

MODELS 988 and 989

GLOBE-STYLE PNEUMATIC CONTROL VALVE BODY

SECTION I

I. DESCRIPTION AND SCOPE

Model 988's and 989's are pneumatically actuated, globe-style control valves. Sizes are 3/4", 1", 1-1/2" and 2". Materials are available in cast carbon steel, Grade WCB (CS); cast 316L SST, Grade CF3M (SST); and cast CW-12MW, similar to Hastelloy C (H-C).

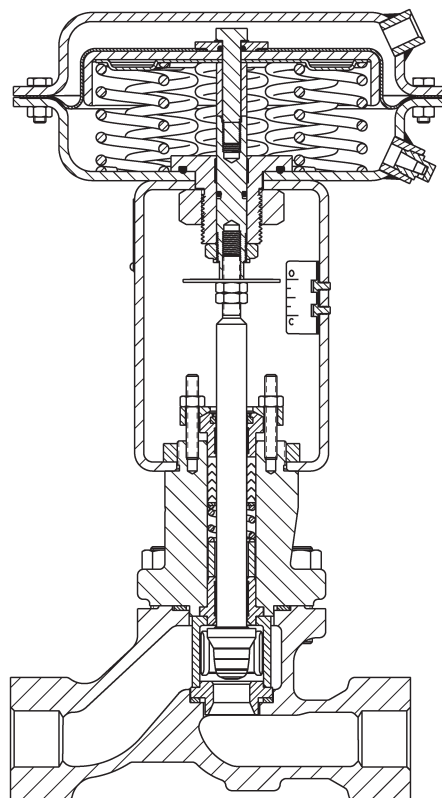
Failure position is determined by actuator for:

"D" = Direct action; on increasing air loading pressure, the actuator stem extends. Fail-safe position is with the stem retracted.

"R" = Reverse action; on increasing air loading pressure, the actuator stem retracts. Fail-safe position is with the stem extended.

These valves are designed for chemical service and most common liquid, gaseous, or steam services.

Models 988 and 989 differ only in the face-to-face dimensions of flanged units; 988's have a "regular" ("long") body pattern, and the 989's have a "short" body pattern.



Model 988
with ATC - FO Actuator
Shown with Internal Live-Loaded Packing

SECTION II

II. REFERENCE

Refer to Technical Bulletin 988-TB or 989-TB for complete technical specifications coupled with either Cashco Actuator Model C27 or C53.

www.cashco.com/techbulletins/988.pdf

www.cashco.com/techbulletins/989.pdf

Refer to following Installation, Operation & Maintenance Manuals (IOM's) for either actuator and/or devices that maybe mounted to a Model 988 or 989:

Actuators: www.cashco.com/iom/C27-C53.pdf

ABBREVIATIONS

ATO-FC	Air-to-Open, Fail Closed
ATC-FO	Air-to-Close, Fail Open
CCW	Counter Clockwise
CW.....	Clockwise
D or DIR.....	Direct Acting
HC	Cast CW-12MW or Wrought Hast C-22
IAS.....	Instrument Air Supply
LOAD.....	Positioner Output Air Pressure
R or REV	Reverse Acting
SIG	Output Signal from Instrument
SST.....	Cast or Wrought 316L Stainless Steel
V	Vent

SECTION III

III. INSTALLATION

A. Orientation:

1. Recommended orientation when installed in a horizontal pipeline is with the stem vertical. Valves may also be installed in vertical pipelines with stems horizontal.
2. Outdoors, all installations may be oriented any angle from horizontal-to-vertical. (Orient actuator vent cap, if supplied, to not collect rainwater that might freeze.)
3. Model 988/989 valves with actuators are not recommended for installation with the actuator oriented downwards.

B. Piping System:

1. It is recommended that the control valve unit be installed with a double-block and bypass as indicated in Figure 1. This arrangement is recommended especially where maintenance will be done on the valve body while still installed in the pipeline.

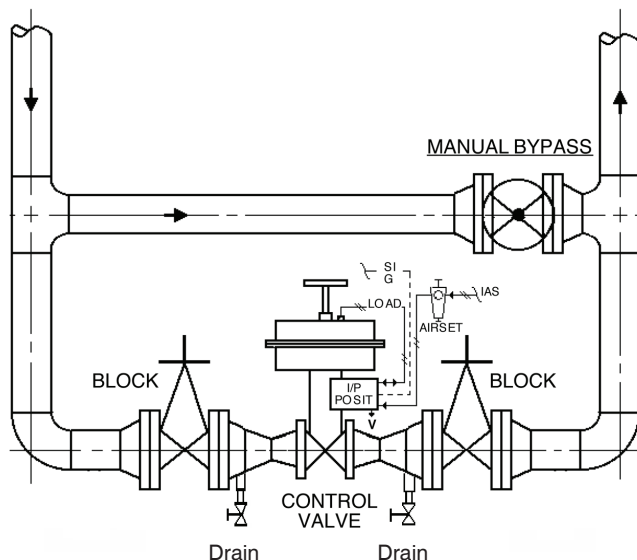


Figure 1: Typical Control Valve Station

2. Pipe unions are recommended for NPT screwed or socket welded installations to allow complete removal from system. If removal for maintenance is by cutting torch for socket welded valves, leave sufficient pipe nipple space between the body and the next piping component up or downstream to allow socket weld couplings for reinstallation.
3. If pipe reducers are located before and/or after the valve body, keep the reducers as close as practical to the valve body; this is especially important where the reducers are more than one line size larger than the valve body size, which is common in gaseous service.

4. For split-ring flanged end connections, install flange bolting to following torque values.

Recommended Maximum Flange Bolting Torque (ft-lbs.)			
Body Size	Body Material	150# Flange	300# Flange
3/4"	CS	23	28
1"		29	36
1-1/2"		43	43
2"		66	33
3/4"	SST	19	25
1"		24	30
1-1/2"		36	36
2"		54	27
3/4"	HC	26	32
1"		32	40
1-1/2"		48	48
2"		72	36

5. Clean piping of all foreign debris, including chips, weld scale, weld spatter, oil, grease, sand or dirt prior to installing the control valve. This is an absolute requirement for valves supplied with composition soft seats. System startup strainers for removal shortly after initial startup are recommended.
6. Field hydrostatic testing the completed piping system to 1-1/2 x CWP in psig indicated on the nameplate including the Model 988/989 is acceptable. If hydro test pressure exceeds the 1-1/2 x CWP limit, the 988/989 must be removed for such testing. Before pressurization, the valve plug should be lifted from the seat if of reverse, ATO-FC action. Tighten packing as required.
7. In placing thread sealant on pipe ends prior to engagement, ensure that excess material is removed and not allowed to enter the valve upon startup.
8. Flow Direction: Install so the flow direction matches the arrow on the valve body.
9. For best performance, install in well drained horizontal pipe, properly trapped if a steam service application.
10. Valves are not to be direct buried underground.
11. Insulation may be applied as indicated in Figure 2. Drainage away from the packing area must be ensured when fully installed, sealed and lagged for outdoors installation.
12. Undue piping stress/strain or bending torques may not be transmitted through the control valve body. One pipe (inlet or outlet) should be anchored rigidly for piping that is "hot" or "cold" with respect to ambient temperature; the remaining pipe (inlet or

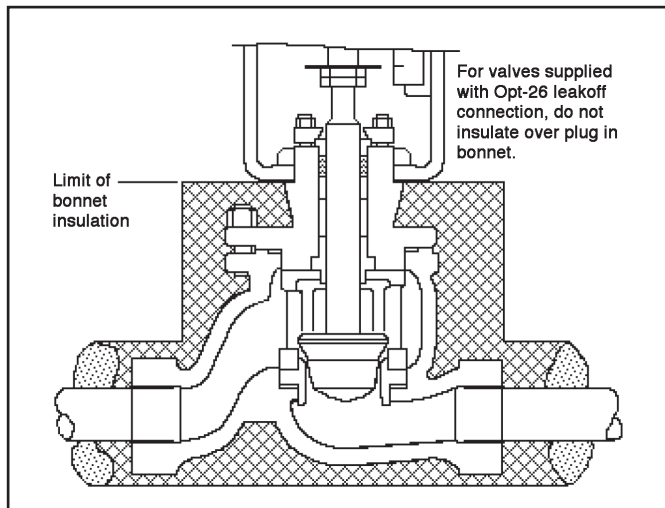


Figure 2: Body Insulation

outlet) should be supported and guided to ensure unidirectional expansion/contraction.

C. Removal From Piping System:

1. Care should be taken in removal of separable flanged units. Run wire across the flange face and through bolt holes in 180° crossing pattern to prevent flanges from coming loose during handling.



CAUTION

Exhibit care in handling flanged units to prevent separable flanges from coming loose, falling to floor and smashing feet/toes.

SECTION IV

IV. STARTUP

A. General:

1. Ensure that the Model 988/989 unit has been properly adjusted and calibrated, including the positioner if installed.
2. Recommend startup to be in a "manual" mode. This procedure assumes double block (isolation) and bypass valves for the "control valve station". See Figure 1.
3. Start with either of the two block valves closed, with the other open. The bypass valve should be closed. Pressurize system if possible/practical.
4. Back out the airset's adjusting screw until loose.
5. Turn on air supply pressure.
6. Adjust the air supply airset (filter-regulator) to the proper level as indicated as follows:

Bench Setting	Airset Output
psig (Barg)	psig (Barg)
5–15 (.34–1.0)	20 (1.4)
15–60 (1.0–4.1)	75 (5.2)

7. Place loop controller into "manual" mode. Vary setting from minimum – mid-range – maximum SIG output. Observe response of control valve unit to these changes of input SIG. The valve should fully stroke at the variation from minimum SIG to maximum SIG; the mid-range SIG should have the valve stem at/near 1/2 travel.

8. Confirm that action of controller and positioner – direct or reverse – are producing the desired response in the control unit. Confirm that the control valve "fail" position is as required.
9. Hereafter, the procedure assumes that actual fluid flow may be established. This may not be practical/possible in all cases; if so, vary procedure as required. Always "heat" or "cool" down the system piping SLOWLY by opening the control valve station bypass valve in small increments.
10. With one of the control valve station block valves still closed, and the loop controller still in "manual" mode, open bypass valve and vary flow rate manually to observe the response of the controller and control valve unit together.
11. Attempt to develop manual control of the loop by opening/closing the manual bypass as required, or by manually controlling mainstream flow as required.
12. When the control valve is partially open, slowly crack open the closed block valve while simultaneously closing the bypass valve. Continue this procedure until the bypass is closed and the block valves are both fully open. The system is still under "manual" mode control, but all flow is passing through the control valve.
13. Vary controller "manual" SIG output until matching the "automatic" SIG output, then change the mode of the controller over to "automatic". The loop will experience a minimum of upset conditions, and will be in automatic control.



CAUTION

DO NOT WALK AWAY AND LEAVE A MANUALLY CONTROLLED CONTROL VALVE UNATTENDED!

SECTION V



WARNING

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

V. MAINTENANCE

A. General:

1. Maintenance procedures hereinafter are based upon removal of the valve/actuator unit from the pipeline where installed.
2. Owner should refer to Owner's procedures for removal, handling and cleaning of non-reusable parts, i.e. gaskets, suitable solvents, etc.
3. Valves supplied from the factory do not use any aid to assist in gasket sealing such as oil, sealant or pipe dope. Owner may use such aids provided the aids are compatible with the Owner's fluid. (See below for "oxygen cleaned" valves.)
4. Valves originally supplied per Option-55 require special cleaning procedures. Refer to Cashco Specification No. S-1134 for details. When in compliance with/to Spec. No. S-1134, the valve is suitable for oxygen service. This procedure is limited to bodies of SST or HC only.
5. All indicated Item Numbers that are with respect to the actuator assembly (AA) will be in parenthesis and underscored; i.e. (20); All Item Numbers that are with respect to the body assembly (BA) are not underscored; i.e. (32).
6. **Special care must be exhibited when rotating the plug/stem (3) of the valve to not mar that portion of the surface of the stem where it contacts with the packing (6). To rotate the plug/stem use the jam nuts (52) or a soft jawed pliers. NOTE:** When using the jam nuts to rotate the plug/stem, use the upper jam nut to rotate the stem CW, and the lower jam nut to rotate the stem CCW, when viewed from above valve plug/stem.
7. Hereafter, whenever text has the following notation, "(Note PA.)", the following text is to be applied:

"For ATO-FC units ONLY, connect a temporary air source with gauge to the actuator and pressurize to a level sufficient to initiate travel to approximately mid-stroke."

8. Hereafter, whenever text has the following notation, "(Note RP.)", the following text is to be applied:

"For ATO-FC units ONLY, release all temporary air pressure."

B. Actuator Assembly Removal:

1. Refer to the correct actuator IOM for this procedure.
2. Secure the (BA) in vise with (AA) oriented vertically.
3. Rig (AA) to be supported above the (BA). Place matchmarks between the bonnet/yoke and yoke/accessory plate.
4. This procedure assumes that the (BA) is fully assembled through the bonnet (2), including the packing flange (4), follower (5), and packing (6).
5. **(Note PA.)** Securing the "flats" of the actuator stem (6) by wrench, loosen stem jam nuts (52) by rotating CW (viewed from above) one-at-a-time.
6. Fully loosen any accessory devices that are connected to/with the stems (6), (3), such as accessory plate ((AP)) for limit switch or positioner. If actuator has handwheel - see Actuator IOM for removal instructions.
7. Using a blunt end tool, hammer rap the tool to loosen yoke nut (25), turning CCW (viewed from above) approximately 1/2 revolution.
8. If the actuator is to be reinstalled, put paint or dye marker between the plug/stem (3) and the actuator stem (6), to serve as matchmarks.
9. Loosen packing (6) by rotating nuts (15) CCW 2-3 revolutions. **(Note RP).**

NOTE: To fully disengage the actuator stem (6) from the plug/stem (3) is a two-step procedure. Be aware of the valve's stroke length as indicated on the nameplate (40) before beginning disengagement. During the disengagement, measure the distance extended and attempt to make each step about half of full stroke. Keep track of the number of revolutions for each step in the box below.

For Steps 10A and 10B: Count the Number
of revolutions to disengage plug/stem from actuator stem:

Step A. _____ Step B. _____

TOTAL _____

10A. For ATO-FC Reverse Action Actuators:

- a. **(NOTE PA).**
- b. **Step A.** Rotate plug/stem (3) CW (viewed from above the valve) to disengage the actuator stem from the plug/stem. Record number of plug/stem revolutions for Step A in box above. When disengagement reaches approximately 50% of full stroke travel, Step A is complete.

- c. **Step B.** Support the (AA) from above. Fully loosen yoke nut (25) to removal. Lift the (AA) upwards approximately 1/4"–3/8" (6–8 mm). Again, rotate plug/stem (3) CW (viewed from above) until disengagement from actuator stem (6). Record number of plug/ stem revolutions for Step B in box on previous page.

NOTE: Take notice of the parts "dangling loosely" about the stem, the order of their location and their proper orientation.

- d. Fully raise (AA) above (BA). Remove carefully to prevent "dangling parts" (position indicating washer (51), accessory plate ((AP)), yoke nut (25)) from falling. **(Note RP).**

10B. For ATC-FO Direct Action Actuators:

- a. **Step A.** Rotate plug/stem (3) CW (viewed from above the valve) to disengage the actuator stem from the plug/stem. Record number of plug/stem revolutions for Step A in box on previous page. When disengagement reaches approximately 50% of full stroke travel, Step A is completed.
- b. **Step B.** Support the (AA) from above. Fully loosen yoke nut (25) to removal. Lift the (AA) upwards approximately 1/4"–3/8" (6–8 mm). Again rotate plug/stem (3) CW (viewed from above valve) until disengagement from actuator stem (6). Record the number of valve stem revolutions for Step B in box on previous page.

NOTE: Take notice of the parts "dangling loosely" about the stem, the order of their location and their proper orientation.

- c. Fully raise (AA) above (BA). Remove carefully to prevent "dangling parts" (position indicating washer (51), accessory plate ((AP)), yoke nut (25)) from falling.

C. Mounting Actuator Assembly to Body Assembly:

1. Refer to the correct actuator IOM for completion of this procedure.
2. Secure the (BA) in a vise with the plug/stem (3) oriented vertically. Push stem down until plug touches the seating surface in the body.
3. Rig (AA) to be supported above the (BA).
4. This procedure assumes that the packing assembly and bonnet (2) have been bolted to the body (1).
5. Engage stem jam nuts (52) one-at-a-time to the plug/stem (3) by rotating CW (viewed from above stem end). Rotate jam nuts all the way down to the root of the stem threads.

6. Lower (AA) until the opening of the actuator yoke (3) is at the level of upper jam nut (52).
7. Place yoke nut (25) over the plug/stem (3) and lower the nut to rest upon the yoke.
8. Place travel indicator washer (51) and accessory plate ((AP)) over stem (3) and allow to rest upon upper stem jam nut (52).
9. Align matchmarks between body/bonnet, bonnet/ yoke and yoke/accessory plate. Continue to lower (AA) until two stems are approximately 3/8" (8mm) apart.
10. Ensure that plug/stem (3) is resting on seat ring.
- 11A. **For ATC-FO:** Hook up a temporary air supply hose that has an adjustable airtset connected at the actuator inlet to allow pressurization. Slowly pressurize actuator to bring the actuator stem to within 1/8" (3mm) of touching the plug/stem.
- 11B. **For ATO-FC:** Continue lowering (AA) until actuator's stem (6) and valve's stem (3) almost touch.
12. Rotate yoke nut (25) onto bonnet (2) threads as far as able to help stabilize topworks. Wrench-tighten one-half (1/2) extra revolution.
13. Use hand to lift plug/stem (3) upwards to engage with actuator stem (6). Rotating plug/stem CW (viewed from plug end) the same number of revolutions recorded to disengage the stem per B Step 10A.
14. **For ATC-FO:** Release air pressure from (AA). **For ATO-FC:** **(NOTE PA).**
15. Fully lower the (AA) downwards until the yoke (3) is properly positioned on the valve bonnet (2). Hand-tighten yoke nut (25).
16. Complete the engagement of plug/stem into the actuator stem the same number of revolutions recorded to disengage the stems per B Step 10B. **(NOTE RP)**
17. Connect "dangling parts" – accessory plate (AP) and travel indicator disc (51) – to actuator stem (6) with stem jam nuts (52).
18. Retighten packing flange nuts (15).
19. Hammer rap yoke nut (25) with a blunt end tool until tight.
20. Check valve stem stroke by alternately pressurizing and then depressurizing the actuator. Repeat several times. DO NOT OVER PRESSURIZE.
21. Release all air pressure from (AA) and remove temporary air supply hook up.

D. Trim and Packing Removal and Replacement for Units with Internal Live-Loaded Packing; Opt-STD or Opt-KRI: (See pg. 19 for Item # identification.)

1. Remove (AA) as described in Sub-Section V.B. Leave (BA) in vise with plug/stem (3) upwards.
2. Continue to loosen stem packing (6) by rotating packing nuts (15) CCW to just short of disengagement from packing studs (14). **DO NOT REMOVE PACKING NUTS (15).**
3. Remove all bonnet stud nuts (17).
4. Lift bonnet (2), plug/stem assembly (3), cage (10) and all packing zone parts up and out of the body - grasp stem (3) to prevent from falling. Lay these parts down horizontally on a workbench. **NOTE:** *Seat ring (11) (and seat retainer (23) and soft seat insert (24) for composition/soft seated designs) may also pull out with the above parts assembly.*
5. Remove both stem nuts (52).
6. Withdraw plug/stem (3) out through bottom of the bonnet (2) and packing (6). Hold cage (10) to prevent from dropping. Set parts (3, 10) aside.
7. Place bonnet (2) into a second vise with the packing zone on top.
8. Remove the packing nuts (15).
9. Remove packing flange (4) and follower (5).



CAUTION

Take extreme care to not mar internal wall surface of the bonnet (2).

10. Using a sharp, hooked-end, pick-type tool, hook and pull the packing rings (6) up and out of the bonnet's (2) stuffing box individually. Examine for excessive wear. Discard old packing.
11. Remove bonnet (2) from vise and invert to allow packing washer (7), packing spacer (9) and packing spring (21) to slide out of the bonnet's stuffing box.
12. Solvent clean all parts to be reused, including bonnet (2). Examine any parts for wear and corrosion. Replace any corroded or worn parts.
13. Examine plug/stem (3) at lower guide bushing (8) area for wear. If there are signs of excess wear, guide bushing (8) should be replaced:
 - a. Place the bonnet (2) on a bench press. Press the guide bushing (8) out of the bonnet and discard.
 - b. Rotate bonnet (2) end-for-end. Place a new guide bushing (8) into position and press fully into the bonnet.
 - c. Reclean bonnet with suitable solvent.

14. Examine plug/stem (3) in critical finish zone where contact is made with the packing (6). It is desirable to restore the surface of the stem (3) to a #4 Ra μ -in surface finish; metal removal should not exceed 0.001 inch material. A deeply scratched or pitted stem should be replaced.
15. Examine plug/stem (3) for wear around the seating area. Examine seat ring (11).
 - a. Plug head of stem assembly (3) for metal seated design may be hand lapped using suitable lapping compound. If hand lapping will not restore surfaces to an acceptable degree, then replacement of plug/stem assembly is recommended.
 - b. For composition seated design, if plug/stem assembly is wear damaged, the stem should be replaced.
16. Examine the inner surface of the bonnet's (2) stuffing box. It is desirable to restore the surface of stuffing box to a #8 Ra μ -in surface finish; metal removal should not exceed 0.001 inch material. A deeply scratched or pitted bonnet (2) should be replaced.
17. Examine packing follower (5) for corrosion. Replace if corroded:
 - a. Replace follow bushing (26) with new bushing.
 - b. Replace wiper ring (22) with new wiper ring.
18. Turn attention to the body (1) and remaining parts yet therein. Remove seat ring (11) (and seat retainer (23) and soft seat insert (24) for composition/soft seated design) if not already removed. Discard used soft seat insert (24); always use a new soft seat insert upon reassembly. If seat ring (11) or seat retainer (23) are damaged, replace.
19. Examine gaskets (12,13) to see if leakage occurred. Remove and discard both the seat ring gasket and bonnet gasket. Always use new gaskets upon reassembly.
20. Remove body (1) from vise. Solvent clean all loose parts with suitable solvent. Determine parts to be replaced due to wear and/or corrosion. Clean seat ring (11), cage (10), and seat retainer (23).
21. Place body (1) into vise with body/bonnet flange face up.
22. Place a new seat ring gasket (13) into position.
23. Note correct orientation of seat ring (11) and place inside the body (1).
24. For composition/soft seat design, position a new soft seat insert (24) and the seat retainer (23) into position on top of seat ring (11).
25. Place new bonnet gasket (12) on the body's bonnet flange face.

26. With the cage (10) oriented correctly on the stem assembly (3), set plug head down into the seat ring (11). Keep firm hold of the plug/stem with one hand; use other hand to push cage down into proper alignment.
27. Lift bonnet (2) over threaded end of plug/stem (3) and carefully lower bonnet down over stem, ensuring that the critical finish zone of the bonnet's stuffing box is not scratched by the stem's threads. Align body (1)-to-bonnet (2) flanges to matchmarks as bonnet comes down over bonnet studs (16). Carefully release plug/stem (3) only when bonnet is completely resting on the body.
28. Install bonnet nuts (17) on studs (16) finger-tight.
29. Place packing spacer (9) over end of plug/stem (3) and carefully lower into stuffing box.
30. Place packing spring (21) over end of plug/stem (3) and carefully lower down into stuffing box.
37. Install packing stud nuts (15), finger-tight, on top of the packing flange (4).
38. Continue tightening nuts (15) evenly in 1/2 revolution increments, until the shoulder of packing follower (5) is resting evenly on the upper edge of the bonnet (2) at the stuffing box.
39. Thread the two stem jam nuts (52) onto the stem (3) and rotate as far down the plug/stem as possible.
40. Push valve stem (3) down into the seat ring (11). Wiggle the loose assembly to ensure initial alignment/stacking.
41. Tighten bonnet bolting (16,17) in an alternating cross-pattern in 1/4 revolution increments to the following torque levels:

Size	Torque
3/4", 1", 1-1/2"	70-75 ft-lbs (95-102 N-M)
2"	50-55 ft-lbs (68-75 N-M)

42. Reinstall the (AA) as recorded in Sub-Section V.C.
43. Position suitable end closures – plugs, blind flanges, etc., – and leak test with 100 psig air pressure minimum. No packing (6) adjustment should be required to get a tight seal.
44. Recalibrate per Section VI.

E. Trim and Packing Removal and Replacement for Units With External Live-Loaded Packing; Opt-EXT, Opt-KRE, Opt-HTE-Hi, or Opt-HTE-Lo: (See pg. 20 for Item # identification.)

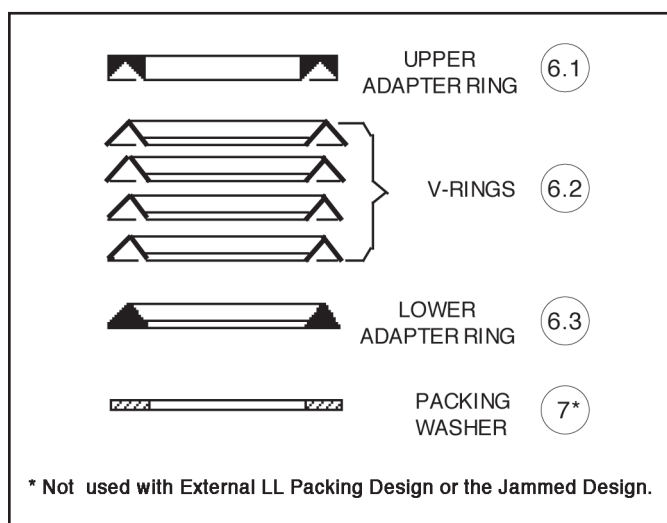


Figure 3: "STD" and "KRI" Packing Orientation

31. Place packing washer (7) over end of plug/stem (3) and carefully lower into stuffing box. See Figure 3 for proper packing orientation.
32. Carefully place lower adapter (6.3) of packing ring set (6) over plug/stem's (3) end, properly oriented. Using the packing follower (5), push the lower adapter into the bonnet's (2) stuffing box.
33. Carefully place a packing ring (6.2) properly oriented over the plug/stem's (3) end and push into the stuffing box similar to the adapter (6.3). Repeat for each of the four rings (6.2).
34. Place upper adapter (6.1) over the stem (3)
35. Place packing follower (5) with new wiper ring (22) and new follower bushing (26) tape over the end of the plug/stem (3).
36. Place packing flange (4) over end of plug/stem (3) and over packing studs (14).



WARNING

Failure to ensure proper release of forces from Belleville spring washers can cause flying parts that might cause bodily injury.

1. Remove (AA) as described in Sub-Section V.B. Leave (BA) in vise with plug/stem (3) upwards.
2. Place thread penetrating lubricant on bonnet bolting (16,17) and packing bolting (14,15).
3. Loosen both packing stud nuts (15) until clearance exists between the bottom of the nuts (15) and the upper retainers (39). See Figure 4.
4. Spacer rings (40) should "spin freely". If stacked mechanism (39,40,41) is not "loose" due to corrosion, debris, packed dirt, etc., tap the spacer rings lightly with a hammer while attempting to pry up the spacer ring /lower retainer with a flat tool. **DO NOT REMOVE PACKING NUTS (15).**
5. Continue to loosen packing stud nuts (15) to just short of disengagement from packing studs (14). **DO NOT REMOVE PACKING NUTS.**

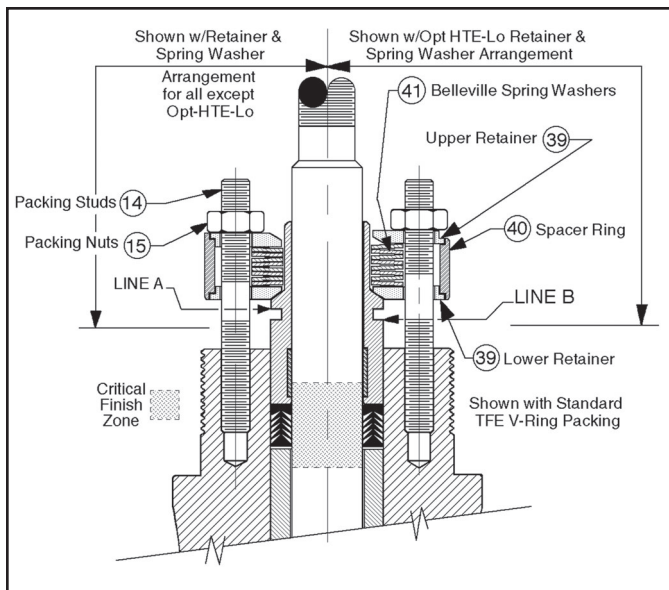


Figure 4: External Live Loaded Packing Orientation

6. Remove all bonnet stud nuts (17).
7. Lift bonnet (2), plug/stem assembly (3), cage (10), and all packing zone parts up and out of the body (1) - grasp stem to prevent from falling. Lay these parts down horizontally on a workbench. **NOTE:** *Seat ring (11) (and seat retainer (23) and soft seat insert (24) for composition/soft seated designs) may also pull out with above parts assembly.*
8. Remove both stem nuts (52).
9. Withdraw plug/stem assembly (3) from within the bonnet (2) and packing (6). Hold cage (10) to prevent from dropping. Set parts (3,10) aside.
10. Place the bonnet (2) into a second vise with the packing zone on top. Remove packing nuts (15).
11. Grasp the lower retainers (39) from its underneath side and lift the lower retainers, spacer rings (40), Belleville spring washer stacks (41), and upper retainers(39) together up and over the packing studs (14). Set these parts (39,40,41) aside without disturbing the orientation.
12. Remove packing follower (5) together with follower bushing (26 or 5.2). Discard Rulon tape bushing (26) if supplied.



CAUTION

Take extreme care to not mar internal wall surface of the bonnet (2).

13. Using a sharp, hooked-end, pick-type tool, hook and pull the packing rings (6) up and out of the bonnet's (2) stuffing box individually. Examine for excessive wear. Discard packing.
14. Remove bonnet (2) from vise and invert to allow packing spacer (9) to slide out of the bonnet's stuffing box.

15. Solvent clean all parts to be reused including bonnet (2). Examine all parts for wear and corrosion. Replace any corroded or worn parts. Belleville spring washers (41), studs (14,16), nuts (15,17) and retainers (39) should be replaced in sets.
16. Examine plug/stem (3) at lower guide bushing area (8) for wear. If there are signs of excess wear, guide bushing should be replaced:
 - a. Place the bonnet (2) on a bench press. Press the guide bushing (8) out of the bonnet and discard.
 - b. Rotate bonnet (2) end-for-end. Place a new guide bushing (8) into position and press fully into the bonnet.
 - c. Reclean bonnet with suitable solvent.
17. Examine plug/stem (3) in critical finish zone where contact is made with the packing (6). It is desirable to restore the surface of the stem to a #4 Ra μ -in surface finish; metal removal should not exceed 0.001 inch material. A deeply scratched or pitted stem should be replaced.
18. Examine plug/stem (3) for wear around the seating area. Examine seat ring (11).
 - a. Plug head of stem assembly (3) of metal seated design may be hand lapped using suitable lapping compound. If hand lapping will not restore surfaces to an acceptable degree, then replacement of plug/stem assembly is recommended.
 - b. For composition seated design, if plug/stem assembly (3) is wear damaged, the stem (3) should be replaced.
19. Examine inner surface of the bonnet's (2) stuffing box. It is desirable to restore the surface of stuffing box to a #8 Ra μ -in surface finish; metal removal should not exceed 0.001 inch material. A deeply scratched or pitted bonnet (2) should be replaced.
20. Examine packing follower (5) for corrosion. Replace if significantly corroded:
 - a. Place new follower bushing tape (26) into follower's (5) interior groove.
 - b. If packing Opt-HTE-Hi or Opt-HTE-Lo is supplied, the packing follower (5) contains carbon bushing (5.2) that is pressed into the follower (5.1). This bushing (5.2) is not field replaceable and must be supplied as a packing follower sub-assembly (5). Examine the carbon bushing (5.2) for wear or corrosion. Replace follower sub-assembly when necessary.
21. Turn attention to the body (1) and the remaining parts yet therein. Remove seat ring (11) (and seat retainer (23) and soft seat insert (24) for composition/soft seated design). Discard used soft seat insert (24); always use a new soft seat insert upon reassembly. If seat ring(11) or seat retainer (23) are damaged, replace.

22. Examine gaskets (12,13) to see if leakage occurred. Remove and discard both gaskets. Always use new gaskets upon reassembly.
23. Remove body (1) from vise. Solvent clean all loose parts with suitable solvent. Determine parts to be replaced due to wear and/or corrosion. Clean seat ring (11), cage (10), and seat retainer (23).
24. Place body (1) into vise with body/bonnet flange up. Install a new seat ring gasket (13) inside body
25. Note correct orientation of seat ring (11) and place inside the body (1).
26. For a composition/soft seat design, position a new soft seat inset (24) and the seat retainer (23) into position on top of seat ring (11).
27. Place a new bonnet gasket (12) on the body's (1) bonnet flange face.
28. With cage (10) oriented correctly on the stem assembly (3), set plug head down into the seat ring (11). Keep firm hold of stem with one hand; use other hand to push cage down into proper alignment.
29. Lift bonnet (2) over threaded end of plug/stem (3) and carefully lower bonnet down over stem, ensuring that the critical finish zone of the bonnet's stuffing box is not scratched by the stem's threads. Align body (1) to-bonnet (2) flanges to matchmarks as bonnet comes down over bonnet studs (16). Carefully release stem (3) only when bonnet is completely resting on the body.
30. Install bonnet nuts (17) onto bonnet studs (16) and finger -tighten.
31. Place packing spacer (9) over end of plug/stem (3) and carefully lower into stuffing box.
- 32A. For Opt-EXT and Opt-KRE Packing option – (Reference Figure 3 for proper packing orientation) –
 - a. Carefully place lower adapter (6.3) of the new packing ring set (6) over plug/stem's (3) end, properly oriented. Using the packing follower (5), push the lower adapter into bonnet's (2) stuffing box.
 - b. Carefully place a packing ring (6.2) properly oriented over the plug/stem's end and push into the stuffing box similar to the adapter (6.3). Repeat for each of the four rings (6.2).
 - c. Carefully place upper adapter (6.1) similar to lower adapter (6.3). Leave packing follower (5) in position, properly oriented.
 - d. Place lower retainers (39) over each packing stud (14). See Fig. 4 for proper orientation.
 - e. Orient spring washers (41) stacks per Figure 5. Lower spring washer stacks over studs and down onto the lower retainers (39).
 - f. Place spacer rings (40) over studs and onto ledge of lower retainers (39).

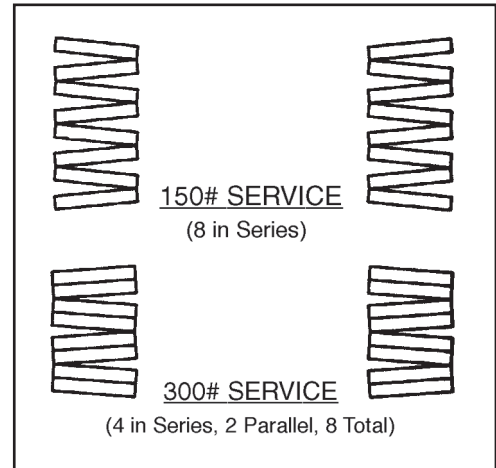


Figure 5: Belleville Spring Washers Orientation

- g. Place upper retainers (39) over the packing studs (14), and onto the ledge of the spacer rings (40). Ensure the upper retainers (39) are properly positioned around its circumference.
- h. Install packing stud nuts (15), finger-tight, on top of the upper retainers (39). (See Fig. 4.)
- i. Ensure that nuts (15) are drawn down evenly such that the upper retainers (39) are level. Wrench tighten packing nuts in 1/2 revolution increments. Continue to tighten nuts until the spacer rings (40) can no longer be manually rotated by use of fingers; add 1/2 revolution of additional draw-down to each nut to properly load the packing (6).

32B. For Opt-HTE-Hi and Opt-HTE-Lo packing options (Refer to Fig. 6 for proper packing orientation) –

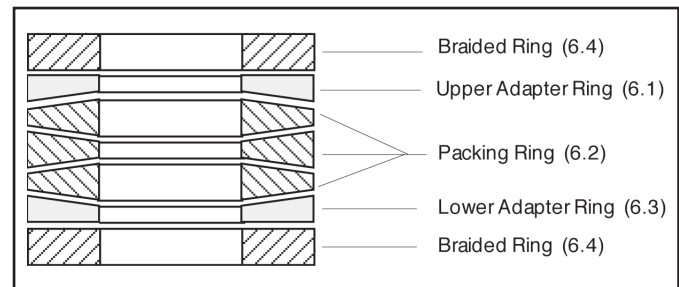


Figure 6: Packing Orientation for Opt-‘HTE-Hi & Lo’

- a. Carefully place the lower braided ring (6.4) over the plug/stem's (3) end. Using the packing follower (5) push the lower braided ring (6.4) into the bonnet's (2) stuffing box.
- b. Carefully place lower adapter (6.3) properly oriented over the plug/stem's end and push into the stuffing box similar to the lower braided ring.
- c. Carefully place a packing ring (6.2) properly oriented over the plug/stem's end and push into the stuffing box similar to the lower braided ring . Repeat for each ring.
- d. Carefully place the upper adapter (6.1) similar to the lower adapter (6.3). Leave packing follower (5) in position, properly oriented.
- e. Place one of the lower retainers(39) over each of the packing studs (14). Install packing nuts (15) and finger-tighten.

- f. Wrench-tighten the packing stud nuts (15) evenly and in 1/2 revolution increments until the “upper groove on the packing follower (5), identified as “Line A” (Fig. 4), is flush with the top edge of the bonnet’s (2) stuffing box.
 - g. Remove the packing nuts (15), lower retainers (39) and packing follower (5).
 - h. Carefully place the upper braided ring (6.4) over the plug/stem’s (3) end and push into the stuffing box similar to the lower braided ring (6.4). Leave the packing follower in position, properly oriented.
 - i. Place lower retainers (39) over each of the packing studs (14). Install packing stud nuts (15) and finger-tighten.
 - j. Repeat Step f. with the exception that the packing set (6) is to be compressed into the stuffing box until the “lower groove” identified as “Line B” on the packing follower (5) is flush with top edge of the bonnet’s (2) stuffing box.
 - k. Remove the packing nuts (15). Leave the follower (5) and lower retainers in place.
 - l. Orient spring washer (41) stacks per Figure 5. Lower stacks over studs and onto ledge of lower retainers (39).
 - m. Place spacer rings (40) over studs and onto ledge of lower retainers (39).
 - n. Place upper retainers (39) over packing studs (14), and onto the ledge of the spacer rings (40). Ensure the upper retainers (39) are properly positioned around its circumference and that the inversion is correct for HTE-Hi versus HTE-Lo options.
 - o. Install packing stud nuts (15), finger-tight, down to the upper retainers (39).
 - p. Manually stroke the plug/stem (3) a minimum of fifty full strokes.
 - q. Ensure that packing stud nuts (15) are drawn down such that the upper retainers (39) are level with top of spacer rings (40). Wrench-tighten packing stud nuts in 1/2 revolution increments. Continue to tighten nuts until the spacer rings can no longer be manually rotated by use of fingers; add 1/2 revolution of additional draw-down to each nut to properly load the packing (6).
33. Reinstall the two stem jam nuts (52) onto the plug/stem (3) and rotate as far down the as possible.
 34. Push valve stem (3) down into the seat ring (11). Wiggle the loose assembly to ensure initial alignment/stacking.
 35. Tighten bonnet bolting (16, 17) in an alternating cross-pattern in 1/4 revolution increments to the following torque levels:

Size	Torque
3/4", 1", 1-1/2"	70-75 ft-lbs 95-102 N-M)
2	50-55 ft-lbs (68-75 N-M)

36. Reinstall the actuator assembly (AA) as recorded in Sub-Section V.C.

37. Position suitable end closures – plugs, blind flanges, etc., – and leak test with 100 psig air pressure minimum. No packing (6) adjustment should be required to get a tight seal.
38. Recalibrate per Section VI.

F. Trim and Packing Removal and Replacement for Units with Jammed Packing; Opt-38J, Opt-34A, Opt-34B, Opt-34C:(See pg. 11 & 19 for Item # identification.)

1. Remove (AA) as described in Sub-Section V.B. Leave (BA) in vise with plug/stem (3) upwards.
2. Continue to loosen stem packing (6, 47) by rotating packing stud nuts (15) CCW to just short of disengagement from packing studs (14).
3. Remove all bonnet stud nuts (17).
4. Lift bonnet (2), plug/stem assembly (3), cage (10) and all packing zone parts up and out of the body - grasp stem (3) to prevent from falling. Lay these parts horizontally on a workbench. **NOTE:** *Seat ring (11) (and seat retainer (23) and soft seat insert (24) for composition/soft seated designs) may also pull out with the above parts assembly.*
5. Remove both stem nuts (52).
6. Withdraw plug/stem assembly (3) from within the bonnet (2) and packing (6, 47). Holding cage (10) to prevent from dropping. Set parts (3, 10) aside.
7. Place bonnet (2) into a second vise with the packing zone on top. Remove the two packing nuts (15).
8. Remove packing flange (4), packing follower (5), wiper ring (22) and TFE bias tape follower bushing (26).

⚠ CAUTION

Take extreme care to not mar internal wall surface of the bonnet (2).

9. Using a sharp, hooked-end, pick-type tool, hook and pull the packing rings (47) up and out of the bonnet’s (2) stuffing box individually. Examine for proper orientation (see Figures 7, 8, 9 and 10).
10. Remove bonnet (2) from vise and invert to allow lantern ring (27) or packing spacer (9) to slide out of the bonnet’s stuffing box.

For Opt-34 –

- a. Invert bonnet (2) again and place back in vise with packing zone on top.

⚠ CAUTION

Take extreme care to not mar internal wall surface of the bonnet (2).

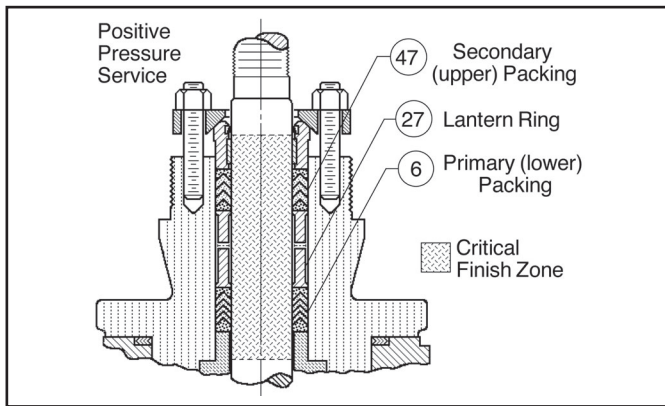


Figure 7: Dual Packing – Arr. "A", Opt-34A

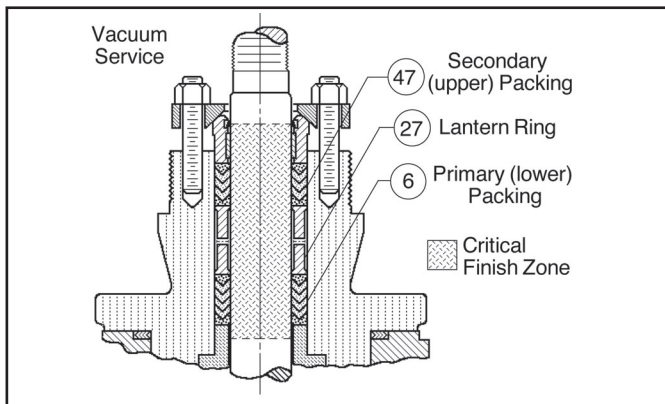


Figure 8: Dual Packing – Arr. "B", Opt-34B

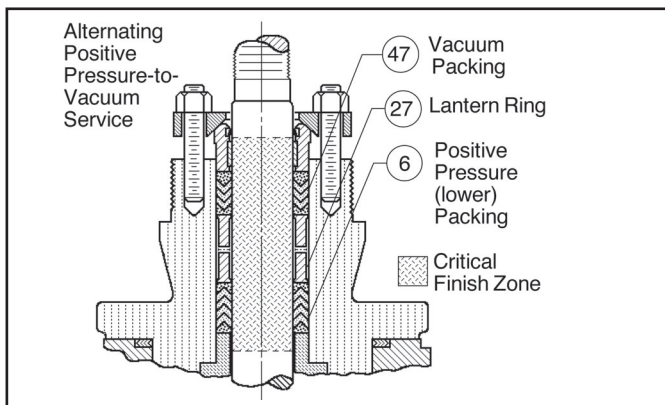


Figure 9: Dual Packing – Arr. "C", Opt-34C

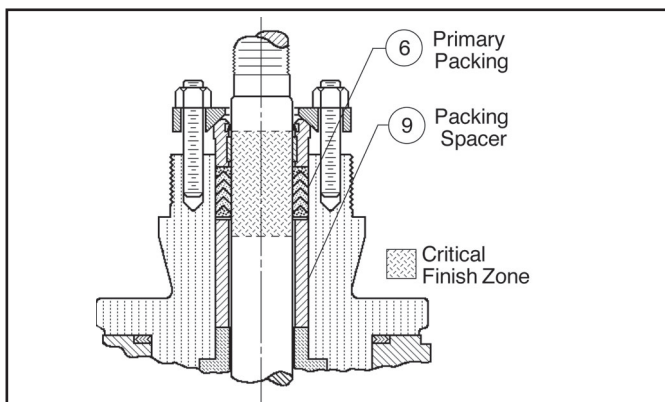


Figure 10: Jammed Packing, Opt-38J

- b. Using a sharp, hooked-end, pick-type tool, hook and pull the primary lower packing ring set (6) up and out of the bonnet's (2) stuffing box individually. Examine for proper orientation (see Figures 7, 8 and 9).
11. Solvent clean all parts to be reused, including bonnet. Examine any parts for wear and corrosion. Replace any corroded or worn parts. Discard old packing.
12. Examine plug/stem (3) at lower guide bushing (8) area for wear. If there are signs of excess wear, guide bushing should be replaced:
 - a. Place the bonnet (2) on a bench press. Press guide bushing out of bonnet and discard.
 - b. Rotate bonnet end-for-end. Place a new guide bushing into position and press fully into the bonnet.
 - c. Reclean bonnet with suitable solvent.
13. Examine plug/stem (3) in critical finish zone where contact is made with the packing (6,47). It is desirable to restore the surface of the stem to a #4 Ra μ -in surface finish; metal removal should not exceed 0.001 inch material. A deeply scratched or pitted stem should be replaced.
14. Examine plug/stem (3) for wear around the seating area. Examine seat ring (11).
 - a. Plug head of stem assembly of metal seated design may be hand lapped using suitable lapping compound. If hand lapping will not restore surfaces to an acceptable degree, then replacement of plug/stem assembly is recommended.
 - b. For composition seated design, if stem assembly is wear damaged, the plug/stem should be replaced.
15. Examine the inner surface of the bonnet's (2) stuffing box. It is desirable to restore the surface of stuffing box to a #8 Ra μ -in surface finish; metal removal should not exceed 0.001 inch material. A deeply scratched or pitted bonnet (2) should be replaced.
16. Examine packing follower (5) for corrosion. Replace if significantly corroded:
 - a. Replace follower bushing (26) with new bushing (26).
 - b. Replace wiper ring (22) with new ring (22).
17. Turn attention to the body and remaining parts yet therein. Remove seat ring (11) (and seat retainer (23) and soft seat insert (24) for composition/soft seated design). Discard used soft seat insert (24); always use a new soft seat insert upon reassembly. If seat ring or seat retainer are damaged, replace.
18. Examine gaskets (12, 13) to see if leakage occurred. Remove and discard both the seat ring gasket (13) and bonnet gasket (12). Always use new gaskets (12, 13) upon reassembly.

19. Remove body (1) from vise. Solvent clean all loose parts with suitable solvent. Determine parts to be replaced due to wear and/or corrosion. Clean seat ring (11), cage (10), and seat retainer (23) as required.
20. Place body (1) back into vise with body/bonnet flange up.
21. Place a new seat ring gasket (13) into position.
22. Note correct orientation of seat ring (11) and place inside the body (1).
23. For a composition/soft seat design, position a new soft seat insert (24) and the seat retainer (23) into position on top of seat ring (11).
24. Place a new bonnet gasket (12) on the body's (1) bonnet flange face.
25. With the cage (10) oriented correctly on the plug/stem assembly (3), set stem's plug head down into the seat ring (11). Keep firm hold of the stem with one hand; use other hand to push cage down into proper alignment.
26. Lift bonnet (2) over threaded end of plug/stem (3) and carefully lower bonnet down over stem, ensuring that the critical finish zone of the bonnet's stuffing box is not scratched by the stem's threads. Align body (1)-to-bonnet (2) flanges to matchmarks as bonnet comes down over bonnet studs (16). Carefully release plug/stem only when bonnet is completely resting on the body.
27. Install bonnet nuts (17) onto bonnet studs (16) and finger-tighten.
- 28A. **For Opt-38J –**
 - a. Make reference to Figs. 3 and 10 for proper packing orientation.
 - b. Place packing spacer (9) over end of plug/stem (3) and carefully lower into stuffing box.
 - c. Carefully place lower adapter (6.3) of new packing ring set (6) over plug/stem's end, properly oriented. Using the packing follower (5), push the lower adapter into the bonnet's (2) stuffing box.
 - d. Carefully place a packing ring (6.2) properly oriented over the plug/stem's end and push into the stuffing box similar to the adapter (6.3). Repeat for each of the four rings (6.2).
 - e. Carefully place upper adapter (6.1) similar to lower adapter (6.3).
- 28B. **For Opt-34 –**
 - a. Make reference to Figs. 3 and 7, 8 or 9 for proper packing orientation. (Opt-34A, Opt-34B or Opt-34C).
 - b. Carefully install correct adapter of lower packing ring set (6) over plug/stem's (3) end, properly oriented. Using the lantern ring (27) and packing follower (5), push the adapter into the bonnet's (2) stuffing box.

- c. Carefully place a packing ring properly oriented over the plug/stem's end and push into the stuffing box similar to the adapter in previous step. Repeat for each of the **four** rings.
 - d. Carefully install correct adapter of packing ring set over plug/stem's end, properly oriented and push into the stuffing box as per previous step. Leave lantern ring (27) in position in stuffing box.
 - e. Carefully install correct adapter of secondary packing ring set (47) over plug/stem's end, properly oriented. Using the packing follower (5), push the adapter into the bonnet's (2) stuffing box.
 - f. Carefully place a packing ring, properly oriented, over plug/stem's end and push into the stuffing box similar to Step e. previous. Repeat for each of the **three** rings.
 - g. Carefully install correct adapter of packing ring set over plug/stem's end, properly oriented, and push into the stuffing box similar to Step f. previous.
29. Place packing follower (5) with new wiper ring (22) and new follower bushing (26) tape over the end of the plug/stem (3).
 30. Place packing flange (4) over end of plug/stem (3) and over packing studs (14).
 31. Install packing stud nuts (15), finger-tight, down to the packing flange (4).
 32. Tighten packing nuts (15) evenly in 1/2 revolution increments, until the shoulder of the packing follower (5) is resting evenly on the upper edge of the bonnet (2) at the stuffing box. Snug both nuts tightly.
 33. Reinstall the two stem jam nuts (52) onto the stem (3) and rotate as far down the stem as possible.
 34. Push valve stem (3) down into the seat ring (11). Wiggle the loose assembly to ensure initial alignment/stacking.
 35. Tighten bonnet bolting (16, 17) in an alternating cross-pattern in 1/4 revolution increments to the following torque levels:

Size	Torque
3/4", 1", 1-1/2"	70-75 ft-lbs (95-102 N-M)
2	50-55 ft-lbs (68-75 N-M)

36. Reinstall the (AA) as recorded in Sub-Section V.C.
37. Position suitable end closures – plugs, blind flanges, etc., – and leak test with 100 psig air pressure minimum. No packing (6) adjustment should be required to get a tight seal.
38. Recalibrate per Section VI.

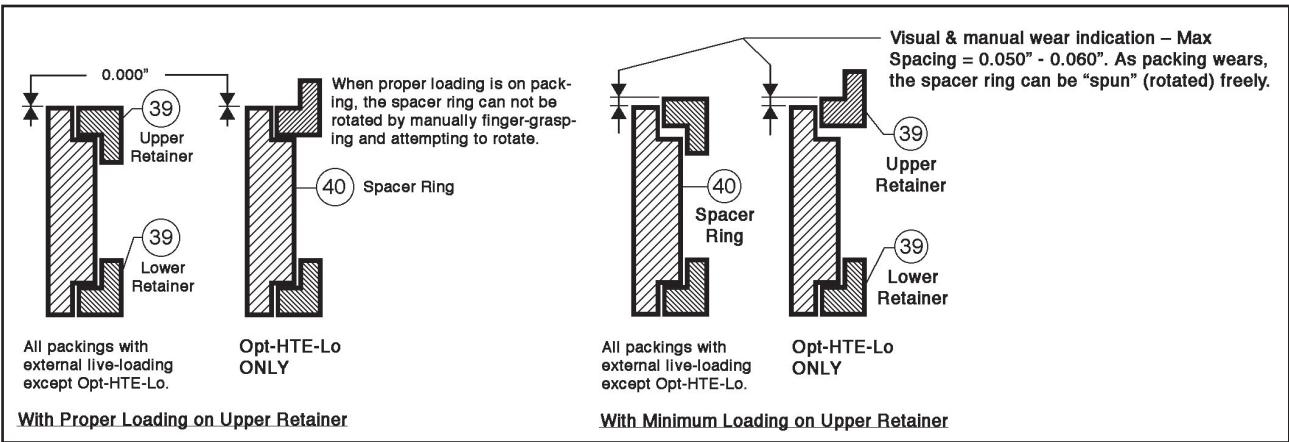


Figure 11: Dimensionals for Proper Packing Load

G. External Live-Loaded Packing Adjustment:

1. There are two types of indicators for determining "packing wear" –
 - a. Ability to "freely spin" the spacer rings (40).
 - b. Measure the spacing between the upper retainers (39) spacer rings (40) (see Fig. 11).

NOTE: Regardless of live loaded packing design, all use the same method for obtaining the proper pre-load to new or used packing.

2. To properly tighten packing, grasp spacer ring (40) between the thumb and forefinger at points approximately 180° from each other.
 - a. Tighten packing stud nuts (15) in 1/2 revolution increments, alternating from one nut to the other, while attempting to rotate the spacer rings (40).

- b. Once spacer rings (40) can no longer be rotated by the fingers, attempt to "even" the opposite packing nut (15) so that the upper retainers (39) are level, then add 1/2 revolution to each packing nut. Adjustment completed.

3. If the spacing between the upper retainers (39) and spacer rings (40) are used as visual indicator, the spacing should not exceed 0.060" (1.5 mm) (approximately 1/16"). When this level of "packing wear" is indicated, adjustment per Step 2. above is required.
4. Packing (6) adjustment can be made at any time.

NOTE: If packing (6) live-load is set too high, the packing will act as non-live-loaded, jammed packing. Excess actuator thrust will be required and packing wear will be accelerated.

SECTION VI

VI. CALIBRATION

A. General:

1. This section only covers calibration of the control valve with Actuator Models C27/C53.
2. Positioner, if installed, requires reference to the specific positioner model IOM for proper calibration procedure.
3. All indicated items numbers that are with respect to IOM-C27-C53 will be in parenthesis and underscored; i.e. (20); those that reference the positioner IOM will be in double parentheses; i.e. ((AP)). All item numbers that are with respect to this IOM-988/989 are not underscored; i.e. (3).

B. Procedure - Reverse Action, ATO-FC:

1. Reference the nameplate (40) attached to the actuator yoke (3). Determine the bench setting of the installed range springs (10) from the nameplate; i.e. 5-15 psig (.34 -1.0 Barg), or 15-60 psig (1-4.1 Barg).
2. Connect a temporary air supply with an in-line adjustable airset regulator and gauge to the lower actuator connection. See Section IV. A. 6. for appropriate supply pressure. **DO NOT LOAD** with any air pressure at this point.
3. To determine when stem/plug (3) begins to lift out of the seat, touch the stem above the packing studs with one finger. (Stem will begin to move when actuator pressure exceeds the spring load.)

4. Slowly pressurize the actuator to a pressure equal to the lower pressure level of the bench setting; i.e. for a 5-15 psig (.34 -1.0 Barg) range, set pressure at 5 psig (.34 Barg). Take note of pressure reading when the stem first begins to move.
 5. If the loading pressure for the start of stem movement **is below the lower end** of the desired bench setting, then the combined stem (3, 6) length is too **short**.
 - a. Rotate both jam nuts (52) down to base of threads on stem (3) and tighten together.
 - b. Increase pressure in the actuator to approximately mid range of the bench setting.
 - c. Rotate upper jam nut CW to increase the combined stem length. **DO NOT** allow actuator stem (6) to rotate in the actuator.
 - d. Rotate upper jam nut CCW to hold indicating washer (51) up against stem (6).
 - e. Release all pressure from the actuator and repeat Step 4 previous.
 6. If the loading pressure for the start of stem movement **is above the lower end** of the desired bench setting, then the combined stem (3, 6) length is too **long**.
 - a. Rotate both jam nuts (52) down to base of threads on stem (3) and tighten together.
 - b. Increase pressure in the actuator to approximately mid range of the bench setting.
 - c. Rotate lower jam nut CCW to shorten the combined stem length. **DO NOT** allow actuator stem (6) to rotate in the actuator.
 - d. Rotate upper jam nut CCW to hold indicating washer (51) up against stem (6).
 - e. Release all pressure from the actuator and repeat Step 4 previous.
 7. After the opening set point pressure has been established, rotate lower jam nut (51) CCW up tight under the upper jam nut.
 8. Release all pressure from the actuator.
 9. Examine the location of the indicating washer (51) to the "C" mark on the indicator plate (23), making sure to use the "top edge" of the indicating washer as the reference point. Adjust indicator plate as needed.
 10. Increase pressure in the actuator until the indicating washer (51) is in alignment with the "O" mark on the indicator plate.
 11. To limit the up travel at the desired stroke length, rotate the travel stop nut (52) CW and secure to bottom of the attachment hub (4). **NOTE:** Secure the actuator stem (6) by the flats when rotating the travel stop nut. **NOTE:** "Stroke" length is indicated on the nameplate (40), and is the distance between the "C" and "O" marks of the indicator plate (23). **NOTE:** The proper calibration of the actuator/ valve unit will occur when at the lower pressure level of bench setting, the valve plug (3) will just begin to travel from the "C" position. At the upper level of the bench setting, the actuator pressure should be within $\pm 8\%$ of the upper bench setting for the designed stroke length.
 12. Release all pressure from actuator.
- C. Procedure - Direct Action, ATC-FO:**
1. Reference the nameplate (40) attached to the actuator yoke (3). Determine the bench setting of the installed range springs (10) from the nameplate; i.e. 5-15 psig (.34 -1.0 Barg), or 15-60 psig (1-4.1 Barg).
 2. Connect a temporary air supply with an in-line adjustable airset regulator and gauge to the upper actuator connection. See Section IV. A. 6. for appropriate supply pressure. **DO NOT LOAD** with any air pressure at this point.
 3. To determine when stem/plug (3) makes contact with the seat and travel stops, touch the stem above the packing studs with one finger. (Stem movement will stop when the plug engages the seat.)
 4. Slowly pressurize the actuator to a pressure equal to the upper pressure level of the bench setting; i.e. for a 5-15 psig (.34 -1.0 Barg) range, set pressure at 15 psig (1.0 Barg). Take note of the pressure reading when stem travel actually stops.
 5. If the loading pressure, when the stem movement stops, **is below the upper end** of the desired bench setting, then the combined stem (3, 6) length is too **long**.
 - a. Rotate both jam nuts (52) down to base of threads on stem (3) and tighten together.
 - b. Decrease pressure in the actuator to approximately mid range of the bench setting.
 - c. Rotate lower jam nut CCW to shorten the

- combined stem length. **DO NOT** allow actuator stem (6) to rotate in the actuator.
- d. Rotate upper jam nut CW to hold indicating washer (51) up against stem (6).
 - e. Release all pressure from the actuator and repeat Step 4 previous.
6. If the loading pressure when the stem movement stops **is above the upper end** of the desired bench setting, then the combined stem (3, 6) length is too short.
 - a. Rotate both jam nuts (52) down to base of threads on stem (3) and tighten together.
 - b. Decrease pressure in the actuator to approximately mid range of the bench setting.
 - c. Rotate upper jam nut CW to increase the combined stem length. **DO NOT** allow actuator stem (6) to rotate in the actuator.
 - d. Rotate upper jam nut CCW to hold indicating washer (51) up against stem (6).
 - e. Release all pressure from the actuator and repeat Step 4 previous.
 7. After the closed set point pressure has been established, rotate lower jam nut (52) CCW up tight under the upper jam nut.
 8. Increase pressure in the actuator to the upper pressure level of the bench setting.
 9. Observe the location of the indicating washer (51) to the "C" mark on the indicator plate (23), making sure to use the "top edge" of the indicating washer (51) as the reference point. Adjust indicator plate as needed.
 10. Slowly release air pressure in the actuator until the indicating washer (51) is in alignment with the "O" mark on the indicator plate.
 11. To limit the up travel at the desired stroke length, rotate travel stop nut (52) CW and secure to bottom of the attachment hub (4).

NOTE: Secure the actuator stem (6) by the flats when rotating the travel stop nut.

NOTE: "Stroke" length is indicated on the nameplate (40), and is the distance between the "C" and "O" marks of the indicator plate (23).

NOTE: The proper calibration of the actuator/ valve unit will occur when at the upper pressure level of bench setting, the valve plug (3) will be in the "C" position. At the lower level of bench set the actuator pressure should be within $\pm 8\%$ of the lower bench setting for the designed stroke length.
 12. Release all pressure from actuator.

SECTION VII

VII. TROUBLE SHOOTING GUIDE

1. Valve is “jumpy” in stroking.

Possible Cause	Remedy
A. Excess packing friction.	A1. Realign body–stem–actuator. A2. Packing follower too tight for optional packing designs. A3. Install positioner. A4. Increase bench set by changing to stiffer actuator range spring. Will require positioner if not installed. May require different airset.
B. Installed backwards.	B. Install per flow arrow.

2. Valve makes “screeching” noise.

Possible Cause	Remedy
A. Excess pressure drop.	A. Bring pressure drop within design limits.
B. Lower guide bushing wear.	B. Replace upper and lower guide bushings.
C. Misalignment.	C. Realign body–stem–actuator.

3. Valve exhibits “excess” vibration.

Possible Cause	Remedy
A. Excess pressure drop.	A. Bring pressure drop within design limits.
B. Lower guide bushing wear.	B. Replace upper and lower guide bushings.
C. Excessive cavitation in liquid service.	C1. Change operation parameters to relieve causes of cavitation. C2. Replace valve with valve equipped for cavitation control.
D. High outlet velocity.	D1. Reduce flow rate and/or pressure drop. D2. Use multiple valves in series or parallel. D3. Increase outlet pipe size.

4. Valve exhibits “excess” seat leakage.

Possible Cause	Remedy
A. Excess pressure drop.	A1. Reduce pressure drop conditions. A2. Convert to reduced trim.
B. Improper actuator bench setting.	B1. Calibrate actuator-to-valve. B2. Ensure proper engagement of actuator stem-to-valve stem. Adjust as calibration dictates.
C. Metal seat design instead of composition seat design.	C. Convert valve to composition seat design.

4. Valve exhibits “excess” seat leakage.

Possible Cause	Remedy
D. Excess wear.	D1. Oversized valve operating too close to seat; go to reduced trim. Incorporate stellite trim. D2. Remove particulate. D3. Possible excess cavitation in liquid service. Change operation parameters. D4. Re-lap plug–seat surface. D5.
E. Misalignment.	E. Realign body–stem–actuator.
F. Composition seat failure.	F1. Replace soft seat. F2. Remove “dirty” portion of fluid causing failure.
G. Seat ring gasket failure.	G. Replace seat ring gasket.

5. Premature packing leakage.

Possible Cause	Remedy
A. Over-temperature.	A1. Bring process temperature to 450°F (232°C) or less. A2. Remove insulation along bonnet; allow direct contact with ambient air. A3. Replace standard packing with high-temp. packing.
B. Misalignment.	B. Realign body–stem–actuator.
C. Wear.	C1. Remove dirt/grit from fluid. C2. Reduce cyclic travel.
D. Improper design for applied service.	D. Install alternate packing design.
E. Corrosion of stem.	E1. Use alternate stem material. E2. Incorporate leak-off option.
F. Insufficient spring force.	F1. Replace packing spring. F2. Add one packing ring.

6. Bonnet gasket leaking.

Possible Cause	Remedy
A. Improper bonnet bolting draw down.	A. Replace gasket and draw down bolting evenly in a cross-pattern.
B. Corrosion.	B. Alternate gasket material and/or alternate body/bonnet material.
C. Warped bonnet and/or body flange.	C. Replace body and/or bonnet and bonnet gasket. Draw down bonnet bolting evenly in a cross-pattern.

7. Body flange leakage.

Possible Cause	Remedy
A. Over-tightening flange bolting.	A1. Loosen bolting, replace gasket, reinstall new flange bolting. A2. Replace warped flanges.
B. Corrosion of split rings.	B. Replace CS split rings with SST split rings.
C. Improper pipe supports and anchors.	C. Provide piping anchors and guides at control valve station. Restrain bending movements.

SECTION VIII

VIII. ORDERING INFORMATION

NEW REPLACEMENT UNIT vs PARTS "KIT" FOR FIELD REPAIR

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

□□□□-□□□□ 7-□□□□□□□□□□

NEW REPLACEMENT UNIT:

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

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.



CAUTION

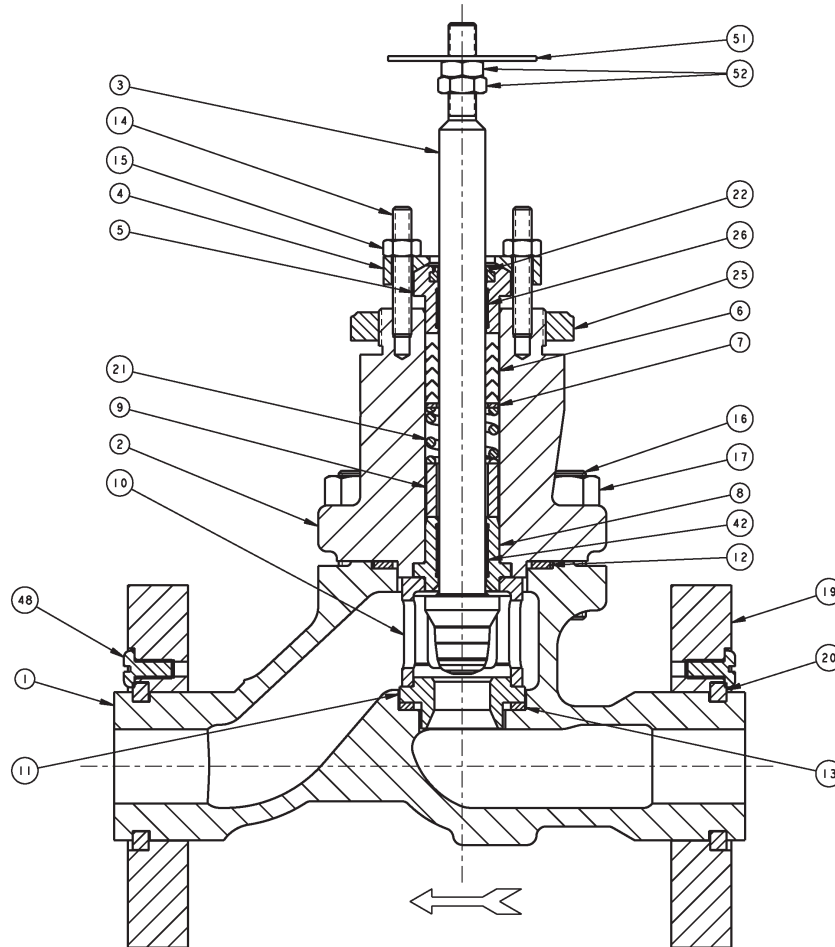
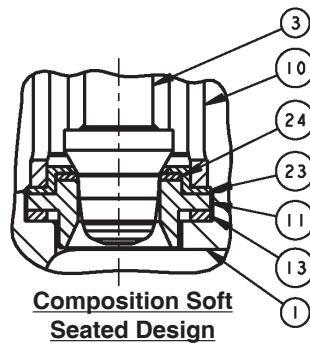
Do not attempt to alter the original construction of any unit without assistance and approval from the factory. All purposed changes will require a new name plate with appropriate ratings and new product code to accommodate the recommended part(s) changes.

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.

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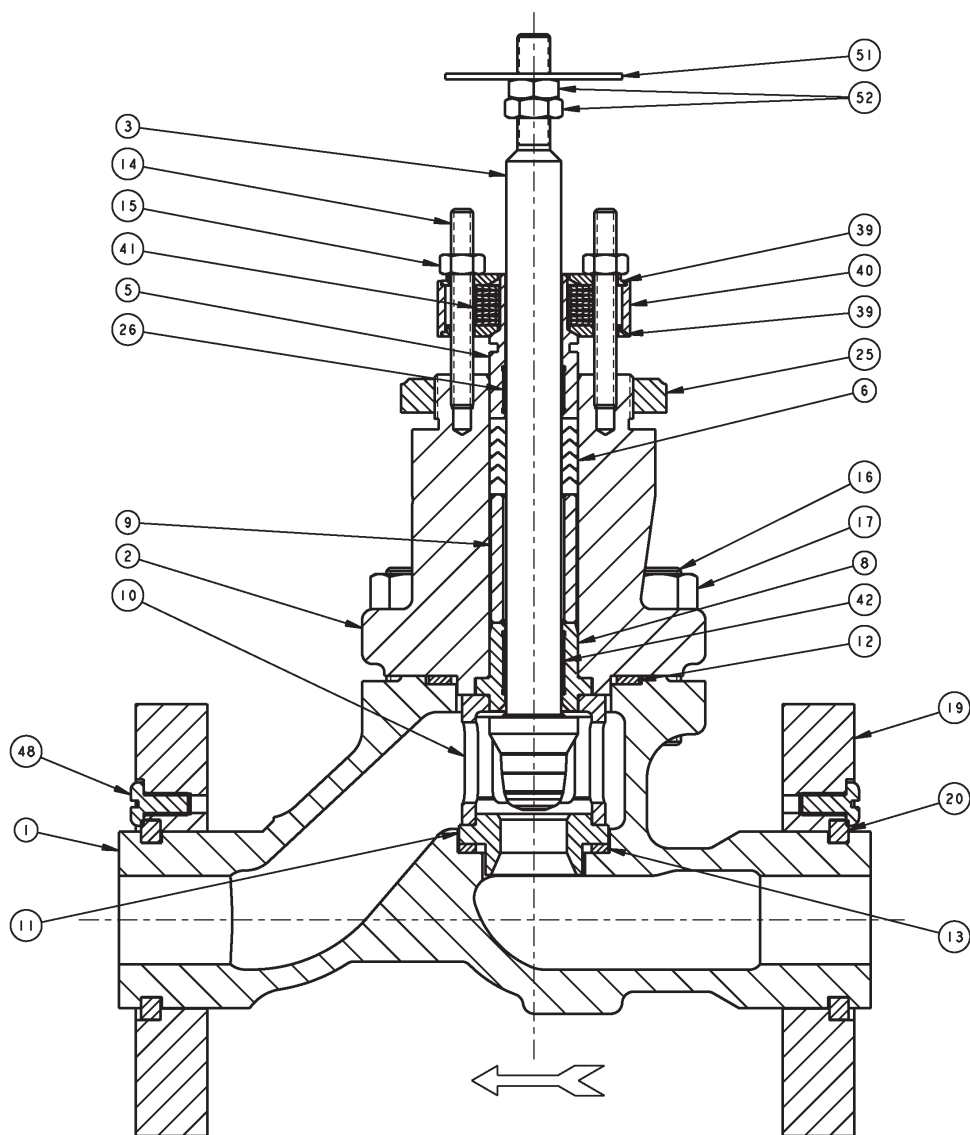


MODEL 988/989 BODY ASSEMBLY (BA)
Internal Live Loaded Packing — Metal Seated Design

ITEM NO.	DESCRIPTION	ITEM NO.	DESCRIPTION	ITEM NO.	DESCRIPTION
1	Body	13	Gasket (Seat Ring)	24	Seat Insert (Soft Seat)
2	Bonnet	14	Stud (Packing Flange)	25	Yoke Nut
3	Plug & Stem Assembly	15	Hex. Nut (Packing Flange)	26	Follower Bushing
4	Packing Flange	16	Bonnet Stud	42	Bushing
5	Packing Follower	17	Stud Nut	48	Screw (Split Rings)
6	Packing	19	Flange (Body 150# or 300#)	51	Indicating Washer
7	Packing Washer	20	Split Ring	52	Stem Nuts
8	Guide Bushing	21	Packing Spring		
9	Packing Spacer	22	Wiper Ring		
10	Cage	23	Seat Retainer (Soft Seat)		
11	Seat Ring (Metal or Soft Seat)				
12	Bonnet Gasket				

ITEMS NOT SHOWN

ITEM NO.	DESCRIPTION
31	Pipe Plug (-26 Leak Off Connection)
53	Bonnet Spacer (2" Size)



MODEL 988/989 BODY ASSEMBLY (BA)
External Live Loaded Packing — Metal Seated Design

ITEM NO.	DESCRIPTION	ITEM NO.	DESCRIPTION	ITEM NO.	DESCRIPTION
1	Body	12	Bonnet Gasket	24	Seat Insert (Soft Seat)
2	Bonnet	13	Gasket (Seat Ring)	25	Yoke Nut
3	Plug & Stem Assembly	14	Stud	26	Follower Bushing
5	Packing Follower	15	Hex. Nut	39	Retainer
6	Packing	16	Bonnet Stud	40	Spacer
8	Guide Bushing	17	Stud Nut	41	Belleville Spring
9	Packing Spacer	19	Flange (Body 150# or 300#)	42	Bushing
10	Cage	20	Split Ring	48	Screw (Split Rings)
11	Seat Ring (Metal or Soft Seat)	23	Seat Retainer (Soft Seat)	51	Indicating Washer
				52	Stem Nuts

ITEMS NOT SHOWN	DESCRIPTION
31	Pipe Plug (-26 Leak Off Connection)
53	Bonnet Spacer (2" Size)

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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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