VacuComp™ LoPro™ Compact Vacuum Valves Instruction Manual

651 Lowell Street
Methuen, MA 01844

Main Telephone: (800) 227-8766
www.mksinst.com

p/n 100012201
Rev 00B

1. IN THIS MANUAL

This manual details functional information for the HPS LoPro Series, angle and in-line bellows sealed poppet valves, their options and accessories.

2. DESCRIPTION OF LOPRO SERIES VALVES

The HPS LoPro Series of valves are pneumatically operated, bellows sealed poppet valves, designed for compact size, light weight, and long life.

LoPro valves have a pneumatic cylinder attached directly to the top of the valve. The valve is opened when pneumatic pressure is supplied to the bottom of this cylinder. When the air is vented, the valve is closed by an internal spring. In the event of a power or pneumatic failure, the valve returns to its closed position.

The body of the valve is available in angle and concentric in-line configurations with a variety of flanging. Custom body configurations and flange combinations are available upon request.

0-rings function as static face seals on the bonnet and nosepiece, while the movement of the poppet is sealed by a metal bellows. 0-rings are available in a variety of elastomers.

Optional limit switches for the remote indication of the open and closed positions are mounted on the top of the cylinder. These switches are directly actuated by a cam extending from the upper end of the stem.

Solenoid operated pneumatic pilot valves may, optionally, be installed. This pilot valve allows electrical control of the LoPro valve while it is connected directly to the facility pneumatic supply. Solenoid valves are available in a variety of voltages.

Figure 1 summarizes the options available for the LoPro Valve family.

3. SAFETY PROCEDURES AND PRECAUTIONS

3.1 Modification

Unauthorized modification of the product voids the warranty and may affect its operation. Contact HPS Applications Engineering for more information on customizing your valve.

3.2 Maintenance

Install only HPS replacement parts or their equivalents following the procedures detailed in section 7.

3.3 Hazardous Materials

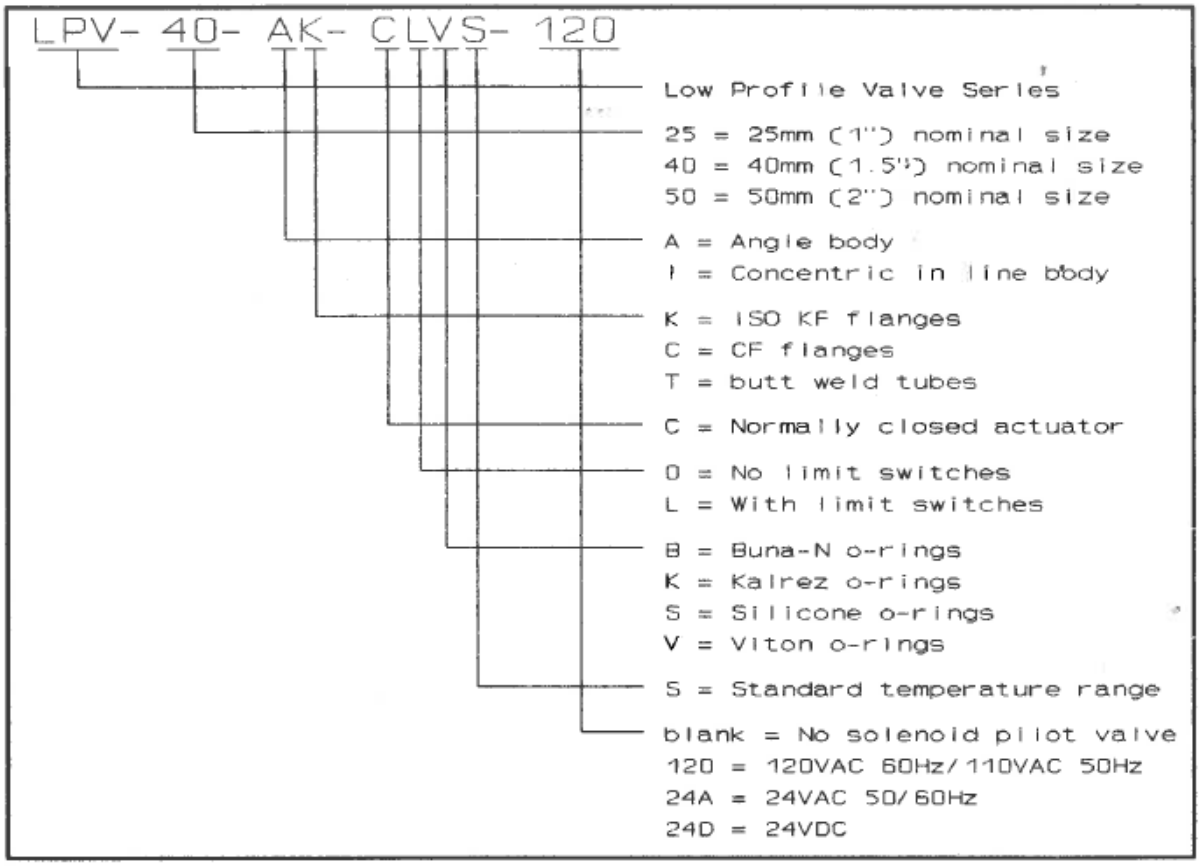

Figure 1 - LoPro™ Valve options

If hazardous materials are used, users must take responsibility to observe the proper safety precautions and insure that the material used is compatible with those from which the valve is fabricated.

3.4 Insta11ation

All flanges and fittings interfacing with the valve must be consistent with those on the valve. Assemble and tighten vacuum flanges and pneumatic fittings according to standards and carefully check for leaks prior to operation. Valves with solenoid pilot valves and/or limit switches should be properly grounded.

3.5 Operation

Keep fingers, clothing, hair, and other intrusive materials away from the valve ports during operation. Never exceed the upper limits for internal or pneumatic pressure. If equipped with solenoid pilot valve or limit switches, do not operate in explosive atmospheres.

4. OPERATING PRINCIPLES

4.1 Pneumatic Cycling

Figure 2 illustrates the components of the pneumatic valve. From its normally closed position, the valve is opened with the admission of compressed air to the pneumatic cylinder through the 1/8" female NPT port in the side of the cylinder (1). A small orifice between this port and the cylinder interior serves as a flow restrictor to help determine the valve opening/closing time.

When the pneumatic pressure in the cylinder reaches a value sufficient to overcome the force of the spring (3), the piston (2) starts to rise, pulling the nosepiece (7) off of the seat (8). The stem (6) is attached to the piston with a flat head screw (14)that is vented to allow air from within the bellows (4) to escape (and enter)as its volume changes. At the lower end of the stem, the nosepiece is welded to the stem. It carries an o-ring seal (9)in a trapezoidal groove, which, when squeezed between the nosepiece and the seat, effects the seal at the valve orifice. The bellows forms a flexible hermetic seal between the nosepiece and the fixed elements of the body (10).

As long as adequate pneumatic pressure is applied, the piston continues to travel upward, further compressing the spring, until the top of the nosepiece, spring bushing (5), and bottom of the cylinder are all in contact. This is the open position stop.

To close the valve, the cylinder is vented through the same 1/8" NPT port. As the air pressure falls below the value necessary to maintain compression on the spring at the open position stop, the piston and the nosepiece start to move towards the closed position. As venting continues, the nosepiece and seal reach the seat. After the valve is closed, full seal force is not attained until the cylinder has reached minimum (usually atmospheric) pressure.

4.2 Limit Switch Actuation

When a valve is equipped with limit switches, they are mounted on top of the cylinder as shown in Figure 3. When the valve is closed, the lever of the closed position switch (18) is depressed by the cam extension (17)on the top of the stem (6). When the valve is fully opened, the cam extension activates the lever of the open position switch (16).

Observing that the closed position limit switch is actuated does not necessarily verify that the valve is sealed leak tight, as contamination or damage to the seal or seat could affect seal integrity. It does confirm, however, that the valve, and its control, obeyed the command to move to the closed position.

4.3 Solenoid Operated Pilot Valve Operation

Optional installation of a solenoid operated pneumatic pilot valve in the 1/8" female NPT port in the side of the cylinder (1), as shown in Figure 4, enables remote electrical control of the valve when direct pneumatic control is inconvenient. In its un-energized state, this 3-way valve vents the cylinder of the LoPro through a threaded hole centered in the top of the solenoid coil (20).

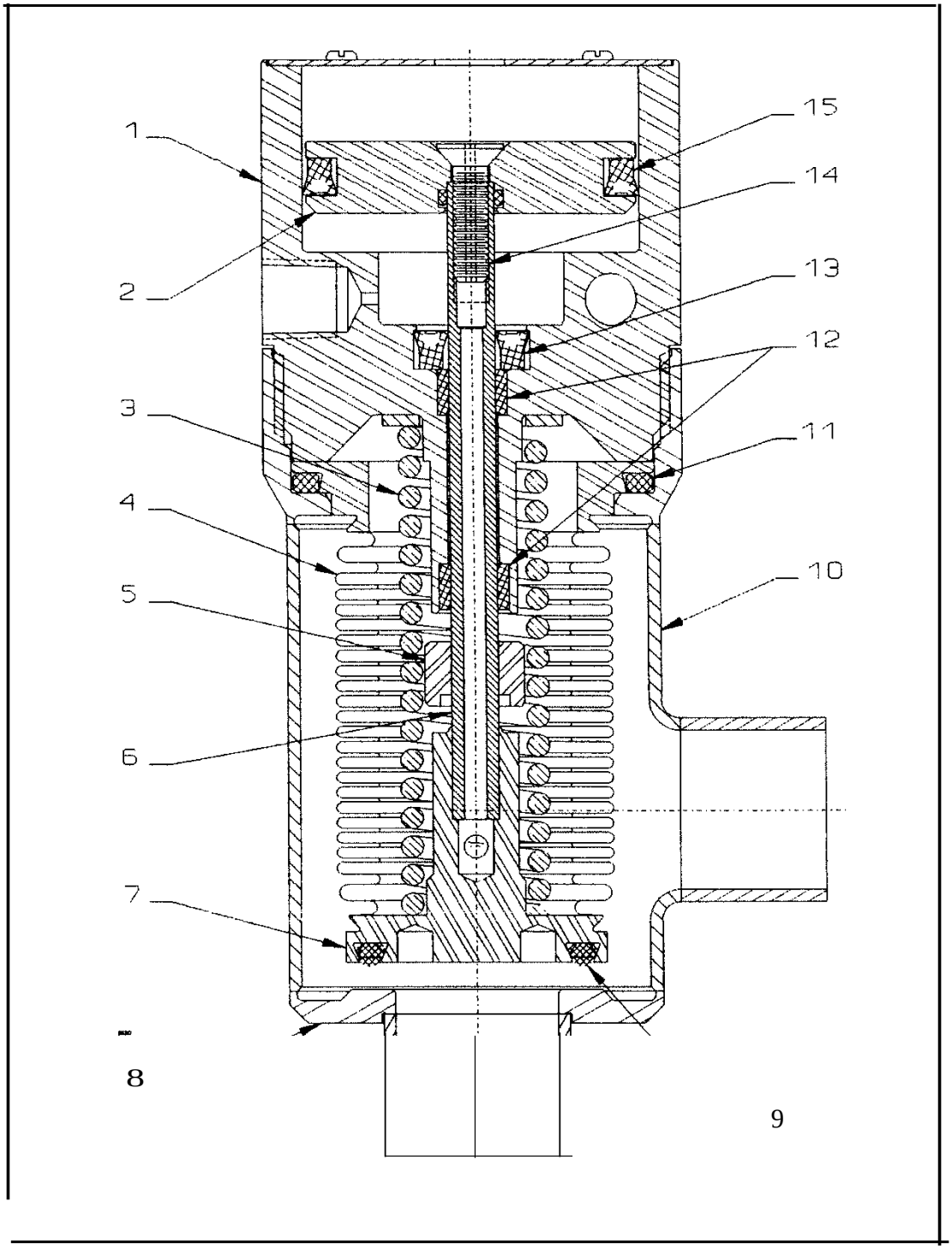

Figure 2 - Pneumatic operation

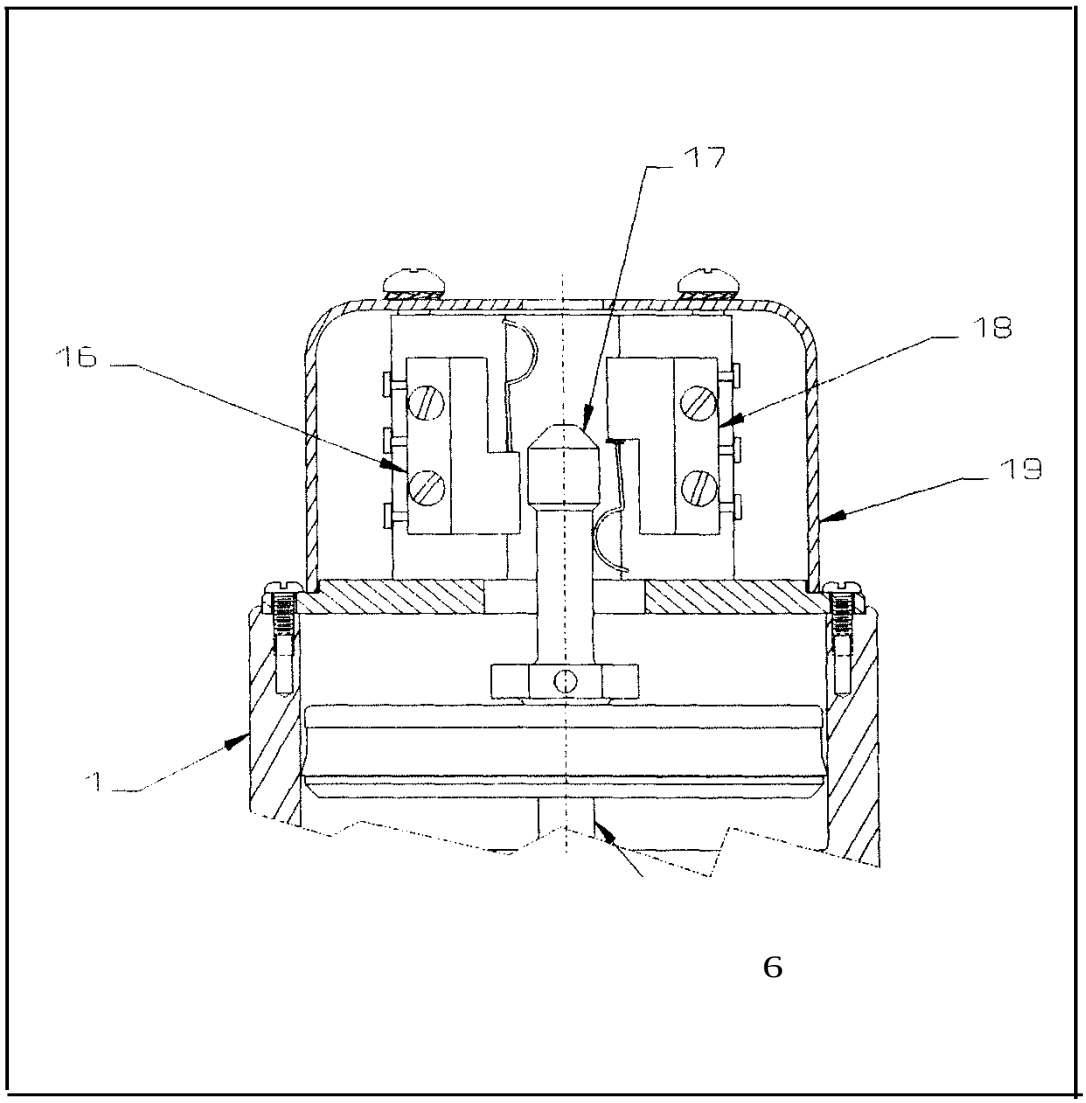

Figure 3- Limit switch operation

A nipple (24) connects the 1/8" female NPT outlet port on the solenoid valve to the cylinder of the LoPro. The joints are sealed with an anaerobic pipe compound.

When power is applied, the magnetic field developed by the coil overcomes the force of the spring (22) and lifts the plunger (21) off the seat (23). While this opens a pressurized flow path from the pneumatic line connected to the 1/8" NPT inlet port, it also seals the venting flow path. Being at the vent port's pressure (usually, but not necessarily atmospheric), the cylinder of the LoPro is quickly pressurized and the LoPro opens (see section 3.1).

When power to the solenoid is turned off, the spring forces the plunger back to

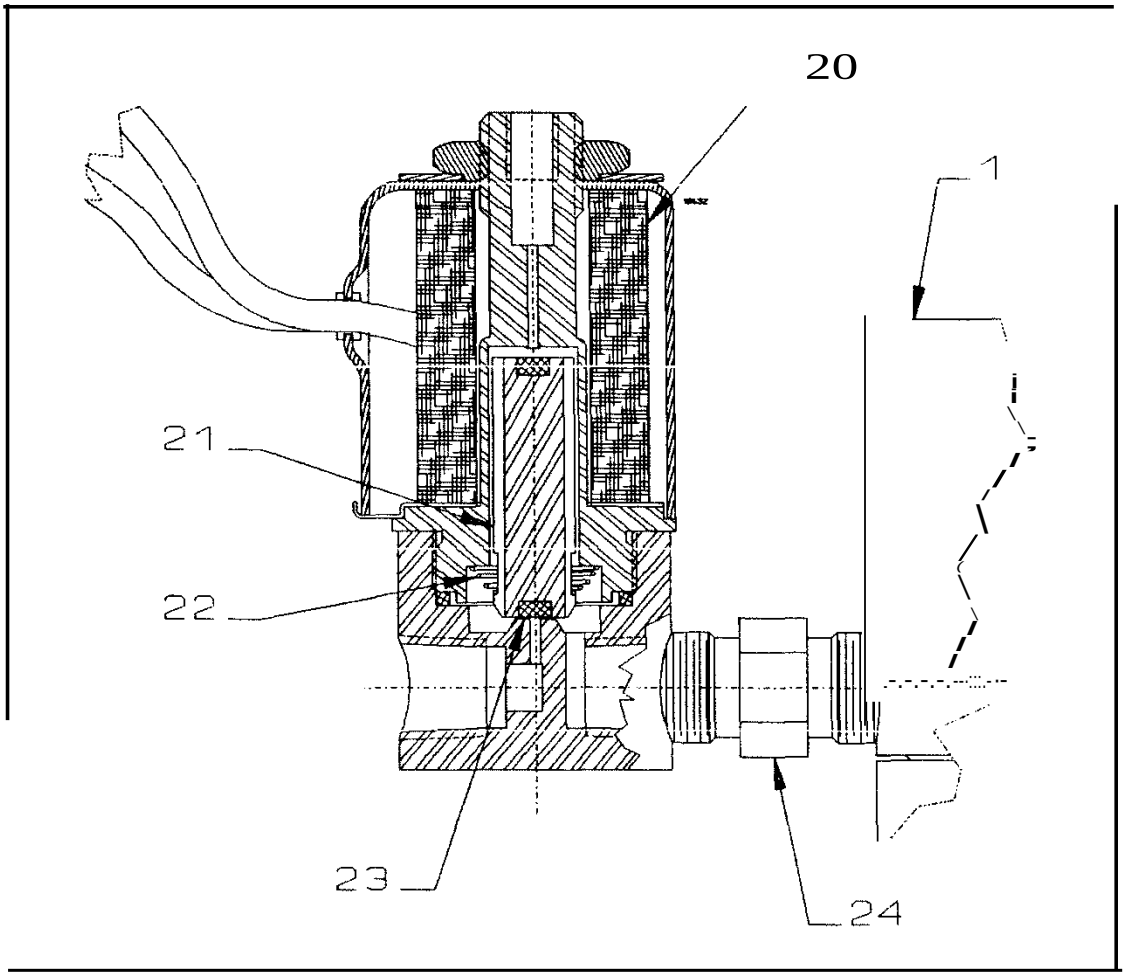

Figure 4– Solenoid pilot valve

its original position, simultaneously closing the pressurized port and opening the vent port. Pressurized air in the cylinder of the LoPro quickly escapes through grooves on the outside of the plunger and out the vent port, allowing the LoPro to close (see section 3.1).

Users mag supply their own solenoid operated pilot valve. A solenoid valve rated for > 10 cycles continuous duty and a conductance > .05 in^3/min is recommended. The lengths and diameters of pneumatic feed lines must also be considered for peak performance.

5. SPECIFICATIONS

5.1 Environment

5.1.1 Installation Orientation

LoPro Series valves function equally well installed in any orientation.

5.1.2 Applied Forces

As with any vacuum piping component, improper installation in the vacuum line may result in damage to the component. The strength of the LoPro body is roughly equivalent to an elbow of similar size. Care must be taken to protect the body of the LoPro from excessive stress resulting from torquing forces, thermal expansion, or high amplitude vibration. Where such forces might be encountered, stress buildup in the vacuum line may be avoided by the proper installation of flexible metal hose(s). The HPS Applications Engineering department is available to help with such problems.

5.1.3 Temperature Extremes

The LoPro valve, without the optional limit switch package or solenoid operated pilot valve, is rated for service from -20°C to 93: C. Addition of the optional limit switch package decreases the upper temperature limit to 82° C, while adding the optional solenoid pilot valve increases the lower limit to 0°C.

The LoPro valve's most vulnerable components to temperature extremes are the organic compounds used in seals, bearings, and lubrication. The pressurized cavity n the pneumatic cylinder (1 in Figure 2) is sealed by a pair of Parker PolyPak Seals (13,15). These standard temperature range seals (see Figure 1) are rated for service from -51c c to 93 c .

O-rings (9,11) seal the bonnet and poppet of the valve and are available in a variety of seal elastomers., These elastomers have the following recommended operating temperature ranges[3]:

Buna-N	-54° C to 135° C
Ka1rez[4]	-26° C to 260° C
Silicone	-114° C to 232° C
Viton[4]	-26° C to 204° C

Excessive temperatures, especially in combination with dry air or gas, can cause o-rings and seals to dry out, harden, crack, or even melt, possibly resulting in a vacuum or pneumatic leak. However, because the transfer of heat from/to the valve's pneumatic actuator assembly to/from the body (10) and the nosepiece (7) of the valve is relatively inefficient, the nosepiece o-ring (9) may be subjected to significantly higher/lower temperatures without affecting the pneumatic seals. However, to avoid pneumatic seal damage, the cylinder temperature should be monitored in the presence of sustained extreme system or ambient temperatures.

---

1) PolyPak is the registered trademark of the Parker Hannifin Corp.

2) PolyPak Seal Design Handbook, 2, (1989)

3) Parker 0-Ring Handbook, A3-4/A3-6, (1991)

4) Kalrez and Viton are the registered trademarks of E.I. Dupont de Nemours Co.

The Rulon LR[5] PTFE bearings (12) supporting the stem (6) are rated for service between -240° C and 287°C[6].

Lubricating greases used on the stem and piston seal (15) increase their viscosity at low temperatures which increases the force required to move the poppet. Lighter fractions of these lubricants begin to evaporate at temperatures below 100° C, ultimately resulting in dried lubricant, increased friction on the sliding surfaces, and also increasing the force required to move the poppet. While the operating temperatures of these lubricants do not pose immediate problems, regular maintenance, with attention to the condition of the piston and stem lubricants, should be performed on valves run for extended periods at or near the high temperature limit.

Similarly, the optional limit switch package contains polymers and elastomers in the switch housings and grommets. The temperature ratings for these components are as follows:

switches	-53°C to 85°C
grommets	-51°C to 82°C

The wire or cable connected to the limit switches and/or solenoid valve should be selected for use in the appropriate temperature range.

Optional solenoid operated pneumatic pilot valves also have organic compounds in their seals and in the insulation of the coil and lead wires. All Peter Paul solenoid valves normally supplied with LoPro valves are rated for operation between 0° C and 104° C.

5.2 Operation & Performance

5.2.1 Cycle Rate and Life

Maximum cycle rate is limited by opening and closing times. If the valve is cycled faster than the sum of the opening and closing time, it will fail to open or close completely, possibly resulting in failure.

Although opening and closing times are dependent upon the pneumatic pressure, flow available and other parameters, the following values represent the time for the poppet to move full stroke at median recommended pneumatic pressure, with unrestricted flow, and at room temperature.

	Opening	Closing
NW25	0.12 sec	0.18 sec
NW40	0.27 sec	0.53 sec
NW50	0.45 sec	1.13 sec

5) Rulon is the registered trademark of Dixon, Division of Furon

6) Guide to Dixon Bearings, 04

7) Courtesy of Microswitch Division of Honeywell Corp.

Under normal conditions, LoPro valves will greatly exceed *1 million* cycles before failure.

5.2.2 System Pressure Limits

LoPro Series valves are designed to function from UHV to greater than 2 Atm pressure (depending on size). Due to the elastomer seal on the bonnet, the low pressure limit is determined by the vacuum system's tolerance for the gas load due to permeation through and leakage around that seal. All vacuum seals and welds in LoPro Series valves are He mass spectrometer tested with the maximum allowable leak rate being 1×10^{-9} std Atm cc/ sec. Although the LoPro valve may be a factor in the base pressure of a system, there is, in fact, no low system pressure limiting the valve's function.

High pressure, however, can cause failure of the valve. With the valve open, the opening force exerted on the nosepiece (7 in Figure 2) by excessive internal pressures will exceed the spring's (3)closing force and the valve will fail to close completely. A similar pressure applied to the bottom port of a closed valve could force the valve to open or "blow by." These pressures are as follows:

NW25	43 psia	(3.0 x 10Nt/mabs)
NW40	60 psia	(4.1 x 10Nt/mabs)
NW50	38 psia	(2.6×10^5 Nt/m'abs)

Higher pressures could cause bonnet seal (11) extrusion, collapse of the bellows (4), failure of the bonnet seal compression thread on the cylinder (1), or rupture of the valve body (10).

5.2.3 Pneumatic Pressure Limits

The dynamic seals (13 & 15 in Figure 2) used in the LoPro are rated for use at pressures significantly greater than those found on a typical compressed air system as are the other components of the cylinder. However, we strongly recommend not using pneumatic pressures in excess of 150 psig. If the valve is equipped with the optional solenoid pilot valve, pneumatic pressures in excess of 125 psig will result in pneumatic leakage and possible valve failure.

As described in section 4.1, sufficient force (hence pneumatic pressure) must be applied to the piston (2) to overcome the spring's (3) closing force and open the valve. As the nosepiece (7) moves away from the seat (8), the spring is compressed further requiring more force. A minimum pneumatic pressure of 40 psig is required for proper valve function.

5.2.4 Pneumatic Flow

Insufficient pneumatic flow due to inadequate line diameter, can result in temporary downstream decreases in pressure. As the LoPro valves are able to cycle quite quickly, requiring one full actuator cylinder of air for each stroke, the lines leading to the valve must be able to provide the volume of air at the pressure specified in section 5.2.3 for the valve to open in the time listed in section 5.2.1. Although the flow is dependent upon upstream restrictions, the

cylinder volume required is as follows:

NW25	1.16 in^3	(19.0 cm^3)
NW40	2.21 in^3	(36.2 cm^3)
NW50	6.36 in^3	(104.2 cm^3)

5.2.5 Limit Switch Ratings

The optional limit switch package uses miniature switches rated for 5 Amp at 250 V AC and 5 Amp at 30 V DC.

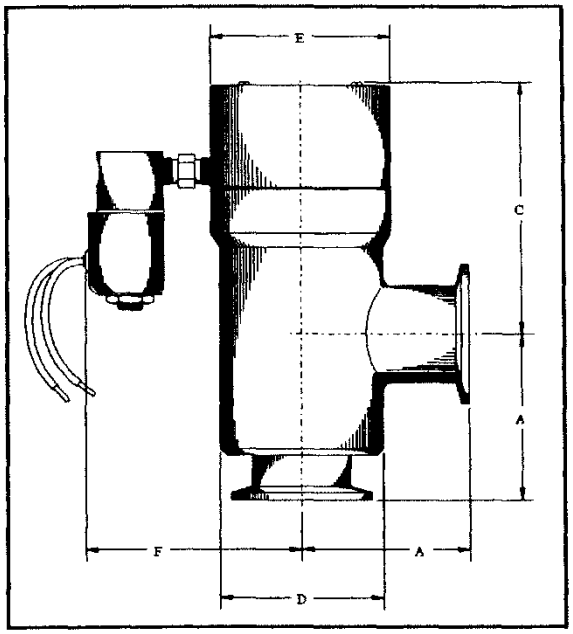

Figure 5 - Angle valve dimensions

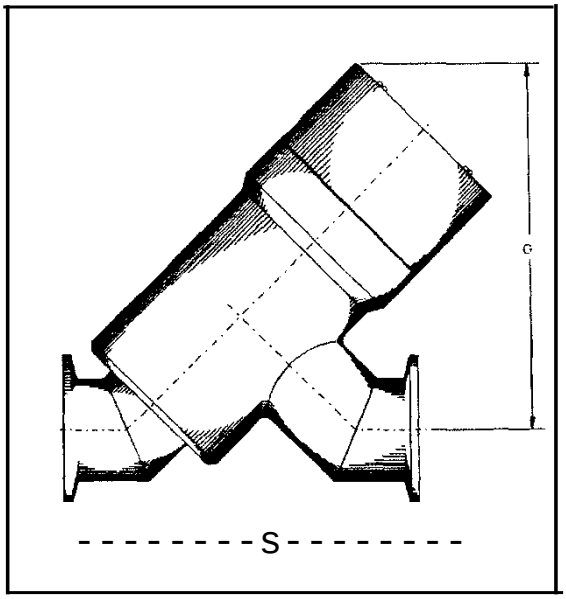

Figure 6 - In-line valve dimensions

5.2.7 Solenoid Duty Cycle and Power Requirements

The solenoid coils supplied with valves equipped with pneumatic pilot valves are rated for continuous duty at their specified voltages and frequencies. Power requirement for the coil is 6 Watts in AC and 7 Watts in DC.

5.3 Physical Parameters

5.3.1 Dimensions

Refer to Figures 5 and 6 for the following table of dimensions:

	A	B	C	D	E	F	G
LPV-25-AC-	2.02	-	3.73	2.00	2.25	3.13	-
LPV-25-AK-	1.97	-	3.73	2.00	2.25	3.13	-
LPV-25-AT-	1.88	-	3.73	2.00	2.25	3.13	-
LPV-25-IC-	-	4.62	-	-	-	-	5.00
LPV-25-IK-	-	3.94	-	-	-	-	5.00
LPV-25-IT-	-	4.35	-	-	-	-	5.00
LPV-40-AC-	2.43	-	4.32	2.50	2.75	3.38	-
LPV-40-AK-	2.56	-	4.32	2.50	2.75	3.38	-
LPV-40-AT-	2.25	-	4.32	2.50	2.75	3.38	-
LPV-40-IC-	-	5.19	-	-	-	-	5.64
LPV-40-IK-	-	5.12	-	-	-	-	5.64
LPV-40-IT-	-	4.83	-	-	-	-	5.64
LPV-50-AC-	3.19	-	5.47	3.25	3.50	3.75	-
LPV-50-AK-	2.76	-	5.47	3.25	3.50	3.75	-
LPV-50-AT-	3.00	-	5.47	3.25	3.50	3.75	-
LPV-50-IC-	-	7.59	-	-	-	-	7.07
LPV-50-IK-	-	7.00	-	-	-	-	7.07
LPV-50-IT-	-	7.20	-	-	-	-	7.07

All values are in inches.

5.3.2 Weight

Measurements of weight for LoPro valves and their options are as follows:

NW25 LoPro valve	1.83 lbs (830 g)
NW40 LoPro valve	2.74 lbs (1243 g)
NW50 LoPro valve	5.01 lbs (2272 g)
NW25 limit switches	0.16 lbs (72.6 g)
NW40 1imit switches	0.20 lbs (90.7 g)
NW50 1imit switches	0.27 lbs (122 g)
Solenoid pilot valve	0.46 lbs (209 g)

6. INSTALLATION INFORMATION

6.1 Pneumatic Supply

Facility pneumatic supplies often contain contamination including rust, metal particles, oil, and water. The particulate contamination may be removed by a simple in-line filter in series with the supply for each valve, or the supply for an entire system. Available from HPS, part number 100001504, the Master

Pneumatic- Detroit, Inc. model FC50-1 is a suitable filter for local filtration of typical pneumatic supplies.

The exhaust vents on the solenoid valves originally provided with HPS valves are internally tapped to accept 10-32 UNF fittings to attach to a vent manifold if local external venting is not desired. If desired, a non-restrictive exhaust muffler can be fitted to the valves to help reduce the vent noise.

The piston seal's (15 in Figure 2) sliding surface has been lubricated, making possible the use of "dry" pneumatic supplies without harm to the LoPro valve. However, the life of the solenoid pilot valve is considerably longer when the air supply contains trace quantities of moisture or oil.

6.2 Electrical Connections

Electrical connections within the valve assembly must be made whenever the valve is equipped with limit switches and sometimes when using the optional solenoid pilot valve.

Two entries with grommets are provided in the limit switch cover (19 in Figure 3), one for a multiconductor cable and the other for the solenoid pilot valve leads. Normally, the space inside the limit switch cover is used as a junction box for the solenoid and limit switch wires. However, care must be exercised to keep insulated wires from interfering with the movement of the cam extension (17) and the levers of the limit switches (16, 18). More important, exposed conductors must never make contact with any part of the limit switch assembly. Additionally, use of the stress relief clamps and ground lug provided are essential to safe electrical operation.

Care must be used when soldering leads to the terminals of the limit switches. A soldering iron with thermostatically controlled tip should be used. The soldering iron should not be in contact with the switch terminals for longer than 10 seconds.

6.3 Clean Installation

Valves are shipped with plastic snap-on covers over the ports. These covers should be left in place until the valve is installed. All LoPro valves are cleaned at the factory for direct installation and high vacuum service. Normal clean assembly techniques should be practiced, as the presence of airborne particulates on the nosepiece seal (9 in Figure 2), the seat (8), or on the sealing surfaces of the port flanges may result in leakage.

6.4 Flange Care

Care should be taken not to damage the flanges. To help protect the flanges, the plastic caps supplied with the valve should remain in place until installation and be replaced when removed from a system. A small scratch on the flange seal surface of an elastomer sealed flange could prevent a leak tight seal. Similarly, on valves with CF (metal seal) flanges, scratches or dents in the knife edge may prevent the flange from sealing. Since the flanges are integral with the body, a defective flange could result in replacement of the body.

When installing the valve, adequate clearance should be allowed between adjacent components so there is no sliding of seal surfaces against one another. Flanges that have been assembled for some time may have a tendency to stick together. Care should be exercised when prying flanges apart as to avoid damaging their sealing surfaces.

7. SERVICE

7.1 Removal from System

Prior to removing the entire valve or a valve's actuator assembly from a vacuum system, it is necessary to bring the system up to atmospheric pressure. Purge and vent hazardous gasses appropriately.

Detach the pneumatic supply. To avoid injury, be sure the pneumatic line is depressurized prior to disconnection from the valve.

If the valve is equipped with the solenoid operated pilot valve, it will be necessary to disconnect these leads. To avoid electrocution, be sure the power to the pilot valve is off prior to disconnection. Refer to section 7.7 for details on solenoid pilot valve repair.

If the valve is equipped with limit switches, the limit switch assembly may be removed from the valve without disconnecting the leads. For details on this procedure, refer to section 7.5.

Loosen and remove the clamps or bolts on the port flanges. If possible, pull one of the flanges mating to a port flange directly away from the valve to allow removal of the valve without scraping sealing surfaces. Replace the protective plastic caps on the port flanges or cover the ports with aluminum foil.

Avoid touching the interior surfaces of the valve. Moisture, skin oils, and dirt may contaminate the interior of the valve, affecting its performance upon reinstallation, and/or, more importantly, films deposited on the interior surfaces of the valve may be toxic.

7.2 Actuator Assembly

7.2.1 Actuator Assembly Removal and Disassembly

The following procedure does not require removal of the valve body from the system. However, several aspects of the procedure are more easily performed if the entire valve is removed. Read section 7.1 prior to removing the entire valve or a valve's actuator assembly from a vacuum system.

The actuator assembly is attached to the bonnet of the valve by 12 pitch threads on the cylinder and bonnet. Grasp the cylinder firmly and turn counterclockwise. Approximately 4 revolutions are required to free the actuator assembly from the body of the valve.

Sometimes elastomer nosepiece o-ring seals will stick to clean metal sealing

surfaces. This is most prevalent with valves that have been run warm. Also, the friction from the force of the spring on the nosepiece a-ring may be sufficient to prevent turning the threaded cylinder by hand. This is more prevalent in large valves. Consequently, a "cheater" hole has been provided. Inserting a bar not exceeding 1/4" in diameter into this hole, creates a lever arm aiding in disassembly. A #2 Phillips screwdriver works well.

Actuating the cylinder using a temporary pneumatic connection totally removes the friction of the nosepiece. This usually allows removal of the actuator assembly by hand.

After the threads have disengaged, pull the actuator assembly out of the valve body. The bellows is fabricated of .006" thick 321 stainless steel. While withdrawing the actuator assembly, exercise care to avoid damaging the bellows. If the bonnet a-ring has adhered to the sealing surface in the body, carefully remove it by hand. If a tool is required for this task, it should be made of a material softer than stainless steel to avoid scratching the sealing surface.

The actuator assembly contains a powerful spring under some compression at all times. Special fixturing is required for further, safe disassembly of the actuator. Replacement of malfunctioning actuators with new assemblies is recommended (see parts list in section 8 for details).

7.2.2 0-ring Replacement

The bonnet a-rings may be removed easily without special fixturing. With a little stretch, the bonnet a-ring clears the bellows and drops off of the actuator assembly.

Removal of the nosepiece a-ring usually requires a thin tool to pry it out of its trapezoidal groove. Exercise care to avoid damaging the sealing surface at the bottom of the groove. Start prying at the vent hole and carefully move around far enough to allow grasping the seal with the fingers. Then pull the seal from the remainder of the groove.

Be sure that no dust or other contamination is in the groove or on the a-ring. To install the a-ring, nest the a-ring on the opening of the groove. With the thumbs at points 180° apart, firmly press the a-ring into the groove. Move 90° and press again. Move 45° and press again. Alternately press the a-ring into the groove until it is completely in the groove. Hand installation will likely leave humps on the installed a-ring. As long as the a-ring has not twisted during assembly, this will disappear after a small number of cycles, after which the valve should function properly.

7.2.3 Actuator Assembly Installation

Insert the actuator assembly into the valve body. As with removal, take care to avoid damaging the bellows. Be sure that the bonnet a-ring is in place. The bellows flange is appropriately tapered to aid in retaining the a-ring in the proper position during assembly.

Engage the first thread. To avoid cross threading the cylinder and body, be sure

the axis of the actuator assembly is concentric with that of the body. Turn the cylinder clockwise approximately 4 revolutions.

As with removal, it is sometimes necessary to apply a mechanical advantage in order to complete the installation. Use of the "cheater" hole with a lever bar and/or actuating the cylinder through a temporary pneumatic connection can be useful. Also, it can be helpful to apply a light film of a thread lubricant to the threads on the bonnet of the valve and the cylinder. Be careful not to contaminate the interior of the valve body or the bellows with this lubricant.

The actuator assembly is completely installed when the pneumatic port is 180° from the side port of the body (this may differ in custom applications) *and* there is a .030" +/- .010" gap between the body and the cylinder.

Reconnect the pneumatic supply and electrical connections(if applicable). Refer to section 7.6 for details on limit switch assembly.

It is highly recommended to check the assembly for leaks using a high quality Helium mass spectrometer leak detector. The vent hole in the top of the flat head screw (on the side of the extended screw if equipped with limit switches) is used for leak detection. With the interior of the valve evacuated and attached to the He mass spectrometer, insert the tracer gas probe into this hole. The bellows and bonnet seal are accessed for leak detection through this hole. The nosepiece seal and port flange seals may be tested through a variety of methods and will not be detailed here.

7.3 Limit Switches

7.3.1 Limit Switch Removal

Be sure to disconnect all power prior to working on or adjusting the limit switches.

This first step applies to NW25 LoPro valves only; for larger valves, proceed to the next paragraph. Loosen and remove the two 6-32 pan head screws with star washers on the top of the limit switch housing. Slide the housing off of the assembly. Sometimes, the wires will hold the grommets in position as the housing is removed. This is not only acceptable, but can aid in reassembly.

Loosen and remove the four 2-56 pan head screws on the top of the actuator assembly. (On the NW50 LoPro valves, there are six 2-56 pan head screws.) Withdraw the limit switch assembly directly away from the actuator assembly, keeping the central axis of the assembly concentric with that of the remainder of the valve until it is clear.

7.3.2 Limit Switch Installation

Carefully insert the cam extension into the hole in the center of the bottom of the 1imit switch assembly, keeping the axis of the 1imit switch assembly concentric with that of the cam extension.

Align the four holes (six in the NW50 LoPro valves) in the top of the cylinder

with the four in the bottom of the limit switch assembly. Insert and tighten the pan head cap screws.

If the limit switch assembly was previously removed from *the valve it is being insta77ed upon,* and the limit switches functioned properly before disassembly, readjustment is probably not necessary. Otherwise, see section 7.8 for details on limit switch adjustment.

On the NW25 LoPro valves, install the limit switch housing. Insert and tighten the two 6-32 pan head screws with star washers in the top of the housing.

7.3.3 LS Retrofit

With the valve in its closed position, loosen and remove the four 2-56 pan head screws holding the cover to the top of the cylinder. (On the NW50 LoPro valves, there are six 2-56 pan head screws.) Remove the piston cover.

Using a 1/8 Allen wrench (5/32 for the NW50 LoPro valves), loosen and remove the vented flat head cap screw in the center of the piston. Insert the threads of the cam extension into the hole in the center of the piston. Tighten the threads using a 9/16 deep socket or open end wrench.

Install the limit switch assembly as described in section 7.6, make electrical connections as discussed in section 6.2, and adjust the switches as detailed in section 7.8.

7.3.4 Limit Switch Adjustment

An ohmmeter and pneumatic supply are required for limit switch adjustment.

Connect the ohmmeter to the NC (normally closed) and C (common)terminals ofthe closed position limit switch. With the valve in its closed position, open circuit resistance should be indicated. Cycle the valve to its open position. Closed circuit resistance should be indicated (less than 0.5 ohm). Run the valve through several cycles to be sure that the switch is actuating properly and sufficiently near full closure.

If the switch does not actuate, actuates too early, or is always actuated, the switch needs adjustment. Loosen the lower 2-56 screw holding the switch just enough to allow movement of the switch about the upper 2-56 screw. Move the switch to correct the problem and tighten the lower 2-56 screw. Test the operation of the switch through several cycles to ensure proper function. Repeat these steps until it functions properly.

Connect the ohmmeter to the NC and C terminals of the open position limit switch. With the valve in its closed position, closed circuit resistance should be indicated. Cycle the valve to its open position. Open circuit resistance should be indicated. Run the valve through several cycles to be sure that the switch is actuating properly and when the valve is fully opened.

If the switch does not actuate, actuates too early, or is always actuated, the switch needs adjustment. Loosen the upper 2-56 screw holding the switch just

enough to allow movement of the switch about the lower 2-56 screw. Move the switch to correct the prob1em and tighten the upper 2-56 screw. Test the operation of the switch through several cycles to ensure proper function. Repeat

these steps until it functions properly.

7.4 Solenoid Pilot Valve Service

In normal use, solenoid pilot valves should last millions of cycles, although this number is reduced by about a factor of ten when a dry pneumatic supply is used.

The solenoid valve is held to the actuator cylinder by a 1/8" NPT nipple and the threads are sealed with a jointing compound or Teflon[8] tape. If Teflon tape is used, excess tape overlapping the end of the nipple in the assembly can be sheared off, resulting in blockage of pneumatic flow and possible valve failure.

The coil is the only replaceable component of the solenoid pilot valve. After removing the jam nut, the coil slips off of the housing of the valve. Install the new coil and tighten the jam nut. Orientation of the coil wires has no affect on the function of the valve.

7.5 Replacement Parts list

NW25 LoPro valves	
actuator with viton seals	100006622
Buna-N seal kit	100002215
Kalrez(R) seal kit	100002218
Silicone seal kit	100002221
Viton(R) seal kit	100002224
limit switch kit	100002227
NW40 LoPro valves	
actuator with viton seals	100006656
Buna-N seal kit	100002216
Kalrez(R) seal kit	100002219
Silicone seal kit	100002222
Viton(R) seal kit	100002225
limit switch kit	100002228
NW50 LoPro valves	
actuator with viton seals	100006708
Buna-N seal kit	100002217
Kalrez(R) seal kit	100002220
Silicone seal kit	100002223
Viton(R) seal kit	100002226
limit switch kit	100002229

8) Teflon is a registered trademark of E.I. Dupont de Ne11ours Co.

Solenoid pilot valves

24 VAC 50/60Hz	100001416
coil for above	100001531
24 VDC	100001397
coil for above	100001526
100-120 VAC 50 Hz- 110-130 VAC 60Hz	100001417
coil for above	100001528

8. TROUBLE SHOOTING

The following sections outline diagnosis of possible problems encountered when using HPS LoPro Series valves and detail possible causes and their remedies.

8.1 Problems and Diagnosis

8.1.1 Won't close completely

High magnitude leakage across the nosepiece seal when the valve is supposedly closed is evidence for failure to close completely. The absence of a signal from the closed limit switch (if so equipped) would be further evidence. In valves that have visual access to one or both of the ports, a gap between the nosepiece and the seat might be observed.

If the gap between the nosepiece and seat is large (greater than .1") or there seems to be loose components rattling about inside the bellows, see section 8.2.1 on spring failure. Otherwise refer to section 8.2.13 covering improper assemb1y.

8.1.2 Won't open completely

Failure to open completely can be detected directly by the absence of a signal from the open limit switch (if so equipped). It can also be observed through the hole in the center of the piston cover. Lastly, a significant decrease in the valve's conductance may be an indication.

First, see section 8.2.16 on inadequate air pressure. If pneumatic pressure is within recommended limits and compressed air is leaking and possibly heard through the hole in the piston cover but is not coming out of the vent in the flat head screw, see section 8.2.9 on piston seal leakage. If the air is spraying through the hole in the center of the flat head screw when the valve is static, see section 8.2.10 on stem seal leakage. Last, if there are no other symptoms other than incomplete opening, see section 8.2.14 on loose piston hold down screws.

8.1.3 Opens slowly or in jumps

An abnormally long delay between signals from the two limit switches is direct evidence of slow opening. It can also be observed through the hole in the center of the piston cover, comparing the actuation time to that in the specifications. Movement in jumps, called slip sticking, can be observed through the same hole. The vibration caused by slip stick jumps can often be felt manually and sometimes heard.

First, see section 8.2.16 on inadequate air pressure. If pneumatic pressure is within recommended limits, refer to section 8.2.17 covering inadequate air flow. Last, see section 8.2.15 on inadequate or exhausted lubrication.

8.1.4 Won't open at all

Continuation of the signal from the closed limit switch (if so equipped)and zero conductance through the valve are both good indications that the valve has not opened. Visual observation of the piston's failure to move can be made through the hole in the center of the piston cover.

First, see section 8.2.16 on inadequate air pressure. If pneumatic pressure is within recommended limits, refer to section 8.2.2 on stem weld failure. Last, if air is blasting from the vent in the piston hold down screw when the valve is trying to open, see section 8.2.14 on loose piston hold down screws.

8.1.5 Squeaks when opening and/or closing

LoPro valves normally make a barely audible squeak when they open. This is caused by the spring making contact with the bushing that prevents the spring from buckling and damaging critical components.

A loud grinding or squeaking may be indicative of a problem. If there seems to be loose components rattling about inside the valve, see section 8.2.1 on spring failure. Also check section 8.2.15 on inadequate lubrication.

8.1.6 Leaks across closed nosepiece seal

Detection of leakage across the nosepiece seal when the valve is closed can be symptomatic of several problems. See section 8.1.1 if the valve also isn't closing completely.

Refer to section 8.2.12 on nosepiece seal omission. If the o-ring is present, particles, contamination, and corrosion may be the problem, see section 8.2.5. If the valve continues to leak after the seat and sealing area have been cleaned, see section 8.2.8 on bonnet seal failure.

8.1.7 Leaks from atmosphere when closed

If leakage is detected from atmosphere when the valve is closed, see section 8.2.13 on improper assembly. If the assembly is correct, refer to section 8.2.8 on bonnet seal failure. Last, see section 8.2.3 on body damage.

8.1.8 Leaks from atmosphere when open

If leakage is detected from atmosphere when the valve is open, see section 8.2.6 on bellows failure.

8.1.9 Leaks from atmosphere at all times

If leakage is detected from atmosphere at all times, see section 8.2.6 on bellows failure. If the bellows has not failed, refer to section 8.2.8 on bonnet seal

failure. Also see sections 8.2.11 on bonnet seal omission, 8.2.13 on improper assembly, 8.2.3 on body damage, and 8.2.4 on port flange damage.

8.1.10 Air leaks from around piston when open

If compressed air can be heard and possibly felt escaping from the hole in the center of the piston cover, but is not emanating from the vent hole in the center of the flat head screw directly underneath the hole in the piston cover, see section 8.2.9 on piston seal failure.

8.1.11 Air leaks from vent hole while opening

The hole in the flat head screw in the center of the piston, visible through the hole in the piston cover, vents the interior of the bellows as its volume changes during the stroke. This venting is normal and necessary *while the valve is dynamic (opening or closing),* and can be felt as a puff of air through the hole in the piston cover *while opening.*

8.1.12 Air leaks from vent hole when open

If compressed air can be felt escaping from the vent hole in the center of the piston, visible through the hole in the piston cover, see section 8.2.10 on stem seal failure.

.1.13 Limit switches don't send signal

Be sure that the valve is opening and/or closing completely, see sections 8.1.1 and 8.1.2. If the valve has travelled its full stroke, see section 8.2.18 about limit switch failure.

8.1.14 Solenoid valve buzzes or doesn't work

If air is not passing through the solenoid pilot valve or is buzzing during activation, see section 8.2.19 on solenoid valve failure.

8.2 causes and Remedies

8.2.1 Spring failure

The normal LoPro valve spring has a life greater than 1×10^6 cycles. In the rare event of a failure, due to the special fixturing required for complete disassembly of the actuator assembly, the best remedy is to return the valve to the manufacturer for repair.

8.2.2 Stem weld failure

A disproportionately high percentage of the early LoPro valves experienced a failure in the weld joining the nosepiece to the stem. This process problem was corrected January 10, 1992. There have been no reports of this failure on any valve built after that date. Such a failure, due to the special fixturing required for complete disassembly of the actuator assembly, may only be repaired

at the factory.

8.2.3 Body damage

All LoPro valves are thoroughly tested after assembly. Body damage serious enough to result in detectable leakage could be caused by mishandling or abuse in shipping or in the installation. A damaged body is not easily repaired, usually costing more for the repair than a replacement. Often, with serious body damage, the actuator assembly has also been damaged, making replacement of the entire valve the best solution.

8.2.4 Port flange damage

Flanges are easi1y damaged after the protectors have been removed. *Avoid contact between the flanges and any surface.* Small sealing surface defects can sometimes be corrected with application of a good quality vacuum grease, such as Apiezon, to the seal. Larger defects might be repaired by rubbing out the scratch or dent with a light abrasive, such as Scotch Brite[1] • Working of the abrasive should always be parallel to the direction of the seal. For example, a scratch on a surface sealed by a circular o-ring should, likewise, be worked with the abrasive in circular fashion. Heavier damage would require replacement of the body.

8.2.5 Particulates, condensation. and corrosion

In normal use, airborne particulates, process condensation, and/or corrosion, may effect seal integrity. Particulates might be moved by simple turbulent gas flow. However, condensed or sublimated films nearly always require further cleaning. Additionally, corroded sealing surfaces may be irreparable. Replacing the component being the only remedy.

8.2.6 Bellows failure

Although the mean time between failures for the LoPro bellows is greater than 10^6 cycles, nearly all valve failures are the result of bellows failures. Stress cracks in the convolution crowns are first detected when the valve is open and the bellows is in compression. At this time, the outside of the bellows material is in tension, opening minute cracks wider than when the bellows is relaxed or in extended. Eventually, the crack(s) will propagate around the entire convolution and the bellows will separate. Long before, the atmospheric leak will be detected constant1y. The on1y remedy is to rep1ace the actuator assembly.

8.2.7 Nosepiece seal failure

Elastomer seals that have remained in a compressed condition for long periods of time may not return to their circular cross section when released. Such seals may stick to the mating sealing surface as they are pulled apart, leaving bits

---

9) Apiezon is the trademark of GEC Alsthom, ltd.

10) Scotch Brite is a registered trademark of 3M.

of the seal behind. Old elastomers tend to lose some of their elasticity and may crack. All of these effects are accelerated by various process gasses and/or high temperatures. Reference section 7.2.2 on o-ring replacement.

8.2.8 Bonnet seal failure

Elastomer seals that have remained in a compressed condition for long periods of time may not return to their circular cross section when released. Such seals may stick to the mating sealing surface as they are pulled apart, leaving bits of the seal behind. Old elastomers tend to lose some of their elasticity and may crack. All of these effects are accelerated by various process gasses and/or high temperatures. Reference section 7.2.2 on o-ring replacement.

8.2.9 Piston seal failure

The seals used on LoPro's piston are normally good for much more than 10^6 cycles. However, an occasional defect in the material, in the seal's installation, or inadequate lubrication could cause a bit of the edge of this seal breaking off, resulting in a pneumatic leak. Due to the special fixturing required to fully disassembly the actuator assembly, factory repair or replacement is recommended.

8.2.10 Stem seal failure

The seals used on LoPro's stem are normally good for much more than 10^6 cycles. However, an occasional defect in the material, in the seal's installation, or inadequate lubrication could cause a bit of the edge of this seal breaking off, resulting in a pneumatic leak. Due to the special fixturing required to fully disassembly the actuator assembly, factory repair or replacement is recommended.

8.2.11 Bonnet seal omission

After service, during reassembly, omission of the bonnet seal will cause the valve to leak from atmosphere at all times. Remove the actuator assembly and install the seal.

8.2.12 Nosepiece seal omission

After service, during reassembly, omission of the nosepiece seal will cause the valve to leak from one port to the other when the valve is closed. Remove the actuator assembly and install the seal.

8.2.13 Improper assembly

After service, the actuator must be inserted to its stop, reference section 7.2.3 on actuator assembly installation. Failure to do so could result in the valve not closing completely, or leaking in its closed position. More importantly, cross threading the actuator assembly into the body could result in one or both being ruined, requiring replacement or factory repair.

8.2.14 Loose piston hold down screw

The piston hold down screw, a vented flat head socket drive cap screw, can work

itself loose if not tightened adequately during assembly or if improperly assembled. Remove the piston cover and, *with the valve closed,* remove the piston hold down screw. (If the valve is equipped with the optional limit switch package, follow the directions for its removal.(Apply a light film of a good quality thread locking compound, such as Tight[11], to the threads of the piston hold down screw and tighten.

8.2.15 Inadequate lubrication

Normally the LoPro's dynamic components require very little lubrication. However, dry environments, high temperatures, and corrosive atmospheres may exhaust most of the lubricating properties of the greases used. The least effect of this is to increase the friction on the piston and stem, but could result to damaged components and failure. Remove the piston cover and apply a film of a high quality lubricant for elastomer/metal interfaces, such as Fomblin VAC 3[12], to the inside of the cylinder. Cycle the valve several times and reapply the grease.

8.2.16 Inadequate air pressure

The specifications define minimum operating pressures for LoPro valves. If the pneumatic supply pressure is too low, it must be increased.

8.2.17 Inadequate air flow

More difficult to detect than inadequate pressure, low flow may cause slow actuation of the valve. If the pneumatic line is equipped with a gauge, watch the pressure as the valve is actuated. If it decreases significantly with each slow actuation then pneumatic flow is inadequate. Check for kinks or other blockages in the line. If the low flow is due to demand greater than capacity, installation of additional capacity must be considered.

8.2.18 Limit switch failure

If a limit switch cannot be activated manually when the cam is at the opposite switch, replace the limit switches. Check to be sure the valve is, indeed, opening and/or closing completely. If these check out, refer to section 7.3.4 on limit switch adjustment.

8.2.19 Solenoid valve failure

During long or quickly repeated duty cycles, the solenoid valve's coil will normally exceed 70° C. Voltages lower than specified can increase that temperature and accelerate the failure of the coi 1. Incorrect voltages can cause immediate failure and subsequent replacement of the solenoid valve's coil.

Dirt or other contamination from the pneumatic supply can inhibit the movement

11) Tight is a trademark of Fel Pro, Inc.

12) Fomblin is a registered trademark of Montefluos, Ausi111ont Group, Montedison Specialty Chemicals.

of the plunger and cause the valve to leak. Sometimes this problem manifests itself in an oscillation of the plunger, resulting in readily audible buzz. The best remedy is to replace the entire solenoid valve. Installation of a filter in the pneumatic line upstream from the valve can prolong the life of the valve.

9. RETURN TO FACTORY FOR REPAIR OR SERVICE

Before shipping a LoPro valve to the factory, please observe the following procedure:

9.1 Call the factory

The MKS Customer Service Department or any MKS Service Center will prepare a Returned Material Authorization (RMA). Consequently, when the item is received, it will be dispositioned in a timely manner.

The customer service person will need information on the following:

> What is the problem?
> What are the symptoms, and how were they observed?
> What is the application?
> Is it an urgent repair?
> What is the valve's serial number.
> What is the user's name and where can he be reached.
>Was the valve used with any dangerous, toxic, or radioactive materials? HPS is not equipped to handle such items. Items having ***ANY*** unidentified coatings or films will be treated as hazardous waste and appropriately disposed at the sender's expense. Additionally, the shipment of hazardous materials through the mail or on any private carrier not specifically licensed for the handling of such materials is a federal offense.

With this information, the customer service person will issue an RMA number specific to this return.

9.2 Prepare for shipment

Be sure the valve is clean and free of any hazardous materials. Cap the ports to prevent entry of foreign material and to protect the sealing surfaces. Place the valve in a sealed plastic bag, and pack securely in a sturdy shipping container. Poor packing can result in damage to the valve. Insert a packing slip or letter referencing the RMR number issued by the customer service person.

9.3 Payment

Warranty repairs or replacement are performed at no cost. If the item returned is no longer under warranty, a purchase order for the cost of the repair will be required. Of course, an estimate of the repair cost will be provided.

10. WARRANTY

10.1 COVERAGE

MKS Instruments, Inc. ("HPS") warrants LoPro Series valves to be free from defects in materials and workmanship for a period of ONE YEAR from the date of shipment by HPS or its authorized representative to the original purchaser ("Purchaser"). Any product or parts of the product repaired or replaced by HPS under this warranty are warranted only for the remaining unexpired portion of the one year original warranty period applicable to the product which has been repaired or replaced. After expiration of the applicable warranty period, the Purchaser shall be charged HPS's current prices for parts and labor, plus any transportation for any repairs or replacement.

The obligations of HPS under this warranty shall be, at its option, to either repair, replace or adjust the product so that it meets applicable product specifications published by HPS, or to refund the purchase price.

10.2 WARRANTY PERFORMANCE

To obtain warranty satisfaction, contact your local MKS Instruments, Inc. district sales office or:

MKS Instruments, Inc.
2 Tech Drive
Andover, MA 01810
Voice (800) 227-8766

10.3 WHAT IS NOT COVERED

The above warranties do not apply to the following:

› damages or malfunctions due to failure to provide reasonable and necessary maintenance in accordance with HPS operating instructions.
› damages or malfunctions due to chemical or electrolytic influences, or use of the product in working environments outside the specifications.
› seals, bellows, and all expendable items which by their nature or limited lifetimes may not function for one year. (If such items fail to give reasonable service for a reasonable period of time within the warranty period of the product, they will, at the option of HPS, be repaired or replaced.)
› defects, damages, or malfunctions caused by modifications and/or repairs effected by the Purchaser or unauthorized third parties.

10.4 OTHER RIGHTS AND REMEDIES

HPS SHALL NOT BE LIABLE FOR CONSEQUENTIAL DAMAGES, FOR ANTICIPATED OR LOST PROFITS, INCIDENTAL DAMAGES, OR LOSS OF TIME OR OTHER LOSSES INCURRED BY THE PURCHASER OR BY ANY THIRD PARTY IN CONNECTION WITH THE PRODUCT COVERED BY THIS WARRANTY, OR OTHERWISE. Some states do not allow the exclusion or limitation of

incidental or consequential damages, so the above limitation or exclusion may not apply.

Any implied warranty on these products shall be limited to one year from date of shipment to Purchaser. Some states do not allow limitations on how long an implied warranty lasts, so the above limitations may not apply.

Unless otherwise explicitly agreed in writing, it is understood that these are the only written warranties given by HPS. Any statements made by any persons including representatives of MKS/HPS which are inconsistent or in conflict with the terms of the warranty shall not be binding on HPS unless reduced to writing and approved by an authorized officer of HPS.

This warranty gives you specific legal rights and you may also have other rights which may vary from state to state.

For more information or literature contact:

MKS Instruments, Inc.
651 Lowell Street
Methuen, MA 01824
Phone: (800) 227-8766
www.mksinst.com