Technology for Productivity

HPS® Products

HPS® Integrated LoPro Valve (ILP)

OPERATION AND MAINTENANCE MANUAL

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HPS® Integrated LoPro Valve (ILP)

January 2002
Part #100012201

Part #

Please fill in these numbers and have them readily available when calling or service or additional information.

(The part number can be found on your packing slip, and both the port number serial number are located on the side of the housing.)

For more information or literature, contact:

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Table of Contents

1. IN THIS MANUAL

This manual details functional information for the HPS® Integrated LoPro valve (ILP), a heatable 2-stage valve with a bellows sealed poppet main stage and an integrated dynamic o-ring sealed bypass.

2. DESCRIPTION OF INTEGRATED LOPRO SERIES VALVES

The Integrated LoPro Valve is a pneumatically actuated 2-stage vacuum valve used to minimize turbulent flow where particulate contamination is a concern. The bypass stage is an adjustable, low conductance internal valve used to slow down pumping speed.

Main Stage: The main stage uses an o-ring as a static face seal on the bonnet and nosepiece, while the movement of the poppet is sealed by a metal bellows. See section 4.1 for more details.

Bypass: The bypass uses an o-ring as a static face seal on the nosepiece and a dynamic o-ring to seal the nosepiece movement. See section 4.1 for more details.

Limit Switches: Optional limit switches are available for remote indication of the open and closed positions of the valve's main stage. See section 4.2 for more details.

Solenoids: Solenoid operated pneumatic pilot valves may, optionally, be installed. This pilot valve allows electrical control of the ILP valve while it is connected directly to the facility pneumatic supply. Solenoid valves are available in a variety of voltages. See section 4.3 for more details.

Heaters: Optional heaters are available to keep the internal operating temperature of the ILP valve at a minimum of 105°C. See section 4.4 for more details.

Figure 2 summarizes the available options for the Integrated LoPro Valve.

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.

33XX-XXXXX

Size

	Size
25	1” (25mm)
40	1.5 (40mm)
50	2” (50mm)

Body Configuration

	Body Configuration
11	Inline KF
12	Inline Tube
21	Angle KF
22	Angle Tube

Limit Switch Option

	Limit Switch Option
0	No limit switch
1	Limit switch

Seals

	Seals
1	Viton
2	Chemraz
3	Kalrez

Solenoid Options

	Solenoid Options
1	No Solenoid
1	120 VAC
1	208 VAC
1	240 VAC
1	24 VAC
1	24 VDC
1	T12
1	T25

Figure 2: ILP Valve Options

3.2 Maintenance

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

3.3 Hazardous Materials

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 Installation

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 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 the 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

See Figure 8 for valve drawing with part identification, i.e. "bellows (15)." From its normally closed position, the main and bypass valve are opened with the admission of compressed air to the pneumatic cylinder (23) through the 1/8" female NPT ports in the side of the cylinder. A small orifice between this port and the cylinder interior serves as a flow restrictor to determine the valve opening and closing time. Both stages are normally closed and are held closed with a compression spring (16, 17).

On the main stage, when the pneumatic pressure is applied to the left port, the cylinder (23) reaches a value sufficient to over come the force of the spring, (16) the piston (19) starts to rise, pulling the nosepiece (21) off of the seat. The piston (19) is mechanically attached to the stem that is welded to the nosepiece. (21) As the nosepiece (21) rises, the bellows (15) is compressed. A small vent groove is located 180 degrees from the actuation ports. This vent allows air to escape from the compressed bellows (18) and to allow for easy Helium leak checking of the bellows(15). The nosepiece (21) is sealed against the seat with an elastomer o-ring (2) that is contained in a trapezoidal groove. The bellows (15) forms a flexible hermetic seal between the nosepiece (21) and the fixed elements of the body. As long as adequate pneumatic pressure and flow is applied, the piston (19) continues to travel upward, further compressing the spring, (16) until the valve reaches full open position. Conductance of the main stage is roughly equivalent to 85% of a similarly dimensioned 90° elbow.

The bypass stage of the valve is also pneumatically actuated through the right port. As pressure is applied, the bypass piston (20) is forced upward, lifting the bypass nosepiece (22) off the seat (18) and compressing the closing spring (17). This allows for a restricted flow through the small orifice on the bypass seat (18). A restricted flow will extend pumpdown times and reduce turbulent flow that may disturb particles throughout a vacuum system causing particulate contamination. Once the bypass has allowed for a soft pumpdown to a user specified pressure, the main stage may safely be opened for a higher conductance and lower base pressure. The bypass stage conductance is adjustable by turning the bypass adjustment screw (13). Turning the bypass screw fully counter-clockwise will allow for maximum conductance. The bypass screw (13) may be turned approximately 3 1/2 turns clockwise before it makes contact with the bypass piston (20), which will prevent the bypass from allowing any flow across the ports. The bypass screw (13) has machined detents that lock the screw into place during cycling. There are 10 detents per full turn. See figure 4.1 for the bypass pump-down curve.

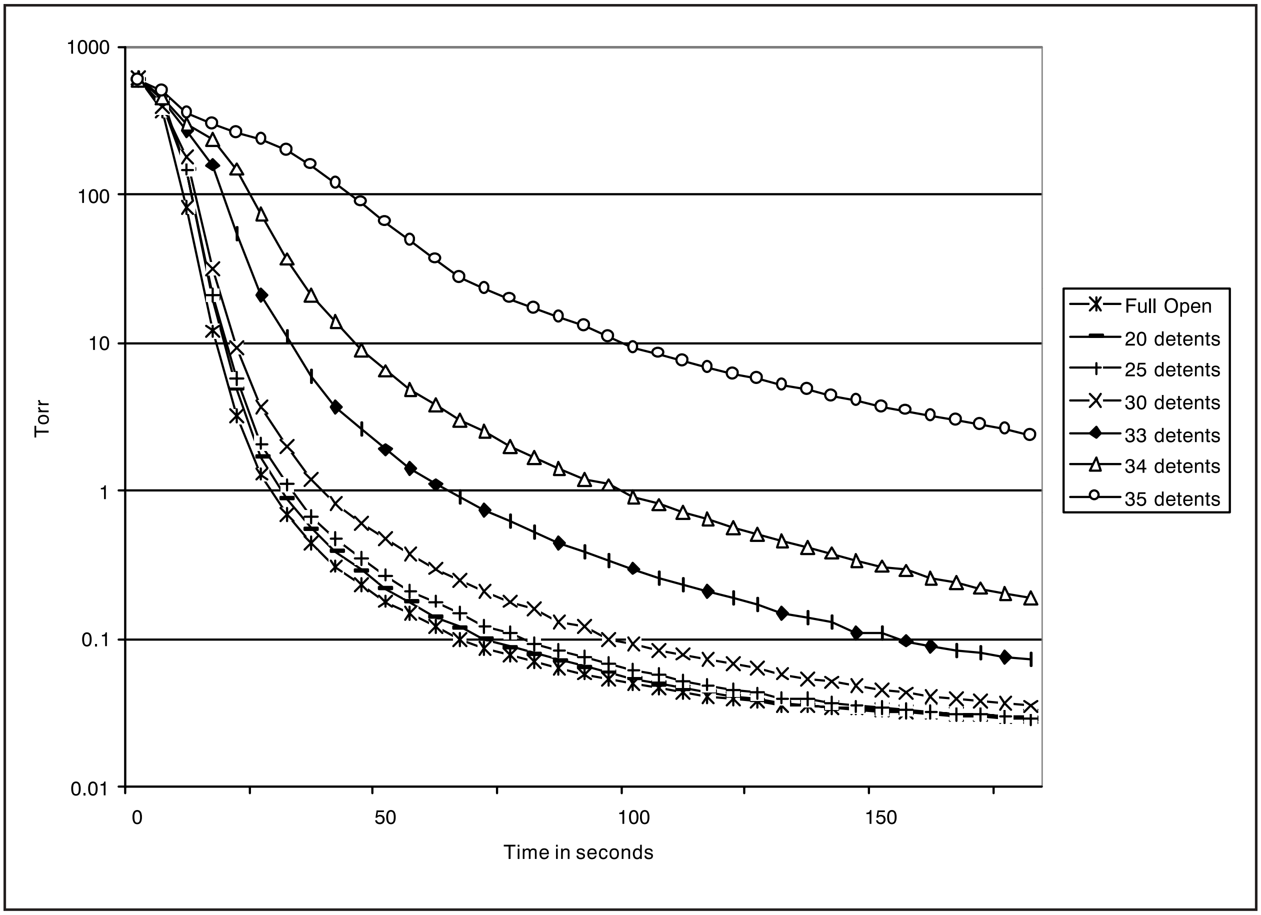

Figure 4.1:
Bypass Pump-down curve (Approximately 9 liters of air)

4.2 Limit Switch Actuation

Limit Switches: Optional limit switches are available for remote indication of the open and closed positions of the main stage of the valve, but not the bypass. The switch is an electric proximity switch. The internal reed contact is actuated magnetically and completes the electrical circuit. The limit switch can be moved along the machined groove in the actuator cylinder (23) to allow for adjustments in actuation position. To move the switch, use a .9mm Allen wrench. Maximum torque on the setscrew should be limited to 0.2 Nm.

Care should be taken to avoid interference with the reed switch, it is very sensitive to magnetic fields or electromagnets with field strength greater than 0.16 mT (T = Tesla). If the proximity switch is to be used near magnetic fields, proper shielding must be installed to isolate the device.

Observing that the closed position limit switch is actuated does not necessarily verify that the valve is sealed in a leak tight state, 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.

Technical data:	
* Function of actuation	Normally Open
* Operating voltage range	12-27 VDC (24 VDC nominal)
* Switching current max.	100mA
* Contact rating max. (DC)	1W
* Response time	on: <0.6 ms
* Short-circuit-proof	no
* Polarity-reversal protection	no
* Temperature range	-20C to +70C
* Housing material	PPS- reinforced, epoxy resin
* Cable material	PUR

Electrical connections for proximity switch (LOAD is customer supplied and could be an LED, indicator light, relay, etc.):

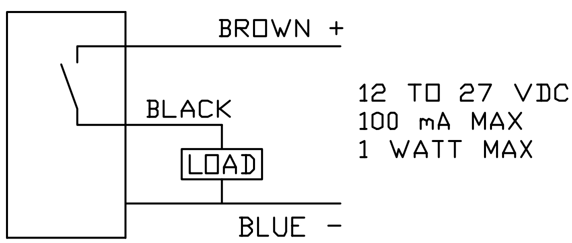

Figure: 4.2

4.3 Solenoid Operated Pilot Valve Operation

Optional installation of solenoid operated pneumatic pilot valves in the 1/8" female NPT ports in the side of the cylinder (23) enables remote electrical control of the valve when direct pneumatic control is inconvenient. In its unenergized state, this 3-way valve vents the cylinder (23) of the ILP through a threaded hole centered in the top of the solenoid coil. A nipple connects the 1/8" female NPT outlet port on the solenoid valve to the cylinder (23) of the ILP. 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 and lifts the plunger off the seat. 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 (23) of the ILP is quickly pressurized and the ILP opens.

When power to the solenoid is turned off, the spring forces the plunger back to its original position, simultaneously closing the pressurized port and opening the vent port. Pressurized air in the cylinder (23) of the ILP quickly escapes through grooves on the outside of the plunger and out the vent port, allowing the ILP to close.

Users may supply their own solenoid operated pilot valve. A solenoid valve rated for > 1 million cycles continuous duty and a conductance > 0.05 cubic inches per minute is recommended. The lengths and diameters of pneumatic feed lines must also be considered for peak performance.

4.4 Heaters

The optional heaters available for the ILP valves will keep the minimum internal operating temperature to 105°C while maintaining a low outside temperature. From room temperature, the heaters typically reach their set temperature in less than 30 minutes.

Heat is distributed with wire heating elements closely and evenly spaced. Any potential for hot and cold spots is virtually eliminated. Since each heater is uniformly heating a component, there is no need for costly controllers or thermocouples with messy wires.

The heaters are made of a 1/2 -inch thick silicone foam insulation bonded, using a patented technology, onto a reinforced silicone rubber mat. The heaters' elastic, conforming shape and convenient snaps make installation and removal fast and easy.

The heaters are easily daisy chained to other HPS® heaters or powered from a separate power cable (sold separately). Heater options include 120 or 240 Volt and optional low temperature alert. See Figure 4.4 for heater options and part numbers.

Part Number	Description
9510-0601	Heater, NW 25, 105°C, no LTA, Angled, 120V
9510-0602	Heater, NW 25, 105°C, with LTA, Angled, 120V
9510-0605	Heater, NW 25, 105°C, no LTA, Inline, 120V
9510-0606	Heater, NW 25, 105°C, with LTA, Inline, 120V
9515-0601	Heater, NW 40, 105°C, no LTA, Angled, 120V
9515-0602	Heater, NW 40, 105°C, with LTA, Angled, 120V
9515-0605	Heater, NW 40, 105°C, no LTA, Inline, 120V
9515-0606	Heater, NW 40, 105°C, with LTA, Inline, 120V
9520-0601	Heater, NW 50, 105°C, no LTA, Angled, 120V
9520-0602	Heater, NW 50, 105°C, with LTA, Angled, 120V
9520-0605	Heater, NW 50, 105°C, no LTA, Inline, 120V
9520-0606	Heater, NW 50, 105°C, with LTA, Inline, 120V
43PWRCORD01	Power cable, 6 ft. (1.83M), 120VAC
43PWRCORD02	Power cable, Custom Length, max 25 ft., 120VAC
43PWRCORD04	Power cable, 6 ft., 120VAC with ground fault leakage circuit interrupt
100010832	Low Temperature Alert (LTA) Monitor
100006985	Series 43/45 Heater Jacket Power Cord spare fuses, 12A, Qty: 5
100008680	Kit, LTA lead, with male and female connector and 10 ft. of wire
100008683	Kit, LTA jumper, with male and female connector and 6 in. of wire

Figure 4.4: Heater part numbers and accessories.

5. SPECIFICATIONS

5.1 Environment

5.1.1 Installation Orientation

The Integrated 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 Integrated LoPro body is roughly equivalent to an elbow of similar size. Care must be taken to protect the body of the Integrated LoPro from excessive stress resulting from torque, 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

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.

Lubricating grease used on the stem and piston seal increase their viscosity at low temperatures, which increases the force required to move the poppet. Lighter fractions of these lubricants also begin to evaporate at higher temperatures, ultimately resulting in dried lubricant, increased friction on the sliding surfaces, and 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.

Heaters are available for the ILP series valves at 105(C. While the ILP valves may withstand slight intermittent temperature spikes, the valves are rated for an operating temperature of only 105(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
Bypass	<0.1 sec	<0.1 sec

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

5.2.2 System Pressure Limits

ILP series valves are designed to function from UHV to greater than 2 Atm pressure (depending on size). Due to the elastomer seal (1) 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 ILP series valves are He mass spectrometer tested with the maximum allowable leak rate being 1 x 10-9 std Atm cc/ sec. Although the ILP 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 (21, 22) by excessive internal pressures will exceed the spring's (16, 17) 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	100 psig
NW40	50 psig
NW50	45 psig

Higher pressures could cause bonnet seal (1) extrusion, collapse of the bellows (15), failure of the bonnet seal compression screws on the cylinder, or rupture of the valve body.

5.2.3 Pneumatic Pressure Limits

Proper valve function requires sufficient pressure from the facilities pneumatic system. A minimum pressure of 60 psig and a maximum pressure of 120 psig is required.

5.2.4 Pneumatic Flow

Insufficient pneumatic flow due to inadequate line diameter can result in temporary downstream decreases in pressure. As the ILP 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 in3	(19.0 cm3)
NW40	2.21 in3	(36.2 cm3)
NW50	6.36 in3	(104.2 cm3)
Bypass	0.16 in3	(2.6 cm3)

5.2.5 Limit Switch Ratings

See section 4.2

5.2.6 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

In addition to the dimensions given below, allowance must be made for the bushing (12) that protrudes out of the top of the actuator cap when the main stage is open. The bushing travel for the NW25, NW40, and NW50 are 0.45", 0.525", and 0.90" respectively.
If solenoids are to be attached to the two 1/8" NPT ports, extra space needs to be allowed for the solenoids, adapters, and pneumatic lines. See Figure 6.

Refer to Figures 5 for the following table of dimensions:

Part Number	A	B	C	D	E
3325-11XXX	N/A	N/A	3.94	5.26	2.27
3325-12XXX	N/A	N/A	4.35	5.27	2.27
3325-21XXX	1.97	6.05	N/A	N/A	2.27
3325-22XXX	1.88	6.34	N/A	N/A	2.27
3340-11XXX	N/A	N/A	5.12	5.95	2.76
3340-12XXX	N/A	N/A	4.83	5.95	2.76
3340-21XXX	2.56	6.81	N/A	N/A	2.76
3340-22XXX	2.247	6.97	N/A	N/A	2.76
3350-11XXX	N/A	N/A	7	7.74	3.51
3350-12XXX	N/A	N/A	7.2	7.42	3.51
3350-21XXX	2.76	8.33	N/A	N/A	3.51
3350-22XXX	3.00	8.88	N/A	N/A	3.51

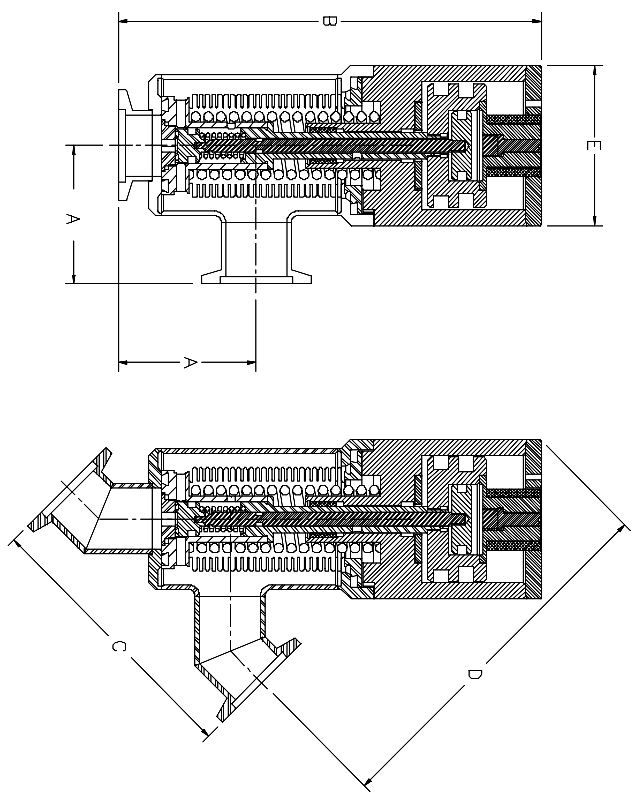

Figure 5: Overall dims of ILP valve

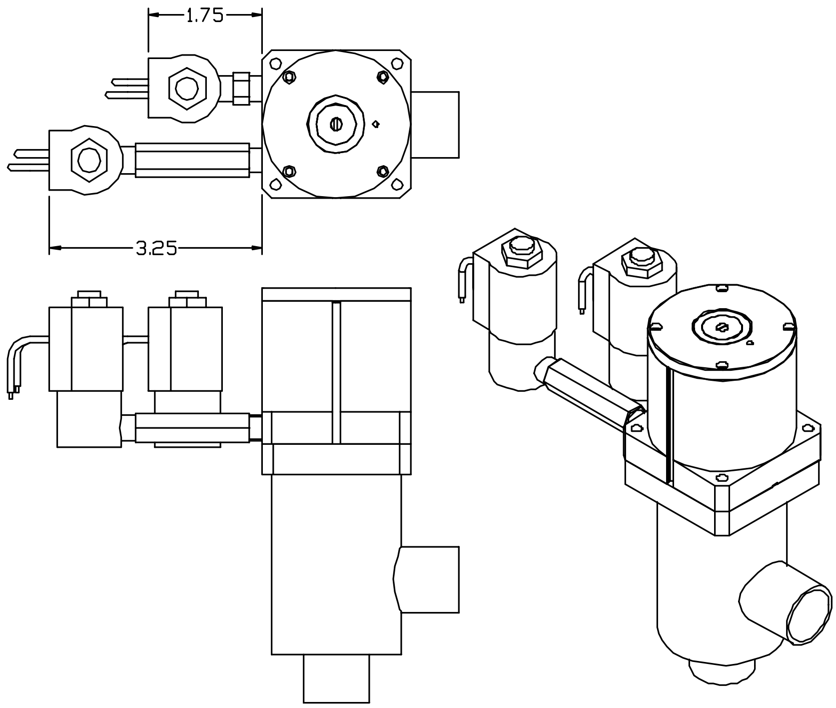

Figure 6: Solenoid Dimensions (All sizes)

5.3.2 Weight

No solenoids or limit switches are included in the weight table.

Valve Size/ Body	Angle	Inline
KF25	2.3 lb	2.4 lb
KF40	3.6 lb	3.7 lb
KF50	6.0 lb	6.4 lb

Solenoid pilot valve: 0.46 lb (209 g) each

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 sliding surface has been lubricated, making possible the use of "dry" pneumatic supplies without harm to the ILP 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 must be made whenever the valve is equipped with limit switches or when using the optional solenoid pilot valves.

Care must be used when soldering leads to the terminals of the limit switches or solenoid valves. 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 Installations

Valves are shipped with plastic covers over the ports. These covers should be left in place until the valve is installed. All ILP 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, the seat, 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. Since the flanges are integral with the body, a defective flange could result in a replacement of the body.

When installing the valve, adequate clearance should be allowed between adjacent components so there is no sliding of the 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 electric shock or 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 switches may be removed from the valve without disconnecting the leads. The switches are locked into place with a small setscrew. Before removing the switch, marking the switch's location with a piece of tape or marker will save time when reinstalling. To loosen the setscrew, use a 0.9 mm Allen wrench and turn counter-clockwise. Once loose, the switch is free to slide along the groove. The switches may be removed from the top or bottom of the groove. If the actuator is to be removed, the switch may slide out the bottom. Otherwise, remove the screws that hold the lid (24) in place on the top of the actuator (23), 4 screws on the NW25 and NW40, 6 screws on the NW50. Once the lid (24) is removed the, switches may be slid out the top.

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. Section 7.1 should be read for information on solenoid and limit switch removal

The actuator assembly is attached to the bonnet of the valve by 4 screws. These screws have been silver plated to ensure easy removal after thermal cycling.

Sometimes the elastomer nosepiece o-ring seal (2) and the bonnet seal (1) will stick to clean metal sealing surfaces. This is most prevalent with valves that have been run warm.

After the screws have been removed, pull the actuator assembly out of the valve body. The bellows (15) is fabricated of .006" thick 321 stainless steel. While withdrawing the actuator assembly (23), care should be exercised to avoid damaging the bellows. If the bonnet o-ring (1) 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.

CAUTION: The actuator assembly contains a powerful spring (16) under some compression at all times. Special fixture is required for further, safe disassembly of the actuator. Replacement of malfunctioning actuators with new assemblies is recommended (see parts list in section 7.4 for details).

7.2.2 O-ring Replacement

The bonnet o-ring (1) may be removed easily without special fixturing. With a little stretch, the bonnet o-ring clears the bellow (15) and drops off of the actuator assembly (23).

Removal of the nosepiece o-ring (2) on the main stage 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 grooves or on the o-rings. To install the o-rings into the trapezoidal grooves, nest the o-ring on the opening of the groove. With the thumbs at points 180(apart, firmly press the o-ring into the groove. Move 90(and press again. Move 45(and press again. Alternately press the o-ring into the groove until it is completely in the groove. Hand installation will likely leave humps on the installed o-ring. As long as the o-ring has not twisted during assembly, this will disappear after a small number of cycles, after which the valve should function properly.

The bypass has two o-rings that are easily accessible for replacement. A 3/16" Allen wrench is required to remove the bypass seat (18), located in the center of the main stage nosepiece (21). Once the seat (18) is removed, the first o-ring (3) will easily slide off of the seat. The bypass nosepiece o-ring (4) requires a thin tool to pry it out of the trapezoidal groove. Care should be taken to avoid damage to the nosepiece sealing surface during removal. Since the seat o-ring (3) is compressed with a twisting motion, a light coat of vacuum grease is recommended to prevent damage during reassembly.

The dynamic o-ring (6) in the bypass can be removed and replaced but requires special tools to access. It is recommended that the entire valve be removed from the system and returned to an approved MKS service center for repair or replacement.

7.2.3 Actuator Assembly Installation

If applicable, replace the limit switches by sliding them into the machined grooves from the bottom of the actuating cylinder.

Insert the actuator assembly (23) into the valve body. As with removal, take care to avoid damaging the bellows (15). Be sure that the bonnet o-ring (1) is in place. The bellows flange is appropriately tapered to aid in retaining the o-ring in the proper position during assembly. Tighten the four actuator-cap screws until the cap bottoms out on the valve body. The screws should be lightly tightened in an X pattern, the X pattern should be repeated 2 to 3 times to ensure all screws are fully seated. These screws should be sufficiently tight to compress the bonnet o-ring and prevent themselves from loosening.

Reconnect the pneumatic supply and electrical connections (if applicable).

It is highly recommended to check the assembly for leaks using a high quality Helium mass spectrometer leak detector. The small rectangular vent located 180 degrees from the pneumatic ports is used for leak detection. With the interior of the valve evacuated through the side port and attached to the He mass spectrometer, point the tracer gas probe toward this vent. The bellows (15), dynamic o-ring (5), and bonnet seal (1) are accessed for leak detection through this vent. The nosepiece seal and port flange seals may be tested through a variety of methods and will not be detailed here.

7.3 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 TFE thread seal tape. If TFE 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 entire solenoid valve must be replaced in the event of solenoid pilot valve malfunction. See replacement parts lists, Section 7.4 for solenoid part numbers.

7.4 Replacement Parts List

NW25 ILP valves

Actuator Assembly w/ Viton(R)	100011461
Actuator Assembly w/ Chemraz(R)	100011464
Actuator Assembly w/ Kalrez(R)	100011467
Viton(R) seal kit	100011470
Chemraz(R) seal kit	100011473
Kalrez(R) seal kit	100011476
Limit switch kit (qty: 2)	100011479

NW40 ILP valves

Actuator Assembly w/ Viton(R)	100011462
Actuator Assembly w/ Chemraz(R)	100011465
Actuator Assembly w/ Kalrez(R)	100011468
Viton(R) seal kit	100011471
Chemraz(R) seal kit	100011474
Kalrez(R) seal kit	100011477
Limit switch kit (qty: 2)	100011479

NW50 ILP valves

Actuator Assembly w/ Viton(R)	100011463
Actuator Assembly w/ Chemraz(R)	100011466
Actuator Assembly w/ Kalrez(R)	100011469
Viton(R) seal kit	100011472
Chemraz(R) seal kit	100011475
Kalrez(R) seal kit	100011478
Limit switch kit (qty: 2)	100011479

Solenoid pilot valves

24 VDC (7.0 Watts)	100008163
24 VAC 50/60 Hz (6.0 Watts)	100008164
120VAC 50/60 Hz (7.5 Watts)	100008165
208VAC 50/60 Hz (7.5 Watts)	100008166
220VAC 50/60 Hz (7.5 Watts)	100008167
12VDC (7.0 Watts)	100008539

8. TROUBLE SHOOTING

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

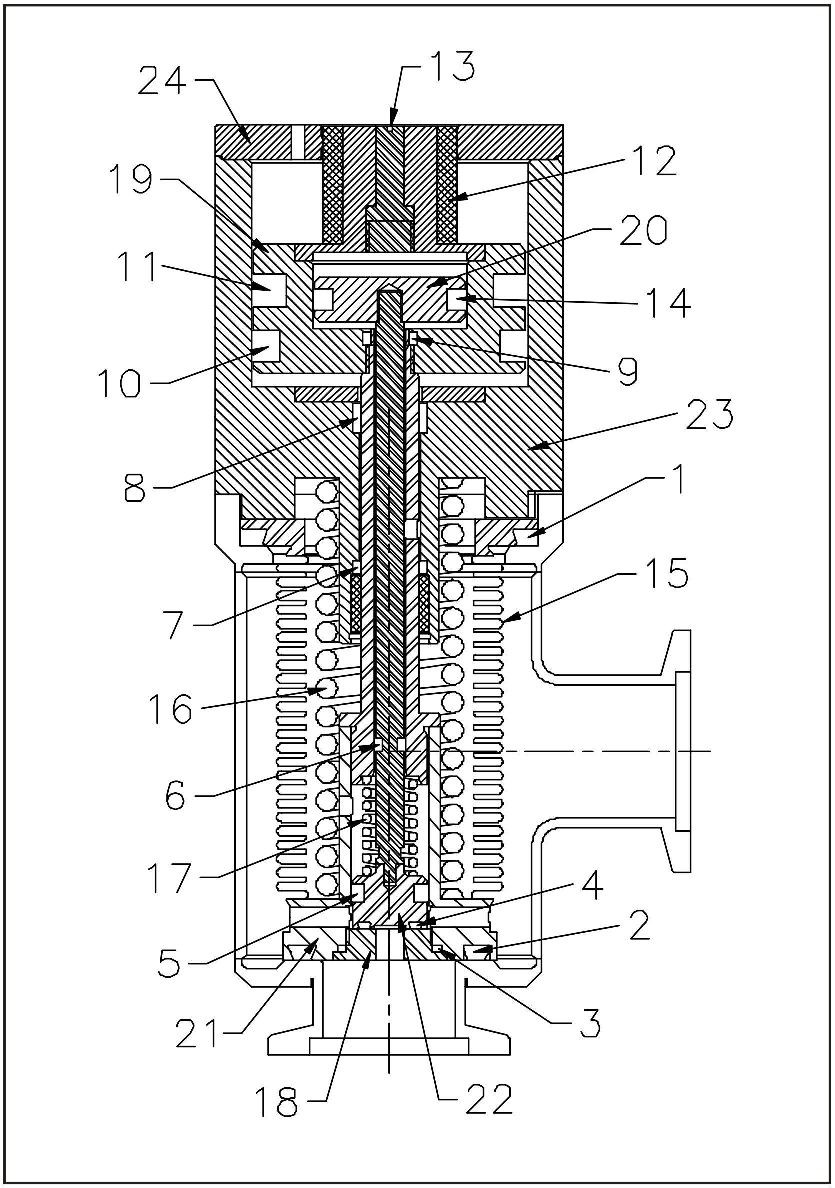

Figure 8: Part Identification

8.1 PROBLEMS AND DIAGNOSES

8.1.1 Won't close completely

The most common reason for either the main or bypass stage of the ILP not to close completely is due to failure of the compression springs (16, 17). Further evidence of main-stage spring failure would include; high magnitude leak across nosepiece seal (2), bushing (12) not flush with top of valve and/or the limit switch not indicating full close.
If you suspect the bypass stage is not closing completely due to a high magnitude leak, you can manually shut the bypass by fully closing (clockwise) the adjustment screw (13) on the top of the valve. If this seals the valve, the bypass spring (17) has likely failed. See section 8.2.1 for recommended service.

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 by the position of the main-stage bushing (12). When the bypass stage opens there should be a sharp metallic sound as the bypass piston (20) hits the bypass adjustment screw (13). 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 lid (24) but is not coming out of the side vent located 180 degrees from the pneumatic ports, then see section 8.2.9 on piston seal leakage. If the air is spraying through the side vent while the valve is static, see section 8.2.10 on stem seal leakage. Lastly, if there are no other symptoms other than incomplete opening, see section 8.2.14 on loose pistons (19, 20).

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 from the bushing (12) location and comparing the actuation time to that in the specifications. 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 airflow. Lastly, 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 from the bushing (12) position on the main stage. 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. Lastly, if air is leaking from the side vent when the valve is trying to open, see section 8.2.14 on loose pistons (19, 20).

8.1.5 Squeaks when opening and/or closing

ILP valves normally make a barely audible squeak when they open and close. This is caused by the spring (16) making contact with the bushing (NW40 and 50 only) 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 (2) when the valve is closed can be symptomatic of several problems. See section 8.1.1 if the valve is also not closing completely.

Refer to section 8.2.12 on nosepiece seal (2) 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 and 8.2.20 on dynamic 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 and 8.2.20 on dynamic seal 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 (15) 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 vent hole in the actuator lid (24), but is not emanating from the vent in the side of the actuator (23), 180 degrees from the pneumatic ports, see section 8.2.9 on piston seal failure.

8.1.11 Air leaks from vent hole while operating

The vent located on the side of the actuator (23), 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 side vent, see section 8.2.10 on stem seal (7,8,9) failure.

8.1.13 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 traveled 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.

8.1.15 Air leaking from non-actuated port or solenoid

When air leaks from one pneumatic port or solenoid vent while the other is actuated, stem seal failure is likely. See section 8.2.10 on Stem seal failure.

8.2 CAUSES AND REMEDIES

8.2.1 Spring failure

The normal Integrated LoPro valve springs have lifetimes greater than 1 x 10^6 cycles. In the rare event of a failure, due to the special fixturing required for complete disassembly of the actuator assembly the valve must be returned for service. See section 9 for Return to Factory for Repair or Service.

8.2.2 Stem weld failure

If the piston is actuating but the valve remains closed, stem weld failure (or a loose piston) could be the problem. See section 9 for Return to Factory for Repair or Service.

8.2.3 Body damage

All Integrated LoPro valves are thoroughly tested after assembly. Body damage serious enough to result in detectable leakage could be cause by mishandling or abuse in shipping or in the installation. A damaged body is not easily repaired, usually costing more 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 easily 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 Bright*. 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 a 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 affect seal integrity. Particulates might be moved by simple turbulent gas flow. However, condensed or sublimates films nearly always require further cleaning. Additionally, corroded sealing surfaces may be irreparable. In this case, replacing the component would be the only remedy.

8.2.6 Bellows failure

Although the mean time between failures for the Integrated 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 are 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 extension. Eventually, the crack(s) will propagate around the entire convolution and the bellows will separate. Long before, the atmospheric leak will be detected constantly. The only remedy is to replace 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 sectional shape 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. Various process gasses and/or high temperatures accelerate all of these effects. 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 sectional shape 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. Various process gasses and/or high temperatures accelerate all of these effects. Reference section 7.2.2 on 0-ring replacement.

8.2.9 Piston seal failure

The seals (10, 14) used on the ILP's pistons are normally good for more than 106 cycles. However, an occasional defect in the material, damage caused during the seal's installation, or inadequate lubrication could cause seal failure, resulting in a pneumatic leak. Due to the special fixturing required to fully disassemble the actuator assembly, factory repair or replacement is recommended.

8.2.10 Stem seal failure

The seals used on the ILP's stem are normally rated for much more than 10^6 cycles. However, an occasional defect in the material, damage caused during the seal's installation, or inadequate lubrication could cause seal failure, resulting in a pneumatic leak. Due to the special fixturing required to fully disassemble 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 seals (2, 3 or 4) 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 section7.2.3 on actuator assembly installation. Failure to do so could result in the valve not closing completely, or leaking in its closed position.

8.2.14 Loose piston

In the unlikely case that either piston, bypass (20) or main (19) should unscrew itself, the valve would no longer be able to open. Due to the special fixturing required to fully disassemble the actuator assembly, factory repair or replacement is recommended.

8.2.15 Inadequate lubrication

Normally the ILP'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. This could increase the friction on the piston and stem and could result to damaged components and failure. Remove the piston lid (24) and apply a film of a high quality lubricant for elastomer/ metal interfaces 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 ILP 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

First, refer to section 4.2 to insure the switch is wired properly. Second, if the switch appears to be wired properly, try adjusting the switch location by loosening the setscrew and sliding it along the groove until you get a visual indication from the integrated LED. Next, if the switch is wired properly, remove it from the groove and check its function with a permanent magnet. If the switch is operating properly with the permanent magnet, the piston magnet (11) may have been omitted or demagnetized by a strong magnetic field or excessive heat. If the switch does not function, it must be replaced, see section 7.4 for the replacement parts list.

8.2.19 Solenoid valve failure

During long or quickly repeated duty cycles, the solenoid valve's coil will normally exceed 70^{o} C. Voltages lower than specified can increase that temperature and accelerate the failure of the coil. 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 of the plunger and cause the valve to leak. Sometimes this problem manifests itself in an oscillation of the plunger, resulting in a 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.

8.2.20 Dynamic bypass seal failure

Due to the special tools and fixturing required to replace this seal, return of the valve to the factory for service is recommended.

9 RETURN TO FACTORY FOR REPAIR OR SERVICES

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

9.2 Call the factory

The HPS® Customer Service Department or any MKS Service Center will prepare a Returned Materials Report (RMR). 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/she 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 RMR number specific to this return.

9.3 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.

9.4 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

HPS® Products of MKS Instruments, Inc. ("HPS®") warrants Integrated 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 it's 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 that has been repaired or replaced. After expiration of the applicable warranty period, the Purchaser shall be charged current prices for parts and labor, plus any transportation for any repairs or replacement.

The obligation of HPS® under this warranty shall be, at its option, to 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:

HPS® Division of MKS Instruments, Inc.
5330 Sterling Drive
Boulder, CO 80301
Voice 303-449-9861 Fax 303-442-6880

10.3 WHAT IS NOT COVERED

The above warranties do not apply to the following:

> Damages or malfunction due to failure to provide reasonable and necessary maintenance in accordance with HPS® operating instructions.
> Damages or malfunctions due to chemical or electrolyte influences, or use of the product in working environments outside the specifications.
> Seals, bellows, and all expendable items which by their nature or limited lifetime 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 THEIR RIGHTS AND REMEDIES

HPS® SHALL NOT BE LIABLE FOR CONSEQUENTIAL DAMGES, FOR ANTICIPATED OR LOST PROFITS, INCIDENTAL DAMAGES, OR LOSS OF TME 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 limitation 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 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.
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