MODEL SLR-1
DIRECT-ACTING, PRESSURE LOADED,
PRESSURE REDUCING REGULATOR
with SELF-RELIEVING LOADER

SECTION I

I. DESCRIPTION AND SCOPE

The Model SLR-1 uses the pressure set point of a self-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-1-TB for technical specifications for this regulator.

ABBREVIATIONS

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

SECTION III

III. INSTALLATION

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-1-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

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.
IV. PRINCIPLE OF OPERATION

1. When a loading pressure – $P_{\text{Load}}$ – 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 - $P_{\text{L}}$. (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.

2. Rotate the knob (4) of the loading regulator CCW three revolutions to decrease the set point pressure of the main regulator.

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 valve is flowing. Observe the outlet pressure gauge to ensure not overpressurizing.

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-1. 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.)

SECTION VII

VII. MAINTENANCE

A. General:

1. The SLR-1 may be serviced without removing the regulator from pipeline. The 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:

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Seal Type</th>
<th>Part Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>13</td>
<td>All</td>
<td>Guide Bearing</td>
</tr>
<tr>
<td>14</td>
<td>All</td>
<td>Static Stem Seal</td>
</tr>
<tr>
<td>14.1</td>
<td>All</td>
<td>Upper Static Stem Seal</td>
</tr>
<tr>
<td>14.2</td>
<td>All</td>
<td>Middle Static Stem Seal</td>
</tr>
<tr>
<td>14.3</td>
<td>All</td>
<td>Lower Static Stem Seal</td>
</tr>
<tr>
<td>15</td>
<td>All</td>
<td>Cage O-ring Seal</td>
</tr>
<tr>
<td>16</td>
<td>CW</td>
<td>Wiper</td>
</tr>
<tr>
<td>17.1</td>
<td>CW</td>
<td>Wiper Washer</td>
</tr>
<tr>
<td>17.3</td>
<td>UC</td>
<td>Seal Retainer</td>
</tr>
<tr>
<td>19</td>
<td>All</td>
<td>Cage</td>
</tr>
<tr>
<td>20</td>
<td>All</td>
<td>Valve Plug</td>
</tr>
<tr>
<td>21</td>
<td>All</td>
<td>Seat Ring</td>
</tr>
<tr>
<td>27.1</td>
<td>All</td>
<td>Dynamic Side Seal</td>
</tr>
<tr>
<td>27.2</td>
<td>CW</td>
<td>TFE Cap Seal</td>
</tr>
<tr>
<td>27.3</td>
<td>UC</td>
<td>O-ring Energizer/Seal</td>
</tr>
<tr>
<td>27.4</td>
<td>OR</td>
<td>O-Ring Seal</td>
</tr>
</tbody>
</table>

A detailed view of the dynamic side seal parts is shown in Figure 1 on the next page.
B. Main Regulator Disassembly:

1. Shut down system in accordance Section VI.

2. Disconnect the external sensing line, if installed. Disconnect tubing at inlet connection of the main regulator body, the inlet and outlet of the loader.

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).

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).


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.

   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](image)

   Not supplied. Use any bolt, washers (2) and nut of same approximate hole size.

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.


   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 halfway 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, press the guide bearing (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, 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:
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.

<table>
<thead>
<tr>
<th>Body Size in (DN)</th>
<th>Torque Value</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1/2” - 1”</td>
<td>60 - 70</td>
<td>(81 - 95)</td>
</tr>
<tr>
<td>1 1/4” - 2”</td>
<td>120 - 130</td>
<td>(163 - 176)</td>
</tr>
<tr>
<td>2 1/2” - 4”</td>
<td>180 - 200</td>
<td>(244 - 271)</td>
</tr>
</tbody>
</table>

**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.
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 loader drawing for item numbers for Brass and SST Loaders. For Aluminum Loaders - contact Cashco Inc.

4. Remove cap screws that secure loader to mounting bracket. Disconnect tubing and fittings that connect the loading regulator to the 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.

K. Diaphragm Replacement

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.

**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.

4. Remove the diaphragm subassembly (7): consisting of the actuator nut (7.3), diaphragm (7.1), actuator post (7.2), actuator gasket (7.4), actuator o-ring (7.5) and the self relieving seat (23). **NOTE:** These parts are pre-assembled at the factory, must order new diaphragm sub-assembly if replacement is needed.

5. Remove diaphragm gasket (10). 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.

6. Place a new diaphragm gasket (10) onto the body (1) diaphragm flange.

7. Install a new diaphragm subassembly on top of the diaphragm gasket (10).

8. 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).

9. 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

1. Remove spring chamber subassembly and diaphragm subassembly per Steps K.1. – K.5 previous.

2. With a 5/16” socket - rotate seat retainer (13) CCW to remove from the body.

3. Place the lower end of the poppet (8) in a smooth jawed vise; (button (24) directed upwards). Use a smooth jawed pliers to grasp the large end of the button and rotate CCW to remove.

4. Lift the seat retainer (13) up off the poppet. Remove the pressed in seat (12). Remove poppet spring (9) from body.

5. Clean debris from within the body (1) cavity. Clean all parts to be reused according to owner's procedures. \textit{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. \textit{NOTE:} \textit{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: 12 – 15 Ft-lbs (16 – 20 Nm).

12. Apply one drop of Loctite 430 or equivalent to poppet threads. Thread the self relieving button (24) onto the poppet threads until the bottom edge of the button is flush with the top edge of the seat retainer (13). Then rotate the button CCW 3/4 to 1 full turn so the bottom edge of the button appears slightly above flush with the seat retainer.


14. Bench test unit for suitable operation. \textit{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.
VIII. PRESSURE LOADING

1. The Loading pressure for the SLR-1 is supplied from the inlet (P1) and is regulated by the Pressure Loader.

2. The Model SLR-1 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.

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

\[ P_{Load} = P_2 + [\text{ISR} \times (P_1 - P_2)] + \frac{C_{\text{Req'd}}}{C_{\text{Max}}} \times \Delta P_{\text{Piston Spr.}} + \text{LVPS} + \text{S/O Factor} \]

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 outlet pressure
- Range of flow rate
- Range of fluid temperature
- Range of inlet pressure
- 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.

<table>
<thead>
<tr>
<th>1. Erratic regulation, instability or hunting.</th>
<th>Remedies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Possible Causes</td>
<td></td>
</tr>
<tr>
<td>A. Sticking of internal parts.</td>
<td>A. Remove internals, clean, and if necessary, replace.</td>
</tr>
<tr>
<td>B. Load changes are too quick for system.</td>
<td>B. Convert to external sensing (if necessary) and install an orifice or needle valve in external sensing line.</td>
</tr>
<tr>
<td>C. Oversized regulator.</td>
<td>C. Check actual flow conditions; resize regulator for minimum and maximum flow; if necessary, replace with smaller regulator.</td>
</tr>
<tr>
<td>D. Too much variation in Inlet Pressure - P1.</td>
<td>D. Consider use of a pilot for closer Outlet Pressure – P2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>2. Erratic regulation, instability or hunting (liquid service).</th>
</tr>
</thead>
<tbody>
<tr>
<td>Possible Causes</td>
</tr>
<tr>
<td>A. Air trapped under diaphragm.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>3. Downstream pressure will not reach desired setting.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Possible Causes</td>
</tr>
<tr>
<td>A. Supply pressure is down (confirm on pressure gauge.</td>
</tr>
<tr>
<td>B. Undersized regulator.</td>
</tr>
<tr>
<td>C. Pressure loading system pressure restricted.</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>D. Faulty loading pressure control device.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>4. Diaphragm continually breaks (all regulators).</th>
</tr>
</thead>
<tbody>
<tr>
<td>Possible Causes</td>
</tr>
<tr>
<td>A. Differential pressure across diaphragm may have exceeded limits. (See Table 6 in SLR-1-TB)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>5. Leakage at diaphragm flange.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Possible Causes</td>
</tr>
<tr>
<td>A. Body bolts not torqued properly.</td>
</tr>
<tr>
<td>B. Pressures at diaphragm may be too high.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Possible Causes</th>
<th>Remedies</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Contamination (debris) in regulator.</td>
<td>A. Remove internals, clean, and if necessary, replace sealing and seating elements. *</td>
</tr>
<tr>
<td>B. Oversized regulator; valve plug operates directly next to seat.</td>
<td>B. Check actual flow conditions; resize regulator for minimum and maximum flow; if necessary, replace with smaller regulator.</td>
</tr>
</tbody>
</table>

* Seat leakage may be diagnosed when a failure of the dynamic side seal has occurred. Inspect both 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).

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.

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.

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.
## Main Regulator Assembly

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

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

The contents of this publication are presented for informational purposes only, and while every effort has been made to ensure their accuracy, they are not to be construed as warranties or guarantees, express or implied, regarding the products or services described herein or their use or applicability. We reserve the right to modify or improve the designs or specifications of such product at any time without notice. Cashco, Inc. does not assume responsibility for the selection, use or maintenance of any product. Responsibility for proper selection, use and maintenance of any Cashco, Inc. product remains solely with the purchaser.
Brass & SST Loader

Mounting Bracket for Brass & SST Loader

If Aluminum Loader Contact Cashco for Replacement

Item No. | Repair Parts 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
23 ** | Self Relieving Seat
24 ** | Self Relieving Button
39 | Snap in cover
** | Recommended Spare Part
These valves satisfy the safety conditions according to EN 13463-1 and EN 13463-5 for equipment group IIG 2 c.

Caution: Because the actual maximum temperature depends not on the equipment itself, but upon the fluid temperature, a single temperature class or temperature cannot be marked by the manufacturer.

Specific Precaution to Installer: Electrical grounding of valve must occur to minimize risk of effective electrical discharges.

Specific Precaution to Installer: Atmosphere vent holes should be plugged to further minimize the risk of explosion.

Specific Precaution to Maintenance: The Valve Body/ Housing must be regularly cleaned to prevent buildup of dust deposits.

Specific Precaution to Maintenance: Conduct periodic Continuity Check between Valve Body/ Housing and Tank to minimize risk of electrical discharges.

Attention: When repairing or altering explosion-protected equipment, national regulations must be adhered to. For maintenance and repairs involving parts, use only manufacturer's original parts.

ATEX requires that all components and equipment be evaluated. Cashco pressure regulators are considered components. Based on the ATEX Directive, Cashco considers the location where the pressure regulators are installed to be classified Equipment-group II, Category 3 because flammable gases would only be present for a short period of time in the event of a leak. It is possible that the location could be classified Equipment-group II, Category 2 if a leak is likely to occur. Please note that the system owner, not Cashco, is responsible for determining the classification of a particular installation.

Product Assessment

Cashco performed a conformity assessment and risk analysis of its pressure regulator and control valve models and their common options, with respect to the Essential Health and Safety Requirements in Annex II of the ATEX directive. The details of the assessment in terms of the individual Essential Health and Safety Requirements, are listed in Table 1. Table 2 lists all of the models and options that were evaluated and along with their evaluation.

Models and options not listed in Table 2 should be assumed to not have been evaluated and therefore should not be selected for use in a potentially explosive environment until they have been evaluated.

Standard default options for each listed model were evaluated even if they were not explicitly listed as a separate option in the table. Not all options listed in the tables are available to all models listed in the tables. Individual TB's must be referenced for actual options.

When specifying a regulator that is to be used in a potentially explosive environment one must review the evaluations in Table 1 and 2 for the specific model and each and every option that is being specified, in order to determine the complete assessment for the unit.

A summary of the models and options found to have an impact on ATEX assessment due to potential ignition sources or other concerns from the ATEX Essential Health and Safety Requirements, are listed below.

1. The plastic knob used as standard on some models, (P1, P2, P3, P4, P5, P7, 3381, 4381, 1171, and 2171) is a potential ignition source due to static electricity. To demonstrate otherwise, the knob must be tested to determine if a transferred charge is below the acceptable values in IEC 60079-0 Section 26.14 (See items 25, 27, and 28 in Appendix A). Until the plastic knob has been shown to be acceptable, then either the metal knob option, or a preset outlet pressure option is required to eliminate this ignition source (See items 45 and 64 in Tables).

2. The pressure gauges offered as options on a few of the regulator models (DA’s, P1-7, D, 764, 521), use a plastic polycarbonate window that is a potential ignition source due to static electricity. To demonstrate that the gauges are not a potential source of ignition, the gauges would need to be tested to determine if a transferred charge is below
indicating the gauge is compliant with the ATEX Directive (See items 26, 27, and 28 in Appendix A). Until compliance is determined, regulators should not be ordered with pressure gauges for use in potentially explosive environments.

3. Tied diaphragm regulators with outlet ranges greater than 100 psig should be preset to minimize the risk that improper operation might lead to an outboard leak and a potentially explosive atmosphere (See item 6 in Table 1).

4. 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 regulator with the self-relieving option in a flammable gas system could create an explosive atmosphere in the vicinity of the regulator.

5. Regulators with customer supplied parts are to be assumed to not have been evaluated with regard to ATEX and thus are not to be used in a potentially explosive environment unless a documented evaluation for the specific customer supplied parts in question has been made. Refer to Table 1 for all models and options that have been evaluated.

Product Usage

A summary of ATEX related usage issues that were found in the assessment are listed below.

1. Pressure regulators and control valves must be grounded (earthed) to prevent static charge build-up due to the flowing media. The regulator can be grounded through any mounting holes on the body with metal to metal contact or the system piping can be grounded and electrical continuity verified through the body metal seal connections. Grounding of the regulator should follow the same requirements for the piping system. Also see item 30 in Table 1.

2. The system designer and users must take precautions to prevent rapid system pressurization which may raise surface temperatures of system components and tubing due to adiabatic compression of the system gas.

3. Heating systems installed by the user could possibly increase the surface temperature and must be evaluated by the user for compliance with the ATEX Directive. User installation of heating systems applied to the regulator body or system piping that affects the surface temperature of the pressure regulator is outside the scope of this declaration and is the responsibility of the user.

4. 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 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 rise under any operating conditions. If a process gas temperature rise is possible under operating conditions, then the system designer must investigate whether the regulator body and downstream piping may increase in temperature enough to create a potential source of ignition.

The process gas expansion is typically modeled as a constant enthalpy throttling process for determining the temperature change. A Mollier diagram (Pressure – Enthalpy diagram with constant temperature, density, & entropy contours) or a Temperature – Entropy diagram with constant enthalpy lines, for the process gas, can be used to determine the temperature change. Helium and hydrogen are two gases that typically increase in temperature when expanding across a regulator. Other gases may increase in temperature at sufficiently high pressures.

Product Declaration

If the above issues are addressed by selecting options that do not have potential sources of ignition, avoiding options that have not been assessed, and by taking the proper usage issue precautions, then Cashco regulators can be considered to be a mechanical device that does not have its own source of ignition and thus falls outside the scope of the ATEX directive.