



ISO Registered Company

MODEL DA2

DIRECT-ACTING, POSITIVE BIAS DIFFERENTIAL PRESSURE REDUCING REGULATOR

SECTION I

I. DESCRIPTION AND SCOPE

The Model DA2 is a differential pressure reducing regulator used to control differential pressure between downstream (outlet or P₂) pressure and a loading (P_{Load}) pressure to the spring chamber. Sizes 1/2" (DN15), 3/4" (DN20), 1" (DN25), 1-1/4" (DN32), 1-1/2" (DN40), 2" (DN50), 2-1/2" (DN65), 3" (DN80) and 4" (DN100). With proper trim utilization, the unit is suitable for liquid, gaseous, or steam service. Refer to Technical Bulletin DA2-TB for design conditions and selection recommendations.

SECTION II

II. REFERENCES

Refer to Technical Bulletin DA2-TB and DAG-TB for technical specifications.

ABBREVIATIONS

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

SECTION III

III. INSTALLATION

1. Regulator may be rotated around pipe axis 360 degrees. For ease of maintenance, the recommended position is with the spring chamber (4) upwards. In liquid service it is recommended that the spring chamber (4) be oriented downwards, and that a customer supplied and installed vent valve be provided at the external sensing connection to bleed-off trapped gas/air under the diaphragm.
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. An isolation valve on the loading line is not recommended.
4. An outlet pressure gauge should be located approximately ten pipe diameters downstream, and within sight. A loading pressure (or differential pressure) gauge is recommended.
5. All installations should include a downstream relief device if the inlet pressure could exceed the pressure rating of any downstream equipment or the maximum outlet pressure rating of the unit.
6. Clean the piping of all foreign material including chips, welding scale, oil, grease and dirt before installing the regulator. Strainers are recommended.
7. In placing thread sealant on pipe ends prior to engagement, ensure that excess material is removed and not allowed to enter the regulator upon startup.
8. Flow Direction: Install so the flow direction matches the arrow cast on the body.
9. If the loading pressure is not lowered sufficiently prior to shutting off the process fluid supply, then the diaphragm will be damaged with the standard construction. The startup, shutdown, and emergency operating procedures should be reviewed to ensure that the loading pressure is less than 50% of the Diaphragm Proof Rating (See Table 1) before shutting off the process fluid supply pressure. If the regulator is specified with a fully supported diaphragm, then the diaphragm will withstand a loading pressure equal to the Diaphragm Proof Rating for the fully supported diaphragm.

10. Downstream Sensing Installation Considerations
 – Internal or External Sensing:
- 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, Paragraph H).
 - Reference DAG-TB, Table DAG-11 for recommendations for applying external pressure sensing.
 - For internal sensing, no external line is required. For external sensing, use an external control line. The line is connected from the port (1/4" NPT) on the side of the body diaphragm flange (see port 5 in Fig. 5) to a pressure tap. The pressure tap should be located a minimum of 10 pipe diameters downstream of the regulator. It is recommended that the downstream pressure tap be located close to the point of use to minimize the adverse affect of variable line losses. A tubing outer diameter of 0.25 inch is adequate for short sensing lines (less than 4 feet). Use 3/8" tubing or 1/4" Sch 40 pipe for sensing lines of 5 to 50 feet.
 - For condensable vapors (i.e. steam) slope the external sensing line downward 2 to 5 degrees to outlet piping to prevent water pockets, which allows the diaphragm chamber to always be self draining. The external sensing line may be sloped upward for liquids or gases.

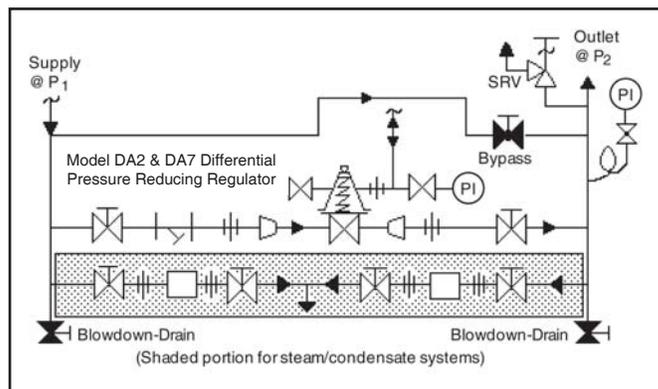
⚠ CAUTION

The proof test pressure must not exceed the diaphragm and body rating for the regulator.

⚠ 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.

A hydrostatic or pneumatic proof test is allowable under the following conditions for the standard diaphragm construction: Uniformly pressurize the valve body inlet, valve body outlet, and loading chamber to the lesser of the Diaphragm Proof Rating or 1.5 times the Outlet Pressure Rating shown on the nameplate. For example, a 1" DA2 with Cast Iron Body and Spring Chamber, Neoprene Diaphragm (BC) has an Outlet Pressure Rating of 400 psig CWP. The lesser pressure of 1.5X 400 psig = 600 psig and the BC diaphragm proof rating of 1250 psig is **600 psig**. Therefore, uniformly pressurizing the DA2 to 600 psig is allowable.



Recommended Piping Schematic for Differential Pressure Reducing Station

**TABLE 1
 MAXIMUM DIAPHRAGM RATING * - psig (Barg)**

NOTE: The below ratings may be further "derated" by limitations thru the Pressure Equipment Directive (97/23/EC-May '97).

DIAPHRAGM MATERIAL	BODY SIZE 1/2" - 2" (DN15-50)		BODY SIZE 3" - 4" (DN80-100)
	STD DIAPHRAGM CONSTRUCTION	**OPT-81 FULL DIAPHRAGM SUPPORT	STD DIAPHRAGM CONSTRUCTION
	P ₂ MAX	P ₂ MAX	P ₂ MAX
BC, EPR	1250 (86.1)	1250 (86.1)	800 (55.1)
NBR	450 (31.0)	1250 (86.1)	300 (20.6)
FKM, FKM+TFE, FK	700 (48.2)	1250 (86.1)	550 (37.9)
3-ply (PTFE+FKM+PTFE)	125 (8.6)	125 (8.6)	125 (8.6)
METAL Be-Cu	1500 (103)	NA	NA

*Maximum setting of pressure safety device – safety relief valve or rupture disc.

**Not available for CI/CI, BRZ/CI, BRZ/BRZ, BRZ/CS, BRZ/SST, CS/CI & SST/CI constructions.

NA = NOT AVAILABLE

SECTION IV

IV. PRINCIPLE OF OPERATION

1. Valve plug movements modulate the flow across the valve seat to maintain the outlet pressure (P_2) equal to the sum of the differential pressure (ΔP_{DIFF}) and the loading pressure (P_{Load}). The outlet pressure acting on the underside of the diaphragm tends to close the valve plug against the valve seat. The outlet pressure acting on the topside of the diaphragm tends to lift the valve plug off the valve seat. The positive differential setting of the range spring tends to lift the valve plug off the valve seat. The outlet pressure tracks

with changes to the loading pressure. Each one psi increase or decrease in the loading pressure produces a respective one psi increase or decrease in the outlet pressure.

2. For a DA2 (single diaphragm) design, a complete diaphragm failure will cause the outlet process fluid to mix with the loading fluid.

SECTION V

V. STARTUP

1. Start with the block valves closed.
2. Relax the range spring by turning the adjusting screw CCW for the DA2 (viewed from above) a minimum of three (3) full revolutions. This reduces the ΔP_{DIFF} (differential) pressure set point.
3. If it is a "hot" piping system, and equipped with a bypass valve, partially open the bypass valve to preheat the system piping and to allow slow expansion of the piping. Check for proper steam trap operation if installed. 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.



CAUTION

Do not walk away and leave a bypassed regulator unattended!

5. Slowly open the inlet (upstream) block valve to about 25% open, observing the outlet (downstream) pressure gauge. Determine if the regulator is flowing. If not, slowly rotate the DA2 regulator adjusting screw CW (viewed from above) until flow begins. Slightly open the bleeder valve to vent any air as the spring chamber is filling with a liquid loading fluid.
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 is not 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. Set the DA2 regulator set point (ΔP_{DIFF}) by turning the adjusting screw clockwise (CW) to increase outlet pressure or CCW to reduce outlet pressure. The outlet (P_2) pressure under these conditions will approximate the desired differential pressure when loaded with P_{Load} for the DA2.
10. Pressurize the source of loading (P_{Load}) pressure and allow to fill the spring chamber cavity. Slightly open the bleeder valve to vent any air as the spring chamber is filling with a liquid loading fluid.
11. Develop system flow and pressure and readjust setpoint as required to obtain desired response. Performance should be analyzed at minimum and maximum flow levels.
12. Install closing cap where applicable. The standard regulator relies on a double o-ring rotary seal (item 34) around the non-rising adjusting screw.

SECTION VI

VI. SHUTDOWN

CAUTION

Loading Pressure should be lowered as described in Section III, paragraph 9 before shutting down the system pressure.

1. To prevent force imbalances and possible diaphragm failure of the standard diaphragm construction, the loading pressure (P_{Load}) should be lowered until the loading pressure (P_{Load}) is less than 50% of the diaphragm proof rating for the

standard construction. System sequencing must ensure this occurs.

2. It is recommended that manual operation not be attempted by a bypass valve during a shutdown.
3. When the outlet pressure (P_2) has been lowered to 5 - 10 psig, the inlet (upstream) block valve may be closed. The inlet pressure (P_1) should then decay to zero psig before the outlet (downstream) block valve is closed.

SECTION VII

VII. MAINTENANCE

A. General:

1. The regulator 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 spare parts for the regulator. The information should include: Size, Product Code and Serial Number.
3. Refer to Section VIII for recommended spare 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 Special Cleaning Option-55, -56, or -57, maintenance must include a level of cleanliness equal to Cashco cleaning standards of #S-1134, #S-1542, and #S-1589 respectively. Contact factory for details.*

5. The Inner Trim 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 depending on what dynamic sealing system the regulator is using:

Item No.	Dynamic Seal Type	Part Description
13	All	Guide Bearing/Piston
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,PW	Wiper
17.1	CW,PW	Wiper Washer
17.2	OR,CP,PR	Camber Adjusting Washer *
17.3	UC	Seal Retainer
19	All	Cage
20	All	Valve Plug
21	All	Seat Ring
27	All	Dynamic Side Seal
27.1	CP,CW	TFE Cap Seal
27.2	CP, CW	O-ring Energizer
27.3	UC	U-Cup Seal w/Metal Energizer
27.4	OR	O-Ring Seal
27.5	PR,PW	Piston Ring Seal w/Metal Energizer

* Metal Diaphragm Only.

† Comp. Diaphragm Only.

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

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.*

* Includes external sensing connection if applicable.

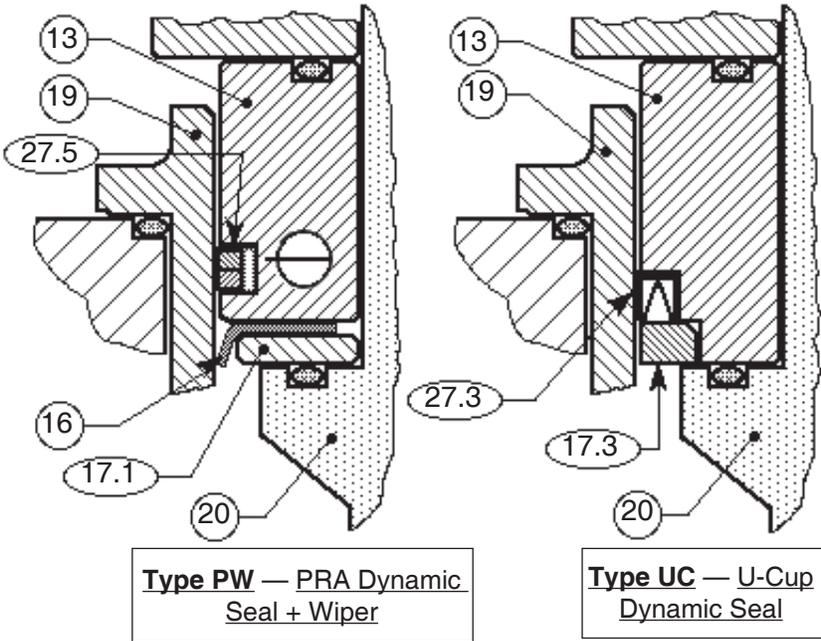
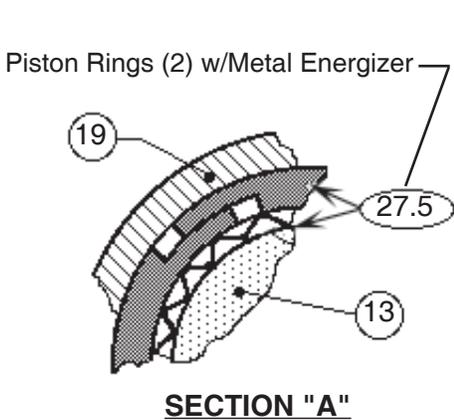
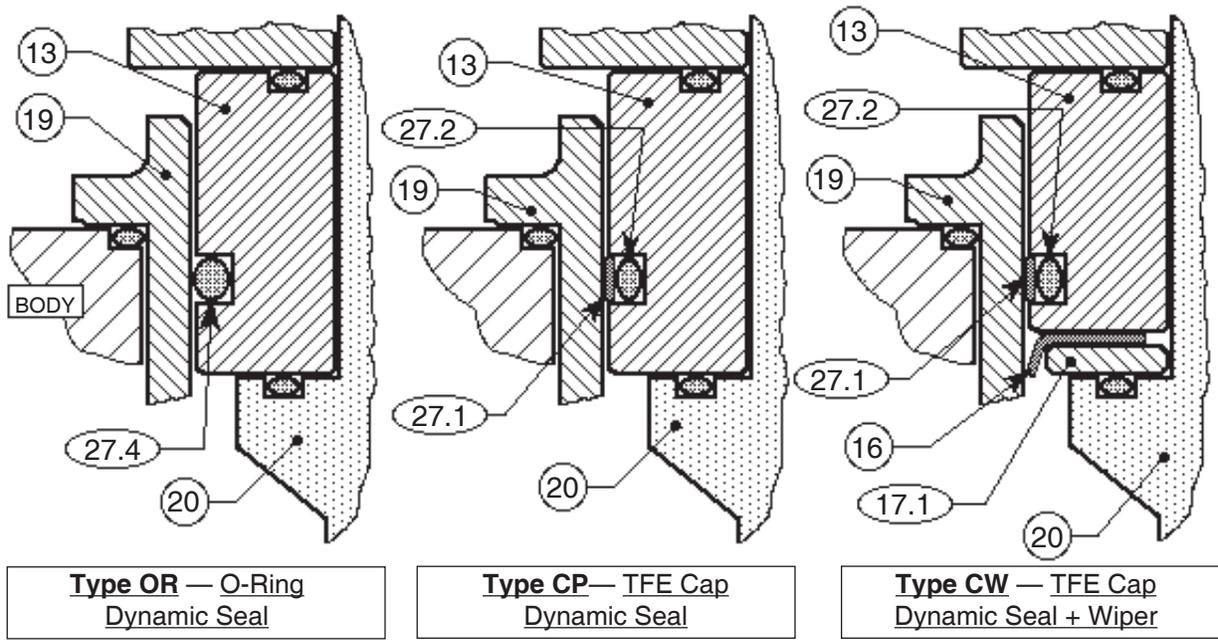


Figure 1: Dynamic Side Seals

B. Main Valve Disassembly:

1. Shut down the system in accordance with Section VI.
2. Disconnect the external sensing line, if installed.
3. The quick change trim allows for the disassembly of the regulator while installed in the pipeline. Alternatively the maintenance can be done in a shop area. **NOTE:** *It is easier to repair the regulator when mounted upright in a horizontal pipe run compared to a vertical pipe run or a regulator mounted with spring facing down. The description hereafter will assume shop disassembly.*
4. Remove regulator body (23) from pipeline. Place the regulator in a vise with the spring chamber (4) upwards.
5. Relax range spring (6) forces by turning adjusting screw (1) CCW (viewed from above) until spring relaxes. The easiest way to check this, is to carefully loosen the locknut (item 2). If the adjusting screw (item 1) sinks into the chamber as the locknuts are loosened, then the spring assembly is still in extension. Turn the adjusting screw CW to remove the extension. Fully remove the locknuts.
6. Loosen the diaphragm flange bolts (11) and nuts (12) uniformly.
7. Place match marks on body (23) and spring chamber (4) flanges. Remove the spring chamber (4).
8. Remove spring follower (5) and range spring (6.1).
9. For composition diaphragm construction, hold the milled "flats" on top of the valve plug (20) stationary with appropriate socket wrench. Loosen and remove the diaphragm lock nut (7). **NOTE:** *Metal diaphragm constructions do NOT have a diaphragm lock nut (7).*
10. Remove upper diaphragm pressure plate (8).
11. Remove diaphragm(s) (9, 9.1, 9.2, 9.9) and o-ring upper stem seal (14.1). Examine diaphragm(s) to determine whether failed; determine if operating conditions are exceeding pressure, pressure drop or temperature limits.
12. For composition diaphragm construction, remove lower diaphragm pusher plate (10).
13. Evenly loosen the three cage cap screws (18) in single revolution increments. If the regulator contains 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 piston-guide bearing (13) to prevent the ITA from popping up as the last threads of the cage cap screws (18) are backed out.
14. Remove the ITA by pulling up on the valve plug (20). Set ITA aside.
15. Remove the lower piston spring (22), as applicable, from within the body (23). **NOTE:** *Composition diaphragm constructions do not normally include a lower piston spring (22); all metal diaphragm constructions MUST include a lower piston spring (22).*
16. Remove o-ring cage seal (15).
17. Remove body (23) from vise. Clean all reusable metal parts according to owner's procedures. (See Article VII.A.4. comments concerning cleaning for oxygen service.)

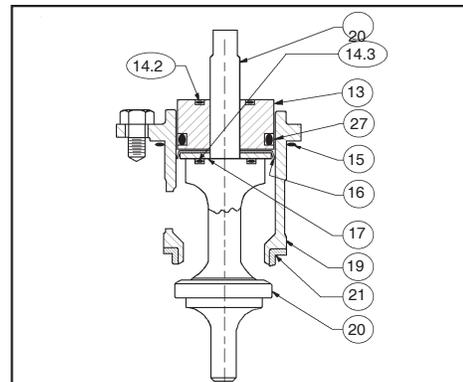


Figure 2: Assembled ITA,
Composition Diaphragm Construction

C. Disassembly of the ITA:

1. Removal of piston-guide bearing (13).
 - a. For a regulator with a composition diaphragm(s) (see figure 2); pull the valve plug (20) downwards and out the piston-guide bearing (13) and out of the lower end of the cage (19). Remove the piston-guide bearing (13) from the upper end of the cage (19).
 - b. For a regulator with a metal diaphragm(s) (see figure 3); hold the lower part of the

valve plug (20) in a bench vise, grasping the milled flats directly under the seat disc section of the plug (20). **DO NOT** clamp the machined lower spindle area of the plug (20) in the vise. The lower spindle area must slide smoothly in the lower guide bushing (24), therefore it cannot be marred. Loosen the piston-guide bearing (13) by turning CCW. A double-posted spanner wrench should be used to allow for easy loosening and correct reassembly (see Double-Posted Spanner Wrench in Section IX). Remove the valve plug from the vise and complete the unthreading of the valve plug from the piston-guide bearing. Remove the valve plug from the lower end of the cage (19) and remove the piston-guide bearing from the upper end of the cage.

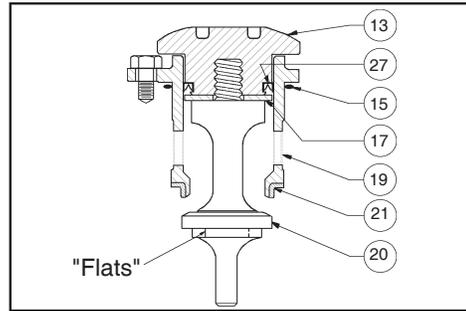


Figure 3: Assembled ITA,
Metal Diaphragm Construction

D. Inspection of Parts:

2. Examine the components (27.1, 27.2, 27.3, 27.4, 27.5) 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 piston-guide bearing (13) groove.
 3. Remove wiper seal (16), if supplied, from within cage (19).
 4. Remove wiper washer (17.1), camber adjusting washer (17.2), or seal retainer (17.3), if supplied, from within cage (19).
 5. Remove o-ring lower stem seal (14.3) from plug (20).
 6. Remove seat ring (21); examine for signs of leakage. If seat ring (21) shows signs of significant leakage, determine if operating conditions of pressure, pressure drop, or temperature are exceeding limits.
 7. Clean all reusable metal parts according to owner's procedures. **NOTE:** *On regulators originally supplied as Special Cleaning Option-55, -56, or -57, maintenance must include a level of cleanliness equal to Cashco cleaning standards of #S-1134, #S-1542, #S-1589 respectively. Contact factory for details.*
1. After inspection remove from the work area and discard the old "soft goods" parts (i.e. o-rings, diaphragms, seals, gaskets, etc.). These parts **MUST** be replaced with factory supplied new parts.
 2. Inspect the metal parts that will be reused. The parts should be free of surface contaminants, burrs, oxides, and scale. Rework and clean the 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 on 1/2" - 2" sizes):
 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 (32);
 1. Ensure that bore is minimum 0.125 inch (3.20 mm). Clean or 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 wiper seal (16), the wiper seal (16) should be “performed” from the factory. It will, however, require reforming. Reform the wiper seal (16) by pressing the temporary assembly parts into the cage (19) backwards as shown in Figure 4 (only applicable to composition diaphragm design). The wiper seal (16) is best left in this position overnight, but a minimum of 30 minutes prior to reassembly. Soaking in a bucket of hot water will speed up the reforming process.

2. After reforming 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 piston-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 piston-guide bearing (13). **NOTE:** A very slight amount of fluid and elastomer compatible o-ring lubricant is recommended as an installation aid.

2. For metal diaphragm construction, insert camber adjusting washer (17.2) into cage (19) and allow to rest in the bottom of the cage (19).

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

b. **Type CP:**

1. Stretch o-ring energizer/seal (27.2) over lower circumference of piston-guide bearing (13), taking care not to “cut” o-ring energizer/seal (27.4). Using thumbs, work the o-ring energizer/seal (27.4) up and into the groove of the piston-guide bearing (13). **NOTE:** A very slight amount of fluid and elastomer compatible o-ring lubricant is recommended as an installation aid.

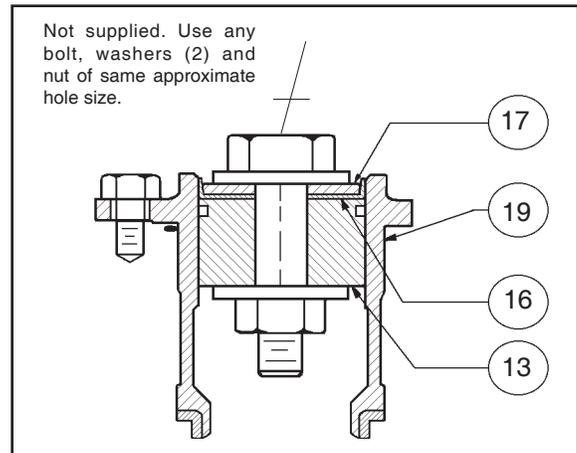


Figure 4

2. For metal diaphragm construction, insert camber adjusting washer (17.2) into cage (19) and allow to rest in the bottom of the cage (19).

3. Position TFE cap seal (27.1) ring with rectangular cross-section at end of piston-guide bearing (13). Stretch cap seal (27.1) over lower end of piston-guide bearing (13) using thumbs to work the cap seal (27.1) onto the piston-guide 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 piston-guide bearing (13).

4. Position piston-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 piston-guide bearing (13) into the cage (19), simultaneously use fingers to lightly press the cap seal (27.1) inwards into the groove of the piston-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).**

c. **Type CW:**

1. Stretch o-ring energizer/seal (27.2) over lower circumference of piston-guide bearing (13), taking care not to “cut” o-ring energizer/seal (27.4). Using thumbs, work the o-ring energizer/seal (27.4) up and into the groove of the piston-guide bearing (13). **NOTE:** *A very slight amount of fluid and elastomer compatible o-ring lubricant is recommended as an installation aid.*
2. Place wiper washer (17.1) into cage (19). Allow wiper washer (17.1) to rest on bottom of cage (19). Insert wiper seal (16) into cage (19) at an approximate 45° angled approach. The 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). The serrated face of the wiper washer (17.1) must contact the lower face of the wiper seal (16) when the valve plug (20) is inserted into the cage (19).
3. Position TFE cap seal (27.1) ring with rectangular cross-section at end of piston-guide bearing (13). Stretch cap seal (27.1) over lower end of piston-guide bearing (13) using thumbs to work the cap seal (27.1) onto the piston-guide 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 piston-guide bearing (13).
4. Position piston-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 piston-guide bushing (13) into the cage (19), simultaneously use fingers to lightly press the cap seal (27.1) inwards into the groove of the piston-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).**

d. **Type PW:**

1. Place wiper washer (17.1) into cage (19). Allow wiper washer (17.1) to rest on bottom of cage (19). Insert wiper seal (16) into cage (19) at an approximate 45° angled approach. The 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). The serrated face of the wiper washer (17.1) must contact the lower face of the wiper seal (16) when the valve plug (20) is inserted into the cage (19).
2. **NOTE:** *Piston ring assy (27.5) consists of one metal corrugated energizer and two piston ring seals.* Wrap corrugated metal piston ring energizer into the groove of piston-guide bearing (13).
3. Spread a piston ring seal and slide over lower circumference of piston-guide bearing (13). Using thumbs and fingers, work the piston ring seal into the groove of the piston-guide bearing (13). Repeat this procedure with a second piston ring seal. Orient the Z-cuts in the piston ring seals 180 degrees apart to minimize leakage by the piston ring assembly.
4. Position piston-guide bearing (13) over and into upper end of cage (19) until the lower piston ring seal touches the upper lip of the cage (19). While gently applying force to press the piston-guide bearing (13) into the cage (19), simultaneously use fingers to lightly circumferentially press the piston ring assembly (27.5) inwards into the piston-guide bearing (13) groove until the piston ring assembly (27.5) “slips into” the cage (19).

e. **Type UC:**

1. Insert seal retainer (17.3) into top of cage and allow to rest in bottom of the cage.
2. Position u-cup seal (27.3) over lower circumference of piston-guide bearing (13). Ensure that the u-cup seal (27.3) is oriented with the center-open-downwards as shown in Figure 1. The u-cup seal (27.3) depends upon the P1-Inlet Pressure to activate the seal for proper sealing action.

3. Position piston-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 piston-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 piston-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 its shoulder at the lower end of cage (19).
5. Composition Diaphragm Designs.
 - a. Place new o-ring lower stem seal (14.3) into groove of valve plug (20).
 - b. Insert valve plug (20) upwards through lower end of cage (19) and through the center hole in piston-guide bearing (13), also capturing camber adjusting washer (17.2), wiper washer (17.1) and wiper seal (16), if supplied. Hold plug (20) and cage (19) together.
 - c. This completes ITA reassembly.
6. Metal Diaphragm Designs.
 - a. Insert valve plug (20) upwards through lower end of cage (19) and through the center hole of camber adjusting washer (17.2) or wiper washer (17.1) and wiper seal (16).
 - b. Engage valve plug (20) with piston-guide bearing (13) threads and tighten manually as far as possible.
 - c. Place ITA into a vise and grasp at a hub location on the valve plug (20) that is not in the “spindle” zone. (See Figure 3.)
 - d. Using a special double-posted spanner wrench, (to order see NOTE in Section IX, Parts Ordering Information), tighten the piston-guide bearing (13) to the valve plug (20) with the following torque values. Do NOT allow valve plug (20) to rotate against seat ring (21) during tightening.

Recommended Torque values are:			
Body Size		Torque	
in	(DN)	ft-lbs	(N-m)
1/2" - 1"	(15-25)	30-50	(41-68)
1 1/4" - 2"	(32-50)	45-70	(61-95)

- e. This completes ITA reassembly.

F. Main Reassembly:

1. Place body (23) in a vise.
2. Reinstall internal sensing drilled plug (32) 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, taking care NOT TO “COCK” THE ITA IN THE BODY. Torque the cage bolts (18) to 13-15 ft-lbs (18-20 N-m).
7. Composition Diaphragm Designs:
 - a. For the following steps b.–h., the upper end of valve plug (20) **MUST** be manually held up if unit is not supplied with lower piston spring (22).
 - b. Place new o-ring middle stem seal (14.2) into groove of piston-guide bearing (13) upper surface.
 - c. Position lower diaphragm pusher plate (10) over upper end of valve plug (20) with tongue and groove “groove” on upper side.
 - d. Place new o-ring upper stem seal (14.1) into groove on lower diaphragm pusher plate (10).
 - e. Place diaphragm(s) (9) over end of valve plug (20). ***NOTE: For multiple diaphragms (9) that include TFE material, the TFE should be on wetted side.***
 - f. Place upper diaphragm pressure plate (8) over upper end of valve plug (20) with tongue and groove “ridge” on lower side.
 - g. Place anti-seize 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		Torque	
in	(DN)	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. Units with V-TFE & CTFE seat ring (21): Due to the relative "hardness" of the V-TFE & CTFE material, to obtain the best possible shutoff it is necessary to "coin" the V-TFE & CTFE with a permanent indentation.
 - a. Close-off the outlet connection.
 - b. The level of seat leakage can be quantified at the internal sensing drilled plug (32) for internal sensing units. For external sensing units, it will be necessary to remove the internal sensing plug (33).
 - c. Pressurize the valve's inlet with gas or air to 50 - 150 psig (3.5 - 10 Barg).
 - d. Using a soft-headed mallet (rubber, leather), sharply rap the top end of the plug (20) for composition diaphragm designs, or the piston-guide bearing (13) for metal diaphragm designs. (**NOTE:** Gas will escape as the plug (20) opens at the seat ring (21). Allow sufficient time for leakage pressure on outlet to bleed-off.) The hammer rap should be strong enough to "bounce" the plug (20) into the seat ring (21), leaving the "coined" indentation. Check for leakage at the internal sensing port with a leak detection fluid. One bubble per second is typical of Class IV shut off.
 - e. Repeat d. a minimum of 2 times until the best possible seat leakage is obtained.
 - f. After "coining" completed, remove gas pressure source, remove outlet closure, and reinstall plug (33) if removed.
 9. Metal Diaphragm Designs:
 - a. Install new diaphragm gasket (37) onto body (23) diaphragm flange.
 - b. Position diaphragm(s) (9) onto body's (23) diaphragm flange.
 - c. Position upper diaphragm pressure plate (8) onto center top of diaphragm(s) (9) with counterbore upwards.

10. Lubricate and install o-rings (34) into grooves on the adjusting screw (1).
11. Assembly of range spring and spring chamber:
 - a. Lubricate the threads of adjusting screw (1) then thread into the spring follower (5). The spring follower should be threaded up adjusting the screw to within 3/8" of the top threads (see sectional drawing, figure 5).
 - b. Insert adjusting screw-spring follower into spring chamber (4). **NOTE:** Milled slots in spring follower must align with ribs in the bore of the spring chamber. The top of the adjusting screw must fit in the center hole of spring chamber. A light rap with a wooden handle of a hammer may be needed to fully install the adjusting screw into the spring chamber.
 - c. Aligning match marks and bolt holes, place spring chamber (4) over range spring (6.1). If the spring chamber flange reaches the body flange without a gap, turn adjusting screw (1) CW 2-3 turns. Repeat this procedure until the flanges are approximately 1/8" apart. Be sure that range spring is properly seated into counterbore on spring follower. **NOTE:** For metal diaphragm construction, if flanges do not come together equally, the upper diaphragm pressure plate (8) may be off-center. Remove spring chamber (4) and reposition upper diaphragm pressure plate (8) until the spring chamber (4) comes down evenly on all sides.
12. Reinstall all flange bolts (11) and nuts (12) with nameplate (99) located under one bolt head. Hand-tighten nuts (12).

NOTE: If a three-ply diaphragm is being used, it is important that the diaphragm (9) is "preformed" – allow formation of a diaphragm (9) convolution. Starting with the body bolts and nuts (11, 12) hand tightened, "preforming" can be accomplished by any one of the following techniques:

 - a. Relax range spring fully by rotating adjusting screw CCW.
 - b. Apply 30 psig (2.1 Barg) pressure to the valve outlet.

OR

Block the valve outlet and apply 30 psig (2.1 Barg) under the diaphragm through the 1/4" NPT (plugged) external pressure sensing connection on the valve diaphragm flange.

 - c. Leave pressure on through tightening of bolting (11, 12).

13. Evenly tighten the body bolting (11,12) in an alternating cross pattern in one revolution increments to the following torque value:

Body Size		Torque	
in	(DN)	ft-lb	(N-m)
1/2" - 2"	(15-50)	30-35	(41-47)
2 1/2" - 4"	(65-100)	45-50	(61-69)

If supplied, remove pressure of previous Step 12.

G. Units with Supported Diaphragm Designs:

1. A supported diaphragm (9) construction is designated as Opt-81.
2. For a Model DA2 the only "special" part to be supplied is the support plate (35) fitted into a counter bore cut into the body (23).

H. Converting Internal/External Sensing:

1. Disassemble the regulator and remove the diaphragm(s) (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 (32) and install a solid pipe plug. Reverse this step for converting from external to internal sensing.
3. Reassemble the regulator according to Part F – Main Regulator Reassembly.

I. Pressure Testing:

1. Pressure Containment Test (External Leak Test.).
 - a. See Section III, last paragraph and Table 1 for restrictions.
 - b. Spray leak detection solution over the bolting, diaphragm edge, body, spring chamber and all other pressure boundary areas, during external leak test.
2. Inboard Leakage Test.
 - a. Release all range spring force by turning adjusting screw CCW.
 - b. Pressurize inlet to 50 psig (3.5 Barg) with air, GN₂.
 - c. Tube outlet to a beaker of water to observe number of escaping gas bubbles.
3. Excessive leakage will require disassembly, examination of sealing elements, correction of problem, reassembly and retesting. Leakage path may be via plug/seat or dynamic side seal. Before disassembling the regulator check the DAG-TB Table DAG-10 to determine the acceptable inboard leak rates of the seat and dynamic seal combination of the regulator.

SECTION VIII

VIII. 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 that 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.

Below 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. Unstable loading pressure.	D1. Stabilize loading pressure; i.e. pump, control valve, etc. D2. Air in loading piping. Vent spring chamber.

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 (conformation 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.

4. Diaphragm continually breaks (steam service regulators).

Possible Causes	Remedies
A. Stem seals (14) which protect fluorocarbon elastomer in diaphragm assembly may have deteriorated.	A. Replace with new stem seals (14).
B. Diaphragm nut (7) may not be torqued to proper value.	B. Confirm torque value in accordance with Section VII, paragraph F-7.
C. Diaphragm too stiff causing it to crack in service.	C. Follow proper preforming and air evacuation techniques during diaphragm installation in accordance with Section VII, paragraph F-12.

5. Diaphragm continually breaks (all regulators).

Possible Causes	Remedies
A. Differential pressure across diaphragm may have exceeded limits. (See Table 1)	A. Be aware of limits as well as where the various pressures are acting. Install pressure safety equipment as necessary.

6. Leakage at diaphragm flange.

Possible Causes	Remedies
A. Body bolts not torqued properly.	A. Torque to proper value (see Section VII, paragraph F-13).
B. Pressures at diaphragm may be too high for regulator design.	B. Consult factory.

7. Leakage across seat.

Possible Causes	Remedies
A. Contamination (debris) in regulator.	A1. Remove internals, clean and if necessary, replace sealing and seating elements.* A2. "Coin" seat if V-TFE or CTFE seat material.
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.
* Excess seat leakage may be diagnosed when a failure of the dynamic side seal has occurred. Inspect <u>both</u> potential internal leak paths.	

SECTION IX

IX. 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).

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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.

NOTE: *In addition to ordering repair parts, it is recommended that a special double-posted spanner wrench fitting be ordered for use in the maintenance of the ITA. See the following table for correct size:*

Double-Posted Spanner Wrench	
Body Size	Part Number
All	A96-75-9-P0459-00

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.

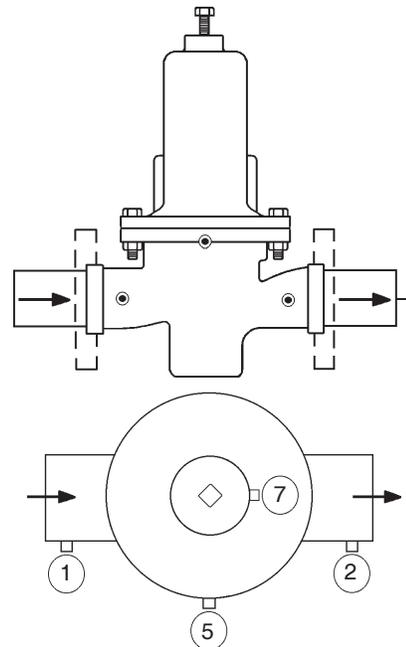


Figure 5: Location of Auxiliary Ports

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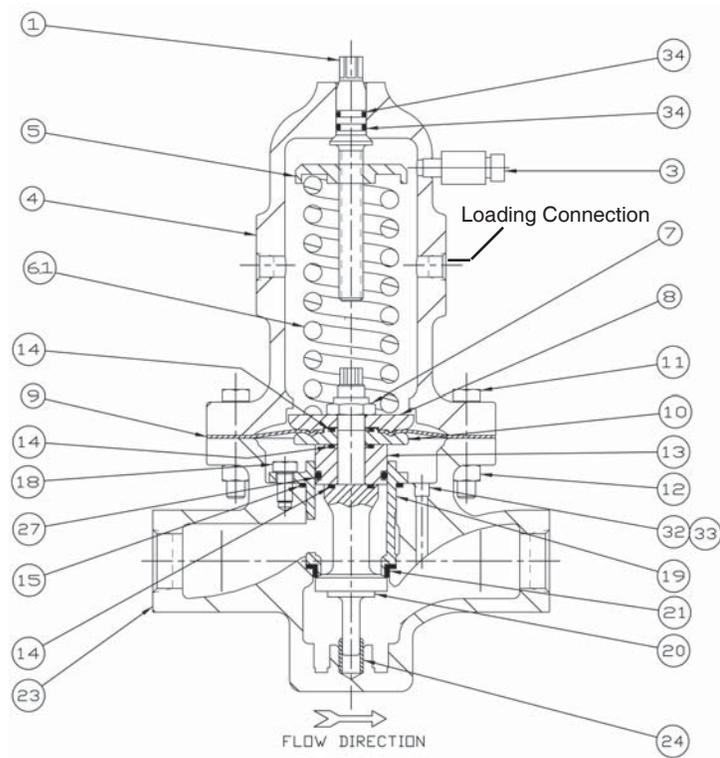


Figure 5
Composition Diaphragm
(w/Item 27.4 O-ring Seal)

Item No.	Description	Item No.	Description
1	Adjusting Screw	17.1	Wiper Washer
3	Bleeder Valve Assembly	18	Cage Cap Screws
4	Spring Chamber	19	Cage
5	Spring Follower (Button)	20	Valve Plug
6.1	Range Spring	21 ‡‡	Seat Ring
7**	Diaphragm Lock Nut	22	Lower Piston Spring (if supplied)
8	Upper Diaphragm Pressure Plate	23	Body
9 ‡‡	Diaphragm	24	Lower Guide Bushing
9.1 ***	Diaphragm (Material #1)	26	Tap Plug (Not Shown)
9.2 ***	Diaphragm (Material #2)	**27 ‡‡	Dynamic Side Seal
9.9 ***	Diaphragm TFE Cover	27.1	TFE Cap Seal
10 **	Lower Diaphragm Pusher Plate	27.2	O-ring Energizer/Seal
11	Flange Bolts	27.3	U-cup with Metal Energizer
* 12	Flange Bolt Nuts	27.4	O-ring Seal
13	Piston-Guide Bearing	27.5	Piston Ring Seal w/Metal Energizer
14 ‡‡	Stem Seals	32	Internal Sensing Plug (External Sensing Only)
14.1	Upper Stem Seal	33	Internal Sensing Drilled Plug (Internal Sensing Only)
14.2	Middle Stem Seal	34 ‡‡	Adjusting Screw O-ring
14.3	Lower Stem Seal	35	Support Plate (Not Shown)
15 ‡‡	Cage Seal		
16	Wiper Seal		

* Not required on 2" CS & SST Body Material.
 ** Reference Figure 1 for details of Item #27 - Dynamic Side Seal.
 *** Not utilized on metal diaphragm construction.

‡‡ Recommended Repair Parts

ATEX 94/9/EC: Explosive Atmospheres and Cashco Inc. Regulators



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.

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