



ISO Registered Company

MODEL SLR-2

DIRECT-ACTING, PRESSURE LOADED, PRESSURE REDUCING REGULATOR with NON-RELIEVING LOADER

SECTION I

I. DESCRIPTION AND SCOPE

The Model SLR-2 uses the pressure set point of a non-relieving loader to control the outlet pressure of the main reducing regulator. Sizes are 1/2" (DN15), 3/4" (DN20), 1" (DN25), 1-1/4" (DN32), 1-1/2" (DN40), 2" (DN50), 3" (DN80) and 4" (DN100). This model is suitable for gaseous applications.

SECTION II

II. REFERENCES

Refer to Technical Bulletin SLR-2-TB for technical specifications for this regulator.

ABBREVIATIONS

CW	–	Clockwise
CCW	–	Counter Clockwise
ITA	–	Inner Trim Assembly

SECTION III

III. INSTALLATION



CAUTION

For welded installations, all internal trim parts, seals and diaphragm(s) must be removed from regulator body prior to welding into pipeline. The heat of fusion welding will damage non-metallic parts if not removed.



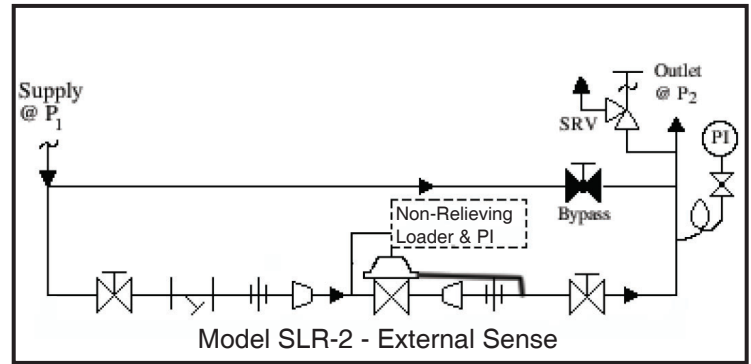
CAUTION

Installation of adequate overpressure protection is recommended to protect the regulator from overpressure and all downstream equipment from damage in the event of regulator failure.

1. This regulator may be rotated around pipe axis 360 degrees. For ease of maintenance, the recommended position is with the cover dome (25) upwards.
2. Provide space below, above, and around regulator for removal of parts during maintenance.
3. Install block valves and pressure gauges to provide means for adjustment, operation, bypass, or removal of the regulator. A pipeline strainer is recommended before inlet to remove typical pipeline debris from entering valve and damaging internal "soft goods", primarily the dynamic seal.
4. Downstream Sensing Installation Considerations – Internal or External Sensing:
 - a. The regulator may be installed with internal or external sensing. Unless otherwise specified, the regulator is supplied by factory with internal sensing. The regulator may be converted in the field to external sensing. (See Section VII Maintenance, Part G – Converting Internal/External Sensing.
 - b. Reference SLR-2-TB, Table -11 for recommendations when to apply external sensing.
 - c. For internal sensing, no external line is required. For external sensing, use an external control line. The line is connected from the 1/4" (DN8) NPT tap (Port 5 – See Fig. 5) on the side of the body diaphragm flange to a pressure tap downstream of the regulator. Use 1/4" or 3/8" (DN8 or 10) outer diameter tubing or 3/8" (DN10) pipe having an inner diameter equivalent to Schedule 40 pipe.

⚠ CAUTION

DO NOT HYDROSTATIC TEST THROUGH AN INSTALLED UNIT; ISOLATE REGULATOR FROM TEST. The "OUTLET RATING" as printed on the nameplate is the recommended "upper operating limit" for the sensing diaphragm. Higher pressures could cause internal damage. In addition, note on the nameplate that the Inlet and Outlet pressure and temperature ratings are at different levels.



Recommended Piping Schematic
For Pressure Reducing Station
Loader Relieves to outlet of Main Regulator

SECTION IV

IV. PRINCIPLE OF OPERATION

1. When a loading pressure – P_{Load} – is applied to the top side of a diaphragm, the outlet controlled pressure – P_2 – will balance at approximately .90 – .98 of the loading pressure - P_L . (**NOTE:** *Fluctuations in P_1 – Inlet Pressure will cause a deviation in P_2 – Outlet Pressure due to inverse sympathetic ratio effect.*) See Section VIII.
2. Movement occurs as pressure variations register on the diaphragm. The registering pressure is the

outlet, P_2 , or downstream pressure. The loading pressure fluid opposes diaphragm movement. As outlet pressure drops, the loading pressure pushes the diaphragm down, opening the port; as outlet pressure increases, the diaphragm pushes up and the port opening closes.

3. A diaphragm failure will tend to cause the regulator to fall below setpoint. A loss of loading pressure while inlet pressure is imposed will cause the regulator to fail close.

SECTION V

V. STARTUP

- 1 Start with the block valves closed. A bypass valve may be used to maintain outlet pressure in the downstream system without changing the following steps.

⚠ CAUTION

Do not walk away and leave a bypassed regulator unattended!

2. Rotate the knob (4) of the loading regulator CCW three revolutions to decrease the set point pressure of the main regulator. **NOTE:** *If no set point is specified at the time of purchase, the knob (4) of the loading regulator is backed all the way off, CCW. Caution should be taken during start up to prevent exceeding the pressure drop across the seat, potentially damaging the seat.*
3. If it is a "hot" piping system, and equipped with a bypass valve, slowly open the bypass valve to preheat the system piping and to allow slow expansion of the piping. Closely monitor outlet (downstream) pressure via gauge to ensure not over-pressurizing. **NOTE:** *If no bypass valve is*

installed, extra caution should be used in starting up a cold system; i.e. do everything slowly.

4. Crack open the outlet (downstream) block valve to approximately 10% full open.
5. Slowly open the inlet (upstream) block valve to about 25% open. Rotate the knob on the loading regulator CW to increase the setpoint pressure if necessary until the main regulator is flowing. Observe the outlet pressure gauge to ensure not over pressurizing.
6. Continue to slowly open the inlet (upstream) block valve until fully open.
7. Continue to slowly open the outlet (downstream) block valve, especially when the downstream piping system isn't pressurized. If the outlet (downstream) pressure exceeds the desired pressure, close the inlet block valve and go to Step 2. Close bypass valve approximately 25%, and repeat procedure.
8. When flow is established steady enough that the outlet (downstream) block valve is fully open, begin to slowly close the bypass valve if installed.

9. Develop system flow to a level near its expected normal rate, and reset the pressure for the main regulator to the desired outlet pressure by adjusting the knob on the loading regulator.
10. Reduce system flow to a minimum level and observe pressure set point. Outlet pressure will rise from the set point of Step 9 for a Model SLR-2. The maximum rise in outlet pressure on decreasing flow should not exceed the 10%. If it does, consult factory.

SECTION VI

VI. SHUTDOWN

1. On systems with a bypass valve, fully close the inlet (upstream) block valve. Allow the pressure to the loader, the cover dome and the main regulator to decrease to zero. Close the outlet (downstream) block valve. Slowly open the bypass valve. (When on bypass, the system pressure must be constantly observed and manually regulated.



CAUTION

Do not walk away and leave a bypassed regulator unattended.

SECTION VII

VII. MAINTENANCE

A. General:



WARNING

SYSTEM UNDER PRESSURE. Prior to performing any maintenance, isolate the regulator from the system and relieve all pressure. Failure to do so could result in personal injury.

1. The SLR-2 may be serviced without removing the regulator from pipeline. The main regulator is designed with quick-change trim to simplify maintenance.
2. Record the nameplate information to requisition repair parts for the regulator. The information should include: size, Product Code, Serial Number, and internal or external sensing. (**NOTE: Never both types of sensing.**) If external sensing is used, be sure that the external sensing line is dis-connected.
3. Refer to Section X for recommended repair parts. Only use original equipment parts supplied by Cashco for rebuilding or repairing regulators.
4. Owner should refer to owner's procedures for removal, handling, cleaning and disposal of nonreusable parts, i.e. gaskets, etc.

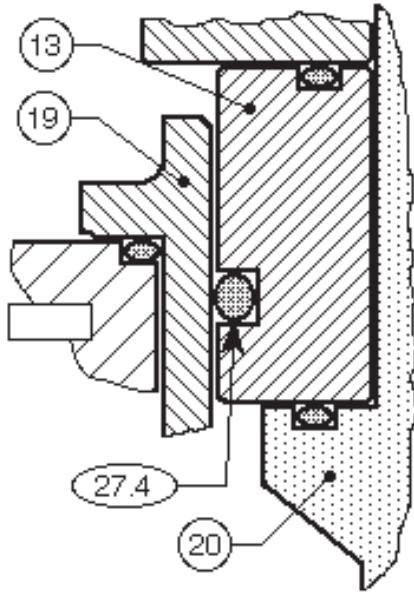
NOTE: On regulators originally supplied as "oxygen clean" – Opt-55, maintenance must include a level of cleanliness equal to Cashco cleaning standard #S-1134.

5. The Inner Trim Assembly (Figure 3) is removed and replaced in the body (23) as an assemblage of parts. The Inner Trim Assembly, hereinafter called **ITA**, consists of the following parts:

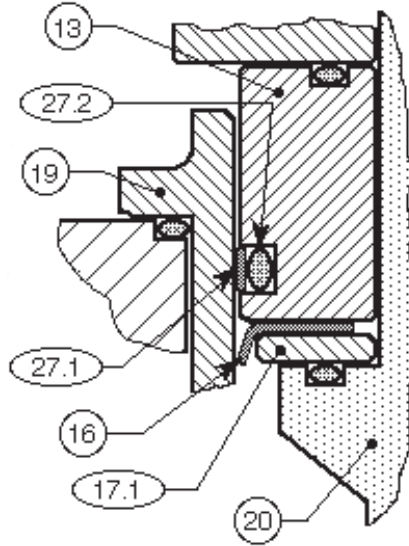
Item No.	Dynamic Seal Type	Part Description
13	All	Guide Bearing
14	All	Static Stem Seal
14.1	All	Upper Static Stem Seal
14.2	All	Middle Static Stem Seal
14.3	All	Lower Static Stem Seal
15	All	Cage O-ring Seal
16	CW	Wiper
17.1	CW	Wiper Washer
17.3	UC	Seal Retainer
19	All	Cage
20	All	Valve Plug
21	All	Seat Ring
27	All	Dynamic Side Seal
27.1	CW	TFE Cap Seal
27.2	CW	O-ring Energizer/Seal
27.3	UC	U-Cup Seal w/Metal Energizer
27.4	OR	O-Ring Seal

A detailed view of the dynamic side seal parts is shown in Figure 1 on the next page.

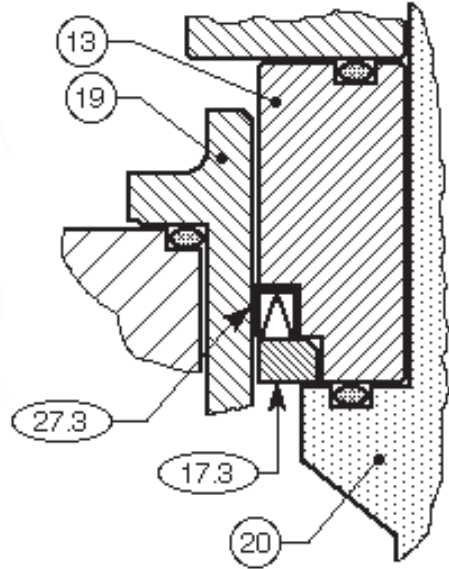
Figure 1: Dynamic Side Seals



**Type OR — O-Ring
Dynamic Seal**



**Type CW — TFE Cap
Dynamic Seal + Wiper**



**Type UC — U-Cup
Dynamic Seal**

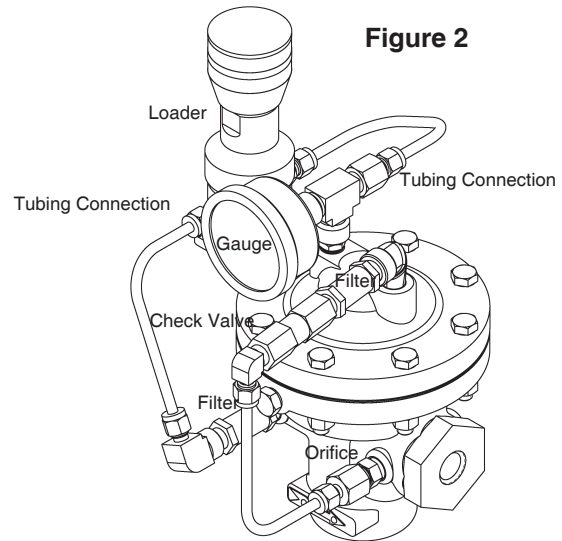
B. Main Regulator Disassembly:

⚠ WARNING

SYSTEM UNDER PRESSURE. Prior to performing any maintenance, isolate the regulator from the system and relieve all pressure. Failure to do so could result in personal injury.

1. Shut down system in accordance Section VI.
2. Disconnect external sensing line, if installed. Disconnect tubing at inlet connection of the main regulator body, the inlet and outlet of the loader and at the outlet of main regulator.
3. Though it is possible to disassemble the valve unit while installed in a pipeline, it is recommended that maintenance be done in a shop when possible. The instructions hereafter will assume shop disassembly. Remove main regulator from pipeline.
4. Place the main regulator body in a vise with the cover dome (25) upwards.
5. Loosen and remove the diaphragm flange bolts (11) and nuts (12) uniformly. Set loading regulator aside.
6. Place matchmarks on body (23) and cover dome (25) flanges. Remove cover dome (25).

Figure 2



7. Hold the milled "flats" on top of the valve plug (20) stationary, rotate the diaphragm lock nut (7) CCW to remove.
8. Remove upper diaphragm plate (8).
9. Remove diaphragm (9) and o-ring upper stem seal (14.1). Examine diaphragm to determine whether failed; determine if operating conditions are exceeding pressure, pressure drop or temperature limits.
10. Remove lower diaphragm plate (10).

11. Evenly loosen the three cage cap screws (18) in single revolution increments. **NOTE:** *Regulator may contain a lower piston spring (22); the ITA should rise as the cage cap screws (18) are evenly backed out. A downwards holding force should be applied to the top of the guide bearing (13) to prevent the ITA from popping up as the last threads of the cage cap screws (18) are backed out.*
12. Remove the ITA by pulling up on the valve plug (20). Set ITA aside.

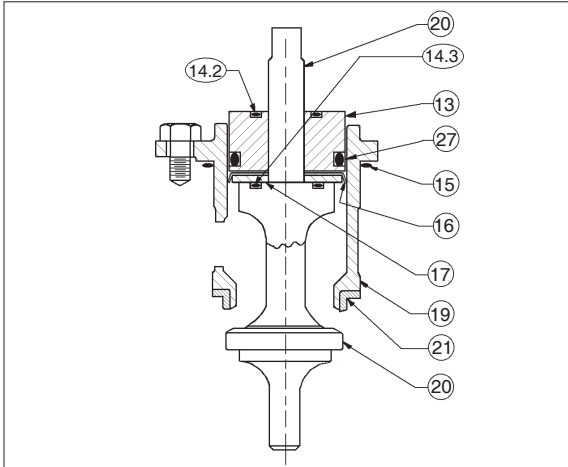


Figure 3: Assembled ITA

13. Remove the lower piston spring (22), as applicable, from within the body (23).
14. Remove o-ring cage seal (15).
15. If supplied, remove internal sensing drilled plug (33) using 5/32" (4 mm) Allen wrench.
16. Remove body (23) from vise. Clean all reusable metal parts according to owner's procedures.

C. Disassembly of the ITA: (See Figure 3)

1. Pull the valve plug (20) downwards and out of the guide bearing (13) and cage (19).
2. Remove the guide bearing (13) from the upper end of the cage (19).
3. Remove o-ring middle stem seal (14.2) from guide bearing (13).
4. Examine the components (27.1, 27.2, 27.3, 27.4) of the dynamic side seal (27) mechanism to determine if significant leakage was occurring. If the dynamic side seal (27) shows signs of significant leakage, determine if operating

conditions are exceeding pressure, pressure drop, or temperature limits.

Remove dynamic side seal (27) components. Special care should be taken when using "tools" to remove the components to ensure that no scratches are imparted to any portion of the guide bearing (13) groove.

5. Remove wiper seal (16), if supplied, from within cage (19) I.D.
6. Remove wiper washer (17.1) from within the cage (19) I.D.
7. Remove o-ring lower stem seal (14.3) from plug (20).
8. Remove seat ring (21); examine for signs of leakage. If seat ring shows signs of significant leakage, determine if operating conditions of pressure, pressure drop, or temperature are exceeding limits.
9. Clean all reusable metal parts according to owner's procedures.

D. Inspection of Parts:

1. After inspection remove from the work area and discard the old "soft goods" parts (i.e. o-rings, diaphragms, seals, gaskets, etc.) after inspection. These parts **MUST** be replaced with factory supplied new parts.
2. Inspect metal parts that will be reused. The parts should be free of surface contaminants, burrs, oxides, and scale. Rework and clean parts as necessary. Surface conditions that affect the regulator performance are stated below; replace parts that can not be reworked or cleaned.
3. QC Requirements:
 - a. Valve plug (20);
 1. 16 rms finish on its seating surface for tight shutoff.
 2. No major defects on bottom guide spindle.
 - b. Cage (19);
 1. 16 rms finish on cylinder bore. No "ledges" formed due to wear from moving dynamic side seal (27) or wiper seal (16).
 - c. Lower guide bushing (24) (non-replaceable):
 1. 16 rms finish on bore.
 2. Max 0.015 inch (0.38 mm) clearance

between valve plug (20) spindle and lower guide bushing (24).

d. Internal sensing drilled plug (33);

1. Ensure that bore is minimum 0.125 inch (3.20 mm). Drill out as required.

4. Staging Material for Reassembly.

- a. Inspect and clean parts, as necessary, from the spare parts kit. (See Article VII .A.4. comments concerning cleaning for oxygen service.)
- b. Lay out all the regulator parts and check against the bill of material.

E. Reassembly of the ITA:

1. When replacing the optional wiper seal (16), the replacement wiper seal (16) is “pre-formed”. It may, however, require reforming. Under normal circumstances, this step may not be required. If needed, reform the wiper seal (16) by pressing the temporary assembly parts into the cage (19) backwards as shown in Figure 4. The wiper seal (16) is best left in this position overnight (minimum of two (2) hours) prior to reassembly.

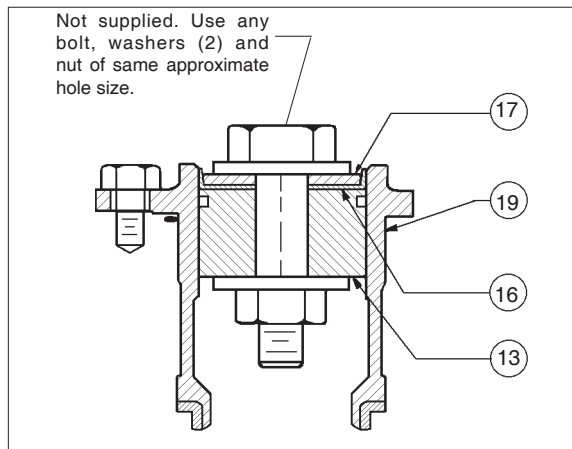


Figure 4: Temporary Assembly Parts

2. After forming the wiper seal, remove parts (13, 16, 17) from cage (19) and disassemble the temporary assembly of Step 1. above.
3. Installation of dynamic side seal (27) (See Figure 1):
 - a. Type OR:
 1. Stretch o-ring seal (27.4) over lower circumference of guide bearing (13), taking care not to “cut” o-ring seal (27.4). Using thumbs, work the o-ring seal (27.4) up and into the groove of the guide bearing (13). **NOTE:**

A very slight amount of fluid and elastomer compatible lubricant is recommended as an installation aid.

2. Position guide bearing (13) over upper end of cage (19) properly oriented. Using thumbs, evenly press guide bearing (13) into the cage (19), ensuring not to “cut” o-ring seal (27.4). Continue pressing guide bearing (13) until in approximate final position.

b. Type CW:

1. Stretch o-ring energizer/seal (27.2) over lower circumference of guide bearing (13), taking care not to “cut” o-ring energizer/seal (27.2). Using thumbs, work the o-ring energizer/seal up and into the groove of the bearing (13). **NOTE:** *A very slight amount of fluid and elastomer compatible lubricant is recommended as an installation aid.*
2. Place wiper washer (17.1) into “cup” of Wiper Seal (16). Holding these parts (17.1 & 16) between thumb and forefinger, insert into cage (19) at an approximate 45° angled approach with wiper washer (17.1) on bottom, wiper seal (16) on top with turned-down lip of wiper seal (16) entering cage (19) first. Rotate wiper seal (16) and wiper washer (17.1) to a level position approximately half way down into cage (19). Allow wiper washer (17.1) to rest on bottom of cage (19).
3. Position TFE cap seal (27.1) ring with rectangular cross-section at end of guide bearing (13). Stretch cap seal (27.1) over lower end of guide bearing (13) using thumbs to work the cap seal (27.1) onto the bearing (13). **DO NOT USE A TOOL FOR THIS STEP.** Continue pressing cap seal (27.1) upwards towards the groove until the cap seal (27.1) “snaps” into the groove of the guide bearing (13).
4. Position guide bearing (13) over and into upper end of cage (19) until the cap seal (27.1) edge touches the upper lip of the cage (19). While gently applying force to press the guide bushing (13) into the cage (19), simultaneously use fingers to lightly press the cap seal (27.1) inwards into the groove of the guide bearing (13) until the cap seal (27.1) “slips into” the cage (19). **DO NOT USE TOOLS,**

LUBRICANT, OR HEAVY FORCE TO ENGAGE THE CAP SEAL (27.1) INTO THE CAGE (19). Do not press inwards on the Cap Seal (27.1) too much or the cap seal (27.1) may slide out of its groove or the cap seal (27.1) can be damaged.

c. Type UC:

1. Stretch u-cup seal (27.3) over lower circumference of guide bearing (13), taking care not to "cut" u-cup seal (27.3) on the protruding shelf that is part of the guide bearing's (13) groove. Ensure that the u-cup seal (27.3) is oriented with the center-open-downwards as shown in Figure 1, as the u-cup seal (27.3) depends upon the P1-Inlet Pressure to pressure activate the seal for proper sealing action.
2. Position guide bearing (13) over and into upper end of cage (19) until the cap seal (27.1) edge touches the upper lip of the cage. While gently applying force to press the guide bearing (13) into the cage (19), simultaneously use fingers to lightly press the u-cup seal (27.3) inwards into the groove of the guide bearing (13) until the u-cup seal (27.3) "slips into" the cage (19). **DO NOT USE TOOLS, LUBRICANT, OR HEAVY FORCE TO ENGAGE THE U-CUP SEAL (27.3) INTO THE CAGE (19).**
4. Place properly oriented seat ring (21) onto the shoulder at the lower end of cage (19).
5. Place new o-ring lower stem seal (14.3) into groove of valve plug (20).
6. Insert valve plug (20) upwards through lower end of cage (19) and through the center hole in guide bearing (13), also capturing the wiper washer (17.1) and wiper seal (16), if supplied. Hold plug (20) and cage (19) together.
7. Place an oversized nut or stack of washers, the same approximate height of the upper diaphragm plate (8) and the lower diaphragm plate (10), over the upper end of valve plug (20) and temporarily secure with diaphragm lock nut (7), manually tightened. Do **NOT** allow valve plug (20) to rotate against seat ring (21) during tightening.
8. This completes ITA preliminary reassembly.

F. Main Regulator Reassembly:

1. Place body (23) in a vise.
2. Reinstall internal sensing drilled plug (33) with compatible thread sealant.
3. Insert the lower piston spring (22) into the body (23), if supplied.
4. Fit the o-ring cage seal (15) into its body (23) groove.
5. With the ITA held manually in the closed position, insert ITA into body (23).
6. Properly align all three cage bolt (18) holes as there is only one circumferential location possible for this alignment. If a lower piston spring (22) is used, apply downward force to the top of the cage (19) until the ITA is lowered sufficiently to engage the cage bolts (18) into the body (23). Engage all of the cage bolts (18), then evenly screw in the cage bolts in one-half revolution increments to pull down the ITA evenly, taking care **NOT TO "ANGLE"** the ITA in the BODY. Torque the cage bolts (18) to 13-15 ft-lbs (17.6-20.3 N-m).
7. For the following steps a.– g., the upper end of valve plug (20) **MUST** be manually held up if unit is not supplied with lower piston spring (22).
 - a. Remove temporarily installed diaphragm lock nut (7) and spacers of previous Step E.7 this Section.
 - b. Place new o-ring middle stem seal (14.2) into groove of guide bearing (13) upper surface.
 - c. Position lower diaphragm plate (10) over upper end of plug (20) with tongue and groove "groove" on upper side.
 - d. Place new o-ring upper stem seal (14.1) over upper end of valve plug (20).
 - e. Place diaphragm (9) over end of valve plug (20).
 - f. Place upper diaphragm plate (8) over upper end of plug (20) with tongue and groove "ridge" on lower side.
 - g. Place lubricant on valve plug (20) threaded end. Engage diaphragm lock nut (7) with upper end of valve stem (20) as far as possible manually.
 - h. Place a wrench on diaphragm lock nut (7) and a torque wrench on the upper end of valve plug (20). Hold torque wrench stationary and rotate diaphragm lock nut (7) to the following torque values:

Body Size in (DN)	Torque Value Ft-lbs (N-m)
1/2" - 1" (15 - 25)	60 - 70 (81 - 95)
1 1/4" - 2" (32 - 50)	120 - 130 (163 - 176)
2 1/2" - 4" (65 - 100)	180 - 200 (244 - 271)

DO NOT allow valve plug (20) to rotate against seat ring (21) during tightening.

- i. This completes ITA reassembly.
8. Aligning matchmarks and bolt holes, place cover dome (25) onto body (23).
9. Reinstall all flange bolts (11) and nuts (12) with nameplate (99) located under one bolt head. Hand-tighten nuts (12).
10. Evenly tighten the body bolting (11,12) in an alternating cross pattern in one revolution increments to the following torque values:

Body Size in (Dn)	Torque Value Ft-lbs (N-m)
1/2" - 2" (15 - 50)	30 - 35 (41 - 47)
2 1/2" - 4" (65 - 100)	45 - 50 (61 - 69)

G. Converting Internal/External Sensing:

1. Disassemble the regulator and remove the diaphragm (9) according to Steps 1-12 in Part B – Main Regulator Disassembly.
2. To convert from internal to external sensing, remove the drilled pipe plug (33) and install a solid pipe plug (32). Connect external sensing line to port 5 on side of the body. Reverse this step for converting from external to internal sensing. Disconnect external sensing line.
3. Reassemble the regulator according to Part F – Main Regulator Reassembly.

H. Pressure Testing:

1. If a hydrostatic pressure test is performed, pressure must be applied to all three of cover dome (25), inlet and outlet of body at the same level.
DO NOT HYDROSTATICALLY TEST WITHOUT COVER DOME PRESSURIZED. NOT ADHERING WILL DO PHYSICAL DAMAGE TO INTERNALS THAT COULD RENDER THE UNIT INOPERABLE.
2. Inboard Leakage Test.
 - a. Release all loading pressure in cover dome.
 - b. Pressurize inlet to 30 psig (2.1 Barg) with air or GN₂.

- c. Tube outlet to a beaker of water to observe number of escaping gas bubbles.

Inboard leakage path may be via plug/seat or dynamic side seal.

3. Pressure Containment Test.
 - a. Pressurize inlet to 200 psig (13.8 Barg) and outlet and cover dome to 150 psig (10.3 Barg) with air or GN₂.
 - b. Spray liquid lead detector and check all external leak points; i.e. plugged connections, diaphragm flange and diaphragm bolting.
4. Excessive leakage will require disassembly, examination of sealing elements, correction of problem, reassembly and retesting.

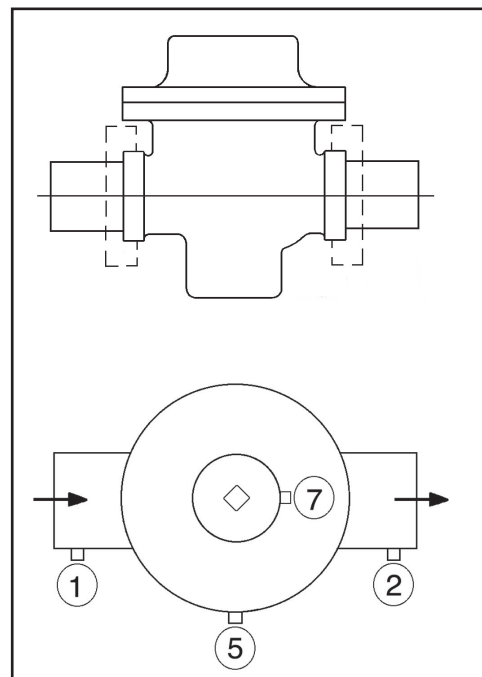


Figure 5: Location of Auxiliary Ports

I. Loading Regulator Disassembly:



WARNING

SYSTEM UNDER PRESSURE. Prior to performing any maintenance, isolate the regulator from the system and relieve all pressure. Failure to do so could result in personal injury.

J. General:

1. Maintenance procedures hereinafter are based upon removal of the loading regulator from the main regulator.
2. Owner should refer to owner's procedures for removal, handling, cleaning and disposal of nonreusable parts, i.e. gaskets, etc.
3. Refer to Figures 6 and 8 for item numbers for Brass and SST Loaders. (Figure 9 for High Pressure Construction.) For Aluminum Loaders - contact Cashco Inc.
4. Remove cap screws that secure loader to mounting bracket. Disconnect tubing and fittings between loader and main regulator.



CAUTION

To prevent damage to body, use lead jaws when placing body in a vise. Position so that vise closes over the flats on lower end of body.



WARNING

SPRING UNDER COMPRESSION. Prior to removing spring chamber, relieve range spring compression by turning knob CCW until rotation comes to a complete stop. Failure to do so may result in flying parts that could cause personal injury.

K. Diaphragm Replacement - (Loader w/2 - 750 psig range springs)

1. Securely the body (1) in a vise with the knob (4) directed upwards.
2. Relax range spring (15) by turning knob (4) CCW until rotation comes to a complete stop.
NOTE: It is not necessary to remove knob before removing the spring chamber from the body.
3. To remove spring chamber (6), grasp the flats and rotate CCW. Upon removal, the spring (15), clip (16), and spring button (5) should remain inside the spring chamber.

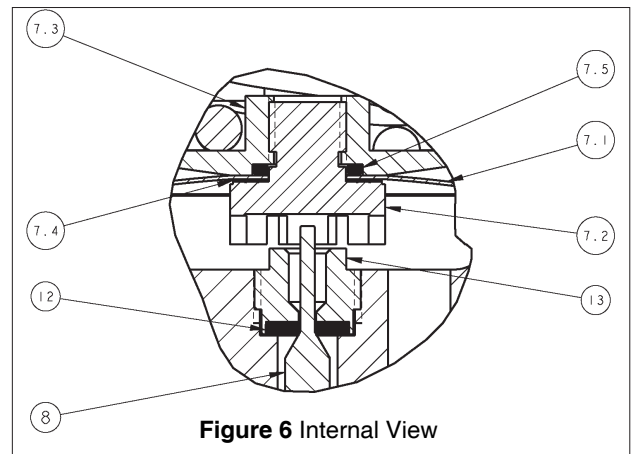


Figure 6 Internal View

4. Remove the diaphragm subassembly (7): consisting of the nut (7.3), diaphragm (7.1), actuator post (7.2), actuator gasket (7.4), actuator o-ring (7.5).
5. Secure actuator post (7.2) in soft jawed vice. Rotate actuator nut (7.3) CCW to remove and separate all parts of the diaphragm subassembly (7).
6. Remove diaphragm gasket (10).
7. Clean body (1) diaphragm flange and all reusable parts according to owner's procedures. **Do not scratch diaphragm gasket seating surface.** **NOTE:** On regulators originally supplied as "oxygen clean", Option-55, maintenance must include a level of cleanliness equal to Cashco's cleaning standard #S-1134.
8. Place a new diaphragm gasket (10) onto the body (1) diaphragm flange.
9. Reassemble diaphragm subassembly (7) by placing the actuator gasket (7.4), new diaphragm (7.1), and actuator o-ring (7.5) over the threads of the actuator post (7.2). Place a thread sealant compound on the threads of the actuator post (7.2) prior to installing the actuator nut (7.3). Install actuator nut (7.3) and tighten to the following torque value:
15 Ft-lbs (20 Nm).
10. Place the diaphragm gasket (10) onto the body (1) diaphragm flange. Place diaphragm subassembly on top of the gasket (10).
11. Lubricate the threads of the body (1) with a lightweight grease that is compatible with service use. Rotate the spring chamber (6)

CW by hand onto the threaded portion of the body (1) until firmly seated against the diaphragm gasket (10). Tighten to the following torque value:
65–70 Ft lbs (88–95 Nm).

12. Pressurize with air and spray liquid leak detector around body (1) and spring chamber (6) to test for leakage. Ensure that an outlet pressure is maintained during this leak test of at least mid-range spring level; i.e. 2-100 psig (.14-6.9 Barg) range spring, 51 psig (3.5 Barg) test pressure minimum. Rotate knob (4) CW to obtain set point.

L. Trim Replacement - (Loader w/2 - 750 psig range springs)

1. Remove spring chamber subassembly and diaphragm subassembly per Steps K.1. – K.6 previous.
2. With a 5/16" socket - rotate seat retainer (13) CCW to remove from the body.
3. Remove poppet (8) and poppet spring (9).
4. Remove the pressed in seat (12) from retainer (13).
5. Clean debris from within the body (1) cavity. Clean all parts to be reused according to owner's procedures. **NOTE:** *On regulators originally supplied as "oxygen clean", Option-55, maintenance must include a level of cleanliness equal to Cashco's cleaning standard #S-1134.*
6. Inspect all parts for damage and replace if necessary. **NOTE:** *Use only parts manufactured and supplied by Cashco, Inc. for these products. See Section X.*
7. Place the body (1) into a soft-jawed vise, grasp the flats on the body.
8. Press the seat (12) into the seat retainer (13) with the chamfer side of the seat inserted first.
9. Place poppet spring (9) into body (1) cavity.
10. Place poppet (8) inside the poppet spring (9). The angled seating surface of the poppet (8) must face up toward the seat (12).

11. Install new seat retainer (13) with seat (12) into body (1) cavity with the seat facing downward toward the angled seating surface of the poppet (8). Tighten seat retainer to the following torque value:
6.25 Ft-lbs (8.47 Nm).

12. Place a new diaphragm gasket (10) onto the body (1) diaphragm flange. Place diaphragm subassembly on top of the gasket.
13. Lubricate the threads of the body (1) with a lightweight grease that is compatible with service use. Rotate the spring chamber (6) CW by hand onto the threaded portion of the body (1) until firmly seated against the diaphragm gasket (10). Tighten to the following torque value:
65–70 Ft lbs (88–95 Nm).
14. Bench test unit for suitable operation. **NOTE:** *Regulators are not tight shutoff devices. Even if pressure builds up beyond set point, a regulator may or may not develop bubble tight shutoff.*
15. Pressurize with air and spray liquid leak detector around body (1) and spring chamber (6) to test for leakage. Ensure that an outlet pressure is maintained during this leak test of at least mid-range spring level; i.e. 2-100 psig (.14-6.9 Barg) range spring, 51 psig (3.5 Barg) test pressure minimum.
16. Install loader on mounting bracket and connect inlet and outlet tubing.

M. Piston Replacement - (Loader w/50 - 1250 psig range springs)

1. Refer to Figure 9 for item numbers.
2. Securely the body (1) in a vise with the knob (4) directed upwards.
3. Relax range spring (15) by turning knob (4) CCW until rotation comes to a complete stop. **NOTE:** *It is not necessary to remove the knob before removing the spring chamber (6) from the body (1).*
4. Remove spring chamber (6) by grasping the flats and turning CCW. Upon removal, the range spring (15), range spring clip (16), and spring button (5) should remain inside the spring chamber.
5. Remove pusher plate (18).

6. Remove snap ring (7) from piston (14).
7. Lift piston (14) out of body (1) and remove back-up ring (19) and piston o-ring (20). Remove body gasket (10).
8. Clean body (1) according to owner's procedures. **NOTE:** *On regulators originally supplied as "oxygen clean", Option-55, maintenance must include a level of cleanliness equal to Cashco's cleaning standard #S-1134. Contact factory for details.*
9. Inspect and replace any necessary parts. *Use only parts manufactured and supplied by Cashco, Inc. for these products. See Section VIII.*
10. Place a new gasket (10) onto the body (1) flange. Use o-ring lube on o-ring (20) and slide o-ring and back-up ring (19) on piston (14). Place piston subassembly into the body (1).
11. Install snap ring (7) above piston assembly. Position pusher plate (18) on top of piston post.
12. Lubricate the threads of the body (1) with a lightweight grease that is compatible with service use. Rotate the spring chamber (6) CW by hand onto the threaded portion of the body (1) until firmly seated against the body gasket (10). Tighten to the following torque value: 65–70 Ft lbs (88–95 Nm).
13. Pressurize with air and spray liquid leak detector around body (1) and spring chamber (6) to test for leakage. Ensure that an outlet pressure is maintained during this leak test of at least mid-range spring level; i.e. 2-100 psig (.14-6.9 Barg) range spring, 51 psig (3.5 Barg) test pressure minimum.

N. Trim Replacement - (Loader w/50 - 1250 psig range springs)

1. Remove spring chamber subassembly and piston subassembly per Section VI, Steps M.1. – M.7.
2. With a 5/16" socket - rotate seat retainer (13) CCW to remove from the body.
3. Remove the pressed in seat (12) from re-

tainer (13). Remove poppet (8) and poppet spring (9).

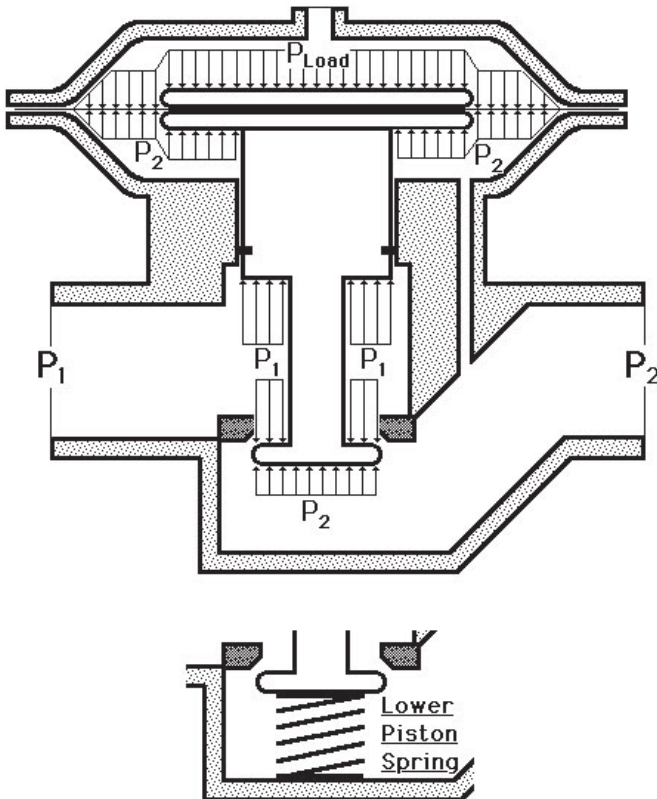
4. Clean debris from within the body (1) cavity. Clean all parts to be reused according to owner's procedures. **NOTE:** *On regulators originally supplied as "oxygen clean", Option-55 maintenance must include a level of cleanliness equal to Cashco's cleaning standard #S-1134. Contact factory for details.*
5. Inspect all parts for damage and replace if necessary. **NOTE:** *Use only parts manufactured and supplied by Cashco, Inc. for these products. See Section VIII.*
6. Place poppet spring (9) into body cavity.
7. Place poppet (8) inside the poppet spring (9). The angled seating surface of the poppet must face up toward the seat (12).
8. Install new seat retainer (13) with seat (12) into body (1) cavity with the seat facing downward toward the angled seating surface of the poppet (8). Tighten seat retainer to the following torque value:
12 – 15 Ft-lbs (16 – 20 Nm).
9. Reinstall piston subassembly and spring chamber assembly per Section VI, Steps M.10. – M.12.
10. Bench test unit for suitable operation. **NOTE:** *Regulators are not tight shutoff devices. Even if pressure builds up beyond set point, a regulator may or may not develop bubble tight shutoff.*
11. Pressurize with air and spray liquid leak detector around body (1) and spring chamber (6) to test for leakage. Ensure that an outlet pressure is maintained during this leak test of at least mid-range spring level; i.e. 2-100 psig (.14-6.9 Barg) range spring, 51 psig (3.5 Barg) test pressure minimum.
12. Install loader on mounting bracket and connect inlet and outlet tubing.

SECTION VIII

VIII. PRESSURE LOADING

1. The Loading pressure for the SLR-2 is supplied from the inlet (P₁) and is regulated by the Pressure Loader.
2. The Model SLR-2 exhibits a deviation in outlet controlled pressure when the inlet pressure varies; this “effect” is identified as ISR – Inverse Sympathetic Ratio. Its relative pressure effect can be calculated from the following equation.

LOADING PRESSURE FOR Main Regular Assembly APPLIED PRESSURES



ISR FACTOR	
BODY SIZE in (DN)	ISR – %
1/2" - 1" (15 - 25)	3.0
1 1/4" - 1 1/2" (32 - 40)	4.0
2" (50)	2.0
2 1/2" - 4" (65 - 100)	5.4

PISTON SPRING		
LOWER PISTON SPRING RANGE psig (Barg)	ΔP Piston Spring psig (Barg)	LVPS psig (Barg)
none (none)	0 (0)	0 (0)
2 - 5 (.14 - .34)	3 (.21)	2 (.14)
1 - 2 (.07 - .14)	1 (.07)	1 (.07)
4 - 10 (.28 - 6.9)	6 (.41)	4 (.28)

SIZE / ORIENTATION – S/O Factor		
Body Size in (DN)	Orientation	
	Cover Dome on Top	Cover Dome on Bottom
1/2" - 1" (15 - 25)	1	-1
1 1/4" - 1 1/2" (32 - 40)	2	-2
2" (50)	2.5	-2.5
2 1/2" - 3" (65 - 80)	3	-3
4" (100)	4	-4

$$P_{LOAD} = \text{ISR Effect} + \text{Lower Piston Spring Compression Effect} + \text{Lower Piston Spring Spring Preload} + \text{Body Size Orientation Effect}$$

$$P_{Load} = P_2 + [ISR \times (P_1 - P_2)] + \left[\frac{C_{vReq'd}}{C_{vMax}} \times \Delta P_{Piston Spr.} \right] + LVPS + S/O_{Factor}$$

Figure 6: Loading Pressure Formula

SECTION IX

IX. TROUBLE SHOOTING GUIDE

When trouble shooting this regulator there are many possibilities as to what may be causing problems. Many times, the regulator itself is not defective, but one or more of the accessories may be. Sometimes the process may be causing difficulties.

The key to efficient trouble shooting is information and communication. The customer should try to be as precise as possible in their explanation of the problem, as well as their understanding of the application and operating conditions.

It is imperative the following information be provided by the customer:

- Fluid (with fluid properties)
- Range of flow rate
- Range of inlet pressure
- Range of outlet pressure
- Range of fluid temperature
- Range of ambient temperature

Pressure readings should be taken at every location where pressure plays a role - i.e., regulator inlet (as close as possible to inlet port), regulator outlet (as close as possible to outlet port), etc.

Following are some of the more common complaints along with possible causes and remedies.

1. Erratic regulation, instability or hunting.	
Possible Causes	Remedies
A. Sticking of internal parts.	A. Remove internals, clean, and if necessary, replace.
B. Load changes are too quick for system.	B. Convert to external sensing (if necessary) and install an orifice or needle valve in external sensing line.
C. Oversized regulator.	C. Check actual flow conditions; resize regulator for minimum and maximum flow; if necessary, replace with smaller regulator.
D. Too much variation in Inlet Pressure - P1.	D. Consider use of a pilot for closer Outlet Pressure – P2
2. Erratic regulation, instability or hunting (liquid service).	
Possible Causes	Remedies
A. Air trapped under diaphragm.	A. Install valve on external sensing port and bleed off air. (Install regulator upside down to help prevent reoccurrence.
3. Downstream pressure will not reach desired setting.	
Possible Causes	Remedies
A. Supply pressure is down (confirm on pressure gauge.	A. Increase supply pressure.
B. Undersized regulator.	B. Check actual flow conditions; resize regulator for minimum and maximum flow; if necessary, replace with larger regulator.
C. Pressure loading system pressure restricted.	C1. Clean restriction or bleed orifices. C2. Clean filter(s). C3. Clean loading pressure control device.
D. Faulty loading pressure control device.	D. Replace/repair loading pressure control device.
4. Diaphragm continually breaks (all regulators).	
Possible Causes	Remedies
A. Differential pressure across diaphragm may have exceeded limits. (See Table 6 in SLR-2-TB)	A1. Be aware of limits as well as where the various pressures are acting. Install pressure safety equipment as necessary.
5. Leakage at diaphragm flange.	
Possible Causes	Remedies
A. Body bolts not torqued properly.	A. Torque to proper value (see Section VII, F-10).
B. Pressures at diaphragm may be too high.	B. Consult factory.

6. Leakage across seat.	
Possible Causes	Remedies
A. Contamination (debris) in regulator.	A. Remove internals, clean, and if necessary, replace sealing and seating elements. *
B. Oversized regulator; valve plug operates directly next to seat.	B. Check actual flow conditions; resize regulator for minimum and maximum flow; if necessary, replace with smaller regulator.
* Seat leakage may be diagnosed when a failure of the dynamic side seal has occurred. Inspect <u>both</u> potential internal leak paths.	

SECTION X

X. ORDERING INFORMATION

NEW REPLACEMENT UNIT vs PARTS "KIT" FOR FIELD REPAIR

To obtain a quotation or place an order, please retrieve the Serial Number and Product Code that was stamped on the metal name plate and attached to the unit. This information can also be found on the Bill of Material ("BOM"). a parts list that was provided when unit was originally shipped. (Serial Number typically 6 digits). Product Code typical format as follows: (last digit is alpha character that reflects revision level for the product).

-

7-

NEW REPLACEMENT UNIT:

Contact your local Cashco, Inc., Sales Representative with the Serial Number and Product code. With this information they can provide a quotation for a new unit including a complete description, price and availability.



CAUTION

Do not attempt to alter the original construction of any unit without assistance and approval from the factory. All purposed changes will require a new name plate with appropriate ratings and new product code to accommodate the recommended part(s) changes.

PARTS "KIT" for FIELD REPAIR:

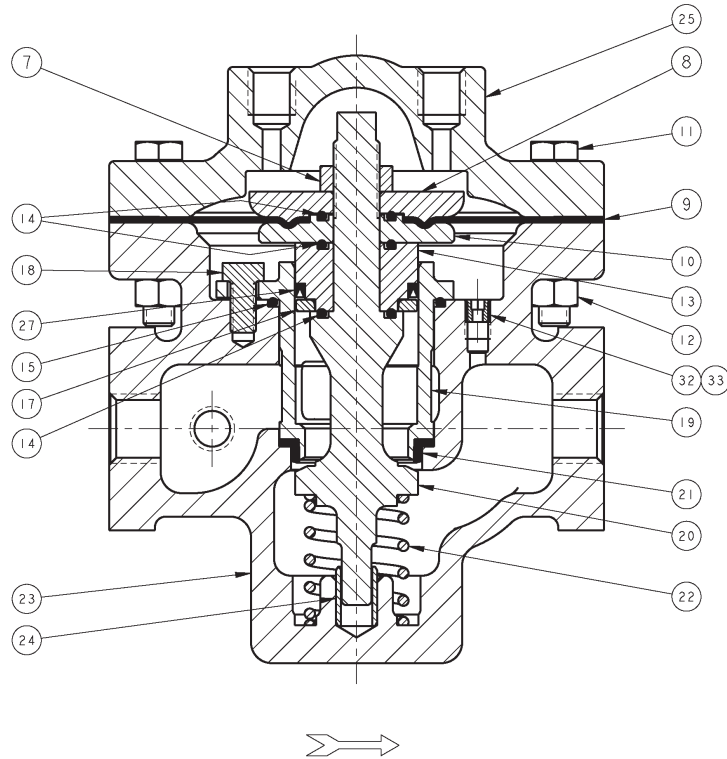
Contact your local Cashco, Inc., Sales Representative with the Serial Number and Product code. Identify the parts and the quantity required to repair the unit from the "BOM" sheet that was provided when unit was originally shipped.

NOTE: *Those part numbers that have a quantity indicated under "Spare Parts" in column "A" reflect minimum parts required for inspection and rebuild, - "Soft Goods Kit". Those in column "B" include minimum trim replacement parts needed plus those "Soft Goods" parts from column "A".*

If the "BOM" is not available, refer to the cross-sectional drawings included in this manual for part identification and selection.

A Local Sales Representative will provide quotation for appropriate Kit Number, Price and Availability.

Figure 7
Main Regulator Assembly



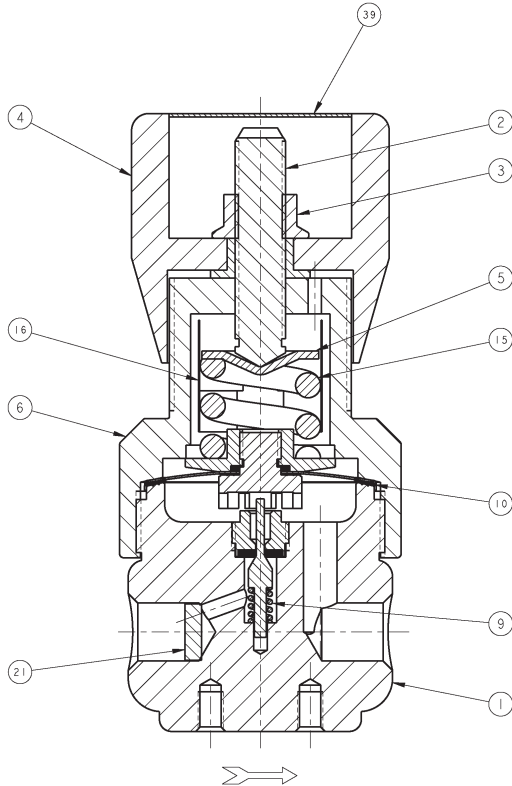
<u>Item No.</u>	<u>Description</u>	<u>Item No.</u>	<u>Description</u>
7	Diaphragm Lock Nut	21**	Seat Ring
8	Upper Diaphragm Plate	22	Lower Piston Spring (if supplied)
9**	Diaphragm	23	Body
10	Lower Diaphragm Plate	24	Lower Guide Bushing
11	Flange Bolts	25	Cover Dome
12 *	Flange Bolt Nuts	26	Plug (Not Shown)
13	Guide Bearing	27**	Dynamic Side Seal (See Figure 1)
14**	Stem Seals	32	Internal Sensing Plug – Solid (External Sensing Only)
14.1	Upper Stem Seal	33	Internal Sensing Plug – Drilled (Internal Sensing Only)
14.2	Middle Stem Seal	99	Nameplate (Not Shown)
14.3	Lower Stem Seal		
15**	Cage Seal		
17	Seal Retainer		
18	Cage Cap Screws		
19	Cage		
20	Valve Plug		

* Not required on 2" CS & SST Body Material.

** Recommended Repair Parts.

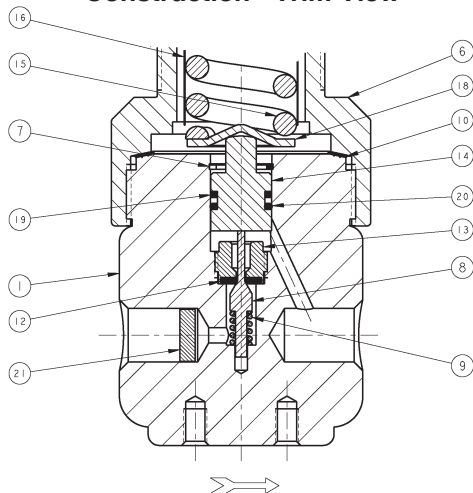
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Figure 8
Brass & SST
Loader (2-750 psig) Construction



**If Aluminum
Loader
Contact Cashco for
Replacement**

Figure 9
SST Loader
(50-1250 psig) High Pressure
Construction - Trim View



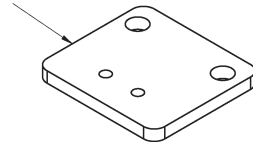
Item No. Parts List for Brass & SST Loaders

1	Body
2	Adjusting Screw
3	Knob Nut
4	Knob
5	Spring Button
6	Spring Chamber
7	Diaphragm Subassembly
7.1 **	Diaphragm
7.2	Actuator Post
7.3	Actuator Nut
7.4 **	Actuator Gasket
7.5 **	Actuator O-ring
8 **	Poppet
9 **	Poppet Spring
10 **	Diaphragm Gasket
12 **	Seat
13 **	Seat Retainer
15	Range Spring
16	Spring Clip
21	Inline Filter
39	Snap in cover

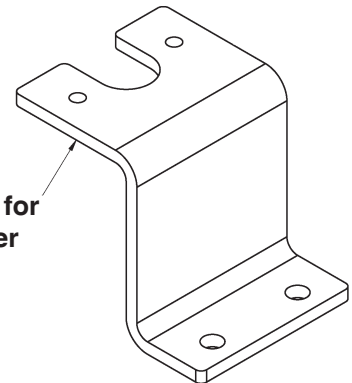
** Recommended Spare Part

See Figure 6 for detail drawing of trim internals.

**Mounting Bracket for
Brass & SST Loaders**



**Mounting Bracket for
Aluminum Loader**



Item No. Parts List for Figure 9 SST Loader
(Construction differences include)

7 **	Snap Ring
14 **	Piston
18	Pusher Plate
19 **	Ring
20 **	O-ring


** Recommended Spare Part

See Figure 8 & Part List for common parts.

ATEX 2014/34/EU: Explosive Atmospheres and Cashco Inc. Products



Cashco, Inc. declares that the products listed in the table below has been found to comply with the Essential Health and Safety Requirements relating to the design and construction of products intended for use in potentially explosive atmospheres given in Annex II of the ATEX Directive 2014/34/EU. Compliance with the Essential Health and Safety Requirements has been assured by compliance with EN ISO 80079-36:2016 and EN ISO 80079-37:2016. The product will be marked as follows:

CE  II 2 G
Ex h IIB T6... T1 Gb
1000ATEXR1 X

The 'X' placed after the technical file number indicates that the product is subject to specific conditions of use as follows:

1. The maximum surface temperature depends entirely on the operating conditions and not the equipment itself. The combination of the maximum ambient and the maximum process medium temperature shall be used to determine the maximum surface temperature and corresponding temperature classification, considering the safety margins described prescribed in EN ISO 80079-36:2016, Clause 8.2. Additionally, the system designer and users must take precautions to prevent rapid system pressurization which may raise the surface temperature of system components and tubing due to adiabatic compression of the system gas. Furthermore, the Joule-Thomson effect may cause process gases to rise in temperature as they expand going through a regulator. This could raise the external surface temperature of the regulator body and the downstream piping creating a potential source of ignition. Whether the Joule-Thomson effect leads to heating or cooling of the process gas depends on the process gas and the inlet and outlet pressures. The system designer is responsible for determining whether the process gas temperature may raise under any operating conditions.
2. Where the process medium is a liquid or semi-solid material with a surface resistance in excess of 1GΩ, special precautions shall be taken to ensure the process does not generate electrostatic discharge.
3. Special consideration shall be made regarding the filtration of the process medium if there is a potential for the process medium to contain solid particles. Where particles are present, the process flow shall be <1m/s (<3.3 ft/s) in order to prevent friction between the process medium and internal surfaces.
4. Effective earthing (grounding) of the product shall be ensured during installation.
5. The valve body/housing shall be regularly cleaned to prevent build up of dust deposits.
6. Regulators must be ordered with the non-relieving option (instead of the self-relieving option) if the process gas they are to be used with is hazardous (flammable, toxic, etc.). The self-relieving option vents process gas through the regulator cap directly into the atmosphere while the non-relieving option does not. Using regulators with the self-relieving option in a flammable gas system could create an explosive atmosphere in the vicinity of the regulator.
7. Tied diaphragm regulators with outlet ranges greater than 7 barg (100 psig) should be preset to minimize the risk that improper operation might lead to an outboard leak and a potentially explosive atmosphere.
8. All equipment must only be fitted with manufacturer's original spare parts.
9. Ensure that only non-sparking tools are used, as per EN 1127-1, Annex A.

	PRODUCT
REGULATORS	31-B, 31-N
	1164, 1164(OPT-45)
	1171, 1171(OPT-45), 1171(CRYO)
	2171, 2171(OPT-45), 2171(CRYO), 3171
	1465, 3381, 3381(OPT-45), 3381(OPT-40)
	4381, 4381(OPT-37), 4381(CRYO), 4381(OPT-45), 5381
	MPRV-H, MPRV-L
	PBE, PBE-L, PBE-H
	CA-1, CA-2
	CA1, SA1, CA4, SA4, CA5, SA5
	DA2, DA4, DA5, DA6, DA8
	DA0, DA1, DAP, SAP
	SLR-1, SLR-2, PTR-1
	ALR-1, ULR-1, PGR-1
	BQ, BQ(OPT-45), BQ(CRYO)
	123, 123(CRYO), 123(OPT-45), 123(OPT-46G)
	123-1+6, 123-1+6(OPT-45), 123-1+6(OPT-46G), 123-1+6+S, 123-1+6+S(OPT-40)
	1000HP, 1000HP(OPT-37), 1000HP(OPT-45), 1000HP(OPT-45G), 1000HP(CRYO)
	1000HP-1+6, 1000HP-1+8, 1000LP, 1000LP(OPT-45), 1000LP(OPT-46G)
	6987
	8310HP, 8310HP-1+6, 8310HP-1+8, 8310LP, 8311HP, 8311LP
	345, 345(OPT-45)
	BA1/BL1, PA1/PL1
	C-BPV, C-PRV, C-CS
	D, D(CRYO), D(OPT-37), D(OPT-20), D(OPT-45)
	DL, DL(LCC), DL(OPT-45)
	BR, BR(CRYO)
	HP, HP(LCC), HP(OPT-45), HP(OPT46G), HP-1+6+S(OPT-40), HP-1+6+S
	P1, P2, P3, P4, P5, P7
	B2, B7
	POSR-1, POSR-2
	5200P, 5300P
	135
	NW-PL, NW-SO
	CG-PILOT
	FG1
CONTROL VALVES	RANGER, 987, PREMIER
	964, 521, 988, 988-MB, 989
	2296/2296HF
	SCV-30, SCV-S
	FL800/FL200
TANK BLANKETING	8700, 8910, 8920, 8930, 8940
	2100, 2199
	3100, 3200, 3300, 3400, 3500, 3600, 3700
	1078, 1088, 1100, 1049
	5100, 5200, 5400, 5500
	4100, 4200, 4300, 4400, 4500, 4600
MISC	764P/PD, 764-37, 764T

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