

MODEL DA5

DA5 - DIRECT-ACTING, SPRING LOADED BACK PRESSURE REGULATOR

SECTION I

I. DESCRIPTION AND SCOPE

The Model DA5 is a spring operated back pressure regulator used to control upstream (inlet or P1) pressure. Sizes are 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. The Model DA5 is available in a more common "reverse" flow direction arrangement, that is balanced against outlet pressure variations, and a "standard" flow direction arrangement that is unbalanced. Refer to Technical Bulletin DA5-TB for design conditions and selection recommendations. (**NOTE:** This product was formerly identified as a Model D5 or Type V; a Model DA5, D5 and Type V are one and the same product.)

SECTION II

II. REFERENCES

Refer to Technical Bulletin DA5-TB and DAG-TB for technical specifications of a Model DA5 regulator.

ABBREVIATIONS

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

SECTION III

III. INSTALLATION

CAUTION

For welded installations, all internal trim parts, seals and diaphragm(s) must be removed from regulator body prior to welding into pipeline. The heat of fusion welding will damage non-metallic parts if not removed. NOTE: This does not apply to units equipped with extended pipe nipples.

1. Install per direction of flow arrow indicated on body, or "IN" and "OUT" markings.
2. 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 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 during initial startup.
3. Provide space below, above, and around regulator for removal of parts during maintenance.
4. Install block valves and pressure gauges to provide means for adjustment, operation, bypass, or removal of the regulator. A pipeline strainer is recommended upstream of inlet port to remove typical pipeline debris from entering valve and damaging internal "soft goods", primarily the dynamic side seal and V-TFE seat when applied.
5. Upstream 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 the factory with internal sensing. The regulator may be converted in the field to external sensing. (See Section VII maintenance, Part H – Converting Internal/External Sensing.
 - b. Reference DAG-TB, Table DAG-12 for recommendations for applying external pressure sensing.
 - c. 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" (DN8) NPT on the side of the body diaphragm flange (see following schematic) to a pressure tap upstream of the regulator.

A tubing outside diameter of 0.25 inch is adequate for short sensing lines (less than 4 feet). Use 3/8" tubing or 1/4" schedule 40 pipe for sensing lines of 5 to 50 feet.

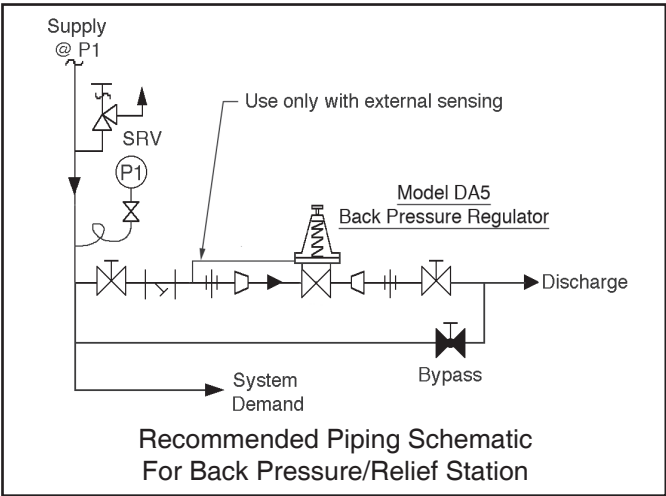
- d. For condensable vapors (i.e. steam) slope the external sensing line downward 2 to 5 degrees to inlet piping to prevent water pockets, which allows the diaphragm chamber to always be self draining. The external sensing line may be sloped upward for gas or liquid service; i.e. non-condensibles.

⚠ CAUTION

DO NOT HYDROSTATIC TEST THROUGH AN INSTALLED UNIT; ISOLATE REGULATOR FROM TEST. The upper range spring pressure level on the nameplate is the recommended "upper operating limit" for the sensing diaphragm. Higher pressures could cause internal damage. See Table 2 in DA5-TB for pressure limits of different diaphragm materials.

⚠ 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.



SECTION IV

IV. PRINCIPLE OF OPERATION

1. Movement occurs as pressure variations register on the diaphragm. The registering pressure is the inlet, P1, or upstream pressure. The range spring opposes diaphragm movement. As inlet pressure increases, the diaphragm pushes the range spring

up, lifting the valve plug further off the seat; as inlet pressure decreases, the range spring pushes the diaphragm down closing the valve plug toward the seat.

2. A complete diaphragm failure will cause the regulator to fail closed and process fluid will discharge from the spring chamber vent hole.

SECTION V

V. STARTUP

- 1 Start with the block valves closed.
2. Relax the range spring by turning the adjusting screw CCW (viewed from above) a minimum of three (3) full revolutions. This reduces the inlet (upstream) pressure set point.
3. Crack open manual bypass valve. Initially pressurize system while simultaneously controlling P₁ pressure through manual actuation of bypass valve.

trap operation if installed. Closely monitor inlet (upstream) 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).**

5. Open the outlet (downstream) block valve.
6. Slowly open the inlet (upstream) block valve to about 25% open, observing the inlet (upstream) pressure gauge. Determine if the regulator is flowing. If not, slowly rotate the regulator adjusting screw CCW (viewed from above) until flow begins.
7. When flow is established steady enough that the inlet (upstream) block valve can be fully opened, begin to slowly close the bypass valve if installed.
8. Develop system flow to a level near its expected normal rate, and reset the regulator set point by turning the adjusting screw CW to increase inlet pressure, or CCW to reduce inlet pressure.
9. Reduce system flow to a minimum level and observe pressure set point. Inlet pressure will de-

⚠ CAUTION

Do not walk away and leave a bypassed regulator unattended!

4. 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. Ensure proper steam

crease from the set point of Step 8. The maximum build in inlet pressure on increasing flow should not exceed the stated upper limit of the range spring

by greater than 30%. If it does, consult factory.

SECTION VI

VI. SHUTDOWN

1. Shutoff inlet block valve.
2. Remove range spring compression by turning the adjusting screw CCW to reduce the inlet pressure.

3. Shutoff the outlet block valve.
4. Relieve the trapped upstream and downstream pressure.
5. The regulator may now be removed from the pipeline or disassembled for inspection and preventative maintenance while in-line.

SECTION VII

VII. MAINTENANCE

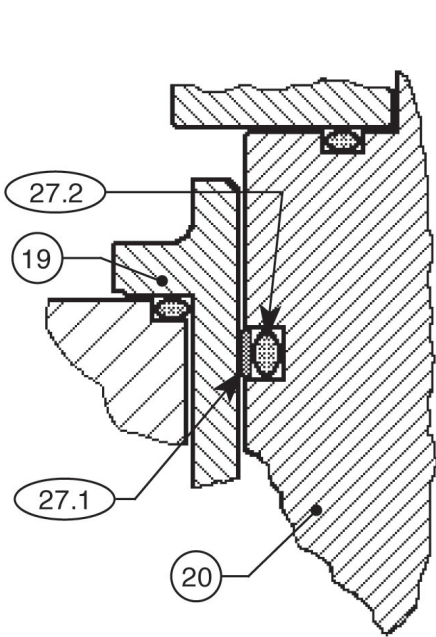
A. General:

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, KM Product Code, Serial Number.
3. Refer to Section IX for selection of recommended spare parts. Only use original equipment parts supplied by Cashco/KM 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 (ITA) is removed and replaced in the body (23) as an assemblage of parts. The ITA consists of the following parts:

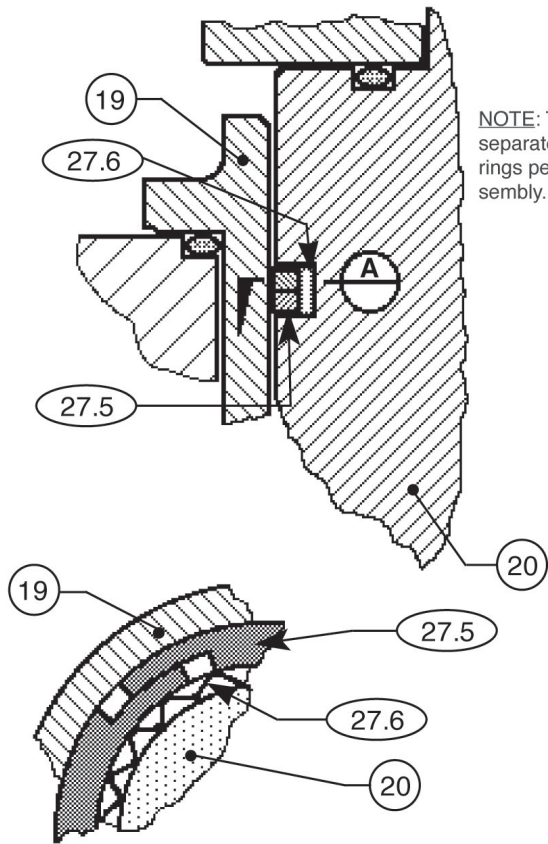
Item No.	Dynamic Side Seal Type	Part Description
7	All	Diaphragm Fastener (Cap Screw or Locknut)
8	All	Upper Diaphragm Pressure Plate
9	All	Diaphragm(s)
10	All	Lower Diaphragm Pusher Plate
13	All	Piston/Guide Bearing
14	All	Stem Seals
14.1	All	Upper Stem Seal
14.2	All	Middle Stem Seal
14.3	All	Lower Stem Seal
14.4	All	Lower Pusher Plate Gasket
20	All	Valve Plug
27	All	Dynamic Side Seal *
27.1	CP	TFE Cap Seal
27.2	CP	O-ring Energizer/Seal
27.3	UC	U-Cup Seal w/Metal Energizer
27.5	PR	Piston Ring Seal
27.6	PR	Piston Ring SST Energizer
28	All	Seat Disc
29	All	Seat Disc Washer
30	All	Seat Disc Nut

* The Dynamic Side Seal (27) and the Cage Seal (15) are omitted for the FTC flow direction regulator. This is Type NO. See Figure 1.
√ 2-1/2" thru 4" body sizes only.

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

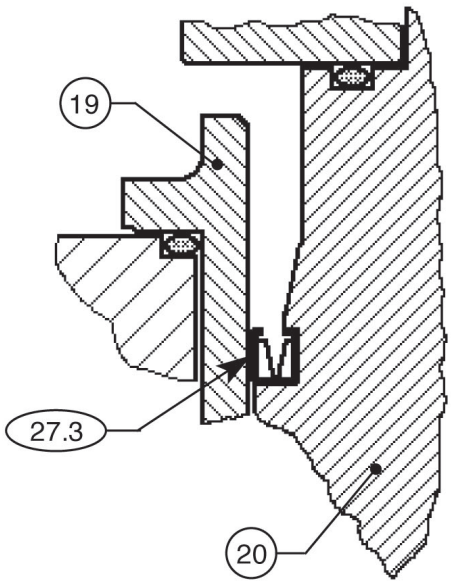


Type CP – TFE Cap Dynamic Seal

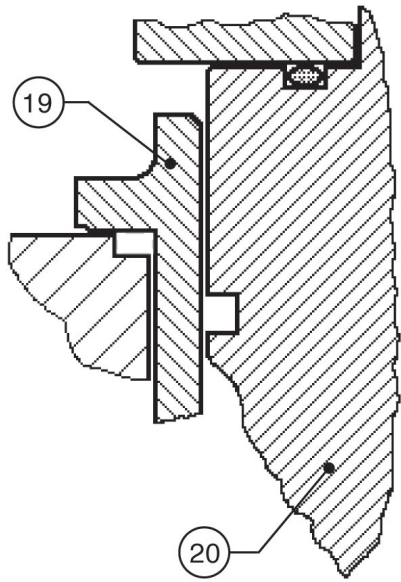


NOTE: Two separate piston rings per assembly.

Type PR – PRA Dynamic Seal



Type UC – U-Cup Dynamic Seal



Type NO – No Dynamic Seal

(FTC Flow Direction Only)

Figure 1: Dynamic Side Seals

B. Main Valve 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.*

* Includes external sensing connection if applicable.

1. Shut down the system in accordance with Section VI.
2. Disconnect the external sensing line, if installed.
3. Though it is possible to disassemble the regulator while installed in a pipeline, it is recommended that maintenance be done in a shop when possible. The descriptions hereafter will assume shop disassembly. Remove regulator from pipeline.
4. Place the body (23) in a vise with the spring chamber (4) oriented upwards.
5. Loosen adjusting screw lock nut (2) and relax range spring (6) forces by turning adjusting screw (1) CCW (viewed from above) until removed from spring chamber (4).
6. Loosen the diaphragm flange bolts (11) and nuts (12) uniformly.
7. Place matchmarks on body (23) and spring chamber (4) flanges. Completely remove bolting (11,12) Remove the spring chamber (4).
8. Remove spring follower (5) and range spring (6).
9. Grasp opposite edges of diaphragm (9) and withdraw the ITA from within the cage (19). Set the ITA aside.
10. Evenly loosen the cage cap screws (18) in single revolution increments until fully loosened; remove cage cap screws (18).
11. Pull cage (19) up and out of body.
12. Remove o-ring cage seal (15).
13. Remove lower cage gasket (21).
14. If supplied, remove internal sensing drilled plug (32) using 5/32" (4 mm) Allen key wrench for 1/2" - 2" size regulators. Use 3/16" Allen key wrench for 2 1/2" - 4" size regulators.

NOTE: Valves with "Large Internal Sensing" will not be equipped with any plug (32,33).

15. For metal diaphragm constructions, remove diaphragm gasket (37) from body (23) diaphragm flange.
16. Remove body (23) from vise. Solvent clean all removed metal parts.

C. Disassembly of the ITA:

1. Body Sizes 1/2" – 2". (See Figures 3 and 4):
 - a. Obtain two pieces of square-section barstock with a 3/8"-7/16" dimension, approximately 2 inches long.
 - b. Place plug (20) into a vise using the bars of a. above, use "flats" located on plug (20) to prevent vise jaw marks from direct surface contact with the plug (20). Orient with diaphragms on topside.
 - c. Sizes 1/2"-1": Remove diaphragm locknut (7) by rotating CCW.
Sizes 1-1/4"-2": Remove diaphragm cap-screw (7) by rotating CCW.
 - d. Remove upper diaphragm pressure plate (8).
 - e. Remove diaphragm(s) (9, 9.1, 9.2, 9.9). Examine diaphragm(s) to determine whether failed; determine if operating conditions are exceeding pressure drop or temperature limits.
 - f. For composition diaphragm construction, remove upper stem seal (14.1).
 - g. For metal diaphragm construction, remove lower pusher plate gasket (14.4).
 - h. Remove lower diaphragm pusher plate (10).
 - i. Remove middle stem seal (14.2).
 - j. Remove plug (20) from vise, rotate end-for-end, and re secure in vise using same metal bars above.
 - k. Loosen seat disc nut (30) CCW (viewed from above) approximately two (2) revolutions.
 - l. Remove assembly (20, 27, 28, 29, 30) from vise. Complete removal of seat disc nut (30), seat disc washer (29), and seat disc (28).
2. Body Sizes 2-1/2" – 4". (See Figure 2):
 - a. Place seat disc nut (30) into a vise with the plug (20) oriented vertically. **DO NOT** over-tighten nut (30) in vise.
 - b. Place closed-end hex wrench onto diaphragm locknut (7). Place socket wrench on hex upper end of plug (20). Loosen diaphragm locknut (7) while holding plug (20) from rotating by socket wrench.

- Remove diaphragm locknut (7) after fully loosened and socket wrench is removed.
- c. Remove upper diaphragm pressure plate (8).
- d. Remove diaphragm(s) (9, 9.1, 9.2, 9.9). Examine diaphragm(s) to determine whether failed; determine if operating conditions are exceeding pressure drop or temperature limits.
- e. Remove upper stem seal (14.1).
- f. Remove lower diaphragm pusher plate (10).
- g. Remove middle stem seal (14.2).
- h. Remove piston/guide bearing (13) with dynamic side seal (27) in place.
- i. Remove lower stem seal (14.3).
- j. Place socket wrench on upper end of plug (20) as in Step b. above. Rotate plug (20) CCW (viewed from above) to loosen seat disc nut (30). Once nut (30) is loosened, remove partial assembly (20, 27, 28, 29, 30) from vise. Complete removal of seat disc nut (30), seat disc washer (29) and seat disc (28).

3. Examine the components (27.1, 27.2, 27.3, 27.5, 27.6) of the dynamic side seal (27) 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 from plug (20) for sizes 1/2" – 2", or from piston/guide bearing (13) for sizes 2-1/2" – 4". Special care should be taken when using "tools" to remove the components to ensure that no scratches are imparted to any portion of the plug (20) or piston/guide bearing (13) groove.

4. Solvent clean all metal parts to be reused.

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, etc.). Metal diaphragms should always be replaced. 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 Finish & Dimensional Requirements:
 - a. Valve plug (20);
 1. No major defects on plug's (20) bottom guide spindle, or at guide area near dynamic seal groove.
 - b. Cage (19);
 1. 16 rms finish on cylinder bore. No "ledges" formed due to wear from moving dynamic side seal (27).
 2. 16 rms finish on its seating surface for tight shutoff.
 - c. Lower guide bushing (24);
 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). Drill out as required.
 - e. Piston/Guide Bearing (13)(2-1/2"-4" only);
 1. No defects at guide area near dynamic seal groove.
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. Position valve plug (20) with seat disc-end upwards. Place new seat disc (28) into recess of lower end of valve plug (20) properly oriented.
2. Position seat disc washer (29) next to seat disc (28).
3. Engage seat disc nut (30) to secure washer (29) and seat disc (28) to valve plug (20). Firmly hand-tighten.
4. Body Sizes 1/2" thru 2":
 - a. Using the two square-section metal bar-stock pieces of VII.C.1.a., clamp the plug (20) into a vise with the plug's (20) spindle pointed upwards.
 - b. Using a torque wrench, tighten the seat disc nut (30) to 20-35 ft-lbs. by rotating CW.
 - c. Remove assembly (20, 28, 29, 30) from vise and rotate end-for-end and re secure

in vise using same metal bars.

5. Body Sizes 2-1/2" thru 4":

- a. Orient plug (20) with threaded end upwards, place into a vise, grasping the seat disc nut (30); tighten the vise *lightly*, only enough to "hold" the plug (20) from rotating out of the vise. **Caution:** Over-tightening the vise can distort the seat disc nut (30) and give bad final torque values.
- b. Place a torque wrench on the 3/4" hex upper end of the plug (20); tighten the seat disc nut (30) to 40-60 ft-lbs by rotating CW.

6. Installation of dynamic side seal (27) (See Figure 1): **NOTE:** *Dynamic side seal (27) for sizes 2-1/2"-4" is located on the piston/guide bearing (13). The dynamic side seal can be installed on a work bench without need of a vise.*

a. Type CP:

1. Stretch o-ring energizer/seal (27.2) over lower circumference of valve plug (20), 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 valve plug (20). **NOTE:** *A very slight amount of fluid and elastomer compatible lubricant is recommended as an installation aid. DONOT "ROLL" O-RING.*
2. Position TFE cap seal (27.1) ring with rectangular cross-section at lower end of valve plug (20). Stretch cap seal (27.1) over lower end of valve plug (20) using thumbs to work the cap seal (27.1) onto the valve plug (20). **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 valve plug (20).

b. Type PR:

1. Wrap corrugated metal piston ring energizer (27.6) over lower circumference groove of valve plug (20). Using thumbs work the energizer (27.6) into the valve plug (20) groove.
2. Spread a piston ring seal (27.5) and slide over lower circumference groove of valve plug (20), taking care not to "cut" piston ring seal (27.5). Using thumbs, work the piston ring seal (27.5) into the groove of the valve plug (20). Repeat this procedure with a

second piston ring seal (27.5). Orient/rotate the "splits" in piston ring seals (27.5) 180° across from each other.

c. Type UC:

1. Stretch u-cup seal (27.3) over upper circumference of valve plug (20), taking care not to "cut" u-cup seal (27.3) on the protruding shelf that is part of the valve plug's (20) groove. Ensure that the u-cup seal (27.3) is oriented with the center-open-upwards 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.

d. Type NO:

1. For "FTC" flow direction applications, it is not required that a dynamic side seal (27) be installed. (When included with the dynamic seal (27), better guiding of valve plug (20) results.) Type "NO" dynamic seal (27) means **NO** dynamic seal.
2. The **more common** "FTO Reverse" flow direction always requires a dynamic side seal (27).

7. Place fluid compatible thread anti-seize, Loctite Corp., "Nickel Anti-Seize", or equal on threaded portion of diaphragm cap screw (7), sizes 1-1/4" and 1-1/2"; or, threaded post portion of valve plug (20), sizes 1/2" – 1" and 2-1/2" – 4". (**NOTE:** *Regulators cleaned for oxygen service should use Fisher Scientific Co., "Fluorolube GR-362", or equal.*)

8. Body sizes 2-1/2" thru 4".

- a. Place o-ring lower stem seal (14.3) over upper-end of plug (20) and into groove in plug (20).
- b. Place properly oriented piston/guide bearing (13) over upper-end of plug (20) and into position on plug (20).
- c. Place o-ring middle seal (14.2) over upper-end of plug (20) and into groove of piston/guide bearing (13).

9. Body sizes 1/2" thru 2".

Place new o-ring middle stem seal (14.2) into groove of valve plug (20) upper surface.

10. Position lower diaphragm pusher plate (10) on/over upper end of valve plug (20) properly oriented. For composition diaphragm construction the "tongue and groove" "ridge" should be on upper side, "flat" side downwards. For

metal diaphragm construction the "rounded" surface of the lower diaphragm pusher plate (10) should be on upper side, "flat" side downwards.

11. For composition diaphragm construction, place new o-ring upper stem seal (14.1) on/over upper end of valve plug (20) and into groove of lower diaphragm pusher plate (10).
12. For metal diaphragm construction, place compatible gasket sealant on both sides and place new lower pusher plate gasket (14.4) on/over upper end of valve plug (20) and onto lower diaphragm pusher plate (10). (Gasket sealant is Federal Process Corp. "Gasolite", or equal.) A Teflon gasket (37) may alternatively be fitted between diaphragm and flange of body.
13. Position new diaphragm(s) (9) on/over upper end of valve plug (20). **NOTE:** For multiple diaphragms (9) that include TFE material, the TFE should be on the wetted side; for 3-ply elastomeric TFE diaphragm (9), stackup is TFE-HK-TFE, beginning with the lower wetted diaphragm (9) first.
14. Position upper diaphragm pressure plate (8) on/over upper end of valve plug (20) properly oriented. For composition diaphragm construction the "tongue and groove" "ridge" should be on lower side, "flat" side upwards. For metal diaphragm construction the "rounded" surface of the upper diaphragm pressure plate (8) should be on lower side, "flat" side upwards.
15.
 - a. Body sizes 1/2" thru 1": Engage diaphragm locknut (7) to threaded post portion of valve plug (20) and torque to 60-70 ft-lbs. by rotating CW.
 - b. Body Sizes 1-1/4" thru 2": Insert anti-seize coated diaphragm cap screw (7) through stacked parts (8, 9, 10, 14.1, 14.4) and into upper end of valve plug (20). Torque-tighten diaphragm cap screw (7) to 120-130 ft-lbs.
 - c. Body Sizes 2-1/2" thru 4": Engage diaphragm lock nut (7) to threaded post of valve plug (20) and wrench-tighten firmly. While restraining valve plug (20) from rotating by torque wrench on upper end 3/4" hex, use another wrench to tighten diaphragm locknut (7) to a torque of 180 - 200 ft-lbs.

16. This completes assembly of ITA; remove from vise.

F. Main Reassembly:

1. Place body (23) in a vise.
2. Reinstall internal sensing drilled plug (32) with compatible thread sealant.
3. Fit the o-ring cage seal (15) into its body (23) groove for reverse flow regulators.
4. For metal diaphragm construction, place sealant ("Gasolite" or equal) on both sides of diaphragm gasket (37) and position on body (23) diaphragm flange.
5. Position properly oriented lower cage gasket (21) onto lower shoulder of cage (19).
6. Insert cage (19) into body (23) recess. Properly align all three cage bolt (18) holes as there is only one circumferential location possible for this alignment. Engage all of the cage bolts (18), then evenly screw in the cage bolts in one-half revolution increments, taking care **NOT TO "COCK" THE CAGE (19) IN THE BODY**. Torque the cage bolts (18) to 13-15 ft-lbs.
7. Dynamic Side Seals:
 - a. Type CP: Position the ITA's valve plug (20) lower end 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 valve plug (20) into the cage (19), simultaneously use hand thumbs to lightly press the cap seal (27.1) inwards into the groove of the valve plug (20) 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.
 - b. Type PR: Position the ITA's valve plug (20) lower end over and into upper end of cage (19) until the lower piston ring seal (27.5) touches the upper lip of the cage (19). While gently applying force to press the valve plug (20) into the cage (19), simultaneously use fingers to lightly circumferentially press the first (lower) piston ring seal (27.5) inwards into the valve plug (20) groove until the first piston

- ring seal (27.5) “slips into” the cage (19). Repeat for the second piston ring seal (27.5)
- c. **Type UC:** Position the ITA's valve plug (20) lower end 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 valve plug (20) into the cage (19), simultaneously use hand thumbs to lightly press the u-cup seal (27.3) inwards into the groove of the valve plug (20) 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).**
 - d. **Type NO:** Position the ITA's valve plug (20) lower end over and into the cage (19), allowing plug (20) to enter fully.
8. For composition diaphragm construction, align diaphragm (9) bolt holes with body (23) diaphragm bolt holes.
 9. Place a small amount of heavy grease into the adjusting screw (1) threaded opening of spring chamber (4). Reengage both adjusting screw (1) and its lock nut (2) with spring chamber (4). Allow end of adjusting screw to protrude into interior approximately 1/2 inch.
 10. Place range spring (6) centered on upper diaphragm pressure plate (8).
 11. Place a dab of heavy grease in the recess of the spring follower (5). Place spring follower on upper end of range spring (6).
 12. Aligning matchmarks and bolt holes, place spring chamber (4) over range spring (6). If spring chamber (4) flange reaches body (23) flange without a gap, remove and lower adjusting screw (1) deeper into spring chamber (4) cavity another 1/4 inch. Repeat this procedure until the adjusting screw (1) keeps the two flanges from touching by approximately 1/8 inch.
 13. 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” – pulled together to remove as much entrapped air as possible and 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. Apply 30-50 psig pressure to the regulator inlet and the regulator outlet.
OR
 - b. Block the valve inlet and outlet and apply 30-50 psig under the diaphragm through the 1/4" NPT external pressure sensing connection on the valve diaphragm flange.
AND
 - c. Leave pressure on through tightening of bolting (11,12).
14. 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 13.

G. 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.

H. Pressure Testing:

1. If a hydrostatic pressure test is performed, pressure must be applied uniformly to the spring chamber, inlet and outlet of body.
2. Inboard Leakage Test (Seat + Dynamic Seal Leakage).
 - a. Determine test pressure. If upper value of range spring is less than 55 psig, use test pressure of 5 psig less than upper value of range spring. If upper value of range spring is greater than 55 psig, use

CAUTION

DO NOT HYDROSTATICALLY TEST WITHOUT SPRING CHAMBER PRESSURIZED. NOT ADHERING WILL DO PHYSICAL INTERNALS DAMAGE THAT COULD RENDER THE UNIT INOPERABLE.

- test pressure of 50 psig.
- b. While applying GN₂ or air pressurization fluid, turn adjusting screw CCW until valve appears to be closed. Add one additional revolution CCW to adjusting screw.
 - c. Tube outlet to a beaker of water to observe number of escaping gas bubbles.
3. Pressure Containment Test.
- a. Pressurize inlet and outlet to 1.0 x Upper Value of Range Spring or 30 psig with air or GN₂, whichever is higher.
 - b. Soap solution test all external leak points; plugged connections, diaphragm flange, diaphragm bolting and spring chamber

vent opening.

4. Excessive leakage will require disassembly, examination of sealing elements, correction of problem, reassembly and retesting. **NOTE:** *This valve is NOT a bubble-tight shutoff device. See DAG-TB, Table DAG-10 for leakage classes.*

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.

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

1. Erratic regulation, instability or hunting.

Possible Causes	Remedies
A. Sticking of internal parts.	A. Remove internals, clean, and if necessary, replace.
B. Load changes are too quick for system.	B. Convert to external sensing (if necessary) and install a 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.

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. Upstream pressure too high.

Possible Causes		Remedies	
A.	Debris in trim preventing movement.	A.	Clean unit of debris.
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, which protect fluorocarbon elastomer in diaphragm assembly, may have deteriorated.	A.	Replace with new seals.
B.	Diaphragm nut may not be torqued to proper value.	B.	Confirm torque value in accordance with Section VII, paragraph E-15.
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-13.

5. Diaphragm continually breaks (all regulators).

Possible Causes		Remedies	
A.	Differential pressure across diaphragm may have exceeded limits.	A.	Reference limits as recorded in technical bulletin DA5-TB, as well as where the various pressures are acting.

6. Leakage at diaphragm flange.

Possible Causes		Remedies	
A.	Body bolts not torqued high enough.	A.	Torque to proper value (see Section VII, paragraph F-14).

7. Leakage across seat or dynamic side seal.

Possible Causes		Remedies	
A.	Contamination (debris) in regulator.	A.	Remove internals, clean, and if necessary, replace regulator.
B.	Oversized regulator.	B.	Check actual flow conditions; resize regulator for minimum and maximum flow; if necessary, replace with smaller regulator.

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.

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.

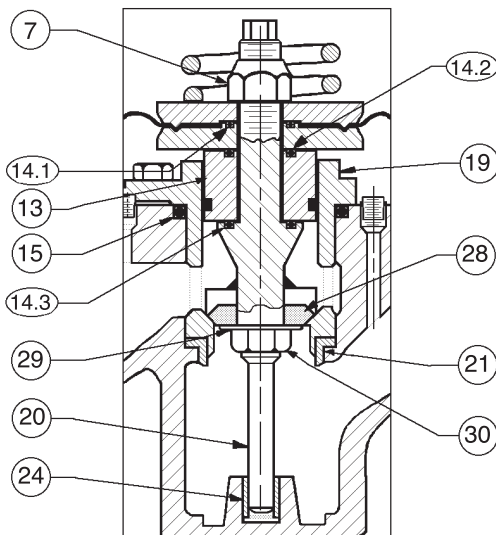
NOTE: Those part numbers that have a quantity indicated under "Spare Parts" in column "A" reflect minimum parts required for inspection and rebuild, - "Soft Goods Kit". Those in column "B" include minimum trim replacement parts needed plus those "Soft Goods" parts from column "A".

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.



<u>Item No.</u>	<u>Description</u>
7	Diaphragm Cap Screw
13	Piston/Guide Bearing
14	Stem Seals
14.1	Upper Stem Seal
14.2	Middle Stem Seal
14.3	Lower Stem Seal
15	Cage Seal
19	Cage
20	Valve Plug
21	Lower Cage Gasket
24	Lower Guide Bushing
28	Seat Disk
29	Seat Disk Washer
30	Seat Disk Nut

Figure 2: Body Sizes
2-1/2" – 4", Composition Diaphragm
FTO – Reverse Flow Direction

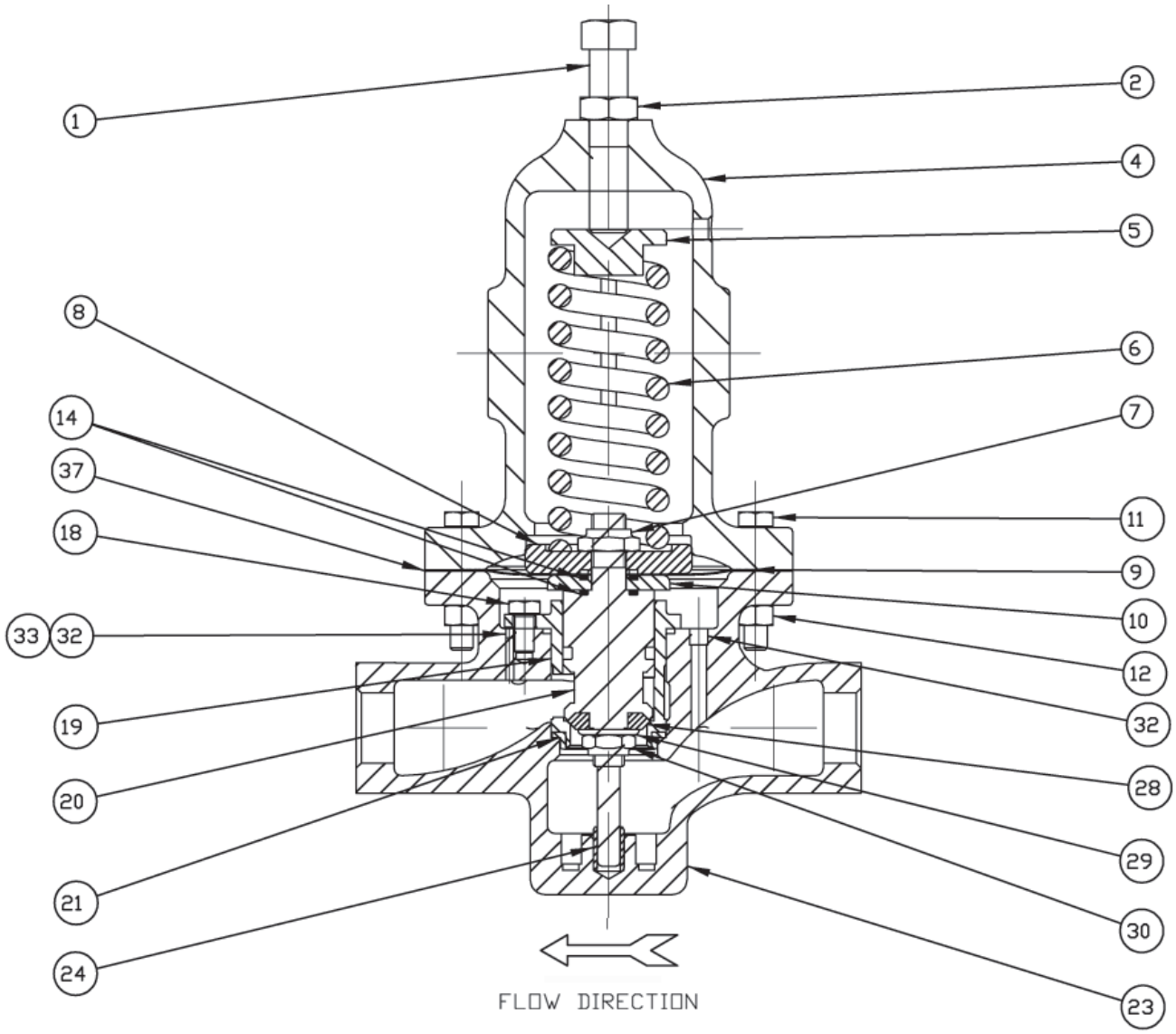


Figure 3
Metal Diaphragm
FTO – Flow To Open

<u>Item No.</u>	<u>Description</u>	<u>Item No.</u>	<u>Description</u>
1	Adjusting Screw	18	Cage Cap Screws
2	Adjusting Screw Lock Nut	19	Cage
4	Spring Chamber	20	Valve Plug
5	Spring Follower (Button)	21 ‡‡	Seat Ring
6	Range Spring	23	Body
7	Diaphragm Lock Nut	24	Lower Guide Bushing
8	Upper Diaphragm Pressure Plate	26	Tap Plug (Not Shown)
9 ‡‡	Diaphragm	28 ‡‡	Seat Disc
9.1	Diaphragm (Material #1)	29	Seat Disc Washer
9.2	Diaphragm (Material #2)	30	Seat Disc Nut
10	Lower Diaphragm Pusher Plate	32	Internal Sensing Plug (External Sensing Only)
11	Flange Bolts	33	Internal Sensing Drilled Plug (Internal Sensing Only)
12 *	Flange Bolting Nuts	37	Diaphragm Gasket
14 ‡‡	Stem Seal	99	Name Plate (Not Shown)
14.2	Middle Stem Seal		
14.4	Lower Pusher Plate Gasket		

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

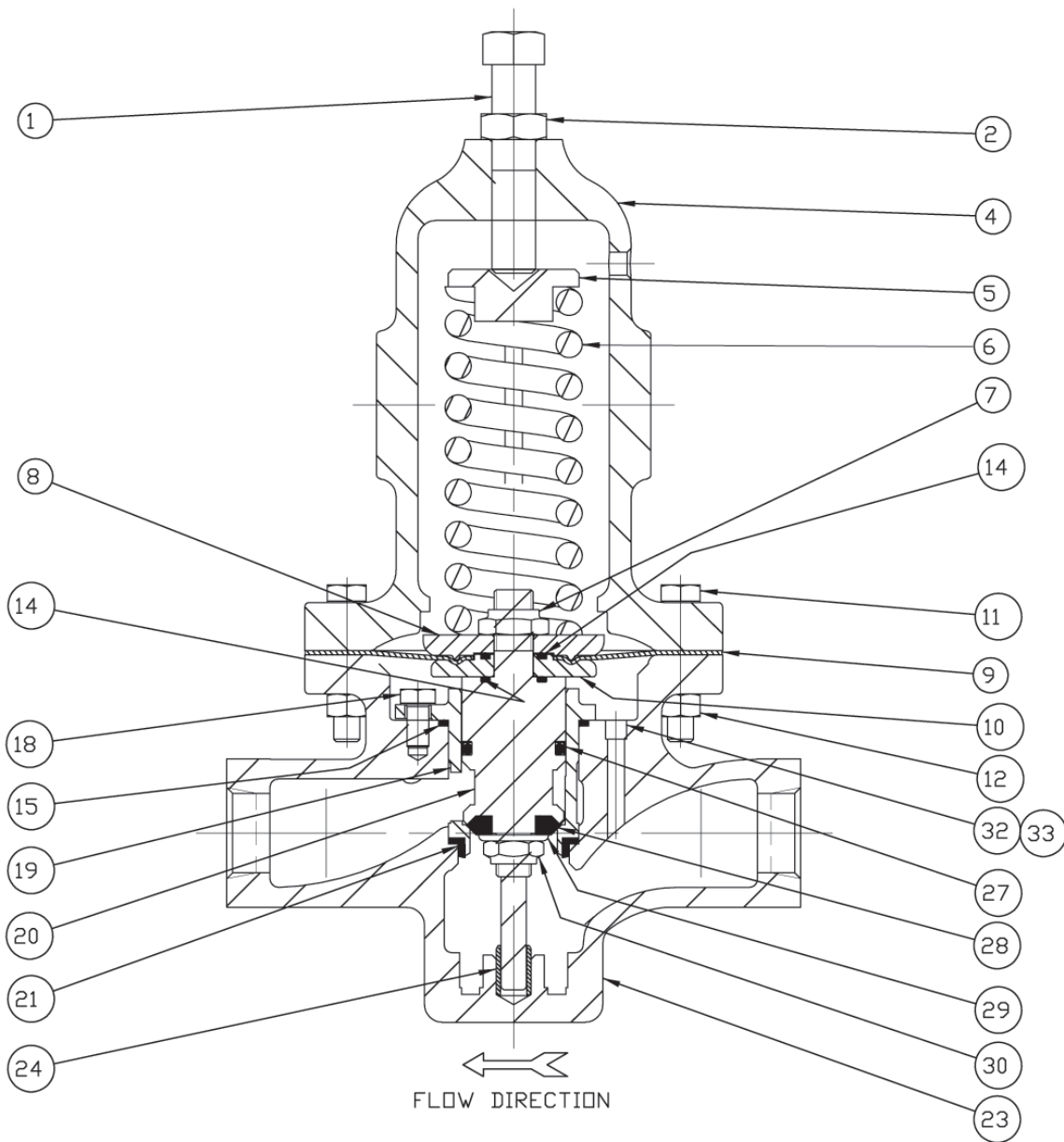


Figure 4
Composition Diaphragm
FTO – Flow to Open
Reverse Flow Direction

<u>Item No.</u>	<u>Description</u>	<u>Item No.</u>	<u>Description</u>
1	Adjusting Screw	19	Cage
2	Adjusting Screw Lock Nut	20	Valve Plug
4	Spring Chamber	21 ‡‡	Lower Cage Gasket
5	Spring Follower (Button)	23	Body
6	Range Spring	24	Lower Guide Bushing
7	Diaphragm Cap Screw or Diaphragm Lock Nut	26	Tap Plug (Not Shown)
8	Upper Diaphragm Pressure Plate	27 ‡‡	Dynamic Side Seal
9 ‡‡	Diaphragm	27.1	TFE Cap Seal
9.1	Diaphragm (Material #1)	27.2	O-ring Energizer/Seal
9.2	Diaphragm (Material #2)	27.3	U-cup with Metal Energizer
9.9	Diaphragm TFE Cover	27.5	Piston Ring Seal
10	Lower Diaphragm Pusher Plate	27.6	Piston Ring Energizer
11	Flange Bolts	28 ‡‡	Seat Disc
12 *	Flange Bolting Nuts	29	Seat Disc Washer
14 ‡‡	Stem Seal	30	Seat Disc Nut
14.1	Upper Stem Seal	32	Internal Sensing Plug (External Sensing Only)
14.2	Middle Stem Seal	33	Internal Sensing Drilled Plug (Internal Sensing Only)
15 ‡‡	Cage Seal		
18	Cage Cap Screws	99	Nameplate (Not Shown)

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

‡‡ Recommended Repair Parts



IOM ADDENDUM:

ATEX DIRECTIVE 2014/34/EU and THE EQUIPMENT AND PROTECTIVE SYSTEMS INTENDED FOR USE IN POTENTIALLY EXPLOSIVE ATMOSPHERES REGULATIONS 2016

Cashco, Inc. declares that the products listed in the table below has been found to comply with the Essential Health and Safety Requirements relating to the design and construction of products intended for use in potentially explosive atmospheres given in Annex II of the ATEX Directive 2014/34/EU and given in Schedule 1 of The Equipment and Protective Systems Indented for Use in Potentially Explosive Atmospheres Regulations 2016. Compliance with the Essential Health and Safety Requirements has been assured by compliance with EN ISO 80079-36:2016 and EN ISO 80079-37:2016. The product will be marked as follows:



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

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

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

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