MODEL 1000HP - DIFFERENTIAL
PRESSURE REDUCING REGULATOR
SECTION I

I. DESCRIPTION AND SCOPE

The Model 1000HP-1+6 and 1000HP-1+8 are differential pressure reducing regulators used to control differential pressure between downstream (outlet or P_2) pressure and a loading (P_{Load}) pressure to the spring chamber. Sizes are 1/2" , 3/4", 1", 1-1/4", 1-1/2" and 2" (DN15, 20, 25, 32, 40 and 50). With proper trim utilization and jet selection, this unit is suitable for liquid, gaseous, or steam service. Refer to Technical Bulletin 1000HP-DIFF-TB for sizing, application and selection recommendations.

SECTION II

II. INSTALLATION

1. An inlet block valve should always be installed. An outlet block valve is desirable.

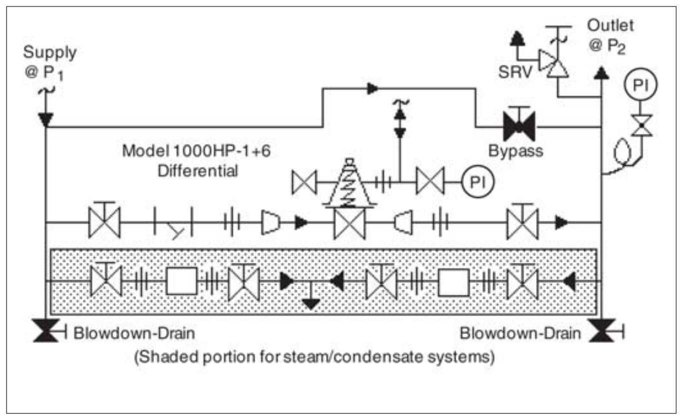
2. A manual bypass valve is recommended for "hot piping" systems to assist in piping warm-up at startup.

3. An isolation valve on the loading line is not recommended. The annular body ring of the 1000HP-1+8 may be piped to a safe drainage point, but no valve should be installed in the drain line.

4. Pipe unions must be installed to allow removal from piping. Trim can only be changed by unit removal from pipeline. If flanges are utilized, a lap joint flange is required on the inlet end of the regulator to help align bolt holes as the cylinder screws into place. ***NOTE:*** *Cashco does not recommend field welding on the cylinder (inlet) end of the valve due to the possibility of warpage.*

⚠ CAUTION

DO NOT HYDROSTATIC TEST THROUGH AN INSTALLED UNIT; ISOLATE FROM TEST. DO NOT HYDROSTATIC TEST THE LOADING PRESSURE WITHOUT PRESSURE IN THE MAIN REGULATOR. The nameplate indicated outlet pressure rating, if reached, may cause internal damage. Refer to Technical Bulletin Model 1000HP-DIFF-TB, Table 3 for "emergency overpressure level" that will not do irreparable internals damage. In addition, note on the nameplate that the Inlet and Outlet pressure and temperature ratings are at different levels.



Recommended Piping Schematic for Differential Pressure Reducing Station

5. An outlet pressure gauge should be located approximately ten pipe diameters downstream, and within sight. A loading pressure (or differential pressure) gauge is recommended.

6. All installations should include a downstream relief device if the inlet pressure could exceed the pressure rating of any downstream equipment or the maximum outlet pressure rating of the unit.

7. Clean the piping of all foreign material including chips, welding scale, oil, grease and dirt before installing the regulator. Strainers are recommended.

8. In placing thread sealant on pipe ends prior to engagement, ensure that excess material is removed and not allowed to enter the regulator upon startup.

9. Flow Direction: Install so the flow direction matches the arrow cast on the body.

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

11. Differential Regulator – (Refer to Dwg. Opt-1+6 for single diaphragm or Dwg. Opt-1+8 for double diaphragm design): Regulator may be rotated around the pipe axis 360° and may be installed in a horizontal or vertical pipeline.

12. Regulators are not to be direct buried underground.

SECTION III

III. PRINCIPLE OF OPERATION

1. The differential Model 1000HP is also available in two options: 1000HP-1+6 is single diaphragm construction; 1000HP-1+8 is double diaphragm construction. The double diaphragm construction prevents the loading fluid from direct mixing with the system fluid in case of diaphragm failure.

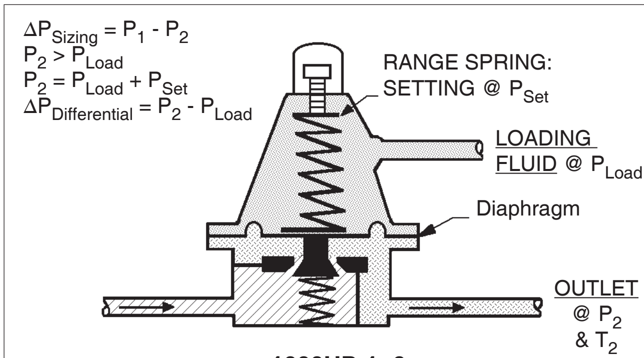
2. Movement occurs as pressure variations register on the diaphragm. One pressure is the outlet (p_2) or downstream pressure, which registers on the "underneath" side of the diaphragm. The second pressure registered is the loading (P_{Load}) pressure in the spring chamber "above" the diaphragm. The range spring determines the differential pressure level (P_{Set}). As outlet (P_2) pressure drops, the range spring pushes the diaphragm down, opening the port; as outlet (P_2) pressure increases, the diaphragm pushes up and the port closes. As the loading (P_{Load}) pressure varies, the outlet (P_2) pressure tends to follow. An increase in P_{Load} (ΔP_{Load}) will increase outlet P_2 pressure by nearly an equal amount ($\Delta P_{Load} = \Delta P_2$); a decrease in P_{Load} will have a similar effect on outlet P_2 pressure.

3. The Model 1000 includes a rocker arm in its operation mechanism. The rocker arm allows the regulator to operate flow-to-open (FTO), rather than conventional flow-to-close (FTC), which increases rangeability.

4. Due to the FTO design, there is a limit as to how low of a downstream (P_2 or outlet) pressure level setting is capable for a given inlet P_1 pressure. This is a function of the ratio of the port area to the diaphragm area. It is possible for there to be too high of an inlet pressure for the regulator to close off against. (Refer to 1000HP-DIFF-TB, Tables 9, 10, 11 and 12 for limits.) Reduced port, Opt-12, allows lower downstream (P_2 or outlet) pressure settings for a given upstream (P_1 or inlet) pressure level.

5. The Model 1000 includes an aspiration jet effect, due to the clearance of the piston from the body near the outlet. These clearances vary as to whether the fluid is a gas (including steam), a liquid, or a viscous liquid (required Opt-27). Jets must be selected to match one of these three general fluids. An improper jet will reduce performance.

   NOTE: *The regulator requires minimum output pressure level or the regulator will not close.*



1000HP-1+6
DIFFERENTIAL SCHEMATIC

6. For a 1000HP-1+6 (single diaphragm) design, a complete diaphragm failure will cause the fluids to mix in the spring chamber or loading pressure piping system.

7. For a 1000HP-1+8 (double diaphragm) design, a complete diaphragm failure will cause the regulator to fail open, leaking fluid through the annular ring vent hole.

   NOTE: *Composition (soft) diaphragms may be utilized only on -1+6 single diaphragm construction.*

8. For viscous fluids normally heated (heavy fuel oil), it may be desirable to include a flow-through spring chamber, the -65 Option.

SECTION IV

IV. STARTUP

1. Start with the block valves closed. A bypass valve may be used to maintain outlet pressure in the downstream system without changing the following steps.

2. Remove closing cap and relax the range spring by turning the adjusting screw counterclockwise (CCW) a minimum of three (3) full revolutions. This reduces the outlet (downstream) pressure set point.

3. If it is a “hot” piping system, and equipped with a bypass valve, slowly open the bypass valve to pre-heat the system piping and to allow slow expansion of the piping. Ensure proper steam trap operation if installed. Closely monitor outlet (downstream) pressure, via gauge, to ensure not over-pressurizing. ***NOTE:*** *If no bypass valve is installed, extra caution should be used in starting up a cold system; i.e. do everything slowly.*

> **⚠ CAUTION**
>
> **Do not walk away and leave a bypassed regulator unattended!**

4. Crack open the outlet (downstream) block valve.

5. Slowly open the inlet (upstream) block valve observing the outlet (downstream) pressure gauge. Determine if the regulator is flowing. If not, slowly rotate the regulator adjusting screw clockwise (CW) until flow begins.

6. Continue to slowly open the inlet (upstream) block valve until fully open.

7. Continue to slowly open the outlet (downstream) block valve, especially when the downstream piping system isn’t pressurized. If the outlet (downstream) pressure exceeds the desired pressure, close the block valve and go to Step 2, then return to Step 4.

8. When flow is established steady enough that the outlet (downstream) block valve is fully open, begin to slowly close the bypass valve if installed.

9. Set the regulator set point (P_{set}) by turning the adjusting screw clockwise (CW) to increase outlet pressure or CCW to reduce outlet pressure. The outlet (P_2) pressure under these conditions will approximate the desired differential pressure when loaded with P_{Load}.

10. Pressurize the source of loading (P_{Load}) pressure and allow to fill the spring chamber cavity. Slightly open the bleeder valve to vent any air as the spring chamber is filling.

11. Develop system flow and pressure and readjust setpoint as required to obtain desired response. Performance should be analyzed at minimum and maximum flow levels.

12. Install closing cap.

SECTION V

V. SHUTDOWN

> **⚠ CAUTION**
>
> **Loading Pressure must be shut off before shutting down the system pressure.**

1. To prevent force imbalances and possible diaphragm failure, the loading pressure (P_{Load}) should always be shutdown first from its source of pressure. Systems sequencing must ensure this occurs.

2. It is recommended that manual operation not be attempted by a bypass valve during a shutdown.

3. When the loading pressure (P_{Load}) has been shutdown, the regulator outlet pressure (P_2) should decrease substantially. When this is observed, the inlet (upstream) block valve may be closed.

SECTION VI

VI. MAINTENANCE

⚠ WARNING

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

A. General:

1. Maintenance procedures hereinafter are based upon removal of the unit from the pipeline where installed.

2. Owner should refer to owner's procedures for removal, handling and cleaning of reusable parts, and disposal of non-reusable parts, i.e. gaskets.

3. If desired, the gaskets may be lubricated with a light oil provided it is compatible with the fluid.

B. Diaphragm Replacement:

1. Securely install the body (1) in a vice with the spring chamber (2) directed upwards.

⚠ WARNING

SPRING UNDER COMPRESSION. Prior to removing flange bolts, relieve spring compression by backing out the adjusting screw. Failure to do so may result in flying parts that could cause personal injury.

2. Remove closing cap (31). Relax range spring (27) by turning adjusting screw (6) CCW until removed from spring chamber (2).

3. Paint or embed a match mark between body casting (1), spring chamber casting (2), and body spacer (42) along flanged area.

4. Remove all diaphragm flange nuts (9) and bolts (8). Remove nameplate (28).

5. Remove spring chamber (2), spring button (4) and range spring (27).

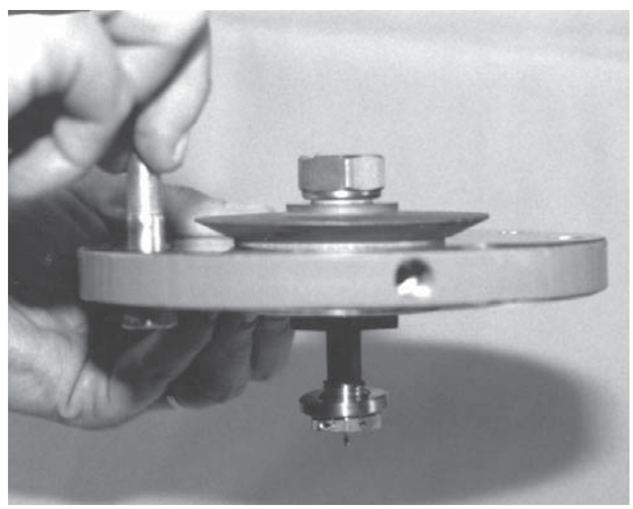
6. Pry up the diaphragm(s) (20) and diaphragm gasket (19) around the perimeter of the spring chamber (2) flange to ensure the diaphragm(s) (20) are not "sticking". (Diaphragm gasket (19) is not used with a composition (soft) diaphragm.)

NOTE: *The text hereafter will refer to:*

a. The -1+8 double diaphragm optional construction (-1+6 single diaphragm construction is similar. Text regarding composition diaphragm(s) (20) applies only to -1+6 option). Text portions dealing with body spacer (42), diaphragm spacer (41) and separation of total diaphragm (20) quantity into two "stacks" applies only to -1+8 option.

b. The "pusher plate and stud" (13) as a single part for 1/2" – 1-1/4" sizes and as two separate parts, a "pusher plate" (5) and a "pusher stud" (13) , for 1-1/2" and 2" sizes.

7. Pry up the diaphragm(s) (20) and diaphragm gasket (19) around the perimeter of the body (1) diaphragm flange to ensure the diaphragm(s) (20) are not "sticking". (Diaphragm gasket (19) is not used with a composition (soft) diaphragm.)



8. Remove diaphragm subassembly by sliding the pusher plate and stud (13), body spacer (42) and nut (11) in the direction of the regulator inlet, approximately 1/2"–3/4" (15-20 mm) The pusher plate and stud (13), stud nut (10), and stud collar (16) should disengage with the rocker arm (14) slot. Lift vertically for diaphragm subassembly removal, carefully holding the assembly at its outer edge to prevent the body spacer (42) from falling from between the diaphragm(s) (20).

9. Place the pusher plate stud (13) in a separate vise, gripping the stud (13) on the hexagonal cast-in-place edges located on the underneath side of the pusher plate stud. ***NOTE:*** *Do not remove the stud nut (10), stud collar (16), and the location locking cotter pin (15).*

10. Loosen and remove nut (11).

11. Lift and remove pressure plate (3) and O-ring (50).

12. Remove upper diaphragm(s) (20), diaphragm spacer (41) and body spacer (42).

13. Pry loose pusher plate and stud (13) from lower diaphragm(s) (20) or from lower pusher plate gasket (12). (Pusher plate gasket (12) is not utilized with composition (soft) diaphragm.) Remove the diaphragm(s) (20).

14. Remove pusher plate gasket (12) from pusher plate and stud (13).

15. Clean gasket sealing surfaces of pusher plate and stud (13), spring chamber (2), body (1), and pressure plate (3) thoroughly.

16. Install new pusher plate gasket (12) over pusher plate and stud (13).

17. Install one-half of total quantity of new diaphragm(s) (20) over pusher plate and stud (13). ***NOTE:*** *Refer to quantity of diaphragms (20) incorporated in the bill of materials listing. Depending on outlet pressure level, various quantities of metal diaphragms will be "stacked". They should always be in multiples of two for -1+8 option.*

18. Place diaphragm spacer (41) over pusher plate and stud. Place body spacer (42) over outer perimeter of diaphragm(s) (20).

19. Install remaining quantity of diaphragm(s) (20) over pusher plate and stud (13).

20. Place O-ring (50) over pusher plate and stud (13).

21. Inspect pressure plate (3) to ensure no deformation due to over-pressurization. If deformed, bent, or otherwise distorted, replace.

22. Ensuring that the curved outer rim side of the pressure plate (3) is down, place the pressure plate (3) over the pusher plate and stud (13). Place nut (11) onto the stud (13) and tighten. Recommended torques are as follows:

Body Size	Metal Diaphragm	Comp. Diaphragm
3/8" – 1/2"	45–50 ft. lbs.	25–30 ft. lbs.
3/4" – 1"	45–50 ft. lbs.	30–45 ft. lbs.
1-1/4" – 2"	80–90 ft. lbs.	50–60 ft. lbs.

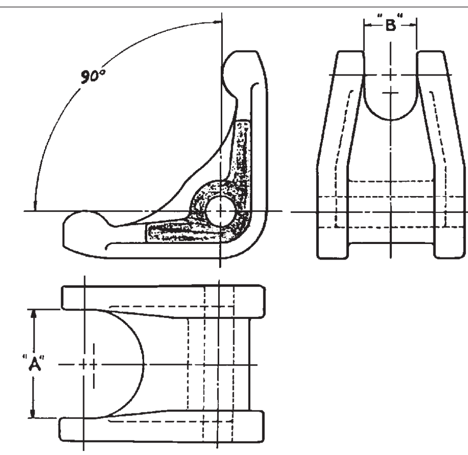
Use two flange bolts (8) to keep multiple diaphragms' (20) bolt holes properly aligned while tightening the nut (11).

CAUTION

Do not use your fingers to hold diaphragms (20) during tightening of nut (11)!

23. Remove cotter pin (15) securing stud nut (10) to lower end of pusher plate and stud (13), and replace with a new pin (15). (Do not allow the stud nut (10) to move when the cotter pin (15) is removed.)

24. Remove rocker arm shaft (17) and rocker arm (14). Measure inside of rocker arm (14) "prongs" as indicated in the following diagram. If either of the below dimensions are exceeded by 1/8" (3mm), replace rocker arm (14).



Valve Size							
DIM	MAT'L	1/2"	(DN15)	3/4"	(DN20)	1"	(DN25)
A	BRZ	7/8"	22 mm	1-5/32"	29 mm	1-7/16"	37 mm
B	BRZ	5/8"	16 mm	25/32"	20 mm	3/4"	20 mm
A	SST	13/16"	21 mm	1-1/16"	27 mm	1-7/16"	37 mm
B	SST	9/16"	14 mm	23/32"	18 mm	3/4"	20 mm
DIM	MAT'L	1-1/4"	(DN32)	1-1/2"	(DN40)	2"	(DN 50)
A	BRZ	1-13/16"	46 mm	1-25/32"	45 mm	2-3/16"	56 mm
B	BRZ	29/32"	23 mm	7/8"	22 mm	29/32"	23 mm
A	SST	1-1/2"	38 mm	1-25/32"	45 mm	2-5/32'	55 mm
B	SST	11/16"	17 mm	7/8"	22 mm	29/32"	23 mm

25. Check rocker arm shaft (17) for wear and straightness. Replace if damaged. Reinstall in body (1) through rocker arm (14). Apply thread sealant to the rocker arm shaft (17) threads prior to tightening. Make sure that the rocker arm shaft (17) enters the support slot opposite the threaded opening, and does not align crooked and restrained from full thread engagement of the rocker arm shaft (17). Make sure that the rocker arm (14) prongs that straddle the piston (24) hold the piston collar (23) against the piston (24); do not allow the rocker arm (14) prongs to push directly on the piston (24).

26. Install a new diaphragm gasket (19). Composition (soft) diaphragms require no diaphragm gasket. ***NOTE:*** *Use only gaskets manufactured by Cashco, Inc., that are of the same material as those originally supplied. Substitution may cause improper gasket compression.* It may also adversely change the diaphragm setting, which will affect the unit's performance, i.e. Option 1000-45, non-asbestos construction utilizes special gaskets.

27. Using small gauge wire approximately 18" (457 mm) long, form a hook and place the hook over one prong of the rocker arm (14), and rotate the rocker arm (14) up until slack is removed in the mechanism. Secure the wire through a body (1) flange bolt hole on the outlet side of the regulator.

28. Firmly holding the outer perimeter, take the diaphragm subassembly (Step 8) and lower it down into the body (1) cavity off-center approximately 3/4"–1" (20–25 mm) and towards the inlet side of the regulator. When fully lowered, slide the diaphragm subassembly horizontally towards the regulator outlet. The wire of Step 27. should hold the rocker (14) up to allow engaging of the pusher plate and stud (13) (with stud nut (10) and stud collar (16)), so the rocker arm (14) prongs rest directly on the stud collar. ***NOTE:*** *DO NOT ALLOW THE ROCKER ARM (14) PRONGS TO GET BETWEEN THE STUD NUT (10) AND THE STUD COLLAR (16). Pull firmly to remove wire holding rock*er arm (14) up.

29. Align diaphragm(s) (20) bolt holes with body (1) flange bolt holes. Install new diaphragm gasket (19) on top of diaphragm(s) (20). Visually center range spring (27) on to pressure plate (3), place spring button (4) on top of range spring (27).

30. Aligning the matchmarks, place spring chamber (2) over the above stacked parts. Install all bolts (8), nuts (9) and nameplate (28) by hand tightening. Tighten bolting (8 and 9) in a cross pattern that allows spring chamber (2) to be pulled down evenly. Recommended torques are as follows.

Body Size	Bolt Size	Metal Diaph [1]	Comp Diaph [2]
1/2"	3/8"-24	25 ft-lb	25 ft-lb
3/4"	7/16"-20	30 ft-lb	30 ft-lb
1"–1-1/4"	1/2"-20	35 ft-lb	35 ft-lb
1-1/2"	9/16"-18	45 ft-lb	45 ft-lb
2"	5/8"-18	45 ft-lb	45 ft-lb

[1] Minimum recommended torque regardless of gasket materials. Some gasket materials may require higher bolt torques to obtain adequate seal.

[2] Gasket material may "set" with time; a recheck of torques should be made if the unit has been stored on the shelf for over 30 days.

NOTE: *Never replace bolting (8 and 9) with just any bolting. Bolt heads and nuts are marked with specification identification markings. Use only proper grades as replacements.*

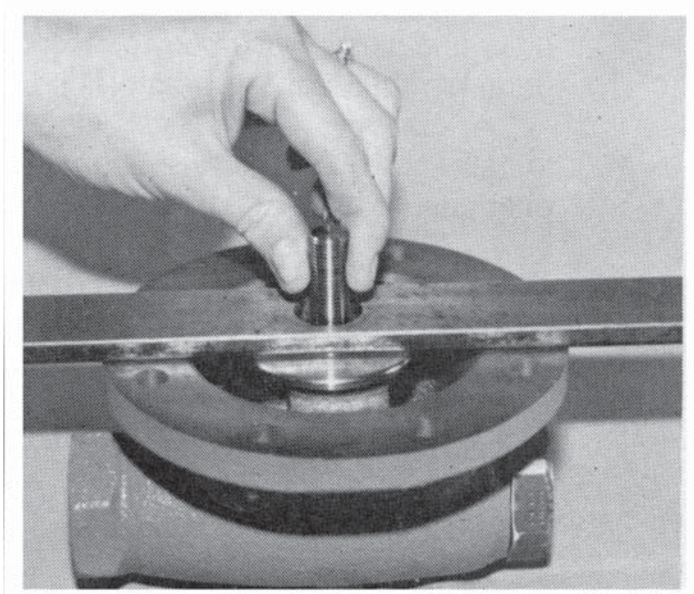
31. Reinstall adjusting screw (6) with sealing locknut (7); install new closing cap gasket (32); install closing cap (31).

32. Pressurizing the body (1) and spring chamber (2) to the same level, soap solution test around bolting (8 and 9), body (1), spring chamber (2) flanges, closing cap (31) and cylinder (21) - to body (1) joint for leakage. Use 100 psig minimum inlet pressure to leak test. Actual service conditions should be used if in excess of the minimum condition. (***NOTE:*** *Do not pressurize spring chamber without equal or greater pressure in body registering on diaphragm(s) (20) underneath side.)*

C. Diaphragm Setting Adjustment:

1. In the previous "Sub-Section B., Diaphragm Replacement", care was taken to prevent removal of the stud collar (16) and stud nut (10). Location of the stud nut (10) is a critical adjustment for a Model 1000 regulator.

2. Not removing the stud nut (10) will provide performance equal to original factory performance when diaphragm(s) (20) is replaced with like diaphragm(s) (20); however, if the stud nut (10) is removed, or a switch is made from metal to composition (soft) diaphragm(s) (20), or vice versa, the diaphragm setting should be checked.



3. Follow procedure "Sub-Section B., Diaphragm Replacement" to the point of removing diaphragm(s) (20), Step 13. Remove diaphragm gasket (19) and pusher plate stud gasket (12). Obtain a flat 12" x 1-1/2" x 1/4" (15 mm x 40 mm x 6 mm) plate bar with a 3/4" (20 mm) hole drilled in the center. "Hook" the pusher plate stud (13) into the rocker arm (14) prongs properly. Pull firmly up on the pusher plate stud (13) to ensure that all slack is removed from the mechanism and that the piston (24) is seated firmly. Relax the pulling and place the flat bar over the pusher plate stud (13) with the stud (13) passing through the hole of the bar. Again, pull firmly up to remove mechanism slack. One of three positions will be reached:

   a. Diaphragm setting too high. Pusher plate stud (13) will lift the flat bar <u>over</u> 0.020" (.51 mm).

   b. Diaphragm setting acceptable. Bar lifted <u>between</u> 0.010"–0.020" (.25–.51 mm).

   c. Diaphragm setting too low. Bar lifted <u>less</u> than 0.010" (.25 mm), or failed to be lifted.

4. The castle style stud nut (10) has six locations per revolution to align the stud nut (10) slots with the drilled hole through the pusher plate stud (13). Each stud nut (10) slot represents a movement up/down of 0.010" (.25 mm).

   NOTE: *The ideal diaphragm setting is 0.015" (.4 mm) high. Better performance is usually obtained when the diaphragm is at this value, rather than a lower level. As the measuring of a thousandths of an inch is difficult with such a procedure, it is recommended that the "null" position be found where the diaphragm(s) (20) is flush with the body (1) flange (bar approximately at 0.000"). Remove the pusher plate stud (13), rotate the stud nut (10) one or two slots CCW to bring the setting to 0.010–0.020" (.25–.51 mm) high.*

5. Place cotter pin (15) through the slot, bend over ends.

6. Continue reassembly per Sub-Section B, Diaphragm Replacement, Step 16.

E. Trim Removal and Replacement:

1. Install body (1) horizontally in a vise with the spring chamber (2) directed upwards, and the body (1) held at the outlet end.

2. Use a box end wrench, or socket, with a lever length of at least 24 inches (610 mm), and place over the hex surfaces of the cylinder (21). The wrench should be rapped with a hammer to loosen.

3. Continue to unscrew cylinder (21) until removed. The piston (24) and piston collar (23) should come out by gravity with the cylinder (21) removal.

⚠ CAUTION

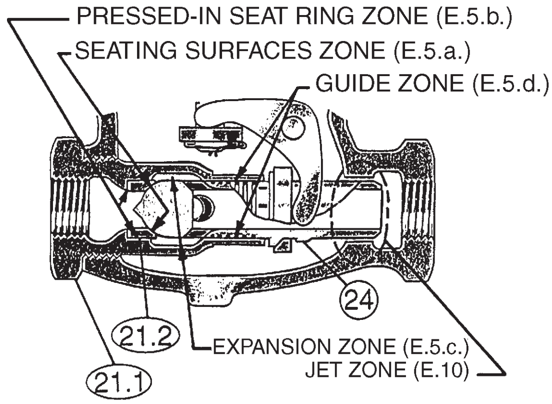
Take precautions not to allow the piston (24) to fall from within the cylinder (21); tip cylinder with hex end down.

4. If an Option 1000-17 piston spring (30) is utilized, it also should be removed and replaced at trim replacement.

5. Inspect inside surface of cylinder (21) at four points:

   a. Seat (21.2) ring. Check for erosion/wear on seating surfaces. If wear is excessive, consider utilizing Option 1000-15, stellited seat surface.

   b. Seat (21.2). Check for wire drawing between cylinder (21.1) and seat (21.2) where pressed in. If wear exists here, an Option 1000-14, integral seat, should be utilized as a replacement.



<u>CYLINDER SUBASSEMBLY (21) WITH PISTON (24) – METAL SEATED CONSTRUCTION</u>

c. Flow induced wear at expansion zone where fluid turns to enter the piston (24) center.

d. Where the piston (24) ribbed guides bear (guide zone).

If wear is significant at any of these points, both cylinder subassembly (21) and piston subassembly (24 or 24, 25, and 26) should be replaced. (Cashco does not recommend attempting to replace the seat (21.2) by pressing out and then repressing in. Cashco also recommends that a cylinder (21) and piston (24 or 24, 25 and 26) be replaced as a set. Composition seat discs (25) may be replaced individually.

6. If a composition (soft) seat trim design is utilized, use the following sub-steps:

   a. Tighten the “flats” of the seat disc screw (26) within a vise. Firmly hand-grip the piston (24) and turn CCW to loosen the seat disc screw (26). If too tight, place a screwdriver or similar rod within the piston (24) port holes and rotate. Remove the piston (24), and inspect for raised burrs around the port holes if a device is used to loosen; de-burr as required. NOTE: Do not grip the piston (24) with a wrench.

   b. Remove the seat disc (25) and clean the recessed piston (24) area where the seat disc (25) is placed. If the edges which form the recess of the piston (24) are worn, also replace piston (24) and seat disc screw (26).

   c. Place seat disc (25) into recessed end of piston (24).

   d. Place thread sealant on threaded portion of seat disc screw (26), and manually rotate piston (24) into seat disc screw (26) (still fixed in vise) to secure seat disc (25). Tighten seat disc screw (26) firmly. Do not over-tighten to the point of embedding the seat disc screw (26) into the seat disc (25); the seat disc (25) should lay flat with no rounded surface. A mechanical aid is normally not required; hand tightening is normally sufficient.

7. Insert piston assembly (24 - metal seat) (24, 25 and 26 composition (soft) seat) into end of cylinder (21).

8. Place piston collar (23) over the end of piston (24), ensuring that the spherical surface of the piston (24) and the piston collar (23) bear against each other.

9. Clean the body (1) cavity through the openings. Clean the “jet area” just inside the body (1) outlet end through which the piston (24) projects. Clean all parts to be reused.

10. Use special care cleaning the flat mating surfaces of the body (1) and cylinder (21) shoulder, as this pressurized joint is metal-to-metal with no gasket. (See NOTE next step.)

11. Lubricate the cylinder (21) threads lightly with thread sealant. Insert the entire trim stack into the body (1) opening and screw until tightly seated. Using the hammer and wrench handle, impact the cylinder (21) into the body (1).

    NOTES: *1. Take special precaution to keep piston collar from getting “cocked” at an angle when inserted.*
    2. On 2" brass bodies (1) with brass trim, a TFE body O-ring (43) is utilized to seal between the body (1) and the cylinder (21) subassembly. This O-ring is not indicated on drawings.

12. Inspect the body (1) outlet end to ensure that the piston (24) is located nearly concentric to the body (1) bore in the jet area with clearance. Under no condition should the piston (24) be touching the body (1). Use two pencils or similar shafts to place in inlet and outlet ends of regulator and alternately push on each end

of the piston (24) to ensure free movement. (Total movement is approximately 1/8" (3mm).

13. Bench test unit for suitable operation and seat leakage. ***NOTE:*** *Regulators are not normally tight shutoff devices.* Pressure must build above setpoint for best shutoff.

14. Soap solution test around cylinder (21)-to-body (1) connection for leakage. Test pressure should be a minimum of 100 psig at the inlet or actual service conditions if higher.

SECTION VII

VII. TROUBLE SHOOTING GUIDE

1. Erratic operation; chattering.

Possible Causes	Remedies
A. Oversized regulator; inadequate rangeability.	A1. Check actual flow conditions, resize regulator for minimum and maximum flow. A2. Increase flow rate. A3. Decrease regulator pressure drop; decrease inlet pressure by placing a throttling orifice in inlet piping union. A4. Replace full orifice with reduced orifice; i.e. new cylinder required.
B. Worn piston/cylinder; inadequate guiding.	B. Replace trim.
C. Flow induced instability.	C1. Get straight runs of piping (5 diameters upstream, 10 downstream) to and from regulator. C2. Ensure outlet velocity is not excessive; use pipe reducer close to regulator outlet. C3. Add next higher range spring. Contact factory. C4. If composition diaphragm, switch to metal diaphragm.
D. Improper (oversized) jet.	D. Replace existing piston with new piston with proper jet.
E. Plugged trim.	E. Remove trim and check for plugged holes in piston, or debris in guide zone or jet zone.
F. Unstable loading pressure.	F1. Stabilize loading pressure; i.e. pump, control valve, etc. F2. Air in loading piping. Vent spring chamber.

2. Regulator differential pressure too low.

Possible Causes	Remedies
A. Setpoint too low.	A. Turn adjusting screw down (CW) to increase setpoint.
B. Regulator undersized; outlet pressure (P_2) droops below loading pressure (P_{Load}).	B1. Confirm by opening bypass valve together with regulator. B2. Check actual flow conditions, resize regulator; if regulator has inadequate capacity, replace with larger unit.
C. Plugged inlet strainer.	C. Remove strainer screen and clean; consider leaving screen out.
D. Plugged trim.	D. Remove trim and check for plugged holes in piston, or debris in guide zone or jet zone.
E. Incorrect range spring (turning adjusting screw CW does not allow bringing pressure level up to proper level).	E. Replace range spring with proper higher range. Contact factory.
F. Too much proportional band (droop); outlet pressure (P_2) droops below loading pressure (P_{Load}).	F1. Review P.B. (droop) expected. (See 2.B1 above.) F2. Diaphragm setting too low; check setting and raise as required. F3. Consider composition diaphragm over metal. F4. Improper jet; make sure jet matches actual fluid.
G. Restricted diaphragm movement. (Pressure plate hitting downstops.)	G. Diaphragm setting too low; check and raise as required.

3. Leakage through the body spacer vent hole, or mixing of fluids.

Possible Causes	Remedies
A. Normal-life diaphragm failure.	A. Replace diaphragm.
B. Abnormal short-life diaphragm failure.	B1. Can be caused by excessive chattering. See No. 1. to remedy valve chatter. B2. Can be caused by corrosive action. Consider alternate diaphragm material. B3. For composition diaphragms, ensure not subjecting to over-temperature conditions. B4. Downstream (outlet) pressure buildup occurring that overstresses diaphragms. B5. Shutoff of valve inlet pressure while loading pressure is still on.
C. Pusher plate gasket or O-Ring leaking.	C. Replace gasket and O-ring.

4. Excessive pressure downstream.

Possible Causes	Remedies
A. Regulator not closing tightly.	A1. Overly compressed range spring; i.e. approaching solid height. Use next higher range spring. A2. Inspect the seating. Clean and lap metal seat surfaces; replace if lapping does not remedy. If composition seats are depressed, nicked or embedded with debris, replace seat disk. A3. Diaphragm setting too high; check setting. A4. Inlet pressure too high for orifice size; check permissible inlet (P_1) pressure level for a given outlet. Change to reduced port if required. A5. Leakage past pressed in seat ring; consider integral seat. A6. When diaphragm subassembly was put into place, the rocker arm got between the stud collar and the stud nut rather than on top of the stud collar.
B. Downstream block.	B. Check system; isolate (block) flow at regulator inlet, not outlet. Relocate regulator if necessary.
C. No pressure relief protection.	C. Install safety relief valve, or rupture disc.
D. Restricted diaphragm movement.	D1. Diaphragm setting too high; check and lower as required. D2. Ensure no moisture in spacer ring at temperatures below freeze point. Ensure no dust or debris entering vent opening. If rainwater or debris can enter, reorient spring chamber. (Not possible on -1+6.)

5. Sluggish operation.

Possible Causes	Remedies
A. Plugged piston or jet zone.	A. Remove trim and clean.
B. Fluid too viscous.	B. Heat fluid.
C. Improper (undersized) jet.	C. Replace existing piston with new piston for viscous service; i.e. Opt-27.

6. Frequent resetting of setpoint.

Possible Causes	Remedies
A. Overpressurization downstream resulting in: 1. Bent metal diaphragm(s) 2. Sprung rocker arm 3. Range spring overstressed/fatigued.	A1. Replace diaphragms. Correct potential source of downstream overpressure. A2. Check measurements of rocker arm. Replace if necessary. A3. Replace range spring; consider next higher range spring.

7. Not able to maintain setpoint.

Possible Causes	Remedies
A. Diaphragm may be bent due to pressure reversal.	A. Make sure to prevent system reversal.

8. Excess leakage:

Possible Causes	Remedies
A. Faulty seating surfaces.	A1. Seat has been nicked by welding splatters. A2. Composition seat is damaged. A3. Composition seat driven into metal seat surface due to overpressure.
B. Outlet pressure setting too low for inlet pressure.	B. Refer to Technical Bulletin.

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).

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NEW REPLACEMENT UNIT:

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

⚠ CAUTION

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

PARTS "KIT" for FIELD REPAIR:

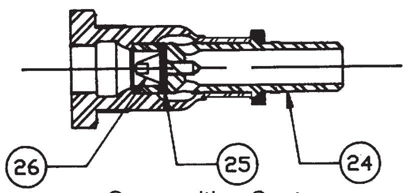
Contact your local Cashco, Inc., Sales Representative with the Serial Number and Product code. Identify the parts and the quantity required to repair the unit from the "BOM" sheet that was provided when unit was originally shipped.

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

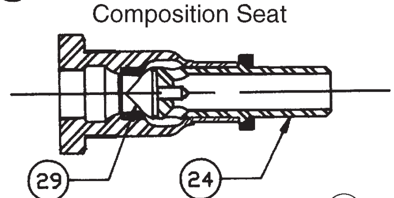
If the "BOM" is not available, refer to the cross-sectional drawings included in this manual for part identification and selection.

A Local Sales Representative will provide quotation for appropriate Kit Number, Price and Availability.

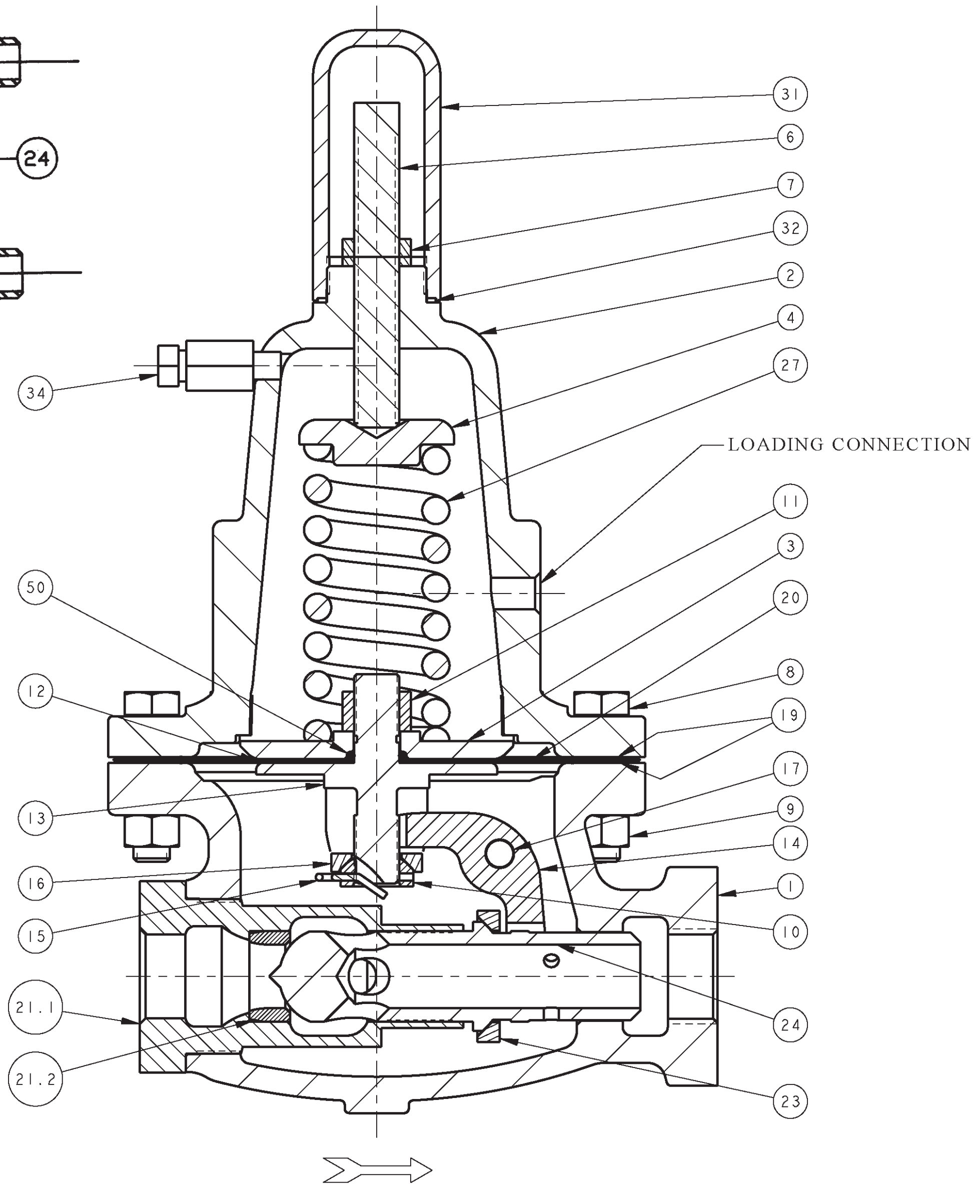
MODEL 1000HP-1+6
DIFFERENTIAL PRESSURE REDUCING REGULATOR



Composition Seat



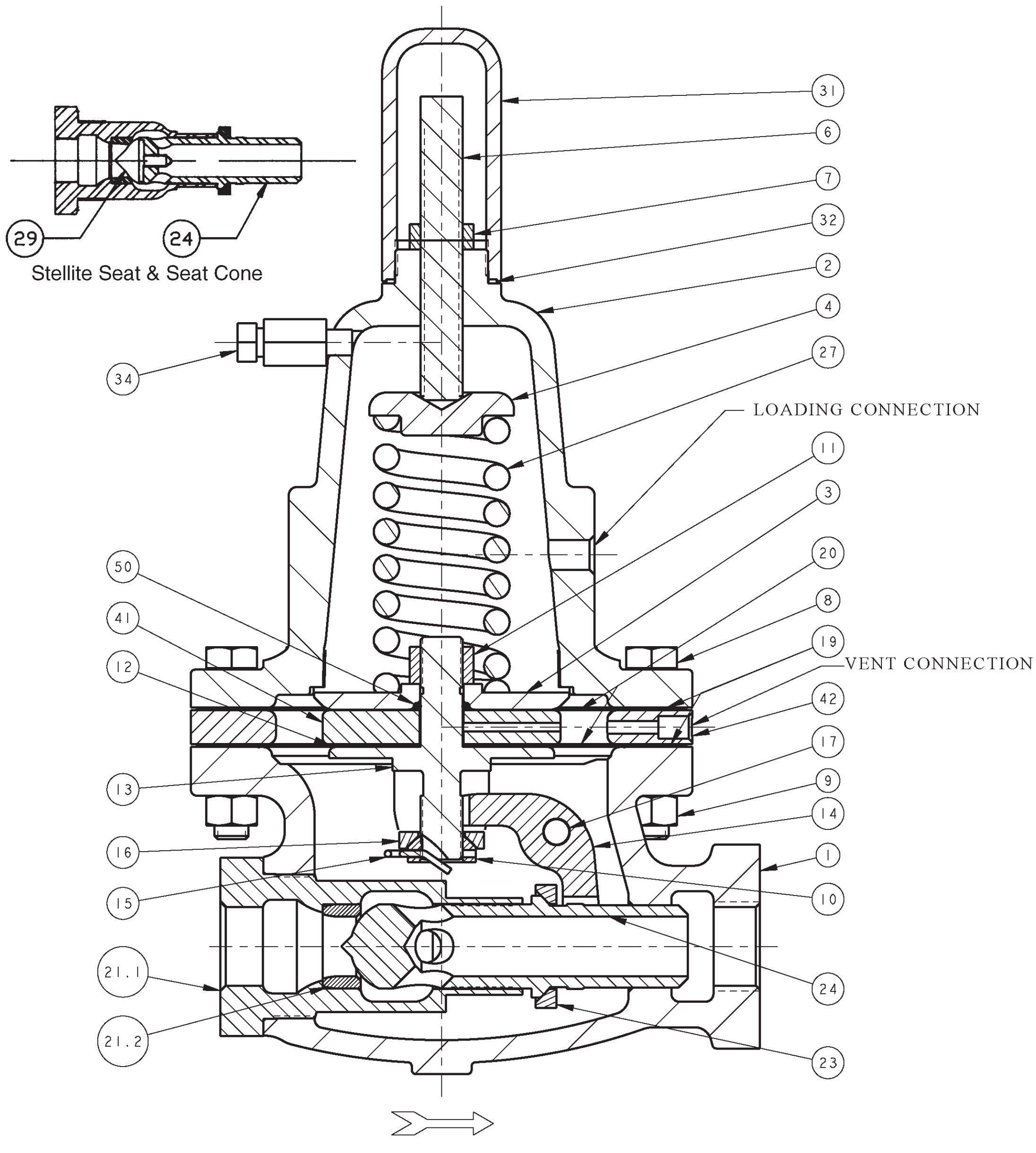
Stellite Seat & Seat Cone



ITEM NO. DESCRIPTION	REPAIR PARTS KIT A	REPAIR PARTS KIT B	ITEM NO. DESCRIPTION	REPAIR PARTS KIT A	REPAIR PARTS KIT B
1. BODY & BODY ASSY 2. SPRING CHAMBER			19. DIAPHRAGM GASKET	*	**
(or Loading Chamber)			20. DIAPHRAGM(S)	*	**
3. PRESSURE PLATE			21. CYLINDER ASSEMBLY		**
4. SPRING BUTTON			21.1 CYLINDER		
6. ADJUSTING SCREW			21.2 VALVE SEAT		
7. ADJUSTING SCREW LOCK NUT	*	**	23. PISTON COLLAR		**
9. FLANGE NUT			24. PISTON		**
10. STUD NUT			25. SEAT DISC	*	**
11. PRESSURE PLATE NUT	*	**	26. SEAT DISC SCREW		**
12. PUSHER PLATE GASKET	*	**	27. RANGE SPRING		
13. PUSHER PLATE STUD			28. NAME PLATE		
14. ROCKER ARM			29. SEAT CONE (-15 OPT)		
15. COTTER PIN		**	31. CLOSING CAP (-1 OPT)		
16. STUD COLLAR			32. CLOSING CAP GASKET (-1 OPT)	*	**
17. ROCKER ARM SHAFT			34 BLEEDER VALVE ASSEMBLY		
			50 O-RING	*	**

Items Not Shown	
5	Pusher Plate
18	Body Plug/Drain Tap
30	Piston Spring
33	Spring Chamber Pipe Plug
36	Identification Plate (Supplied upon request)
43	Body O-ring

MODEL 1000HP-1+8
DIFFERENTIAL PRESSURE REDUCING REGULATOR



ITEM NO. DESCRIPTION	REPAIR PARTS KIT A	KIT B
1. BODY & BODY ASSY		
2. SPRING CHAMBER (or Loading Chamber)		
3. PRESSURE PLATE		
4. SPRING BUTTON		
6. ADJUSTING SCREW		
7. ADJUSTING SCREW LOCK NUT	*	**
9. FLANGE NUT		
10. STUD NUT		
11. PRESSURE PLATE NUT	*	**
12. PUSHER PLATE GASKET	*	**
13. PUSHER PLATE STUD		
14. ROCKER ARM		
15. COTTER PIN		**
16. STUD COLLAR		
17. ROCKER ARM SHAFT		

ITEM NO. DESCRIPTION	REPAIR PARTS KIT A	KIT B
19. DIAPHRAGM GASKET	*	**
20. DIAPHRAGM(S)	*	**
21. CYLINDER ASSEMBLY		**
21.1 CYLINDER		
21.2 VALVE SEAT		
23. PISTON COLLAR		**
24. PISTON		**
27. RANGE SPRING		
28. NAME PLATE		
29. SEAT CONE (-15 OPT)		
31. CLOSING CAP (-1 OPT)		
32. CLOSING CAP GASKET (-1 OPT)	*	**
34 BLEEDER VALVE ASSEMBLY		
41. DIAPHRAGM SPACER		
42. BODY SPACER		
50 O-RING	*	**

Items Not Shown	
5	Pusher Plate
18	Body Plug/Drain Tap
30	Piston Spring
33	Spring Chamber Pipe Plug
36	Identification Plate (Supplied upon request)
43	Body O-ring

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

NOTICE

Only for Product Codes wherein hazard category ATEX has been selected.

These valves satisfy the safety conditions according to EN 13463-1 and EN 13463-5 for equipment group IIG 2 c.

Caution: Because the actual maximum temperature depends not on the equipment itself, but upon the fluid temperature, a single temperature class or temperature cannot be marked by the manufacturer.

Specific Precaution to Installer: Electrical grounding of valve must occur to minimize risk of effective electrical discharges.

Specific Precaution to Installer: Atmosphere vent holes should be plugged to further minimize the risk of explosion.

Specific Precaution to Maintenance: The Valve Body/ Housing must be regularly cleaned to prevent buildup of dust deposits.

Specific Precaution to Maintenance: Conduct periodic Continuity Check between Valve Body/ Housing and Tank to minimize risk of electrical discharges.

Attention: When repairing or altering explosion-protected equipment, national regulations must be adhered to. For maintenance and repairs involving parts, use only manufacturer's original parts.

ATEX requires that all components and equipment be evaluated. Cashco pressure regulators are considered components. Based on the ATEX Directive, Cashco considers the location where the pressure regulators are installed to be classified Equipment-group II, Category 3 because flammable gases would only be present for a short period of time in the event of a leak. It is possible that the location could be classified Equipment-group II, Category 2 if a leak is likely to occur. Please note that the system owner, not Cashco, is responsible for determining the classification of a particular installation.

Product Assessment

Cashco performed a conformity assessment and risk analysis of its pressure regulator and control valve models and their common options, with respect to the Essential Health and Safety Requirements in Annex II of the ATEX directive. The details of the assessment in terms of the individual Essential Health and Safety Requirements, are listed in Table 1. Table 2 lists all of the models and options that were evaluated and along with their evaluation.

Models and options not listed in Table 2 should be assumed to not have been evaluated and therefore should not be selected for use in a potentially explosive environment until they have been evaluated.

Standard default options for each listed model were evaluated even if they were not explicitly listed as a separate option in the table. Not all options listed in the tables are available to all models listed in the tables. Individual TB's must be referenced for actual options.

When specifying a regulator that is to be used in a potentially explosive environment one must review the evaluations in Table 1 and 2 for the specific model and each and every option that is being specified, in order to determine the complete assessment for the unit.

A summary of the models and options found to have an impact on ATEX assessment due to potential ignition sources or other concerns from the ATEX Essential Health and Safety Requirements, are listed below.

1. The plastic knob used as standard on some models, (P1, P2, P3, P4, P5, P7, 3381, 4381, 1171, and 2171) is a potential ignition source due to static electricity. To demonstrate otherwise, the knob must be tested to determine if a transferred charge is below the acceptable values in IEC 60079-0 Section 26.14 (See items 25, 27, and 28 in Appendix A). Until the plastic knob has been shown to be acceptable, then either the metal knob option, or a preset outlet pressure option is required to eliminate this ignition source (See items 45 and 64 in Tables).

2. The pressure gauges offered as options on a few of the regulator models (DA's, P1-7, D, 764, 521), use a plastic polycarbonate window that is a potential ignition source due to static electricity. To demonstrate that the gauges are not a potential source of ignition, the gauges would need to be tested to determine if a transferred charge is below

indicating the gauge is compliant with the ATEX Directive (See items 26, 27, and 28 in Appendix A). Until compliance is determined, regulators should not be ordered with pressure gauges for use in potentially explosive environments.

3. Tied diaphragm regulators with outlet ranges greater than 100 psig should be preset to minimize the risk that improper operation might lead to an outboard leak and a potentially explosive atmosphere (See item 6 in Table 1).

4. Regulators must be ordered with the non-relieving option (instead of the self-relieving option) if the process gas they are to be used with is hazardous (flammable, toxic, etc.). The self-relieving option vents process gas through the regulator cap directly into the atmosphere while the non-relieving option does not. Using regulator with the self- relieving option in a flammable gas system could create an explosive atmosphere in the vicinity of the regulator.

5. Regulators with customer supplied parts are to be assumed to not have been evaluated with regard to ATEX and thus are not to be used in a potentially explosive environment unless a documented evaluation for the specific customer supplied parts in question has been made. Refer to Table 1 for all models and options that have been evaluated.

Product Usage

A summary of ATEX related usage issues that were found in the assessment are listed below.

1. Pressure regulators and control valves must be grounded (earthed) to prevent static charge build-up due to the flowing media. The regulator can be grounded through any mounting holes on the body with metal to metal contact or the system piping can be grounded and electrical continuity verified through the body metal seal connections. Grounding of the regulator should follow the same requirements for the piping system. Also see item 30 in Table 1.

2. The system designer and users must take precautions to prevent rapid system pressurization which may raise surface temperatures of system components and tubing due to adiabatic compression of the system gas.

3. Heating systems installed by the user could possibly increase the surface temperature and must be evaluated by the user for compliance with the ATEX Directive. User installation of heating systems applied to the regulator body or system piping that affects the surface temperature of the pressure regulator is outside the scope of this declaration and is the responsibility of the user.

4. The Joule-Thomson effect may cause process gases to rise in temperature as they expand going through a regulator. This could raise the external surface temperature of the regulator body and downstream piping creating a potential source of ignition. Whether the Joule-Thomson effect leads to heating or cooling of the process gas depends on the process gas and the inlet and outlet pressures. The system designer is responsible for determining whether the process gas temperature may rise under any operating conditions. If a process gas temperature rise is possible under operating conditions, then the system designer must investigate whether the regulator body and downstream piping may increase in temperature enough to create a potential source of ignition.

The process gas expansion is typically modeled as a constant enthalpy throttling process for determining the temperature change. A Mollier diagram (Pressure – Enthalpy diagram with constant temperature, density, & entropy contours) or a Temperature – Entropy diagram with constant enthalpy lines, for the process gas, can be used to determine the temperature change. Helium and hydrogen are two gases that typically increase in temperature when expanding across a regulator. Other gases may increase in temperature at sufficiently high pressures.

Product Declaration

If the above issues are addressed by selecting options that do not have potential sources of ignition, avoiding options that have not been assessed, and by taking the proper usage issue precautions, then Cashco regulators can be considered to be a mechanical device that does not have its own source of ignition and thus falls outside the scope of the ATEX directive.

Cashco, Inc.
P.O. Box 6
Ellsworth, KS 67439-0006
PH (785) 472-4461
Fax. # (785) 472-3539
www.cashco.com
email: sales@cashco.com

Cashco GmbH
Handwerkerstrasse 15
15366 Hoppegarten, Germany
PH +49 3342 30968 0
Fax. No. +49 3342 30968 29
www.cashco.com
email: germany@cashco.com

Cashco do Brasil, Ltda.
Al.Venus, 340
Indaiatuba - Sao Paulo, Brazil
PH +55 11 99677 7177
Fax. No.
www.cashco.com
email: brazil@cashco.com

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