

MODEL SAP

ULTRA HIGH PURITY, PRESSURE LOADED PRESSURE REDUCING REGULATOR

SECTION I

I. DESCRIPTION AND SCOPE

Model SAP is a piston operated, pressure reducing regulator used to control downstream (outlet or P₂) pressure. Sizes are 3/4" (DN20), 1" (DN25), 2" (DN50), 3" (DN80) and 4" (DN100).

II. REFERENCES

SECTION II

Refer to Technical Bulletin SAP-TB for technical specifications.


ABBREVIATIONS

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

SECTION III


CAUTION

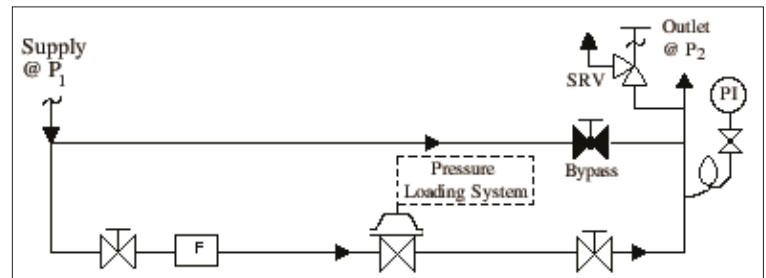
Installation of adequate overpressure protection is recommended to protect the regulator and all downstream equipment from damage in the event of regulator failure.


CAUTION

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

III. INSTALLATION

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 orientation is with the loading chamber (4) upwards.
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 UHP filter is recommended before inlet to remove typical pipeline debris from entering valve and damaging internal "soft goods", primarily the dynamic seal and valve seat.



Recommended Piping Schematic
for Pressure Reducing Station

NOTE: This unit only comes as internal sensed and no sense line should be connected.

SECTION IV

IV. PRINCIPLE OF OPERATION

1. When a loading pressure – P_{Load} – is applied to the top side of a guide bearing, the outlet controlled pressure – P_2 – will balance at approximately .90 – .98 of the loading pressure - P_L . (**NOTE:** *Fluctuations in P_1 – Inlet Pressure will cause a deviation in P_2 – Outlet Pressure due to inverse sympathetic ratio effect.*)
2. Movement occurs as pressure variations register on the guide bearing. The registering pressure is the outlet, P_2 , or downstream pressure. The loading pressure fluid opposes upward movement. As outlet pressure drops, the loading pressure pushes the guide bearing down, opening the port; as outlet pressure increases, the guide bearing pushes up and the port opening closes.
3. A loss of loading pressure while inlet pressure is imposed will cause the regulator to fail close.

SECTION V

V. STARTUP

1. Start with the block valves closed.
2. Adjust the loading system pressure control device so that main regulator is trying to be controlled at 0 psig pressure.
3. If it is a “hot” piping system, and equipped with a bypass valve, slowly open the bypass valve to preheat the system piping and to allow slow expansion of the piping. Closely monitor outlet (downstream) pressure via gauge to ensure not over-pressurizing. **NOTE:** *If no bypass valve is installed, extra caution should be used in starting up a cold system; i.e. do everything slowly.*
4. Crack open the outlet (downstream) block valve to approximately 10% full open.
5. Slowly open the inlet (upstream) block valve to about 25% open, observing the outlet (downstream) pressure gauge. Determine if the regulator is flowing. If not, slowly increase the loading pressure into the cover dome until flow begins.
6. Continue to slowly open the inlet (upstream) block valve until fully open.
7. Continue to slowly open the outlet (downstream) block valve, especially when the downstream piping system isn’t pressurized. If the outlet pressure exceeds the desired pressure, close the inlet block valve and go to Step 2. Close bypass valve approximately 25%, and repeat procedure.
8. When flow is established steady enough that the outlet (downstream) block valve is fully open, begin to slowly close the bypass valve if installed.
9. Develop system flow to a level near its expected normal rate, and reset the regulator set point by increasing the loading pressure to increase outlet pressure, or decreasing the loading pressure to reduce outlet pressure.
10. Reduce system flow to a minimum level and observe pressure set point. Outlet pressure will rise from the set point of Step 9. The maximum rise in outlet pressure on decreasing flow should not exceed the stated upper limit of the range spring by greater than 10%. If it does, consult factory.



CAUTION

Do not walk away and leave a bypassed regulator unattended!

VI. SHUTDOWN

1. Shutoff auxiliary loading pressure source. Close inlet block valve.
2. Allow sufficient time for the line pressure downstream of the inlet block valve to bleed down.
3. Close the outlet block valve.
4. Relieve the trapped upstream and downstream pressure and any loading pressure.
5. The regulator may now be 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, Product Code, and Serial Number.
3. Refer to Section IX 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. seals, etc.

B. Main Regulator Disassembly:



WARNING

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

1. Shut down system in accordance Section VI.
2. Disconnect loading pressure supply line from loading chamber. Loosen cover bolts (12) and nuts (11) uniformly and remove from regulator.
3. Place matchmarks on body (23) and loading chamber (4) flanges. Remove the loading chamber by lifting vertically. **NOTE:** Seal (28) may fall out of loading chamber recess.

C. To replace the guide bearing and dynamic seals and plug o-ring:

For 3/4" - 1" Sizes:

4. Rotate cap screws (38) CCW and remove. Lift seal retainer (36) up to remove seal (35).
5. Grasp the upper part of the plug (20) with a wrench and with a second wrench rotate nut (40) CCW to remove nut.
6. Using hands, grasp guide bearing (13) and lift upwards to remove. Slide dynamic seal (27)

off end of guide bearing and replace with new seal. Ensure seal's u-cup is oriented with the center-open-downwards as shown in Figure 1, as the u-cup seal depends upon the inlet pressure to activate proper sealing action.

7. Carefully remove o-ring (39) from shoulder of plug and replace with new o-ring.
8. Reposition the guide bearing (13) over end of plug and carefully slide it down into the cage. Place a new u-cup seal (35) with the center-open-upwards into the recess at the top of the guide bearing.
9. Place the seal retainer (36) on top of the guide bearing and engage cap screws (38) tight into the guide bearing.
10. Thread nut (40) on to plug threads and tighten: Sizes - 3/4" - 1" Torque 60-70 ft. lbs.
11. Place new loading chamber seal (28) in recess in the body flange face. Set loading chamber on top of body. Align matchmarks from step B.3. and insert nuts and bolts (11 & 12). Tighten bolting equally in a star pattern - torque to 35-40 ft. lbs.

For 2" Size:

4. Grasp the upper part of the plug (20) with a wrench and with a second wrench rotate nut (40) CCW to remove nut.
5. Lift seal retainer (36) up and over threaded end of plug (20) to remove piston seal (35).
6. Using hands, grasp guide bearing (13) and lift upwards to remove. Slide dynamic seal (27) off end of guide bearing and replace with new seal. Ensure seal's u-cup is oriented with the center-open-downwards as shown in Figure 1, as the u-cup seal depends upon the inlet pressure to activate proper sealing action.
7. Carefully remove o-ring (39) from shoulder of plug and replace with new o-ring.
8. Reposition the guide bearing (13) over end of plug and carefully slide it down into the cage. Place a new u-cup seal (35) with the center-open-upwards into the recess at the top of the guide bearing.
9. Place the seal retainer (36) on top of the guide bearing.

10. Thread nut (40) on to plug threads and tighten: Torque 120-130 ft. lbs.
11. Place new loading chamber seal (28) in recess in the body flange face. Set loading chamber on top of body. Align matchmarks from step B.3. and insert nuts and bolts (11 & 12). Tighten bolting equally in a star pattern - Torque to 35-40 ft. lbs.

For 3" & 4" Sizes:

4. Place hands around O.D. of the cage (19) and lift the complete guide bearing and plug sub-assembly out of the body. Secure the lower part of the valve plug (20) in a bench vise; grasp in "smooth jaws" directly under plug's seating disc portion on hub "flats" provided. Do not hold on the machined surface in the plug's spindle area.
5. Use a wrench to rotate cap screw (40) CCW and remove.
6. Lift retainer (36) up and over threaded end of plug (20). Remove seal (35) and o-ring (41).
7. Using hands grasp the guide bearing (13) and lift upwards to remove. Slide dynamic seal (27) off end of guide bearing and replace with new seal. Ensure seal's u-cup is oriented with the center-open-downwards as shown in Figure 1, as the u-cup seal depends upon inlet pressure to activate proper sealing action.
8. Carefully remove o-ring (39) from shoulder of plug and replace with new o-ring.
9. Place a new u-cup seal (35) with the center-open-upwards into the recess at the top of the guide bearing. Reposition the guide bearing (13) over end of plug and carefully slide it down into the cage.
10. Place the seal retainer (36) on top of the guide bearing. Engage cap screw (40) tight onto the guide bearing. Torque to 180 - 200 ft. lbs.
11. Place new loading chamber seal (28) in recess in the body flange face. Place new o-ring (41) in groove in top of guide bearing. Set loading chamber on top of body. Align matchmarks from step B.3. and insert nuts and bolts (11 & 12). Tighten bolting equally in a star pattern. Torque to 35 - 40 ft. lbs.

D. To replace the seat:

For 3/4" - 1" Sizes:

1. Return to Section VII.B. & C. steps 4 thru 7.
2. Remove seal retainer (37) from plug shoulder.
3. Evenly loosen the cage cap screws (18) CCW in single revolution increments. The regulator contains a return spring (22); the cage should rise as the cage cap screws are backed out evenly. Using hand pressure apply downward force to the top of the cage to prevent the cage from popping up as the last threads of the cage cap screws are disengaged. Remove washers (17).
4. Remove the cage and static seal (15) from the body. **NOTE:** *Seat (21) maybe stuck to the bottom of the cage as cage is removed. If not, remove seat from body cavity.*
5. Check the seating surface of the plug for wear. Examine for signs of leakage. If seat ring or plug show signs of significant leakage, determine if operating conditions - pressure, pressure drop, or temperature exceed design limits. Replace as necessary.
6. Remove spring (22) from within the body (23).
7. Remove seal (28) from body flange groove.
8. Clean all metal parts to be reused according to owner's procedures. **NOTE:** *Regulators are originally supplied with a level of cleanliness equal to Cashco cleaning standard #S-1662. Contact factory for details. Go to Step E.*

For 2" Size:

1. Return to Section VII.B. & C. steps 4 thru 7.
2. Lift clamp ring (42) up to remove. Not necessary to remove dowel pin (43).
3. Remove seal retainer (37) from plug shoulder. **NOTE:** *Flat surface of retainer touches guide bearing.*
4. Remove cage (19) and static seal (15) from the body. **NOTE:** *Seat (21) maybe stuck to the bottom of the cage as cage is removed. If not, remove seat from body cavity.*

5. Check the seating surface of the plug for wear. Examine for signs of leakage. If seat ring or plug show signs of significant leakage, determine if operating conditions - pressure, pressure drop, or temperature exceed design limits. Replace as necessary.
6. Remove spring (22) from within the body (23).
7. Remove seal (28) from body flange groove.
8. Clean all metal parts to be reused according to owner's procedures. **NOTE: Regulators are originally supplied with a level of cleanliness equal to Cashco cleaning standard #S-1662. Contact factory for details. Go to Step E.**

For 3" & 4" Sizes:

1. Return to Section VII.B. & C. steps 4 thru 8.
2. Remove seal retainer (37) from plug shoulder. **NOTE: Flat surface of retainer touches guide bearing.**
3. Remove cage (19) and static seal (15) from the body. **NOTE: Seat (21) maybe stuck to the bottom of the cage as cage is removed. If not, remove seat from body cavity.**
4. Check the seating surface of the plug for wear. Examine for signs of leakage. If seat ring or plug shows signs of significant leakage, determine if operating conditions - pressure, pressure drop, or temperature exceed design limits. Replace as necessary.
5. Remove spring (22) from within the body (23).
6. Remove seal (28) from body flange groove.
7. Clean all metal parts to be reused according to owner's procedures. **NOTE: Regulators are originally supplied with a level of cleanliness equal to Cashco cleaning standard #S-1662. Contact factory for details. Go to Step E.**

E. Main Regulator Reassembly:

For 3/4" - 1" Sizes:

1. Insert the return spring (22) into the body (23).
2. Install non-threaded end of plug (20) into the bore in the bottom of the body. Fit cage O-ring seal (15) into the body groove.

3. Slide seat (21) over the lower end of the cage. Place cage over plug into the body. Ensure that the cage/seat are not cocked to one side.
4. Position seat retainer (37) on shoulder of plug. Install o-ring (39) on inner shoulder of plug.
5. Properly align all three cage (18) bolt holes as there is only one proper alignment possible. Use hand to apply a downward force to the top of the cage (19) until the cage is lowered sufficiently to engage the cage bolts (18) with washers (17) into the body (23). Engage all cage bolts, then tighten the cage bolts in alternating one-half revolution increments to pull the cage down evenly. Tighten cage bolts (18) to a torque value of 13-15 Ft-lbs (17.5-20.5 Nm).
6. Slide dynamic seal (27) over small end of guide bearing. Ensure u-cup seal (27) is oriented with the center-open-downwards as shown in Figure 1, as the u-cup seal depends upon the P1-Inlet pressure to activate proper sealing action.
7. Reposition the bearing guide (13) over end of plug and carefully slide it into the cage. Place a new u-cup seal (35) with the center-open-upwards into the recess at the top of the guide bearing.
8. Place the seal retainer (36) on top of the guide bearing and engage cap screws (38) tight into the guide bearing.
9. Thread nut (40) on to plug threads and tighten as follows:
Sizes - 3/4" - 1" Torque 60-70 ft. lbs.
10. Place new loading chamber seal (28) in recess in the body flange face. Set loading chamber on top of body. Align matchmarks from step B.3. and insert nuts and bolts (11 & 12). Tighten bolting equally in a star pattern. Torque to 35-40 ft. lbs.

For 2" Size:

1. Insert the return spring (22) into the body (23).
2. Install non-threaded end of plug (20) into the bore in the bottom of the body. Fit cage O-ring seal (15) into the body groove.

3. Slide seat (21) over the lower end of the cage. Place cage over plug into the body. Ensure that the cage/seat are not cocked to one side.
4. Position seat retainer (37) on shoulder of plug. **NOTE:** *Flat surface of retainer touches guide bearing.* Install o-ring (39) on inner shoulder of plug.
5. Align hole in clamp ring (42) with dowel pin (43) and install clamp ring on cage (19).
6. Slide new dynamic seal (27) over end of guide bearing. Ensure u-cup seal (27) is oriented with the center-open-downwards as shown in Figure 1, as the u-cup seal depends upon the P1-Inlet pressure to activate proper sealing action.
7. Carefully position guide bearing (13) over plug and into the cage.
8. Place a new u-cup seal (35) with the center-open-upwards into the recess at the top of the guide bearing. Place the seal retainer (36) on top of the guide bearing.
9. Thread nut (40) on to plug threads and tighten. Torque to 120-130 ft. lbs.
10. Place new loading chamber seal (28) in recess in the body flange face. Set loading chamber on top of body. Align matchmarks from step B.3. and insert nuts and bolts (11 & 12). Tighten bolting equally in a star pattern. Torque to 35-40 ft. lbs.
5. Slide new dynamic seal (27) over lower end of guide bearing. Ensure u-cup seal (27) is oriented with the center-open-downwards as shown in Figure 1, as the u-cup seal depends upon the P1-Inlet pressure to activate proper sealing action.
6. Carefully position guide bearing (13) over plug and into the cage.
7. Place a new u-cup seal (35) with the center-open-upwards into the recess at the top of the guide bearing. Place the seal retainer (36) on top of the guide bearing and engage threads of cap screw (40) tight into the guide bearing. Torque to 180 - 200 ft. lbs.
8. Remove this sub-assembly from the vise and install it inside the body cavity.
9. Place new loading chamber seal (28) in recess in the body flange face. Place new o-ring (41) on top edge of cage. Set loading chamber on top of body. Align matchmarks from step B.3. and insert cap nuts and bolts (11 & 12). Tighten bolting equally in a star pattern. Torque to 35-40 ft. lbs.

For 3" & 4" Sizes:

1. Insert the return spring (22) into the body (23).
2. Secure the lower part of the valve plug (20) in a bench vise; grasp in "smooth jaws" directly under plug's seating disc portion on hub "flats" provided. Do not hold on the machined surface in the plug's spindle area.
3. Slide seat (21) over the lower end of the cage. Lower and position cage over plug. Ensure that the cage/seat are not cocked to one side.
4. Place seat retainer (37) on shoulder of plug. **NOTE:** *Flat surface of retainer touches guide bearing* Install o-ring (39) on inside shoulder of plug.

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. Oversized regulator	B. Check actual flow conditions; resize regulator for minimum and maximum flow; if necessary, replace with smaller regulator.

2. Downstream pressure will not reach desired setting.

Possible Causes	Remedies
A. Supply pressure is down (confirm on pressure gauge).	A. Increase supply pressure
B. Undersized regulator.	B. Check actual flow conditions; resize regulator for minimum and maximum flow; if necessary, replace with larger regulator.

3. Leakage at flange.

Possible Causes	Remedies
A. Body bolts not torqued properly.	A1. Torque to proper value (see Section VII, C. 11.) A2. Failed C-ring seal. Replace seal.
B. Pressures may be too high for regulator design.	B. Consult factory.

4. Leakage across seat.

Possible Causes	Remedies
A. Contamination (debris) in regulator.	A1. Remove internals, clean and if necessary, replace sealing seating elements. * A2. Install UHP filter at inlet.
B. Oversized regulator; 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 both potential internal leak paths.	
C. Failure due to wear.	C1. Replace seat. C2. Replace all internal trim due wear.

SECTION IX

IX. ORDERING INFORMATION

NEW REPLACEMENT UNIT VS PARTS "KIT" FOR FIELD RE

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
<p>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.</p>

Sizes 3/4" - 1"

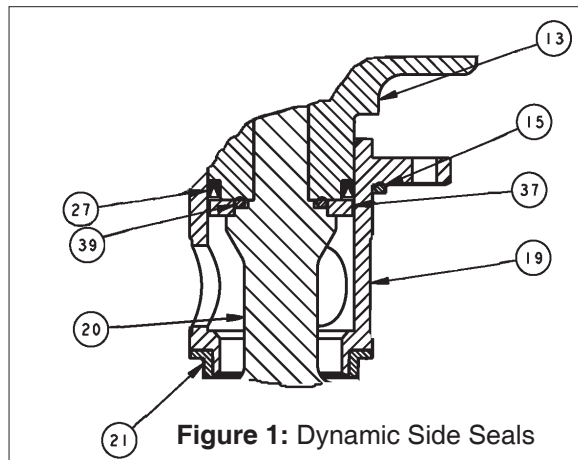
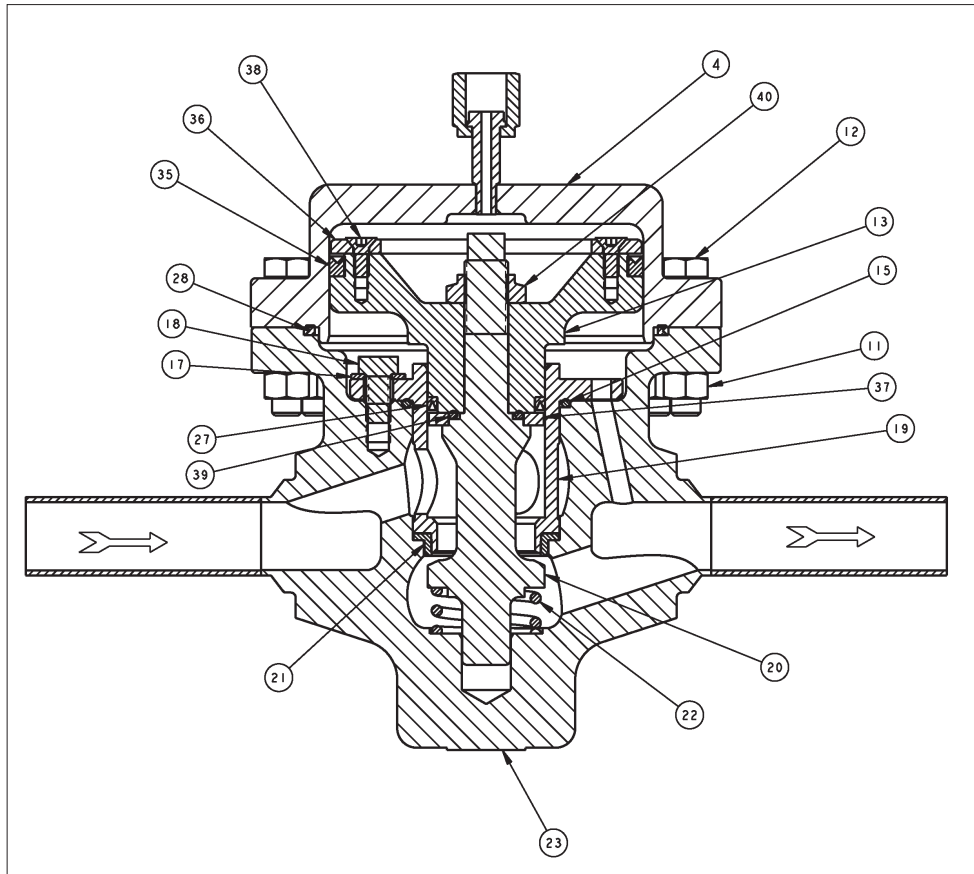
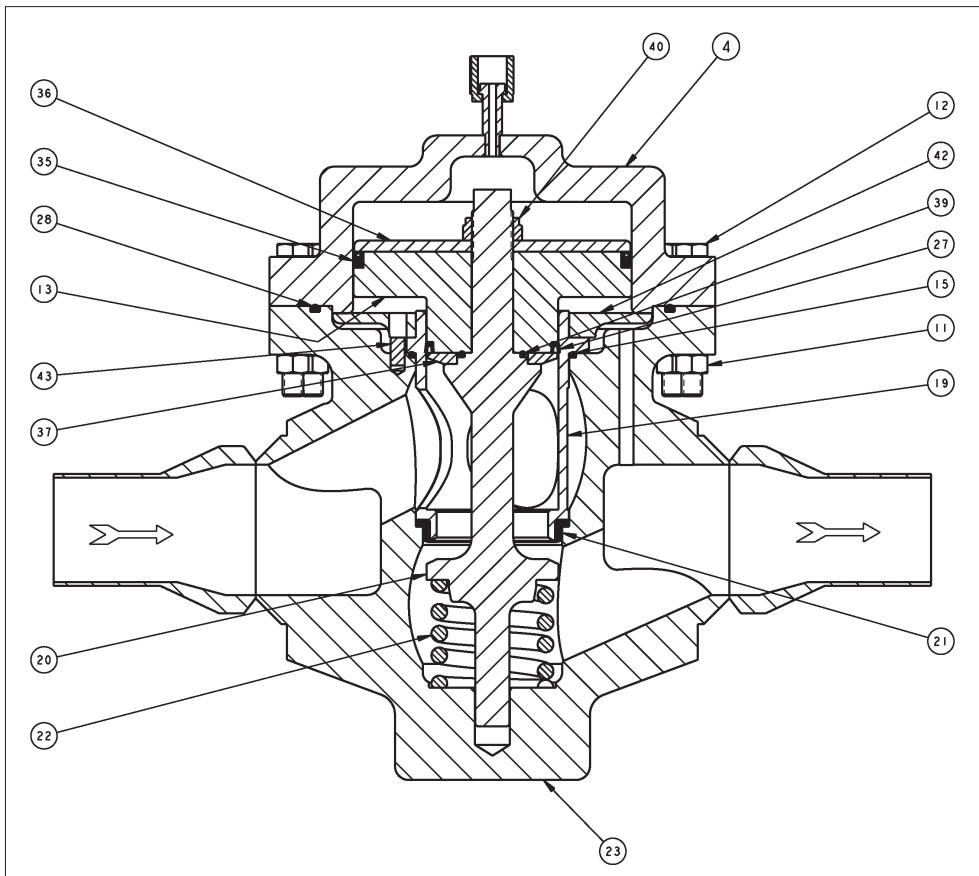


Figure 1: Dynamic Side Seals

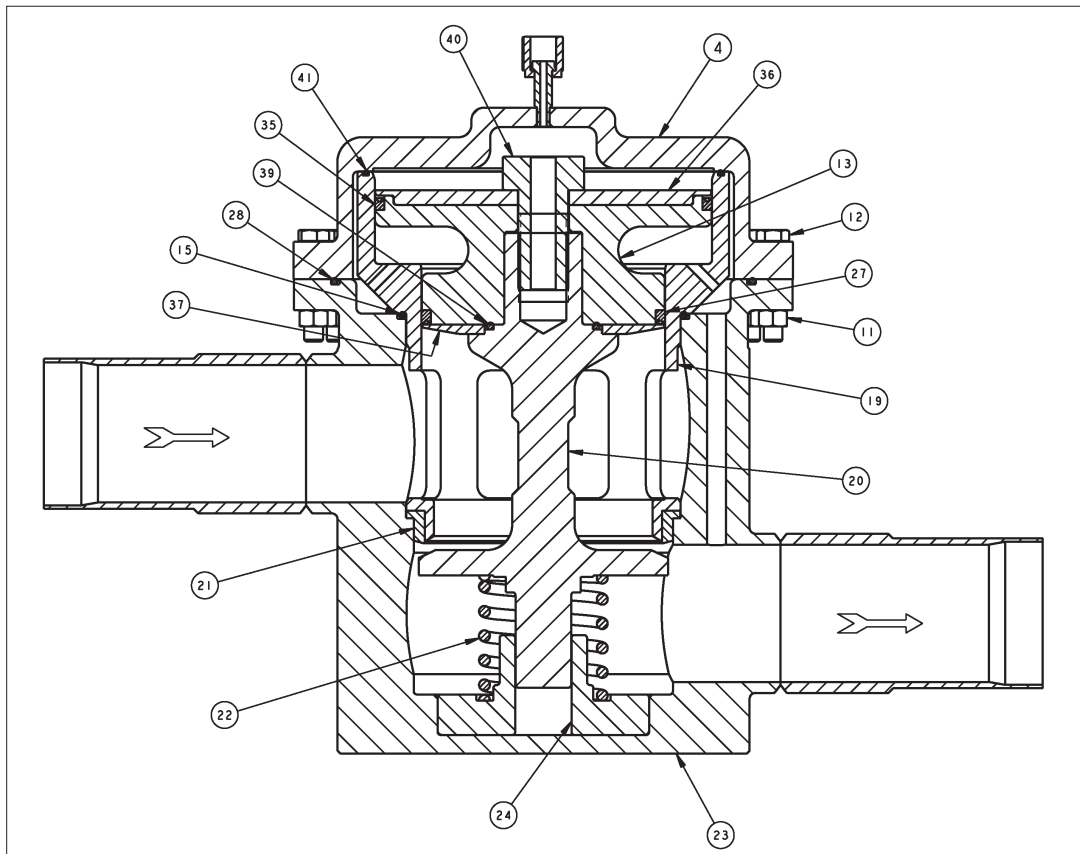
<u>Item No.</u>	<u>Description</u>	<u>Item No.</u>	<u>Description</u>
4	Loading Chamber	27 *	Dynamic Side Seal (u-cup)
11	Flange Nuts	28 *	Flange Seal
12	Flange Bolts	35 *	Seal (u-cup)
13	Guide Bearing	36	Seal Retainer
15 *	FKM Elastomer O-ring	37	Seal Retainer
17	Cage Washer	38	Cap Screw
18	Cage Cap Screw	39 *	FKM Elastomer O-ring
19	Cage	40	Nut (Cap Screw 3" & 4" sizes)
20	Plug	41 *	FKM Elastomer O-ring (3" & 4" sizes)
21 *	Seat	42	Clamp Ring (2" size)
22	Return Spring	43	Dowel Pin (2" size)
23	Body		
24	Bushing (3" & 4" sizes)		

* Recommended Repair Parts

Sizes 2"



Sizes 3" & 4"





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 1GΩ, special precautions shall be taken to ensure the process does not generate electrostatic discharge.
3. Special consideration shall be made regarding the filtration of the process medium if there is a potential for the process medium to contain solid particles. Where particles are present, the process flow shall be <1m/s (<3.3 ft/s) in order to prevent friction between the process medium and internal surfaces.
4. Effective earthing (grounding) of the product shall be ensured during installation.
5. The valve body/housing shall be regularly cleaned to prevent build up of dust deposits.
6. Regulators must be ordered with the non-relieving option (instead of the self-relieving option) if the process gas they are to be used with is hazardous (flammable, toxic, etc.). The self-relieving option vents process gas through the regulator cap directly into the atmosphere while the non-relieving option does not. Using regulators with the self-relieving option in a flammable gas system could create an explosive atmosphere in the vicinity of the regulator.
7. Tied diaphragm regulators with outlet ranges greater than 7 barg (100 psig) should be preset to minimize the risk that improper operation might lead to an outboard leak and a potentially explosive atmosphere.
8. All equipment must only be fitted with manufacturer's original spare parts.
9. Ensure that only non-sparking tools are used, as per EN 1127-1, Annex A.

	PRODUCT
REGULATORS	31-B, 31-N
	1164, 1164(OPT-45)
	1171, 1171(OPT-45), 1171(CRYO)
	2171, 2171(OPT-45), 2171(CRYO), 3171
	1465, 3381, 3381(OPT-45), 3381(OPT-40)
	4381, 4381(OPT-37), 4381(CRYO), 4381(OPT-45), 5381
	MPRV-H, MPRV-L
	PBE, PBE-L, PBE-H
	CA-1, CA-2
	CA1, SA1, CA4, SA4, CA5, SA5
	DA2, DA4, DA5, DA6, DA8
	DA0, DA1, DAP, SAP
	SLR-1, SLR-2, PTR-1
	ALR-1, ULR-1, PGR-1
	BQ, BQ(OPT-45), BQ(CRYO)
	123, 123(CRYO), 123(OPT-45), 123(OPT-46G)
	123-1+6, 123-1+6(OPT-45), 123-1+6(OPT-46G), 123-1+6+S, 123-1+6+S(OPT-40)
	1000HP, 1000HP(OPT-37), 1000HP(OPT-45), 1000HP(OPT-45G), 1000HP(CRYO)
	1000HP-1+6, 1000HP-1+8, 1000LP, 1000LP(OPT-45), 1000LP(OPT-46G)
	6987
	8310HP, 8310HP-1+6, 8310HP-1+8, 8310LP, 8311HP, 8311LP
	345, 345(OPT-45)
	BA1/BL1, PA1/PL1
	C-BPV, C-PRV, C-CS
	D, D(CRYO), D(OPT-37), D(OPT-20), D(OPT-45)
	DL, DL(LCC), DL(OPT-45)
	BR, BR(CRYO)
	HP, HP(LCC), HP(OPT-45), HP(OPT46G), HP-1+6+S(OPT-40), HP-1+6+S
	P1, P2, P3, P4, P5, P7
	B2, B7
	POSR-1, POSR-2
	5200P, 5300P
135	
NW-PL, NW-SO	
CG-PILOT	
FG1	
CONTROL VALVES	RANGER, 987, PREMIER
	964, 521, 988, 988-MB, 989
	2296/2296HF
	SCV-30, SCV-S
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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