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## 1.0 GENERAL VALVE DESCRIPTION

### 1.1 OPERATION

The Type LCP safety relief valve uses the principle of loading the larger area of a differential area piston with line pressure to hold the piston closed up to set pressure. On rising system pressure, the pilot actuates at set pressure venting the volume above the main valve piston allowing the piston to rise and permitting system pressure discharge through the main valve. When system pressure drops sufficiently, the pilot reseats and line pressure recharges the volume above the piston closing the main valve.

### 1.2 INSTALLATION AND START-UP

Refer to Anderson Greenwood Report 05.9040.311 for Type LCP installation and start-up instructions.

## 2.0 VALVE MAINTENANCE

### 2.1 DISASSEMBLY - Refer to Figure 1

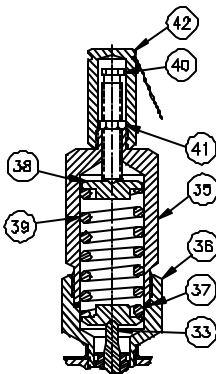
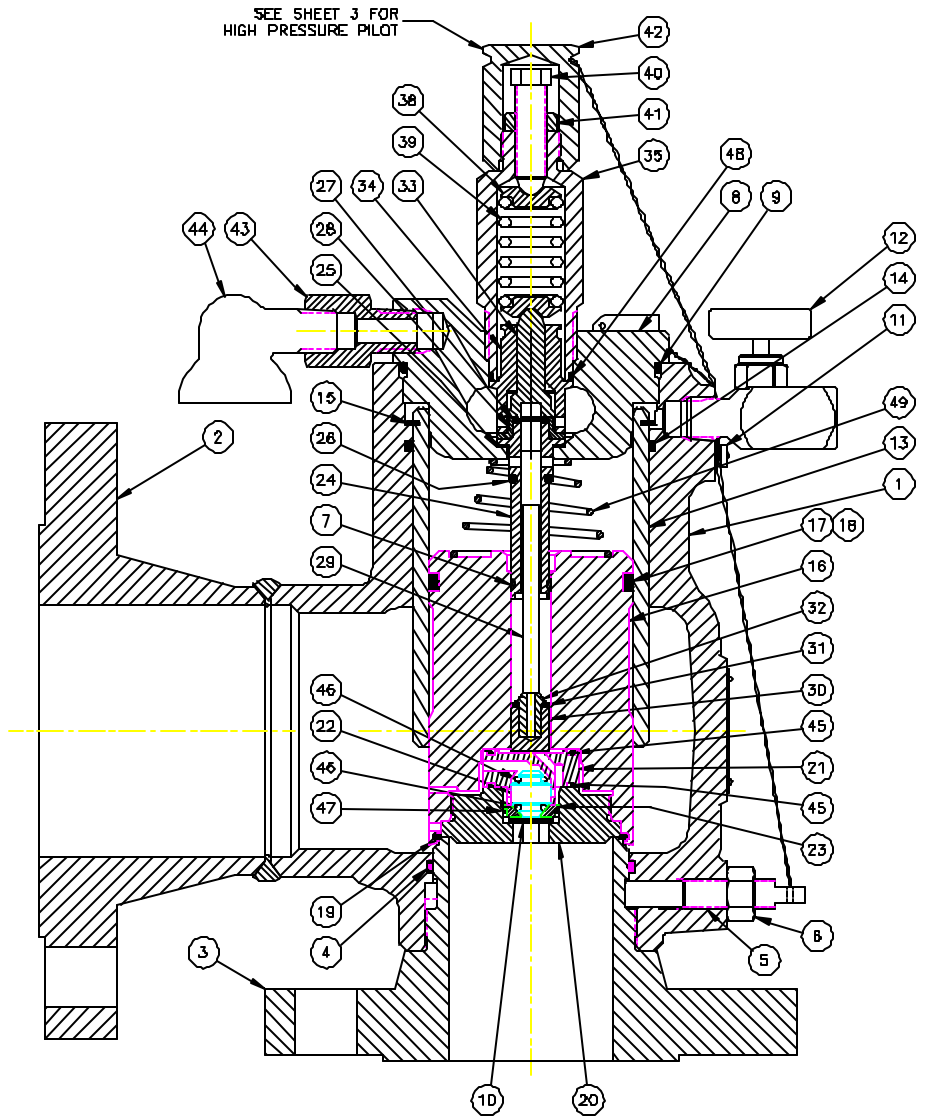
2.1.1 With the valve sitting on the inlet flange, remove lockwire from pilot cap (42) only. While holding pilot bonnet (35) with a wrench, remove pilot cap.

2.1.2 Loosen lock nut (41) and back out adjustment screw (40) to relieve tension on pilot spring. Note: To make it easier to reset the pilot after completing repairs, make note of the number of adjustment screw turns required to relieve spring pressure, or measure the distance from the top of the adjustment screw to the shoulder on the pilot bonnet before loosening the screw.

2.1.3 For pilot set pressures below 1481 psig - Remove pilot bonnet (35) from main valve cap (8) along with the pilot spring (39) and spring washers (38). Remove and discard bonnet seal (48). Note: Main valve cap may unscrew from body (1) while attempting to remove the pilot bonnet (35) if the lockwire on the main valve cap is broken or removed. If this occurs, place the main valve cap in a soft jawed vise making sure not to clamp on threads and remove bonnet.

ITEM	DESCRIPTION
1	BODY
2	OUTLET FLANGE
3	INLET FLANGE
4	INLET FLANGE SEAL
5	FLANGE LOCK PIN
6	JAM NUT
7	SPLIT BUSHING
8	M.V. CAP
9	CAP SEAL
10	SCREEN
11	LOCK WIRE PIN
12	HAND VALVE (H5RIS-22)
13	LINER
14	LINER SEAL
15	RETAINING RING
16	M.V. PISTON
17	PISTON SEAL
18	BACKUP RING
19	M.V. PISTON SEAT
20	M.V. SEAT RETAINER
21	BFP SHUTTLE GUIDE
22	BFP PISTON
23	BFP SHUTTLE SEAT
24	PILOT NOZZLE
25	PILOT NOZZLE SEAL
26	DOME SEAL
27	PILOT SEAT
28	PILOT SEAT RETAINER
29	PILOT SPACER ROD
30	RESEAT PISTON
31	PILOT RESEAT SEAT
32	RESEAT SEAT RETAINER
33	SPINDLE
34	GUIDE
35	BONNET
36	BONNET ADAPTER
37	BONNET ADAPTER SEAL
38	SPRING WASHER
39	SPRING
40	ADJUSTMENT SCREW
41	LOCK NUT
42	PILOT CAP
43	VENT ADAPTER
44	VENT
45	BFP SHUTTLE GUIDE SEAL
46	BFP PISTON SEAL
47	BFP SHUTTLE SEAT SEAL
48	BONNET SEAL
49	DOME SPRING

▷ 1481 PSIG AND ABOVE ONLY.



DETAIL "A"

SET PRESSURES 1481 PSIG AND ABOVE

FIGURE 1

For pilot set pressures 1481 psig and above - While holding bonnet adapter (36) with a wrench, remove bonnet (35) along with the pilot spring (39) and spring washers (38). Remove and discard adapter seal (37) from adapter ID. Remove adapter (36) from main valve cap (8). Remove and discard bonnet seal (48). Note: Main valve cap may unscrew from body (1) while attempting to remove the bonnet adapter (36) if the lockwire on the main valve cap is broken or removed. If this occurs, place the main valve cap in a soft jawed vise making sure not to clamp on threads and remove adapter.

- 2.1.4 Remove vent adapter (43) from the main valve cap along with the cap lockwire. Unscrew cap from main valve body (1) using the wrenching boss on top of the cap. Then remove the pilot guide (34), spindle (33), pilot seat retainer (28), and pilot nozzle (24) from the main valve cap.
- 2.1.5 Remove and discard pilot nozzle seal (25) and cap seal (9) from the main valve cap. Remove and discard split bushing (7) and dome seal (26) from the pilot nozzle (24). Remove and discard pilot seat (27) from the seat retainer (28).
- 2.1.6 Remove pilot spacer rod (29) and dome spring (49) from the body of the main valve piston (16).
- 2.1.7 Reposition main valve body to stand on its outlet flange. Push piston (16) out of the liner (13) and through the top of the main valve body. Be careful not to lose the reseal piston (30) and reseal seat retainer (32) that are still inside the piston body. After removal of the main valve piston, the reseal piston (30) and seat retainer (32) can be removed by inverting the piston. Remove and discard the pilot reseal seat (31) from the seat retainer (32).
- 2.1.8 Remove piston seal (17) from the main valve piston (16) and discard. Also remove and discard any backup ring (18) found on the piston.

2.1.9 Unscrew main valve seat retainer (20) from piston using hexagonal hole provided in the face of the retainer. Take care not to damage the inlet screen (10) during removal of the seat retainer. While taking care not to scratch the tapered sealing surface on the BFP shuttle seat (23), remove it from the seat retainer (20). Discard the BFP shuttle seat seal o-ring (47). Remove the main valve piston seat o-ring (19) from ID of piston face and discard. Turn the main valve piston (16) over and the BFP piston (22) and BFP shuttle guide (21) should drop out of the piston. Remove and discard the two BFP shuttle guide seal o-rings (45). Also remove and discard the two BFP piston seal o-rings (46).

2.1.10 Remove liner (13) from body (1) by pulling the liner out through the top of the body. Note that the liner fits snugly in the body due to the liner seal o-ring (14) and will require some effort to remove. Upon removal of the liner discard the liner seal (14) from the bore of the body.

2.1.11 Loosen jam nut (15) from flange lock pin (5) and remove lock pin from body (1). Unscrew inlet flange (3) from body. Remove and discard inlet flange seal o-ring (4) from body ID.

## 2.2 ASSEMBLY - Refer to Figure 1

Note: It is strongly recommended that Fluorolube<sup>®</sup> LG-160 lubricant be used on all stainless-to-stainless threaded connections as noted in the assembly procedure below to prevent galling. This product is available from:

Occidental Chemical Corp.  
P.O. Box 840642  
Dallas, TX 75284-0642  
Phone: (800)752-5151

2.2.1 Prior to assembly, thoroughly clean all metal valve parts with oil free solvent and carefully dry, paying particular attention to all sealing surfaces. **Do not sand or bead blast any internal parts.**

- 2.2.2 Lightly lubricate inlet flange seal o-ring (4) with Dow Corning No. 33 silicone grease (Molykote<sup>?</sup>). Stand main valve body (1) on top end and install o-ring in ID groove located in the inlet neck area.
- 2.2.3 Before assembling the inlet flange (3) and main valve body, carefully inspect the flange nozzle seating surface area for damage that could result in main valve seat leakage. Damage to the seating surface may require inlet flange replacement as the nozzle is not repairable.
- 2.2.4 Thread inlet flange (3) into main valve body inlet until the the shoulder on the flange almost contacts the body inlet neck. Do not allow full metal-to-metal contact as the flange may jam in the body.
- 2.2.5 Thread flange lock pin (5) into tapped hole on body inlet neck until the pin engages the groove in the inlet flange neck. Rotate flange counterclockwise sufficiently to insure that the pin is engaged in the groove. The inlet flange may then be rotated slightly as required to achieve correct orientation of the flange bolt holes. Thread jam nut (6) onto flange lock pin and tighten securely to prevent lock pin from backing out.
- 2.2.6 Stand body on inlet flange. Lubricate liner seal o-ring (14) with Molykote<sup>?</sup> and place in groove at top of main valve body.
- 2.2.7 Lightly lubricate main valve liner (13) OD with Molykote<sup>?</sup>. Carefully push liner into position inside of main valve body until retaining ring contacts the shoulder inside the body bore. Note that the liner will fit snugly in the body bore due to the presence of the liner seal o-ring.
- 2.2.8 Lightly lubricate the two BFP shuttle guide seal o-rings (45) with Molykote<sup>?</sup> and place on the BFP shuttle guide (21). Invert the main valve piston (16) and install the BFP shuttle guide (21) into the machined pocket in the piston face. Taking care not to use any lubricant, place two BFP piston seal o-rings (26) on the BFP piston (22). Place the unlubricated BFP piston (22) into the BFP shuttle guide (21).

- 2.2.9 Lightly lubricate the BFP shuttle seat seal o-ring (47) with Molykote<sup>?</sup> and insert on the BFP shuttle seat (23). Press the BFP shuttle seat (23) into the seat retainer (20) taking care not to damage the seat's tapered sealing surface. Ensure the BFP shuttle seat sits squarely on the inlet screen (10).
- 2.2.10 Lightly lubricate the main valve piston seat o-ring (19) with Molykote<sup>?</sup> and install in main valve piston face ID groove. Take care not to kink or twist o-ring during installation.
- 2.2.11 Carefully thread seat retainer (20) into piston face and tighten it securely using an Allen wrench and the hexagonal hole provided in the retainer. Take care not to damage the inlet screen (10) while tightening the retainer.
- 2.2.12 Lightly lubricate piston seal o-ring (17) with Molykote<sup>?</sup> and install in OD groove near the top of the main valve piston (16). A backup ring (18) is also used with the piston seal for valves having set pressures above 1480 psig. The backup ring is installed in the same groove just below the o-ring on the side nearest the main valve seat.
- 2.2.13 Lightly lubricate inside of liner (13) with Molykote<sup>?</sup>. Install piston assembly into the main valve body from the top being careful not to damage the piston seal on the liner as the piston is pushed into position. The piston is correctly installed when the piston seat contacts the seating surface on the inlet flange (3).
- 2.2.14 Slide reseal seat o-ring (31) into position on reseal seat retainer (32) until it contacts retainer shoulder. Do not apply any lubricant to this o-ring. Assemble retainer with o-ring to reseal piston (30) by fitting retainer into hole in piston. **Note: The seat retainer must move freely within the piston to insure that the proper amount of squeeze is placed on the seat o-ring.**

- 2.2.15 Insert reseal piston assembly into hole in top of main valve piston (16) with o-ring seal facing top of main valve piston.
- 2.2.16 Install dome spring (49) with the outside diameter snugly fitting into the counter bore on top of the main valve piston (16).
- 2.2.17 Lightly lubricate main valve cap seal o-ring (9) with Molykote and install on main valve cap (8). After lubricating OD threads with Molykote<sup>?</sup>, screw main valve cap into valve body (1) until metal-to-metal contact is made. Tighten cap securely into body using the wrenching boss provided on the cap. Note that excessive torque is not required as this is an o-ring sealed joint. Install in the main valve cap the vent adaptor (43) with its accompanying bug vent (44).
- 2.2.18 Install pilot nozzle seal (25) in machined recess located inside the bottom of main valve cap (1).
- 2.2.19 Lightly lubricate dome seal o-ring (26) with Molykote<sup>?</sup> and place it on small OD of pilot nozzle (24). Using AGCO tool number 14914, slide o-ring onto nozzle body until it snaps into the machined groove. Be careful not to twist or kink the o-ring during installation. Install split bushing (7) into machined groove on opposite end of pilot nozzle using AGCO tool number 14914.
- 2.2.20 Install pilot seat o-ring (27) and pilot seat retainer (28) on large end of pilot nozzle. Take care not to pinch or cut the o-ring while positioning the seat retainer.
- 2.2.21 Carefully insert pilot nozzle body assembly into main valve cap while making sure that lower portion of assembly is aligned with hole in top of main valve piston. Press assembly into position until shoulder on nozzle body seats against the nozzle seal (25).
- 2.2.22 Insert pilot spacer rod (29) into nozzle body assembly bore so that the lower end rests on top of the reseal piston assembly (inside the main valve piston).

- 2.2.23 Carefully position pilot spindle (33) on top of seat retainer (28) inside main valve cap. Slide guide (34) over end of spindle until it stops on pilot seat retainer shoulder. Seat bonnet seal (48) on the shoulder of the guide (34).
- 2.2.24 **For pilot set pressures below 1481 psig** - Thread adjustment screw (40) with jam nut (41) partway into pilot bonnet (35). Apply small amount of Fluorolube<sup>?</sup> LG-160 to bonnet threads. Install spring washers (38) on pilot spring (39) and place spring assembly on top end of spindle (33). While holding pilot spring in place, slide pilot bonnet over spring assembly. Thread bonnet assembly into main valve cap (8). Securely tighten bonnet into cap. Turn adjustment screw (40) until the required distance or number of turns determined in step 2.1.2 is achieved.
- For pilot set pressures 1481 psig and above** - Apply small amount of Fluorolube to bonnet adapter (36) threads. Screw adapter into main valve cap (8) and tighten securely. Lightly lubricate adapter seal o-ring (37) with Molykote<sup>?</sup> and install in bonnet adapter. Thread adjustment screw (40) with jam nut (41) partway into pilot bonnet (35). Apply small amount of Fluorolube<sup>?</sup> LG-160 lubricant to bonnet threads. Install spring washers (38) on pilot spring (39) and place spring assembly on top end of spindle (33). While holding pilot spring in place, slide pilot bonnet over spring assembly. Thread bonnet assembly into bonnet adapter (36). Securely tighten bonnet into adapter while holding adapter with wrench. Turn adjustment screw (40) until the required distance or number of turns determined in step 2.1.2 is achieved.
- 2.2.25 Using a hole near the wrenching boss on the cap (8), lockwire the cap to the lockwire pin (11). Securely tighten the lock wire to prevent loosening of the main valve cap due to vibration. Depending on the orientation of the hole in the cap relative to the locking pin, it may require wrapping the twisted wire pair clockwise around the base of the pilot bonnet or bonnet adaptor.

- 2.2.26 Valve assembly is now ready for pilot set point adjustment. See Section 3.0 for setting procedure.
- 2.2.27 After pilot set point is properly adjusted, install pilot bonnet cap (42) and tighten securely. Secure pilot by wrapping lock wire around groove in bonnet cap and attaching wire to lock wire pin (11). The free end of the wire is then threaded through the hole in the flange lock pin (5) and secured with a lead seal.

### 3.0 PILOT SET PRESSURE ADJUSTMENT

#### 3.1 General

- 3.1.1 Test medium shall be ordinary shop air at ambient conditions unless otherwise specified.
- 3.1.2 Test gauge accuracy shall be within  $\pm 0.5\%$  of the actual pressures at which the valve is being set and tested. Full scale of the gauge used shall not be more than three times set pressure.

#### 3.2 Definitions of Test Pressures (unless otherwise specified on the procurement document)

- 3.2.1 Set Pressure - pressure at which the pilot valve relieves on increasing inlet pressure to reduce the main valve dome pressure sufficiently to allow the main valve piston to open fully.
- 3.2.2 Cracking Pressure - inlet pressure at which the pilot exhaust port exhibits initial air leakage on increasing inlet pressure.
- 3.2.3 Reseat Pressure - pressure at which the pilot valve reseats and closes the main valve.

#### 3.3 Pilot Set Pressure Adjustment

##### 3.3.1 General

The LCP pilot valve is a fixed blowdown design and therefore, reseat pressure is not adjustable.

### 3.3.2 Test Set Up

Connect LCP valve assembly to a pressure source as shown in Figure 2.

### 3.3.3 Set Pressure Adjustment

Verify that the field test connection hand valve on the main valve body is in the closed position prior to beginning the test. Slowly increase inlet pressure to the main valve by opening the air supply valve and note the gauge pressure at which the pilot valve opens. The main valve will also cycle following actuation of the pilot. Correct set pressure is obtained by use of the pilot adjusting screw located inside the bonnet cap. Rotate the adjusting screw clockwise to increase set pressure or counterclockwise to decrease set pressure. Note that the adjusting screw lock nut must be securely tightened after each set pressure adjustment is made. Repeat this procedure until the desired set pressure is obtained. Once the set pressure adjustment is completed, tighten the adjusting screw lock nut securely and install the pilot bonnet cap.

### 3.3.4 Set Pressure Performance Check

Cycle the pilot valve a minimum of five times following the final adjustment to assure that it is relieving consistently. Supply pressure should be increased slowly in order to obtain accurate readings and detect any erratic performance.

## 3.4 Pilot Leakage Test

### 3.4.1 Test Set Up

The valve assembly is connected to a pressure source as shown in Figure 2. Pilot leakage will be determined by applying a bubble checker paddle against the pilot exhaust port.

### 3.4.2 Test Procedure

Slowly increase inlet pressure to the main valve and record the pressure at which the first bubbles are observed. This pressure will be recorded as the pilot cracking pressure.

Continue increasing the inlet pressure until the pilot actuates ("pops") and record this pressure as the set pressure. The main valve will also cycle following pilot actuation. Shut off the supply pressure to the valve and check pilot exhaust for leakage as above.

Repeat the preceding steps a minimum of three times. The cracking pressure and set pressure shall be within the limits specified in the applicable performance requirements for three consecutive cycles. Valve action shall be consistent.

Slowly increase inlet pressure to a value just below the observed cracking pressure. Maintain this pressure for one minute and check for leakage at the pilot exhaust. No pilot leakage is permissible.

### 3.5 Pilot Performance Requirements

#### 3.5.1 ASME Set Pressure Tolerance (1)

70 psig and below	? 2 psig
Above 70 psig	? 3% of specified set pressure

#### 3.5.2 Cracking Pressure

Below 100 psig	90% of specified set pressure
100 psig and above`	95% of specified set pressure

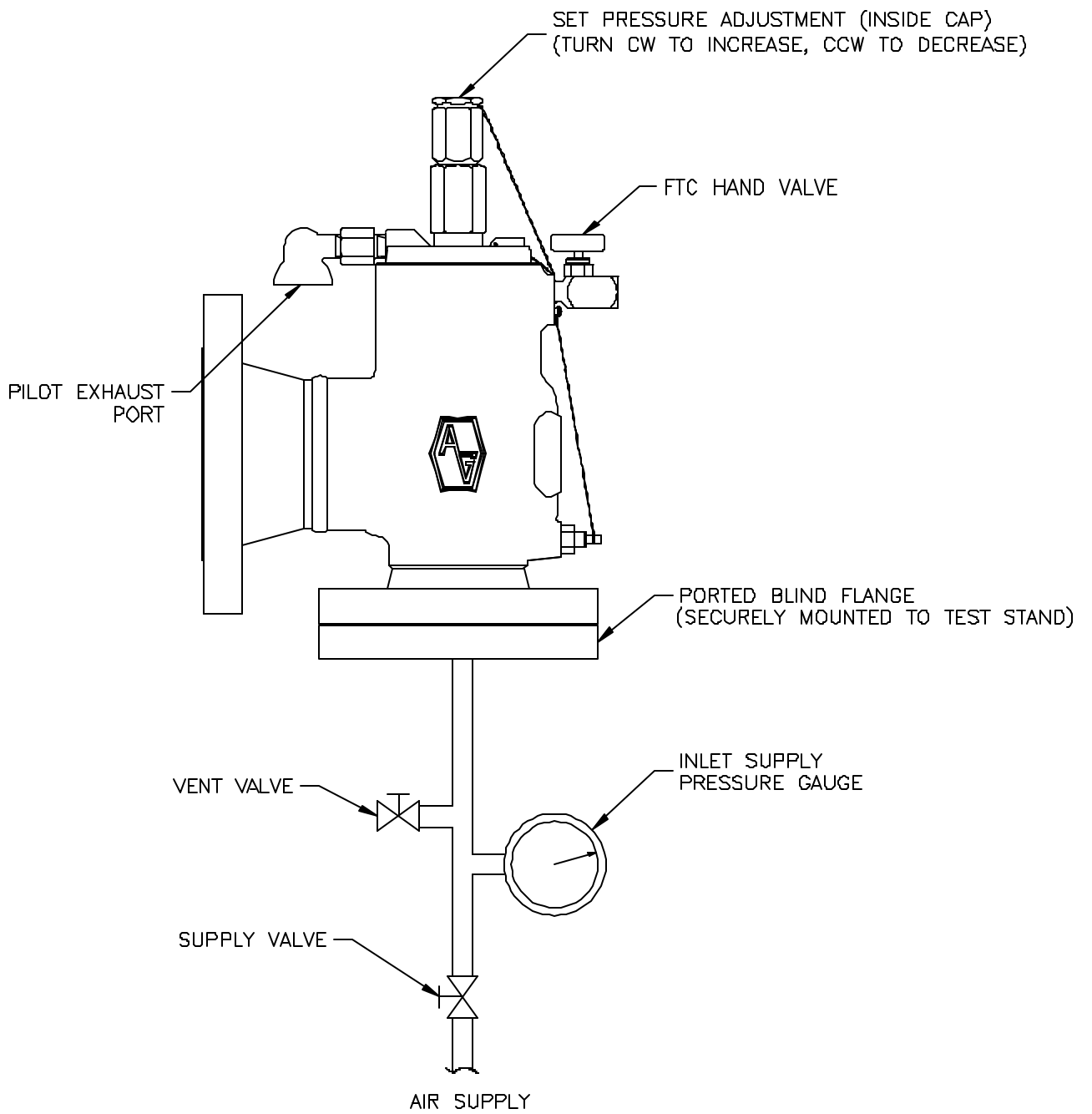


FIGURE 2

### 3.5.3 Leakage Test Pressure

There shall be no leakage for 1 minute at pressures below the cracking pressure.

#### Notes

(1) AGCO set pressure tolerance:

70 psig and below	0 - 1 psig above nameplate
Above 70 psig	0 - 2% above nameplate

## 4.0 VALVE ASSEMBLY LEAK TEST

### 4.1 General

The complete valve assembly should be leak tested for internal and external leaks using pressures equal to 30% and 90% of set. Use the same test set-up as shown in Figure 2.

### 4.2 Internal Leak Test

Main seat: Use a piece of wide masking tape to cover the lower part of the main valve outlet, taped across the opening approximately 2" to 3" high. Pour in enough water to just cover the bottom of the piston. If bubbles are detected, the main seat is leaking. The nozzle or seat may be damaged or the piston may not be seating squarely on the nozzle. For improper piston seating on low pressure valves (less than 275 psig set), pressurize dome of main valve to 275 psig to align seat. See Section 2.0 for replacement of inlet flange / nozzle and seat.

Piston seal: If no bubbles are detected at main seat, increase the water level to cover the lower part of the liner. More masking tape may be used as needed. If bubbles are detected, the piston seal at the top part of the piston is leaking; the piston seal may be defective due to excessive molding flash or the liner may be scratched.

### 4.3 External Leak Test

Following the internal leak test, check for external leakage by applying leak test solution to all joints and seals. Tighten connections or fittings as required.

5.0 FIELD TEST INSTRUCTIONS

A field test connection (FTC) valve is available on the main valve body to allow the pilot set pressure to be checked. It consists of a small hand valve through which test pressure from an external source can be applied.

It is not necessary to remove the safety valve from service to check the set pressure using the FTC since the main valve will not open even if there is process pressure at the valve inlet.

A bottle of compressed nitrogen, equipped with a pressure regulator, block and vent valves, pressure gauge, and high pressure flexible hose is recommended for testing. A set-up and test procedure similar to that shown in Figure 3 and described below should be used.

Test Procedure

- A. Connect test gas bottle to FTC hand valve as shown in Figure 3.
- B. Close Vent Valve "A".
- C. Open FTC hand valve and then open Block Valve "B" slowly to increase pressure until pilot "pops". The set pressure will be the pressure indicated on the test gauge at the time the pilot "pops".
- D. Close valve "B" and slowly open valve "A" to reduce the pressure until the pilot valve closes.
- E. Repeat steps B through D at least 4 times to assure that pilot is popping consistently.
- F. Before disconnecting the gas supply line from the FTC Valve, first close both the FTC Valve and Block Valve "B". Then open Vent Valve "A" to bleed down the pressure in the supply line.

6.0 SOFT GOODS REPAIR KITS

The kits listed below are available from stock. In order to assure that the correct soft goods kits are purchased, the order should specify the valve model and serial number.

**Type LCP Safety Relief Valve**

KIT BASE NUMBER: 06.3648.XXX

VALVE SERIAL NUMBER	1 X 2	1.5 X 2	2 X 3	3 X 4
99-0000 TO 00-07000	.021		.022	.023
00-07001 TO 02-34750	.031		.032	.033
02-34751 AND HIGHER	.041		.042	.043

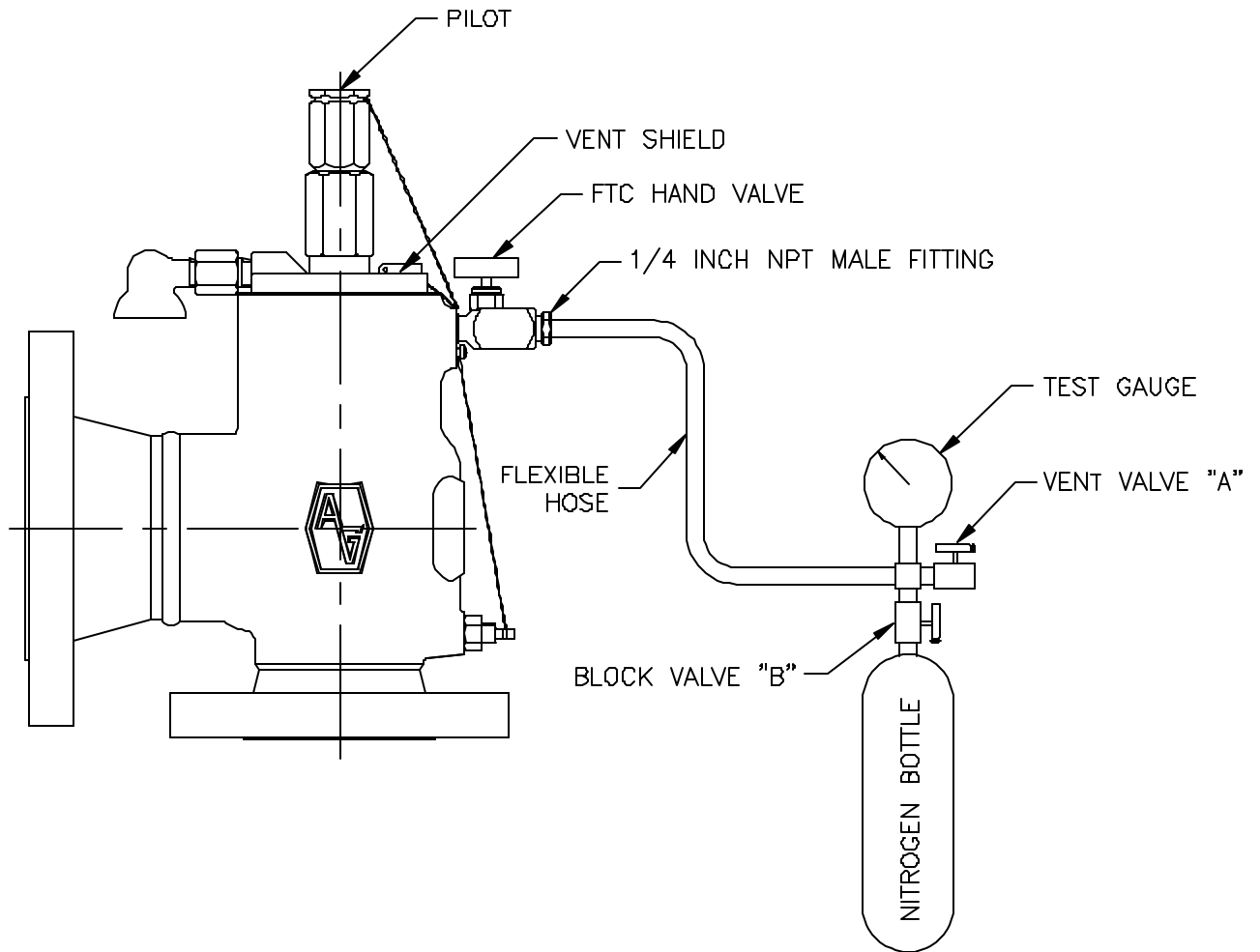


FIGURE 3