MODELS 988 and 989

GLOBE-STYLE PNEUMATIC CONTROL VALVE *BODY*

SECTION I

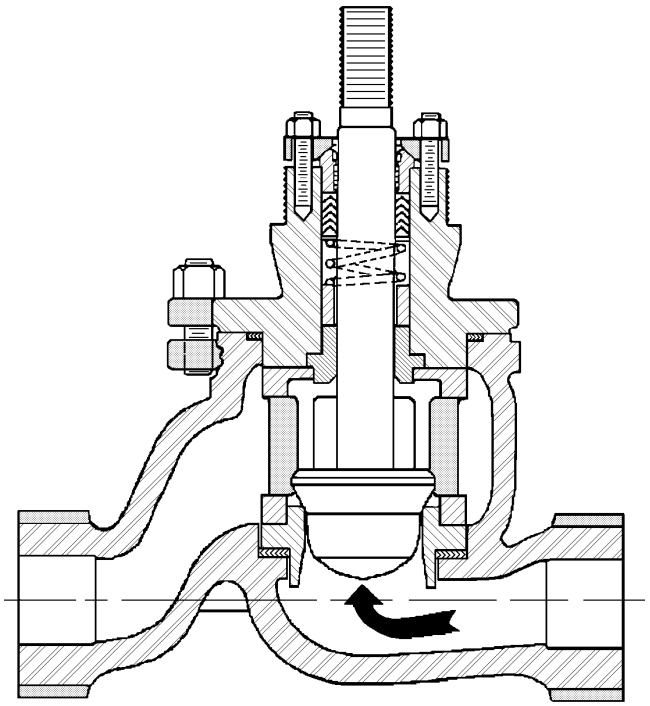
I. DESCRIPTION AND SCOPE

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).

The valves are designed for chemical service and most common liquid, gaseous, or steam service. The body is rated at ANSI 300# for pressure vs. temperature.

Actuators that may be mounted on the 988/989 are the Cashco Models 55D, 55R, 75D, 75R, 115D and 115R.

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 Body
Shown with Internal Live-Loaded Packing

SECTION II

II. REFERENCES

Refer to Technical Bulletin 988-TB or 989-TB for technical specifications of a Model 988 or 989 respectively, coupled with any of the Cashco Models 55, 75 or 115 actuators.

Refer to the following Installation, Operation and Maintenance Manuals (IOM's) for devices mounted to a Model 988/989 body or its actuator:

P/P Positioners	I/P Positioners	Actuators
IOM-9540L	IOM-9520L	IOM-55/75/115

ABBREVIATIONS

ATO-FC ..... Air-to-Open, Fail Closed
ATC-FO ..... Air-to-Close, Fail Open
CCW ..... Counter Clockwise
CW ..... Clockwise
D ..... Direct Acting
DIR ..... Direct Acting
HC ..... Cast CW-12MW or Wrought Hast C-22
IAS ..... Instrument Air Supply
IOM ..... Installation, Operation and Maintenance Manual
LOAD ..... Positioner Output Air Pressure
R ..... Reverse Acting
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.

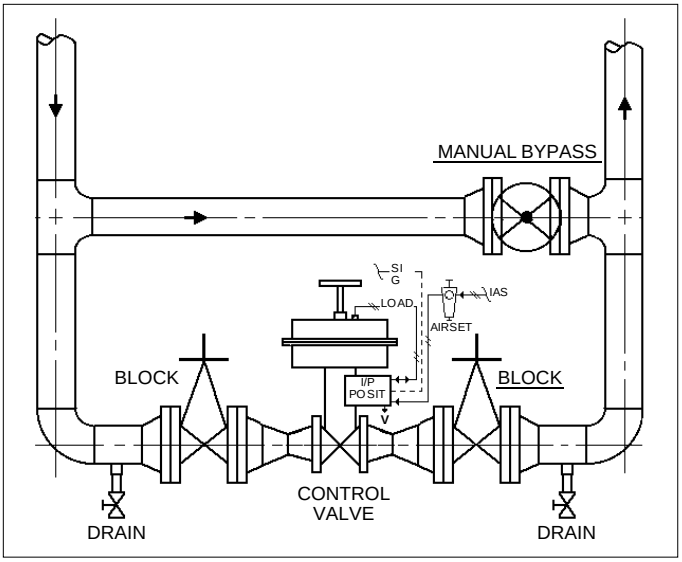


Figure 1: Typical Control Valve Station

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. Clean the 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.

5. 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.

6. 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.

7. Flow Direction: Install so the flow direction matches the arrow on the valve body.

8. For best performance, install in well drained horizontal pipe, properly trapped if a steam service application.

9. Valves are not to be direct buried underground.

10. 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.

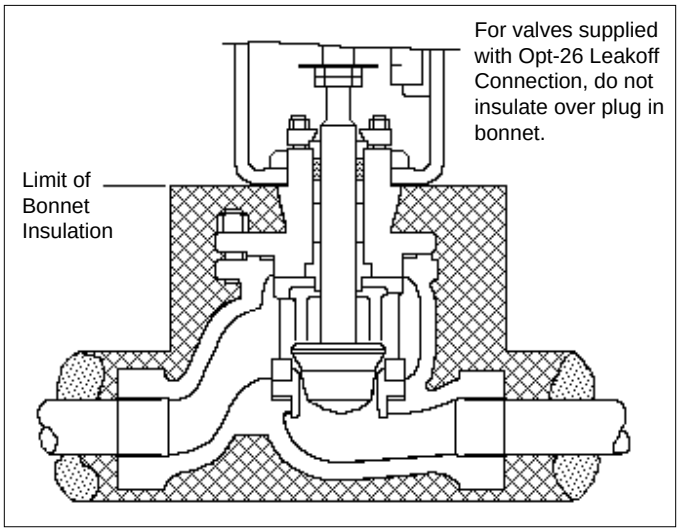


Figure 2: Body Insulation

11. 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 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 in 180° crossing pattern through bolt holes 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. MAINTENANCE

⚠ 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.

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 IOM-55/75/115 will be in parenthesis and underscored; i.e. (20); the same is true for the positioner parts. All Item Numbers that are with respect to this IOM-988/989 are not underscored; i.e. (32).

6. **Special care must be exhibited when rotating the stem (3) of the valve to not mar that portion of the surface of the stem (3) where it contacts with the packing (6). To rotate the stem (3) use the jam nuts (17) or a soft jawed pliers.** ***NOTE****: When using the jam nuts (17) to rotate the stem (3), use the upper jam nut (17) to rotate the stem (3) CW, and the lower jam nut (17) to rotate the stem (3) CCW, when viewed from above valve stem (3).*

B. Actuator Assembly Removal:

1. Reference the correct actuator IOM also for this procedure.

2. Secure the body assembly (BA) in a vise with the valve stem (3) oriented vertically upwards.

3. Rig actuator assembly (AA) to be supported above the valve body assembly (BA).

4. Place matchmarks between the bonnet/yoke and yoke/accessory plate.

5. This procedure assumes that the body assembly (BA) has been fully assembled through the bonnet (2), including the packing flange (4), packing follower (5), and packing (6).

6. Securing the "flats" of the actuator stem (19) by wrench, loosen stem jam nuts (17) by rotating CW (viewed from above) one-at-a-time.

7. Fully loosen any accessory devices that are connected to/with the stems (19), (3), such as accessory plate (AP) for limit switch or positioner.

8. If the actuator is to be reinstalled, put paint or dye marker between the valve stem (3) and the actuator stem (19), to serve as matchmarks.

9. Loosen packing (6) by loosening packing flange nuts (15) CCW 2-3 revolutions.

10. To fully disengage the actuator stem (19) from the valve stem (3) is a two-step procedure. Be aware of the valve's stroke length as indicated on the nameplate (12) 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.

No. of revolutions to disengage valve stem from actuator stem:

Step A. _____ Step B. _____

TOTAL _____

11A. For ATO-FC Reverse Action Actuators;

a. Grasp the valve's stem (3) at a point above the packing follower (5) using soft-jawed locking pliers.

b. Pressurize the actuator to lift the valve's plug (3) away from the seat ring (11) until the plug (3) is 100% open.

c. Using a blunt end tool, hammer rap the tool to loosen yoke nut (25), turning CCW (viewed from above) approximately 1/2 revolution.

d. Step A. Rotate valve stem (3) CW (viewed from above the valve) to disengage the actuator stem (19) from the valve stem (3). When disengagement reaches approximately 50% of full stroke travel, Step A is completed. Record the number of stem revolutions for Step A on previous page.

e. Step B. Support the actuator assembly (AA) from above. Fully loosen yoke nut (25) to removal. Lift the actuator assembly (AA) upwards approximately 1/4"–3/4" (6–8 mm). Again, rotate valve stem (3) CW (viewed from above the valve) until disengagement of valve's stem (3) from actuator stem (19). Record the number of valve stem (3) revolutions for Step B on previous page.

***NOTE**: Take notice of the parts "dangling loosely" about the stem (3), the order of their location and their proper orientation.*

11B. For ATC-FO Direct Action Actuators:

a. Step A. Using soft-jawed pliers, rotate valve stem (3) CW (viewed from above the valve) to disengage the actuator stem (19) from the valve stem (3). When disengagement reaches approximately 50% of full stroke travel, Step A is completed. Record the number of stem revolutions for Step A on previous page.

b. Using a blunt end tool, hammer rap the tool to loosen the yoke nut (25), turning CCW (viewed from above) approximately 1/2 revolution.

c. Step B. Support the actuator assembly (AA) from above. Fully loosen yoke nut (25) to removal. Lift the actuator assembly (AA) upwards approximately 1/4"–3/8" (6–8 mm). Again rotate valve stem (3) CW (viewed from above valve) until disengagement of valve's stem (3) from actuator stem (19). Record the number of valve stem (3) revolutions for Step B on previous page.

***NOTE**: Take notice of the parts "dangling loosely" about the stem (3), the order of their location and their proper orientation.*

12. Fully raise the actuator assembly (AA) from the valve body assembly (BA). Remove cautiously to prevent the "dangling parts" (position indicating disc (20), accessory plate (AP), yoke nut (25)) from falling. Release air pressure from actuator.

C. Mounting Actuator Assembly to Body Assembly:

1. Reference the correct actuator IOM also for this procedure.

2. Secure the body assembly (BA) in a vise with the valve stem (3) oriented vertically.

3. Rig actuator assembly (AA) to be supported above the valve body assembly (BA).

4. This procedure assumes that the bonnet (2) has been bolted to the body (1).

5. Engage stem jam nuts (17) one-at-a-time to the valve stem (3) by rotating CW (viewed from valve stem end). Rotate jam nuts (17) all the way to the root of the valve stem (3) threads.

6. Lower actuator assembly (AA) until the opening of the actuator yoke (1) is at the level of upper jam nut (17).

7. Place yoke nut (25) over the valve stem (3) and lower the nut (25) to rest upon the yoke (1).

8. Place travel indicator disc (20) and accessory plate (AP) over the valve stem (3) and lower the disc (20) and accessory plate (AP) to rest upon upper stem jam nut (17).

9. Align matchmarks between body/bonnet, bonnet/yoke and yoke/accessory plate.

10. Hook up a temporary air supply hose that has an adjustable airset connected at the actuator inlet to allow pressurization.

11. Push valve stem (3) downward towards seating position.

12. ***For Direct Action ATC-FO Actuators Only:*** Pressurize actuator to a level equal to the upper pressure level of the bench setting; i.e. for 5–15 psig (.34–1.03 Barg) range, set pressure at 15 psig (1.03 Barg).

13. Continue lowering the actuator assembly (AA) until the actuator's stem (19) and the valve's stem (3) just touch.

14. Screw yoke nut (25) onto bonnet (2) as far as able to help stabilize topworks. Wrench-tighten one-half (1/2) extra revolution.

15. Engage valve stem (3) to actuator stem (19) by rotating valve stem (3) CW (viewed from valve end) the same number of revolutions as recorded to disengage the stem (3) per Step A on previous page.

16. Fully lower the actuator assembly (AA) downwards until the yoke (1) is properly positioned on the valve bonnet (2). Hand-tighten yoke nut (25).

17. Complete engagement of valve stem (3) into actuator stem (19) the number of revolutions recorded in Step B previous.

18. Connect "dangling parts" – accessory plate (AP) and travel indicator disc (20) – to actuator stem (19) with stem jam nuts (17).

19. Retighten packing flange nuts (15).

20. Impact tighten yoke nut (25) by hammer rapping with a blunt end tool.

21. Test stoke unit by alternately pressurizing and then depressurizing the actuator. Repeat several times. DO NOT OVER PRESSURIZE.

22. Release air pressure from actuator assembly (AA) and remove temporary air supply.

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 actuator assembly (AA) as described in Sub-Section IV.B. Leave body assembly (BA) in vise with stem (3) upwards.

2. Loosen stem packing (6) by further loosening packing nuts (15) to just short of disengagement from packing studs (14). DO NOT REMOVE PACKING NUTS (15).

3. Remove all bonnet nuts (17).

4. Lift bonnet (2), stem assembly (3), cage (10) and all packing zone parts up and out of the body (1) while holding stem (3) to prevent from falling. Set 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 (17).

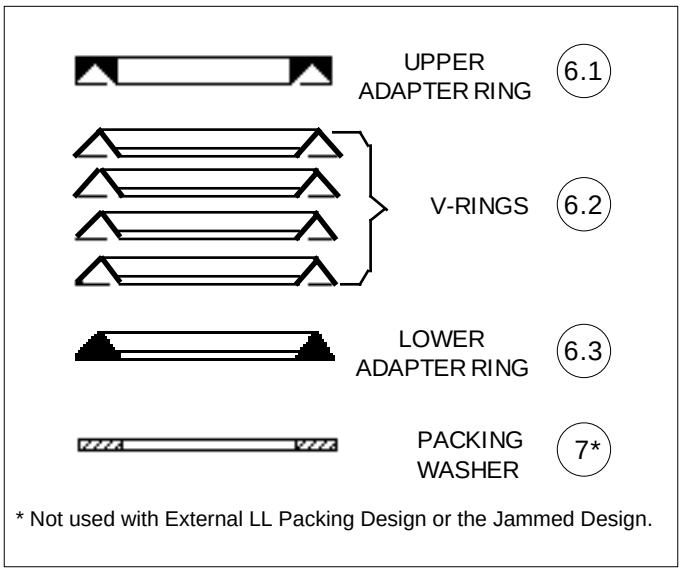
6. Withdraw stem assembly (3) from within the bonnet (2) and packing (6), holding cage (10) to prevent from dropping. Set parts (3, 10) aside.

7. Place the bonnet (2) into a second vise with the packing zone on top.

8. Remove the two packing nuts (15).

9. Remove the packing flange (4) and packing follower (5).

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 proper orientation (see Figure 3). Discard old packing (6).



* Not used with External LL Packing Design or the Jammed Design.

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

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 (2) stuffing box.

12. Solvent clean all parts to be reused, including bonnet (2). Examine any parts for wear and corrosion. Replace any corroded or warn parts.

13. Examine stem (3) at lower guide bushing (8) for wear. If guide bushing (8) appears to have excess wear, it should be replaced:
    a. Place the bonnet (2) on a bench press. Press the guide bushing (8) out of the bonnet (2) and discard.
    b. Rotate bonnet (2) end-for-end. Place a new guide bushing (8) into position and press full into the bonnet (2).
    c. Reclean bonnet with suitable solvent and allow to dry.

14. Examine 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 (3) should be replaced.

15. Examine stem (3) for wear at the seating areas. 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 stem assembly is recommended.
    b. For composition seated design, if stem assembly (3) is wear damaged, the stem (3) 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 significantly corroded:
    a. Replace follower bushing (26) with new bushing (26).
    b. Replace wiper ring (22) with new ring (22).

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). Discard used soft seat insert (24); always use a new soft seat insert (24) 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 (13) and bonnet gasket (12). Always use new gaskets (12,13) 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) as required.

21. Place body (1) back into vise with bonnet flange up.

22. Place a new seat ring gasket (13) into position.

23. Place the new seat ring (11) into correct position within the body (1).

24. If 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).

25. Place new bonnet gasket (12) on the body's (1) bonnet flange.

26. Orient the cage (10) over the stem assembly (3) properly, and set stem's (3) plug head down into the seat ring (11). Keep hold of the stem (3) with one hand; use other hand to push cage (10) down into proper alignment.

27. Lift bonnet (2) over threaded end of stem (3) and carefully lower bonnet (2) down over stem (3), ensuring that the critical finish zone of the bonnet's (2) stuffing box is not scratched by the stem's (3) threads. Align body (1)-to-bonnet (2) flanges to matchmarks as bonnet (2) comes down over bonnet studs (16). Carefully release stem (3) only when bonnet (2) is fully down.

28. Install bonnet nuts (17) onto bonnet studs (16) and finger-tighten.

29. Place packing spacer (9) over end of stem (3) and carefully lower into stuffing box.

30. Place packing spring (21) over end of stem (3) and carefully lower down into stuffing box.

31. Place packing washer (7) over end of stem (3) and carefully lower into stuffing box.

32. See Figure 3 for proper packing orientation.

33. Carefully place lower adapter (6.3) of packing ring set (6) over stem's (3) end, properly oriented. Using the packing follower (5), push the lower adapter into the bonnet's (2) stuffing box.

34. Carefully place a packing ring (6.2) properly oriented over the 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).

35. Carefully place upper adapter (6.1) over the stem's (3) end.

36. Place packing follower (5) with new wiper ring (22) and new follower bushing (26) tape over the end of the stem (3).

37. Place packing flange (4) over end of stem (3) and over packing studs (14).

38. Install both packing nuts (15), finger-tight, down to the packing flange (4).

39. 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 (15) tightly.

40. Reinstall the two stem jam nuts (17) onto the stem (3) and rotate as far down the stem (3) as possible.

41. Push valve stem (3) down into the seat ring (11). Wiggle the loose assembly to ensure initial alignment/stacking.

42. 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)

43. Reinstall the actuator assembly (AA) as recorded in Sub-Section IV.C.

44. 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.

45. Recalibrate per Section V.

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.)

1. Remove actuator assembly (AA) as described in Sub-Section IV.B. Leave body assembly (BA) in vise with stem (3) upwards.

2. Place thread penetrating lubricant on bonnet bolting (16,17) and packing bolting (14,15).

3. Loosen both packing nuts (15) until clearance exists between the bottom of the nuts (15) and the upper retainer (39). See Figure 4.

4. Spacer ring (40) should "spin freely". If stacked mechanism (39,40,41) is not "loose" due to corrosion, debris, packed dirt, etc., tap the spacer ring (40) lightly with a hammer while attempting to pry up the spacer ring (40)/lower retainer (39) with a flat tool. DO NOT REMOVE PACKING NUTS (15).

⚠ WARNING

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

5. Continue to loosen packing nuts (15) to just short of disengagement from packing studs (14). DO NOT REMOVE PACKING NUTS (15).

6. Remove all bonnet nuts (17).

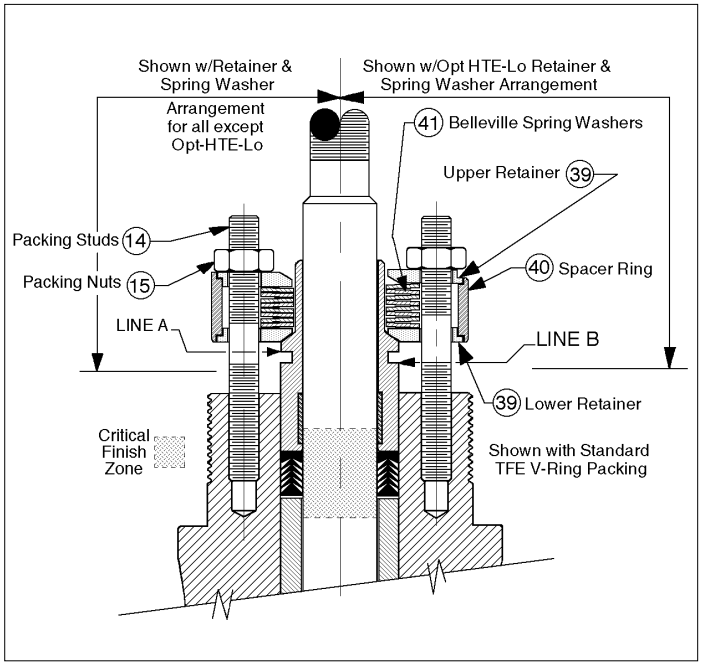


Figure 4: External Live Loaded Packing Orientation

7. Lift bonnet (2), stem assembly (3), cage (10), and all packing zone parts up and out of the body (1) while holding stem (3) to prevent from falling. Set 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 (17).

9. Withdraw stem assembly (3) from within the bonnet (2) and packing (6), holding 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.

11. Remove the two packing nuts (15).

12. Grasp the lower retainer (39) from its underneath side and lift the lower retainer (39), spacer ring (40), Belleville spring washer stack (41), and upper retainer (39) together over the packing studs (14). Set these parts (39,40,41) aside without disturbing the orientation.

13. Remove packing follower (5) together with follower bushing (26 or 5.2). Discard Rulon tape bushing (26) if supplied.

14. 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 proper orientation (see Fig. 3). Discard old packing (6).

15. Remove bonnet (2) from the vise and invert to allow packing spacer (9) to slide out of the bonnet's (2) stuffing box.

16. 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.

17. Examine stem (3) at lower guide bushing (8) for wear. If guide bushing (8) appears to have excess wear, it should be replaced:
    a. Place the bonnet (2) on a bench press. Press the guide bushing (8) out of the bonnet (2) and discard.
    b. Rotate bonnet (2) end-for-end. Place a new guide bushing (8) into position and press fully into the bonnet (2).
    c. Reclean bonnet with suitable solvent and allow to dry.

18. Examine 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 (3) should be replaced.

19. Examine stem (3) for wear at the seating areas. 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 stem assembly is recommended.
    b. For composition seated design, if stem assembly (3) is wear damaged, the stem (3) should be replaced.

20. 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.

21. Examine packing follower (5) for corrosion. Replace if significantly corroded:
    a. Replace follower bushing tape (26), if supplied, 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 (5) if necessary.

22. *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 (24) upon reassembly, If seat ring(11) or seat retainer (23) are damaged, replace.

23. 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.

24. 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.

25. Place body (1) back into vise with bonnet flange up.

26. Place a new seat ring gasket (13) into position.

27. Place the seat ring (11) into position within the body (1).

28. If 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).

29. Place a new bonnet gasket (12) on the body's (1) bonnet flange.

30. Orient the cage (10) over the stem assembly (3) properly, and set stem's (3) plug head down into the seat ring (11). Keep hold of the stem (3) with one hand; use other hand to push cage (10) down into proper alignment.

31. Lift bonnet (2) over threaded end of stem (3) and carefully lower bonnet (2) down over stem (3), ensuring that the critical finish zone of the bonnet's (2) stuffing box is not scratched by the stem's (3) threads. Align body (1) to-bonnet (2) flanges to matchmarks as bonnet (2) comes down over bonnet studs (16). Carefully release stem (3) only when bonnet (2) is fully down.

32. Install bonnet nuts (17) onto bonnet studs (16) and finger -tighten.

33. Place packing spacer (9) over end of stem (3) and carefully lower into stuffing box.

34A. *For Opt-EXT and Opt-KRE Packing option – (Reference Figure 3 for proper packing orientation) –*
    a. Carefully place lower adapter (6.3) of packing ring set (6) over stem's (3) end, properly oriented. Using the packing follower (5), push the lower adapter into the bonnet's (2) stuffing box.
    b. Carefully place a packing ring (6.2) properly oriented over the 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).
    c. Carefully place upper adapter (6.1) similar to lower adapter (6.3). Leave packing follower (5) in position, properly oriented.
    d. Place lower retainer (39) over the stem's (3) end and over the packing studs (14). See Fig. 4 for proper orientation.
    e. Orient spring washers (41) stack per Figure 5. Lower spring washer (41) stack over stem's (3) end and down onto the lower retainer (39).
    f. Place spacer ring (40) over stem's (3) end and onto ledge of lower retainer (39).
    g. Place upper retainer (39) over the stem's (3) end, over both of the packing studs (14), and onto the ledge of the spacer ring (40). Ensure the upper retainer (39) is properly positioned around its circumference.
    h. Install packing nuts (15), finger-tight, down to the upper retainer (39). (See Fig. 4.)
    i. Ensure that packing nuts (15) are drawn down evenly such that the upper retainer (39) is level. Wrench tighten packing nuts (15) in 1/2 revolution increments. Continue to tighten nuts (15)

until the spacer ring (40) can no longer be manually rotated by use of fingers; add 1/2 revolution of additional draw-down to each nut (15) to properly load the packing (6).

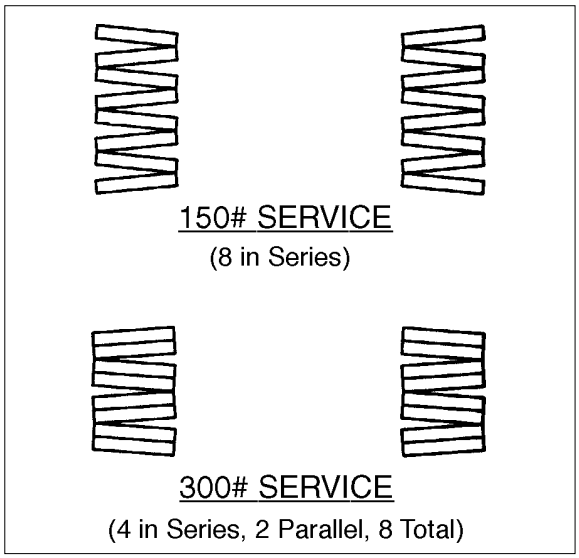


Figure 5: Belleville Spring Washers Orientation

34B. *For Opt-HTE-Hi and Opt-HTE-Lo packing options (Reference Fig. 6 for proper packing orientation) –*

a. Carefully place the lower braided ring (6.4) over the 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 the lower adapter (6.3) properly oriented over the stem's (3) end and push into the stuffing box similar to the lower braided ring (6.4).
c. Carefully place a packing ring (6.2) properly oriented over the stem's (3) end and push into the stuffing box similar to the lower braided ring (6.4). 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 retainers (39) over the stem's (3) end and over the packing studs (14). Install packing nuts (15) and finger-tighten.
f. Wrench-tighten the packing 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), retainer (39) and packing follower (5).
h. Carefully place the upper braided ring (6.4) over the 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 the lower retainer (39) properly oriented (see Fig. 4) over the stem's (3) end and over the packing studs (14). Install packing nuts (15) and finger-tighten.

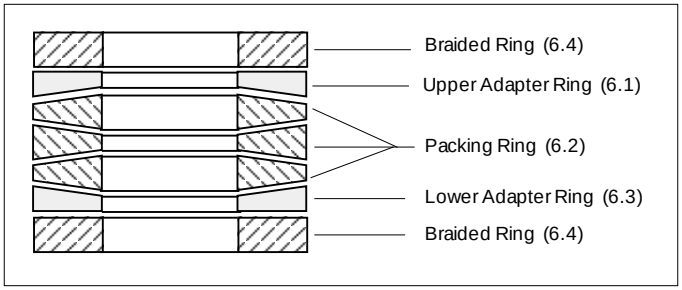


Figure 6: Packing Orientation for Opt-"HTE-Hi & Lo"

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 the top edge of the bonnet's (2) stuffing box.
k. Remove the packing nuts (15). Leave the follower (5) and lower retainer in place.
l. Orient spring washers (41) stack per Figure 5. Lower stack (41) over stem's (3) end and onto ledge of lower retainer (39).
m. Place spacer ring (40) over stem's (3) end and onto ledge of lower retainer (39).
n. Place upper retainer (39) over the stem's (3) end, over both of the packing studs (14), and onto the ledge of the spacer ring (40). Ensure the upper retainer (39) is properly positioned around its circumference and that its inversion is correct for HTE-Hi versus HTE-Lo options.
o. Install packing nuts (15), finger-tight, down to the upper retainer (39).
p. Manually stroke the stem (3) a minimum of fifty full strokes.
q. Ensure that packing nuts (15) are drawn down such that the upper retainer (39) is level with top of spacer ring (40). Wrench-tighten packing nuts (15) in 1/2 revolution increments. Continue to tighten nuts (15) until the spacer ring (40) can no longer be manually rotated by use of fingers; add 1/2 revolution of additional draw-down to each nut (15) to properly load the packing (6).

35. Reinstall the two stem jam nuts (17) onto the stem (3) and rotate as far down the stem (3) as possible.

36. Push valve stem (3) down into the seat ring (11). Wiggle the loose assembly to ensure initial alignment/stacking.

37. 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)

38. Reinstall the actuator assembly (AA) as recorded in Sub-Section IV.C.

39. 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.

40. Recalibrate per Section V.

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

1. Remove actuator assembly (AA) as described in Sub-Section IV.B. Leave body assembly (BA) in vise with stem (3) upwards.

2. Loosen stem packing (6) by further loosening packing nuts (15) to just short of disengagement from packing studs (14).

3. Remove all bonnet nuts (17).

4. Lift bonnet (2), stem assembly (3), cage (10) and all packing zone parts up and out of the body (1) while holding stem (3) to prevent from falling. Set 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 (17).

6. Withdraw stem assembly (3) from within the bonnet (2) and packing (6), holding cage (10) to prevent from dropping. Set parts (3, 10) aside.

7. Place the bonnet (2) into a second vise with the packing zone on top.

8. Remove the two packing nuts (15).

9. Remove the packing flange (4), packing follower (5), wiper ring (22) and TFE bias tape follower bushing (26).

10. 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).

11. Remove bonnet (2) from vise and invert to allow lantern ring (27) or packing spacer (9) to slide out of the bonnet's (2) stuffing box.

11a. **For Opt-34 –**

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

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).

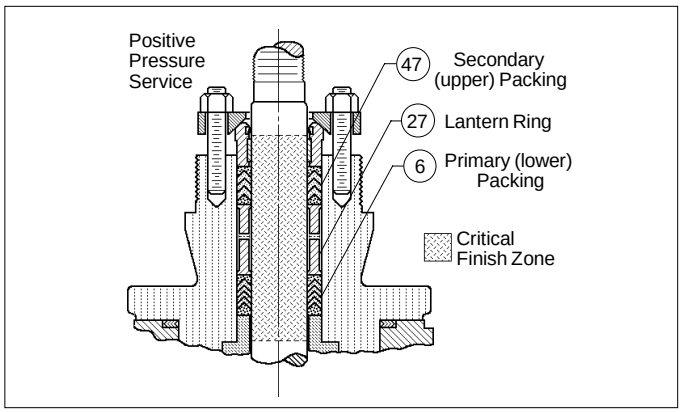


Figure 7: Dual Packing – Arr. "A", Opt-34A

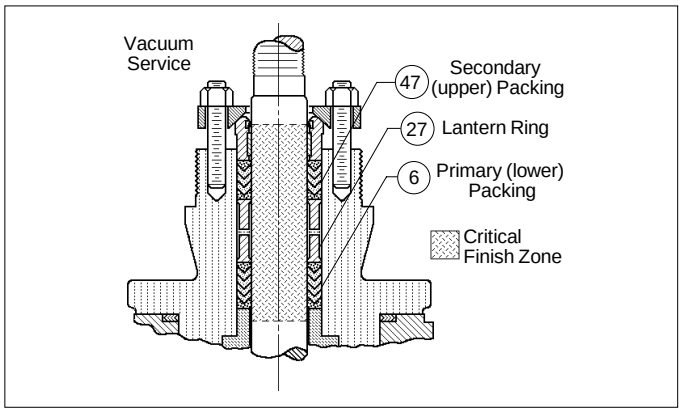


Figure 8: Dual Packing – Arr. "B", Opt-34B

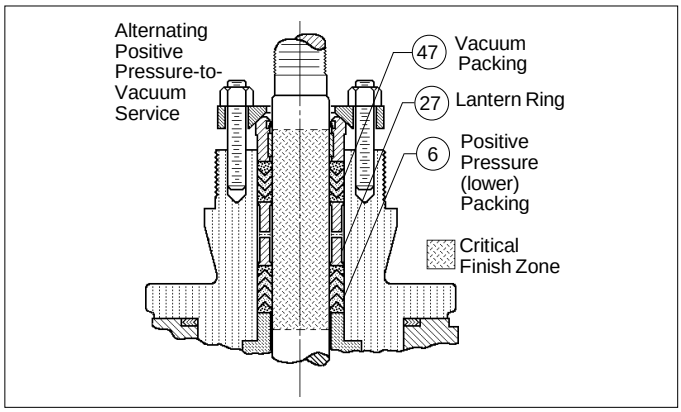


Figure 9: Dual Packing – Arr. "C", Opt-34C

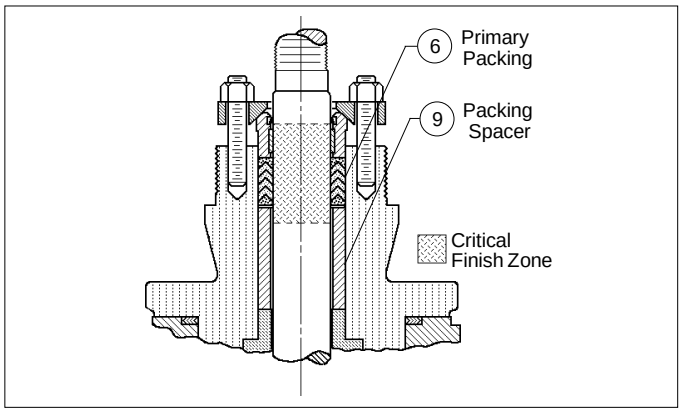


Figure 10: Jammed Packing, Opt-38J

12. Solvent clean all parts to be reused, including bonnet (2). Examine any parts for wear and corrosion. Replace any corroded or worn parts. Discard old packing (6).

13 Examine stem (3) at lower guide bushing (8) for wear. If guide bushing (8) appears to have excess wear, it should be replaced:
   a. Place the bonnet (2) on a bench press. Press the guide bushing (8) out of the bonnet (2) and discard.
   b. Rotate bonnet (2) end-for-end. Place a new guide bushing (8) into position and press fully into the bonnet (2).
   c. Reclean bonnet with suitable solvent and allow to dry.

14. Examine 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 (3) should be replaced.

15. Examine stem (3) for wear at the seating areas. 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 stem assembly is recommended.
   b. For composition seated design, if stem assembly (3) is wear damaged, the stem (3) 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 significantly corroded:
   a. Replace follower bushing (26) with new bushing (26).
   b. Replace wiper ring (22) with new ring (22).

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). Discard used soft seat insert (24); always use a new soft seat insert (24) 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 (13) and bonnet gasket (12). Always use new gaskets (12, 13) 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) as required.

21. Place body (1) back into vise with bonnet flange up.

22. Place a new seat ring gasket (13) into position.

23. Place the seat ring (11) into correct position within the body (1).

24. If 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).

25. Place a new bonnet gasket (12) on the body's (1) bonnet flange.

26. Orient the cage (10) over the stem assembly (3) properly, and set stem's (3) plug head down into the seat ring (11). Keep hold of the stem (3) with one hand; use other hand to push cage (10) down into proper alignment.

27. Lift bonnet (2) over threaded end of stem (3) and carefully lower bonnet (2) down over stem (3), ensuring that the critical finish zone of the bonnet's (2) stuffing box is not scratched by the stem's (3) threads. Align body (1)-to-bonnet (2) flanges to matchmarks as bonnet (2) comes down over bonnet studs (16). Carefully release stem (3) only when bonnet (2) is fully down.

28. Install bonnet nuts (17) onto bonnet studs (16) and finger-tighten.

29A. **For Opt-38J –**
   a. Make reference to Figure 3 for proper packing orientation.
   b. Place packing spacer (9) over end of stem (3) and carefully lower into stuffing box.
   c. Carefully place lower adapter (6.3) of packing ring set (6) over stem's (3) 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 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).
   e. Carefully place upper adapter (6.1) similar to lower adapter (6.3).

29B. **For Opt-34 –**
   a. Make reference to Figures 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 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 stem's (3) end and push into the stuff-

ing box similar to the adapter in the previous step. Repeat for each of the **four** rings.

d. Carefully install correct adapter of packing ring set (6) over stem's (3) 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 stem's (3) 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 stem's (3) 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 (47) over stem's (3) end, properly oriented, and push into the stuffing box similar to Step f. previous.

30. Place packing follower (5) with new wiper ring (22) and new follower bushing (26) tape over the end of the stem (3).

31. Place packing flange (4) over end of stem (3) and over packing studs (14).

32. Install both packing nuts (15), finger-tight, down to the packing flange (4).

33. 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 (15) tightly.

34. Reinstall the two stem jam nuts (17) onto the stem (3) and rotate as far down the stem (3) as possible.

35. Push valve stem (3) down into the seat ring (11). Wiggle the loose assembly to ensure initial alignment/stacking.

36. 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)

37. Reinstall the actuator assembly (AA) as recorded in Sub-Section IV.C.

38. 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.

39. Recalibrate per Section V.

G. External Live-Loaded Packing Adjustment:

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

***NOTE**: Regardless of live loaded packing (6) design, all use the same method for obtaining the proper preload to new or used packing (6).*

2. To properly tighten packing (6), grasp spacer ring (40) between the thumb and forefinger at points approximately 180° from each other.
   a. Tighten packing nuts (15) in 1/2 revolution increments, alternating from one nut (15) to the other, while attempting to rotate the space ring (40).
   b. Once spacer ring (40) can no longer be rotated by the fingers, attempt to "even" the opposite packing nut (15) so that the upper retainer (39) is level, then add 1/2 revolution to each packing nut (15). Adjustment completed.

3. If the spacing between the upper retainer (39) and spacer ring (40) is 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 (6) will act as non-live-loaded, jammed packing (6). Excess actuator thrust will be required and packing (6) wear will be accelerated.*

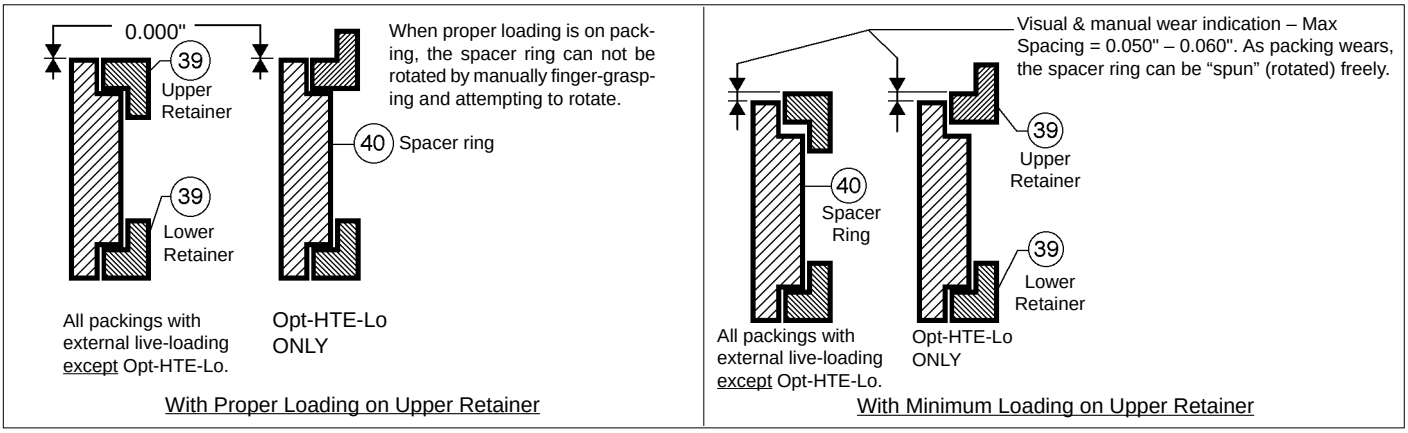


Figure 11: Dimensionals for Proper Packing Load

SECTION V

V. CALIBRATION

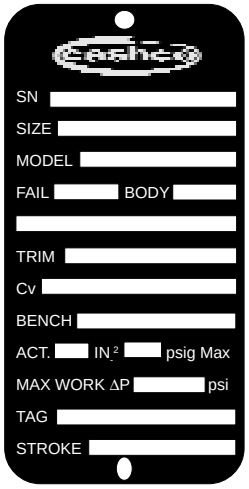
A. General:

1. This section only covers calibration of the control valve unit – actuator Model 55, 75 or 115 plus a Model 988/989 valve body.

2. Positioner, if installed, requires reference to the specific positioner model IOM for proper calibration procedure.

3. All indicated Item Numbers that are with respect to IOM-55/75/115 will be in parenthesis and underscored; i.e. (20); the same is true for the positioner parts. All Item Numbers that are with respect to this IOM-988/989 are not underscored; i.e. (32).

B. Procedure – Reverse Action, ATO-FC:



1. Provide a temporary air supply with an in-line adjustable airset regulator to the actuator topworks connection.

2. Using one stem jam nut (17), firmly locate the indicator disk (20) against the actuator stem (19) bottom. Loosen screws (22) and position the indicator plate (21) at "S" (for "shut"); tighten screws (22) to secure indicator plate (21). ***NOTE:*** *Set the indicator plate (21) at the top edge of the indicator disc (20).*

3. Reference the nameplate (12) attached to the actuator yoke (1). Determine the bench setting of the installed range spring (6) from the nameplate (12); i.e. 5-15 psig (.34-1.03 Barg) or 10-30 psig (.69-2.07 Barg).

4. Pressurize the actuator to a pressure level 2-3 psig (0.1-0.2 Barg) above the upper pressure level of the bench setting; i.e. for 5-15 psig (.34-1.03 Barg) range, set pressure at 17-18 psig (1.2-1.3 Barg). This step will ensure that the actuator stem's (19) upward travel is halted by the actuator's internal upstop mechanism.

5. Observe the position of the indicator disc (20) and the indicator plate (21), making sure to use the "top edge" of the indicator disc (20) as the reference point. If the position indicated is not exactly at "O" (for "open"), then the valve stem (3)-to-actuator stem (19) combined length is incorrect, and must be adjusted.

6. a. If travel goes beyond the "O" position, the combined stem (3, 19) is short. Loosen jam nut (17) holding the indicator disc (20) against actuator stem (19).
   b. Increase combined stem (3, 19) length by rotating the valve stem (3) CCW (viewed from valve side) a distance equal to the amount of over travel.

7. a. If travel comes below the "O" position, the combined stem (3, 19) is long. Loosen jam nut (17) holding the indicator disc (20) against actuator stem (19).
   b. Decrease combined stem (3, 19) length by rotating the valve stem (3) CW (viewed from valve side) a distance equal to the amount of undertravel.

8. Readjust the indicator plate (21) to the indicator disc (20) so they align at the "O" position.

9. Release air pressure in actuator allowing valve stem (3) to travel to the closed or "S" position. Check the position indicated on the indicator plate (21).

10. If the "S" closed position is not correct, repeat Steps 6 through 9 until the combined stem (3, 19) length is correct.

11. Pressurize the actuator to a pressure level corresponding to the lower pressure level of the bench setting; i.e. for 5-15 psig (.34-1.03 Barg) range, set pressure at 5 psig (.34 Barg). Do the pressurization slowly while observing the indicator disc (20) and indicator plate (21) simultaneously.

12. The proper calibration of the actuator / valve unit will occur when, at the lower pressure level of bench setting, the valve stem assembly's (3) plug will just begin to travel from the closed position.

    Pressurize actuator slowly. If plug (3) begins travel before reaching the lower pressure level of bench setting, then increase the actuator's range spring (6) compression by wrench tightening spring adjuster (4) CW (viewed from valve side) in 1/2 revolution increments until desired bench setting is reached.

    Pressurize actuator slowly. If plug (3) begins travel after surpassing the lower pressure level of bench setting, then reduce the actuator's range spring (6) compression by wrench loosening spring adjuster (4) CCW (viewed from valve side) in 1/2 revolution increments until desired bench setting is reached.

13. Increase pressure to actuator up to the upper level of bench setting and observe valve plug (3) position at the indicator plate (21.) The valve plug (3) should be within ±8% (of full "stroke") of the "O" (for "open") position of the indicator plate (21) ("Stroke length is indicated on the nameplate (12), and is the distance between the "S" and "O" points of the indicator plate (21).)

14. Record here the theoretical and actual pressure levels of steps 12 and 13:

Theoretical Bench Setting From Nameplate	_____	psig
	_____	Barg
Setting at "S" Position	_____	psig
	_____	Barg
Setting at "O" Position	_____	psig
	_____	Barg

15. Tighten second stem jam nut (17).

C. Procedure – Direction Action, ATC-FO:

1. Provide a temporary air supply with an in-line adjustable airset regulator to the actuator topworks connection.

2. Using one stem nut (17), firmly locate the indicator disc (20) against the actuator stem (19) bottom. With no pressure in the actuator, the upwards travel is halted by the actuator's internal upstop mechanism. ***NOTE:*** *Set the indicator plate (21) at the top edge of the indicator disc (20).*

3. Reference the nameplate (12) attached to the actuator yoke (1). Determine the bench setting of the installed range spring (6) from the nameplate (12); i.e. 3-13 psig (.20-.90 Barg), or 6-27 psig (.41-1.86 Barg).

4. Pressurize the actuator to a level 2-3 psig (0.1-0.2 Barg) above the upper pressure level of the bench setting; i.e. for 3-13 psig (.20-.90 Barg) range, set pressure at 15-16 psig (1.0-1.1 Barg).

5. Observe the position of the indicator disc (20) and the indicator plate (21), making sure to use the "top edge" of the indicator disc (20) as the reference point. If the position indicated is not exactly at "S" (for "shut"), then the valve stem (3)-to-actuator stem (19) combined length is incorrect, and must be adjusted.

6. a. If travel comes less than the "S" position, the combined stem (3, 19) is long. Loosen jam nut (17) holding the indicator disc (20) against actuator stem (19).
   b. Release 6-8 psig (0.4-0.6 Barg) of pressure level in the actuator. This step will ensure that when the combined stem (3, 19) length is decreased, the plug will not be mistakenly rotated while seated.
   c. Decrease combined stem (3, 19) length by rotating the valve stem (3) CW (viewed from valve side) a distance equal to the amount of undertravel.

7. a. If travel goes beyond the "S" position, the combined stem (3, 19) is short. Loosen jam nut (17) holding the indicator disc (20) against actuator stem (19).
   b. Release 6-8 psig (0.4-0.6 Barg) of pressure level in the actuator. This step will ensure that when the combined stem (3, 19) length is increased, the plug will not be mistakenly rotated while seated.
   c. Increase combined stem (3, 19) length by rotating the valve stem (3) CCW (viewed from valve side) a distance equal to the amount of undertravel.

8. Repressurize the actuator to the level of Step 4. previous. If the "S" closed position is not correct, repeat Steps 6 & 7 until the combined stem (3, 19) length is correct.

9. Pressurize the actuator to a pressure level corresponding to the level of Step 4. Do the pressurization slowly while observing the indicator disc (20) and indicator plate (21) simultaneously.

10. The proper calibration of the actuator / valve unit will occur when, at the upper pressure level of bench setting, the valve stem assembly's (3) plug will just begin to travel from the closed position.

    Depressurize actuator slowly. If plug (3) begins travel before reaching the upper pressure level of bench setting, release all air pressure, then decrease the actuator's range spring (6) compression by wrench loosening spring adjuster (4) CCW (viewed from valve side) in 1/2 revolution increments. Repeat this procedure until desired bench setting is reached.

    Depressurize actuator slowly. If plug (3) begins travel after surpassing the upper pressure level of bench setting, release all air pressure, then increase the actuator's range spring (6) compression by wrench tightening spring adjuster (4) CW (viewed from valve side) in 1/2 revolution increments. Repeat this procedure until desired bench setting is reached.

11. Decrease pressure to actuator down to the lower level of bench setting and observe valve plug (3) position at the indicator plate (21). The valve plug (3) should be within ±8% (of full stroke) of the "S" (for "shut") position of the indicator plate (21). ("Stroke" length is indicated on the nameplate (12), and is the distance between the "S" and "O" points of the indicator plate (21)).

12. Record the theoretical and actual pressure levels of steps 10 and 11 in the box to the right.

13. Tighten second stem jam nut (17).

Theoretical Bench Setting From Nameplate	_____	psig
	_____	Barg
Setting at "S" Position	_____	psig
	_____	Barg
Setting at "O" Position	_____	psig
	_____	Barg

SECTION VI

VI. 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 in IOM-55/75/115 or the technical bulletins 988/989-TB.
DO NOT STROKE THE CONTROL VALVE WITH AN AIR SUPPLY PRESSURE SETTING GREATER THAN RECOMMENDED MAXIMUM PRESSURE!

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 travel at/near 1/2 open.

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.

⚠ CAUTION

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

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", and the loop will experience a minimum of upset conditions, and will be in automatic control.

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 cavitational 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.
D. Excess wear.	D1. Oversized valve operating too close to seat; go to reduced trim. D2. Incorporate stellite trim. D3. Remove particulate. D4. Possible excess cavitation in liquid service. Change operation parameters. D5. Re-lap plug–seat surface.
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. PART ORDERING INFORMATION

There are three methods to obtain parts ordering information/numbers. These methods are isted below, in order of ease of entering. The least expensive method is to utilize parts in kits where possible.

METHOD A – USE OF PRODUCT CODE.

Step 1. If available, obtain the 18 character product code number from the Bill of Materials sheet attached herein.

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Step 2. Identify which kits or parts are desired from the Bill of Materials sheet or refer to the cross-sectional drawings.

NOTE: *Kit "A" contains packing, seals and gasket(s). Kit "B" contains trim replacement parts plus packing, seals and gasket(s).*

Step 3. Contact your local Cashco, Inc., Sales Representative and specify the product code number and any part numbers not included in desired kits. Costs of required parts can be given by the Sales Representative.

METHOD B – NO PRODUCT CODE AVAILABLE – DISASSEMBLED VALVE.

Step 1. Determine all available information from valve's metal tag.
   a. Serial number.
   b. Valve "Type" or "Model" number.
   c. Size.
   d. Body material.
   e. Fail position.
   f. Trim designation number (if available).
   g. Cv or port size.
   h. Bench set.

Step 2. Determine construction of trim (metal or composition (soft) seat).

Step 3. With the information from Steps 1 and 2 above, contact your local Cashco, Inc., Sales Representative.

Step 4. Sales Representative will contact the factory to determine the original internal construction. Factory will relay information to the Sales Representative.

Step 5. Await the Sales Representative's return contact with the proper part numbers and cost.

METHOD C – NO PRODUCT CODE AVAILABLE – ASSEMBLED VALVE IN SERVICE.

Step 1. Determine all available information from valve tag using Step 1, Method B.

Step 2. Contact your local Cashco, Inc., Sales Rep with the above information.

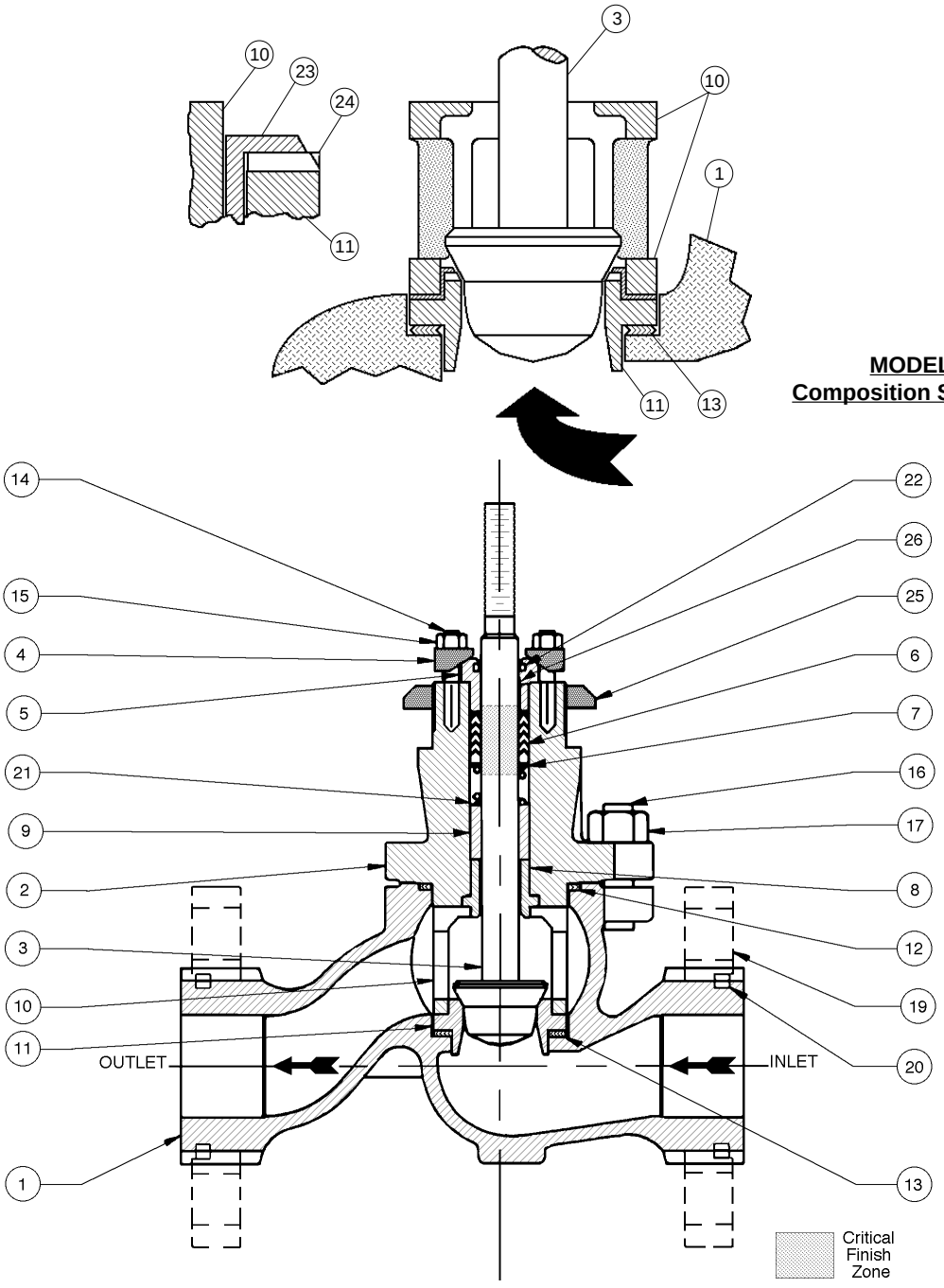
Step 3. Sales Representative will contact the factory to determine the original internal construction. Factory will relay information to the Sales Representative.

Step 4. Await the Sales Representative's return contact with the proper part numbers and cost.

PARTS KIT NUMBERS
MODELS 988/989 VALVE BODY *
EQUAL % TRIM CHARACTER
(Kit Nos. Shaded)

Trim Designation No.	Kit Abbr.	Body Size 3/4" or 1"	Body Size 1-1/2"	Body Size 2"
S1R	A	**86A-0BAK-0AA**	**86D-0BAK-0AA**	**86E-0BAK-0AA**
Full Port	B	**86A-0BAK-0BA**	**86D-0BAK-0BA**	**86E-0BAK-0BA**
S1R	A	**86A-0BBK-0AA**	**N/A**	**N/A**
1-Step Reduced	B	**86A-0BBK-0BA**	**N/A**	**N/A**
S1R	A	**86A-0BEK-0AA**	**N/A**	**N/A**
2-Step Reduced	B	**86A-0BEK-0BA**	**N/A**	**N/A**
S3R	A	**86A-0FAK-0AA**	**86D-0FAK-0AA**	**86E-0FAK-0AA**
Full Port	B	**86A-0FAK-0BA**	**86D-0FAK-0BA**	**86E-0FAK-0BA**
S3R	A	**86A-0FBK-0AA**	**N/A**	**N/A**
1-Step Reduced	B	**86A-0FBK-0BA**	**N/A**	**N/A**
S3R	A	**86A-0FEK-0AA**	**N/A**	**N/A**
2-Step Reduced	B	**86A-0FEK-0BA**	**N/A**	**N/A**

* Refer to IOM-55/75/115 for Kit Nos. for Models 55D, 75D and 115D, and for Models 55R, 75R and 115R.



MODEL 988/989
Composition Soft Seat Design

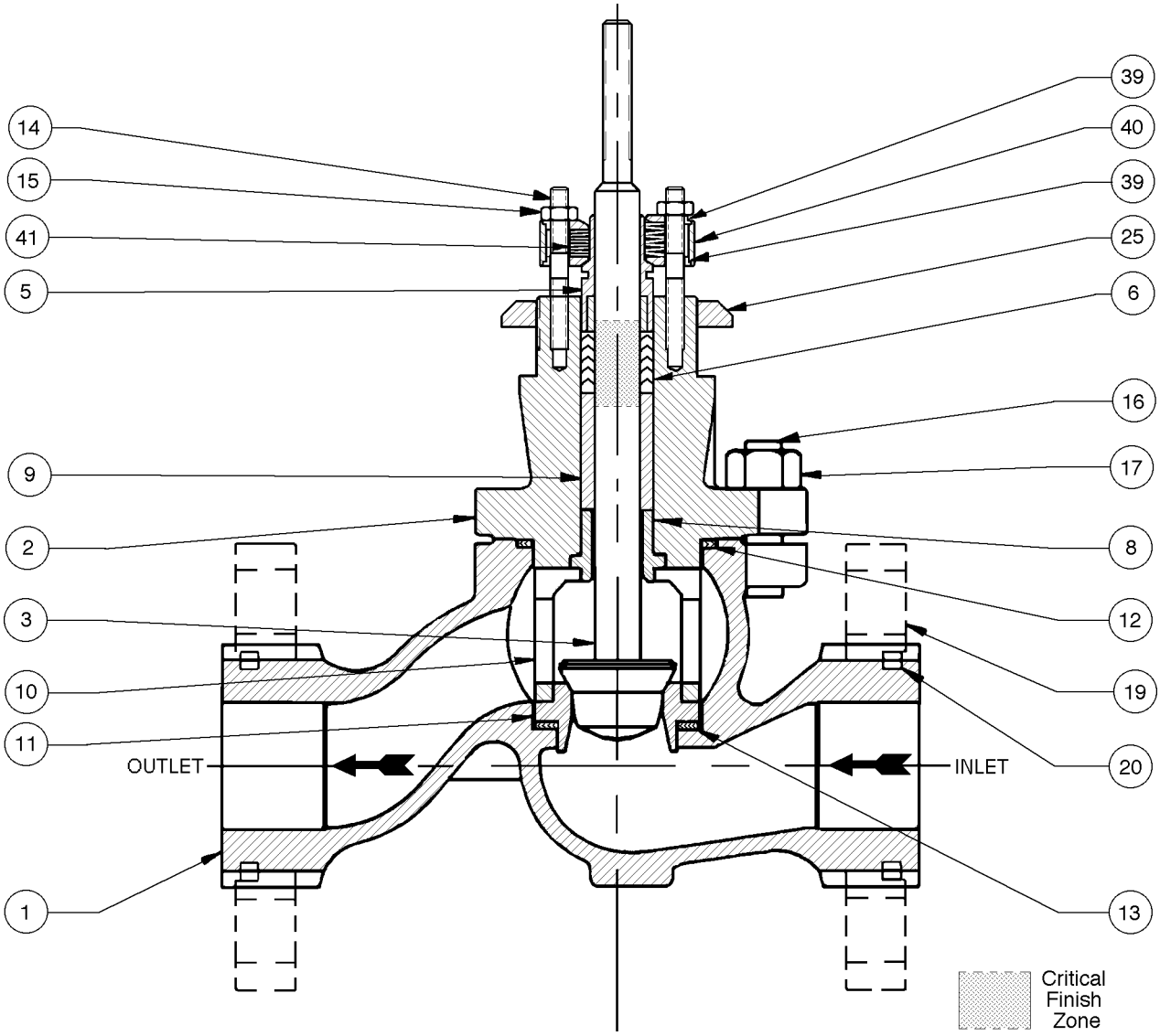
MODEL 988/989 BODY ASSEMBLY (BA)
Internal Live Loaded Packing — Metal Seated Design

ITEM NO.	DESCRIPTION
1.	Body
2.	Bonnet
3.	Plug & Stem Assembly
4.	Packing Flange
5.	Packing Follower
6.	Packing
7.	Packing Washer
8.	Guide Bushing
9.	Packing Spacer
10.	Cage
11.	Seat Ring (Metal or Composition Seat).

ITEM NO.	DESCRIPTION
12.	Bonnet Gasket
13.	Gasket (Seat Ring)
14.	Stud (Packing Flange)
15.	Hex. Nut (Packing Flange)
16.	Bonnet Stud
17.	Stud Nut
19.	Flange (Body 150# or 300#)
20.	Split Ring
21.	Packing Spring
22.	Wiper Ring

ITEM NO.	DESCRIPTION
23.	Seat Retainer (Composition Seat Only)
24.	Seat Insert (Composition Seat Only)
25.	Yoke Nut
26.	Follower Bushing

ITEMS NOT SHOWN	DESCRIPTION
27.	Lantern Ring
31.	Pipe Plug (-26 Leak Off Connection)
48.	Screw (Split Ring)



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

ITEM NO.	DESCRIPTION
1.	Body
2.	Bonnet
3.	Plug & Stem Assembly
4.	Packing Flange
5.	Packing Follower
6.	Packing
7.	Packing Washer
8.	Guide Bushing
9.	Packing Spacer
10.	Cage
11.	Seat Ring (Metal or Composition Seat).

ITEM NO.	DESCRIPTION
12.	Bonnet Gasket
13.	Gasket (Seat Ring)
14.	Stud (Packing Flange)
15.	Hex. Nut (Packing Flange)
16.	Bonnet Stud
17.	Stud Nut
19.	Flange (Body 150# or 300#)
20.	Split Ring
21.	Packing Spring
22.	Wiper Ring

ITEM NO.	DESCRIPTION
23.	Seat Retainer (Composition Seat Only)
24.	Seat Insert (Composition Seat Only)
25.	Yoke Nut
26.	Follower Bushing
39.	Retainer
40.	Spacer
41.	Belleville Spring

ITEM NOT SHOWN	DESCRIPTION
48.	Screw (Split Ring)

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