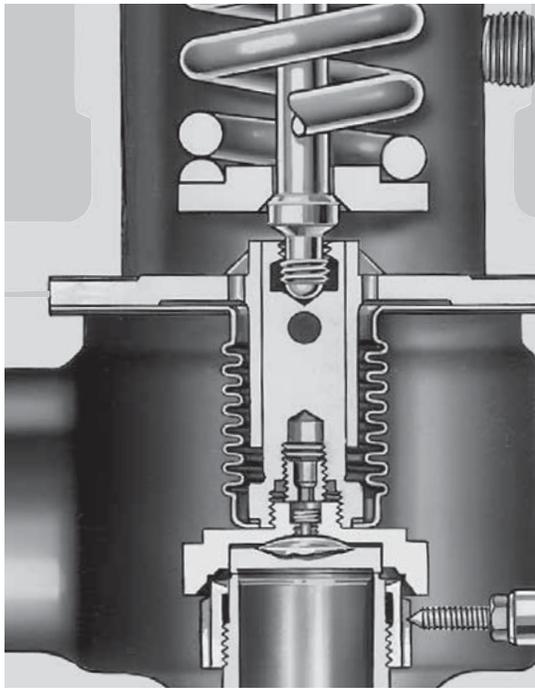
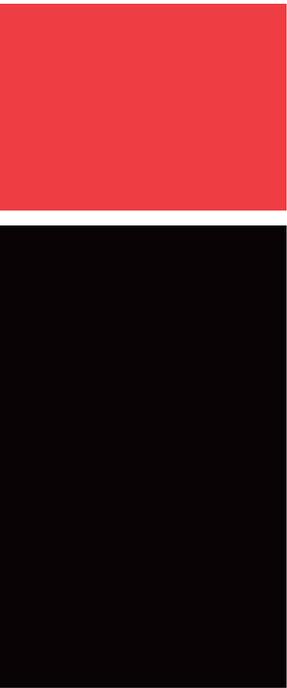


Series 2600

Maintenance Manual





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1. Introduction

This maintenance manual is provided because you have Farris Engineering 2600 Series pressure relief valves protecting equipment and personnel in your plant. We trust that you will find this manual useful, as it is intended to clearly present all the essential information you will need in order to keep your Farris valves in perfect operating condition.

Any maintenance and repair work or testing performed on Farris pressure relief valves should be done in strict accordance with the requirements of all applicable Codes and Standards. Persons performing the work should maintain proper authorization through applicable governing authorities.

To ensure reliable and safe operation, installation, testing, maintenance, adjustment, and repair of Farris valves, these activities shall only be performed by qualified personnel having the required skills and training. No repair, assembly, adjustment or testing performed by individuals other than Farris-authorized representatives shall be covered by the warranty extended by Farris to its customers. All applicable regulations, directives, codes and standards shall be adhered to when performing these activities. Failure to follow proper test procedures or failure to use proper test equipment will lead to incorrect test results, damage to the valve and will invalidate the warranty.

Farris Engineering provides programs which coordinate classroom and hands-on training. It is recommended that individuals performing pressure relief valve maintenance receive training specific to those valve series they expect to repair and set. Only this type of training will ensure the proper application of these instructions. The National Board of Boiler and Pressure Vessel Inspectors conducts training programs on valve repair in conjunction with their VR program. This is a broad-based program and is recommended to supplement training received from specific manufacturers.

These instructions do not cover all details or variations in equipment, nor do they provide for every possible contingency to be met in regards to installation, operation or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purposes, please contact Farris Engineering.

2. Safety Warning and Instruction System

You will find safety warnings and instruction labels throughout this manual. These have been included to ensure your safety and must be followed. Safety labels are vertically oriented rectangles as shown in the samples below. These labels consist of three panels inside a border. Each safety label will communicate the following three key pieces of information. This information is communicated using narrative and pictorials.

- The nature and severity of the hazard
- The consequence of the hazard, if not avoided
- The precautions and measures required to avoid the hazard.

The top panel of the safety label illustrates the signal word (DANGER, WARNING, or CAUTION) which communicates the severity of the hazard, per the above explanations. The center panel contains a pictorial which communicates the nature of the hazard, and the possible consequence of hazard, if not avoided. In some cases, the pictorial may depict the precautions or measures required to avoid the hazard. The bottom panel will then contain the remaining narrative information needed to ensure all three key pieces of information have been conveyed.



DANGER:
Indicates hazards which, if not avoided, will result in death or serious injury.

WARNING:
Indicates hazards which, if not avoided, could result in death or serious injury.

CAUTION:
Indicates hazards which, if not avoided, could result in minor or moderate injury.

NOTICE:
"NOTICE" is reserved for instructions given to prevent property, product, or environmental harm.

SAFETY INSTRUCTIONS:
"SAFETY INSTRUCTIONS" indicates processes or procedures recommended to ensure safety.

General Safety Instructions

The maintenance manual is provided by Farris Engineering, a business unit of Curtiss-Wright Flow Control Company, to its customers as general guidance for the repair and maintenance of Farris valves described herein. Pressure relief/safety valves are critical components in pressurized systems to ensure the safety of people, the environment, and property. Always follow all manufacturer and industry standard recommendations relating to proper installation, testing, maintenance, and reconditioning.

This manual should not be considered an exhaustive manual. Certain configurations, applications, and usages may not be covered. If there is specific information needed which is not covered in this manual, the customer is advised to contact Farris using the contact information on the back of this manual. All information presented in this manual is subject to change without notice. The purchaser should contact Farris regarding any possible changes in information or specifications.

To ensure reliable and safe operation, installation, testing, maintenance, adjustment, and repair of Farris valves, these activities shall only be performed by qualified personnel having the required skills and training.

No repair, assembly, adjustment or testing performed by individuals other than Farris-authorized representatives shall be covered by the warranty extended by Farris to its customers. All applicable regulations, directives, codes and standards shall be adhered to when performing these activities. Failure to follow proper test procedures or failure to use proper test equipment will lead to incorrect test results, damage to the valve and will invalidate the warranty.

Likewise, use of parts in any maintenance or repair activity other than factory-supplied OEM parts will invalidate the warranty extended by Farris to its customers. Incorrect selection or application of Farris valves on the part of the customer is not covered by the warranty extended by Farris to its customers.

These general safety instructions have been provided not only to protect the product and warranty but also are provided for an individual's personal safety in handling Farris pressure relief valves. Failure to follow these procedures could result in severe bodily harm or even death.

- All possible hazards may not be identified in this manual. Conduct your own safety risk assessment given your specific system, environment, and configuration, and ensure proper control procedures are in place to prevent personal injury or illness and property, product or environmental harm.

DANGER

- When the valve is under pressure, do not place any part of your body near or in the path of the outlet of the main valve or other discharge areas. Doing so will result in serious injury or death upon release.
- If a test gag is provided with the valve, it must be removed prior to service installation. Failure to do so will result in equipment failure, serious injury or death in the instance of an overpressure event.

WARNING

- In certain applications it may be impossible to remove the valve from service. Never attempt to remove, adjust, maintain, or repair a pressure relief valve either while it is installed in a pressurized system or on a test stand, unless you have been properly trained to do so. Doing so may result in serious injury or death. Ensure the proper isolation of energy sources and residual pressures by complying with all local, state and country-specific regulations/directives applying to energy control procedures and “lockout/tagout.”
- Ensure that the pressure relief valve and system is at an ambient temperature before inspecting, servicing, or repairing. The valve, system, and contents may be extremely hot or cold. Failure do so may result in serious injury.
- The exhaust from the main valve outlet or any other ports that could exhaust, should be vented to a safe location to eliminate the potential for serious injury or damage during relief operation.

- Prior to valve disassembly, ensure that proper controls are implemented to address potential exposures to hazardous substances, including gases, liquids, or process byproducts contained in or contaminating the valve. Consult applicable material safety data sheets (MSDSs) and established exposure limits for the substances expected to be present to ensure proper exposure controls are implemented. Failure to do so could result in serious injury or illness.
- Ensure the valve is operable at all times and free of potential obstructions due to the conditions of use, or process fluid obstructions resulting from solidifications, byproducts, polymerization or other obstructions. Failure to do so could render the valve inoperable, leading to serious injuries or damage in the event of system over-pressurization.
- Use extreme caution when inspecting a pressure relief valve for leakage. Never use body parts to inspect for flow leaks. Doing so could result in serious injection, burn, or chemical injuries.
- Use all appropriate personal protective equipment to protect against process hazards, including but not limited to, pressurization, temperature extremes, noise, and chemical hazards. Failure to do so could result in serious injury or death.

CAUTION

- Always use the appropriate tools, and in the correct manner, for adjustment or servicing of valves. Failure to do so could result in injury.

SAFETY INSTRUCTIONS

- It is the responsibility of the customer and user of Farris valves to properly train their personnel on all required safety standards and procedures to prevent injuries and illnesses.

3. Serial and Type Numbering Systems

Familiarity with Farris valve type and serial numbering systems will greatly benefit anyone using this manual or any other Farris literature. The ability to recognize certain valve types and construction features along with identifying serial numbers will assist correct maintenance procedures and spare part selection/ordering. All Farris valve nameplates contain a specific valve type number and serial number unique to that particular valve. See Figure 1.2 on page 6 for an example of a typical 2600 Series nameplate.

Serial Numbering System

Each Farris pressure relief valve is assigned a unique serial number. This serial number is assigned by the factory and remains part of the factory records. Providing this serial number to the factory will assist in the identification of the construction and metallurgy of the valve in question. The following outline will give general guidelines on the serial numbering system used on 2600 Series valves.

Serial Suffix Summary For 2600 Maintenance Manual			
Serial # Suffix	Valve Type	Description	Production Dates
-A15/H	2600L BalanSeal "O" Ring Seat Design (Liquid Service)	Improved "G" orifice (150# & 300# Class only) and "F" orifice designs.	2006 - present (G) 2011 - present (F)
-A14/H	2600L Conventional "O" Ring Seat Design (Liquid Service)	Improved "G" orifice (150# & 300# Class only) and "F" orifice designs.	2006 - present (G) 2011 - present (F)
-A15/G	2600L BalanSeal Metal Seat Design (Liquid Service)	Improved "G" orifice (150# & 300# Class only) and "F" orifice designs.	2006 - present (G) 2011 - present (F)
-A14/G	2600L Conventional Metal Seat Design (Liquid Service)	Improved "G" orifice (150# & 300# Class only) and "F" orifice designs.	2006 - present (G) 2011 - present (F)
-A15/M	2600L BalanSeal Design - "O" Ring (air, steam, vapor & liquid services)	Modified "D" through "K" orifice "O" ring seat design that replaced original A14 & A15 "O" ring seat design. Starts at Serial #'s above 300000.	July 1993 - present
-A14/M	2600L Conventional Design - "O" Ring (air, steam, vapor & liquid services)		
-A15	2600L BalanSeal Design (air, steam, vapor & liquid services)	Full nozzle valves conforming to API Standard 526 with ASME Section VIII certification for liquid service. Air & steam certification added in 2005.	1985 - present
-A14	2600L Conventional Design (air, steam, vapor & liquid services)		
-A13	2600 & 2600L BalanSeal Piston Design - All design variations and Services	2600 & 2600L Balanced Piston version of standard 2600 BalanSeal Design. Use of serial suffix changed from A12 to A13 for consistency of numbering system.	Nov. 1997 - present
-A12			1978 - Nov. 1997
-A11/R	2600 BalanSeal Design - "O" Ring (air, steam, & vapor services)	Modified "D" through "K" orifice "O" ring seat design that replaced the modified A10/M & A11/M "O" ring seat design. Starts at Serial #'s above 312123.	August 1996 - present
-A10/R	2600 Conventional Design - "O" Ring (air, steam, & vapor services)		
A11/N	2600 & 2600L BalanSeal Design (air, steam, vapor & liquid services)	Special version of 2600 series built to military specifications with MIL Spec. flanges and semi-nozzle construction	2000 - present
A10/N	2600 & 2600L Conventional Design (air, steam, vapor & liquid services)		2000 - present
A11/H	2600 BalanSeal "O" Ring Seat Design (air, steam, & vapor services)	Improved "G" orifice (150# & 300# Class only) and "F" orifice designs.	2006 - present (G) 2011 - present (F)
A10/H	2600 Conventional "O" Ring Seat Design (air, steam, & vapor services)	Improved "G" orifice (150# & 300# Class only) and "F" orifice designs.	2006 - present (G) 2011 - present (F)
A11/G	2600 BalanSeal Metal Seat Design (air, steam, & vapor services)	Improved "G" orifice (150# & 300# Class only) and "F" orifice designs.	2006 - present (G) 2011 - present (F)
A10/G	2600 Conventional Metal Seat Design (air, steam, & vapor services)	Improved "G" orifice (150# & 300# Class only) and "F" orifice designs.	2006 - present (G) 2011 - present (F)
-A11/M	2600 BalanSeal Design - "O" Ring (air, steam, & vapor services)	Modified "D" through "K" orifice "O" ring seat design that replaced original A10 & A11 "O" ring seat design. Starts at Serial #'s above 300000.	July 1993 - July 1996
-A10/M	2600 Conventional Design - "O" Ring (air, steam, & vapor services)		July 1993 - July 1996
-A11	2600 BalanSeal Design (air, steam, & vapor services)	Full nozzle valves conforming to API Standard 526 with nozzles revised to incorporate ASME 0.9 capacity reduction factor.	1976 - present
-A10	2600 Conventional Design (air, steam, & vapor services)		
-A9	BalanSeal Bellows Design	Full nozzle valves conforming to API Standard 526.	1959 - 1976
-A8	Conventional Design		
-A3, A5, & A7	BalanSeal Bellows Design	Includes both 2605 & 2675 Series	1955 - 1967
-A2, A4, & A6	Conventional Design		
-A	Full nozzle valves, conventional and BalanSeal bellows types.	Serial suffix covers all types of construction including Conventional, FarriSeal, BalanSeal, enclosed and exposed spring designs.	1943 - 1955

Note: Valves covered by serial number suffixes in RED are for obsolete designs.



Type Numbering System

Our type numbering system simplifies the selection and specifying of Farris pressure relief valves because the digits that comprise a specific type number have a distinct significance. The digits describe the basic valve series, orifice, seat and internal construction, inlet temperature range, body, bonnet and spring material, inlet flange class and Code liquid design.

Prefix (if applicable)		26	D				A	1			
		Series Number	Orifice Areas				Construction	Temperatures & Materials			
H* Set Pressure Above API 526 SJ Steam Jacket HTF Heat Transfer Fluid	26	Orifice Letter	Area, Sq. In.		Area, Sq. mm		A Conventional construction B BalanSeal construction C Conventional with O-ring seat pressure seal D BalanSeal with O-ring seat pressure seal E BalanSeal with auxiliary balancing piston F BalanSeal with auxiliary balancing piston and O-ring seat pressure seal T Teflon seat, conventional U Teflon seat, BalanSeal	Designation	Inlet Temperature Range °F	Material	
			API	Actual	API	Actual				Body & Bonnet	Spring
		D	0.110	0.150	71	97		1	-20 to 800	Carbon Steel	Chrome Alloy
		E	0.196	0.225	126	145		2**	451 to 800	Carbon Steel	Chrome Alloy
		F	0.307	0.371	198	239		3	801 to 1000	Chrome Moly Steel	High Temp. Alloy
		G	0.503	0.559	325	361		4*	1001 to 1200	—	—
		H	0.785	0.873	506	563		5*	1201 to 1500	Austenitic St. St.	Inconel Alloy
		J	1.287	1.430	830	923		1	-21 to -75	Use "S3" Trim Options	
		K	1.838	2.042	1186	1317		1	-76 to -450	Use "S4" Trim Options	
		L	2.853	3.170	1841	2045		6	-21 to -75	3-1/2% Nickel Steel	Carbon Steel
		M	3.60	4.000	2323	2581		7	-76 to -150	3-1/2% Nickel Steel	Austenitic St. St.
		N	4.34	4.822	2800	3111		8	-151 to -451	Austenitic St. St.	Austenitic St. St.
		P	6.38	7.087	4116	4572					
		Q	11.05	12.27	7129	7916					
		R	16.0	17.78	10323	11471					
		T	26.0	28.94	16774	18671					
		U	—	31.5	—	203.2*					
		V	—	49.4	—	318.6*					
		W	—	63.6	—	410.2*					
		W2	—	104.0	—	670.8*					
X	—	113.1	—	729.5*							
Y	—	143.1	—	923.0*							
Z	—	176.7	—	1139.7*							

*Available Only on Q, R, T and U Orifices

*The U – Z orifices are not API standard sizes. U – Z metric areas = cm².

This manual only covers maintenance for D – U orifices. For larger orifices, please consult the factory.

* Temperature ranges 4 and 5 are beyond the scope of this catalog. Consult the Factory.

** Temperature range 2 is no longer used as the standard range valve handles temperatures to 800°F.

Note: Items listed in **RED** are for non-current nomenclature designations or options no longer offered.



Figure 1.1 – BalanSeal Identification Plate

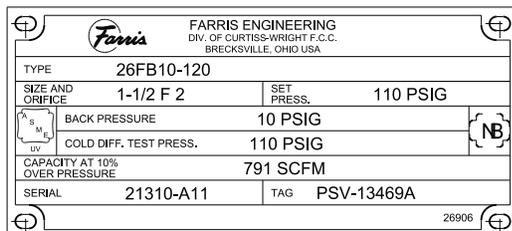


Figure 1.2 – Typical Farris Nameplate

Parts Replacement

Valves – If an exact replacement valve is required, then the valve type, size and serial number must be specified to ensure proper dimensions and material being supplied. If a specific valve is obsolete, a recommendation of the current equivalent will be made if possible.

Spare Parts – When ordering parts, use part names as listed in the bills of materials. Specify valve type, size and serial number. If the serial number is not available, the original Farris factory order number will help us supply the proper part and material.

Springs – Order as an assembly to include spring with upper and lower spring buttons. Specify valve type, size, serial number, set pressure and backpressure, if any.

Note: If valve modification or set pressure changes are required, consideration must be given to correct the nameplate and other data.



2		L -	1	2	0	/S4
Inlet Class		Special Construction (if applicable)	Inlet Facing	Cap Construction	Test Gag	Special Material
Designation	ANSI Nominal Inlet Flange Class	A Expanded API sizes: air, steam and gas service* B Expanded API sizes: ASME liquid valve* C Expanded API sizes: ASME Code Section VIII exposed spring design* D Valve suitable for heat transfer service-vapor E Valve suitable for heat transfer service-liquid F Expanded API size valves suitable for heat transfer service-vapor* G Expanded API size valves suitable for heat transfer service-liquid* H Integral steam jacket expanded API Sizes – Vapor Service J Integral steam jacket Vapor Service K Integral steam jacket – Liquid Service L ASME Code certified for liquid, air and steam service S ASME Code Section VIII exposed spring design X Integral steam jacket expanded API sizes – Liquid Service	0 Special ² 1 Raised Face, ANSI Std. (125 to 160 AARH) 2 Large Female, ANSI Std. 3 Small Male, ANSI Std. 4 Small Female, ANSI Std. 5 Large Tongue, ANSI Std. 6 Large Groove, ANSI Std. 7 Small Tongue, ANSI Std. 8 Small Groove, ANSI Std. 9 Ring Joint (octagonal), ANSI Std. A 125 AARH Smooth Finish B 125 AARH (Outlet Only) C 125 to 160 AARH (Inlet & Outlet) (now indicated by a '1') H 63-83 AARH Smooth Finish RF The following designation can apply to inlet and/or outlet: J 63 to 83 AARH (outlet only) K 63 to 83 AARH (inlet & outlet) X High pressure hub style connection	2 Screwed Cap 3 Bolted Cap 4 Packed Lever 5 L Type Packed Lever 6 R Type Packed Lever 7 Open Lever 8 Remoter (with Packed Lever)	0 Without Gag 1 With Gag	See "Materials for Corrosive Service" Table below.
	0	150				
	1	300 lightweight valve				
	2	300 heavyweight valve				
	3	600				
	4	900				
	5	1500				
6	2500					
		*Letter suffixes for expanded API sizes where 2-1/2" inlet or outlet has been replaced by 3" size.				

Materials for Corrosive Service				
Designation	Body Bonnet, Cap	Special Material Description		
		Nozzle & Disc	Other	Internal Parts
				Springs & Buttons
/S1	Standard	316	316 ¹	316 buttons, Chrome Alloy or High Temperature Alloy Nickel Plated spring
/S2	Standard	316	316	316 buttons, Chrome Alloy or High Temperature Alloy Nickel Plated spring
/S3	316	316	316	316 buttons, Chrome Alloy or High Temperature Alloy Nickel Plated spring
/S4	316	316	316	316
/S5	Standard (NACE)	316	316 & Monel w/Inconel 625 bellows	Standard ²
/S6	Standard (NACE)	316	316 SAS w/standard bellows	Standard ²
/S7	Standard (NACE)	316	316 & Monel w/standard bellows	Standard ²
/H1	Standard	Hastelloy C	Standard	Standard
/H2	Standard	Hastelloy C	Hastelloy C & Monel	316 buttons, Chrome Alloy or High Temperature Alloy Nickel Plated spring
/H3	Hastelloy C [®]	Hastelloy C	Hastelloy C	316 buttons, Chrome Alloy or High Temperature Alloy Nickel Plated spring
/H4	Hastelloy C	Hastelloy C	Hastelloy C	Hastelloy C
/M1	Standard	Monel	Standard	Standard
/M2	Standard	Monel	Monel	316 buttons, Chrome Alloy or High Temperature Alloy Nickel Plated spring
/M3	Monel	Monel	Monel	316 buttons, Chrome Alloy or High Temperature Alloy Nickel Plated spring
/M4	Monel	Monel	Monel	Inconel spring, Monel buttons
/N1	Carbon Steel (NACE)	316 (NACE)	316 ¹	Standard ²
/N4	316 (NACE)	316 (NACE)	316 ¹	316 ²

1. Spring adjusting screw in standard material
 2. The springs shown assume bellows construction. For conventional construction, use Inconel X750.

4. Valve Cross-Section, Parts and Construction

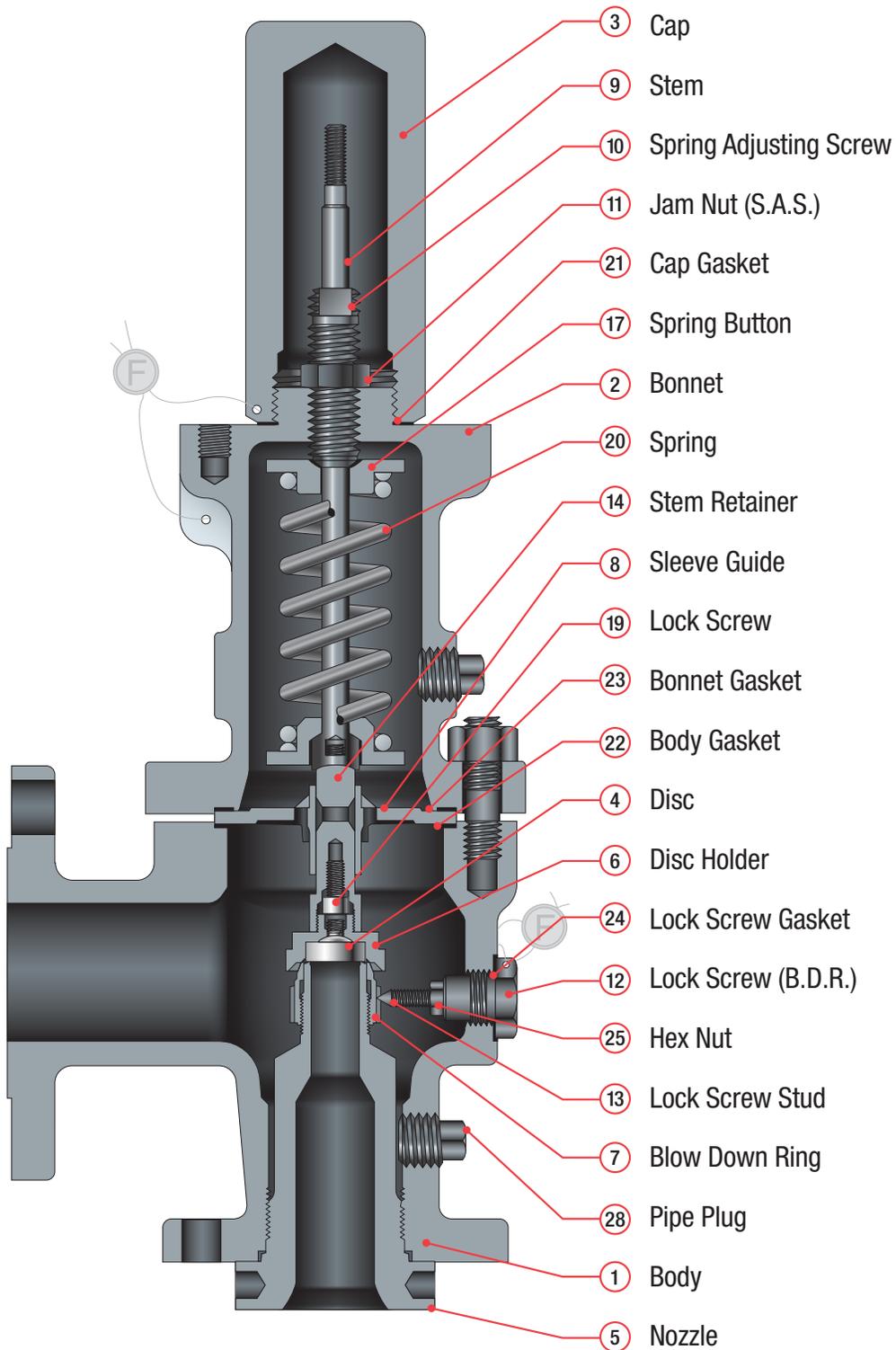


Figure 4.1

General Notes:

The safety valve cross-section illustrated is typical and actual construction details will vary depending on valve size and pressure rating. Consult the other illustrations contained elsewhere in this manual for greater detail or consult the factory for a cross-section drawing for the actual valve size and pressure rating.

Valve Bill of Materials				
Item	Part Name		Conventional (A10) Material	BalanSeal (A11) Material
1	Body	26()10 thru 26()16	SA-216 Gr. WCB, Carbon Steel	SA-216 Gr. WCB, Carbon Steel
		26()32 thru 26()36	SA-217 Gr. WC6, Chrome Moly	SA-217 Gr. WC6, Chrome Moly
2	Bonnet	26()10 thru 26()16	SA-216 Gr. WCB, Carbon Steel	SA-216 Gr. WCB, Carbon Steel
		26()32 thru 26()36	SA-217 Gr. WC6, Chrome Moly	SA-217 Gr. WC6, Chrome Moly
3	Cap		Carbon Steel	Carbon Steel
4	Disc		316 St. St.	316 St. St.
5	Nozzle		316 St. St.	316 St. St.
6	Disc Holder		316 St. St.	316 St. St.
7	Blow Down Ring		316 St. St.	316 St. St.
8	Sleeve Guide		316 St. St.	316 St. St.
9	Stem		316 St. St.	316 St. St.
10	Spring Adjusting Screw		Stainless Steel	Stainless Steel.
11	Jam Nut (S.A.S.)		316 St. St.	316 St. St.
12	Lock Screw (B.D.R.)		316 St. St.	316 St. St.
13	Lock Screw Stud		316 St. St.	316 St. St.
14	Stem Retainer		17-4 Ph. St. St.	17-4 Ph. St. St.
15	Bellows (not shown)		N/A	Inconel Composite
16	Bellows Gasket (not shown)		N/A	Non-Asbestos
17	Spring Button		Carbon Steel, Rust Proofed	Carbon Steel, Rust Proofed
18	Body Stud		ASME SA-193 Gr. B7, Alloy Steel	ASME SA-193 Gr. B7, Alloy Steel
19	Lock Screw (D.H.)		Stainless Steel	Stainless Steel
20	Spring	26()10 thru 26()16	Chrome Alloy Rust Proofed	Chrome Alloy Rust Proofed
		26()32 thru 26()36	High Temp. Alloy Rust Proofed	High Temp. Alloy Rust Proofed
21	Cap Gasket		316 St. St.	316 St. St.
22	Body Gasket		316 St. St.	316 St. St.
23	Bonnet Gasket		316 St. St.	316 St. St.
24	Lock Screw Gasket		316 St. St.	316 St. St.
25	Hex Nut (B.D.R.L.S.)		Stainless Steel	Stainless Steel
26	Hex Nut (Body)		ASME SA-194 Gr. 2H, Alloy Steel	ASME SA-194 Gr. 2H, Alloy Steel
27	Pipe Plug (Bonnet)		Steel	N/A
28	Pipe Plug (Body)		Steel	Steel

Table 4.1

General Notes:
 Parenthesis in type number indicates orifice designation and valve construction, example: 26FA10

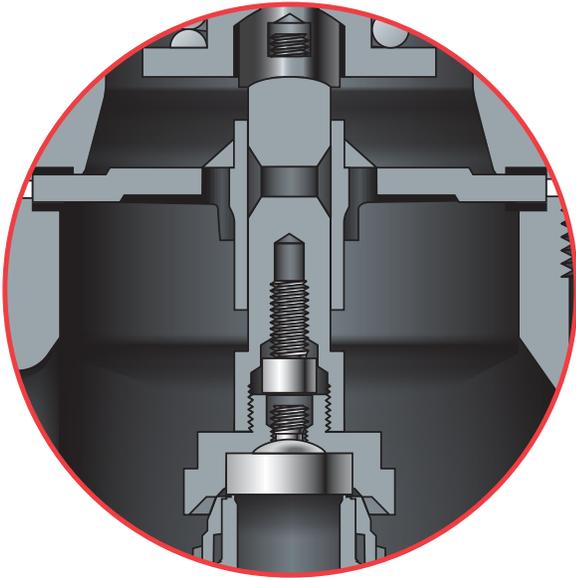


Figure 4.2
Internals for Orifice D-J

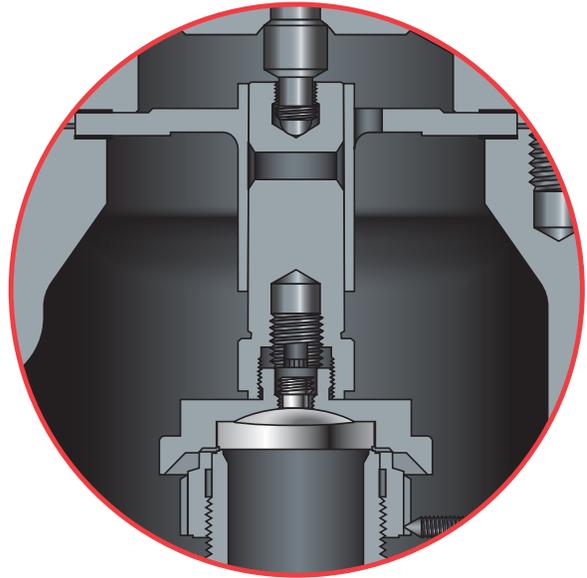


Figure 4.3
Internals for Orifice K-P

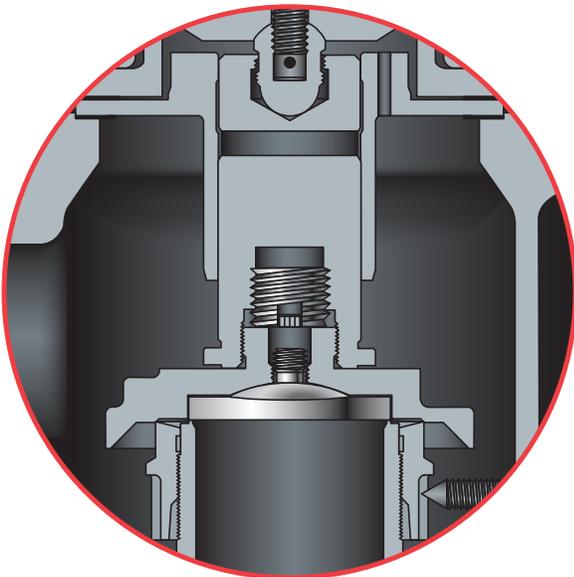


Figure 4.4
Internals for Orifice Q-U

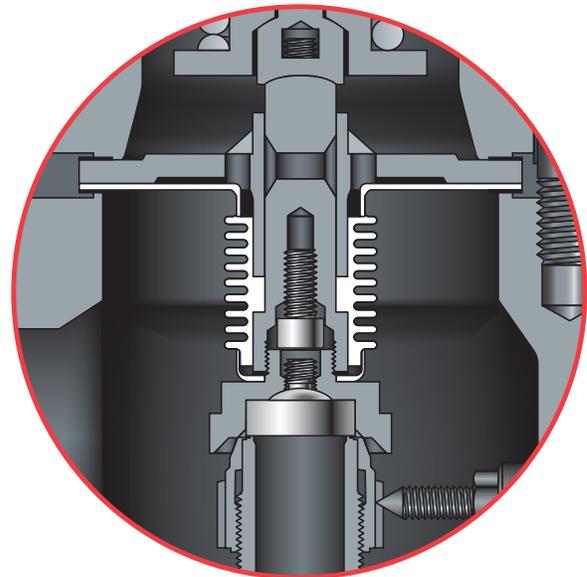


Figure 4.5
BalanSeal® Bellows Safety Valve

5. Valve Removal and Pre-Inspection

General Handling:

After the pressure relief valve is removed from the installation it should be transported to the shop for inspection, testing, maintenance, and resetting. Careful handling in transit is important, as rough handling can change the pressure setting or deform the pressure relief valve parts so they cannot be set or function properly. Flanges on the piping and flange faces on the valve should be protected so that gasket faces are not damaged. Large valves should be handled with suitable rigging equipment to avoid dropping or rough handling. Pressure relief devices should not be stocked in a careless manner and, where practical, they should be segregated and not stored with heavy pipe fittings or other types of valves. Pressure relief valves should be treated as delicate instruments because their accurate functioning is very important to safe plant operation.



Because cleanliness is essential for the satisfactory operation and tightness of a pressure relief valve, all necessary precautions should be taken to keep out foreign materials. Valves which are not installed soon after repair should be closed off properly at both inlet and outlet flanges. Particular care should be taken to keep the valve inlet and internals absolutely clean. Preferably, valves should be stored indoors or in locations where dirt and other forms of contamination are at a minimum. Valves should be handled carefully and not subjected to heavy shocks. If due consideration is not given to this point, some internal damage or misalignment can result and seat tightness may be adversely affected. Store, transport and install valves with the stem in the vertical position.

In practice, a repaired pressure relief valve including one that has been only cleaned or readjusted is called upon to provide the same degree of protection as a new valve. It follows that maintenance personnel must be trained to a level of proficiency that enables them to restore a valve to original condition and function. It is recommended that historical records be established and maintained including test reports. This will provide data to determine the frequency of inspection and repair for various services. One excellent publication for reference on pressure relieving devices is the American Petroleum Institute's (API) **Recommended Practice RP 576, Inspection of Pressure-Relieving Devices**. The use of original manufacturer's replacement parts is necessary to maintain new valve performance, capacity flow and warranty. Farris Engineering expressly voids its warranty and will not be responsible for faulty valve operation if non-factory replacement parts or methods are utilized in product repair.

Field Removal

A visual inspection of pressure relief valves should be made when the valves are first removed from the system. Many types of deposits or corrosive debris may be loose and drop out from the pressure relief valve while it is being transported to the shop. When fouling is a frequent problem, it may be desirable to collect samples for further testing and to make notes regarding deposit location and appearance. Any obstructions in the valve should be noted and corrected.

Inspection of Inlet and Outlet Piping

When a pressure relief valve is removed from service, the upstream and downstream piping is often open and available for inspection. However, where it is the practice to remove pressure relief devices from equipment during operation by closing block valves, it is usually not possible to make a complete inspection of piping. Such inspection should be made when the operation equipment is out of service. Inspection of the piping at the pressure relief valve will often indicate the condition of other process piping which is not readily available for inspection. Piping should be checked for corrosion, indications of thinning and deposits which may interfere with valve operation. The characteristics of the deposits may supply clues regarding leakage from the pressure relief valve in a closed system.

In-Situ Testing

In-situ or in place testing is frequently performed as a substitute for valve removal and in-shop testing. This should not be considered as equivalent to shop maintenance; however it may be employed under controlled situations to extend the shop service frequency of particular valves. The most common method of in-situ testing employs an external power source applied to the valve to determine the valve set pressure at some lower system pressure. While this method can accurately determine the valve set pressure, valve reseal pressure cannot be determined using the method. Care must be exercised with this method to avoid possible valve damage that may go undetected during the in-situ test.



In-Shop Inspection

When a valve is first received in the shop it should be given a visual inspection to note its condition when removed from service. The results of this inspection should be noted on appropriate forms. It is generally considered important to determine the set pressure of the valve when removed from service and prior to the valve being disassembled. If the valve opens at the set pressure, the valve need not be tested further to determine the as-received relieving pressure. If the initial pop is higher than the set pressure, it is advisable to test a second time. If the valve then pops at approximately the set pressure, this indicates that the valve was probably stuck because of deposits. If the valve does not pop near the set pressure, this indicates that the valve setting was either in error originally or may have been changed during operation.

Valves which are found acceptable upon shop pre-test cannot be returned to service with a National Board "VR" stamp being applied unless they are completely disassembled and complete repairs are undertaken. Some maintenance programs may however authorize valves found acceptable on shop pretest to be returned to service based on historical records, tear-down cycles and all seals and valve identifications remaining intact.

Preparation For Maintenance

Before valve teardown is performed a review of previous maintenance records will assist in an understanding of past valve performance, settings and maintenance requirements. A complete maintenance records management system will allow proper stocking of common replacement items such as gaskets and seals and adequate stocking of major replacement parts such as nozzles, discs, and springs. Maintenance records, when properly updated, can serve to identify the need for ordering spare parts when valve servicing shows that the useful life of a particular part has been reached. Rework details and installation of new parts should be recorded to aid future service activities.

6. Disassembly Instructions

General Disassembly of Valves

After the valve is received and checked it is ready for shop inspection and repair. The valve should be carefully dismantled. If you are unfamiliar with this line of Farris valves carefully study the cross-sectional drawings in Figures 4.1 through 4.5 to familiarize yourself with part terminology and location. Proper facilities should be available for segregating parts as the valve is dismantled. At each stage in the dismantling process, all parts of the valve should be visually inspected for evidence of wear and corrosion. If parts are worn, replace them. See Appendix G for necessary tools.

The following general points will provide a brief checklist to follow during disassembly. Detailed discussion will follow for specific critical parts.

- Check for the presence of wire seals at all points of adjustment.
- Check for complete and properly identified nameplates and tags.
- Check the condition of flanges; look for evidence of pitting, roughening, deterioration of gasket surface, distortion, etc.
- Visually inspect springs for evidence of corrosion, cracking, and correct selection.
- Visually inspect bellows (if the valve is of bellows type).
- Examine o-ring condition (if applicable).
- Visually inspect inlet and outlet openings; look for evidence of deposits of foreign material and for corrosion. Note the condition of external surfaces and look for any indication of corrosion or evidence of mechanical damage.
- Check and note the body, nozzle and bonnet wall thickness, thread and stud condition.
- Verify valve components and material and check against nameplate information.



Disassembly Instructions:

Farris 2600 Series valves should be disassembled as described below. Parts identification may be found in Figure 4.1 on page 8. The parts from each valve should be properly marked and segregated to keep them separate from parts used in other valves.

1. Cut the wire seals and remove the **Cap** [3] and **Cap Gasket** [21]. For valves equipped with a lifting lever, follow the instructions in Appendix D. **(Figure 6.1)**
2. Before loosening the **Jam Nut** [11], measure the location of the **Spring Adjusting Screw (SAS)** [10] by marking the **SAS** [10] above the **Jam Nut** [11]; or by counting the number of counter clockwise revolutions of the **SAS** [10] until the **Spring** [20] is no longer compressed. This will allow the approximate set pressure to be re-established when reassembling the valve. **(Figure 6.2)**
3. Remove the **Jam Nut** [11] and **SAS** [10].



Figure 6.1

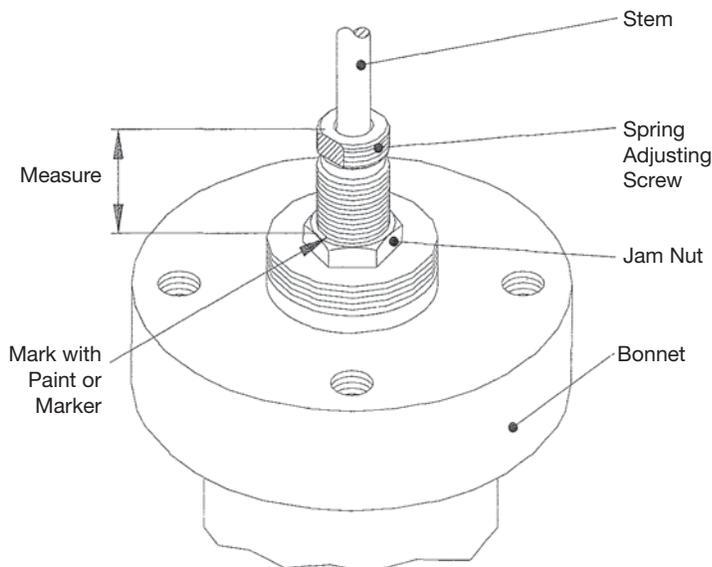
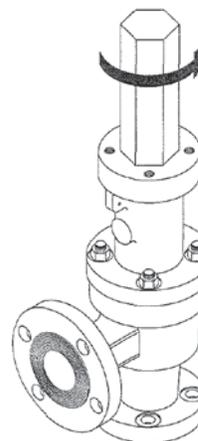


Figure 6.2

4. Remove the **Blow Down Ring Lock Screw** assembly [12,13, 25] and **Lock Screw Gasket** [24]. Record the position of the **Blow Down Ring** [7] with respect to the **Disc Holder** [6] by counting the number of notches required to raise the ring until it just touches the **Disc Holder** [6]. This information will be needed again when reassembling the valve. **(Figure 6.3)**
5. Remove the **Body Hex Nuts** [19]
6. Record the position of the bonnet drain relative to the valve outlet and remove the **Bonnet** [2].
 - a. On larger valves, the combination of bonnet weight and the height that it must be lifted to clear the **Stem** [9] requires that a hoist be used to remove the **Bonnet** [2]. During this operation, the valve **Body** [1] should be secured to prevent it from tipping over once the **Bonnet** [2] is removed.
 - b. Use care when lifting the **Bonnet** [2] as the **Spring** [20] and **Stem** [9] will be able to tip over.
7. Remove the spring assembly (**Spring** [20] and **Spring Buttons** [17]) from the **Stem** [9]. The spring assembly must be kept together. The **Spring Buttons** [17] should be tagged for later identification as the upper and lower buttons may not be identical.

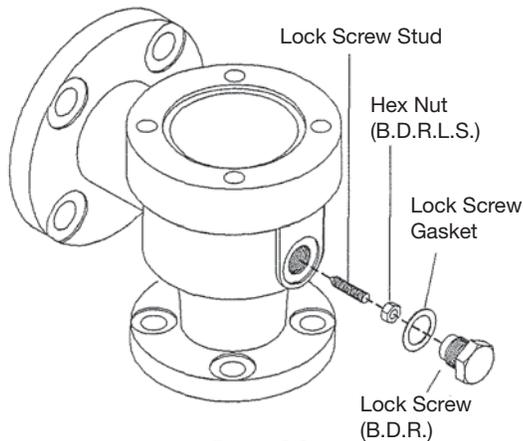


Figure 6.3

8. Using the **Stem** [9] as a handle, lift the complete internal assembly from the valve **Body** [1]. **(Figure 6.4)**
 - a. On larger valves a hoist is advisable due to the weight of the internal assembly.
 - b. An eye bolt may be attached to the stem test washer thread at the end of the **Stem** [9] to assist in lifting.
 - c. For balanced bellows valves, use care not to damage the bellows assembly.
 - d. If parts are difficult to remove due to the presence of corrosive or foreign material soaking in a suitable solvent may be required.
9. Remove the **Body Gasket** [22] and **Bonnet Gasket** [23].
10. To remove the **Stem** [9] from the **Stem Retainer** [14], lift up on the **Stem** [9] while holding the **Stem Retainer** [14] down and rotate counter-clockwise at the same time. This will engage the thread. Continue rotating until the **Stem** [9] is removed. **(Figure 6.5)**

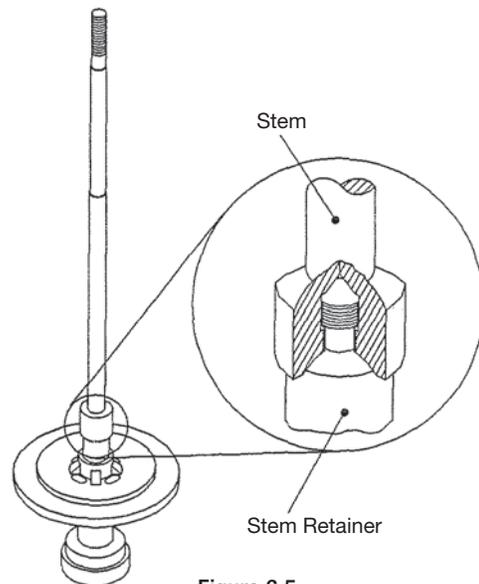


Figure 6.5

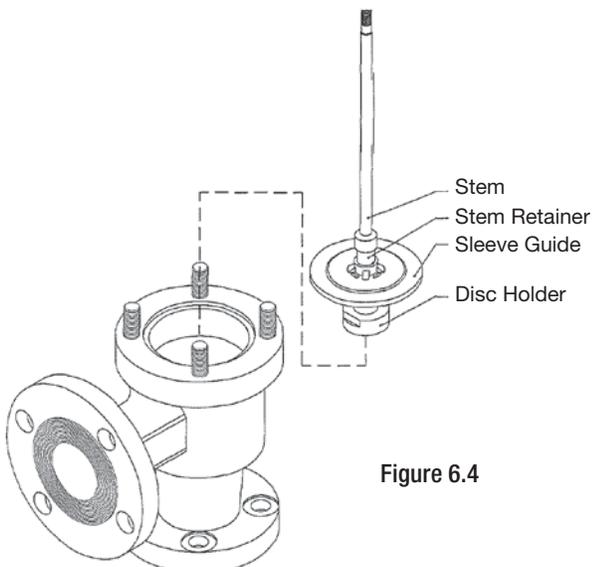


Figure 6.4

11. Remove the **Disc** [4] from the **Disc Holder** [6] (**Figure 6.6**).
 - a. Hold the assembly and rotate the **Disc** [4] with the tip of your finger.
 - b. For o-ring seat type valves, refer to Appendix C for instructions.
12. To separate the **Disc Holder** [6] from the **Stem Retainer** [14], first thread the lock screw up into the **Stem Retainer** [14] using the fixture shown in **Figure 6.7** to hold the assembly.
 - a. Except for the D & E orifice bellows (A11) designs which have a one piece stem retainer/disc holder, the **Stem Retainer** [14] and **Disc Holder** [6] are held together with a **Disc Holder Lock Screw** [26].
 - b. The **Disc Holder Lock Screw** [26] has a hex socket requiring the use of an Allen key (**Figure 6.8**).
 - c. Locking tension is relieved by threading the lock screw UP INTO the **Stem Retainer** [14].

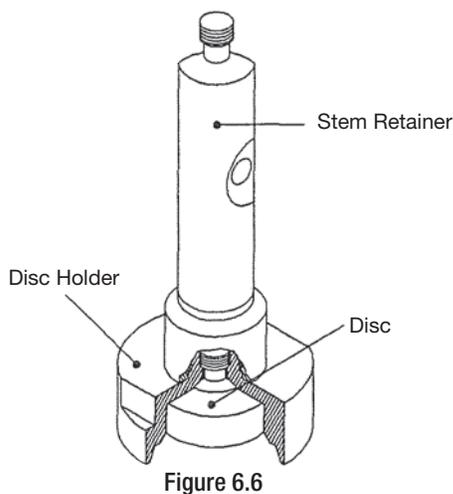


Figure 6.6

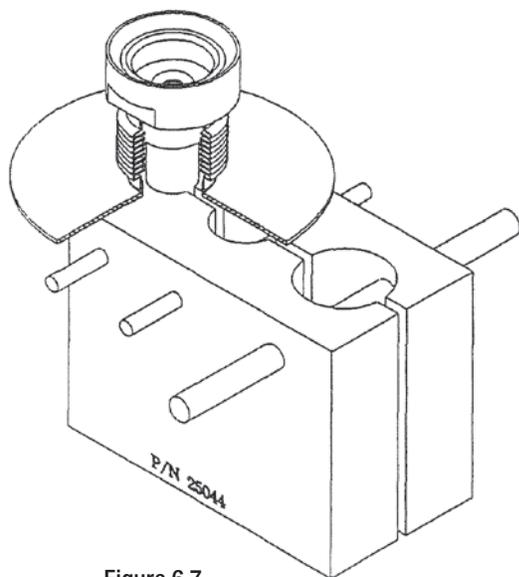


Figure 6.7

- d. Allen key wrench sizes are shown in **Table 6.1**.
 - e. Be careful not to damage the guiding surface of the **Stem Retainer** [14] during disassembly.
 - f. For bellows valves see Appendix B.
13. Remove the **Blow Down Ring** [7] from the **Nozzle** [5].
 14. Turn the valve **Body** [1] over and re-clamp to the work bench. With a spanner wrench and mallet, remove the **Nozzle** [5] from the **Body** [1].
 - a. Some valves may use wrenching flats instead of spanner holes.

NOTES:

1. For **BalanSeal Bellows construction**, please see Appendix B for disassembly instructions.
2. For **O-Ring seat construction**, please see Appendix C for disassembly instructions.
3. For **open lever, packed lever and bolted cap construction**, please see Appendix D for disassembly Instructions.

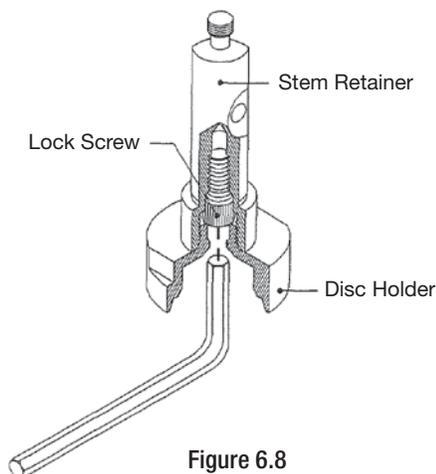


Figure 6.8

Allen Key Sizes	
Disc Holder Lock Screw	
Orifices	Allen Key Size
D thru J	3/16"
K thru P	7/32"
Q thru T	3/8"

Table 6.1

7. Cleaning and Inspection

7.1 Cleaning

Blast Cleaning

2600 Series body, bonnet and cap castings can be sand or bead blasted. When blast cleaning, exercise caution to protect internal and machined surfaces to avoid causing damage. Protect the nameplate prior to blast cleaning. It is not recommended to blast internal parts.

Brush Cleaning

Internal parts (except for guiding surfaces) and the inside of the body and bonnet castings can be cleaned with a wire brush and/or grinder until they are clean. Exercise caution when brush cleaning to avoid damaging or eroding the parts. Only clean stainless steel brushes should be used on stainless steel components.

Immersion/Washing

Castings and internal parts should be thoroughly cleaned with an appropriate solvent or cleaning solution. After immersion/washing, ensure that any residue is removed and parts are dried completely.

Polishing

Guiding surfaces on the stem, stem retainer and guide can be polished using a fine emery cloth.

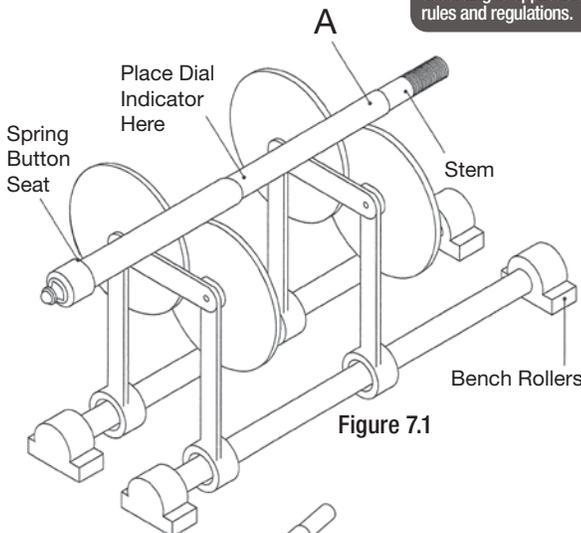


Figure 7.1

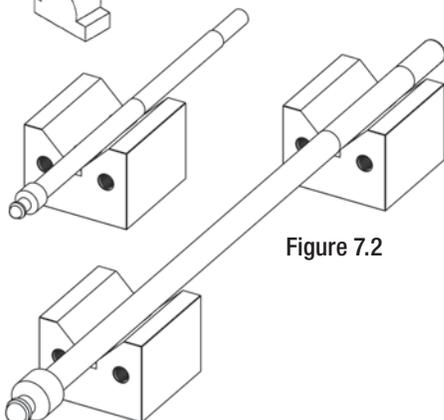


Figure 7.2

7.2 Inspection

Check all valve parts for wear and corrosion. Inspection of valve components is important to ensure proper valve performance. **Damaged valve parts must be repaired or replaced with OEM parts.**



The valve seat (nozzle and disc) must be examined to determine if they have been damaged. Typically, lapping the nozzle and/or disc is all that is needed to restore these parts to their original condition. Prior to lapping, or if machining is necessary, consult section 8 and Appendix E, Critical Dimensions.

The valve spring should be inspected for evidence of cracking, pitting, corrosion or deformation. If any of these are found, the spring should be replaced.

The guiding surfaces on the sleeve guide and stem retainer should be checked for evidence of pitting, corrosion, distortion or galling. If found, these parts should be replaced.

Stems should be inspected as follows:

1. Check the bearing point on the stem tip for a smooth surface. Lap if necessary against the mating part to improve the surface. If the spherical contact is destroyed, the stem should be replaced.
2. Check the critical stem areas for concentricity using the following procedures (Figure 7.1 and 7.2):
 - a. Using "V"-Blocks or bench rollers, check the stem at the midpoint and also at the lower spring button radius for any runout.
 - b. By applying a machinist's dial indicator and rotating the stem, the total indicator reading should not exceed 0.007 inches. Straighten if necessary.
3. The top area of the stem just below the threads serves as the valve's upper guiding surface in conjunction with the spring adjusting screw. This area is supplied from the factory with a 63 AARH finish. This area should be free from any signs of galling, corrosion, distortion or pitting. If seen, the stem should be replaced.

For BalanSeal valves, the bellows should be inspected for evidence of cracking, pitting, corrosion or deformation that might develop into a leak.

Check and inspect all gaskets for evidence of damage or corrosion. Typically, gaskets should be replaced prior to assembly.

8. Maintenance and Repair Procedures

Nozzle Refacing

1. Prior to refacing the nozzle seating area, grip the nozzle flange in a lathe chuck fitted with soft jaws (preferably with removable top jaws), and bored on each set-up to fit the nozzle flange outside diameter.
2. True up the nozzle by means of an indicator, ensuring that the nozzle bore and the machined surface between the nozzle threads and body sealing surface are concentric with each other, within 0.002" full indicator reading.
3. Machine a light cut across the seat until the damaged areas are removed, ensuring compliance with Appendix E. The seat should be machined to the smoothest possible finish. Rigidity of the cutting tool is critical.
4. Relap to the required finish.
5. Discard and replace the nozzle when the length from the seat to the flange becomes less than the minimum specified by the manufacturer. Do not reduce the nozzle flange thickness in an attempt to maintain the "L" dimension. The valve center to face dimension will be altered as a result and nozzle strength may be impaired.
6. See Appendix E for Critical Dimensions.



Lapping Compounds

The three grades of Farris Lapping Compounds are prepared especially for the requirements of pressure relief valves. These are the only compounds recommended for achieving extreme valve tightness. These compounds are available in 2 ounce tubes. Use sparingly.

Farris Lapping Compounds			
Part No.	Grade	Finish	Size
18632X1 (055)	3F	Roughing	1/2 oz. tube
18633X1 (075)	38-500	Medium	1/2 oz. tube
18634X1 (105)	38-1200	Final	1/2 oz. tube

Lapping Procedures (Manual)

1. Use a cast iron lapping block or Pyrex lapping glass which is known to have a perfectly flat face.
2. Select the appropriate lapping compound. When lapping the disc, operate with a light figure eight motion over entire block surface. In this way complete contact will be made (Figure 8.1).

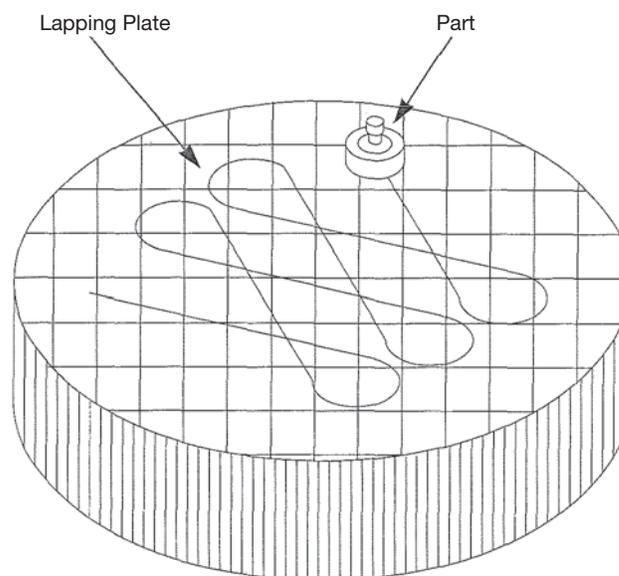


Figure 8.1

Disc Refacing

1. Prior to refacing the disc seating area, grip the disc outside diameter in a universal three-jaw lathe chuck fitted with soft jaws (preferably with removable jaws), and bored on each set-up to the disc outside diameter. Avoid excessive chucking force.
2. True up the disc by means of an indicator, ensuring that the disc outside diameter and seat face are true with each other within 0.002" full indicator reading.
3. Machine light cuts across the seat at 90° to the axis until the damaged areas are removed, facing to the smoothest possible finish. Rigidity of the cutting tool is critical.
4. Relap flat across the full width of the raised seating surface.
5. Discard and replace the disc when the thickness is less than the value in Appendix E.
6. See Appendix E for Critical Dimensions.

3. Lap the disc until all blemishes and score marks have been removed. As the figure eight motion is executed, frequently lift the disc away from the block to get a fresh bite on the compound. Most important, do not contaminate compounds with dirt. Store lapping blocks and lapping glass in a clean, dust-free area.
4. Follow the same procedure for lapping the nozzle. When lapping nozzles, the nozzle can be placed on a table and a lapping block placed on the nozzle. Be sure that the lapping block does not tip over the side of the nozzle (which would cause rounding of the edges). Use a light, rapid figure eight stroke, lifting the block from the nozzle occasionally.
5. When finished, be sure that all parts are carefully cleaned of all lapping compound using a suitable solvent. Residual compound may damage the seating surfaces during valve operation. When reassembling the parts in the valve be careful not to scratch or score the seating surfaces.
6. If the nozzle or disc is badly scored or pitted a fine machine cut should be made to reface the surfaces following instructions in the refacing section of this manual.

Lapping Procedures (Machine)

Lapping machines come in a variety of styles. There are limitations to the parts that can be lapped, which may be due to constraints of the lapping machine or the nature of the part to be lapped.

Limitations:

1. **The size of the lapping machine.**
Obviously, you will be limited by the size of the lapping plate on the machine. A part that is larger than the lapping plate capacity will have to be hand lapped.
2. **The weight of the part to be lapped.**
Some parts will be too heavy to lap on the machine, relative to the area to be lapped. These parts will have to be hand lapped.
3. **How well the part can be balanced on the lapping machine.**
Due to geometry and weight distribution of the part, the part may tend to wobble or fall over in the lapping machine. For these types of parts a holding fixture should be designed or the part should be lapped by hand.

General Operation

This is a general procedure for the use of lapping machines. ALWAYS FOLLOW THE MANUFACTURER'S OPERATING INSTRUCTIONS.

Thoroughly clean all contaminants from the seat area of the nozzle or disc to be lapped. Place the nozzle or disc seating area on the lapping plate. Turn on the machine and adjust the flow of lapping fluid which should be enough to keep the lapping plate covered with a thin film. The lapping plate should be neither dry nor overly lubricated.

The duration of time that the nozzle or disc should be lapped is dependent on the weight of the part, the hardness of the material, and the area to be lapped. A combination of a heavy part with a small area to be lapped made from a soft material will take the shortest time to lap. A combination of a light part with a large area to be lapped made from a hard material will take the longest time to lap.

Once the lapping is complete, remove the nozzle or disc from the lapping plate and remove the lapping fluid with soft tissue and suitable solvent. Protect the seating areas with soft tissue covered by a plastic cap.

Lapping Machine Maintenance and Seat Inspection

Seat flatness is critical to achieving leak tight seats. As the width of most pressure relief valve seats is quite narrow, it is difficult to check seat flatness directly with a monochromatic light. Instead, a standard test block should be kept on the lapping machine that can be periodically checked to determine the condition of the lapping plate. If the test block "reads" flat then all parts lapped on the machine will also be flat. Since the lapped surface needs to be reflective in order to "read" the surface flatness using a monochromatic light source and optical flat, a polishing stand is a needed accessory. Remove the test block from the lapping machine and clean off all lapping fluid. Rub the test block on the polishing stand as if you were hand lapping the test block. Only a few strokes will be necessary to make the surface reflective enough to allow reading the lines produced by the monochromatic light. For full details on how to read these lines and the subsequent adjustments of the machine consult the lapping machine manufacturer.

The quality of the lapped surface produced by the lapping machine can only be as good as the level of maintenance of the machine itself.

9. Assembly Instructions

Lubrication and Sealant:

Threaded parts should be lubricated to prevent galling, especially parts made of similar materials. In addition, guides and pivot points should contain lubricant which is compatible with the service conditions. Sealant should also be applied to prevent fluid from escaping valve boundaries, especially if back pressure is present. The adjacent table lists the suggested lubricant and sealant for air, steam, and liquid service. Service conditions may dictate that other lubricant or sealant be used.



Item	Thread Lubrication	Air	Steam	Liquid
1	Pipe Plug/Body	A	A	A
2	Lock Screw (BDR) Body	A	A	A
3	Blowdown Ring/Nozzle	D	D	D
4	Lock Screw Stud/Jam Nut (BDRLS)	A	A	A
5	Disc/Disc Holder	A	A	A
6	Stem Retainer/Disc Holder (if Applicable)	A	A	A
7	Lock Screw (DH)/Stem Retainer	A	A	A
8	Stem Retainer/Stem	A	A	A
9	Pipe Plug/Bonnet (if applicable)	A	A	A
10	Spring Adjusting Screw/Bonnet/Jam Nut	A	A	A
11	Plain Cap/Bonnet (if applicable)	A	A	A
12	Body Stud/Body/Hex Nut	A	A	A
Guiding and Pivot Lubrication				
13	Disc/Disc Holder	A	A	A
14	Sleeve Guide/Stem Retainer	D	D	D
15	Stem Retainer/Stem	A	A	A
16	Spring Button/Stem	A	A	A
17	Spring Button/Spring Adjusting Screw	A	A	A
Sealant				
18	Body/Nozzle	A	A	A
19	Body/Bonnet/Sleeve Guide/Gaskets	A	A	A
20	Bonnet/Gasket/Cap (if applicable)	A	A	A
21	Bellows Gasket	B	B	B

Code for Above Recommended Lubrication and Sealant

A = Bostic Never Seez

B = Molykote 3452

D = No Lubrication

* Service conditions may require an alternate lubricant or sealant

Assembly Instructions

Farris 2600 Series valves should be assembled as described below. Parts identification may be found in Figure 4.1 on page 8.

For torque requirements, please refer to Appendix H.

1. Thread the **Nozzle** [5] into the **Body** [1].
2. Thread the **Pipe Plug** [28] into the **Body** [1].
3. Thread the **Blow Down Ring** [7] onto the **Nozzle** [5].
4. Thread the **Hex Nut** [25] onto the **Lock Screw Stud** [13]. Thread the **Lock Screw Stud** [13] into the **Lock Screw** (BDR) [12].
5. Thread the **Lock Screw Assembly** into the **Body** [1] including the **Lock Screw Gasket** [24]. Adjust the position of the **Lock Screw Stud** [13] so that it prevents rotation of the **Blow Down Ring** [7] yet does not bind it. Use the position noted during disassembly. (**Figure 9.1**)
6. Thread the **Body Studs** into the **Body** [1].
7. Place the **Body Gasket** [22] in the **Body** [1] counter-bore.
8. Thread the **Lock Screw** [19] into the **Stem Retainer** [14]. (**Figure 9.2**)

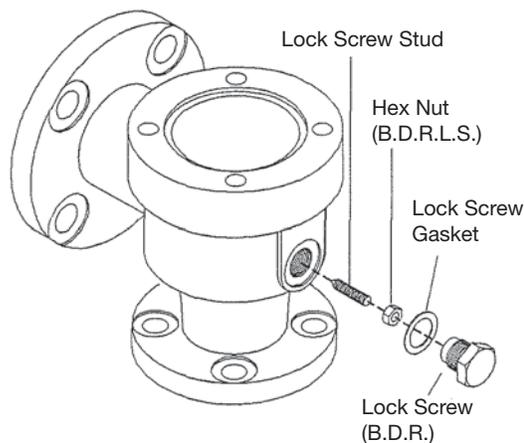


Figure 9.1

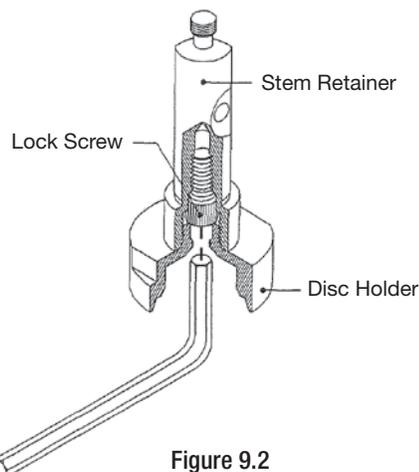


Figure 9.2

9. Thread the **Disc Holder** [6] onto the **Stem Retainer** [14] using a special assembly block (see **Figure 9.3**). Do not attempt to hold the **Stem Retainer** [14] on the guiding surface. Thread the **Lock Screw** [19] counter clockwise until contact is made with the **Disc Holder** [6]. Tighten to lock the assembly together.
10. Thread the **Disc** [4] into the **Disc Holder** [6]. Be sure the **Disc** [4] is free-floating. (**Figure 9.4**)
11. Place the **Sleeve Guide** [8] over the **Stem Retainer** [14] with the long lift stop facing down. Be sure that the guiding motion is smooth.

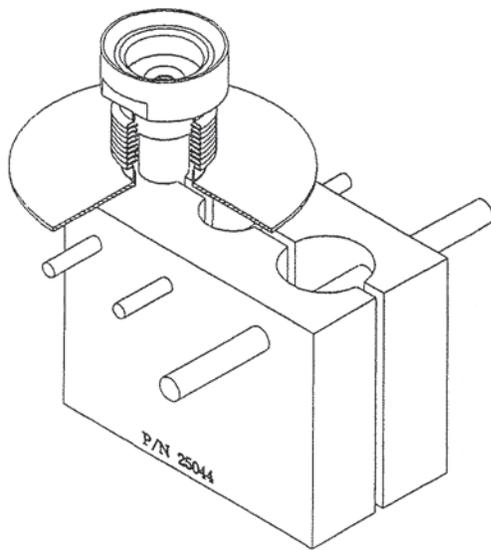


Figure 9.3

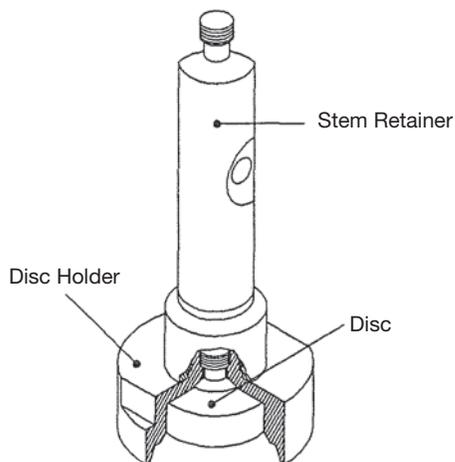


Figure 9.4

12. Thread the **Stem** [9] and **Stem Retainer** [14] together. Be sure this connection is free-floating. (**Figure 9.5**)
13. Lower the **Assembly (Stem** [9], **Sleeve Guide** [8], and **Disc Holder** [6]) into the **Body** [1] counter-bore. (**Figure 9.6**)
14. Place the **Bonnet Gasket** [23] on the **Sleeve Guide** [8], or secure with sealant in the **Bonnet** [2] counter-bore.
15. Place the lower **Spring Button** [17] on the **Stem** [9]. **Caution** – in some valve sizes the upper and lower **Spring Buttons** [17] are different.
16. Place the **Spring** [20] on the lower **Spring Button** [17].

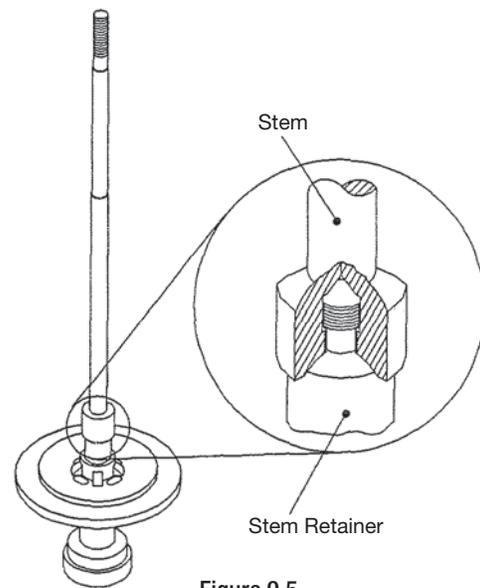


Figure 9.5

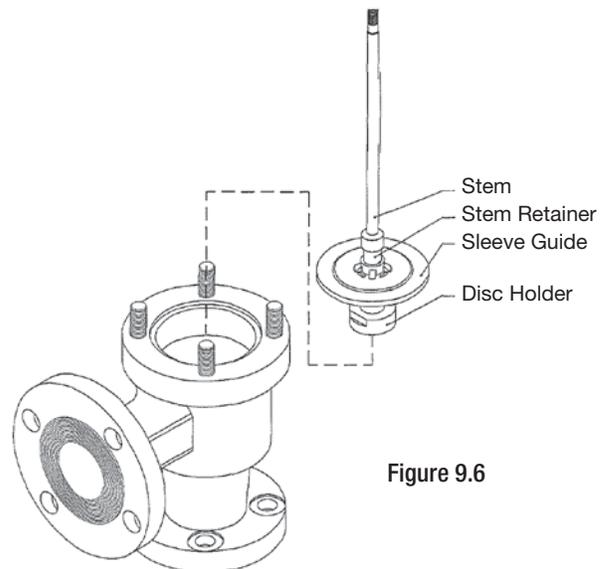


Figure 9.6

17. Place the upper **Spring Button** [17] on the **Spring** [20].
18. Thread the **Pipe Plug** [27] into the **Bonnet** [2]. Skip this step for Bellows Construction.
19. Place the **Bonnet** [2] onto the **Body** [1], making sure to align the **Pipe Plug** [27] to the position indicated in disassembly notes. Normal convention is to position the **Pipe Plug** [27] opposite of the valve outlet.
20. Thread the Hex Nuts (Body) onto Body Studs and tighten. Ensure that the **Body Gasket** [22] and **Bonnet Gasket** [23] are properly positioned in the respective counter-bores.
21. Thread the **Jam Nut (SAS)** [11] onto the **Spring Adjusting Screw (SAS)** [10].
22. Thread the **SAS** [10] into the **Bonnet** [2] to the position indicated in disassembly notes.
23. Valve should now be ready for testing, final assembly and sealing.
24. Following testing, place the **Cap Gasket** [21] on the **Bonnet** [2].
25. Thread the **Cap** [3] onto the **Bonnet** [2] and wire-seal.

NOTES:

1. **For Balanseal Bellows construction** please see Appendix B for assembly instructions.
2. **For O-Ring seat construction** please see Appendix C for assembly instructions.
3. **For open lever, packed lever and bolted cap construction** please see Appendix D for assembly Instructions.

10. Setting, Testing and Adjustments

Equipment

Air testing is the usual method of testing and setting pressure relief valves; however, valves should be set and tested using the approved media according to applicable codes and standards. A pressure source supplies air to a test drum usually 1-1/2 cubic feet internal volume. The air pressure to the test drum is controlled by a quick opening valve (approximately 1 inch). The valve being tested is mounted directly on the test drum without restrictions. If considerable numbers of valves are tested, it is advisable to provide an air receiver between the compressor and the quick opening valve. This arrangement allows a small-volume high-pressure compressor to store air during off-hours.

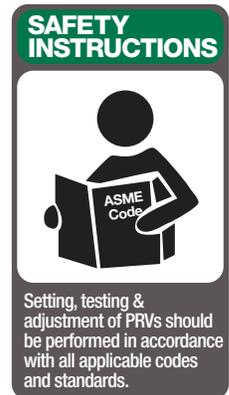


Adjustments & Performance

The use of the correct spring is a matter of critical importance. Attempting to employ a spring below its rated pressure range may result in a loss of lift with resulting loss of capacity and a generally sluggish valve action. Using a spring above or below its rated temperature range may cause a change in spring characteristics and possibly failure of the spring itself. Before changing the set pressure of any valve verify that the new pressure is within the range of the spring and valve construction. When raising the set pressure, check the applicable design code and the design pressure of the protected equipment to ensure compliance with equipment design and local requirements. Before reducing the set pressure, make certain that the capacity at the reduced pressure is sufficient for the protection of your equipment. Valves which are properly installed on steam, gas, or vapor services will relieve with a pronounced pop when opening. After the excess pressure has been relieved, the valve will generally reseal at approximately 5% to 7% below the set pressure. Actual blowdown will vary with each valve and installation. There is generally no distinct pop with liquid service relief valves as the opening will generally be proportional to the rise in pressure. It is important for blowdown rings to be adjusted carefully and accurately in accordance with the table values.

Procedure

To properly test a valve, the test drum pressure is brought up to about 90% of the set pressure of the valve. The quick opening valve is now opened sufficiently to cause the test drum pressure to continue to increase 2 psi/sec until the valve pops. A test gauge connected to the test drum in a static pressure zone will indicate the pressure the valve pops. Further spring setting adjustments may be necessary to achieve the desired set pressure of the valve. The tightness of a pressure relief valve on gas or vapor service is closely connected with the operation of the valve i.e. unless a valve opens and closes sharply, it may leak. The action of such a valve depends upon the expansive and reactive forces of the flowing medium (gas or vapor only) which in turn depends upon the location of the blowdown ring. Since the capacity of the test stand is considerably less than the actual valve capacity, it is essential that the blowdown ring be adjusted for good test stand operation. The lowest ring position that can be tolerated for a given size test drum depends upon the valve size and its set pressure relative to the test drum size. Raising the nozzle ring to within two notches from touching the disc holder will obtain the maximum reaction from the smallest amount of the test fluid. However, this position may produce excessive impact and seat damage to small valves set at high pressures. Using a test gag while testing valves can reduce the damage to the seating surfaces.



Adjusting Valve to Required Set Pressure

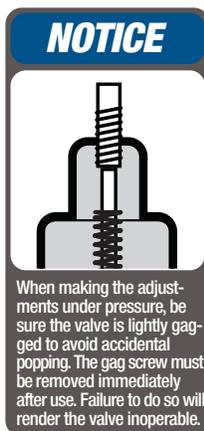
After the valve has been reconditioned and reassembled minus the cap and/or lever assembly, it is ready for a final spring adjustment to the required set pressure. If a new set pressure is required, the limits for adjustment of the spring must be observed. It may be necessary to provide a different spring. After the jam nut is tightened, the valve should be popped at least once more to prove the accuracy of the setting.

Air Test Stand Settings

For spring adjustment or checking set point on air test stands, raise the ring to a position 2 notches down from contact with the disc holder. Return ring to tabulated field setting or setting established through in-place testing before installation. Be sure to include temperature compensation of set pressure where applicable.

Liquid Service

Liquid service valves must be set on water with set pressure indicated as the first steady stream of water perpendicular to the outlet of the valve. Intermittent opening and closing indicates leakage. The reduction in inlet pressure required to reseal the valve depends on the rate of flow and operator manipulation. Set the blow down ring to the position indicated in Table 10.3. Do not attempt to adjust the blow down ring without gagging the valve first (or reducing inlet pressure to zero). Remove the gag. When the valve is first mounted there will be some air under the disc of the valve. This may cause the valve to pop open suddenly. To remove the air, lift up on the stem to let the air slowly seep out, if possible. Pressure may need to be added under the valve to assist in lifting the stem. Next, raise the pressure to the desired set point. When the pressure is within 90% of the set pressure, raise the pressure at a rate of 1 psig per 2 seconds. Adjust the spring adjusting screw until the desired set pressure is reached. We define set pressure for a liquid valve as the first continuous flow which is flowing 90 degrees from the outlet. Confirm that you have the set pressure correct by raising the pressure to where the first steady stream is evident. Then, lower the pressure until the valve re-seats. Repeat this procedure until the valve shows a consistent opening pressure.



Securing The Blowdown Ring

The adjusted position of the ring is maintained by a blow down ring lock screw which threads into the valve body from the outside and engages notches (like gear teeth) on the outside diameter of the blowdown ring. To make an adjustment, loosen and remove the blow down ring lock screw assembly. Insert a screw driver and rotate the nearest notch toward the left to lower the ring or toward the right to raise it, counting the notches as they are moved. Reinstall the lock screw assembly, ensuring that it intercepts a notch without exerting side-pressure on the ring.

Seat Tightness Testing (Figure 10.1)

After the valve is satisfactorily checked for set pressure, it is necessary to check the valve for seat leakage. It is important to minimize leakage from pressure relief valves. Excessive leakage could lead to fouled and inoperable valves, serious product loss and could also be hazardous to personnel and equipment. The valve can be tested for tightness on the test stand by increasing the pressure on the valve to 90 percent or more of the set pressure and observing the discharge side of the valve for evidence of leakage. Methods of determining leakage are covered by applicable standards and specific user requirements.

API Standard 527 is a widely accepted standard for the procedure and acceptance criteria for assessing the seat tightness of pressure relief valves. The user should be familiar with this standard, in addition to any information presented therein. The following seat tightness methods and requirements are in general compliance with API Standard 527.

Air Testing

All openings from the secondary pressure zone shall be closed before counting the bubble rate. This includes such items as caps, drain holes, vents and outlets. A soap solution or equivalent test shall be applied to secondary joints to detect escape of air other than that being measured. Seat tightness tests are normally conducted with pressure at the pressure relief valve inlet held at 90 percent of the set pressure immediately after popping. For valves set at 50 psig or below, the pressure shall be held a 5 psig below the set pressure immediately after popping. Before starting the bubble count, the test pressure shall be applied for a minimum of: 1 minute for valves of inlet sizes 2 inches and smaller; 2 minutes for sizes 2-1/2, 3, and 4 inches; 5 minutes for sizes 6 inches and larger.

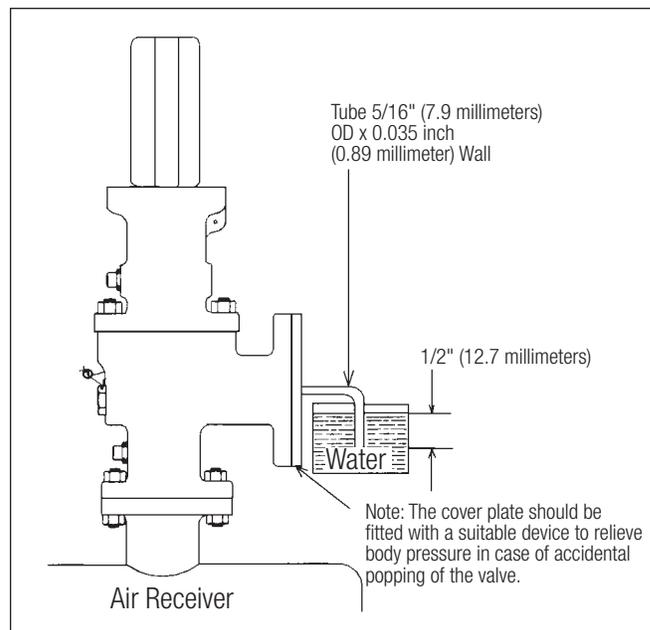


Figure 10.1



Air at ambient temperature shall be used as the pressure medium. The valve shall be observed for leakage for at least 1 minute. The leakage rate in bubbles per minutes shall not exceed the numbers listed in Table 10.1. For an O-ring seated valve, there shall be no leakage for 1 minute (Zero bubbles per minute @ 95% of set pressure). (Figure 10.1)

Maximum Seat Leakage Rates for Metal-Seated Pressure Relief Valves		
Set Pressure psig	Leakage Rate (Bubbles per Minute)	
	F Orifice and Smaller	G Orifice and Larger
15-1000	40	20
1500	60	30
2000	80	40
2500	100	50
3000	100	60
4000	100	80
5000	100	100
6000	100	100

Table 10.1

Steam Testing

Steam service pressure relief valves which are set and adjusted on steam shall be leak-tested on steam visually using a black background. There shall be no visible leakage from the valve outlet when the inlet pressure is held at 90% of the set pressure after popping and reseating. For set pressure below 50 psig this test shall be conducted at 5 psig below set pressure. The valve shall be observed for leakage for at least 1 minute. This criteria applies to both metal and o-ring seated valves.

Liquid Testing

Liquid service pressure relief valves are set and adjusted on water shall be leak-tested on water at near ambient conditions. Before starting the seat tightness test, the set pressure shall be verified, and the outlet body bowl shall be filled with water, which shall be allowed to stabilize with no visible flow from the valve outlet. The inlet pressure shall be increased to the test pressure. The valve shall be observed for 1 minute at the test pressure. For valves set at 50 psig or below, the pressure shall be held at 5 psig below the set pressure. Above 50 psig set pressure hold the pressure at 90% of the set pressure.

Blow Down Ring Settings: Air, Gas, and Vapor Applications									
Orifice	Set Pressure Range, psig								
	15 - 100	101 - 200	201 - 300	301 - 400	401 - 500	501 - 600	601 - 800	801 - 1000	1001 & Up
D ₁	3	4	6	7	7	9	9	9	10
	2	2	3	4	4	5	5	6	7
E ₁	5	9	12	15	15	18	18	19	20
	2	2	3	4	4	5	5	6	7
F	2	3	4	5	5	7	8	9	10
G	3	4	5	6	6	8	9	10	11
H	3	4	5	6	6	8	9	10	11
J	3	5	5	6	6	8	9	10	11
K	4	5	6	7	7	9	10	11	12
L	4	6	9	9	9	10	10	11	12
M	4	6	12	12	12	12	12	12	12
N	5	10	15	15	15	15	15	15	15
P	6	16	20	20	20	20	20	20	20
Q	6	16	20	20	20	20	20	20	–
R	4	16	20	20	–	–	–	–	–
T	4	16	20	–	–	–	–	–	–
U	4	16	20	–	–	–	–	–	–

Blow Down Ring Settings: Steam Applications									
Orifice	Set Pressure Range, psig								
	15 - 100	101 - 200	201 - 300	301 - 400	401 - 500	501 - 600	601 - 800	801 - 1000	1001 & Up
D ₁	3	4	6	7	7	9	9	9	10
	2	3	4	5	6	7	8	9	10
E ₁	5	3	12	15	15	18	18	19	20
	2	2	4	5	6	7	8	9	10
F	2	4	5	6	7	8	9	10	12
G	3	5	6	7	8	9	10	11	13
H	3	5	6	7	8	9	10	11	13
J	3	6	6	7	8	9	10	11	13
K	4	6	7	8	9	10	11	12	14
L	4	7	7	8	9	10	11	12	14
M	4	7	7	8	9	10	11	12	14
N	4	7	7	8	9	10	11	12	14
P	4	7	7	8	11	10	11	12	14
Q	4	8	9	10	11	12	13	15	–
R	4	8	9	10	–	–	–	–	–
T	4	8	9	–	–	–	–	–	–
U	4	8	9	–	–	–	–	–	–

Table 10.2

Note 1: Use the second row only for "D" & "E" orifice valves purchased before July 1, 1993

For both metal and O-Ring seated valves in liquid service, Farris' standard acceptance criteria is no visible leakage at 90% of set pressure for valves with a set pressure of 50 psig and higher. For valves with a set pressure below 50 psig, the test is performed at a 5 psig differential. API Standard 527, Seat Tightness of Pressure Relief Valves, does allow for a more liberal leakage acceptance criteria of 10 cubic centimeters per hour per inch of inlet size. Ultimately, the acceptance criteria selected and the amount of leakage that can be tolerated is the responsibility of the end user based on his experience with the specific application.

Blowdown Ring Setting

Tables 10.2 and 10.3 give blow down ring settings in the number of notches down from disc holder contact. The higher the ring, the sharper the pop and longer the blowdown. The lower the ring, the poorer the pop, the shorter the blowdown.

The 2600L series is now ASME Code Section VIII Certified for use in air, steam and vapor service. Regardless of the service, 2600L Series valves should be adjusted using the liquid service blowdown ring settings in Table 10.3.

Liquid Service Applications	
Orifice	Notches
D/E	2
F	3
G/H/J	4
K/L	8
M/N/P	12
Q/R/T/U	20

Table 10.3

Field Settings

The above settings are final average field settings for good performance under actual operating conditions on the installation. Use recommended number of notches, or maximum adjustment possible if less than table. Finer adjustments may be desirable or necessary because of individual piping and service differences. On applications where the valve will operate at substantially reduced flow, fewer notches may help eliminate chatter and ensure seat tightness.

Compensation for Temperature

Any increase in temperature causes a reduction in set pressure of a safety-relief valve. The primary factors are the linear expansion of the body and top works, which reduces the spring loading, and the direct effect of temperature on the spring itself.

It is customary to compensate for this effect by increasing the setting when a valve is set at ambient conditions on a test stand and the valve is intended for a higher operating temperature in service. Although the adjustment is approximate and may be outweighed by other differences caused by variations in media and blowdown ring adjustments, compensation for temperature as an independent variable improves the accuracy of the setting. It is not recommended to reduce a spring setting for valves intended for sub-zero service. (Table 10.4)

CDTP Temperature Compensation		
Normal Operating Temperature		% Increase in Set Pressure at Atmospheric Temp.
°F	°C	
-400 to 300	-240 to 149	none
301 to 600	150 to 316	1%
601 to 900	317 to 482	2%
901 to 1200	483 to 649	3%

Table 10.4

COLD DIFFERENTIAL TEST PRESSURE (CDTP) is the inlet pressure at which the valve is adjusted to open on a test stand at ambient temperature conditions, discharging to atmosphere. Computation includes compensation for constant back pressure (if required) and inlet operation temperature. Cold Differential Test Pressure is the sum of the Spring Selection and the Increase in Setting to compensate for temperature. The abbreviation is Cold Set. (Table 10.4)

Compensation for Backpressure

Back Pressure is the pressure existing at the valve outlet and in the valve outlet and in the downstream portion of the valve body. It may be superimposed, built-up, constant, or variable. The spring setting should be compensated for constant and superimposed back pressure, except for BalanSeal valves. For these type valves, variable back pressure is not compensated for, but the maximum pressure limit of the bellows is stamped on BalanSeal tag (Figure 1.1).

Operating Differentials

The variety of service conditions which a pressure relief valve is subjected to precludes a rigid set of rules. Operating difficulties can be minimized by providing as much differential as possible for known conditions on a particular application. Table 10.5 lists the suggested minimum differentials.

Final Notes

Once your valve has been assembled and tested make sure that you have completed all necessary records before placing it back in service. These records are important for the effective future use of the valve. They will provide some guidance as to when to retire valves and replace components as well as providing the historical record of the conditions and services under which the valve operated. A sample maintenance record appears in Appendix F which can be photocopied and used for this purpose.

The valve should be properly installed in service or prepared for storage. If the valve is to be stored the inlet and outlet of the valve should be covered to protect against any foreign matter entering the valve.

Set Pressure Tolerance And Operating Differentials: Gases, Vapors, and Liquids				
	Set Pressure psig	Set Pressure Tolerance (+) or (-)	Minimum Differential Suggested (Gases & Vapors)	Minimum Differential Suggested (Liquids)
Metal Seat Soft Seat	15 to 70	2 psi	5 psi	5 psi
Metal Seat Soft Seat	71 to 1000	3%	10%	10%
Metal Seat Soft Seat	1001 to 6000	3%	10%	10%

Table 10.5

11. Troubleshooting

Chatter

The valve is oversized for installation.

If the inlet capacity is less than 25% of the valve capacity there will be a tendency for the valve to chatter.

The inlet piping is of excessive length or the inlet pipe diameter is less than the inlet size of the valve.

Design inlet piping systems so that the pressure drop to the valve is less than 3%. The inlet pipe diameter should be at least the inlet size of the valve.

The outlet piping is of excessive length or the diameter is less than the valve flange size.

Design outlet piping so that the diameter is at least the outlet size of the valve and that pressure on the outlet does not build up causing the valve to shut.

Incorrect Set Pressure

Misreading the nameplate

Always compensate for backpressure and temperature when bench testing the safety-relief valve by following the Cold Differential Test Pressure.

The blowdown ring position changed

Check that the lock screw stud has engaged between the teeth on the blowdown ring to prevent rotation. This could also cause erratic blowdown characteristics as well as leakage.

Internals are misaligned.

See section on leakage.

Jam nut is loose.

Tighten jam nut.

Rough handling.

A safety-relief valve is a precision instrument and should be handled with care. It is also recommended that the valve be popped once or twice to realign the parts after rough handling.

Pressure surge at inlet.

Sudden impact of a fluid may cause the valve to open prematurely. Pressure build-up should be gradual.

The valve contains a bellows and the bonnet is not vented.

Remove bonnet pipe plug so that the bonnet is exposed to atmospheric pressure.

Leakage

The seats are damaged.

Lap the seats to remove the damage. If the scratches are deep, machining may be required. Remove any foreign particles from the system to prevent scoring the seats.

The system operating pressure is too close to the valve set pressure.

Always have at least 10% (or 5 psig, whichever is greater) differential between operating pressure vs. set pressure for metal seated and soft seated valves. See Table 10.5.

Misaligned lifting gear.

Adjust the stem test washer so that there is 1/8 inch clearance between either the cam or lever and the stem test washer. See Appendix D.

Horizontal mounting.

Safety-relief valves must be mounted with the stem in the vertical plane. If mounted horizontally the valve will experience excessive friction on the guides and will not align properly.

Lock screw stud not adjusted properly.

Adjust the length of the lock screw stud so that it does not press into the blowdown ring causing misalignment.

Misaligned internals.

Disassemble valve and check all universal ball joints, flatness of disc and nozzle seat and repair or replace.

Other.

Check for bent stem, springs with uneven ends or out of alignment. A common cause of bent stems is overgagging. Test gags are designed to be finger tightened only.

Blowdown

Blowdown is excessive/the valve is hanging up

Lower the blowdown ring until the desired blowdown is achieved. Also check for dirt or other foreign material in the seating area or on the guiding surfaces.

Blowdown is too short.

Raise the blowdown ring to lengthen the desired blowdown.

Appendix A: Valve Terminology

Safety Valve - An automatic pressure relieving device actuated by the static pressure upstream of the valve, and characterized by rapid full opening or pop action. It is used for steam, gas, or vapor service.

Relief Valve - An automatic pressure relieving device actuated by the static pressure upstream of the valve which opens in proportion to the increase in pressure over the opening pressure. It is used primarily for liquid service.

Safety Relief Valve - An automatic pressure actuated relieving device Suitable for use as either a safety or relief valve, depending on application.

Pressure Relief Valve - A pressure relief valve is a pressure relief device which is designed to reclose and prevent the further flow of fluid after normal conditions have been restored.

Set Pressure - Set pressure, in pounds per square inch gauge, is the inlet pressure at which the pressure relief valve is adjusted to open under service conditions. In a pressure or safety relief valve in gas, vapor, or steam service, the set pressure is the inlet pressure at which the valve starts to discharge under service conditions.

Differential Set Pressure - The pressure differential in pounds per square inch between the set pressure and the constant superimposed back pressure. It is applicable only when a conventional type safety relief valve is being used in service against constant superimposed back pressure.

Cold Differential Test Pressure - Cold differential test pressure, in pounds per square inch gauge, is the inlet static pressure at which the pressure relief valve is adjusted to open on the test stand. This pressure includes the corrections for service conditions of back pressure or temperature, or both.

Operating Pressure - The operating pressure of a vessel is the pressure, in pounds per square inch gauge, to which the vessel is usually subjected in service. A vessel is usually designed for a maximum allowable working pressure, in pounds per square inch gauge, which will provide a suitable margin above the operating pressure in order to prevent any undesirable operation of the relief device. (It is suggested that this margin be as great as possible consistent with economical vessel and other equipment design, system operation and the performance characteristics of the pressure relieving device.)

Maximum Allowable Working Pressure - Maximum allowable working pressure is the maximum gauge pressure permissible at the top of a completed vessel in its operating position for a designated temperature. This pressure is based on calculations for each element in a vessel using nominal thicknesses, exclusive of allowances for corrosion and thickness required for loadings other than pressure. It is the basis for the pressure setting of the pressure-relieving devices protecting the vessel. The design pressure may be used in place of the maximum allowable working pressure in cases where calculations are not made to determine the value of the latter.

Overpressure - Overpressure is a pressure increase over the set pressure of a pressure relief valve, usually expressed as a percentage of set pressure.

Accumulation - Accumulation is the pressure increase over the maximum allowable working pressure of the vessel during discharge through the pressure relief valve, expressed as a percent of that pressure or in pounds per square inch.

Blowdown - Blowdown is the difference between actual popping pressure of a pressure relief valve and actual reseating pressure expressed as a percentage of set pressure or in pressure units.

Lift - Lift is the actual travel of the disk away from closed position when a valve is relieving.

Back Pressure - Back pressure is the static pressure existing at the outlet of a pressure relief device due to pressure in the discharge system.

Superimposed Back Pressure - Superimposed back pressure is the static pressure existing at the outlet of a pressure relief device at the time the device is required to operate. It is the result of pressure in the discharge system from other sources when the valve is closed. Superimposed back pressure can be constant, variable or both:

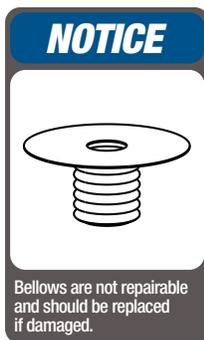
Constant Superimposed Back Pressure - Back pressure which does not change appreciably under any condition of operation whether the pressure relief valve is closed or open.

Variable Superimposed Back Pressure - The pressure existing at the outlet of a pressure relief device, which does not remain constant when the pressure relief valve is closed.

Built-Up Back Pressure - Built-up back pressure is pressure existing at the outlet of a pressure relief device occasioned by the flow through that particular device into a discharging system.

Appendix B: Bellows Construction

Bellows require very thin materials to provide the required flexibility. This results in a delicate assembly which should be carefully handled. Do not attempt to repair a bellows assembly. Any pitting or surface corrosion are sure signs of limited service life even though the bellows may be pressure tight. All bellows assemblies should be pressure tested in accordance with Figure B.1. Any leakage should be cause for bellows replacement. For BalanSeal bellows equipped valves use the assembly fixture shown in Figure B.2. Exercise care in handling the internal assembly when equipped with a bellows as any damage to the bellows in the form of a nick or dent will render the bellows unfit for service. Bellows are not repairable.



1. Place bellows/stem retainer/disc holder assembly into bellows leak test fixture with the bellows flange at the base.
2. Seal the flange of the bellows to the base of the bellows test fixture as illustrated in Figure B.1.
3. Compress the bellows approximately 1/8 inch with a securing bar so that the bellows does not elongate when pressure is applied as in Figure B.1.
4. Fill the disc holder with water. Omit this step for D & E Balanseal designs as these designs have a one piece disc holder/stem retainer.
5. Apply 30 psig pressure to the back side of the bellows.
6. Apply soapy water to bellows exterior to check for bellows integrity.
7. If bubbles appear on bellows exterior there are pin holes or a tear. Replace bellows and repeat the procedure.
8. Check to be sure the bellows/disc holder connection is leak tight. If water in disc holder bubbles or the connection bubbles, tighten the connection or replace gasket.
9. Vent pressure.
10. Release bellows assembly.
11. Air dry bellows assembly to remove soapy water.

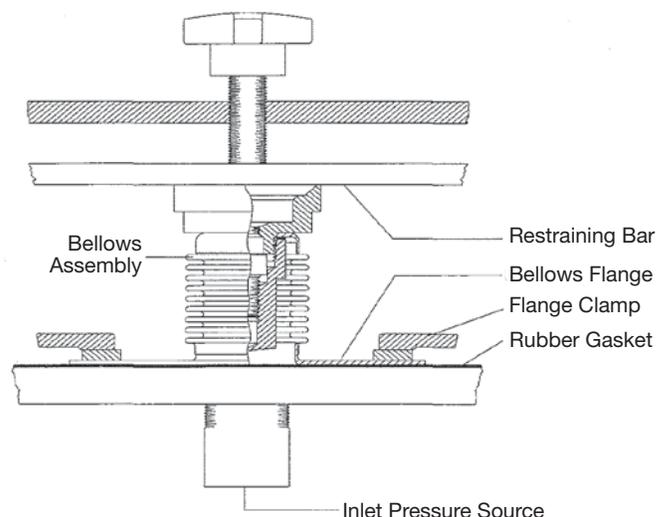


Figure B.1 Bellows Assembly Leak Test

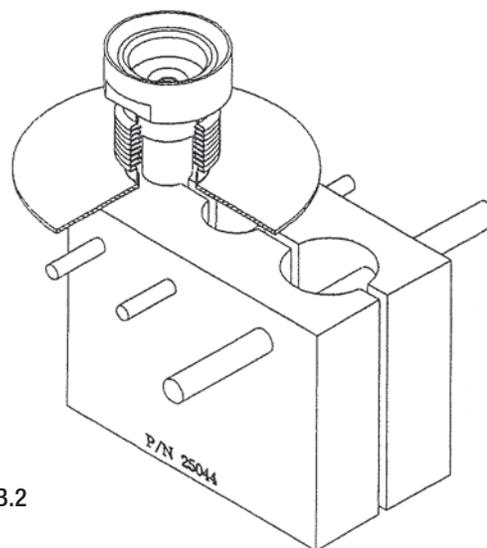


Figure B.2

BalanSeal® Bellows Construction Assembly/Disassembly Instructions

The following instructions are assembly instructions. For disassembly, reverse the order. Parts identification may be found below. Follow the same procedures as for conventional type valves except as follows:

For D and E orifice valves only (Refer to B.3 below):

1. Place the **Bellows Gasket** [16] on **Disc Holder** [6].
2. Thread the **Bellows** [15] onto the **Disc Holder** [6] and securely tighten.
3. Do not thread **Pipe Plug (Bonnet)** into **Bonnet** [2]. **Bonnet** [2] must be vented in accordance with ASME Code.

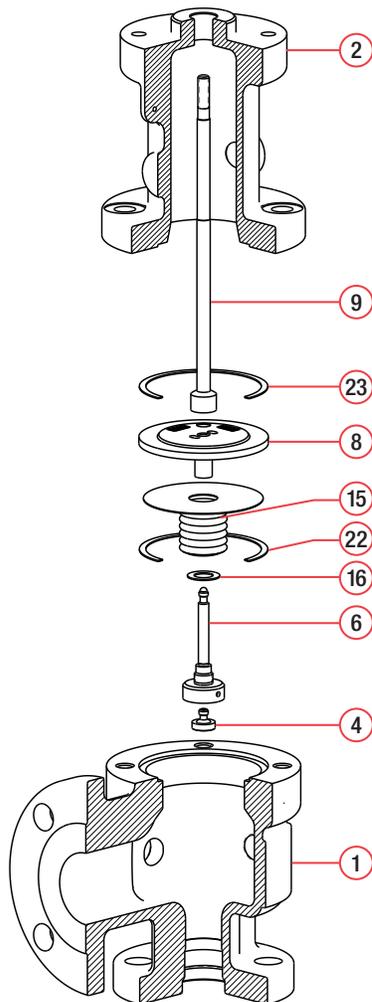


Figure B.3

For all other orifices (Refer to B.4 below):

1. Place the **Bellows Gasket** [16] on the **Stem Retainer** [14].
2. Place the **Bellows** [15] on the **Stem Retainer** [14].
3. Thread the **Disc Holder** [6] to the **Stem Retainer** [14] using the special assembly block.
4. Thread the **Lock Screw** [19] counter clockwise until contact is made with the **Disc Holder** [6]. See **Figure B.1** for bellows leak test.
5. Do not thread **Pipe Plug (Bonnet)** into **Bonnet** [2]. **Bonnet** [2] must be vented in accordance with ASME Code.

Note: For F - K orifices, O-ring seat construction only, an additional **Disc Holder Lock Screw Gasket** must be placed between the **Stem Retainer** [14] and the **Disc Holder** [6].

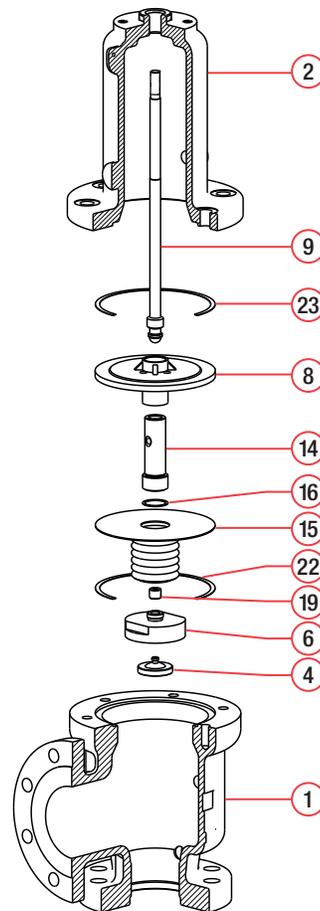


Figure B.4

Appendix C: O-Ring Construction

Due to corrosion, metal-to-metal seats can eventually leak. With the proper selection of the Farris O-ring seat pressure seal, seat tightness can be improved and maintained. Because O-rings are elastomeric, they should be handled carefully. Typically, O-rings should be replaced during your normal maintenance interval. O-rings are not repairable.

Standard seat tightness for O-ring seated valves is no leakage at 90% of set pressure for both conventional and bellows valves following Farris standard seat tightness test procedure. At set pressures of 50 psig and below, leakage test shall be made at 5 psig below set pressure.

The O-ring seat seal option is available for 2600/2600L/2600S Series valves in both conventional and bellows construction. Farris Engineering has two different O-ring designs which depend on the orifice of the pressure relief valve.

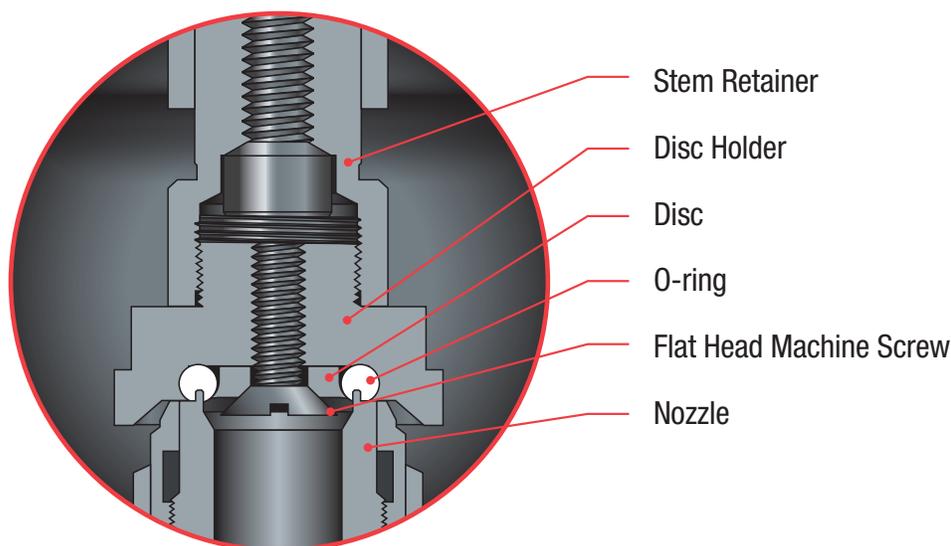
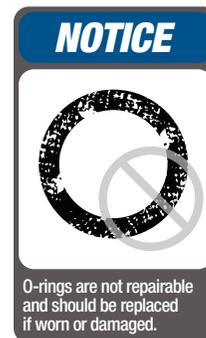


Figure C.1 – O-ring Detail D-K Orifice

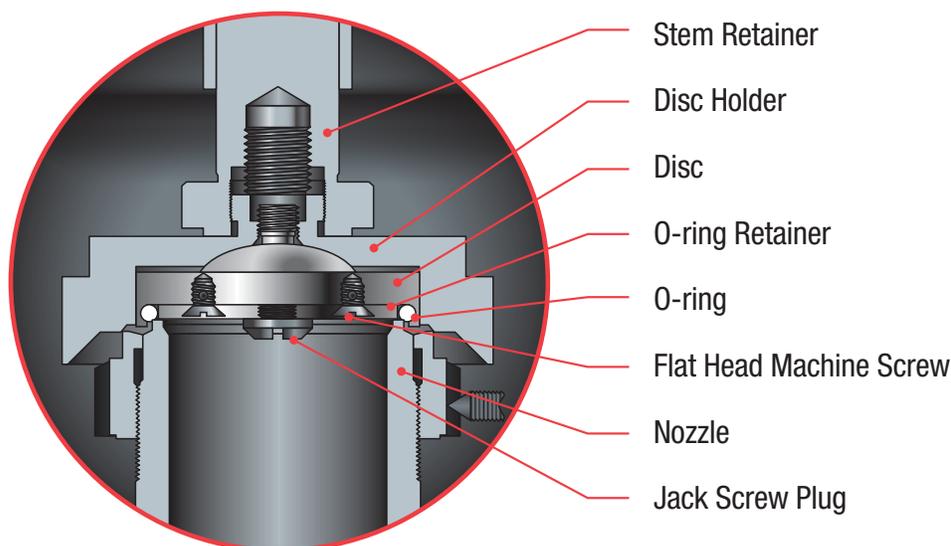


Figure C.2 – O-ring Detail L-U Orifice

O-Ring Material Selection Table					
Material	Temperature Range °F	D to K Orifice		L to T Orifice	
		Set Pressure (psig)	Durometer (Shore A)	Set Pressure (psig)	Durometer (Shore A)
Viton ⁴	-20 to 450	15 to 100	50	15 to 150	50
	-20 to 450	101 to 650	75	150 to 450	75
	-20 to 125	650 to 950	75	450 to 750	75
	125 to 450		90		90
	-20 to 450	950 to 1500	90	750 to 1500	90
Ethylene Propylene	0 to 350	15 to 100	50	15 to 150	50
	0 to 350	101 to 650	70	150 to 450	70
	0 to 125	650 to 950	70	450 to 750	70
	125 to 350		80		80
	0 to 350	950 to 1500	80	750 to 1500	80
Buna N	0 to 200	15 to 100	50	15 to 100	50
	0 to 200	101 to 650	70	100 to 450	70
	0 to 125	650 to 950	70	150 to 750	70
	125 to 200		90		90
	0 to 200	950 to 1500	90	750 to 1500	90
Silicone	-150 to 450	15 to 100	50	15 to 100	50
	-150 to 0	101 to 600	50	100 to 200	50
	0 to 450		70		70
	-150 to 450	600 to 850	70	200 to 450	70
	-150 to 125	850 to 1100	70	450 to 750	70
	125 to 450		80		80
	-150 to 450	1100 to 1500	80	750 to 1500	80
Kalrez	-20 to 550	15 to 200	65	15 to 150	65
	-20 to 550	201 to 650	80	150 to 450	80
	-20 to 200	650 to 950	80	450 to 750	80
	200 to 550		90		90
	-20 to 550	950 to 1500	90	750 to 1500	90
Neoprene	-45 to 300	50 to 750	70	50 to 750	70
	-45 to 300	751 to 1500	80	751 to 1500	80

General Notes:

- Viton and Kalrez are registered trademarks of DuPont Performance Elastomers. We reserve the right to substitute comparable fluorocarbon materials.
- PTFE seat seals available on an application basis. Consult the factory

O-Ring Seat Construction Assembly/Disassembly Instructions

The following instructions are assembly instructions. For disassembly, reverse the order. Parts identification can be found on page 31. Follow the same procedures as for conventional type valves except as follows:

To connect the **Disc Holder** to the **Stem Retainer** for O-ring valves, use the allen key sizes found in Table C.1

Allen Key Sizes	
Disc Holder Lock Screw	
Orifices	Allen Key Size
D thru K	1/8"
L thru U	See Table 6.1

Table C.1

For D and E orifice (Bellows Construction only)(See Figure C.1):

- Place the **O-ring** in the **Disc Holder** groove.
- Thread the **Disc** into the **Disc Holder/Stem Retainer**.

For orifices D and E (Conventional) through K only (See Figure C.1):

- Place the **O-ring** in the **Disc Holder** groove.
- Place the **Disc** into the **Disc Holder**.
- Thread the **Flat Head Machine Screw** through the **Disc** into the **Disc Holder**.

For orifices L through U only (See Figure C.2)

- Place **Disc** in a vice with soft jaws or in a 3-jaw chuck. Be careful not to hold too tight as the **Disc** can be damaged.
- Place the **O-ring** into the **Disc** groove.
- Place the **O-ring Retainer** on the **Disc**.
- Thread the **Flat Head Machine Screws** through the **O-ring Retainer** into the **Disc**.
- Thread the **Jack Screw Plug** into the **O-ring Retainer**.
- Thread the **Disc** into the **Disc Holder** (ensure the **Disc** is free floating).

Appendix D: Cap Construction

Section VIII of the ASME Code requires the use of a lifting device on all steam, air and hot water (over 140°F/60°C) applications. Packed levers should be used on all liquid applications or where cap tightness is a requirement. Levers should be inspected for proper operation and parts replaced as needed.

Packed Levers

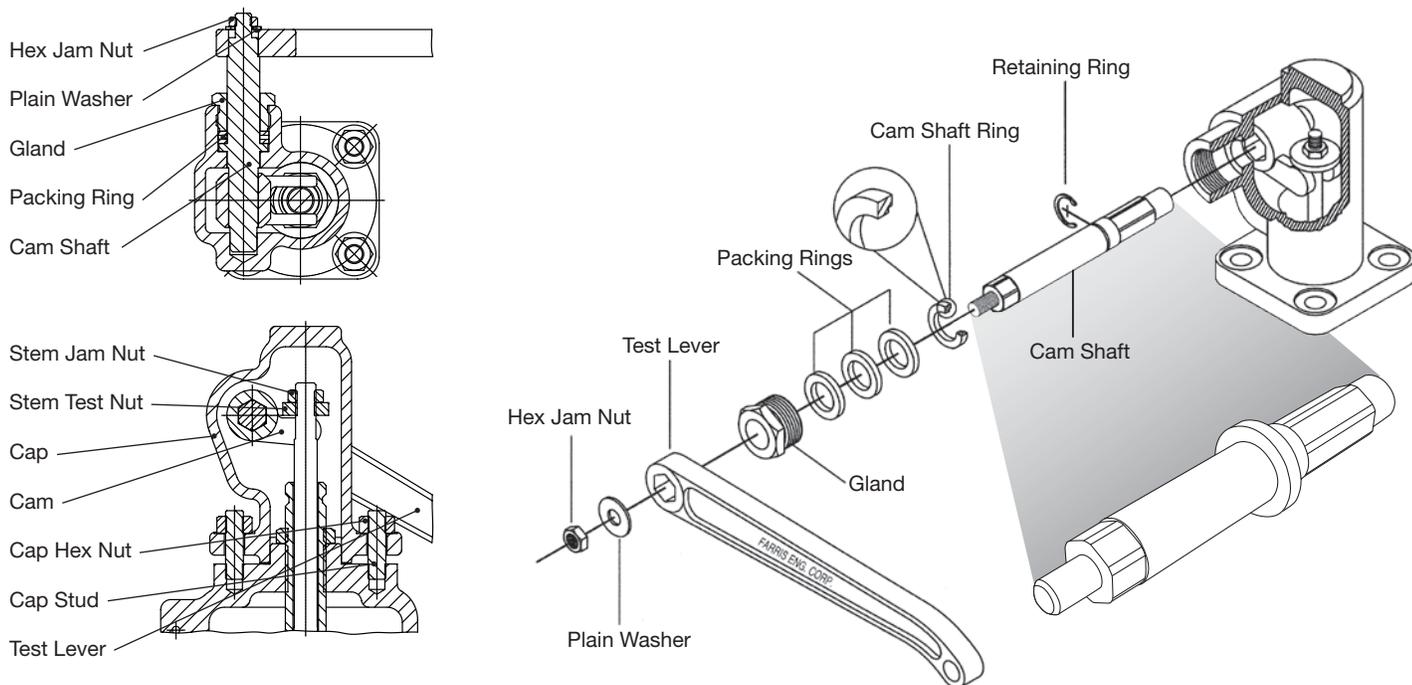


Figure D.1 – Packed Lever Cap Construction
2600 Series, All Sizes

Packed Lever Construction Assembly/Disassembly Instructions

The following instructions are assembly instructions. For disassembly, reverse the order. Parts identification may be found above. Assembly procedures for the balance of valve is identical for all cap design options: plain cap, open lever, bolted cap and packed lever.

1. Thread the **Stem Test Nut** onto the **Stem**.
2. Thread the **Stem Jam Nut** onto the **Stem**.
3. Place the **Cap Gasket** on the **Bonnet**.
4. Place the counter-bored side of the **Retaining Ring** onto the **Cam Shaft**.
5. Place the **Packing Rings** over the **Cam Shaft** and into the **Retaining Ring** cavity.
6. While holding the **Cam** in-place inside the **Cap**, slide the **Cam Shaft** through the hole in the side of the **Cap** and through the **Cam**.
7. Place the **Cap** onto the **Bonnet** ensuring that the cap protrusion is facing the valve outlet.
8. Thread the **Cap Studs** through the **Cap** into the **Bonnet** and tighten.
9. Adjust the **Stem Test Nut** until there is 1/8" clearance between **Stem Test Nut** and the **Cam**.
10. Tighten the **Stem Jam Nut**.
11. Thread the **Gland** into the **Cap**.
12. Place the **Test Lever** on the **Cam Shaft**. **Ensure that the Test Lever is oriented away from the valve outlet.**
13. Place the **Plain Washer** over the **Cam Shaft**.
14. Thread the **Lever Hex Jam Nut** onto the **Cam Shaft**.

Open Levers

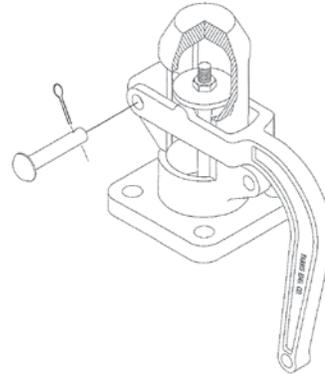
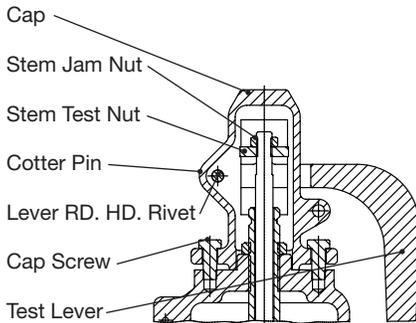


Figure D.2 – Open Lever (Single Acting)
2600 Series, Types 26()A10, A11, A20, A21, All Sizes Except 8x10

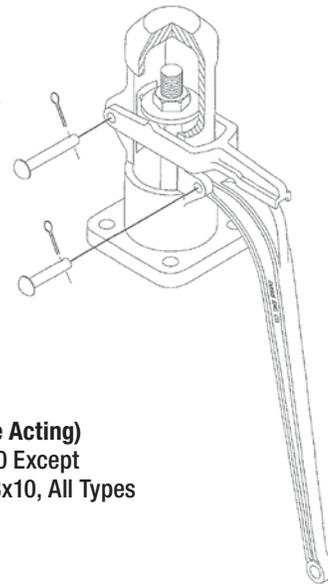
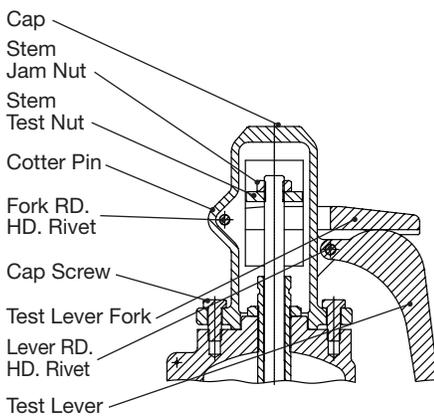


Figure D.3 – Open Lever (Double Acting)
2600 Series, Sizes 1x2 Thru 6x10 Except
Types 26()A10, A11, A20, A21, Sizes 8x10, All Types

Open Lever Cap Construction Assembly/Disassembly Instructions

The following instructions are assembly instructions. For disassembly, reverse the order. Parts identification may be found above. Assembly procedures for the balance of valve is identical for all cap design options: plain cap, open lever, bolted cap and packed lever.

For single acting lever only:

1. Thread the **Stem Test Nut** onto the **Stem**.
2. Thread the **Stem Jam Nut** onto the **Stem**.
3. Place the **Cap** onto the **Bonnet** ensuring that the cap protrusion is facing the outlet of the valve.
4. Thread the **Cap Studs** through the **Cap** into the **Bonnet** and tighten.
5. Place the **Lever Round Head Rivet** through the **Test Lever** and **Cap** hole and secure with the **Cotter Pin**.
6. Adjust the **Stem Test Nut** so there is 1/8" clearance between the **Test Lever** fulcrum and the **Stem Test Nut**.
7. Tighten the **Stem Jam Nut**.

For double acting lever only:

1. Thread the **Stem Test Nut** onto the **Stem**.
2. Thread the **Stem Jam Nut** onto the **Stem**.
3. Place the **Cap** onto the **Bonnet** ensuring that the cap protrusion is facing the outlet of the valve.
4. Thread the **Cap Studs** through the **Cap** into the **Bonnet** and tighten.
5. Place the **Fork Round Head Rivet** through the **Test Lever Fork** and **Cap** hole and secure with a **Cotter Pin**.
6. Place the **Lever Round Head Rivet** through the **Test Lever** and **Cap** hole and secure with the **Cotter Pin**.
7. Adjust the **Stem Test Nut** so there is 1/8" clearance between the **Test Lever Fork** and the **Stem Test Nut**.
8. Tighten the **Stem Jam Nut**.

Cap Constructions Standard Material & Material for Corrosive/Low Temperature Service - Stainless Steel				
Cap Description	Part Name	Std. Materials S1, N1 -20°F to 800°F	S3 -75°F to 800°F	S4 -450 °F to 450°F
Packed Lever	Cap	Carbon Steel	316 St.	316 St.
	Test Lever	Carbon Steel		
	Cam	316 St. St.		
	Cam Shaft	316 St. St.		
	Gland	316 St. St.		
	Stem Jam Nut	316 St. St.		
	Stem Test Nut	316 St. St.		
	Packing Ring	Graphite		
	Plain Washer	Steel		
	Lever Hex. Jam Nut	Steel		
	Cap Stud	Alloy Steel	Stainless Steel	Stainless Steel
	Cap Hex. Nut	Alloy Steel	Stainless Steel	Stainless Steel
Open Lever (Single or Double Acting)	Cap	Iron		
	Test Lever	Iron		
	Test Lever Fork	Iron		
	Stem Jam Nut	316 St. St.		
	Stem Test Nut	316 St. St.		
	Cap Screw	Steel, Plated		
	Fork Rd. Hd. Rivet	Steel		
	Lever Rd. Hd. Rivet	Steel		
	Cotter Pin	Steel, Plated		

Table D.1



Appendix E: Critical Dimensions

These dimensions apply to 2600 Series valves with “A10” through “A15” serial numbers and supersede any dimensions provided in previous revisions to the manual.

Table E.1: Metal Seats - Serial Number Suffixes: A10 & A11 / A14 & A15													
Type	Z ¹	Nozzle Dimensions								Disc Dimensions			
		A +.010 -.000	B +.000 -.005	C +.005 -.000	D min	E min	F min	L min	Nozzle Fig.	H +.000 -.005	J +.005 -.000	N min.	Disc Fig.
26D()z	0 - 3	0.437	0.520	0.580	0.010	0.005	0.010	4.125	2, 3 ²	0.480	–	0.156	1
	4 - 6	0.437	0.520	0.614	0.005	–	0.010	4.375	1				
26E()z	0 - 3	0.535	0.585	0.645	0.010	0.005	0.010	4.062	2	0.545	0.725	0.234	2
	4 - 6	0.535	0.585	0.685	0.005	0.005	0.010	4.375	2				
26F()z ⁴	0 - 1	0.687	0.720	0.780	0.005	0.005	0.010	4.250	2				
	2 - 5	0.687	0.720	0.780	0.005	0.005	0.010	4.375	2	0.680	–	0.265	1
	6	0.687	0.720	0.820	0.005	0.005	0.010	4.375	2				
26G()z	0 - 1	0.844	0.885	0.945	0.010	–	0.010	4.093	1				
	2 - 4	0.844	0.885	0.945	0.005	–	0.010	4.234	1	0.845	–	0.296	1
	5	0.844	0.885	0.995	0.005	–	0.010	5.031	1				
	6	0.844	0.885	0.995	0.005	0.010	0.010	5.031	2				
26H()z	0 - 1	1.054	1.110	1.170	0.005	–	0.010	4.937	1				
	2	1.054	1.110	1.170	0.010	–	0.010	4.156	1				
	3 ³	1.054	1.110	1.210	0.005	–	0.010	5.031	1	1.070	–	0.296	1
	4 - 5	1.054	1.110	1.210	0.005	–	0.010	5.031	1				
26H()z33		1.054	1.110	1.170	0.010	–	0.010	4.156	1				
26J()z	0 - 1	1.350	1.416	1.476	0.005	–	0.010	4.125	1				
	2 - 3	1.350	1.416	1.496	0.005	–	0.010	5.187	1				
	4 ³	1.350	1.416	1.516	0.010	–	0.010	6.562	1	1.376	–	0.296	1
	5	1.350	1.416	1.516	0.010	–	0.010	6.562	1				
26J()z34		1.350	1.416	1.496	0.005	–	0.010	5.187	1				
26K()z	0 - 3	1.612	1.730	1.830	0.010	0.010	0.010	6.546	2				
	4 ³	1.612	1.730	1.830	0.005	0.010	0.010	7.921	2	1.570	–	0.296	1
	5	1.612	1.730	1.830	0.005	0.010	0.010	7.921	2				
26K()z34		1.612	1.730	1.830	0.010	0.010	0.010	6.546	2				
26L()z	0 - 1	2.009	2.106	2.166	0.005	0.010	0.010	6.484	2	2.056	–	0.312	1
	2 - 5	2.009	2.106	2.196	0.010	0.020	0.010	7.609	2				
26M()z	0 - 4	2.257	2.366	2.446	0.005	0.030	0.010	7.546	2	2.306	–	0.375	1
26N()z	0 - 4	2.478	2.598	2.678	0.010	0.030	0.010	7.546	2	2.538	–	0.375	1
26P()z	0 - 4	3.004	3.080	3.200	0.010	0.030	0.010	7.500	2	3.020	–	0.421	1
26Q()z	0 - 3	3.952	4.080	4.220	0.010	0.030	0.010	8.750	2	4.020	–	0.453	1
H26Q()z3		3.952	4.080	4.220	0.010	0.030	0.010	8.750	2				
26R()z	0 - 3	4.758	4.985	5.145	0.005	0.030	0.010	8.031	2	4.895	–	0.703	1
H26R()z3		4.758	4.985	5.145	0.005	0.030	0.020	8.031	2				
26T()z	0 - 2	6.070	6.366	6.546	0.005	0.030	0.010	10.406	2	6.256	–	0.953	1
H26T()z3		6.070	6.366	6.546	0.005	0.030	0.010	10.406	2				

General Notes:

1. Z column designates flange class number to be inserted in type number, example: 26D()z3 would designate any of the D orifice 2600 designs (conventional or bellows) with a 600# inlet flange.
2. For type 2600 (A10 & A11 Serials) see Figure 2. For type 2600L (A14 & A15 serials) see Figure 3.
3. Does not apply to valve type numbers designated for use at a temperature range of 801 to 1000 F.
4. For serial numbers suffixes; A10/G, A11/G, A14/G, A15/G, please consult factory for critical dimensions.



**Table E.2: O-ring Seats - Serial Number Suffixes:
A10 & A11 / A14 & A15**

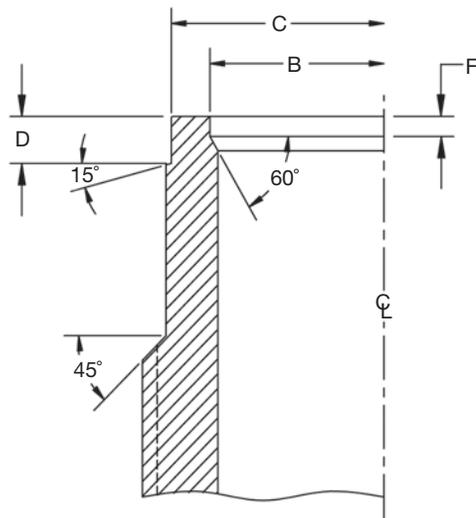
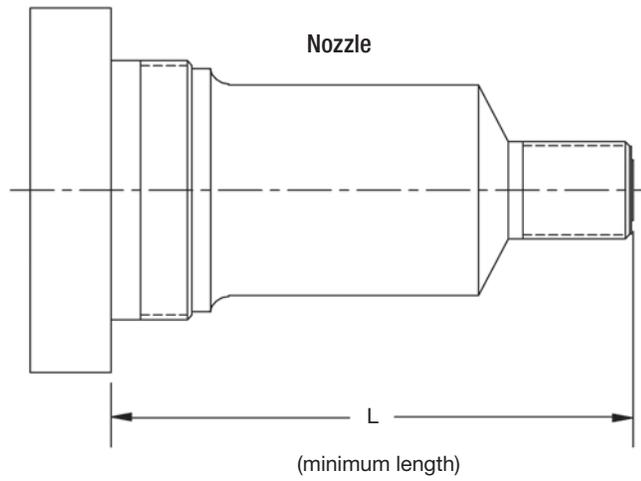
Type	Z ¹	Nozzle Dimensions					Figure
		B +.000 -.005	C +.000 -.002	D min	F min	L min	
26D()z	0 - 3	0.520	0.615	0.078	0.01	4.141	4
	4 ²					4.375	
26E()z	0 - 3	0.585	0.800	-	0.01	4.081	5
	4 ²					4.375	
26F()z ³	0	0.720	0.880	0.078	0.01	4.219	4
	2 - 3					4.344	
	4 ²					4.344	
26G()z	0	0.885	1.052	-	0.01	4.063	5
	2 - 3					4.203	
	4 ²					4.203	
26H()z	0	1.110	1.255	0.078	0.01	4.906	4
	2					4.125	
	3					5.000	
	4 ²					5.000	
26J()z	0	1.416	1.568	0.094	0.01	4.094	4
	2 - 3					5.156	
	4 ²					6.531	
26K()z	0 - 3	1.730	1.937	0.094	0.01	6.516	4
	4 ²					7.891	
26L()z	0	2.106	2.312	0.094	0.01	6.438	4
	2 - 3					7.563	
	4 ²					7.563	
26M()z	0 - 3	2.366	2.566	0.094	0.01	7.531	4
	4 ²						
26N()z	0 - 3	2.598	2.824	0.094	0.01	7.531	4
	4 ²						
26P()z	0 - 3	3.080	3.317	0.094	0.01	7.516	4
	4 ²						
26Q()z	0 - 3	4.045	4.191	0.094	0.01	8.734	4
26R()z	0 - 3	4.985	5.191	0.094	0.02	8.016	4
26T()z	0 - 2	6.366	6.581	0.094	0.01	10.375	4

General Notes:

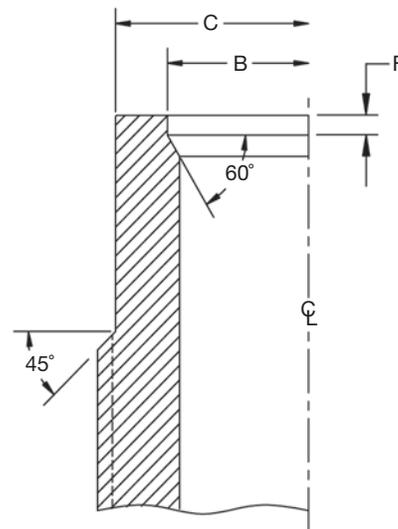
1. Z column designates flange class number to be inserted in type number, example: 26D()3 would designate any of the "D" orifice 2600 designs (conventional or bellows) with a 600# inlet flange.
2. Applies to valves with the A10 & A11 serial number suffix only. All others apply to both the A10 & A11 as well as the A14 & A15 Serial numbers.
3. For serial numbers suffixes; A10/H, A11/H, A14/H, A15/H, please consult factory for critical dimensions.

O-ring Seats A10, A11, A14, A15 Critical Dimensions

Refer to table E.2



Nozzle Figure 4



Nozzle Figure 5

**Table E.3: O Ring Seats - Serial Number Suffixes:
A10/M, A11/M, A14/M, A15/M, A10/R and A11/R**

Type	Z ¹	Nozzle Dimensions					
		/M ³			/R ³		
		B +.000 -.003	C +.003 -.000	L min	B +.000 -.003	C +.003 -.000	L min
26D()z	0 - 3 4 ²	0.520	0.564	4.145 4.390	0.520	0.560	4.145 4.390
26E()z	0 - 3 4 ²	0.585	0.635	4.081 4.390	0.585	0.625	4.081 4.390
26F()z ⁴	0 2 - 3 4 ²	0.720	0.828	4.260 4.390 4.390	0.720	0.760	4.294 4.294 4.294
26G()z	0 2 - 3 4 ²	0.885	0.985	4.100 4.260 4.260	0.885	0.925	4.100 4.260 4.260
26H()z	0 2 3 4 ²	1.110	1.204	4.950 4.170 5.040 5.040	1.110	1.150	4.950 4.170 5.040 5.040
26J()z	0 2, 3 4 ²	1.416	1.536	4.170 5.230 6.600	1.416	1.456	4.170 5.230 6.600
26K()z	0 - 3 4 ²	1.730	1.877	6.590 7.960	1.730	1.770	6.590 7.960

General Notes:

1. Z column designates flange class number to be inserted in type number, example: 26D()3 would designate any of the D orifice 2600 designs (conventional or bellows) with a 600# inlet flange.
2. Applies to valves with the A10 & A11 serial number suffix only. All others apply to both the A10 & A11 as well as the A14 & A15 Serial numbers.
3. For valves with serial number suffix "/M" use figure "M". Use figure "R" for valves with serial number suffix "/R".
4. For serial numbers suffixes; A10/H, A11/H, A14/H, A15/H, please consult factory for critical dimensions.

O Ring Seats A10/M, A11/M, A14/M, A15/M, A10/R and A11/R Critical Dimensions

Refer to table E.3

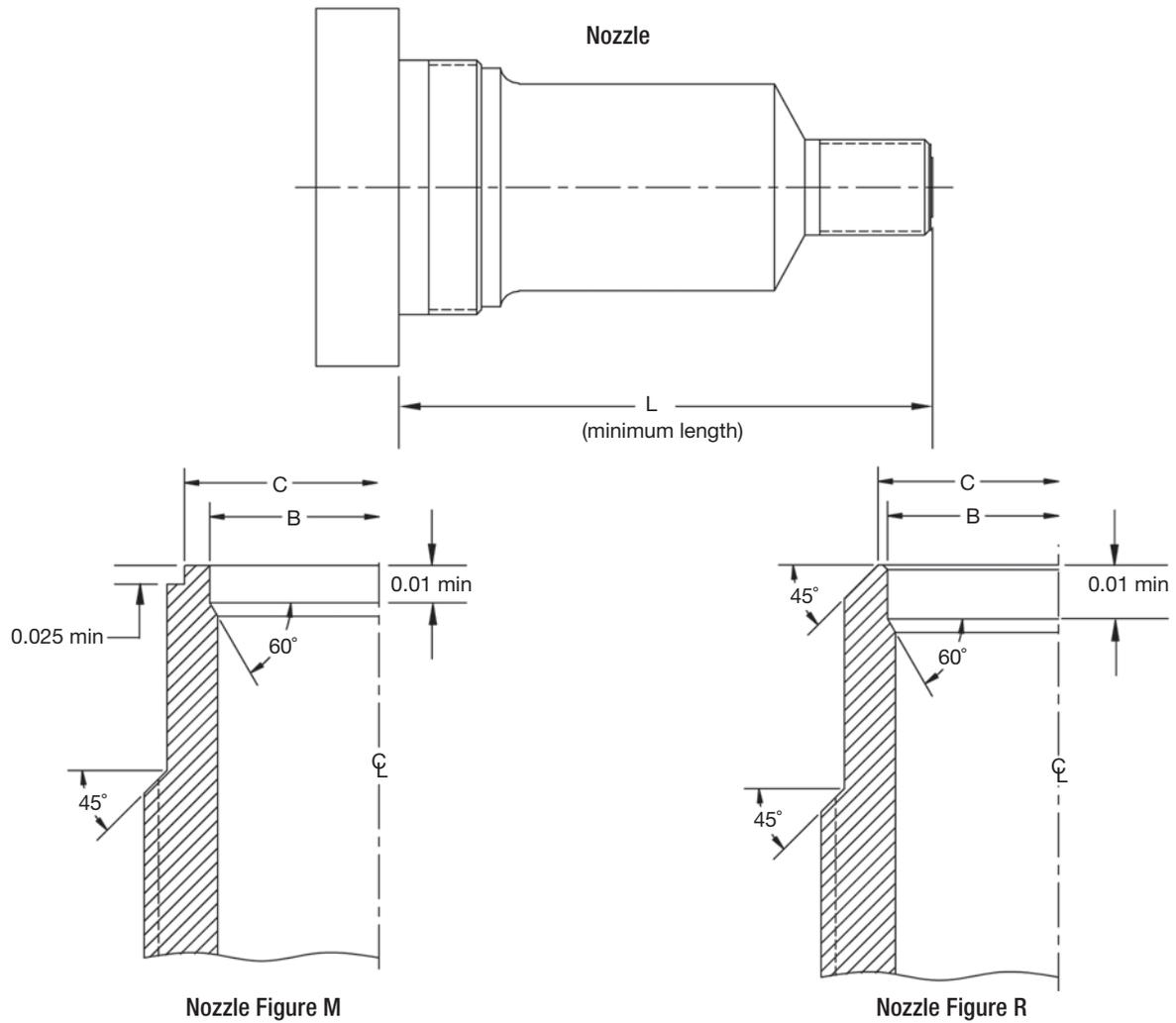




Table E.4: Metal Seats - Serial Number Suffixes: A10 & A11 Interim

Type	Nozzle Dimensions								Disc Dimensions			
	A +.010 -.000	B +.000 -.005	C +.005 -.000	D min	E +.005 -.005	F min	L min	Nozzle Fig.	H +.000 -.005	J +.005 -.000	N min.	Disc Fig.
26D()0	0.437	0.520	0.580	0.005	–	.010	4.125	1	0.480	0.653*	0.156	1, 2 ¹
26D()1	0.437	0.520	0.580	0.005	–	.010	4.125	1	0.480	0.653*	0.156	1, 2 ¹
26D()2	0.437	0.520	0.580	0.005	–	.010	4.125	1	0.480	0.653*	0.156	1, 2 ¹
26D()3	0.437	0.520	0.580	0.005	–	.010	4.125	1	0.480	0.653*	0.156	1, 2 ¹
26D()4	0.437	0.520	0.613	0.005	0.015	.010	4.375	2	0.480	–	0.156	2
26D()5	0.437	0.520	0.613	0.005	0.015	.010	4.375	2	0.480	–	0.156	2
26D()6	0.437	0.520	0.613	0.005	0.015	.010	4.375	2	0.480	–	0.156	2
26E()0	0.535	0.585	0.645	0.005	–	.010	4.062	1	0.545	0.725	0.234	1
26E()1	0.535	0.585	0.645	0.005	–	.010	4.062	1	0.545	0.725	0.234	1
26E()2	0.535	0.585	0.645	0.005	–	.010	4.062	1	0.545	0.725	0.234	1
26E()3	0.535	0.585	0.645	0.005	–	.010	4.062	1	0.545	0.725	0.234	1
26E()4	0.535	0.585	0.685	0.005	0.015	.010	4.375	2	0.545	0.725	0.234	1
26E()5	0.535	0.585	0.685	0.005	0.015	.010	4.375	2	0.545	0.725	0.234	1
26E()6	0.535	0.585	0.685	0.005	0.015	.010	4.375	2	0.545	0.725	0.234	1

General Notes:

1. Only bellows valves use Disc Figure 2 and the 0.653 inch dimension. Conventional valves use Disc Figure 1.

These dimensions only apply to “D” and “E” orifice valves as follows:

United States

A10 serial numbers below 30000.

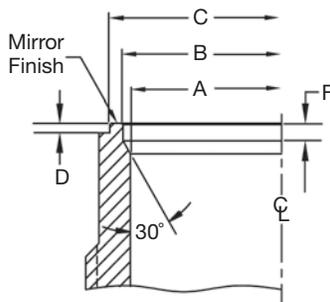
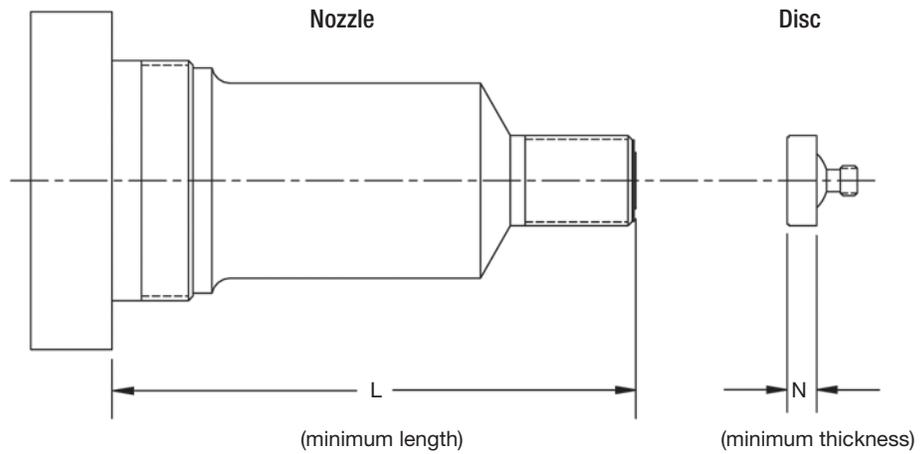
A11 serial numbers below 4000.

Canada

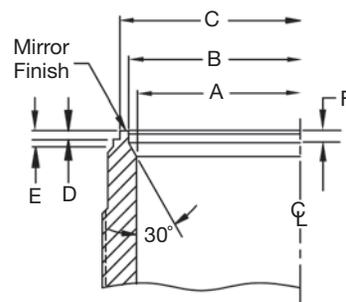
A10 & A11 serial numbers C12001 and above.

Metal Seats A10, A11 Interim Critical Dimensions

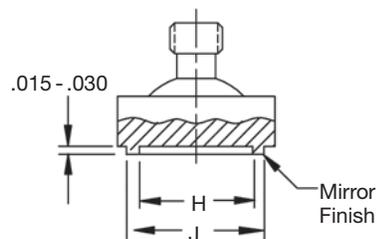
Refer to Table E.4



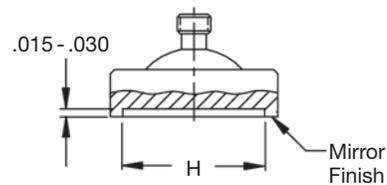
Nozzle Figure 1



Nozzle Figure 2



Disc Figure 1



Disc Figure 2

Appendix G: Required Tools

Required Tools	Orifice													
	D	E	F	G	H	J	K	L	M	N	P	Q	R	T
Open End Wrenches														
7/16"	•	•	•	•	•	•	•	•	•	•	•	•	•	•
9/16"	•	•	•	•	•	•	•	•	•	•	•	•	•	•
3/4"	•	•	•	•	•	•	•	•	•	•	•			
13/16"	•	•	•	•	•	•	•	•	•	•	•			
7/8"	•	•	•	•	•	•	•	•	•	•	•	•	•	•
1"	•	•	•	•	•	•	•	•	•	•	•	•	•	•
1-1/16"	•	•	•	•	•	•	•	•	•	•	•	•	•	
1-1/8"								•	•	•	•	•	•	•
1-1/4"			•	•	•	•	•	•	•	•	•	•	•	•
1-3/8"	•	•	•	•	•									
1-1/2"				•										
1-5/8"					•									
1-3/4"						•	•	•	•	•	•			
2"								•	•	•	•	•	•	•
2-1/4"	•	•	•	•	•	•	•	•	•	•	•			
2-3/4"							•							
3-1/4"						•	•	•	•	•	•	•	•	•
3-1/2"								•	•					
3-11/16"				•	•									
3-3/4"										•				
5"							•			•				
5-1/4"						•								
5-3/4"												•		
6"													•	
6-3/16"							•	•	•	•	•	•	•	•
Allen Wrenches														
3/16"	•	•	•	•	•	•								
7/32"							•	•	•	•	•			
3/8"												•	•	•
Adjustable Pin Spanners														
1-1/4" to 3"	•	•	•		•									
2" to 4-3/4"				•	•	•								
4-1/2" to 6-1/4"							•	•	•	•	•	•	•	
8-1/2"												•	•	
10-5/8"														•
Adjustable Hook Spanners														
2" to 4-3/4"								•	•	•				
4-1/2" to 6-1/4"										•				
6-1/8" to 8-3/4"												•	•	
9-1/4"														•
Adjustable Wrenches	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Flat Head Screw Drivers	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Wire Cutters	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Super Joint Pliers	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Pipe Wrench	•	•												
O-Ring Pick	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Flashlight	•	•	•	•	•	•	•	•	•	•	•	•	•	•

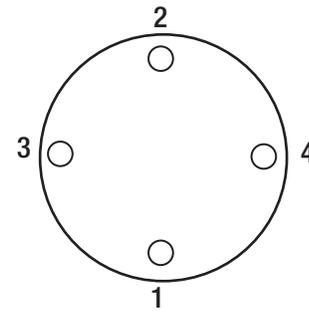
Appendix H: Torque Requirements

This appendix contains the minimum torquing requirements for body/bonnet and bolted/packed cap for Farris pressure relief valves.

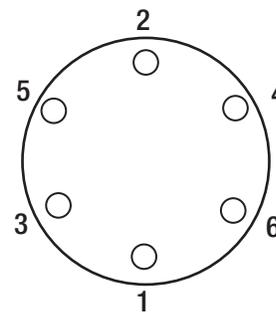
Valve: Body/Bonnet - Bolted/Packed Cap Procedure

(See figures to the right):

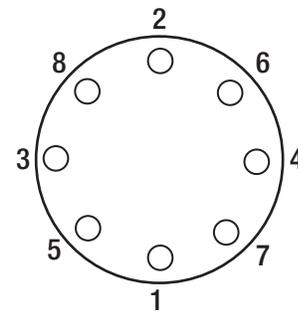
1. Valve studs, nuts and bolts shall be visually inspected to ensure they are free of rust, dirt, or physical damage.
2. Install nuts on the studs finger-tight.
3. Tighten the nuts per the sequence shown in the diagram to the right to approximately one-half the torque value shown in Table H.1. Repeat the same sequence of tightening to the torque value shown in Table H.1. Then starting with the Nut Number 1, tighten each nut in order in a clockwise or counterclockwise direction to the value shown in Table H.1. (16 stud pattern, similar to 12 stud pattern).
4. Bolting torque tolerance: $\pm 10\%$. **Measure torque with a calibrated torque wrench or torque device.**



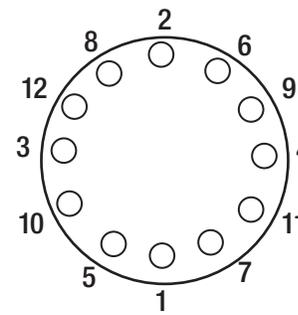
4 Studs



6 Studs



8 Studs



12 Studs

Torque Values			
Stud Thread	Torque (Ft. Lbs.) to Produce Stress in Stud Bolts		
	30 Ksi Stress (B8M, B8MA)	45 Ksi Stress (B7M)	60 Ksi Stress (B7)
	Material Codes 069, 269, D53, D59	Material Codes 235, 551	Material Codes 114
7/16 - 20	20	30	40
1/2 - 13	30	45	60
5/8 - 11	60	90	120
3/4 - 10	100	150	200
7/8 - 9	160	240	320
1 - 8	240	370	500
1 1/8 - 8	355	533	710

Table H.1

Valve Component Bolting Procedure:

1. **Blow down Ring Lock screw:**
Lubricate lock screw with Bostik Never-Seez, except in oxygen service where Holocarbon 25-5s or equivalent is used. Torque lock screw to: 80-100 Ft. Lbs.
2. **1/2"-14 NPT Pipe Plug (P/N: 5098):**
Lubricate threads with: Bostic Never-Seez. Torque pipe plug to: 18-22 Ft. Lbs.
3. **SAS Jam Nut to Bonnet:**
Lubricate threads with Bostik Never-Seez, except in oxygen service where Holocarbon 25-5s or equivalent is used. Torque jam nut to: 25-30 Ft. Lbs.

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