WEIR SPM

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Full Bore Emergency Unloading Valve

Operating and Maintenance Instructions

Standard Service Models
(Nitrogen Charged Design)
3-inch - 15,000 psi working pressure

I. Product Description:

Weir SPM's Emergency Unloading Valve provides over-pressure protection for reciprocating pumps, treating lines, pressure vessels, and other equipment operating under high pressure, high flow conditions. Compact and simple to operate, the valve is direct acting, relying on the system's hydraulic pressure to overcome a preset nitrogen gas force to relieve. It is externally adjustable from 1000 psi pressure to maximum setting.

The valve behaves similar to a "highlift" device in that once it begins to lift, the back pressure is greatly reduced. Consequently, the valve remains open until the liquid end pressure decays to approximately 16% (theoretically) of the initial set pressure. Once the fluid pressure falls below this approximate threshold, the valve will reseat to its original set pressure.

Manufactured to Weir SPM's stringent Quality Assurance System, all pressure bearing components are made from high quality material. The forged body features an integral wing union male inlet, suitable for the pressure rating of the component.

The low-pressure outlet is available with an integral wing union female connection. Conforming to conditions of design and performance in API RP520, the SPM Emergency Unloading Valve is intended for liquid service. It is not intended for elevated temperatures nor as a safety device in case of fire.

Available in 3", this valve offers pressure ranges from 1000 – 15000 psi. The valve is best suited for over pressure protection in a "slick water" medium. However, it should work well in drilling mud applications also.

II. Pressure/Temperature Ratings:

The Weir SPM 3" Emergency Unloading Valve is available in the following configurations at this time.

Fluid Side Ratings:

INLET	(LOW PRESS) DISCHARGE	PRESSURE RANGE (PSI)	INT. END NSCWP (PSI)	SERVICE	SEALS TEMP. RANGE
3" - 1502M	3" - 1502F	1000 - 15000	15000	Standard	-30°C - 110C

Gas Side Specifications:

Low Pressure Working Range:	0 to 800 psi
Recommended Nitrogen Bottle:	2,000 psi
Recommended Rupture Disc:	2,250 psi

Bottle or source gas pressure should be twice maximum low pressure working range.

Operating Temperature: -22°F to 120°F (-30°C to 49°C)

III. End Connections:

Weir SPM's 3" Emergency Unloading Valve is available with Weir SPM Wing Union Connections. The nameplate will indicate the cold working pressure allowable for each assembly.

Wing union connections on the relief valve are interchangeable with other union connections of the same size and figure (pressure rating). Caution must be taken to avoid mixing different ratings of wing connections. There are various sizes and figures that are capable of making marginal connections. Failure to observe good judgement may lead to failure of components and danger to life and limb. Always verify working pressure ratings of each connection before use.

This device is intended to discharge to atmospheric pressure when it relieves. It should not be subjected to any significant backpressure. The choice of discharge connections is offered as a convenience for the user and does not imply high-pressure capability.

Observe all instructions, cautions and warnings as noted in this brochure. Failure to do so can lead to equipment damage, personal injury or loss of life.

IV. Installation:

The SPM Unloading Valve should be installed in a branch on the high-pressure pump line (Fig. 1). The valve should be mounted directly at pump discharge or behind the discharge pulsation damper, if so equipped.

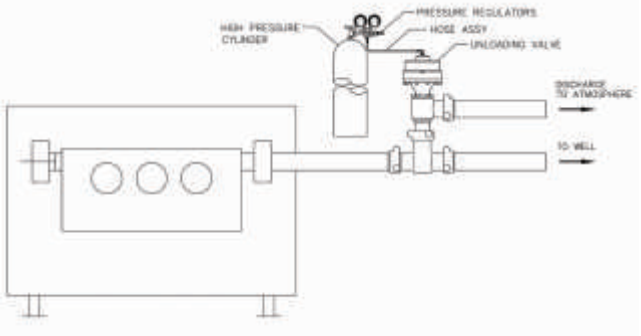

FIG. 1

Preferably, the valve should be mounted in the vertical position as shown, to reduce the tendency for contaminants and particulates in the fluid to collect at the throat of the main seal. However, any position within approximately 30 degree declination is acceptable.

The gas regulator and back pressure regulator should be installed as close to the unloading valve as practical for good practice. The nitrogen filled high-pressure cylinder must be secured to avoid danger of movement.

Any type of liquid may be unloaded through the valve. The valve will tolerate clean liquids better than others. And lighter liquids will flow at greater rates than heavier liquids. Particulates, abrasives and contaminants will not preclude the valve from opening at the appropriate set pressure. However, abrasive materials will cause some wear between the wear sleeve, nozzle, and main seal. While these components are made with wear resistant surfaces, their life will be reduced as the abrasives increase in the fluid.

The effective accuracy of set pressure versus opening pressure is limited by gauge accuracy (1-3%) and regulator accuracy (1-2%). Weir SPM tests show the accuracy of the Unloading Valve does not vary more than ± 2.5%.

NOTE:
Under most conditions, the valve will reset completely when the fluid source is removed and the liquid pressure at the valve is reduced close to zero. This is generally true if the initial nitrogen pressure is set above 120 psi.

However, when the initial nitrogen pressure is below 120 psi (i.e. 3500 psi liquid pressure) it may be necessary to use the optional override valve to force the relief valve to reset.

Figure 2 illustrates the circuit required to employ the override valve. The vent line connects to the valve through the ¼" port, replacing the pipe plug which is normally installed. The override is a normally closed, spring returned valve. Once the Unloading Valve has sequenced and is ready to reset, the override valve must be opened and held open for approximately 5 seconds to relieve gas pressure in the bonnet.

Monitor the pressure gauge until it reduces to zero. At this point the Unloading Valve is reset and the override valve should be released.

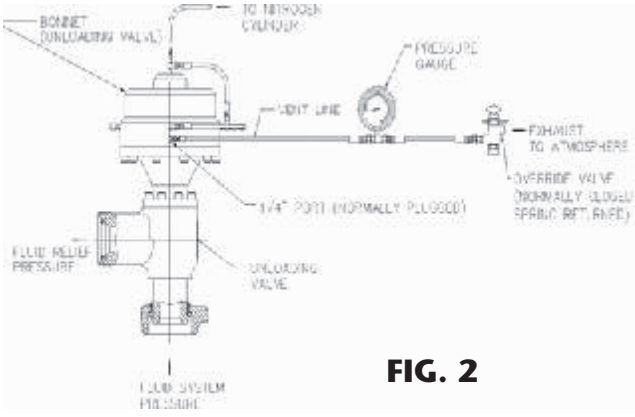

FIG. 2

CAUTION:
It is important for the user to consider the consequences of a valve that does not fully reseat after it has relieved. In the event that this might present a danger to personnel or equipment, SPM highly recommends that an isolator valve be placed between the pressure line and the Relief Valve. separate series of H2S service unloading valve.

CAUTION:
Weir SPM's 3" standard service Emergency Unloading Valve is not intended for use in the sour gas environment. DO NOT USE FOR H2S SERVICE. Weir SPM does offer a separate series of H2S service unloading valve. Contact your Weir SPM representative for advice about sour gas service applications.

V. Description of Operation:

The unloading valve operation is a simple balance between the nitrogen (or suitable gas) acting on the piston and the inlet liquid pressure acting on the rod and wear sleeve. The equation is Pressure times Area equals Force (PxA=F). The ratio of areas is approximately: 25 : 1

Consequently, a theoretical nitrogen pressure of 100 psi can counter an inlet line pressure of 2500 psi for the unloading valve. Variations in actual performance are due to internal friction and will be discussed in (Section VIII).

With the device installed, as shown in (Fig. 1), any time the pressure exceeds the set pressure at the Unloading Valve, the fluid will pass through the valve and out the discharge.

As the rod and wear sleeve rise due to the liquid pressure the valve goes through a transition zone (Fig. 3). During this process the effective force from the nitrogen (or gas) side is reduced to approximately 16% of its initial set pressure, allowing the valve to open quickly and almost completely.

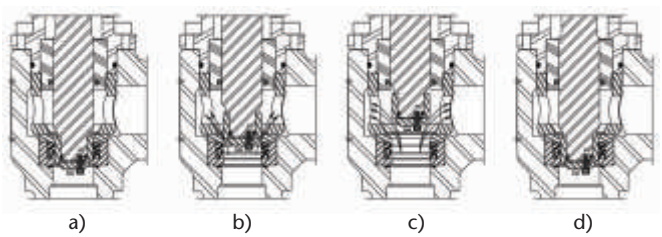

FIG. 3

a.) Fluid pressure below set pressure-rod and wear sleeve seated.
b.) Fluid pressure slightly above set pressure-rod and wear sleeve off main seal.
c.) Fluid pressure substantially above set pressure-rod and wear sleeve off main seal.
d.) Fluid pressure below set pressure-rod and wear sleeve reseated.

VI. Maintenance:

General:
The Weir SPM 3" Emergency Unloading Valve is a well designed, dependable component that should provide long term reliable performance for the user. Like any device, however, it requires routine inspection and servicing to guarantee that it is fully functional.

The valve is intended to be used as an emergency pressure relief device only, and should not be subjected to

continuous fluid flow except in emergency situations. If the valve is subjected to extended flow or abrasive fluids, it may not reseal completely once the pressure is relieved. If complete fluid shut-off is desired, a shut-off valve (such as Weir SPM's plug valve) should be installed in series with the relief valve, which can be closed once the over-pressure is relieved.

There are wear surfaces on this device and elastomer seals that require maintenance. For the valve to operate properly and safely, these items must be kept in good condition. Inspection and servicing should be conducted in accordance with a recognized program. The more severe the usage, the more often the maintenance.

In order to determine the Nitrogen gas line pressure, the valve is equipped with a corrosion resistant bourdon tube gauge with a pressure rating of 0 to 600 psi. This range is adequate to allow the valve to reach maximum operational working pressure, and yet still allow precise adjustments in line pressure. However, if the relief valve is only operated at release pressures below 6000 psi, then the pressure gauge could be replaced with a 0 – 300 psi gauge. This would increase the accuracy at which the Nitrogen gas line pressure could be adjusted. The primary consideration is not to operate the pressure gauge beyond 75% of its rated capacity for any extended period of time. If additional information is needed, please contact the Weir SPM Engineering department.

VII. Service:

ALWAYS REMEMBER

1. **DISASSEMBLY UNDER PRESSURE CAN CAUSE SERIOUS INJURY OR DEATH.**
2. Always use a new parts kit for reassembly.
3. Clean all components thoroughly prior to reassembly using protective clothing and safety glasses.
4. Check sealing surface area of wear sleeve and nozzle for pitting, erosion or other flaws. Failure in sealing can result if these areas are not smooth.
5. Use only Weir SPM relief valve parts on Weir SPM relief valves.
6. This device is intended to discharge to atmospheric pressure when it relieves. It should not be subjected to any significant back pressure.
7. Never block the valve discharge line. It will cause valve damage.

Observe all instructions, cautions and warnings as noted in this brochure. Failure to do so can lead to equipment damage, personal injury or loss of life.

TOOLS REQUIRED

1. Vise
2. Special Torque Tool (See Fig. 6)
3. ½" Hex Socket Wrench & ¼" Hex Socket Wrench
4. Screwdriver
5. 2 lb. Hammer
6. Ø ½" BAR x 12" LG (Aluminum or Brass)
7. 600 Grit Sandpaper
8. Anti-seize Lubrication
9. Hand and Eye Protection

DISASSEMBLY: (Fig. 4 & 5)

MAKE SURE THAT THERE IS NO PRESSURE ON THE VALVE

1. If the nitrogen cylinder (2) is attached, close the high-pressure cylinder valve (20) . Then bleed down and remove the nitrogen line (19) (and vent line from Figure 2, if so equipped) from the unloading valve (1) (Fig. 4).
2. Secure the valve in a horizontal position by clamping the valve body (2) in a vise (Fig. 5).
3. Remove the eight lower and ten upper 5/8" socket screws (32) from the flange (1) . Separate the cylinder (3) from the flange (1) by using jackscrews. Separate the flange (1) from the body (2) by using jackscrews. Remove the entire bonnet assembly from the body.
4. Remove the two 1-1/4" hex jam nuts (23) from the cylinder rod (4) . Hold the cylinder rod (4) by the flats at its mid length. Exercise care to not damage the rod's other surfaces. The jam nuts (23) are installed with blue style thread lock. The piston (8) and sleeve (11) can now be removed from the cylinder rod (4) .
5. Cut the stainless safety wire from the 1/4" socket screws (30) that hold the rod cap (9) to the cylinder rod (4) . Remove the wear sleeve (14) from the cylinder rod.
6. Remove the spider (12) from the valve body (2) . Remove the cartridge (10) along with the main seal assembly (5) from the body.
7. Gently remove the main seal assembly (5) from the cartridge (10) .

Inspecting Components: (Fig. 5)

1.) Body (2) :
Visually inspect the o-ring groove area beneath the cartridge (14) . This is a critical area. If the groove shows indications of damage from either erosion or corrosion, the body should be replaced. It is not repairable.

Visually inspect the fluid discharge surface for erosion or corrosion. Some wear in this area is expected. Any damage to this surface that extends deeper than .10" renders the part unusable and it should be replaced.

Visually inspect the flange (1) seal surface for erosion or corrosion. Damage to this area will allow fluid to leak past the flange during the unloading function. If this surface shows signs of damage, the body should be replaced.

2.) Cylinder (3) :
Visually inspect the inside surface of the cylinder for wear or damage. Damage to this surface renders this component unusable and should be replaced.

3.) Piston (8) & Sleeve (11) :
Visually inspect the piston and sleeve seal areas (25) (28) (31) for damage or wear. If damage or wear is evident, the part should be replaced.

4.) Check Valve (13) :
Blow through the hex end of the check valve mounted in the piston (8) . It should pass air with little breath. Check the threaded end in the same manner. It should not pass breath. If the check valve leaks in the checked direction, it should be replaced.

VII. Service: (Con't)

5.) Flange (1) :
Inspect the seal (31) pocket at the top and the seal (27) pocket in the nylon sleeve at the bottom. The sleeve and seal pockets should be in good condition. If not the flange should be replaced.

6.) Spider (12) :
Visually inspect the fluid discharge areas for erosion and corrosion. Some wear in these areas is expected. Any damage in these areas that extends deeper than .06" renders the parts unusable and they should be replaced.

7.) Cartridge (10) :
Inspect the seal (29) surface where the cartridge fits against the body (2). Inspect the seal surface where the main seal assembly (5) fits. If these surfaces have deteriorated, the cartridge should be replaced.

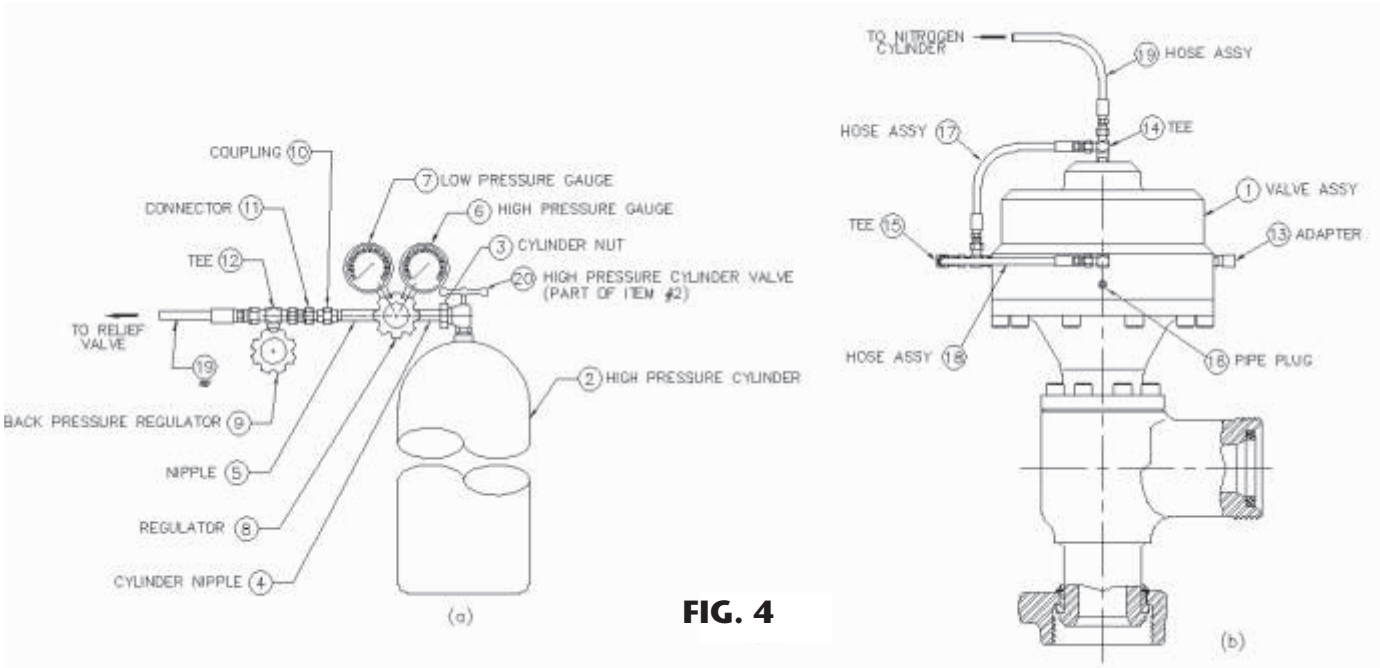

FIG. 4

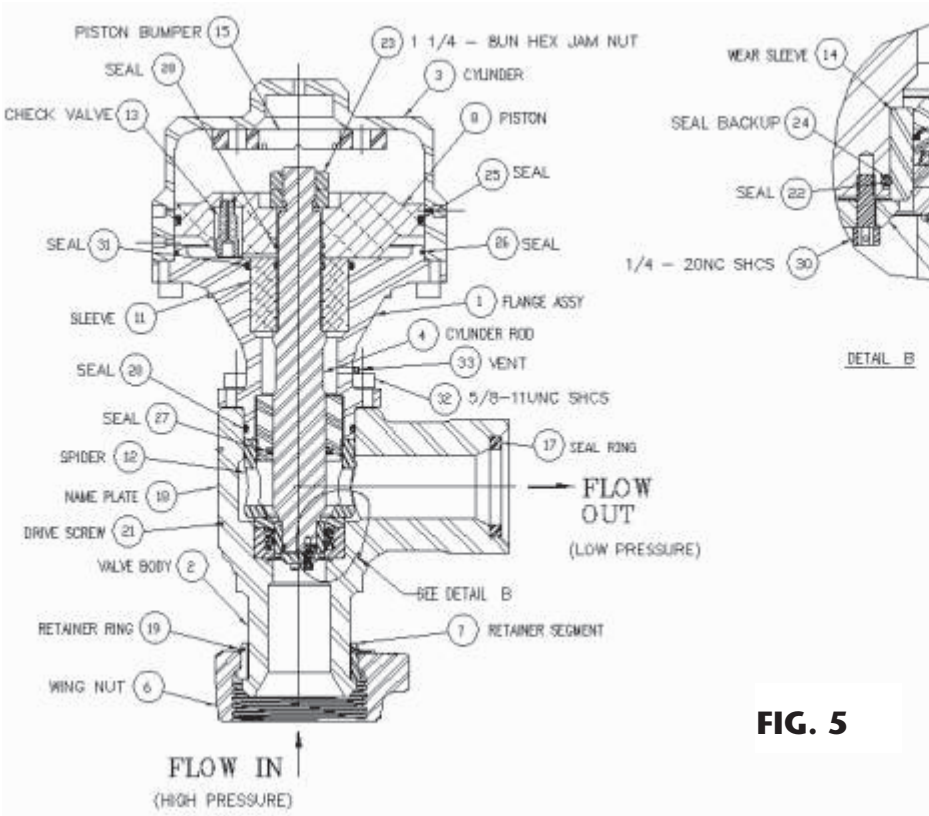

FIG. 5

WEIR SPM REPAIR KITS

Ref. No./FIG 5	Part No.
Complete Internal Parts Kit	**4L23547**
5	3A23356
10	3P23295
11	3P23297
12	3P23298
14	3P23308
16	3P23330
17	4P10258
20	P16637
22	P20006
24	P23302
25	P23303
26	P23304
27	P23333
28	P23334
29	P23335
31	P100875
33	P24707
Seal Kit	**4L23549**
5	3A23356
1	4P10258
20	P16637
22	P20005
24	P23302
25	P23303
26	P23304
27	P23333
28	P23334
29	P23335
31	P100875

VII. Service: (Con't)

8.) Wear Sleeve (14) and Nozzle (16) :
The fit between the wear sleeve, nozzle and main seal assembly(5) is critical. If the surface of the wear sleeve or nozzle has deteriorated, they must be replaced.

9.) All Seals (5) (20) (22) (25) (26) (27) (28) (29) (31) :
All elastomer seals should be replaced regardless of condition.

REPLACEMENT AND ASSEMBLY

- See **ALWAYS REMEMBER** Section before assembly.
- The reassembly of the valve is in approximate reverse order to the disassembly process.
- Lightly lubricate all surfaces prior to assembly. Use "Lubriplate 105" or similar type of grease.

1. Install a complete new main seal assembly(5) into the cartridge and fit over seal (29) into body(2). Slip nozzle into cartridge over main seal assembly.
2. Install wear sleeve (14) over seal (22) with backup ring (24) onto cylinder rod(4). Attach rod cap with 1/4" socket screws (30). Safety wire socket screws.
3. Install sleeve (11) over seal (28) onto rod(4). Install piston (8) over seal (28) onto rod(4). Attach jam nuts (23) to rod(4) with blue thread lock. Install seal(25) onto piston(8).
4. Install seals (26) (31) (27) & (20) into flange(1).
5. Install rod and piston assembly into flange(1). Install entire package into body(2). Be certain that wear sleeve (14) passes fully through main seal assembly(5).
6. Install cylinder(3) onto flange(1) and tighten the ten 5/8" socket screws (32) to 60 ft.lb (lubricated).
7. Tighten the eight 5/8" socket screws (32) that hold the flange(1) to the body(2). Tighten evenly to 110 ft-lb (lubricated). Use special torque tool (See Fig. 6).
8. Using shop air and ports on the cylinder, stroke piston in and out to assure that it moves freely.
9. Reattach hoses.
10. The valve is now ready for pressure testing as discussed in Section VIII, Pressure Testing.

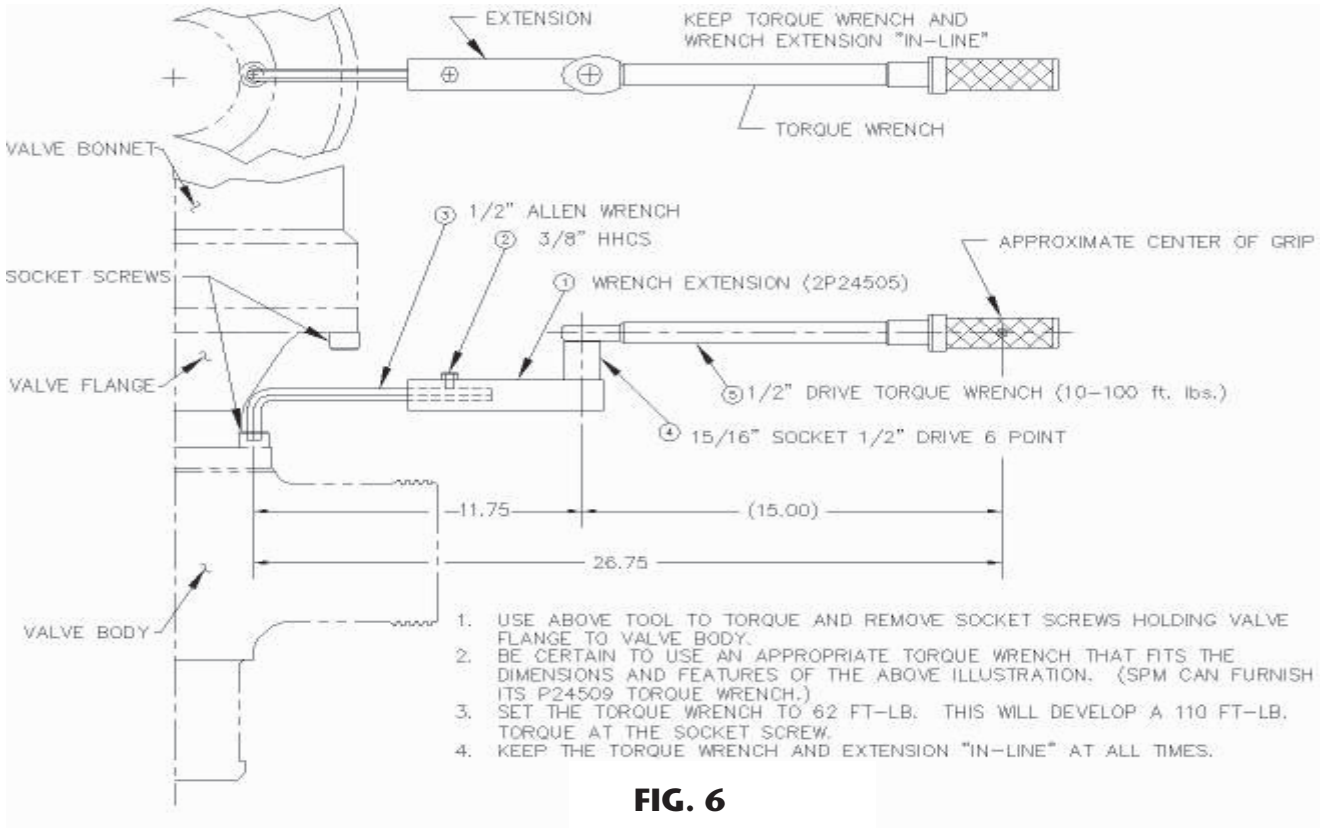

FIG. 6

VIII. Setting and Adjusting Pressure:

The unloading valve is direct acting. The pressure set on the nitrogen regulator is directly related to the relief pressure. The higher the nitrogen pressure, the higher the relief set point. Clean dry air at a minimum of 1,200 psi (6,000 psi max) may also be used.

Use the following procedure to obtain the correct set point. A few attempts at working pressure may be required to confirm the set point (Chart 1).

CAUTION:
Bleed off all air from the fluid system. Trapped air will become energized and may cause injury to personnel when the valve relieves.

1. Screw the pressure regulator (8) adjustment screw all the way out (Counter Clockwise, Fig 4).

CAUTION:
When the handle hits its stop, the top of the regulator may start to unscrew. Do not unscrew the regulator top any further. Failure to comply may cause injury to personnel when pressure is applied to the valve.

2. Open the valve (20) on the nitrogen bottle or from the air source. The inlet gauge (6) on the regulator (8) should indicate the pressure in the nitrogen bottle.

3. Tighten the backpressure regulator (9) adjustment screw fully (Clockwise).

4. Turn the adjustment screw on the regulator (8) until the gas line pressure reaches a nominal set point. Use the Chart 1 to find gas pressure versus "set" pressure.

5. Turn the adjustment screw on the backpressure regulator (9) counter clockwise until the gas starts to exhaust (gas begins to make a sound). Then slightly turn the adjustment screw clockwise until the backpressure regulator just stops exhausting gas.

NOTE:
Always set the pressure in the Rising Direction. If you pass a set point drop the pressure to about 50 psi below the set point then re-approach the set point.

6. Test the working pressure by slowly raising the line (liquid) pressure until the valve begins to relieve. The treating line pressure should stabilize and stop rising once this happens.

7. Reduce the line pressure until the cylinder rod (4) and wear (14) sleeve are fully seated.

8. The relationship between gas pressure and line (liquid) pressure is defined by Chart 1. These values are from actual tests using water as the liquid. However, values in this chart should be considered preliminary and if the predicted gas pressure does not produce the desired set pressure, you may have to adjust the regulator (8) up or down.

   Some of the factors affecting performance include ambient and liquid temperature, and gas media used (air vs nitrogen).

9. Reset the nitrogen pressure to the new setpoint and repeat items 3, 4, 5 of this section. Test the line again until the valve relieves.

NOTE:
Once the relief valve is adjusted to the correct set point it is normal for the gas pressure to rise as fluid in the line (19) approaches the set pressure. The backpressure regulator will vent gas to compensate this increase in gas pressure. It is also normal for the valve to release (unload) liquid at a lower fluid pressure than when it first opened. The set pressure should, however, return to the setpoint fairly rapidly once the liquid pressure has decayed.

CAUTION:
Never block the valve discharge line. It will cause valve damage.

The 3" Full Bore Emergency Unloading Valve Performance Data Values in Chart 1 are for initial set pressures.

Line Set Pressure PSI	Required Nitrogen (or gas) PSI
1000	37
1500	55
2000	73
2500	91
3000	109
3500	127
4000	145
4500	163
5000	181
5500	199
6000	217
6500	235
7000	253
7500	271
8000	288
8500	306
9000	324
9500	342
10000	360
10500	378
11000	396
11500	414
12000	432
12500	450
13000	468
13500	486
14000	504
14500	522
15000	540

Chart. 1

TROUBLESHOOTING GUIDE

Always follow existing company procedure concerning identifying equipment for inspection, and removing equipment from service. The following is intended as a general guide in helping resolve most problems encountered in repairing clapper check valves. If problems are not covered here please contact Weir SPM for assistance at (817) 246-2461.

SYMPTOM	PROBLEM	SOLUTION
1. Rapid erosion	a) Used as continuous bypass b) Used beyond rated capacity	a) Use only as an emergency unloading device b) Install sufficient quantity of valves to meet capacity requirements
2. Shuddering (Rapid opening and closing)	a) System pressure hovering at set pressure	a) Raise set pressure slightly
3. Loss of pressure (Valve does not seal or loses fluid through discharge)	a) Valve not set properly b) Damaged main seal assembly c) Damaged discharge nozzle or wear sleeve d) Damaged high pressure cylinder connection e) Contaminants trapped between wear sleeve and nozzle or main seal	a) Set valve correctly. b) Replace damaged parts c) Replace damaged parts d) Replace damaged parts e) Clean affected parts
4. Valve leaks through weephole or between valve body and cap	a) Damaged inner or outer or both flange seals	a) Replace damaged seals
5. Valve releases higher or lower than intended relief pressure	a) Valve set incorrectly	a) Reset valve to desired pressure per instructions in Section VIII

SAFETY INFORMATION

WARNING

IMPORTANT SAFETY INFORMATION ENCLOSED. READ THIS OPERATING AND MAINTENANCE INSTRUCTIONS MANUAL BEFORE OPERATING PRODUCT.

IT IS THE RESPONSIBILITY OF THE EMPLOYER TO PLACE THE INFORMATION IN THIS MANUAL INTO THE HANDS OF THE OPERATOR. FAILURE TO READ, UNDERSTAND AND FOLLOW THE OPERATING AND MAINTENANCE INSTRUCTIONS MANUAL COULD RESULT IN SEVERE PERSONAL INJURY OR DEATH.

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