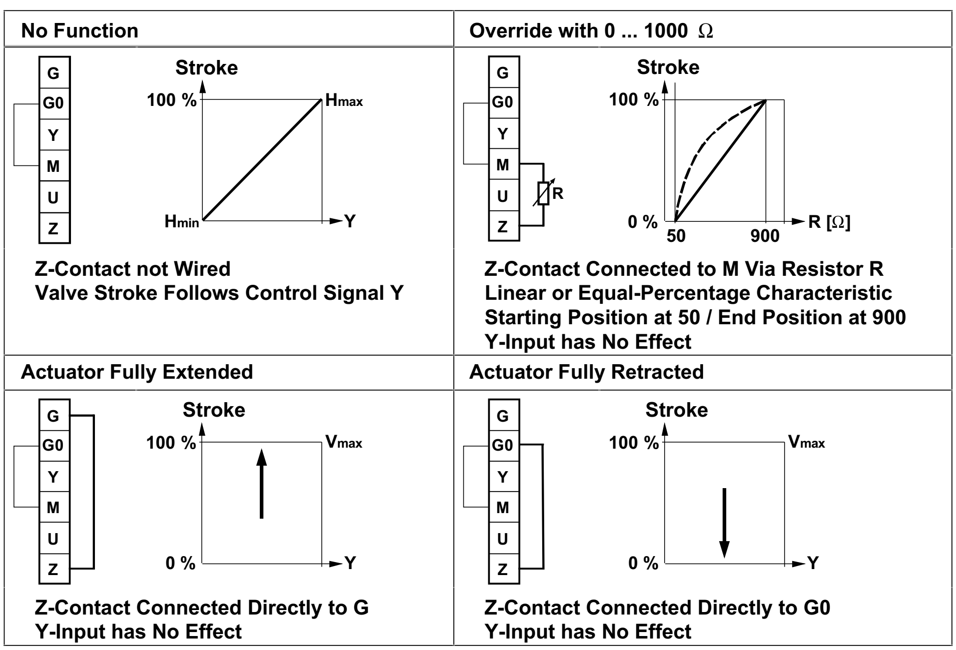


Figure 4-6 Override control

Override Control

The override control input (Z) has three modes of operation (see **Figure 4-6**)

Spring Return Function

All SKB/C/D62UA actuators are factory-fitted with a spring-return function. If the control signal or power supply fails, the actuator will return to the 0% stroke position (stem fully retracted).

Stroke Calibration

⚠ Caution

Before starting calibration, be sure that the manual adjuster is set to **Automatic** for the actual values to register.

To determine the stroke positions 0% and 100% in the valve, calibration is required when the valve/actuator are commissioned for the first time. The actuator must be mechanically connected to a valve and must have a supply voltage of 24 Vac. The calibration procedure can be repeated as often as necessary

There is a slot on the printed circuit boards for the actuators. To initiate the calibration procedure, the contacts inside this slot must be short-circuited (possibly with a screwdriver). See **Figure 4-7**.

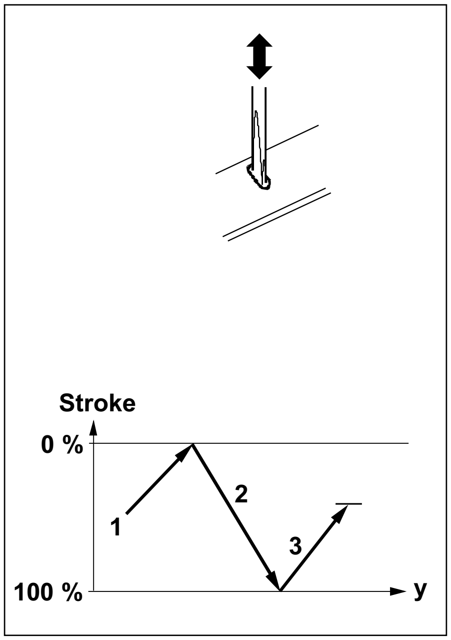


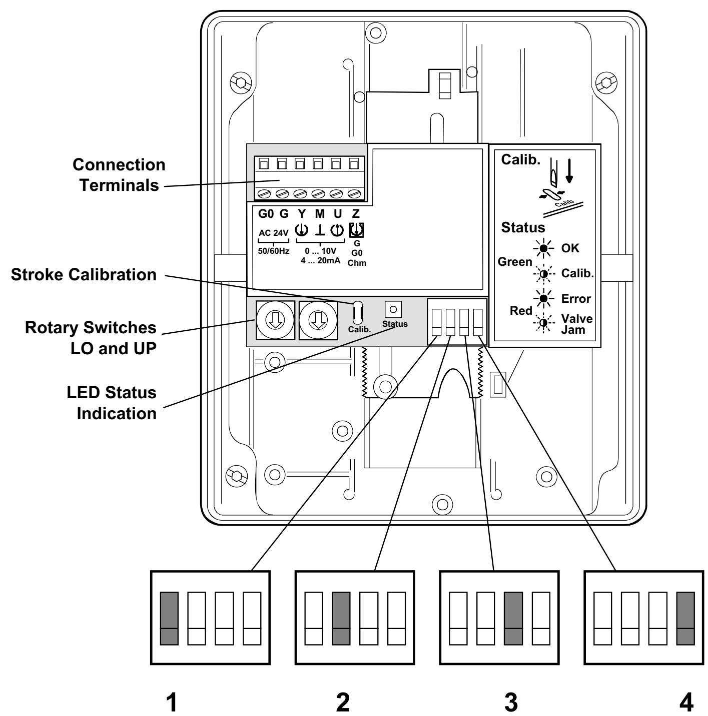
Figure 4-7 Automatic Calibration

Automatic calibration proceeds as follows (See Figure 13):

- Actuator runs to the 0% stroke position (1), the green LED flashes.
- Actuator then runs to the 100% stroke position (2), the green LED flashes.
- Measured values are stored in the EPROM.
- The actuator now moves to the position defined by control signal Y or Z (3), and the green LED now glows steady (normal operation).
- Throughout this procedure, output U is inactive, meaning the values only represent actual positions when the green LED stops flashing and remains on continuously.

LED	Display	Function	Action
Green	ON	Normal Operation	Automatic operation
	Flashing	Stroke calibration In Progress	Wait for calibration to be completed (LED stops flashing)
Red	ON	Faulty stroke calibration Internal Error	- Check mounting - Restart stroke calibration (by short-circuiting calibration slot) - Replace electronics
	Flashing	Valve plug jammed	Check the valve
	OFF	• No power supply • Faulty electronics	- Check mains - Replace electronics

Advanced Features



DIP Switches (From Left to Right)	1 Select Direction of Operation	2 Sequence Control or Stroke Limit Control	3 Selection of Control Signal	4 Selection of Flow Characteristic
ON	Reverse-acting	Sequence control	4 to 20 mA	Modified*
OFF (Factory Settings)	Direct-acting	Stroke limit control	0 to 10 Vdc	Default

*Changing the default setting will modify an equal percentage valve to a linear flow characteristic. When set to default, the flow characteristic is determined by the valve body.

Figure 4-8 DIP Switches

Start-up, continued

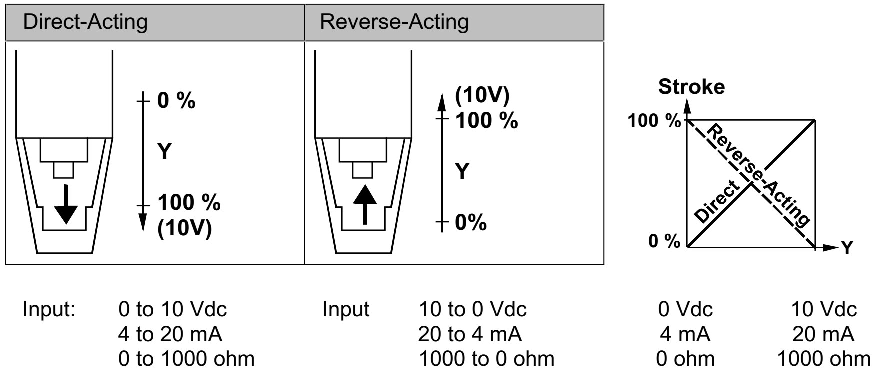


Figure 4-9

Normally Closed Valve When actuator pressure cylinder:

Moves outward (0 to 1): Valve opens.

Moves inward (1 to 0): Valve closes.

Normally Open Valve When actuator pressure cylinder:

Moves outward (0 to 1): Valve closes.

Moves inward (1 to 0): Valve opens.

Three Way Valve When actuator pressure cylinder:

Moves outward (0 to 1): Valve opens between port NC and C.

Moves inward (1 to 0): Valve opens between ports NO and C.

The measuring voltage at terminal U provides valve stem position feedback to an indicating instrument or building automation system.

Manual operation

Turn the manual setting knob clockwise for manual operation. As you begin to turn, a red indicator becomes visible. Each complete revolution (360×) is equal to 3/32-inch (2.5 mm) stroke.

NOTE: If a signal is sent to the actuator while it is in manual operation, the actuator will move, but the control will not be accurate. The valve cannot be commanded to its 0% position while in manual operation.

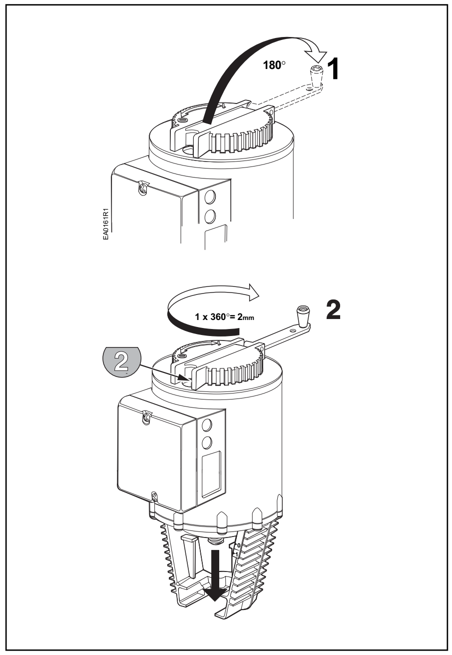


Figure 4-10 SKB/C Manual Operation

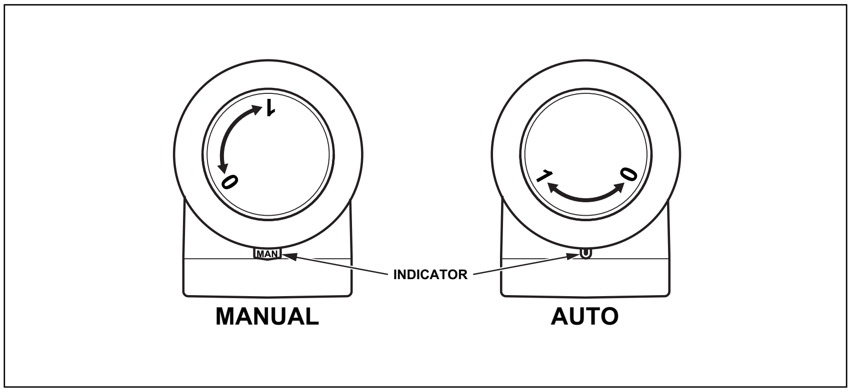


Figure 4-11 SKD Manual Operation

Automatic Operation

SKB/C

When returning to automatic control, you must turn the crank arm of the manual setting knob counterclockwise until the red numbers disappear. It is essential that the window is clear and the crank arm is snapped into position.

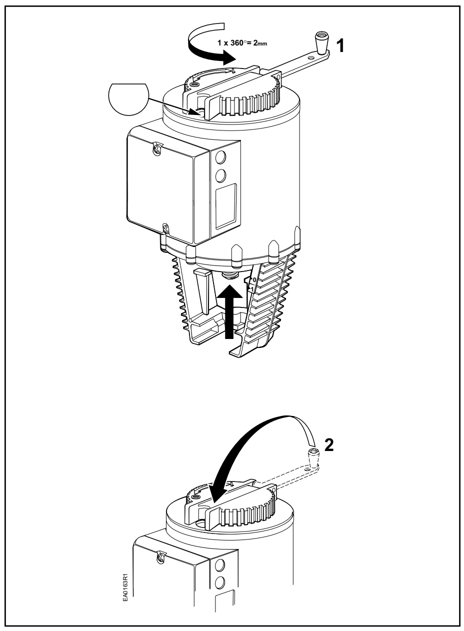


Figure 4-12 SKB/C Automatic Operation

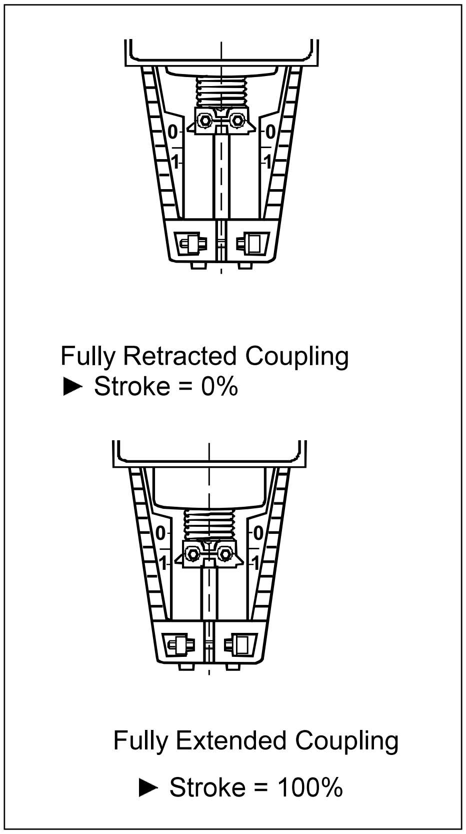


Figure 4-13 SKD Automatic Operation

SKD

For automatic operation, the manual override knob must be in the fully closed position.

Turn the manual override knob counterclockwise until the red indicator disappears.

CAUTION:

The manual adjuster must be rotated counterclockwise to the end stop until the red indicator marked MAN is no longer visible.

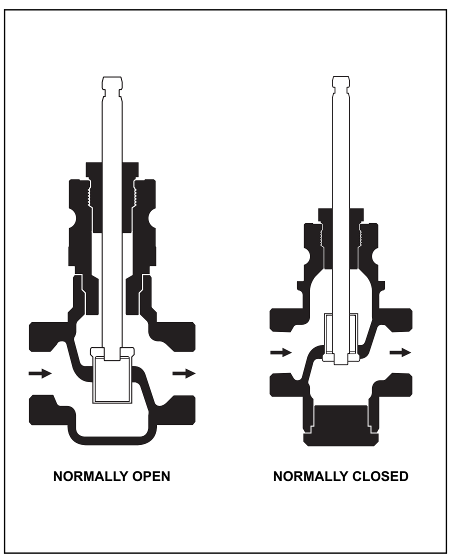


Figure 4-14 Flowrite VF599 Series

D. Flowrite VF 599 Series

Operation

Figure 4-14 shows the normally open valve in the open or full flow position and the normally closed valve in the closed or zero flow position. The actuator spring provides the necessary force to hold the stem in the raised or normal position.

In the event of power failure, a spring return actuator returns the valve to its normal position. Non-spring return actuators will hold the last commanded position. See the Technical Instructions of the various actuators for additional information.

Section 5
Parts

Table 5-1 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
853-936	Gasket, Manhole, 11" x 15"	
853-939	Gasket, Manhole, 12" x 16"	
825-281	Set, Water Gauge	
950-50	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	

Table 5-2 Manhole Cover Assemblies

Gasket 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										
853-936	821-191	1	953-460	2	868-1023	2	869-65	2	952-288	2
12"x 16" Manhole Cover and Yoke Assembly (Standard)										
853-939	821-207	1	953-50	2	868-778	2	869-320	2	952-132	2

Table 5-3 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 deaerator pressure reducing valves.

Table 5-4 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 deaerator pressure reducing valves.

Table 5-5 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 deaerator pressure reducing valves.

Table 5-6 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 5-7 Overflow 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 fit.

DEAERATOR CHART-MAXIMUM WATER CAPACITY-U.S. GALLONS PER MINUTE

PART NUMBER	VALVE SIZE IN INCHES	CV	* FEEDWATER VALVE INLET PRESSURE - PSI						
			*25	30	40	50	60	70	100
941-02570	1/2	4	12.6	15.5	20	23.7	26.8	29.7	36.9
941-02571	3/4	6.3	19.9	24.4	31.5	37	42	46.7	58
941-02572	1	10	31.6	38.7	50	59	67	74	92
941-02573	1-1/4	16	50.6	62	80	94.7	107.3	118.7	147.5
941-02574	1-1/2	25	79	97	125	148	167.7	185.4	230.4
941-02575	2	40	126.4	155	200	237	268	296.6	368.7

*NOTE: TABLE IS BASED ON DEAERATOR OPERATING PRESSURE OF 5 PSI WITH A WATER SPRAY HEAD PRESSURE DROP OF 7-10 PSI. THE SIEMENS FEEDWATER VALVE SELECTION IS BASED ON A VALVE PRESSURE DROP OF 10 PSI @ AT 25 PSI FEEDWATER INLET PRESSURE.

DEAERATORS WITH SIEMENS VALVES SIZES 1/2" THRU 1-1/4" ARE USED WITH ACTUATOR PART NUMBER 945-00222.
DEAERATORS WITH SIEMENS VALVES SIZES 1-1/2" AND 2" ARE USED WITH ACTUATOR PART NUMBER 945-00240.

WHEN MAKE-UP WATER IS FED DIRECTLY TO THE DEAERATOR, THE SIZE AND CAPACITY ARE DEPENDANT ON INLET WATER PRESSURE. TO SELECT VALVE SIZE, FIRST DETERMINE MAKE-UP REQUIREMENT. THEN SELECT A VALVE WITH ADEQUATE CAPACITY AT THE MINIMUM SUPPLY PRESSURE.

EXAMPLE: TOTAL LOAD = 45,000 LB/HR (90 GPM)
MAKE-UP = 50% OR 22,500 LB/HR (45 GPM)
SUPPLY PRESSURE IS 40 PSIG TO 60 PSIG
SELECT A 1" VALVE WHICH WILL PASS 45 GPM MINIMUM @ 40 PSIG.

A THREE VALVE BYPASS AROUND THE MAKE-UP VALVE ALONG WITH AN INLET STRAINER IS RECOMMENDED.

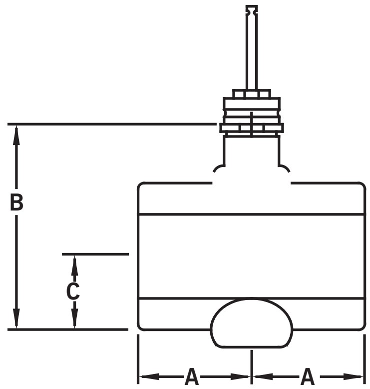
WHEN VALVE IS USED ON DEAERATOR IN A TWO-TANK SYSTEM OR DUO-TANK SYSTEM, ENTIRE LOAD IS PASSED THROUGH VALVE. SELECT VALVE SIZE BASED ON TOTAL CAPACITY AT 25 PSIG SUPPLY PRESSURE.

EXAMPLE: TOTAL LOAD = 45,000 LB/HR (90 GPM)
SELECT A 2" VALVE THAT WILL PASS 90 GPM MINIMUM @ 25 PSI INLET PRESSURE.

GENERAL NOTES:

1) ALL ACTUATORS REQUIRE 24 VDC TRANSFORMER P/N 832-00235, USED WITH LEVEL MASTER AND McDONNELL MILLER LWCO.
2) ACTUATOR AUXILIARY SWITCH SPDT INDICATES ZERO STROKE POSITION P/N 836-1339 MAY BE REQUIRED FOR SPECIFIC CUSTOMER CONNECTIONS (SEE WIRING DRAWING SHEET 4).
3) McDONALD MILLER REQUIRES THE USE OF A 10-12 VDC POWER SUPPLY P/N 832-02179 IN ADDITION TO USING P/N 832-00235.

Table 5-8 Siemens Actuator Series 599



Female NPT by
Female NPT F X F

2-WAY VALVE DIMENSIONS

VALVE ACTION	VALVE SIZE INCHES	A FxF	B	C	VALVE ASSEMBLY WEIGHT
NORMALLY CLOSED	1/2	1-7/16	3-13/16	2-3/16	3
	3/4	1-11/16	3-13/16	2-3/16	4
	1	2	3-13/16	2-3/16	5
	1-1/4	2-1/2	3-13/16	2-3/16	7
	1-1/2	2-9/16	3-7/8	2-1/4	8
	2	3-1/8	4-1/2	2-9/16	16

SIEMENS FEEDWATER VALVE-MAXIMUM WATER CAPACITY-U.S. GALLONS PER MINUTE

PART NUMBER	VALVE SIZE IN INCHES	PRESSURE DIFFERENTIAL - PSI						
		CV	5	10	20	25	30	40
941-2567	1/2	1.0	2.2	3.2	4.5	5.0	5.5	6.3
941-2568	1/2	1.6	3.6	5.1	7.2	8.0	8.8	10.1
941-2569	1/2	2.5	5.6	7.9	11.2	12.5	13.7	15.8
941-2570	1/2	4	8.9	12.6	17.9	20.0	21.9	25
941-2571	3/4	6.3	14.1	20	28	32	35	40
941-2572	1	10	22	32	45	50	55	63
941-2573	1-1/4	16	36	51	72	80	88	101
941-2574	1-1/2	25	56	79	112	125	137	158
941-2575	2	40	89	126	179	200	219	253

Table 5-9 Siemens Actuator Series 599

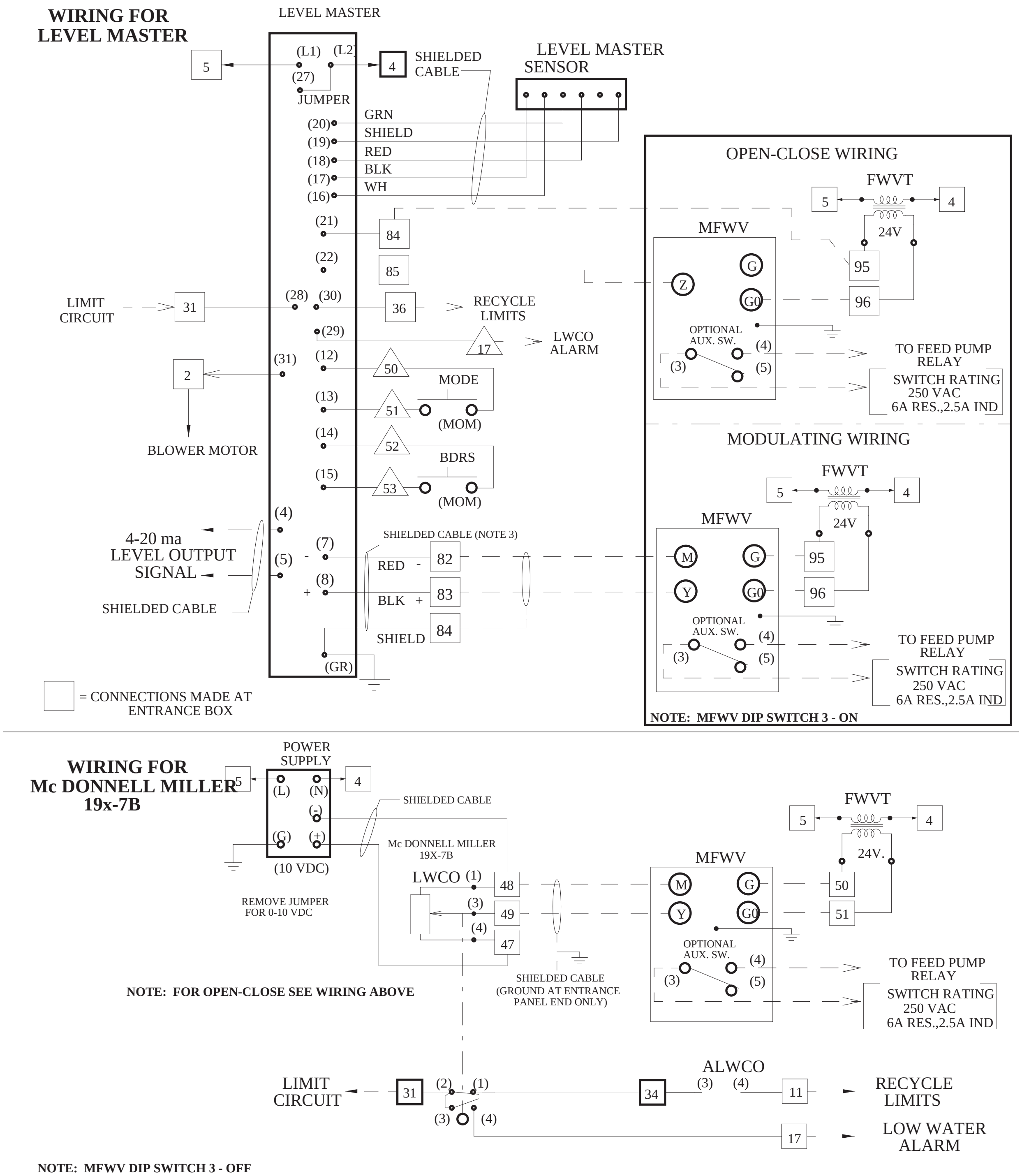


Table 5-10 Wiring Diagram for use with Siemens Actuator Series 599

Table 5-11 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 5-12 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 5-13 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 5-14 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 5-15 Deaerator Retrofit Parts

PART NO.	MODEL USED	DESCRIPTION
277-116	SS15	Water Inlet Assembly
277-117	SS30 - SS45	Water Inlet Assembly
277-118	SS70	Water Inlet Assembly
277-119	SS100	Water Inlet Assembly
295-109	SS15, 30, 45, 70, 100	Spring Loaded Valve Assembly
97-221	SS15, 30, 45 & 70	Cone Assembly
97-222	SS100	Cone Assembly
656-6203	SS15 - SS70 28"	Hinged Manway with Gasket and Hardware - 50#
656-6202	SS100	Hinged Manway with Gasket and Hardware - 50#
141-777	SS15 - SS70 28"	Tank Flange - 50#
141-810	SS100	Tank Flange - 50#
797-4039	All Models	Engineering Calculations

When retrofitting the deaerator to a davited manway, please use these part numbers related to the model.

Table 5-16 Spray Nozzle Assembly or Water Inlet Assembly (SS-15 thru SS-100)

MODEL NUMBER	WATER INLET ASSEMBLY PART NO.
SS-15	277-116
SS-30	277-117
SS-45	277-117
SS-70	277-118
SS-100	277-119

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 five pages shows a parts break down of the water inlet assemblies.

Table 5-17 Spraymaster Gasket for Water Inlet

MODEL NUMBER	WATER INLET GASKET
SS-15	Was 853-913 replaced by 853-974
SS-30	Was 853-914 replaced by 853-976
SS-45	Was 853-914 replaced by 853-976
SS-70	Was 853-914 replaced by 853-976
SS-100	Was 853-914 replaced by 853-976

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

DA MODEL NUMBER			SS-15	SS-30 & 45	SS-70	SS-100
ITEM	QTY	DESCRIPTION	PART NO.	PART NO.	PART NO.	PART NO.
1	1	SPRAYHEAD ASSEMBLY	(1-1/2") 277-00146	(2") 277-00117	(2-1/2") 277-00118	(3") 277-00119
2	1	GASKET, SPRAYHEAD TO TANK FLANGE	853-00974	853-00976	853-00976	853-00976
3	-	BOLTS, SPRAYHEAD TO TANK FLANGE	(8) 841-00742	(12) 841-00952	(12) 841-00952	(12) 841-00952
4	-	NUTS, SPRAYHEAD TO TANK FLANGE	(16) 869-00338	(24) 869-00287	(24) 869-00287	(24) 869-00287
5	1	SPRING LOADED VALVE ASSEMBLY	(6") 295-00109	(6") 295-00109	(6") 295-00109	(6") 295-00109
6	1	COLLECTOR CONE ASSEMBLY	(24") 097-00221	(24") 097-00221	(24") 097-00221	(30") 097-00222
7	8	NUTS, COLLECTOR CONE SUPPORT	869-00372	869-00372	869-00372	869-00372
8	1	OVERFLOW DRAINER	(2") 817-02041	(2") 817-02041	(3") 817-01910	(4") 817-01554

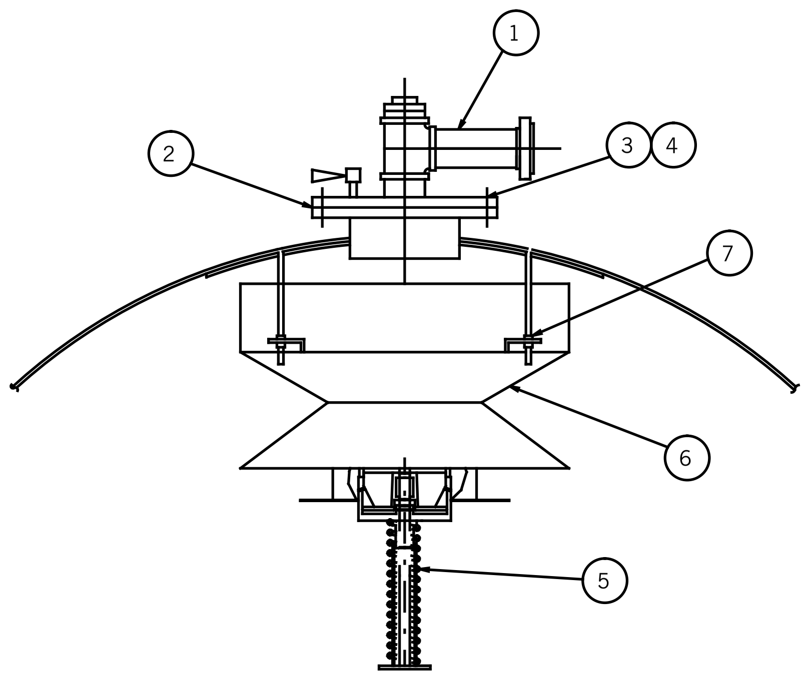


Table 5-18 Spraymaster Deaerator Component Parts List

MODEL PART NUMBER	SS-15-30-45-70 097-00221	SS-100 097-00222
DIM. "A"	24"	30"
DIM. "B"	6"	6"
DIM. "C"	20"	20"

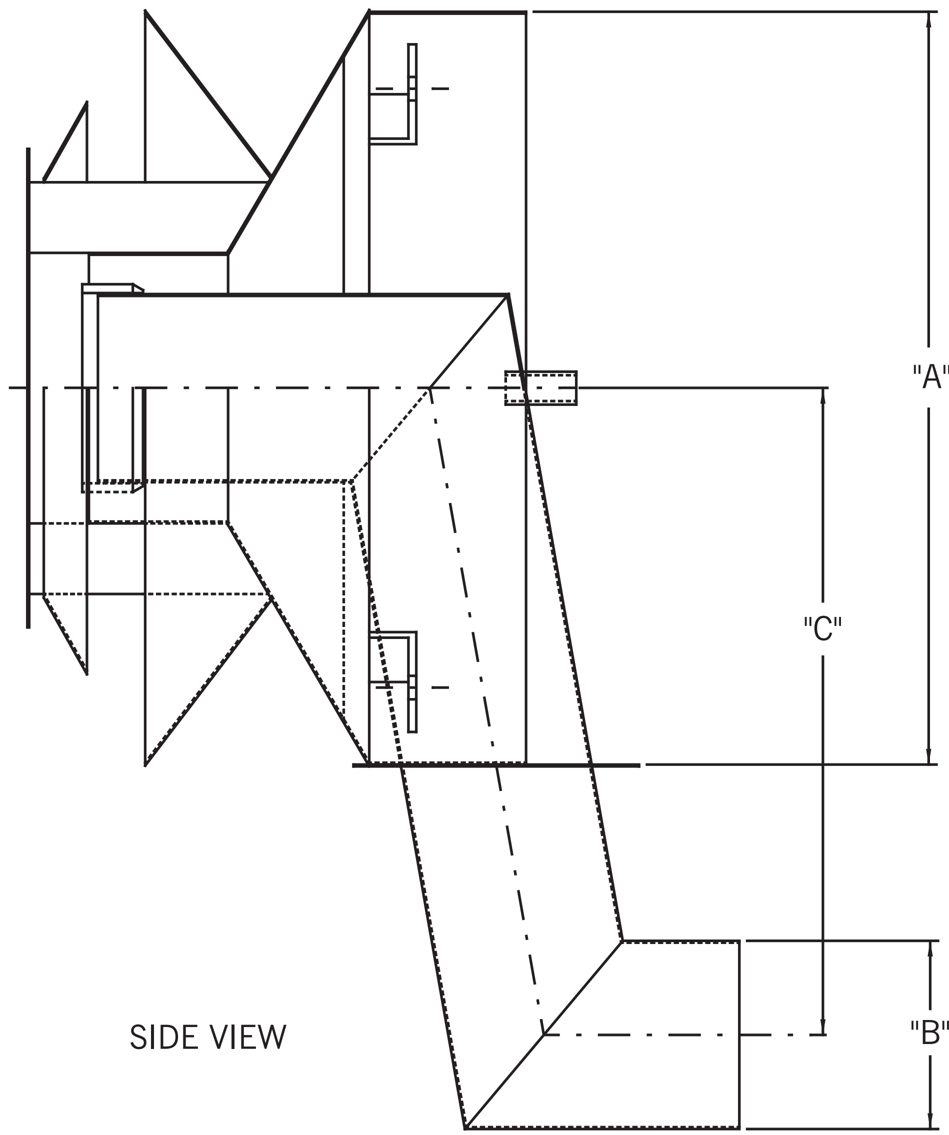


Table 5-19 Spraymaster Collector Cones

ASSEMBLY PART NUMBER 295-00112			
ITEM	REQ.	PART NO.	DESCRIPTION
1	1	194-00108	SEAT, VALVE, 6" W/ ROD ASSEMBLY
2	1	091B00147	DISC, VALVE, 6"
3	-	-	NOT USED
4	1	082B00019	SPRING
5	1	036-00028	GUIDE, SPRING
6	1	869-00100	NUT, JAM
7	1	869-00338	NUT, HEAVY
8	A/N	091-00152	WASHER, SPACER, 304 STN. STL.
9	A/N	091-00151	WASHER, SPACER, 316 STN. STL.

NOTE: SHIM VALVE SEAT TO ACHIEVE PROPER 1/32" GAP

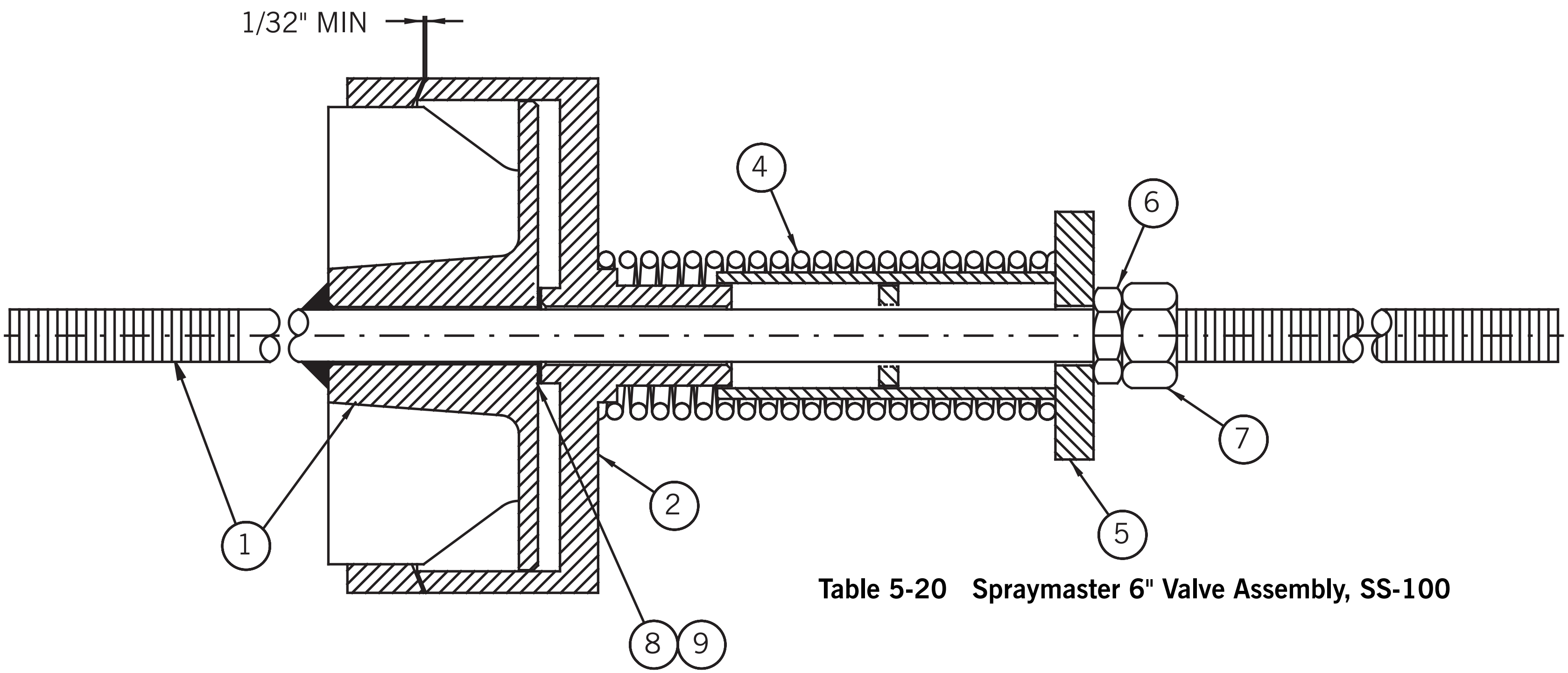


Table 5-20 Spraymaster 6" Valve Assembly, SS-100

ASSEMBLY PART NUMBER 295-00109			
ITEM	REQ.	PART NO.	DESCRIPTION
1	1	194-00108	SEAT, VALVE, 6" w/ ROD ASSEMBLY
2	1	091B00147	DISC, VALVE, 6"
3	-	-	NOT USED
4	1	082B00019	SPRING
5	1	036-00028	GUIDE, SPRING
6	1	869-00100	NUT, JAM
7	1	869-00338	NUT, HEAVY
8	A/N	091-00152	WASHER, SPACER, 304 STN. STL.
9	A/N	091-00151	WASHER, SPACER, 316 STN. STL.

NOTE: SHIM VALVE SEAT TO ACHIEVE PROPER 1/32" GAP

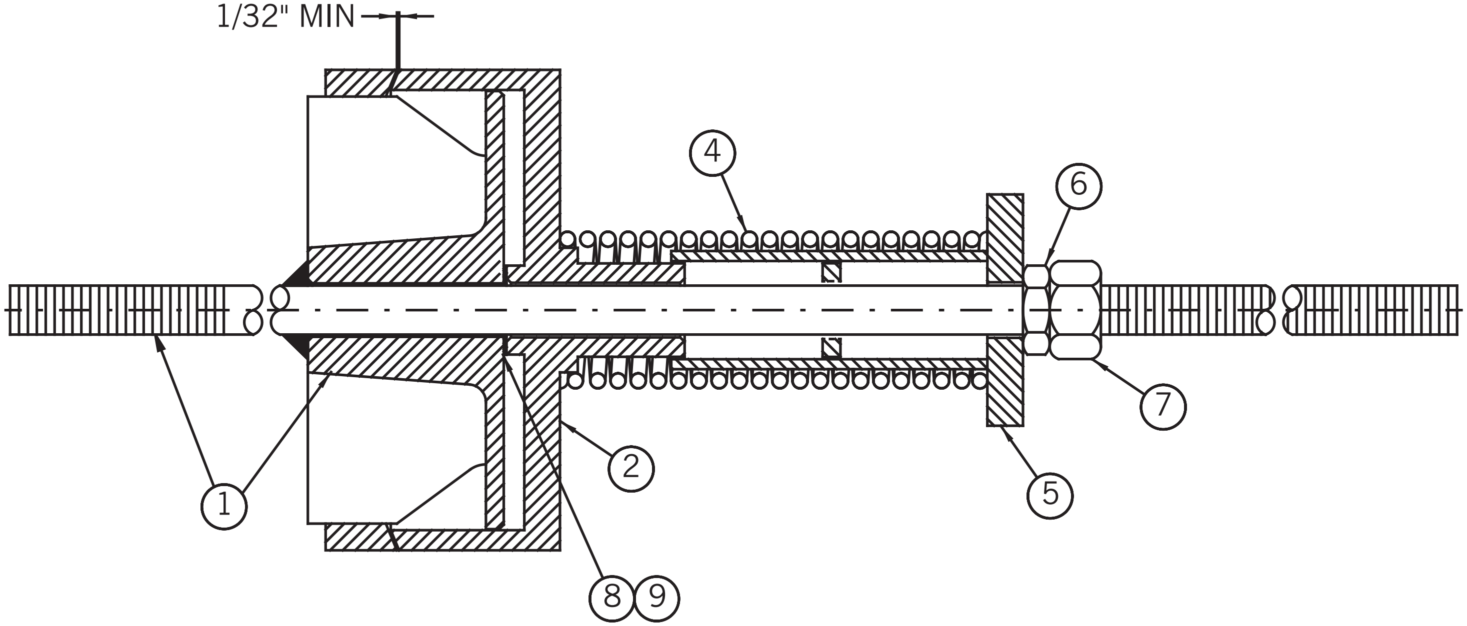
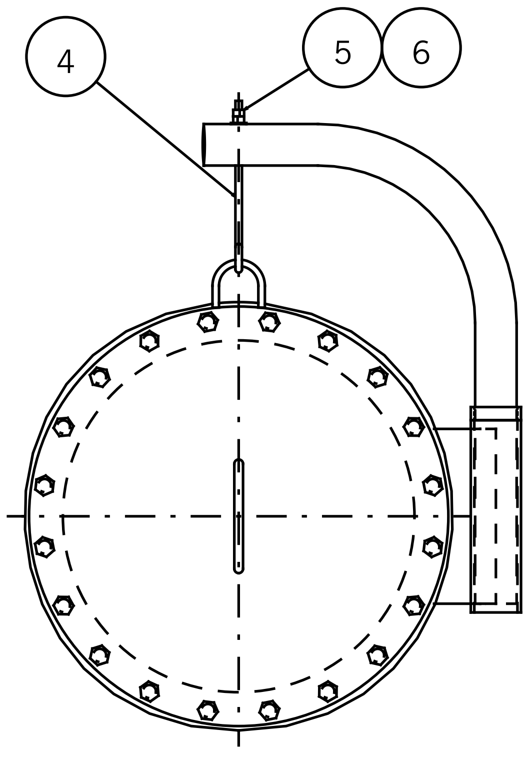


Table 5-21 SPRAYMASTER 6" VALVE ASSEMBLY, SS-15 THRU SS-70

ASSEMBLY P/N 317-00131			
ITEM	QTY	PART NO.	DESCRIPTION
1	1	029-02012	FLANGE, RING, 20" MANWAY, 50# F.F. (029B02003)
2	1	029-01778	FLANGE, BLIND, 20" MANWAY, 50# F.F. (029B01761)
3	1	603-01384	BOLT & GASKET ASSY, 20" 50# F.F. MANWAY (603B01382)
4	1	841-01640	EYE BOLT, PLAIN, FORGED
5	1	952-00111	WASHER, FLAT, PLATED WROUGHT STEEL
6	2	869-00086	NUT, HEX.



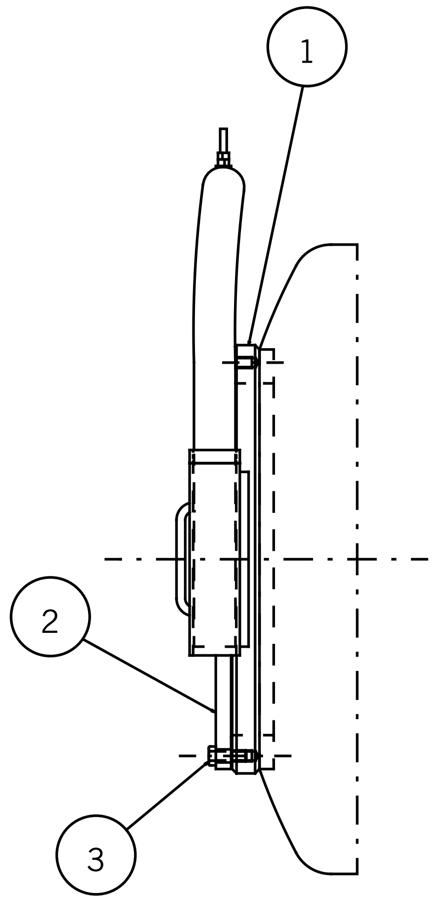
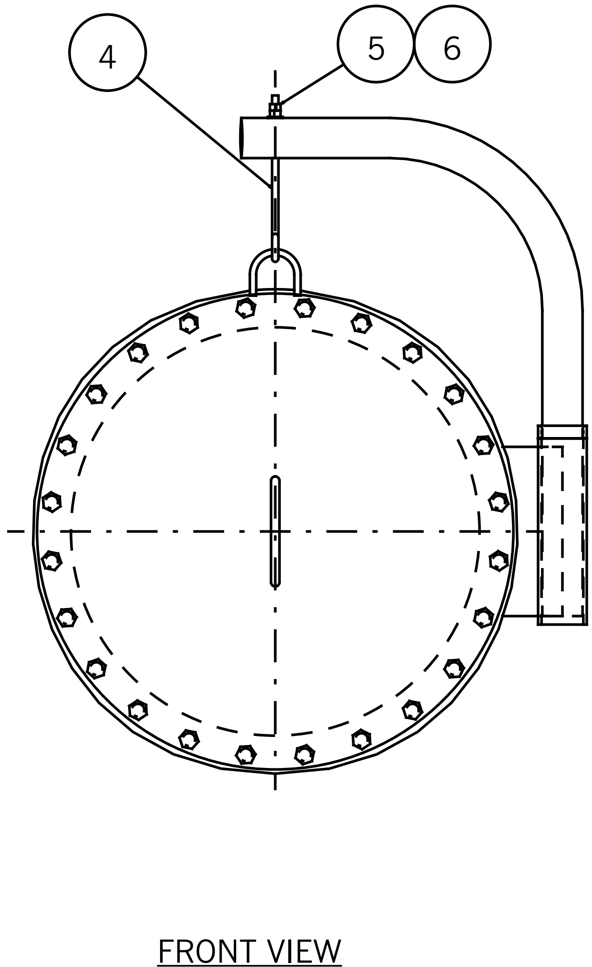


Table 5-22 MANWAY ASSEMBLY, 20" DAVITED, 50# D.P.

ASSEMBLY P/N 317-00132			
ITEM	QTY	PART NO.	DESCRIPTION
1	1	029-02013	FLANGE, RING, 24" MANWAY, 50# F.F. (029B02003)
2	1	029-01811	FLANGE, BLIND, 24" MANWAY, 50# F.F. (029B01761)
3	1	603-01385	BOLT & GASKET ASSY, 24" 50# F.F. MANWAY (603B01382)
4	1	841-01640	EYE BOLT, PLAIN, FORGED
5	1	952-00111	WASHER, FLAT, PLATED WROUGHT STEEL
6	2	869-00086	NUT, HEX, 1/2"-13



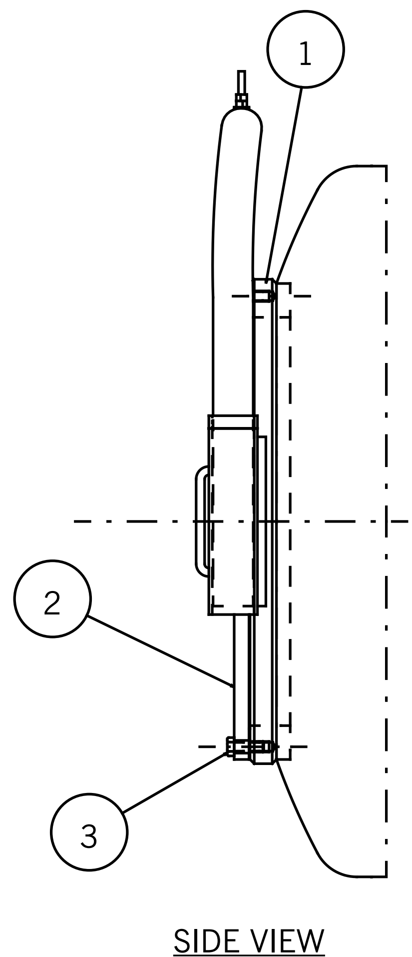


Table 5-23 MANWAY ASSEMBLY, 24" DAVITED, 50# D.P.

ASSEMBLY P/N 317-00133			
ITEM	QTY	PART NO.	DESCRIPTION
1	1	029B02003	FLANGE, RING, 28" MANWAY, 50# F.F.
2	1	029-01823	FLANGE, BLIND, 28" MANWAY, 50# F.F. (029B01761)
3	1	603-01386	BOLT & GASKET ASSY, 28" 50# F.F. MANWAY (603B01382)
4	1	841-01640	EYE BOLT, PLAIN, FORGED
5	1	952-00111	WASHER, FLAT, PLATED WROUGHT STEEL
6	2	869-00086	NUT, HEX

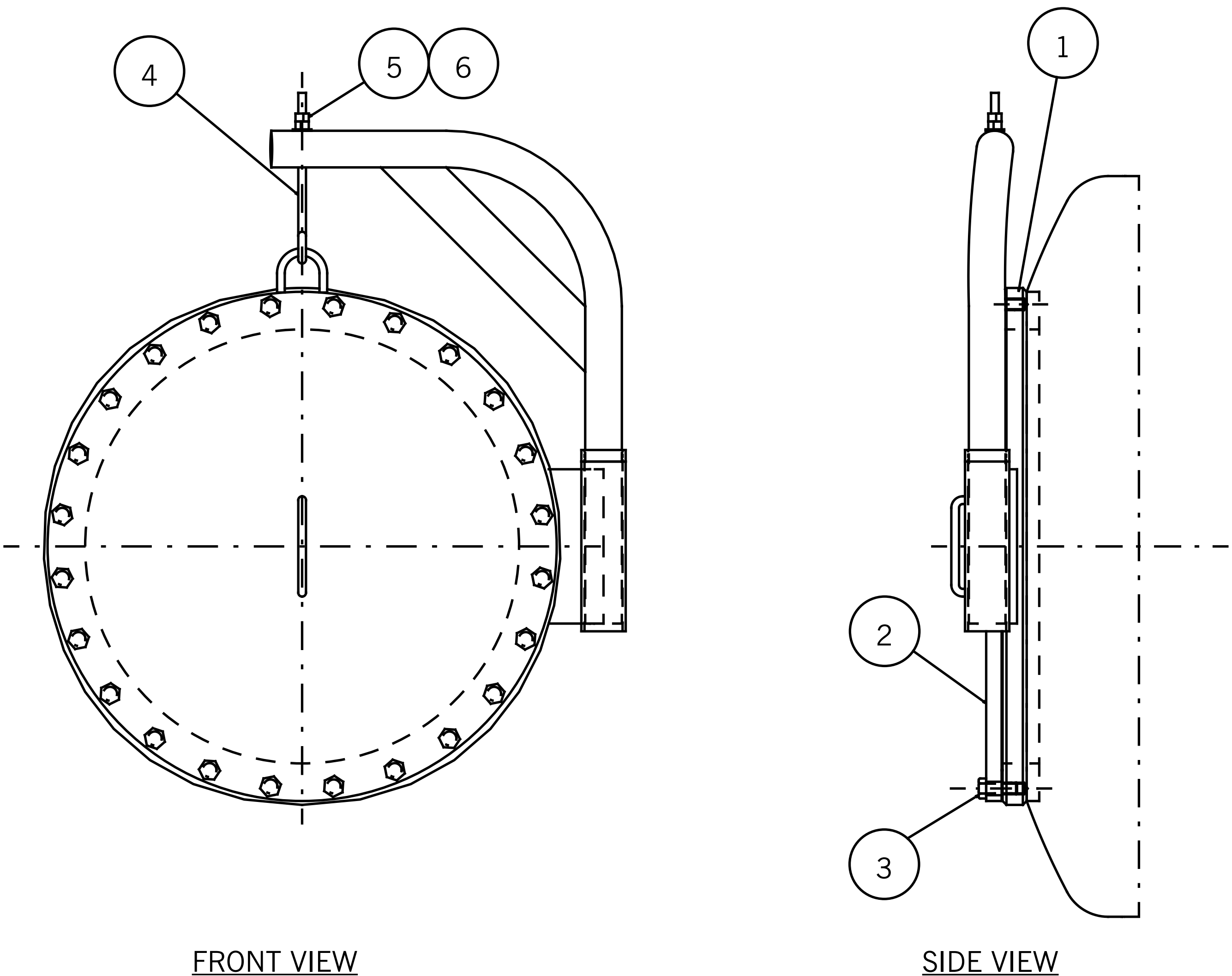


Table 5-24 Manway Assembly, 28" Davited, 50# D.P.

ASSEMBLY P/N 317-00134			
ITEM	QTY	PART NO.	DESCRIPTION
1	1	029-02014	FLANGE, RING, 32" MANWAY, 50# F.F. (029B02003)
2	1	029-01825	FLANGE, BLIND, 32" MANWAY, 50# F.F. (029B01761)
3	1	603-01387	BOLT & GASKET ASSY, 32" 50# F.F. MANWAY (603B01382)
4	1	841-01640	EYE BOLT, PLAIN, FORGED
5	1	952-00111	WASHER, FLAT, PLATED WROUGHT STEEL
6	2	869-00086	NUT, HEX

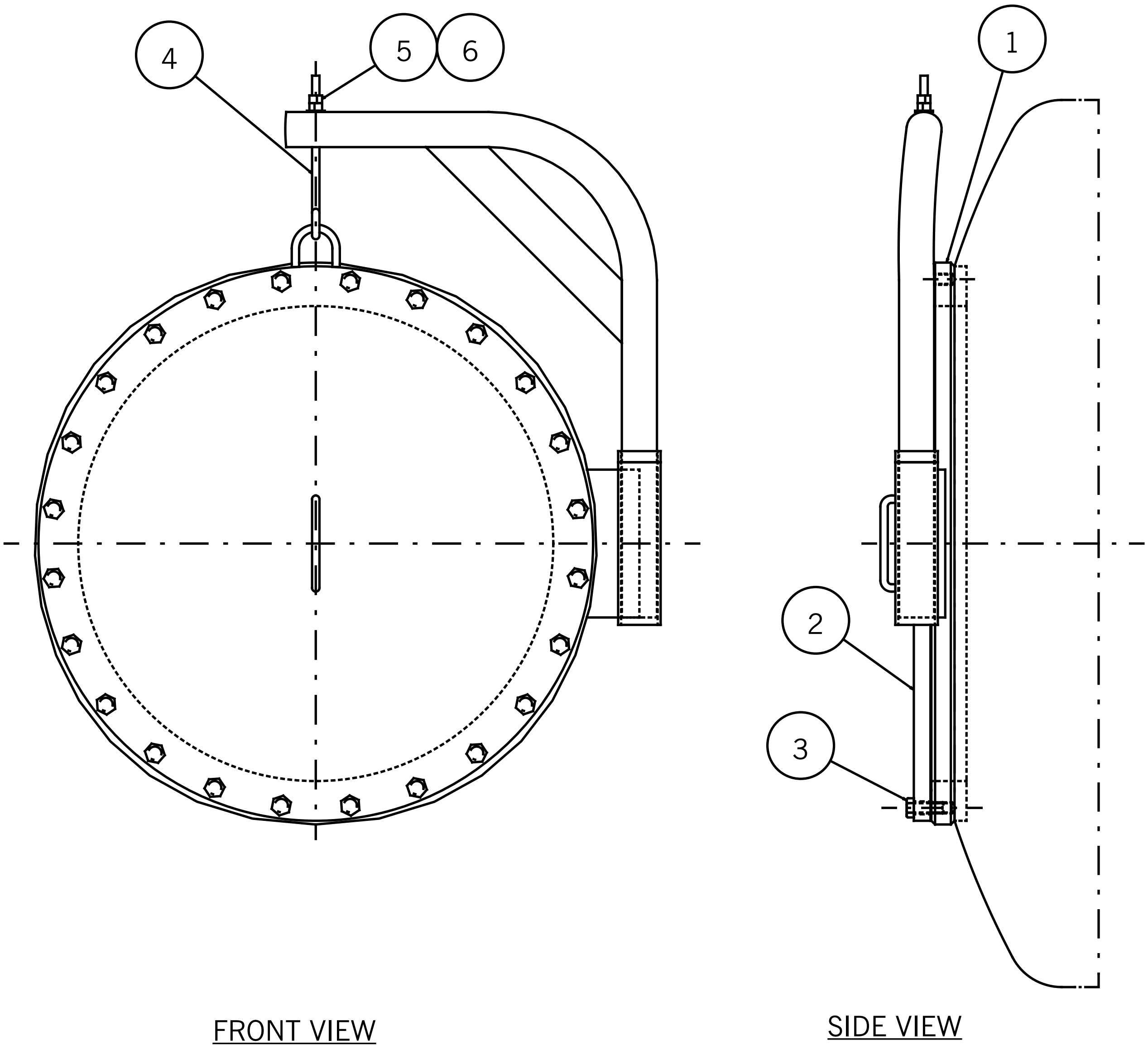


Table 5-25   Maway Assembly, 32" Davited, 50# D.P.

ASSEMBLY P/N 317-00135			
ITEM	QTY	PART NO.	DESCRIPTION
1	1	029-02015	FLANGE, RING, 36" MANWAY, 50# F.F. (029B02003)
2	1	029-01799	FLANGE, BLIND, 36" MANWAY, 50# F.F. (029B01761)
3	1	603-01388	BOLT & GASKET ASSY, 36" 50# F.F. MANWAY (603B01382)
4	1	841-01684	EYE BOLT, PLAIN, FORGED
5	1	952-00205	WASHER, FLAT, PLATED WROUGHT STEEL
6	2	869-00040	NUT, HEX

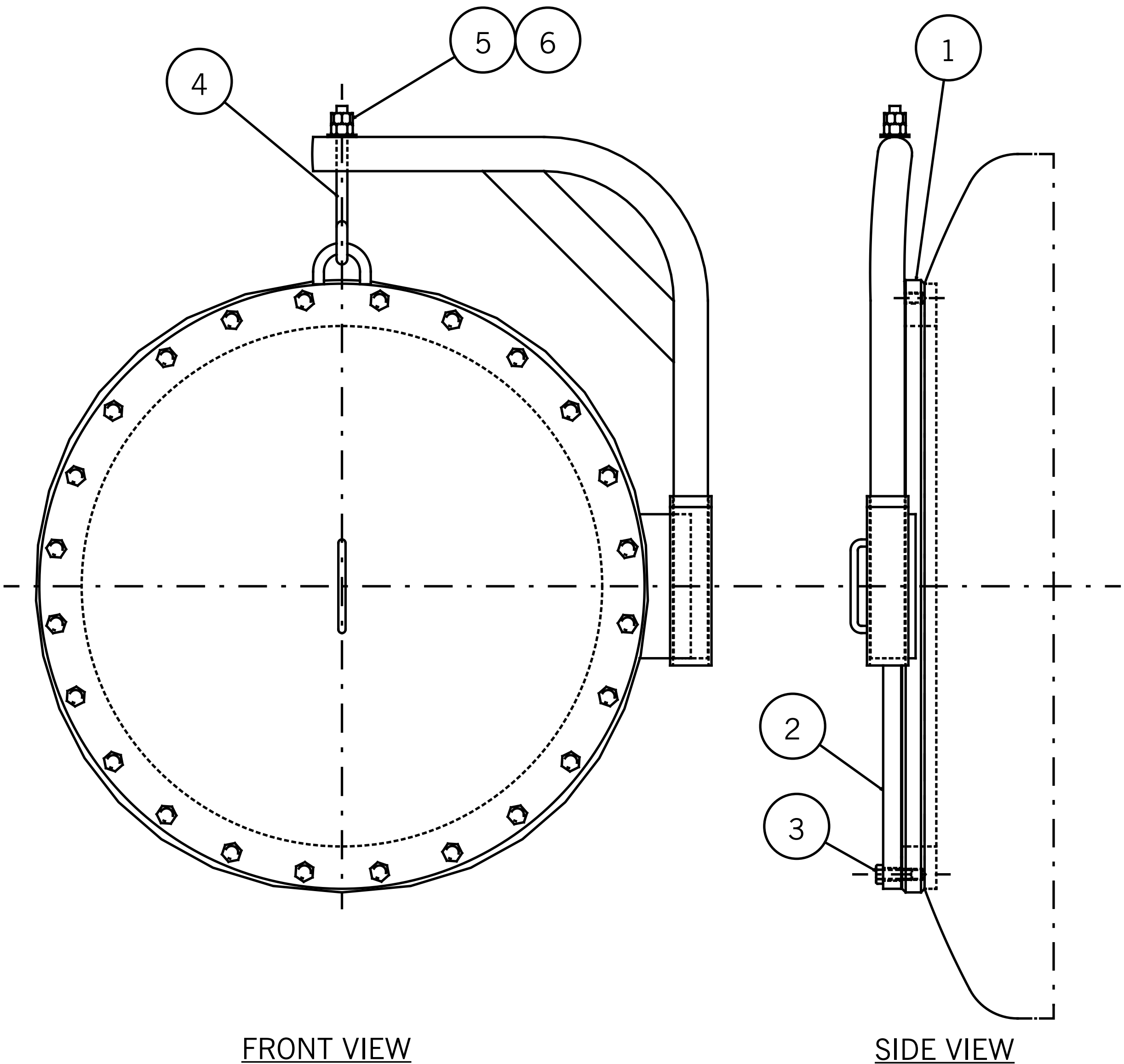
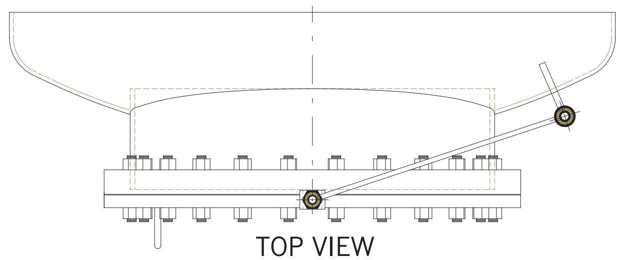


Table 5-26 Manway Assembly, 36" Davited, 50# D.P.

36"	32"	28"	24"	20"	MANWAY SIZE			
656-D-5923	656-6202	656-6203	656-7443	656-6798	ASSEMBLY PART NO.			
PART NO.	PART NO.	PART NO.	PART NO.	PART NO.	ITEM	REQ.	PART NO.	DESCRIPTION
029-01799	029-01825	029-01823	029-01811	029-01778	1	1	SEE TABLE	FLANGE, BLIND, F.F.
603-00697	603-00696	603-00695	603-00691	603-00636	2	1	SEE TABLE	ASSEMBLY, STUD BOLT, GASKET & NUT
					3	1	868-00202	CAPSCREW, HEX. HD.
					4	2	952-00124	WASHER, FLAT
					5	1	869-00018	NUT, HEX.



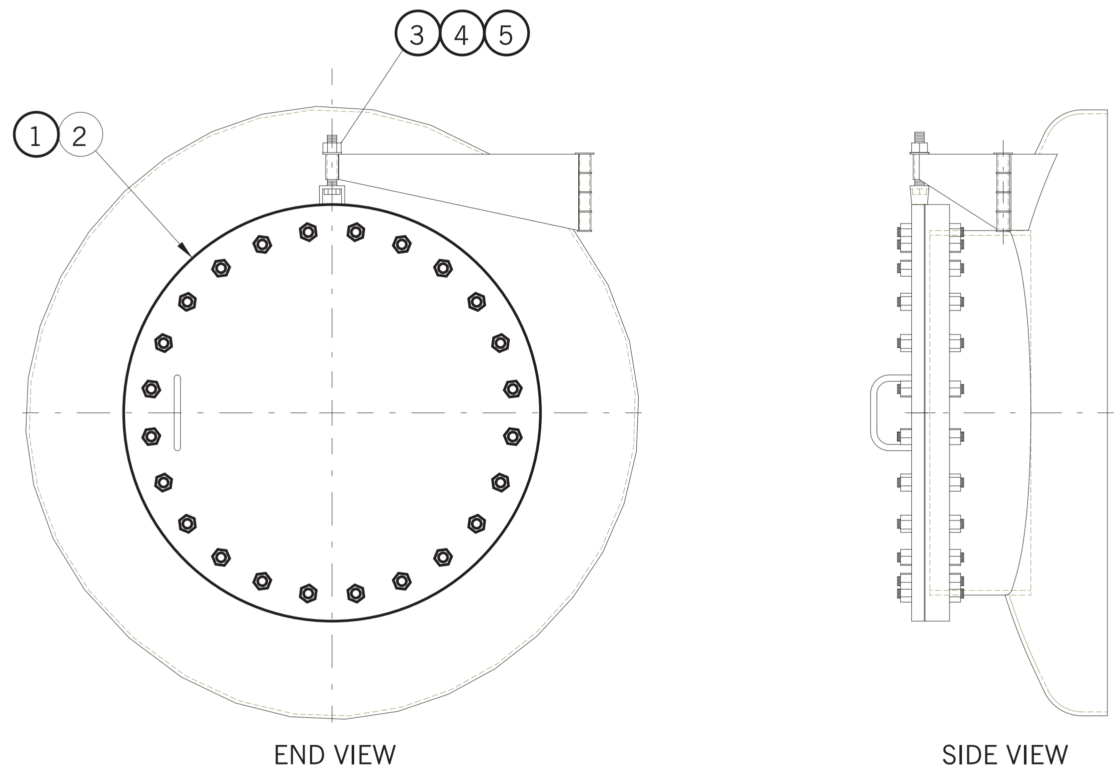


Table 5-27 Manway Assembly, 20"-36", Hinged Design, 50# D.P.

APPENDIX

Spraymaster Signature

High Pressure Deaerator

CONTENTS

GENERAL

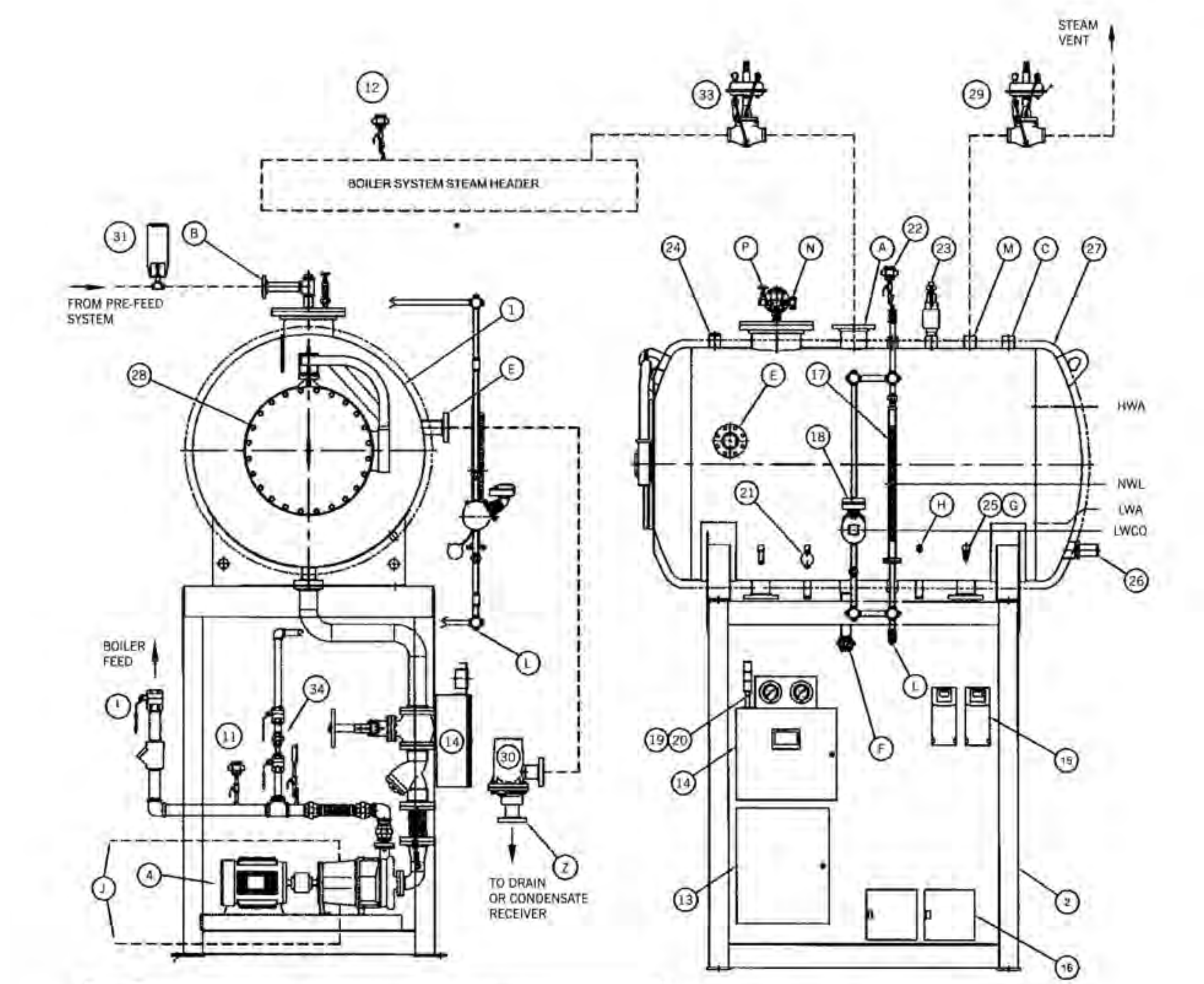
The Cleaver-Brooks High Pressure Deaerator is designed to operate in steam generation plants that have a high percentage of high temperature condensate returns. These high temperature returns when introduced into the deaerator create a high percentage of flash steam in the vessel increasing the pressure in the deaerator. Most standard deaerators are designed to operate under a maximum allowable pressure of 50 psig. However, as a practical limitation, standard deaerators are limited to operate at a nominal pressure of 15 psig or nominal temperature of 250°F due to the limitation of the most standard boiler feedwater pumps. When the deaerator pressure exceeds the equipment pressure limitation, the steam must be vented out of the deaerator through a back pressure relief valve creating a waste of valuable energy and water.

The Cleaver-Brooks High Pressure Deaerator is a design variation of the standard Cleaver-Brooks Signature Deaerator line with increased ratings including special equipment and controls to operate the deaerator at higher operating pressures and temperatures. Operating the deaerator at higher pressure limits the flash steam created by reducing the pressure drop of the high temperature returns entering the vessel thus reducing or eliminating the requirement to vent steam through the back pressure relief valve. Refer to your deaerator dimensional diagrams furnished with your deaerator for the designed pressure and temperature ratings of your deaerator.

COMPONENTS & CONTROL

Refer to the prior sections of this manual and to the (ADAC) Advanced Deaerator Control O&M manual (P/N 750-236) for details on the description of components and the operation and control common to all Cleaver-Brooks Signature deaerators. This appendix details the special components and operating procedures of the high pressure deaerator. Refer to Figure A-1 for the locations of the components and connections of the high pressure deaerator. Refer to Figure A-2 for a simplified flow schematic.

Steam Pressure Control - The high pressure deaerator control system has unique steam pressure control logic to address the complexities of operating a high pressure deaerator. The deaerator operating steam pressure is transmitted to the ADAC from the Deaerator Pressure Transmitter (22). The deaerator operating pressure is controlled by the Steam Pressure Control Valve (33) which supplies steam to the steam inlet assembly. Operating pressure is set by the ADAC High Pressure Deaerator Step Program based on the pressure in the boiler system steam header (see below, **Step Program Description**, for programming information). The step program monitors the pressure of the boiler header transmitted from the Header Pressure Transmitter (12), and sets the deaerator pressure to maintain a differential below the boiler system pressure in order to ensure proper flow through the system. This pressure differential allows condensate to be returned to the deaerator during startup of the boiler system and during normal operation. If the pressure of the deaerator exceeds the limits of the deaerator, the Back Pressure Control Valve (29) will open to relieve the excess pressure. However, if this situation continues to occur, it should be investigated as to the possible cause of over-pressurization.



ITEM	MAJOR COMPONENTS
1	PRESSURE VESSEL
2	STAND
4	HIGH TEMPERATURE PUMP
11	PUMP DISCHARGE PRESSURE TRANSMITTER
12	HEADER PRESSURE TRANSMITTER
13	CONTROL PANEL
14	CONTROL PANEL, ADAC, TOUCHSCREEN
15	VARIABLE SPEED DRIVE
16	LINE REACTOR
17	GEM SURESITE WITH 4-20 mA TRANSMITTER
18	LOW WATER CUTOFF ALARM SWITCH
19	THERMOMETER
20	PRESSURE GAUGE
21	TEMPERATURE TRANSMITTER, WATER
22	DEAERATOR PRESSURE TRANSMITTER, STEAM
23	RELIEF VALVE
24	VACUUM BREAKER
25	CHEMICAL FEED QUILL
26	HIGH TEMPERATURE RETURN DIFFUSER TUBE
27	FIBERGLASS INSULATION AND LAGGING
28	MANWAY
29	BACK PRESSURE VALVE
30	OVERFLOW DRAINER
31	MAKEUP WATER VALVE
33	STEAM PRESSURE CONTROL VALVE
34	PUMP RECIRCULATION ORIFICE

ITEM	MAJOR CONNECTIONS
A	STEAM INLET
B	WATER INLET
C	HIGH TEMPERATURE RETURN
D	RELIEF VALVE CONNECTION
E	OVERFLOW
F	DRAIN CONNECTION
G	CHEMICAL FEED CONNECTION
H	SAMPLE CONNECTION
I	PUMP DISCHARGE
J	BEARING COOLING (SUPPLY - DRAIN)
L	LEVEL CONTROL DRAIN
N	AUTOMATIC VENT VALVE
P	MANUAL VENT VALVE
Z	OVERFLOW DRAINER OUTLET

NOTE: SOME CONNECTIONS AND COMPONENTS MAY BE DIFFEERENT ON YOUR SYSTEM. REFER TO YOUR DIMENSION DIAGRAMS FURNISHED WITH YOUR DEAERATOR FOR DETAILS.

Figure A-1 High Pressure Deaerator Components and Connections

High Temperature Boiler Feed Pump - The high temperature boiler feedwater pump furnished with the deaerator is specifically engineered and designed to operate with high temperature boiler feedwater. Refer to the pump manufacturer's O&M manual furnished with the equipment for details on startup and maintenance of the pump. Depending on the operating temperature, the pumps may require cooling water to the bearings of the pump. The pump discharge pressure is controlled by a Variable Speed Drive (15) which varies the pump discharge pressure based on the pressure of the deaerator and boiler system steam header. The ADAC High Pressure Step Program varies the pressure based on a differential of the pressure of the boiler system. This maintains a relatively fixed differential across the boiler feedwater valve independent of the variations of the deaerator pressure and the boiler operating pressure.

Pre-Feed System - If the deaerator operating pressure exceeds the pressure of the makeup water system supply or exceeds the low pressure condensate return pressure, a Pre-Feed System must be installed. The Pre-Feed System collects low pressure condensate returns and treated makeup water and pumps the water to the high pressure deaerator makeup valve.

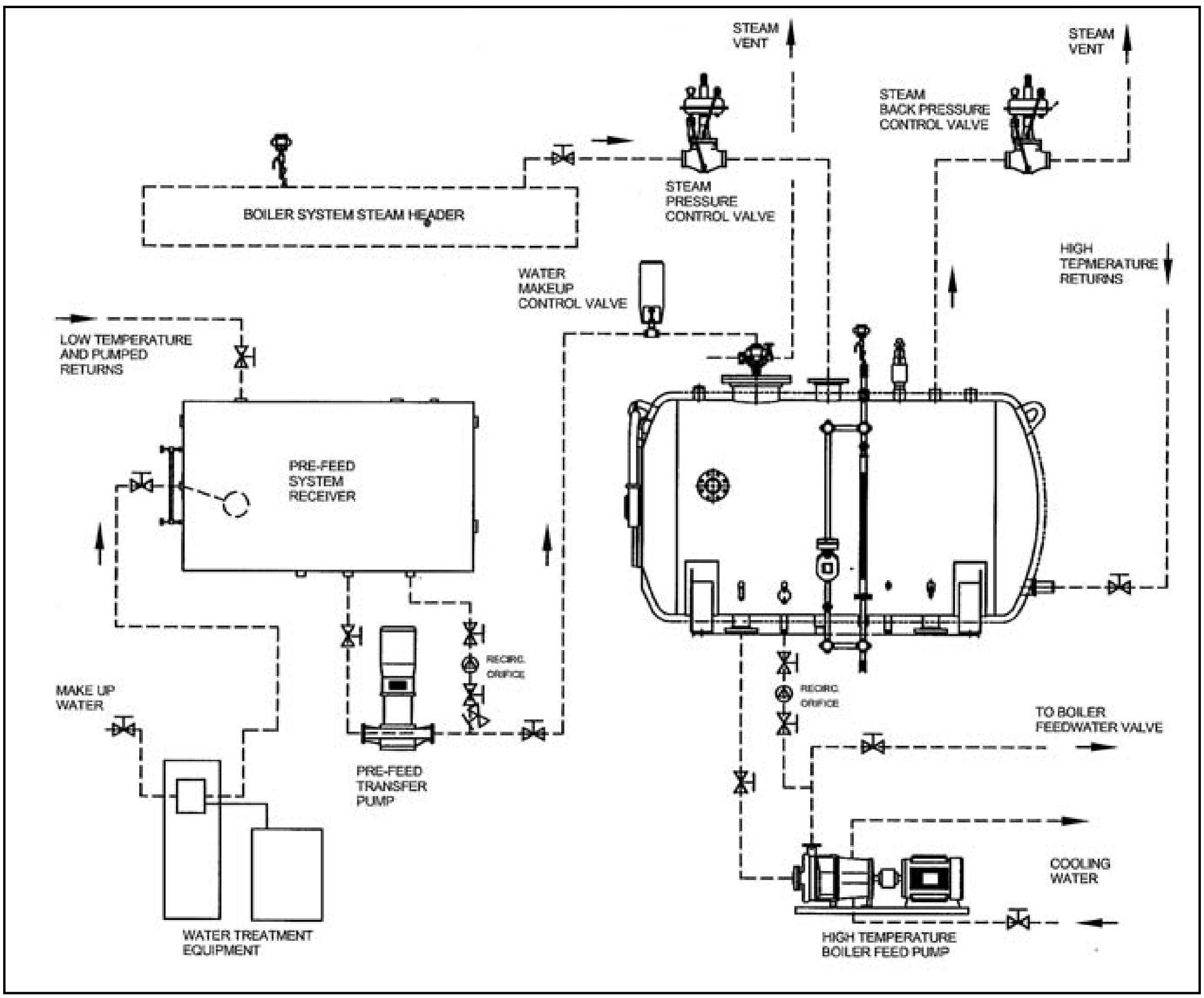


Figure A-2 High Pressure Deaerator Flow Schematic

HIGH PRESSURE DEAERATOR SYSTEM STARTUP

1. Verify ADAC panel is powered and screen is in ready mode.
2. If ADAC panel is powered off, verify all pumps selector switches are in OFF position before energizing. See ADAC O&M manual (P/N 750-236) for details on operation.
3. OPEN all primary makeup water valves going into HPDA and Pre-Feed System and verify all makeup water Pre-Feed System bypass valves are CLOSED.
4. Visually confirm water levels in Pre-Feed System and High Pressure Deaerator (HPDA).
5. Verify Pre-Feed Transfer Pump recirculation valves are OPEN.
6. Verify all condensate return valves are OPEN on Pre-Feed System and HPDA.
7. Activate the Pre-Feed Transfer pump and verify steady discharge pressure.
8. Check oil level in High Temperature Boiler Feedwater Pumps - Level to be at bull's eye sight glass centerline. Refer to the operating manual supplied with the pumps.
9. OPEN Feedwater Pump cooling water line.
10. Verify Feedwater Pump recirculation valves are OPEN.
11. OPEN isolation valve if closed allowing steam to flow to Steam Pressure Control Valve.
12. In ADAC Screen Select Menu select FEED PUMP CONTROL menu.
13. Verify in Pump Control Menu that Lead/Lag control is OFF.
14. Verify or put Feedwater Pump Selector Switches into AUTO position.
15. Select START LEAD LAG button in Feed Pump Control Menu.
16. Check for Alarms.
17. Verify feed pump has started and discharge pressure has reached First Stage Pressure.
18. Follow procedures given with boiler to start boiler system and bring system up to pressure.

HIGH PRESSURE DEAERATOR SYSTEM SHUTDOWN

1. Follow procedures given with boiler to shut down boiler system.
2. Wait for boiler system to completely steam down.
3. After you have assured the boiler is fully steamed down and will not require feedwater, Select ADAC Pump Control Menu and Select STOP LEAD/LAG button.
4. Verify feed pumps shut down.
5. Shut down Pre-Feed System Transfer Pumps.
6. It is recommended to leave ADAC control system powered and energized if system shut down for short periods.

STEP PROGRAM DESCRIPTION

This program has all the features of the standard ADAC programs plus the added sequences described here. For details on the standard features refer to the ADAC O&M manual and the ADAC reference document.

This part of the program uses a separate steam header transmitter to send a 4-20 mA signal to the ADAC PLC.

The program has up to 7 steps (number of steps is user defined).

For each step the user defines the header pressure range, pump discharge pressure set point, and PRV pressure set point. Note that pressure control is only available with the use of VSD's on the pumps and a PRV that can be controlled with a 4-20 mA signal.

There is also a time setting to delay moving from one step to the other when pressure is increasing, and a deadband for moving down a step when pressure is decreasing. There is also a ramp speed setting to control the speed of the set point change from one range to another to ensure the transition is smooth and bumpless.

Example configuration:

Step	Steam Header Pressure	Pump Discharge Pressure	DA Tank Pressure	Delay moving up a step (sec)	Pressure Deadband moving down (psi)	Ramp Rate % / sec
1	0-25	50	5	30	5	10
2	25-50	65	15	30	5	10
3	50-75	90	30	30	10	10
4	75-100	120	50	30	10	10
5	100-110	125	75	30	2	10
6	110-125	140	85	30	2	10
7	125-130	150	100	30	2	10

The HPDA program indexes the operating setpoints for the Tank Pres and the Boiler Feedwater Pres control loops to the Steam Header Pres variable. Likewise, the Tank Pres HIGH alarm value is indexed by manually entering a unique PAH value for each set point from a screen display provided for this purpose.

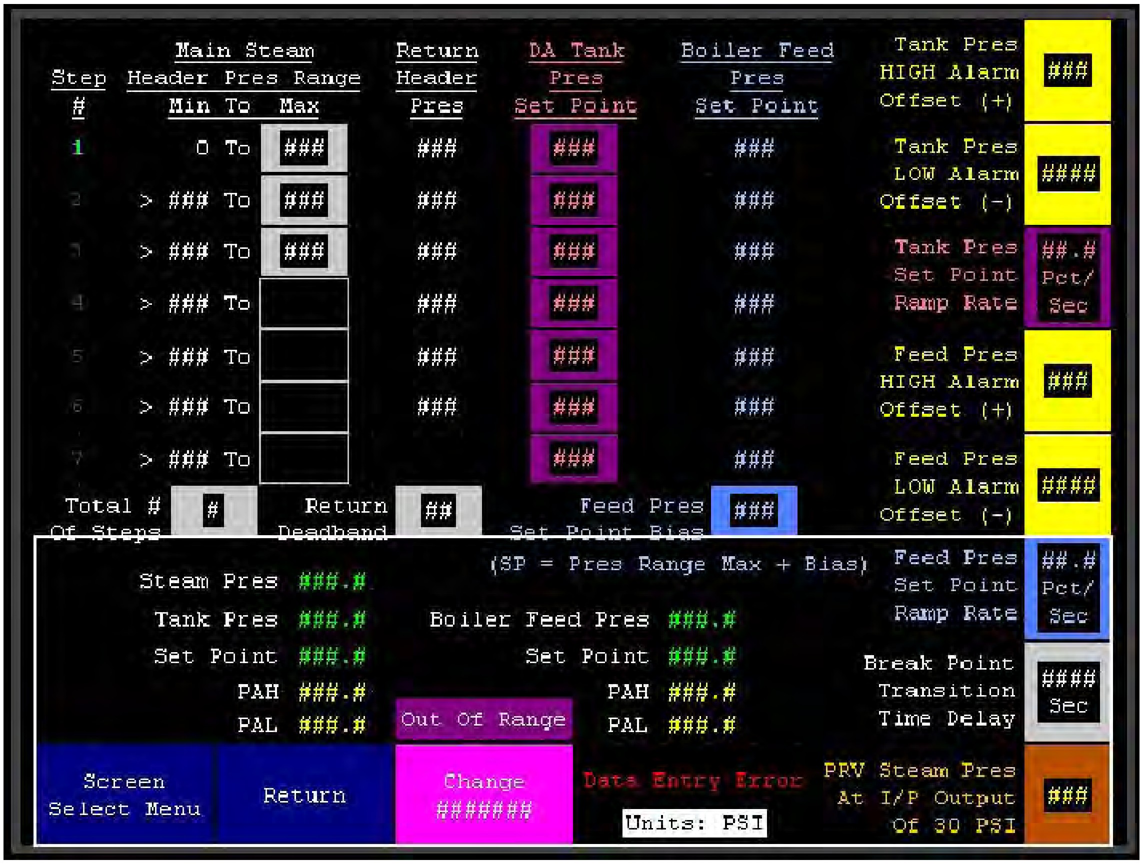
For all the alarm values indexed to Steam Header Pres we enter a HIGH Deviation value and a LOW Deviation value. For example, for the Tank Pres HIGH alarm, we enter 20 PSI. The alarm value then for all Tank Pres setpoints is:

PAH=Setpoint+HDev

PAL=Setpoint+LDev (LOW Deviation would be entered as a negative number (e.g. -20)

When the system starts up and the header pressure is between 0-25 psi, the pumps will deliver 50 PSI and the PRV will modulate to maintain 5 psi. When the header pressure passes 25 psi, the timer counts to 30. If the pressure has stayed above 25 then the ramp rate increases the setpoints to the second step settings. Each step follows this method.

If the pressure drops below a range set point - for example if the pressure dropped below 50 psi for more than 30 seconds and had reached 40 psi (50-10) then the set points will change to the step below, again using the ramp rate.



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