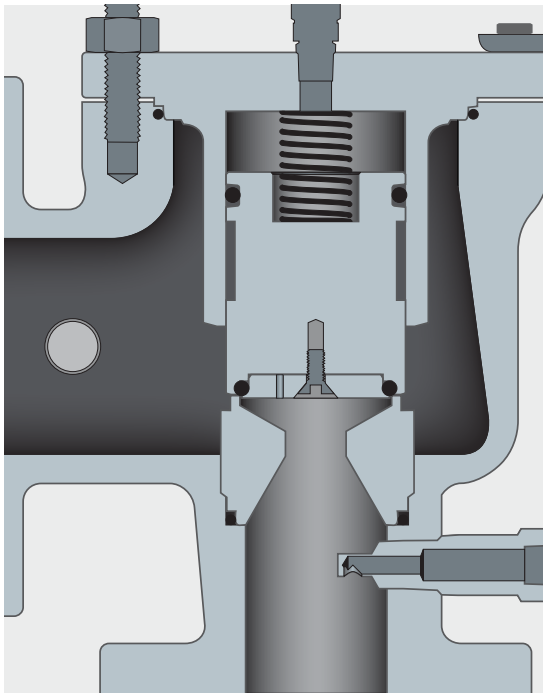
Series 3800

Maintenance Manual



CURTISS WRIGHT
Flow Control Company
Farris Engineering

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Introduction

This Maintenance Manual is intended to present all the essential information you will need in order to keep your Farris valves in perfect operating condition. Generally, maintenance becomes necessary as a result of dirt or scale in the lines, exposure to service conditions, incorrect servicing, improper testing procedure, or improper installation.

This manual covers Series 3800 pilot-operated safety relief valves, which consist of two basic components: a pilot control and the main valve. The pilot control is a spring-loaded valve which senses the pressure and controls the opening and closing of the main valve.

Once the pilot-operated safety relief valve is isolated from the system pressure, it relieves the pressure from the inlet valve. Disconnect the pilot control from the main valve. Take particular note of the tubing connection orientation.

Follow pages 4 – 6 to perform maintenance on the main valve, pages 7 – 12 for the snap acting pilot controls, and pages 13 – 21 for the modulating pilot controls.

If a valve repair requires replacement of parts, only Farris components should be used. Use of parts from other than the original manufacturer will lead to potentially dangerous operating conditions. This valve is ASME Code certified. Unauthorized tampering and repair is in violation of the Code and will void certification that may apply to an ASME Code certified system. If faced with repairs exceeding the scope of this manual, you should contact the Farris Factory.

Safety Tips

- Make sure that the safety relief valve is isolated from the pressure source before it is removed.
- Stand clear and wear protective clothing when removing safety relief valve to prevent exposure to any types of deposits or corrosive debris which may have been trapped inside the valve.
- Do not stand near the discharge side of a safety relief valve when testing the valve.
- Always install a safety valve vertically as the internal parts are designed to operate in that position.
- Avoid hammer blows to the valve.
- Eliminate stress on the valve body whenever possible.
- Be careful when checking a safety valve for visible leakage.

Type Numbering System

The diagram below illustrates the Farris 3800 Series valve type numbering system. You will find this type of number on the nameplate of every Farris 3800 Series valve. The number found on each valve nameplate describes the valve with its construction and metallurgy. Valve types with numbers ending in "SP" are special valves. Example: 38DC12-120/S4/SP.

It may be necessary to contact the factory for assistance when replacement parts or maintenance is required on such valves.

Complete standard metallurgy details for individual parts in the 3800 Series valve line can be obtained by consulting a current sales catalog.

Example: Valve Type 38DC12X-120/S4

38	D	C	1	2	X –	1	2	0/	S4
Series Number	Orifice	Design	Temp Class	Inlet Class	Special Construction	Inlet Facing	Pilot Control	Options	Special Materials

Basic Series

3800

Design Type

C	Soft Seat & Seals
T	Teflon Seat*& Seals
*Main Valve Only	

Orifice

Letter	API Area	Actual Area
D	0.110	0.150
E	0.196	0.225
F	0.307	0.371
G	0.503	0.559
H	0.785	0.873
J	1.287	1.430
K	1.838	2.042
L	2.853	3.170
M	3.60	4.000
N	4.34	4.822
P	6.38	7.087
Q	11.05	12.27
R	16.00	17.78
T	26.00	28.94
A	-	0.719
1	-	1.767
2	-	2.953
3	-	6.605
4	-	11.50
6	-	26.07
8	-	45.66

Inlet Class

Desig.	ANSI Class
0	150
2	300
3	600
4	900
5	1500
6	2500

Special Construction

L	Liquid Service
X	Oversized Vapor Service
Y	Oversized Liquid Service
D	Dual Outlet (Vapor)
E	Dual Outlet (Liquid)
U	Non-Standard API (Vapor)
N	Non-Standard API (Vapor)

Temperature & Materials

Desig-nation	Temp. Range	Material	
		Body & Cover	Spring
1	-20 to 450	Carbon St.	St.St.
1	-450 to -20	Consult Factory	Consult Factory

Inlet Facing

Special	0
Raised Face	1
Ring Joint	9
RF Smooth Finish	H
63 to 83 AARH Outlet Only	J
63 to 82 AARH Inlet & Outlet	K
High Pressure Hub Connection	X

Pilot Control

Snap-Acting Control	2
Modulating Control	M
Steam Modulating Control	S

Options

No Options	0
Dual Pilot Options	2
Auxiliary Filter	3
Manual Depress.	4
Field Test Conn.	5
Reverse Flow Preventer	6
Pressure Spike Snubber	7
Remote Depress.	8
Four Auxiliary Functions (4, 5 or F, 6 & 8)	9
Combination of Options	C
Field Test Connection w/ Indicator	F
Remote Sensing	R
Discharge to Outlet	V
Combo (3 & 5 or F)	A
Combo (5 or F & 6)	B
Combo (3, 5 or F, & 6)	E

Special Materials

S4	Complete 316 SS Construction
S7	NACE Construction (Obsolete – Historical Designation)
M4	Complete Monel Construction
N1	NACE Carbon Body
N4	NACE All Stainless
H4	All Hastelloy C

Operational Principles

Pressure in the protected vessel is sensed through a pressure tap (remotely connected or on the main valve body). The pressure tap is piped to the pilot control sensing line port. The vessel pressure is transmitted to the dome from the pilot control dome port.

When vessel pressure is below pilot control set pressure, the relief seat of the pilot control is closed. Inlet pressure of the main valve is equal to the dome pressure. The difference in the main valve nozzle seat area (smaller) and the dome area (larger) guarantees the main valve to be closed.

When the vessel pressure reaches set pressure, the pilot control relief seat opens. The pilot control relieves the dome pressure to the atmosphere. The force of the pressure in the inlet of the main valve causes the piston to lift from its closed position to relieve excess vessel pressure.

When vessel pressure reaches re-seat pressure (typically 95% of set pressure), the spring force overcomes the pressure force on the lower seat of the pilot control. The relief seat closes instantaneously with the opening of the lower seat. Pressure re-enters the dome and develops the force to move the piston down and close the main valve.

Main Valve

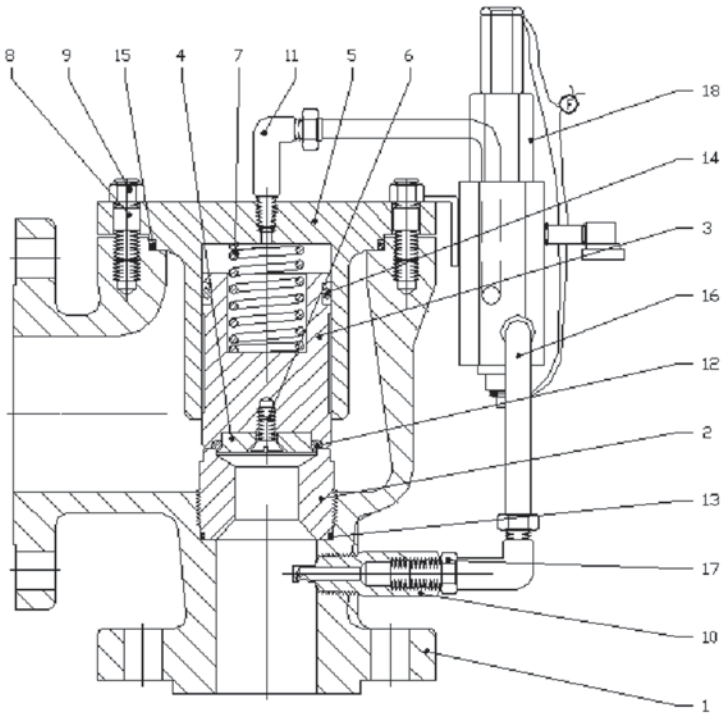

Figure 5.1 Main Valve (1", 1-1/2" & 2" Inlet)

Bill of Materials

Item	Part Name	Material
1	Body	SA-216, Gr. WCB, Carbon St.
2	Nozzle	316 St. St.
3	Piston	316 St. St.
4	Seat Retainer	316 St. St.
5	Guide / Cover	316 St. St.
6	Retainer Screw	316 St. St.
7	Preload Spring	316 St. St.
8	Body Stud	ASTM A193 Gr. B7 Alloy St.
9	Hex Nut (Body)	ASTM A194 Gr. 2H Alloy St.
10	Pressure Pickup	316 St. St.
11	Male Elbow	316 St. St.
12	Seat Seal	Viton
13	Nozzle Seal	Viton
14	Piston Seal	Viton
15	Guide Seal	Viton
16	Tubing	316 St. St.
17	Male Connector	316 St. St.
18	Pilot Control	316 St. St.

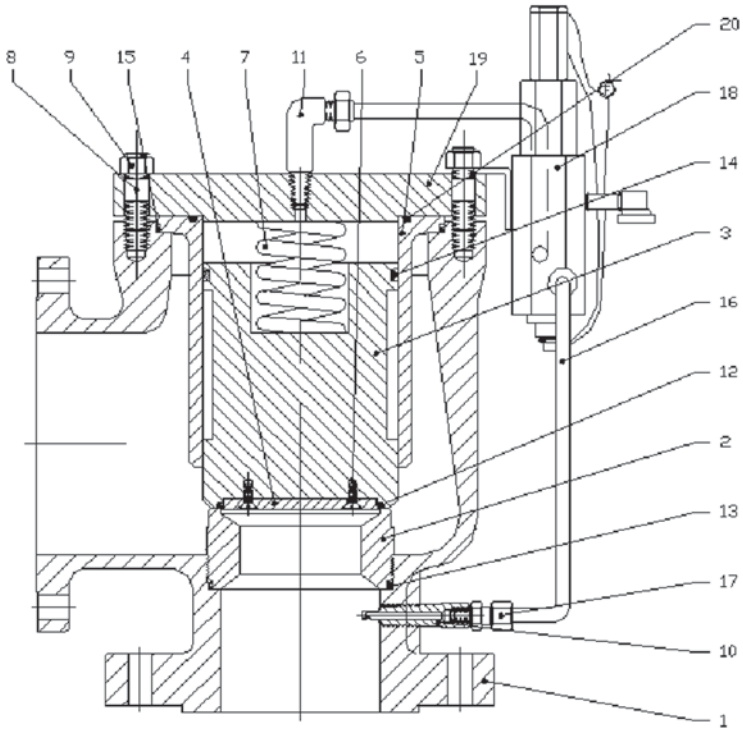

Figure 5.2 Main Valve (3" and larger Inlet)

Bill of Materials

Item	Part Name	Material
1	Body	SA-216, Gr. WCB, Carbon St.
2	Nozzle	316 St. St.
3	Piston	316 St. St.
4	Seat Retainer	316 St. St.
5	Guide	316 St. St.
6	Retainer Screw	316 St. St.
7	Preload Spring	316 St. St.
8	Body Stud	ASTM A193 Gr. B7 Alloy St.
9	Hex Nut (Body)	ASTM A194 Gr. 2H Alloy St.
10	Pressure Pickup	316 St. St.
11	Male Elbow	316 St. St.
12	Seat Seal	Viton
13	Nozzle Seal	Viton
14	Piston Seal	Viton
15	Guide Seal	Viton
16	Tubing	316 St. St.
17	Male Connector	316 St. St.
18	Pilot Control	316 St. St.
19	Cover	SA-105, Carbon St.
20	Cover Seal	Viton

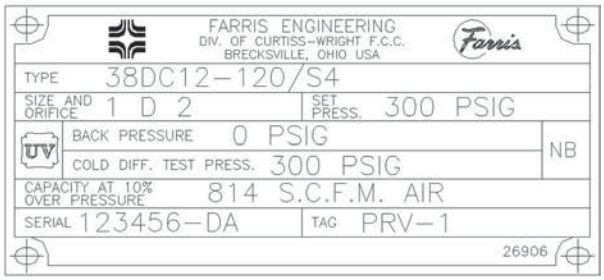

Figure 5.3 Sample Nameplate for Main Valve

Disassembly

Item	Tool Description	Sizes
1	Wrenches	1/2", 5/8", 3/4", 7/8", 1-1/4"
2	O-Ring Pick	
3	1" Square Drive Socket Spanner	1-5/8", 2-1/4", 2-7/16", 3-5/8"
4	1-1/2" Square Drive Socket Spanner	4-1/2"
5	Screw Driver	
6	Wire Cutter	
7	Extension Bar	9", 18"
8	C-Clamp	
9	Eye Bolt	3/8", 1/2"

*Special tool for 6" and 8" inlet size valves.

For 1", 1-1/2" and 2" inlet size (Figure 5.1):

1. Place valve on a clean and well-lit workbench.
2. Remove wire seal.
3. Remove pilot control, bracket and interconnecting tubing.
4. Do not remove sensing nipple from body.
5. Loosen body hex nuts and remove from cover.
6. Using a nipple in the guide connection, carefully lift the guide-piston assembly straight up. Avoid tilting or dropping, which could damage nozzle face.
7. Invert the guide-piston assembly and slide the piston and spring out.
8. Remove cover seal.
9. Remove seat retainer from piston by unscrewing the set screw.
10. Remove seat seal and piston seal with O-ring pick.
11. Unscrew nozzle from body with a socket spanner.
12. Remove nozzle seal.

For 3", 4", 6" and 8" inlet size (Figure 5.2):

1. Place valve on a clean and well-lit workbench.
2. Remove wire seal.
3. Remove pilot control, bracket and interconnecting tubing.
4. Do not remove sensing nipple from body.
5. Loosen body hex nuts and remove from cover.
6. Lift cover using eyebolts and lifting device.
7. Remove spring.
8. Remove cover seal from top of guide.
9. Remove piston from guide using eyebolt and lifting device. Guide may also be lifted along due to piston seal friction. Hold the guide so that it will not be lifted with the piston.
10. Remove guide and guide seal from body.
11. Unscrew set screw to remove seat retainer from piston.
12. Remove piston seal and seat seal.
13. Unscrew nozzle from body with socket spanner or special tool. Remove nozzle from body.
14. Remove nozzle seal from body.

Cleaning and Repairing

Clean all parts thoroughly. Replace all O-rings. Inspect all parts and replace any that are worn. NO REMACHINING IS ALLOWED. Polish guiding surfaces, if required. For O-ring purchasing, be sure to specify original compound. If in doubt, contact the Farris Factory.

Assembly

For 1", 1-1/2" and 2" inlet size:

1. Refer to Figure 5.1 for construction details.
2. Visually inspect all parts to be assembled. Replace any parts that are worn or damaged.
3. Lubricate all threaded and mating surfaces with Bostik Never Seez® or equivalent.
4. Lubricate all seals with grease compound that is compatible to the elastomer.
5. Insert nozzle seal into recess on bottom of nozzle.
6. Screw nozzle into body using socket spanner.
7. Position piston with the seat facing up. Place seat seal on piston, making sure it fits evenly and symmetrically.
8. Place seat retainer on piston and tighten set screw, making sure that seat retainer sits evenly and symmetrically on piston. Use C-clamp to hold the piston and retainer in order to tighten the set screw fully.
9. Insert piston seal into the groove around the circumference of the piston.
10. Place cover seal onto the body.
11. Invert piston so that the seat retainer faces down. Place spring on top of piston. Insert piston into guide with the spring in between. Check manually if there is interference between the guide and the piston. There may be some resistance due to the piston seal and the spring.

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Assembly (continued)

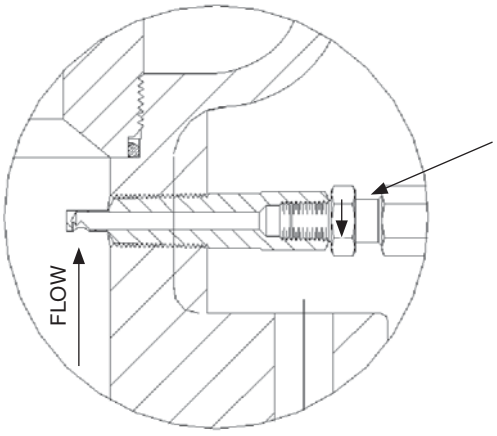
For 1", 1-1/2" and 2" inlet size (continued):

12. Carefully place the guide-piston assembly into the body.
13. Thread body hex nuts onto body studs and tighten.
14. If sensing nipple is removed from the body, thread it to the body and make sure the hole orientation is correct and agrees with the arrows marked (Refer to Figure 5.4).
15. The main valve is now ready for final assembly (See section on Final Assembly, page 22).

For 3", 4", 6" and 8" inlet size:

1. Refer to Figure 5.2 for construction details.
2. Follow steps 2-5 of the assembly procedure for 1", 1-1/2" and 2" main valves.
3. Screw nozzle into body with socket spanner. Use the special tool to tighten nozzle for 6" and 8" inlet size valves.
4. Place the guide seal onto the body.
5. Place guide into the body carefully. Make sure that guide is seated on the body evenly.
6. Position piston with the seat facing up. Place seat seal on piston, making sure it fits evenly.
7. Place seat retainer on piston and align the holes of retainer to the threaded holes on piston. Tighten set screws. Use C-clamp to hold the piston and retainer if necessary.
8. Insert piston seal into the groove around the circumference of the piston.
9. Invert piston so that the retainer faces down. Lift piston with eyebolt and lifting device, and lower it into the guide carefully. Push the piston into the guide if needed. There should not be any interference between the guide and the piston, but there may be some frictional resistance caused by the piston seal.
10. Place spring on top of piston.
11. Place cover seal on guide.
12. Lift cover with eyebolts and lifting device. Align the holes of the cover with the body studs. Lower cover over guide.
13. Thread body hex nuts onto body studs and tighten.
14. If sensing nipple is removed from the body, thread it to the body, making sure that hole orientation is correct and agrees with the arrow marked (Refer to Figure 5.4).
15. The main valve is now ready for final assembly (See section on Final Assembly, page 22).

Fig. 5.4 Sensing Nipple



Snap Acting Pilot Control

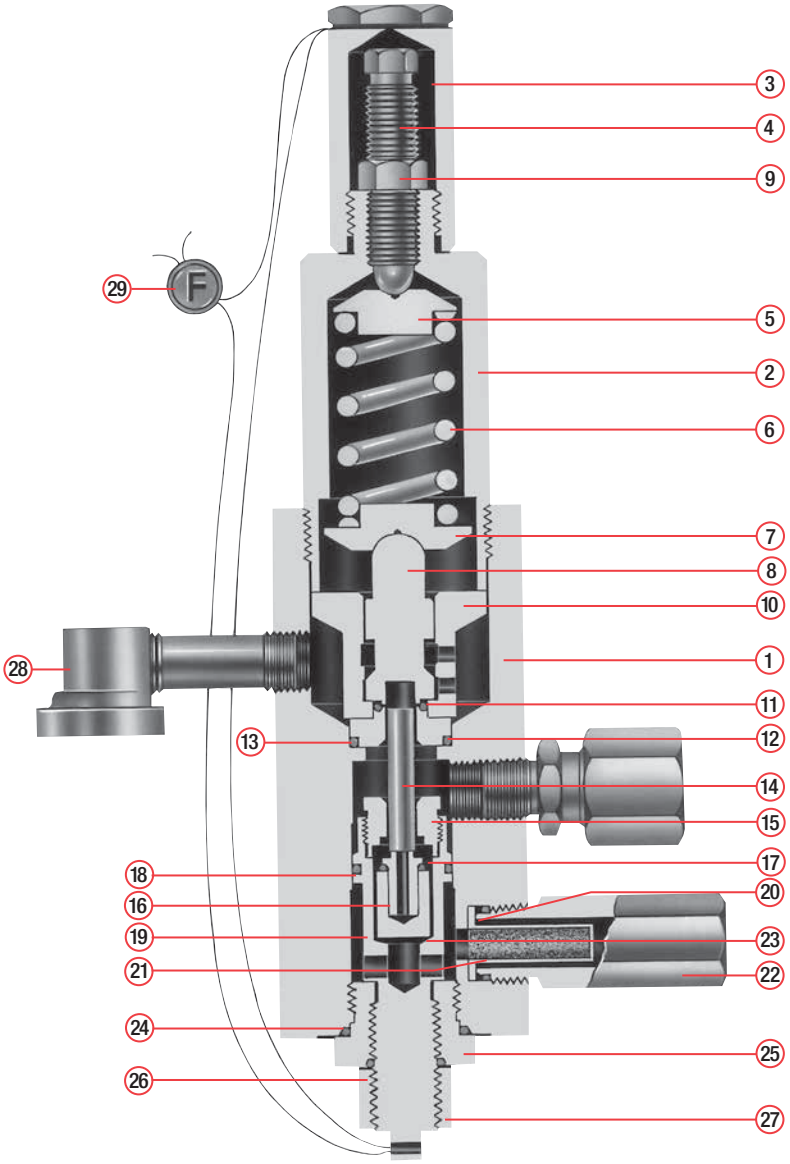


Figure 6.1 Snap Acting Pilot Control

Bill of Materials

Item No.	Part Name	Standard Material
1	Body	SA-479, 316 St. St.
2	Bonnet	SA-479, 316 St. St.
3	Cap	316 St. St.
4	Spring Adjusting Screw	316 St. St.
5	Upper Spring Button	316 St. St.
6	Spring - Standard	316 St. St.
	Spring - NACE	Inconel X750
7	Lower Spring Button	316 St. St.
8	Disc	316 St. St.
9	Jam Nut	18-8 St.
10	Guide	316 St. St.
11	Upper Seat Seal	Viton[1]
12	Upper Seat	316 St. St.
13	Static Seal, Body	Viton[1]
14	Blowdown Relay	316 St. St.
15	Lower Seat	316 St. St.
16	Retainer, Lower Seat Seal	316 St. St.
17	Lower Seat Seal	Viton[1]
18	Static Seal, Adjuster	Viton[1]
19	Blowdown Adjuster	A479, 316 St. St.
20	Static Seal, Filter	Viton[1]
21	Filter	300 Series St. St.
22	Filter Housing	316 St. St.
23	Poppet	316 St. St.
24	Adjuster Cap Seal	Viton[1]
25	Blowdown Adjuster Cap	316 St. St.
26	Thread Seal	Teflon
27	Blowdown Adjuster Lock Nut	18-8 St. St.
28	Bug Vent Housing	Commercial Grade
29	Wire Seal	St. St. Wire/Lead Seal
30	Nameplate (Not Shown)	Stainless Steel

Figure 6.1a
Sample Snap-Acting Control Nameplate

General Notes:
1. For NACE Service (S7 Trim), substitute ethylene propylene.

Disassembly

Like any other safety relief device, the snap acting pilot control requires maintenance on a regular basis. Scheduling of maintenance is the responsibility of the end-user.

The snap acting pilot control shall be taken off-line before any maintenance and service work can be performed. Arrangements for an alternate safety relief device shall be made, if system protection is to remain in effect. Only authorized repair facility with qualified personnel shall do any maintenance/repair.

It is necessary to have the right tools (Table 6.1) and a replacement elastomer kit.

Table 6.1

Item	Tool Description	Sizes
1	Soft Jaw Bench Vise	
2	Adjustable Wrenches	
3	Set Of Open Ended Wrenches	1/4, 7/16, 9/16, 5/8, 3/4, 1-1/8, 1-1/2 & 2 Inch Span
4	O-Ring Pick	
5	Wire Cutters	

Once the pilot control is out of service

1. Place the pilot control on a clean and well-lit workbench.
2. Make a note of the physical condition of the valve before disassembly.
3. Cut and discard lead seals.
4. Remove the strainer assembly, the fitting for the piston (dome) line, and the exhaust port attachment.
5. Clamp the body of the valve on a bench vise. Remove the cap by unscrewing it from the bonnet.
6. Relieve the spring compression by loosening the spring adjustment screw. Take note of the number of turns from the locked position to the point where spring resistance is not felt. This will aid in setting the valve to its original set pressure.
7. Remove the bonnet from the body to expose the internals of the upper sub-assembly. CAREFULLY pull each part and arrange neatly on top of the workbench.
8. Loosen the blow down adjuster. Take note of the number of turns from the locked position to the lowest position. This will be helpful when setting the valve to its original setting.
9. Remove the lower sub-assembly by unscrewing the bushing from the body.
10. Unscrew the seat insert from the adjuster to access the lower disc assembly.

Cleaning & Repairing

Clean all parts with solvent and blow dry with air, being particularly careful on seating surfaces.

Inspect all parts and seating surfaces for excessive wear and corrosion. Discard and replace as necessary. NO REMACHINING IS ALLOWED. Replace all seals. Identify each new elastomer piece from the kit by matching it with Figure 6.2. Be sure to replace with proper compound for the particular service. If in doubt, contact the Farris Factory giving the serial number on the nameplate.

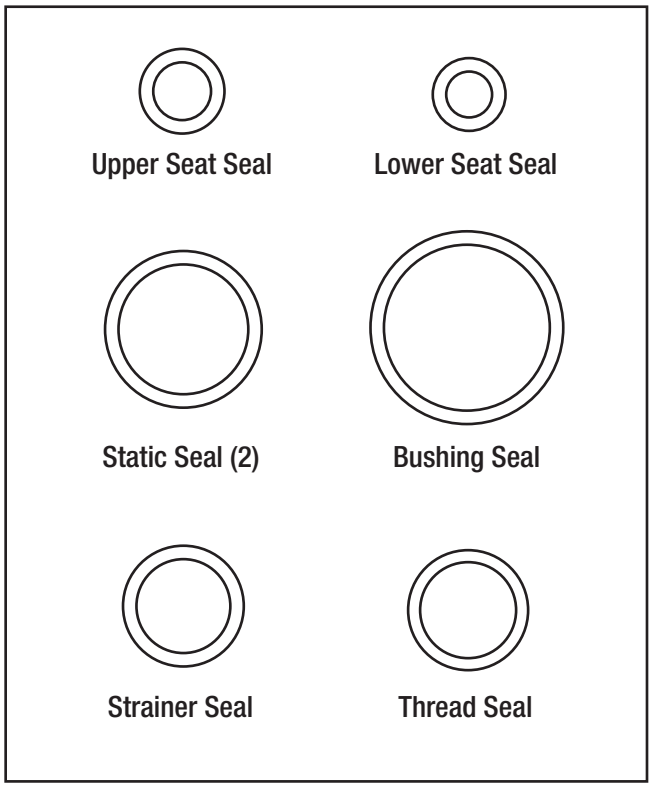


Figure 6.2
Seals for Snap Acting Pilot Control

Assembly

The upper and adjuster sub-assemblies have been identified in Figure 6.3 to help in distinguishing the vertical position of the snap acting control. Orientation of all the parts in each sub-assembly is likewise referred to in their vertical position.

Lubricate all threaded and mating surfaces with Bostik Never Seez (or equivalent).

A. Upper Sub-Assembly

1. Orient body with its length vertical, and the wider opening facing upward.
2. Place a static seal into the counter-bore of the body, via the upper opening.
3. Place the upper seat over the static seal, making sure the side with the bigger outside diameter protrusion faces downward.
4. Orient the guide with its flange upward. Insert the upper seat seal into the recess on the lower side of the guide.
5. Lower the guide onto the upper seat inside the body, making sure that the upper seat seal does not fall out and is in good contact with the upper seat and the guide. Also make sure that the two holes on the guide's side face the outlet (uppermost side-hole) of the body.
6. Slide disc into the guide, taking care not to damage the seats, and making sure that the upper disc rests fully on the upper seat seal. The correct orientation of the disc is with its rounded end facing upwards.
7. Place the two (2) spring buttons over the two ends of the spring. Hold the buttons over the ends of the spring with thumb and forefinger.
8. Match the lower spring button over the rounded top of the disc making sure that rounded top of the disc fits into the recess in the lower spring button.
9. Lower the bonnet over the spring button's subassembly and screw tightly into the body.
10. Screw the spring adjusting screw into the jam nut until the jam nut is about two thirds (2/3) up the spring adjusting screw.
11. Screw the spring adjusting screw – jam nut subassembly into the top of the bonnet. Stop as soon as resistance from the upper spring button is felt.

B. Adjuster Sub-Assembly

1. Position the lower seat seal on the retainer making sure it fits evenly and symmetrically.
2. Lower the retainer into the lower disc with the lower seat seal fitting snugly between the retainer and the lower seat.
3. Lower the lower seat – retainer sub-assembly into the adjuster with the lower disc entering the adjuster first.
4. Screw the seat insert into the adjuster and tighten.
5. Place the second static seal in the groove on the side of the adjuster, making sure it fits evenly.
6. Place the bushing seal on the bushing beyond the threads and against the flat back of the bushing's hex head.
7. Screw the bushing onto the adjuster with the hex head of the bushing facing downward.
8. Position a thread seal on the threads of the adjuster and against the hex head of the bushing.
9. Screw the lock nut onto the adjuster and tighten.
10. Place the spacer rod into the hole of the seat insert until it rests on the top of the retainer.
11. Insert the adjuster sub-assembly into the body through its lower end, making sure the spacer rod passes through the hole of the upper seat.

C. Strainer

1. Position the strainer into the inlet (lowest) port of the body, flange first.
2. Place the second thread seal into the inlet port, bottoming on the strainer flange.
3. Screw the strainer housing into the inlet port and tighten.

D. Connections

1. Connect the sensing line into the strainer housing in the sensing line port of the body.
2. Use the dome line port in the middle of the body to connect to the dome of the main valve.
3. Leave the exhaust port open to the atmosphere for exhaust, or connect it to an exhaust plenum. The snap acting pilot control is ready to be set and tested.

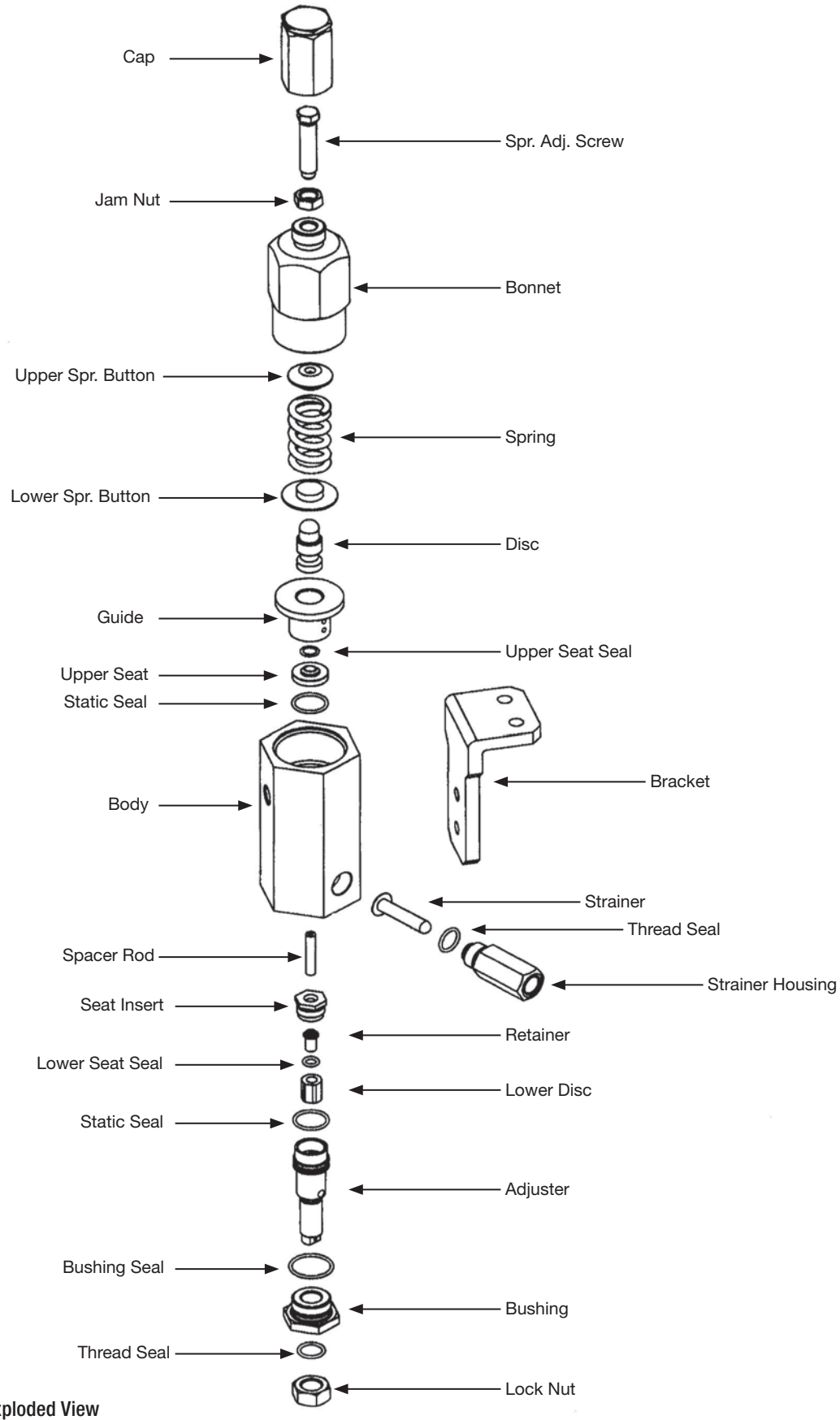


Figure 6.3
Snap-Acting Control Exploded View

Setting & Testing the Snap Acting Pilot Control

Testing of the snap acting pilot control will be performed only after correct assembly has been accomplished. Read the entire test procedure. Test should be conducted only by qualified personnel.

Connect the snap acting control to the test rig (see Test Stand Schematic, Figure 6.4).

A. Test Stand Schematic Description

- **V1 -** Isolation valve, normally open when test is in progress.
- **V2 -** Needle valve, regulates pressure into vessel.
- **V3 -** Vent valve, normally closed when going up on the receiver pressure; also used to dump pressure from vessel.
- **V4 -** Vent valve, normally closed when testing, used as an auxiliary pressure dump valve.
- **P1 -** Pressure gage, to read dome pressure.
- **P2 -** Pressure gage, to read vessel pressure.

Vessel Receiver – Test pressure receiver simulating a vessel.

Dome Receiver – Test pressure receiver simulating the dome/piston volume on the main valve.

In-Line Filter – Filters air going into the vessel.

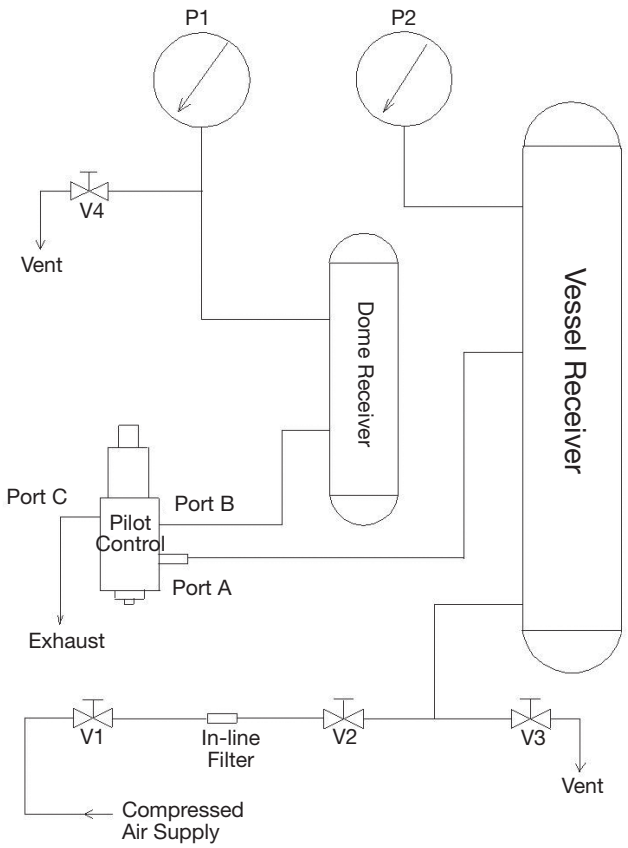


Figure 6.4 Test Stand Schematic

B. Port Identification and its Connections

Port A: Where the pilot control senses the vessel pressure. Connect this to vessel receiver.

Port B: Where the pilot control is connected to the dome or piston of the main valve. Connect this to the dome receiver.

Port C: The exhaust port, normally vented to the atmosphere (i.e. piped to the outlet of the main valve, with bug screen).

C. Set Pressure Testing

Setting the pilot control is similar to setting a spring loaded valve where the spring is being compressed to the desired set pressure. The set pressure is distinguished by the pop.

1. Refer to Table 6.2 (page 12) for the nominal number of turns on the spring adjusting screw required to set the valve. Start counting the number of turns when the spring adjusting screw approximately touches the upper spring button. This can be done by feel.
2. Set the blow down adjuster at its lowest position.
3. Pressurize the vessel receiver by slowly opening V2. Note: both pressure gages P1 and P2 shall have the same pressure reading.
4. Record pop (set) pressure. Note: After pop, P1 should drop to zero. If it does not, carefully turn the blow down adjuster up to equalize P1 and P2. Pop again to confirm zero pressure on P1. Overpressurize the vessel receiver to 10% or 3 psig, whichever is greater.
5. Fine tune the set pressure and blow down to requirement. Use Table 6.2 as a guide to the number of turns required.
6. When the set (pop) pressure on P2 is reached, P1 will read zero pressure (main valve is in the open or flowing mode).
7. Vent the vessel pressure slowly through V3 to determine the re-seat pressure of the valve. Proper re-seat (commonly there's a slurping sound) occurs when P1 and P2 read the same pressure.
8. When performance is satisfactory, tighten the lock nut, jam nut and cap.

D. Pilot Seat Tightness Testing

A 5/16" OD x 0.035" wall thickness copper tube or equivalent immersed no more than 1/2" deep in water shall be connected to the exhaust port. Raise the receiver pressure to the test pressure described below and observe for bubbles. No bubbles are allowed.

Test pressure:

- 90% of set pressure if set pressure is 50 psig or more OR
- 5 psig below set pressure if set pressure is less than 50 psig

Brush soap and water solution on joints internally exposed to pressure. Observe for leakage. No leakage at any joint is allowed.

E. Test Conclusion

Vent out pressure from the receiver tank. Unhook all test connections.

Go on to page 22 for final assembly.

Pilot Control Spring Chart & Spring Adjusting Screw / Blow Down Adjustments

Pilot Control Spring Chart & Spring Adjusting Screw / Blow Down Adjustments

Set Pressure (psig)	Spring Number	Spr. Adj Scr. (turns)	Blow Down Adjustment +/- 1/8	95 % of Set (psig)
15	B1106 SS	3-1/2	1/4	19
35		6	1/2	33
50		8-1/2	5/8	48
51	B0125 SS	3-1/2	1/4	48
65		4-1/2	3/8	62
80		5-1/2	3/8	76
100		7	1/2	95
101	B0530 SS	3-1/2	1/4	96
125		4-1/2	3/8	119
175		6	1/2	166
230		8-1/2	5/8	219
231	B0531 SS	3	1/4	219
280		3-1/2	1/4	266
330		4	1/4	314
380		5	3/8	361
430		5-1/2	3/8	409
480		6	1/2	456
530		7	1/2	504
600		8	5/8	570
601	B0533 SS	5	3/8	571
650		5-1/2	3/8	618
700		6	3/8	665
760		6-1/2	1/2	722
820		7	1/2	779
880		7-1/2	1/2	836
940		8	5/8	893
1000		8-1/2	5/8	950
1001	B0535 SS	5	3/8	951
1080		5-1/2	3/8	1026
1160		6	1/2	1102
1240		6-1/2	1/2	1178
1320		7	1/2	1254
1400		7-1/2	1/2	1330
1500		8	5/8	1425
1501	B0536 SS	5-3/4	1/2	1425
1600		6-1/4	1/2	1520
1700		6-3/4	1/2	1615

Pilot Control Spring Chart & Spring Adjusting Screw / Blow Down Adjustments

Set Pressure (psig)	Spring Number	Spr. Adj Scr. (turns)	Blow Down Adjustment +/- 1/8	95 % of Set (psig)
1800	B0536 SS	7	5/8	1710
1900		7-1/2	5/8	1805
2000		7-3/4	5/8	1900
2100		7-3/4	5/8	1900
2200		8-1/2	3/4	2090
2300		9	3/4	2185
2301	B0403 SS	4-1/2	3/8	2185
2400		4-3/4	3/8	2280
2500		5	3/8	2375
2600		5	3/8	2470
2700		5-1/4	3/8	2562
2800		5-1/2	1/2	2660
2900		5-3/4	1/2	2755
2901	B0404 SS	4	3/8	2755
3000		4	3/8	2850
3100		4-1/4	3/8	2945
3200		4-1/4	3/8	3040
3300		4-1/2	3/8	3135
3301	B0210 SS	3-1/2	1/4	3135
3400		3-1/2	1/4	3230
3500		3-1/2	1/4	3325
3600		3-3/4	1/4	3420
3700		3-3/4	3/8	3515
3800		4	3/8	3610
3900		4	3/8	3705
4000		4-1/4	3/8	3800
4001	B0327 SS	3	1/4	3801
4300		3-1/4	1/4	4085
4500		3-1/2	1/4	4275
4700		3-1/2	1/4	4465
4900		3-3/4	1/4	4655
5100		4	3/8	4845
5300		4	3/8	5035
5301	B0415 SS	3-1/4	1/4	5036
5500		3-1/4	1/4	5225
5700		3-1/2	1/4	5415
5900		3-1/2	1/4	5605
6100		3-3/4	1/4	5795

Modulating Pilot Control

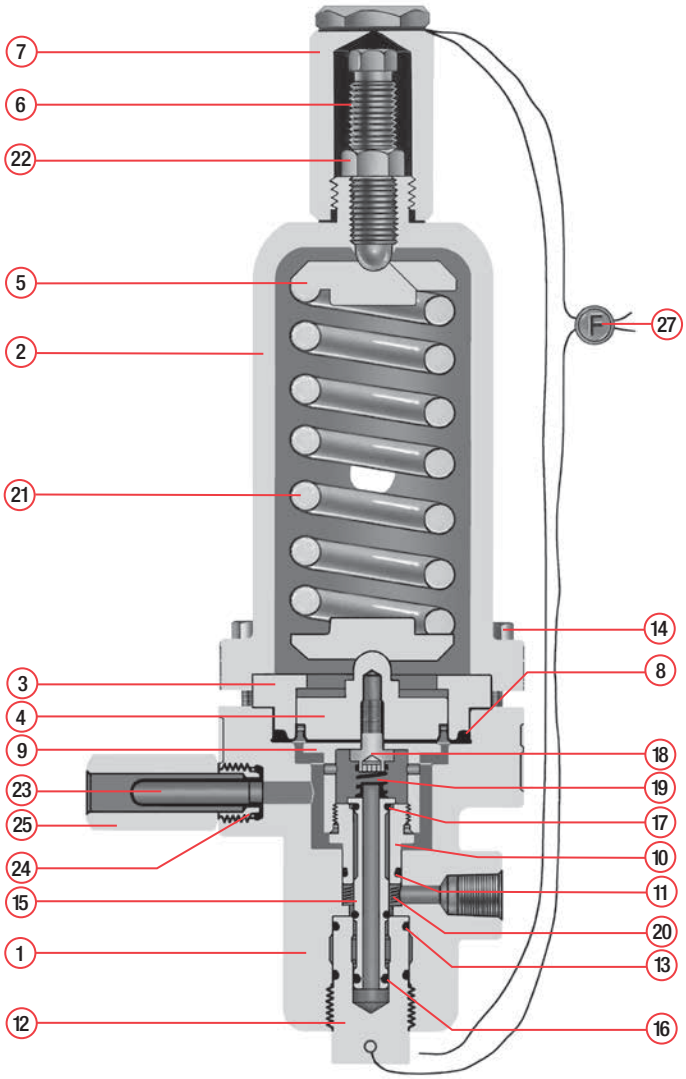
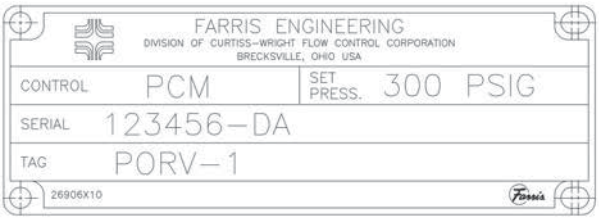


Figure 7.1 Modulating Pilot Control

Bill of Materials

Item No.	Part Name	Materials
1	Body	SA-351 GR. CF8M
2	Bonnet	SA-351 GR. CF8M
3	Guide	316 St. St.
4	Diaphragm Piston	316 St. St.
5	Spring Button	316 St. St.
6	Spring Adjusting Screw	316 St. St.
7	Cap	316 St. St.
8	Diaphragm	Fluorocarbon/Fiber Reinforced[1]
9	Diaphragm Retainer	316 St. St.
10	Inlet Seat	316 St. St.
11	Body Seal	Viton[1]
12	Spool Cap	316 St. St.
13	Spool Cap Seal	Viton[1]
14	Bonnet Cap Screw	Series 300 St. St.
15	Spool	316 St. St.
16	Spool Seal	Viton[1]
17	Seat Seal	Viton[1]
18	Retainer Screw	316 St. St.
19	Spool Return Spring	St. St[1]
20	Lower Return Spring	St. St.[1]
21	Spring	St. St.
22	Jam Nut	Series 300 St. St.
23	Filter	Series 300 St. St.
24	Filter Seal	Viton[1]
25	Filter Housing	316 St. St.
26	Bug Vent (not shown)	Commercial Grade
27	Wire Seal	St. St. Wire/Lead Seal
28	Name Plate (not shown)	St. St.

Figure 7.1a Sample PCM Nameplate



General Notes:
1. For NACE service (S7 trim), substitute ethylene propylene soft goods and Inconel® X for return springs.
   Inconel is a registered trademark of Special Metals Corporation.

Disassembly

Like any other safety relief device, the modulating pilot control requires maintenance on a regular basis. Scheduling of maintenance is the responsibility of the end-user.

The modulating pilot control shall be taken off-line before any maintenance and service work can be performed. Arrangements for an alternate safety relief device shall be made, if system protection is to remain in effect. Only authorized repair facility with qualified personnel shall do any maintenance/repair.

It is necessary to have the right tools (Table 7.1) and a replacement elastomer kit.

Table 7.1

Item	Tool Description	Sizes
1	Soft Jaw Bench Vise	
2	Adjustable Wrenches	
3	Set Of Open Ended Wrenches	1/4, 7/16, 9/16, 5/8, 3/4, 1-1/8, 1-1/2 & 2 Inch Span
4	O-Ring Pick	
5	Wire Cutters	

Once the pilot control is out of service:

1. Place the pilot control on a clean and well-lit workbench.
2. Make a note of the physical condition of the valve before disassembly.
3. Cut and discard lead seals.
4. Remove the strainer assembly, the fitting for the piston (dome) line, and the exhaust port attachment.
5. Clamp the body of the valve on a bench vise. Remove the cap by unscrewing it from the bonnet.
6. Relieve the spring compression by loosening the spring adjustment screw. Take note of the number of turns from the locked position to the point where spring resistance is not felt. This will aid in setting the valve to its original set pressure.
7. Remove the bonnet and piston guide from the body to expose the diaphragm/spool sub-assembly. CAREFULLY arrange each part neatly on top of the workbench.
8. Release the body from the vise, invert, and re-clamp.
9. Remove the spool/cap by unscrewing from the body.
10. Unscrew the seat insert from the adjuster to access the lower disc assembly.

Cleaning & Repairing

Clean all parts with solvent and blow dry with air, being particularly careful on seating surfaces.

Inspect all parts and seating surfaces for excessive wear and corrosion. Discard and replace as necessary. NO REMACHINING IS ALLOWED. Replace all seals. Identify each new elastomer piece from the kit by matching it with Figure 7.2. Be sure to replace with proper compound for the particular service. If in doubt, contact the Farris Factory giving the serial number on the nameplate.

Figure 7.2 within this specification shows the actual sizes of O-ring seals. Match seals to the drawing for ease of seal identification. Immediately following Figure 7.2 are additional seals that are present depending on the type of modulating pilot control being assembled.

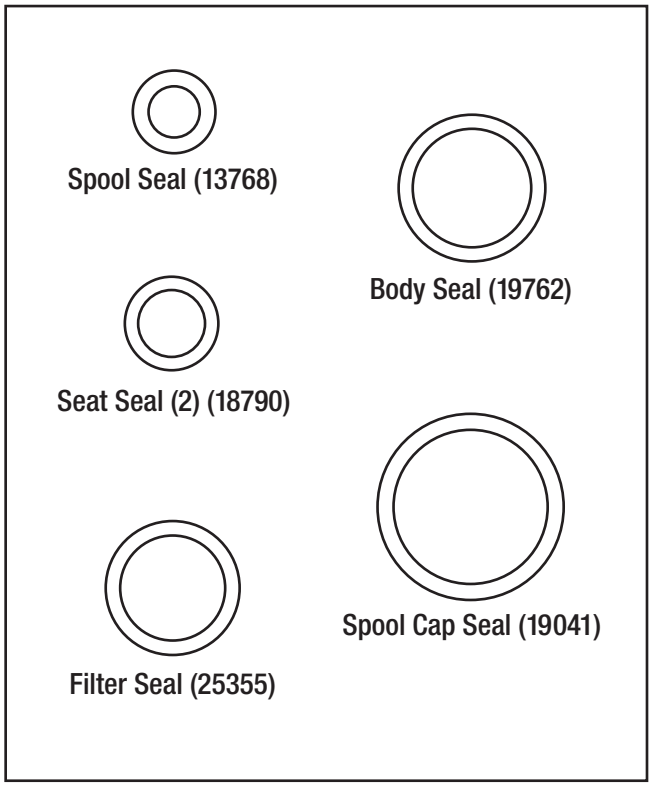


Figure 7.2
Seals for Modulating Pilot Control

Other seals specific to the modulating pilot type:

PCM – Diaphragm (26765)

HPCM – Piston Seal (7267), and Back-Up Ring (27106)

PCMS – Spring Energized Seal (27847), and Guide Seal (7272)

Assembly

A. Spool Sub-Assembly

Spool sub-assembly is identical between the PCM, HPCM, and PCMS.

1. Lay out the parts in sequence as shown in Figure 7.3a, on a clean and well-lit work area.
2. The spool uses three O-ring seals. The first (seat seal #1) is installed in the gland at the top near the flange, an intermediate one (seat seal #2) about midsection, and the lower ring (spool seal) at the bottom. Install seat seal #1 on the spool, starting from the bottom and working it to the flange end.
3. Insert the bottom of the spool through the top hole of the inlet seat. The bottom of the spool should protrude through the bottom end of the inlet seat.

s5. Install the spool seal on the bottom seal gland of the spool.

6. Install the body seal onto the seal gland located on the bottom of the inlet seat.
7. This sub-assembly (Figure 7.3b) is ready to be installed into the appropriate pilot control.

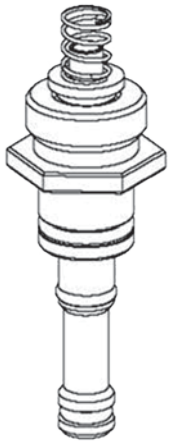


Figure 7.3b
Spool Sub–Assembly

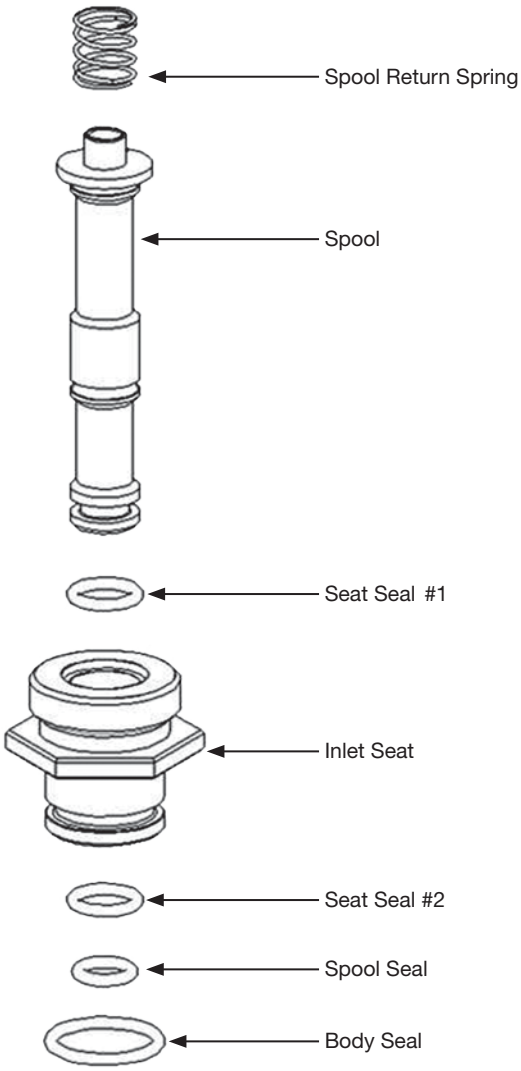


Figure 7.3a
Spool Sub–Assembly, Exploded

Assembly (continued)

B. Piston Sub-Assembly

Use the instructions for the appropriate type of modulating pilot control. Layout the components of the sub-assembly as shown in the corresponding figure.

PCM – Diaphragm Style

1. Lay out the parts in sequence as shown in Figure 7.4a, on a clean and well-lit work area.
2. Invert the diaphragm piston (threaded hole facing up) and clamp it on top of a bench vise using the milled flats provided.
3. Mate the diaphragm's back-side to the diaphragm piston. The back-side can be identified by two circular protrusions on its surface and is the non-pressurized side.
4. Align the axis of the diaphragm retainer with the hole on the diaphragm. Mate the diaphragm retainer to the flat surface of the diaphragm.
5. Install the retainer screw through the diaphragm retainer and diaphragm hole and into the diaphragm piston threads. Use a 3/16" hex key to tighten the retainer screw into the assembly.
6. Insert the spool return spring into the diaphragm retainer, bottoming one end of the spool return spring on the shoulder of the retainer screw.
7. Screw the inlet seat into the diaphragm retainer. The other end of the spool return spring should seat on the flange of the spool. Use a 1-1/8" and a 1" open end wrench on the wrenching flats of the diaphragm retainer and the inlet seat, respectively to tighten together.

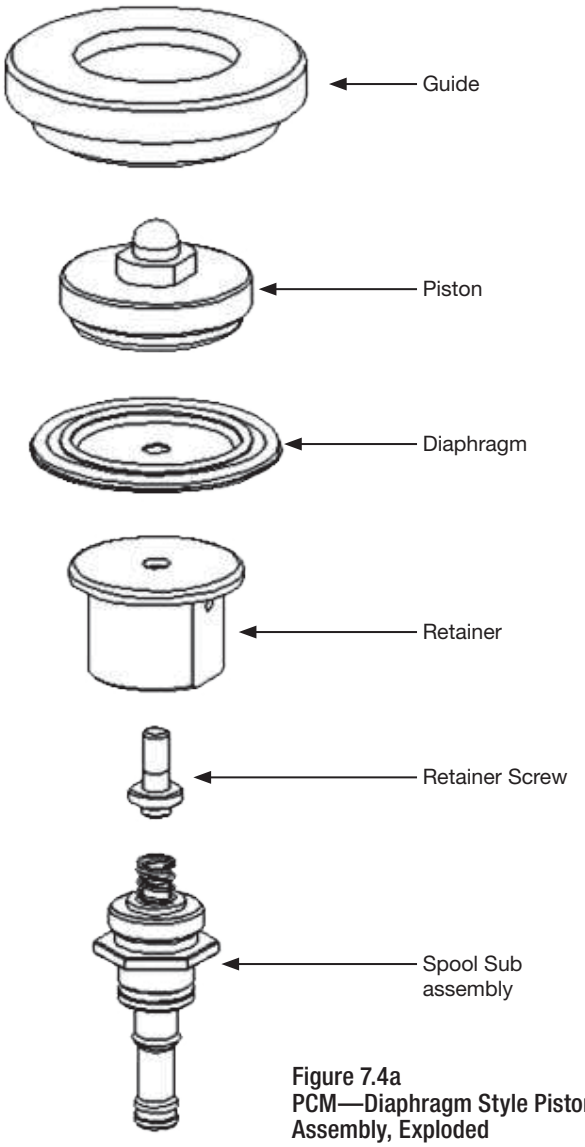


Figure 7.4a
PCM—Diaphragm Style Piston Assembly, Exploded

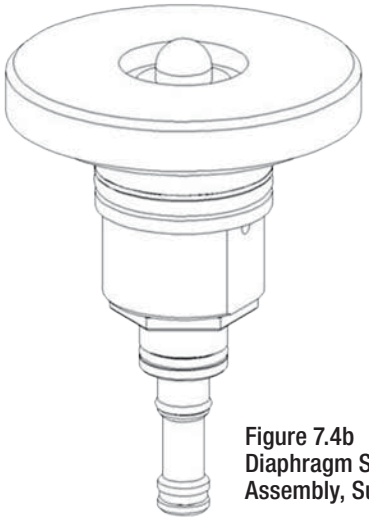


Figure 7.4b
Diaphragm Style Piston Assembly, Sub-Assembly

Assembly (continued)

B. Piston Sub-Assembly (continued)

HPCM – High Pressure Piston Style

1. Lay out the parts in sequence as shown in Figure 7.5, on a clean and well-lit work area.
2. Install the piston seal on the piston seal gland. Install the back-up ring on the gland. Note the ring to be in the upper part of the gland when the piston is oriented vertically.
3. Screw the inlet seat (with spool sub-assembly pre-assembled earlier) into the piston. One end of the spool return spring should seat in the counter bore inside the piston and the other end on the flange of the spool. Use a 1-1/8" and a 1" open end wrench on the wrenching flats of the retainer and the inlet seat, respectively to tighten together.

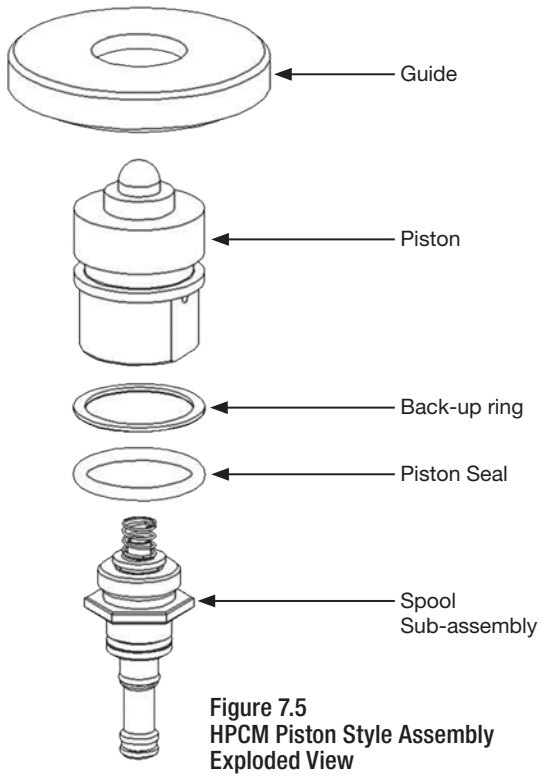


Figure 7.5
HPCM Piston Style Assembly
Exploded View

PCMS – Low and High Temperature Service Piston Style

1. Lay out the parts in sequence as shown in Figure 7.6, on a clean and well-lit work area.
2. Invert the piston (threaded hole facing up) and clamp it on top of a bench vise using the milled flats provided.
3. Install the spring-energized seal with spring exposed mating the bottom of the u-shaped seal with the piston outer ledge.
4. Align the axis of the retainer with the hole on the piston.
5. Install the retainer screw through the retainer and into the piston threads. Use a 3/16" hex key to tighten the retainer screw into the assembly.
6. Insert the spool return spring into the retainer, bottoming one end of the spool return spring on the shoulder of the retainer screw.
7. Screw the inlet seat (with spool sub-assembly pre-assembled earlier) into the retainer. The other end of the spool return spring should seat on the flange of the spool. Use a 1-1/8" and a 1" open end wrench on the wrenching flats of the retainer and the inlet seat, respectively to tighten together.

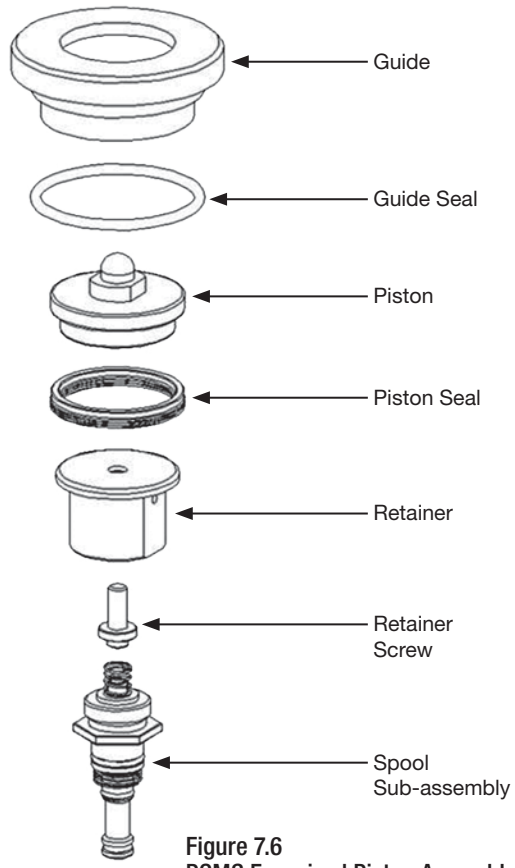


Figure 7.6
PCMS Energized Piston Assembly
Exploded View

Assembly (continued)

C. Body/Bonnet Assembly

1. Lay out the parts in sequence as shown in Figure 7.7, on a clean and well-lit work area.
2. Lightly lube the spool cap seals and install on the seal glands of the spool cap.
3. Insert the spool cap into the base of body and tighten.
4. Clamp the valve vertically in a vise by the body flange flats. Insert the lower return spring.
5. Lubricate the seals in the spool sub-assembly and insert into the body bore, as shown on Figure 7.7. Spool extension should fit into the hole of the spool cap. Apply a light amount of pressure on top of the internal sub-assembly to check for bottoming of seat seal #2 to the spool cap seat.
6. Install the guide over the spool sub-assembly and into the annular opening between the body bore and the diaphragm/piston circumference. For the PCMS the guide seal goes in before the guide.
7. With one spring button on each end of the spring, mate the bottom end to the top of the hemispherical radius on top of the diaphragm piston.
8. Install the bonnet over the spring and mate the bonnet counter bore surface to the guide. Orient the bonnet vent hole axis to the body exhaust port axis on the same plane.
9. Bolt down the bonnet using the bonnet cap screws through the bonnet flange holes and into the threaded holes of the body flange. Tighten the bolts in a crisscross pattern for uniform loading.
10. Screw the spring adjusting screw (SAS) into the jam nut and then into the bonnet until the SAS makes contact with the spring button.
11. Insert the filter; flange first, into the inlet port on the body. This port is closest to the body flange as shown in Figure 7.7. Install the filter seal over the filter and into the inlet port, bottoming on the filter flange inside the port.
12. Screw the filter housing into the body inlet port and tighten.

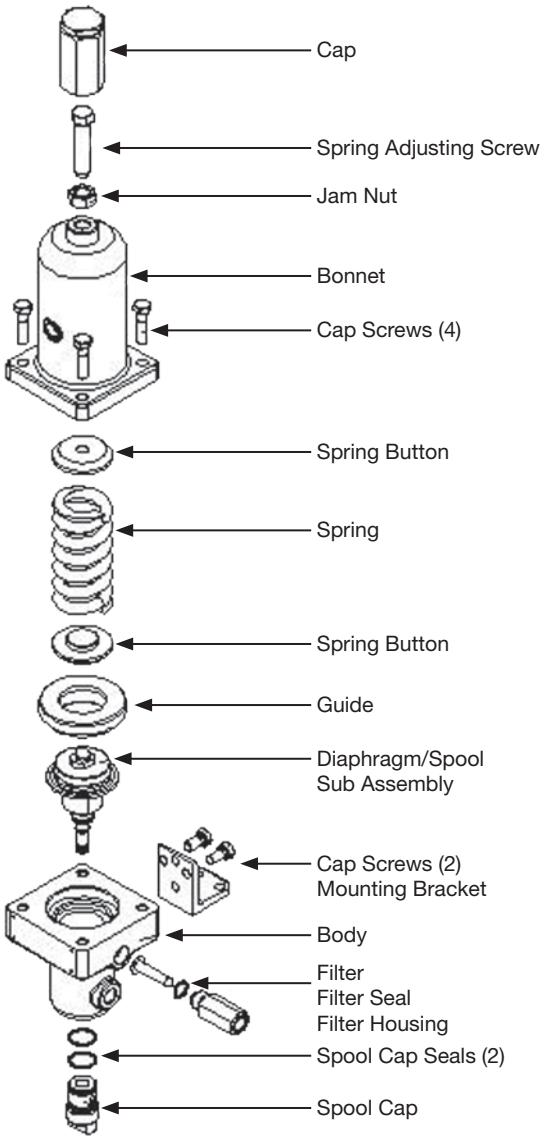


Figure 7.7

Setting & Testing the Modulating Pilot Control

Testing of the modulating control will be performed only after correct assembly has been accomplished. Read the entire test procedure. Test should be conducted only by qualified personnel.

Testing PORV as a Unit

A test stand typically used for conventional safety relief valve testing will be adequate to perform this test method.

1. Complete the assembly of the pilot control and the main valve.
2. Mount the main valve to the test stand.
3. Remove the modulating control cap to access the spring adjusting screw (SAS).
4. Using a wrench, rotate the SAS down (clockwise) a few turns to compress the modulating control spring.
5. Pressurize the test stand to the desired set pressure and let the pressure stabilize. If the main valve relieves before the desired set pressure, depressurize the test stand and turn the SAS down some more to compress the modulating control spring further.
6. When test stand pressure is at desired set point, unscrew the SAS (counterclockwise) slowly until the main valve piston starts to lift. For air testing, an audible leak on the main valve outlet is the common indication of the piston starting to lift. For liquid testing, the first visible flow of fluid from the main valve outlet is the common indication that the piston is starting to lift. The body bowl should be filled with water up to the lowest edge of the discharge outlet prior to testing to aid in determining first flow.
7. When test stand pressure is at desired set point, unscrew the SAS (counterclockwise) slowly until the main valve piston starts to lift. For air testing, an audible leak on the main valve outlet is the common indication of the piston starting to lift. For liquid testing, the first visible flow of fluid from the main valve outlet is the common indication that the piston is starting to lift. The body bowl should be filled with water up to the lowest edge of the discharge outlet prior to testing to aid in determining first flow.
8. The spring compression is close to the desired setting. Use the jam nut to lock the SAS in place.
9. Depressurize the test stand to approximately 80% of the desired set pressure.
10. To confirm the set point, slowly pressurize the test stand until the opening of the main valve is confirmed by either an audible opening of the piston (air), or a visible flow of water from the main valve outlet (liquid test). Fine tune setting by turning down (clockwise) the SAS to increase or unscrewing (counterclockwise) the SAS to decrease the set point. Tighten the jam nut to lock the SAS in place after final adjustments.
11. Install the modulating control cap and tighten before proceeding to Pilot Seat Tightness Testing, section D, in this procedure.

Testing the Modulating as a Separate Unit: (Alternate Method)

Connect the modulating control to the test rig (See Test Stand Schematic, Figure 7.5).

A. Test Stand Schematic Description

- **V1-** Isolation valve, normally open when test is in progress.
- **V2-** Needle valve, regulates pressure into vessel.
- **V3-** Vent valve, normally closed when going up on the receiver pressure; also used to dump pressure from vessel.
- **V4-** Vent valve, normally closed when testing, used as an auxiliary pressure dump valve.
- **P1-** Pressure gage, to read dome pressure.
- **P2-** Pressure gage, to read vessel pressure.

Vessel Receiver – Test pressure receiver simulating a vessel.

Dome Receiver – Test pressure receiver simulating the dome/piston volume on the main valve.

In-Line Filter – Filters air going into the vessel.

Setting & Testing (continued)

B. Port Identification and its Connections

Port A - is system pressure sensing port, it is the port on the filter housing.

Port B - is 180º from Port A, it connects to the main valve dome.

Port C - is the dome exhaust port, it is the lowest port in the body, 90º from Port A and Port B.

Port D - is the bonnet vent.

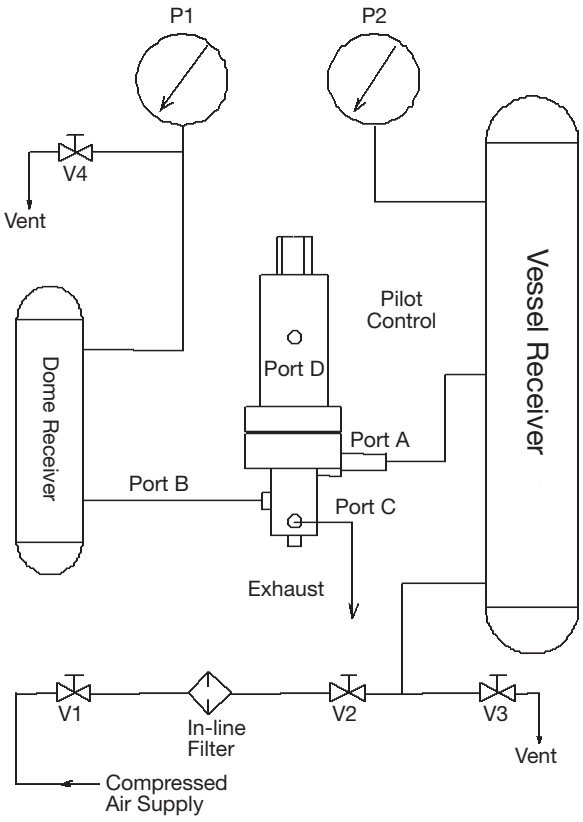


Figure 7.5 Test Stand Schematic

C. Set Pressure Testing

1. Mount the pilot control in the test stand following the port connections shown on the test stand schematic (Figure 7.5).
2. Compress the spring by turning the spring adjusting screw (SAS) clockwise, a few turns after coming in contact with the spring button.
3. Increase the pressure on the vessel receiver and observe the increase in pressure on the dome vessel. If the dome pressure does not increase along with the receiver pressure, stop and vent the pressure, increase the spring compression by turning the SAS clockwise and start over.
4. Increase the pressure on the vessel receiver to the desired set pressure. Dome pressure should read the same.
5. Decrease the spring compression by turning the SAS counterclockwise, to drop the pressure of the dome receiver. The valve is set once the pressure on the dome receiver drops down to the pressure (P_d) determined by the equation (eq. 1).
6. Verify the set point by decreasing the vessel receiver pressure to approximately 80% of the desired set and then increasing to the desired set. At the desired set pressure the dome receiver pressure should have dropped to the pressure (P_d) determined by the equation below (eq. 1).
7. Lock the spring adjusting screw with the jam nut and install the cap. Mount the pilot control to the main valve and connect the corresponding ports together. Proceed to Pilot Seat Tightness Testing Section D.

Equation to determine dome pressure at a given set pressure:

$$P_d = P_o \times m \qquad \text{(eq. 1)}$$

Where:

P_d = dome pressure at desired set pressure, tolerance = +/- 10% of value

P_o = desired set pressure

m = valve size multiplier, taken from table below

The piston vs. seat area ratio for the DX, DL and DM serial suffix valves vary by inlet size. The table below provides the correct multiplier, by inlet size, to allow the setting of a modulating pilot control, separate from the main valve.

The values for item 2 should only be used for the air, gas and vapor service valves, serial suffix DX and DM. The liquid service valves, serial suffix DL, should be converted to the current DA serial design for optimum performance.

Item	Serial Suffix	m Multiplier
1	DA (All Sizes)	0.70
2	DX, DL and DM	See Below
2a	1	0.41
2b	1-1/2	0.56
2c	2	0.60
2d	3 and 8	0.64
2e	4 and 6	0.69

Setting & Testing (continued)

D. Pilot Seat Tightness Testing

A 5/16" OD x 0.035" wall thickness copper tube or equivalent, immersed no more than 1/2" deep in water, shall be connected to the exhaust Port C and Bonnet Vent Port D. Raise the receiver pressure to the test pressure described below and observe for bubbles. No bubbles are allowed.

Test pressure:

- 90% of set pressure if set pressure is 50 psig or more OR
- 5 psig below set pressure if set pressure is less than 50 psig

Brush soap and water solution on joints internally exposed to pressure. Observe for leakage. No leakage at any joint is allowed.

Proceed to Final Assembly and Test.

Table 7.2 Modulating Pilot Control Spring Chart

Set Pressure (psig)	PCM & PCMS Spring Number	HPCM Spring Number
15 - 74	E3486PH	HPCM Control Not for use in these pressure ranges, consult factory
75 - 179	E3478PH	
180 - 349	E3487PH	
350 - 740	E3479PH	
740 - 1000	PCM/PCMS Control Not for use in these pressure ranges, consult factory	E3479PH
1001 - 1480		E3488PH
1481 - 2220		E3480PH
Return Springs – Spool		
15 - 1500	A3481SS	—
740 - 2220	—	A3496SS
Return Springs – Lower		
15 - 1500	A3489SS	—
740 - 2220	—	A3489SS

Final Assembly

The pilot control should have been tested and set prior to final assembly.

Assemble the pilot control to the main valve. Attach the mounting bracket securely to the pilot control. Bolt the mounting bracket to the main valve. Clear foreign matter in tubing by blowing compressed air through one end. The port connection and its orientation shall be exactly the same as the original configuration to guarantee valve operation. Refer to Figures 6.4 and 7.5 for port identification of the pilot control. Connect port A of the pilot control to the inlet of the main valve. Connect port B of the pilot control to the dome or piston of the main valve. Port C is the exhaust port, normally vented to the atmosphere.

Check all fittings for tightness. Pressurize the test stands to 95% of set pressure

Use Snoop or soap and water solution to check all tube fittings and joints internally exposed to pressure. No leaks are allowed on these joints. All leakage shall be corrected as necessary.

Test the assembled pilot valve for proper setting.

Main Valve Seat Tightness Test

Refer to Figure 8.1. Mount bubble test flange, tube, and cup on valve outlet. A tube of 5/16² OD X .035" wall submerged 1/2" below the water level shall be connected to the valve outlet. Apply nitrogen or air pressure to the valve inlet, equal to 90% of set pressure (if set pressure is 50 psig or more) or 5 psig below set pressure (if set pressure is less than 50 psig). This method tests for total leakage across valve seat plus piston seal leakage. No leakage is allowed.

The valve is now ready to be placed back in service.

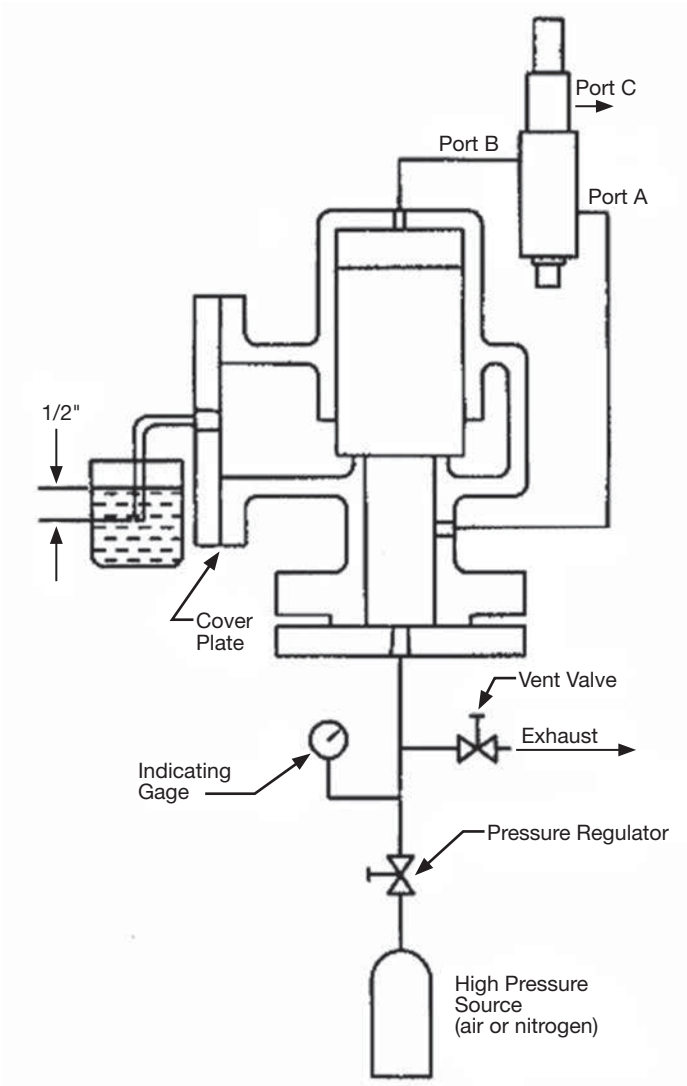


Fig. 8.1 Main Seat Tightness Test

Farris Aftermarket Services

Real Value Behind Every Valve.

Farris Engineering's aftermarket department and global FAST Center Network adds value to every Farris valve. At Farris, our work is never done. Once we sell you a valve, our FAST Team is there to keep your valves in service and your plant safe. Our FAST Centers are:

Responsive. Farris Engineering and its FAST Centers understand the need to quickly and efficiently respond to customer needs.

- **Global Access** - FAST Centers work with and in our extensive representative network, providing support to all global regions.
- **24/7 Valve Service and Replacement** - FAST Centers offer quick, localized testing and repair of valves, or the prompt installation of new Farris ASME certified valves.
- **Mobile Repair Units** - Available at select FAST Centers.

Experienced. Farris Engineering recognizes the value of having pressure relief valve experts as close to the customer as possible. This is accomplished through comprehensive training offered at the factory or on-site. FAST Center sales personnel and technicians are able to provide valuable experience to their customers.

- **Valve Expertise** - Every FAST Center is technically supported by Farris Engineering, a leader in valve design.
- **Factory Trained Technicians** - FAST technicians go through mandatory training consisting of classroom lecture and hands-on practical instruction on Farris Engineering pressure relief valves, repair procedures and applicable codes and standards. The result is a team of highly skilled technicians capable of handling both routine and complex pressure relief valve requirements around the world.
- **OEM parts** - FAST Centers use only OEM parts, restoring valves to OEM specifications. All valves are assembled and tested to ASME standards.

Dedicated. FAST Centers have committed to large investments in inventory, equipment and certifications to better support the customers in their territory.

- **Local Inventory** - Every FAST Center carries a large inventory of new pressure relief valves and spare parts, backed by a web-based global inventory to draw from.
- **ASME Certification** - FAST Centers carry all the required certifications to assemble, set and test Farris valves.
- **VR Certification** - FAST Centers have VR certification issued by The National Board of Boiler and Pressure Vessel Inspectors to effectively and efficiently repair all pressure relief valves where applicable.

CURTISS WRIGHT Flow Control Company
Farris Engineering

ASME UV

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Offices Worldwide: For a listing of our global sales network, visit our website at http://farris.cwfc.com.

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