



## **HPS® UHV VALVES**

# **OPERATION AND MAINTENANCE MANUAL**

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# **HPS<sup>®</sup> UHV VALVES**

November 2001  
PART # 100011617

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Part #

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

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

For more information or literature, contact:

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# Table of Contents

## Table of Contents

1. IN THIS MANUAL .....	1
2. DESCRIPTION OF UHV VALVES .....	2
3. SAFETY PROCEDURES AND PRECAUTIONS .....	4
3.1 Modification .....	4
3.2 Maintenance .....	4
3.3 Hazardous Materials .....	4
3.4 Installation .....	4
3.5 Operation .....	4
4. OPERATING PRINCIPLES .....	5
4.1 Pneumatic Version .....	5
4.1.1 Pneumatic Cycling .....	5
4.1.3 Solenoid Operated Pilot Valve Operation .....	7
4.2 Manual Version .....	7
4.2.1 Manual Cycling .....	7
5. SPECIFICATIONS .....	9
5.1 Environment .....	9
5.1.1 Installation Orientation .....	9
5.1.2 Applied Forces .....	9
5.1.3 Temperature Extremes .....	9
5.2 Operation & Performance .....	10
5.2.1 Cycle Rate and Life .....	10
5.2.1.1 Pneumatic Actuation .....	10
5.2.1.2 Manual Actuation .....	11
5.2.2 System Pressure Limits .....	11
5.2.3 Pneumatic Pressure Limits – Pneumatic Actuation Only .....	12
5.2.4 Pneumatic Flow– Pneumatic Actuation Only .....	12
5.2.5 Solenoid Duty Cycle and Power Requirements .....	12
5.3 Physical Parameters .....	13
5.3.1 Dimensions –NW25 Pneumatic Actuation .....	13
5.3.2 Dimensions –NW40 Manual Actuation .....	14
5.3.3 Dimensions – NW40 Pneumatic Actuation .....	15
5.3.4 Weight .....	16

<b>6. INSTALLATION INFORMATION .....</b>	<b>17</b>
6.1 Pneumatic Supply– Pneumatic Actuation Only .....	17
6.2 Electrical Connections– Pneumatic Actuation Only .....	17
6.3 Clean Installation .....	17
6.4 Flange Care .....	17
<b>7. SERVICE .....</b>	<b>19</b>
7.1 Removal from System.....	19
7.1.1 Pneumatic Version .....	19
7.1.2 Manual Version .....	19
7.2 Actuator Assembly – Pneumatic Version .....	20
7.2.1 Actuator Assembly Removal and Disassembly .....	20
7.2.2 O-Ring Replacement .....	20
7.2.3 Actuator Assembly Installation .....	21
7.3 Actuator Assembly – Manual Version .....	22
7.3.1 Actuator Assembly Removal and Disassembly .....	22
7.3.2 O-Ring Replacement .....	22
7.3.3 Actuator Assembly Installation .....	23
7.4 Solenoid Pilot Valve Service – Pneumatic Actuation Only .....	23
<b>8. TROUBLE SHOOTING .....</b>	<b>26</b>
8.1 Problems and Diagnosis Pneumatic Actuation .....	26
8.1.1 Won't close completely .....	26
8.1.2 Won't open completely .....	26
8.1.3 Opens slowly or jumps .....	26
8.1.4 Won't open at all .....	27
8.1.5 Squeaks when opening and/or closing .....	27
8.1.6 Leaks across closed nosepiece seal .....	27
8.1.7 Leaks from atmosphere when closed .....	27
8.1.8 Leaks from atmosphere when open .....	27
8.1.9 Leaks from atmosphere at all times .....	28
8.1.10 Air leaks from around piston when open .....	28
8.1.11 Air leaks from vent hole while opening .....	28
8.1.12 Air leaks from vent hole when open .....	28
8.1.13 Solenoid valve buzzes or doesn't work.....	28
8.2 Problems and Diagnosis Manual Actuation .....	28
8.2.1 Won't close completely .....	28
8.2.2 Won't open completely .....	29
8.2.3 Difficult to open/close or Squeaks .....	29
8.2.4 Leaks across closed nosepiece seal .....	29
8.2.5 Leaks from atmosphere when closed .....	29
8.2.6 Leaks from atmosphere when open .....	29
8.2.7 Leaks from atmosphere at all times .....	29
8.3 Causes and Remedies .....	30
8.3.1 Spring failure – Pneumatic Actuation Only .....	30
8.3.2 Body damage .....	30
8.3.3 Port flange damage .....	30
8.3.4 Particulates, condensation, and corrosion .....	30

---

8.3.5 Bellows failure .....	30
8.3.6 Nosepiece seal failure .....	30
8.3.7 Bonnet seal failure .....	31
8.3.8 Piston seal failure – Pneumatic Actuation Only .....	31
8.3.9 Stem seal failure – Pneumatic Actuation Only .....	31
8.3.10 Bonnet seal omission .....	31
8.3.11 Nosepiece seal omission .....	31
8.3.12 Improper assembly .....	32
8.3.13 Loose piston hold down screw – Pneumatic Actuation Only .....	32
8.3.14 Inadequate lubrication .....	32
<b>Pneumatic Actuation .....</b>	<b>32</b>
<b>Manual Actuation .....</b>	<b>32</b>
8.3.15 Inadequate air pressure – Pneumatic Actuation Only ...	32
8.3.16 Inadequate air flow – Pneumatic Actuation Only .....	32
8.3.17 Solenoid valve failure – Pneumatic Actuation Only .....	33
8.3.18 Stem Weld Failure .....	33
 9. RETURN TO FACTORY FOR REPAIR OR SERVICE ....	 34
9.1 Call the factory .....	34
9.2 Prepare for shipment .....	34
 10. WARRANTY .....	 35
10.1 COVERAGE .....	35
10.2 WARRANTY PERFORMANCE .....	35
10.3 WHAT IS NOT COVERED .....	35
10.4 OTHER RIGHTS AND REMEDIES .....	36



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# 1. IN THIS MANUAL

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

## 2. DESCRIPTION OF UHV VALVES

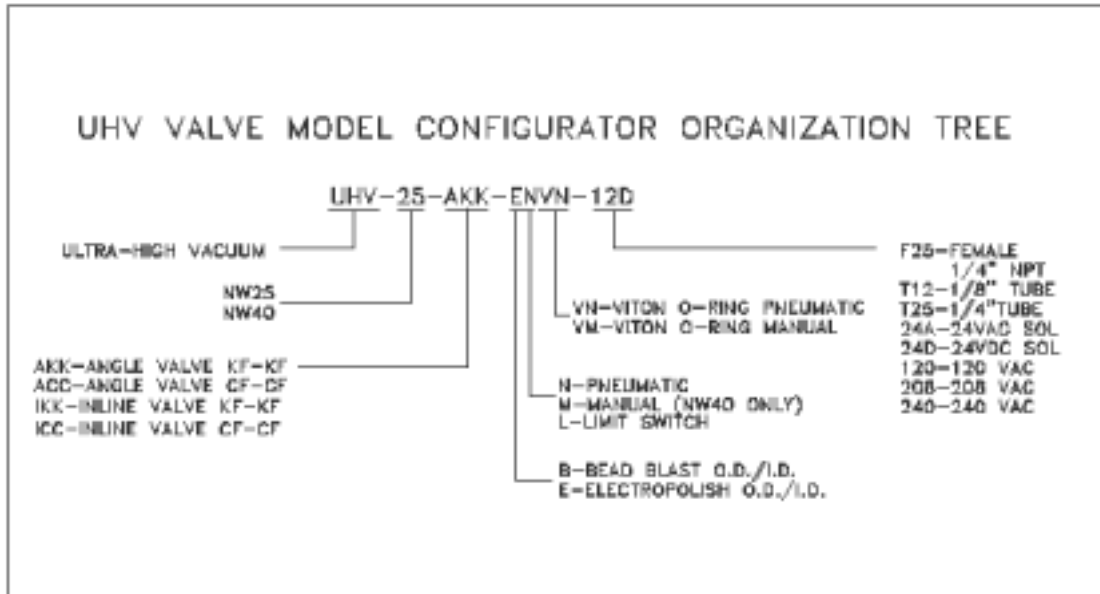


Figure 1 - The options available for the UHV Series

The HPS® Products UHV family of bellows sealed poppet valves are compact in size, lightweight, and are designed for an extended lifetime. These valves are available in both manual and pneumatic operation.

Internal actuation in the pneumatic version of the UHV valve is controlled by a pneumatic cylinder attached directly to the top of the valve. The valve is opened when pneumatic pressure is supplied to the inlet 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.

Internal actuation in the manual version of the UHV valve is controlled by a knob located on the top of the valve. The valve opens when the knob is turned counter clockwise, and the valve closes when the knob is turned clockwise to the bottomed out position.

The bodies of both the pneumatic and manual versions of the valve are available in angle and offset in-line configurations with a variety of

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flanging. Custom body configurations and flange combinations are available upon request.

The UHV valve utilizes a copper or viton bonnet seal and an elastomer o-ring nosepiece seal, while a metal bellows is used to seal the moving poppet. O-rings are available in a variety of compounds.

A solenoid operated pneumatic pilot valve is available for the pneumatic version. This pilot valve allows electrical control of the UHV valve and is connected directly to the facility pneumatic supply. Solenoid valves are available in a variety of voltages.

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## **3. SAFETY PROCEDURES AND PRECAUTIONS**

### **3.1 Modification**

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

### **3.2 Maintenance**

Install only HPS® Products 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. Pneumatic 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 Version

#### 4.1.1 Pneumatic Cycling

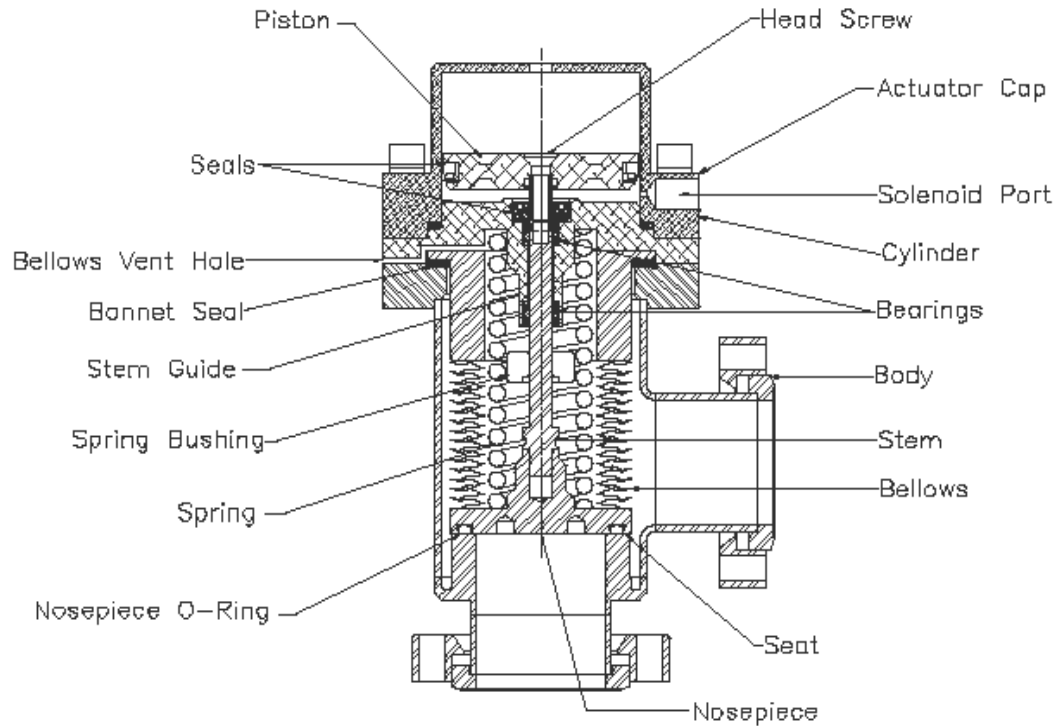


Figure 2 - The components of the pneumatic valve

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.

When the pneumatic pressure in the cylinder reaches a value sufficient to overcome the force of the spring, the piston starts to rise, pulling the nosepiece off of the seat. The stem is attached to the piston with a flat head screw. Air is vented through a hole milled in the bottom of the stem guide to allow air from within the bellows 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 in a trapezoidal groove, which, when squeezed between the nosepiece and the seat, creates the seal at the valve orifice. The bellows forms a flexible hermetic seal between the nosepiece and the fixed elements of the body.

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, 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.

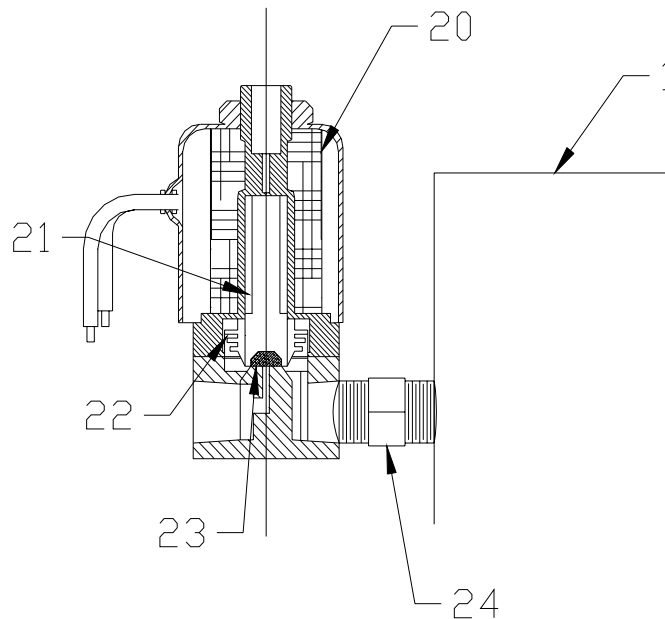


Figure 3 – Solenoid Pilot Valve

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### 4.1.3 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 actuator cylinder, see Figure 2, enables remote electrical control of the valve when direct pneumatic control is inconvenient. In its de-energized state, this 3-way valve vents the cylinder of the UHV through a threaded hole centered in the top of the solenoid coil (20). A nipple (24) connects the 1/8" female NPT outlet port on the solenoid valve to the cylinder of the UHV. 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 valve is quickly pressurized and the valve 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 of the valve quickly escapes through grooves on the outside of the plunger and out the vent port, allowing the valve to close.

Users may supply their own solenoid operated pilot valve. A solenoid valve rated for  $> 10^6$  cycles continuous duty and a conductance  $> .05$  in<sup>3</sup>/min is recommended. The lengths and diameters of pneumatic feed lines must also be considered for peak performance.

## 4.2 Manual Version

### 4.2.1 Manual Cycling

Figure 4 illustrates the components of the manual valve. From the closed position, the valve opens by twisting the manual knob counterclockwise, raising the manual screw in the manual stem guide thus lifting the nosepiece off of the seat. The stem is attached to the manual screw with a pan head screw. Air escapes (and enters) the valve internals through a vent hole in the side of the stem guide. At the lower end, the stem is welded to the nosepiece. The nosepiece carries an o-ring seal in a trapezoidal groove, which, when squeezed between the nosepiece and the seat, creates the seal at the valve orifice. The bellows forms a flexible hermetic seal between the nosepiece and the fixed elements of the body. The open position stop occurs when the top of the nosepiece and the bottom of the cylinder are in contact.

To close the valve, simply turn the manual knob all the way in the clockwise direction. The valve is not closed until the nosepiece and seal are in contact with the seat and full seal pressure is applied.

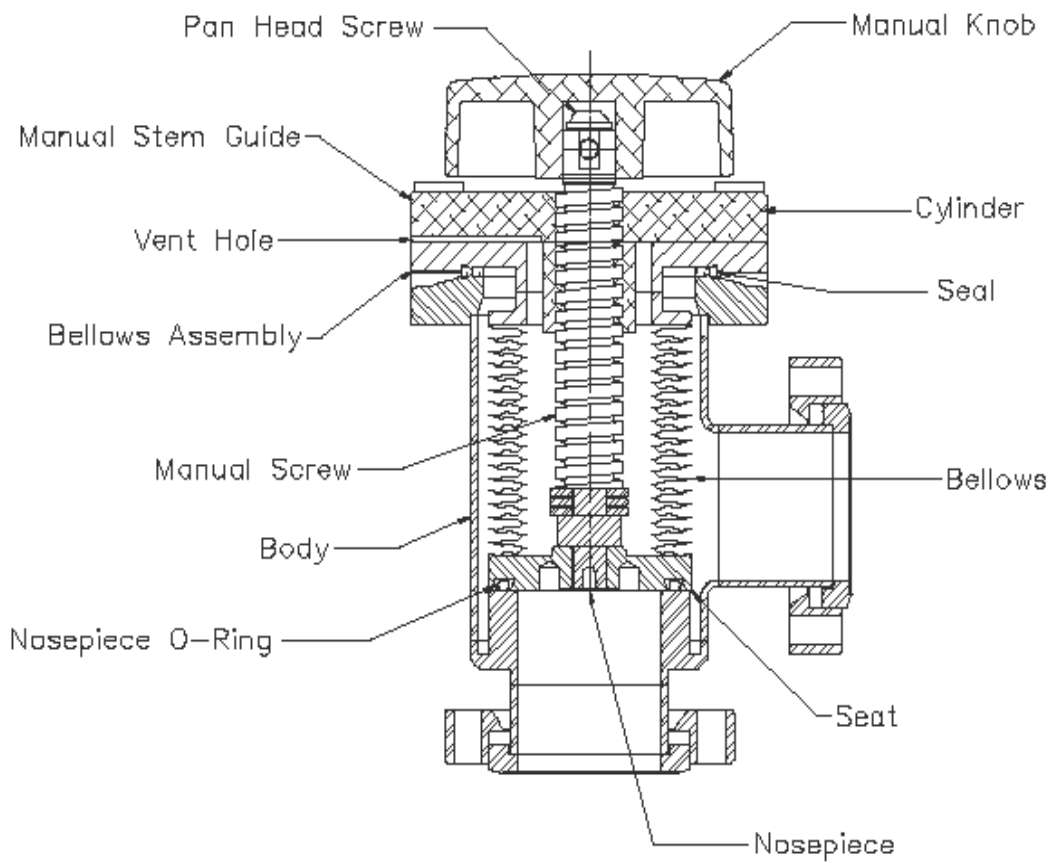


Figure 4 – The components of the manual valve

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## 5. SPECIFICATIONS

### 5.1 Environment

#### 5.1.1 Installation Orientation

Ultra High Vacuum 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 UHV body is roughly equivalent to an elbow of similar size. Care must be taken to protect the body of the UHV from excessive stress resulting from torque 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 UHV valve series is rated for service from -20° C to 93° C (standard manual version, pneumatic version without the optional solenoid operated pilot valve). In the pneumatic version, addition of the optional solenoid pilot valve increases the lower limit to 0° C.

The UHV valve's most vulnerable components to temperature extremes are the organic compounds used in the seals, bearings, and lubrication. In the pneumatic version, the pressurized cavity of the pneumatic cylinder is sealed by a pair of Parker PolyPak<sup>1</sup> Seals (see Seals in Figure 2). These standard temperature range seals are rated for service from -51° C to 93° C<sup>2</sup>.

The Viton nosepiece elastomer has the following recommended operating temperature range<sup>3</sup>:

Viton<sup>4</sup> -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

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<sup>1</sup> PolyPak is the registered trademark of the Parker Hannifin Corp.

<sup>2</sup> PolyPak Seal Design Handbook, 2, (1989)

<sup>3</sup> Parker O-Ring Handbook, A3-4/A3-6, (1991)

<sup>4</sup> Viton is the registered trademark of...

<sup>5</sup> Rulon is the registered trademark of Dixon, Division of Furon

<sup>6</sup> Guide to Dixon Bearings, D4

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transfer of heat from/to the valve's pneumatic actuator assembly to/from the body and the nosepiece of the valve is relatively inefficient, the nosepiece o-ring 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.

The Rulon LR<sup>5</sup> PTFE bearings supporting the stem are rated for service between -240° C and 287° C<sup>6</sup>.

Lubricating greases used on the stem, piston seal, and manual screw increase their viscosity at low temperatures. This increase in viscosity 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, stem and manual screw lubricants, should be performed on valves run for extended periods at or near the high temperature limit.

The wire or cable connected to the 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 UHV valves are rated for operation between 0° C and 104° C.

## **5.2 Operation & Performance**

### **5.2.1 Cycle Rate and Life**

#### **5.2.1.1 Pneumatic Actuation**

The opening and closing times are the limiting factors of the maximum cycle rate. 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	40 msec	90 msec
NW40	60 msec	90 msec

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

### 5.2.1.2 Manual Actuation

The opening and closing times are the limiting factors of the maximum cycle rate. Opening and closing times are dependent upon the operator and will vary dependent upon the application. Under normal conditions, Manual UHV valves will greatly exceed 100,000 cycles before failure.

### 5.2.2 System Pressure Limits

UHV 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 lower 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 the UHV Series valves are Helium mass spectrometer tested with the maximum allowable leak rate being  $1 \times 10^{-9}$  std Atm cc/ sec. Although the UHV valves may be a factor in the base pressure of a system, there is, in fact, no low system pressure limiting the valves' function.

High pressure, however, can cause failure in the pneumatic version. With the valve open, the opening force exerted on the nosepiece by excessive internal pressures will exceed the spring's 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 51 psia ( $3.0 \times 10^5$  Nt/m<sup>2</sup> abs)**

**NW40 38 psia ( $4.1 \times 10^5$  Nt/m<sup>2</sup> abs)**

Higher pressures could cause bonnet seal extrusion, collapse of the bellows, failure of the bonnet seal compression thread on the cylinder, or rupture of the valve body.

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### 5.2.3 Pneumatic Pressure Limits – Pneumatic Actuation Only

The dynamic seals (see Figure 2) used in the UHV valves 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 to overcome the spring's closing force and open the valve. As the nosepiece moves away from the seat, the spring is compressed further requiring more force. A minimum pneumatic pressure of 60 psig is required for proper valve function.

### 5.2.4 Pneumatic Flow– Pneumatic Actuation Only

Insufficient pneumatic flow due to inadequate line diameter can result in temporary downstream decreases in pressure. 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:

<b>NW25</b>	<b>3.7 in<sup>3</sup></b>	<b>(61 cm<sup>3</sup>)</b>
<b>NW40</b>	<b>5.9 in<sup>3</sup></b>	<b>(97 cm<sup>3</sup>)</b>

### 5.2.5 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

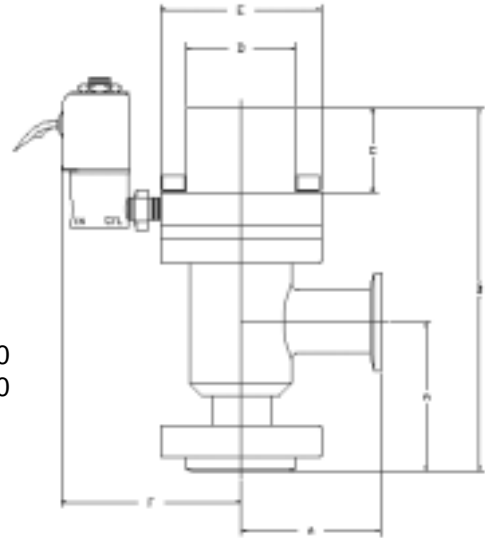
### 5.3.1 Dimensions –NW25 Pneumatic Actuation

#### **Pneumatic Angle Body**

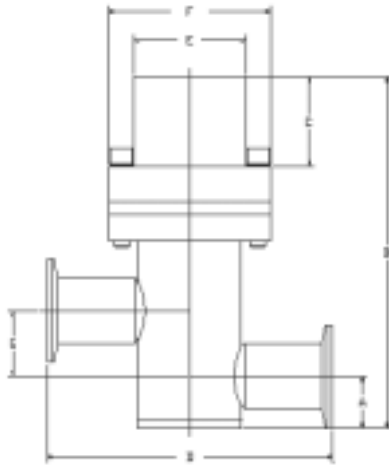
Figure 5 dimensions:

	A	B	C	D	E	F
UHV-25-AKK	2.40	5.87	1.36	1.90	2.75	4.50
UHV-25-ACC	2.40	5.87	1.36	1.90	2.75	4.50

All values are in inches



**Figure 5 – NW25 Pneumatic Angle Body**



**Figure 6 – NW25 Pneumatic Inline Body**

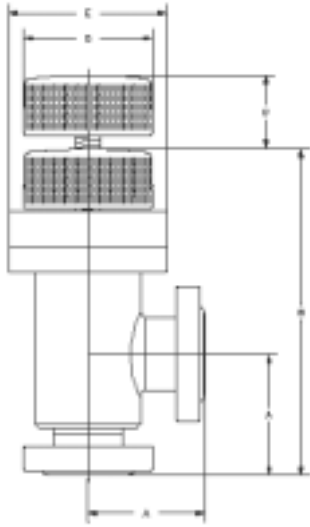
#### **Pneumatic Inline Body**

Figure 6 dimensions:

	A	B	C	D	E	F	G
UHV-25-IKK	0.81	6.04	1.36	4.84	1.90	2.75	1.00
UHV-25-ICC	0.81	6.04	1.36	4.90	1.90	2.75	1.00

All values are in inches

### 5.3.2 Dimensions –NW40 Manual Actuation



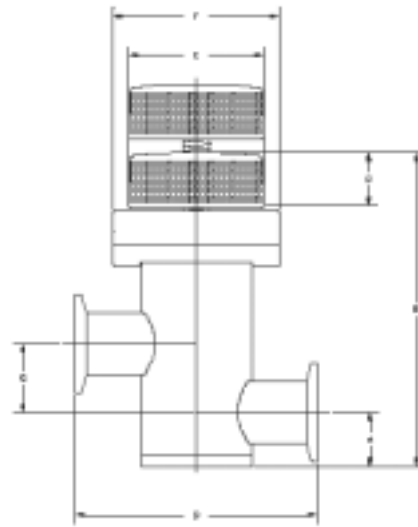
**Figure 7 – NW40 Manual Angle Dimensions**

**Manual Angle Body**

Figure 7 dimensions:

	A	B	C	D	E
UHV-40-AKK	2.50	6.72	1.61	2.75	3.38
UHV-40-ACC	2.50	6.72	1.61	2.75	3.38

All values are in inches.



**Figure 8 – NW40 Manual Inline Valve Dimensions**

**Manual Inline Body**

Figure 8 dimensions:

	A	B	C	D	E	F	G
UHV-40-IKK	1.18	6.97	1.03	4.91	2.75	3.38	1.50
UHV-40-ICC	1.18	6.97	1.03	4.91	2.75	3.38	1.50

All values are in inches.

### 5.3.3 Dimensions – NW40 Pneumatic Actuation

**Pneumatic Angle Body**  
Figure 9 dimensions:

	A	B	C	D	E	F
UHV-40-AKK	2.50	6.89	1.18	2.33	3.38	5.18
UHV-40-ACC	2.50	6.89	1.18	2.33	3.38	5.18

All values are in inches.

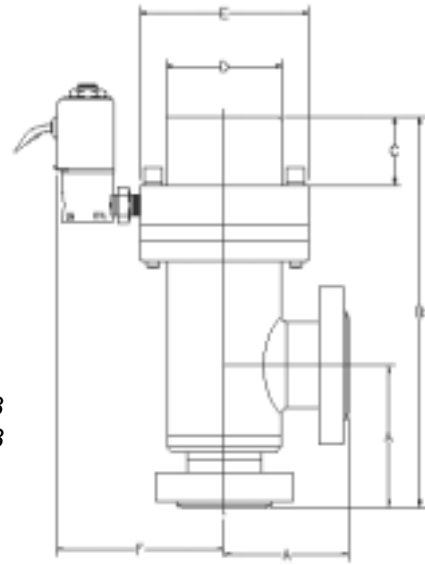


Figure 9 – NW40 Pneumatic Angle Body

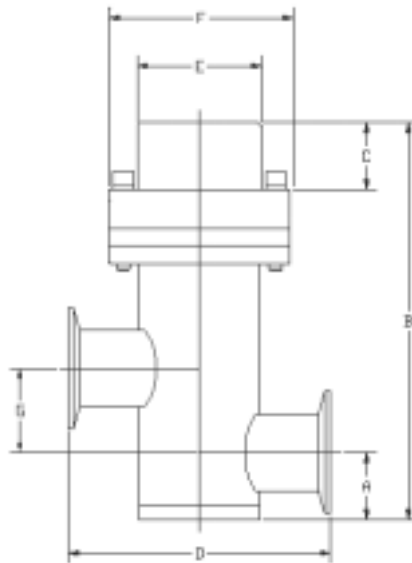


Figure 10- NW40 Pneumatic Inline Body

**Pneumatic Inline Body**  
Figure 10 dimensions:

	A	B	C	D	E	F	G
UHV-40-IKK	1.18	7.29	1.18	4.91	2.33	3.38	1.50
UHV-40-ICC	1.18	7.29	1.18	4.91	2.33	3.38	1.50

All values are in inches.

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### 5.3.4 Weight

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

NW40 Manual UHV valve	2.8 lb
NW25 Pneumatic UHV valve	3.0 lb
NW40 Pneumatic UHV valve	4.8 lb
Solenoid pilot valve	0.46 lb

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## 6. INSTALLATION INFORMATION

### 6.1 Pneumatic Supply– Pneumatic Actuation Only

Facility pneumatic supplies often contain contamination including rust, metal particles, oil, and water. A simple in-line filter in series with the supply for each valve or the supply for an entire system may remove particle contamination.

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 (see Figure 2) sliding surface has been lubricated, making possible the use of "dry" pneumatic supplies without harm to the UHV 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– Pneumatic Actuation Only

Electrical connections within the valve assembly must sometimes be made if the valve is equipped with the optional solenoid pilot valve, also see Section 5.2.5 on solenoid requirements.

### 6.3 Clean Installation

Valves are shipped with plastic covers over the ports. These covers should be left in place until the valve is installed. All UHV 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 particles on the nosepiece seal, the seat (see Figures 2 and 4), 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)

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flanges, scratches or dents in the knife edge may prevent the flange from sealing. Since the flanges are integrated 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.

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## 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.

#### 7.1.1 Pneumatic Version

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.

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.

#### 7.1.2 Manual Version

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.

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## 7.2 Actuator Assembly – Pneumatic Version

### 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 7.1.1 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 NW40 valve by eight bolts and is attached to the NW25 valve by 6 bolts. To remove the actuator assembly, simply loosen and remove these bolts. After the bolts are removed, carefully 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 copper gasket in the bonnet 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. Use extreme caution while removing these seals.

The actuator assembly contains a powerful spring under some compression at all times. Special fixturing is required for further, safe disassembly of the actuator. Such repairs should be handled by the HPS® Products repair facility. It is recommended that either the seals are replaced as a set, or if needed, the entire internal assembly (eg. malfunctioning actuators, section 8).

### 7.2.2 O-Ring Replacement

The bonnet copper gasket may be removed easily without special fixture. Remove the bonnet gasket carefully, ensuring that it clears the bellows and drops off the actuator assembly. If the gasket sticks to one of the knife edge faces, carefully pry it off by inserting a small screwdriver in the vent groove and under the gasket. Care must be taken not to damage the knife edge.

Removal of the nosepiece o-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 gloved fingers. Then pull the seal from the remainder of the groove.

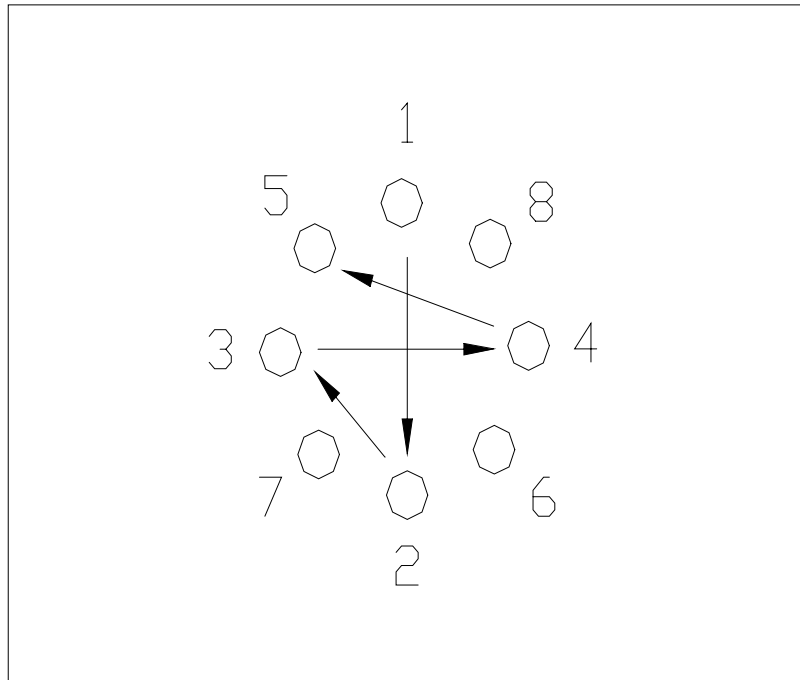
Be sure that no dust or other contamination is in the groove or on the o-ring. To install the o-ring, nest the o-ring on the opening of the groove. With the thumbs at points 180° apart, firmly press the o-ring into the groove. Move 90° and press again. Move 45° and press again.

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.

### 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 copper gasket is in place on the body flange.*

*Before bolting the actuator to the valve body, make sure the pneumatic port is located in the desired orientation. Insert the bolts and tighten the*



#### Bolt Tightening Sequence

#### Max Torque

<b>NW25</b>	<b>26 ft-lbs</b>	<b>(35 N-m)</b>
<b>NW40</b>	<b>16ft-lbs</b>	<b>(22N-m)</b>

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

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*actuator to the valve body. The actuator assembly is completely installed when the attached bolts are tightened to compress the gasket. To ensure a tight seal the bolts should be tightened in an alternating diametrical star pattern (tighten one at the top, one at the bottom, one on the left, etc.).*

It is highly recommended to check the assembly for leaks using a high quality Helium mass spectrometer leak detector. The vent grooves in the body flange and between the stem guide and actuator cap (see Figure 2) are used for leak detection. With the interior of the valve evacuated and attached to the Helium mass spectrometer, insert the tracer gas probe into these grooves. The bellows are accessed through the groove between the stem guide and the actuator cap. The bellows bonnet gasket is accessed through the 2 grooves between the body flange and the stem guide. The nosepiece seal and port flange seals may be tested through a variety of methods and will not be detailed here.

## **7.3 Actuator Assembly – Manual Version**

### **7.3.1 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 7.1.2 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 NW40 valve by eight bolts and by 6 bolts in the NW25 valve. To remove the actuator assembly, simply loosen and remove the bolts. After the bolts are removed, pull the actuator assembly out of the valve body. The bellows is fabricated of .006" thick stainless steel. While withdrawing the actuator assembly, exercise care to avoid damaging the bellows. If the bonnet copper gasket has adhered to the sealing surface in the body, carefully remove it by slipping a pointed tool, like a small screwdriver, under it into the vent groove and prying it off. The tool should be made of a material softer than stainless steel to avoid scratching the sealing surface.

Replacement of malfunctioning actuators with new assemblies is recommended (see parts list in section 8 for details).

### **7.3.2 O-Ring Replacement**

Removal of the nosepiece o-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.

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Be sure that no dust or other contamination is in the groove or on the o-ring. To install the o-ring, 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.

### **7.3.3 Actuator Assembly Installation**

Before installing the actuator assembly, turn the manual knob counter clockwise so that the assembly is not in the bottomed out position. Insert the actuator assembly into the valve body. As with removal, take care to avoid damaging the bellows. Be sure that the bonnet gasket is in place. Insert the bolts and tighten the actuator to the valve body. Also, see section 7.2.3 for the max torque values and torque sequence.

The actuator assembly is completely installed when the knife edges deform the copper gasket.

It is highly recommended to check the assembly for leaks using a high quality Helium mass spectrometer leak detector. The vent grooves in the body flange and between the stem guide and actuator cap (see Figure 1) are used for leak detection. With the interior of the valve evacuated and attached to the He mass spectrometer, insert the tracer gas probe into these grooves. The bellows are accessed through the groove between the stem guide and the actuator cap. The bellows bonnet gasket is accessed through the 2 grooves between the body flange and the stem guide. The nosepiece seal and port flange seals may be tested through a variety of methods and will not be detailed here.

## **7.4 Solenoid Pilot Valve Service – Pneumatic Actuation Only**

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 connected to the actuator cylinder by a 1/8" NPT nipple and the threads are sealed with a jointing compound or Teflon<sup>7</sup> 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.

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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.

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## 7.5 Replacement Parts List

### NW25 UHV Valves

Pneumatic Internals <sup>*</sup> .....	Part # 100002652
Pneumatic Seal Set <sup>†</sup> .....	Part # 100010361

### NW40 UHV Valves

Manual Internals <sup>*</sup> .....	Part # 100009979
Pneumatic Internals <sup>*</sup> .....	Part # 100009978
Manual Seal Set <sup>†</sup> .....	Part # 100010363
Pneumatic Seal Set <sup>†</sup> .....	Part # 100010362

### Replacement Solenoid Valves

24 VAC 50/60 Hz .....	Part # 100008164
12 VDC .....	Part # 100008539
24 VDC .....	Part # 100008163
120VAC 50/60 Hz .....	Part # 100008165
208VAC 50/60 Hz .....	Part # 100008166
220VAC 50/60 Hz .....	Part # 100008167

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

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<sup>†</sup> Teflon is a registered trademark of E.I. DuPont de Nemours Co.  
<sup>\*</sup> Includes Actuator Cap and Viton seals

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## 8. TROUBLE SHOOTING

### 8.1 Problems and Diagnosis Pneumatic Actuation

#### 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. 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 8.3.1 on spring failure. Otherwise refer to section 8.3.12 covering improper assembly.

#### 8.1.2 Won't open completely

Failure to open completely can be detected by observation through the hole in the center of the piston cover. Also, a significant decrease in the valve's conductance may be an indication.

First, see section 8.3.15 on inadequate air pressure. If the pneumatic pressure is within recommended limits and compressed air is leaking (possibly heard) through the hole in the piston cover, but is not coming out of the vent in the side if the valve between the stem guide and the actuator cap, see section 8.3.8 on piston seal leakage. If the air is spraying through the groove between the stem guide and the actuator cap (see Figure 2) when the valve is static, see section 8.3.9 on stem seal leakage. Last, if there are no other symptoms other than incomplete opening, see section 8.3.13 on loose piston hold down screws.

#### 8.1.3 Opens slowly or jumps

Slow opening can 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 8.3.15 on inadequate air pressure. If pneumatic pressure is within recommended limits, refer to section 8.3.16 covering

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\* Each seal set includes a copper seal for the bonnet, a viton nosepiece seal, and fomblin grease.

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inadequate airflow. Lastly, see section 8.3.14 on inadequate or exhausted lubrication.

#### **8.1.4 Won't open at all**

Zero conductance through the valve is a good indication 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 8.3.15 on inadequate air pressure. If pneumatic pressure is within recommended limits, refer to section 8.3.19 on stem weld failure. Last, if air is blasting from the vent between the stem guide and the actuator cap when the valve is trying to open, see section 8.3.13 on loose piston hold down screws.

#### **8.1.5 Squeaks when opening and/or closing**

UHV 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 8.3.1 on spring failure. Also check section 8.3.14 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 8.3.11 on nosepiece seal omission. If the o-ring is present, particles, contamination, and corrosion may be the problem, see section 8.3.4. If the valve continues to leak after the seat and sealing area have been cleaned, see section 8.3.7 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 8.3.12 on improper assembly. If the assembly is correct, refer to section 8.3.7 on bonnet seal failure. Lastly, see section 8.3.2 on body damage.

#### **8.1.8 Leaks from atmosphere when open**

If leakage is detected from atmosphere when the valve is open, see section 8.3.5 on bellows failure.

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### **8.1.9 Leaks from atmosphere at all times**

If leakage is detected from atmosphere at all times, see section 8.3.5 on bellows failure. If the bellows has not failed, refer to section 8.3.7 on bonnet seal failure. Also see sections 8.3.10 on bonnet seal omission, 8.3.12 on improper assembly, 8.3.2 on body damage, and 8.3.3 on port flange damage.

### **8.1.10 Air leaks from around piston when open**

If compressed air can be heard or possibly felt escaping from the hole in the center of the piston cover, but is not emanating from the groove between the stem guide and the actuator cap, see section 8.3.8 on piston seal failure.

### **8.1.11 Air leaks from vent hole while opening**

The small groove between the black anodized stem guide and the black actuator cap, 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 groove *while opening*.

### **8.1.12 Air leaks from vent hole when open**

If compressed air can be felt escaping from the vent groove between the stem guide and the actuator cap, see section 8.3.9 on stem seal failure.

### **8.1.13 Solenoid valve buzzes or doesn't work**

If air is not passing through the solenoid pilot valve or is buzzing during activation, see section 8.3.18 on solenoid valve failure.

## **8.2 Problems and Diagnosis Manual Actuation**

### **8.2.1 Won't close completely**

High magnitude leakage across the nosepiece seal when the valve is supposedly closed is evidence for failure to close completely. In valves that have visual access to one or both of the ports, a gap between the nosepiece and the seat might be observed (see Figure 4).

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 8.3.12 covering improper assembly.

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### **8.2.2 Won't open completely**

Failure to open completely can be detected directly by the manual screw not reaching full extension. A significant decrease in the valve's conductance may also be an indication.

*See section 8.3.12 covering improper assembly.*

### **8.2.3 Difficult to open/close or Squeaks**

UHV valves normally make a barely audible squeak when they open. An increase in squeaking and opening difficulty usually indicates inadequate lubrication on the manual screw.

First, see section 8.3.14 on inadequate lubrication. If the manual screw is properly lubricated, see section 8.3.12 on improper assembly.

### **8.2.4 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 8.2.1 if the valve also isn't closing completely.

Refer to section 8.3.11 on nosepiece seal omission. If the o-ring is present, particles, contamination, and corrosion may be the problem, see section 8.3.4. If the valve continues to leak after the seat and sealing area have been cleaned, see section 8.3.7 on bonnet seal failure.

### **8.2.5 Leaks from atmosphere when closed**

If leakage is detected from atmosphere when the valve is closed, see section 8.3.12 on improper assembly. If the assembly is correct, refer to section 8.3.7 on bonnet seal failure. Lastly, see section 8.3.2 on body damage.

### **8.2.6 Leaks from atmosphere when open**

If leakage is detected from atmosphere when the valve is open, see section 8.3.5 on bellows failure.

### **8.2.7 Leaks from atmosphere at all times**

If leakage is detected from atmosphere at all times, see section 8.3.5 on bellows failure. If the bellows has not failed, refer to section 8.3.7 on bonnet seal failure. Also see sections 8.3.10 on bonnet seal omission, 8.3.12 on improper assembly, 8.3.2 on body damage, and 8.3.3 on port flange damage.

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## 8.3 Causes and Remedies

### 8.3.1 Spring failure – Pneumatic Actuation Only

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

### 8.3.2 Body damage

All UHV 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.

### 8.3.3 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 an application of high quality vacuum grease, such as Apiezon<sup>8</sup>, to the seal. Except for CF flanges, larger defects might be repaired by rubbing out the scratch or dent with a light abrasive, such as Scotch Brite<sup>9</sup>. 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. CF flanges with larger defects should be replaced or repaired by a factory trained technician.

### 8.3.4 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.

### 8.3.5 Bellows failure

Although the mean time between failures for the UHV bellows is greater than  $10^6$  cycles, nearly all valve failures are the result of bellows failures. The only remedy is to replace the actuator assembly.

### 8.3.6 Nosepiece seal failure

Elastomer seals that have remained in a compressed condition for long

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<sup>8</sup> Apiezon is the registered trademark of GEC Alstom, Ltd.

<sup>9</sup> Scotch Brite is a registered trademark of 3M

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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. Various process gasses and/or high temperatures accelerate all of these effects. Reference section 7.2.2 on o-ring replacement.

### **8.3.7 Bonnet seal failure**

In the event of a bonnet seal failure, first retighten the bolts around the actuator cap in a criss-cross pattern. Tighten until the max torque is achieved, 26 ft-lbs for the NW25 and 16ft-lbs for the NW40, or until metal to metal contact is established. If this is unsuccessful, refer to section 7.2.2 on gasket replacement.

### **8.3.8 Piston seal failure – Pneumatic Actuation Only**

The seals used on the pneumatic pistons 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 fixture required to fully disassembly the actuator assembly, factory repair or replacement is recommended.

### **8.3.9 Stem seal failure – Pneumatic Actuation Only**

The seals used on pneumatic stems 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 fixture required to fully disassembly the actuator assembly, factory repair or replacement is recommended.

### **8.3.10 Bonnet seal omission**

After service, during assembly, omission of the bonnet seal will cause the valve to leak from atmosphere at all times. Remove the actuator assembly and install the seal. See section 7.2.2.

### **8.3.11 Nosepiece seal omission**

After service, during assembly, 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. See section 7.2.2.

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### **8.3.12 Improper assembly**

After service, the bolts must be torqued properly and in the correct sequence, reference section 7.2.3 on pneumatic actuator assembly installation or 7.3.3 on manual actuator assembly installation. Failure to do so could result in the valve not closing completely, or leaking in its closed position.

### **8.3.13 Loose piston hold down screw – Pneumatic Actuation Only**

Due to the special fixture required to fully disassembly the actuator assembly, factory repair or replacement is recommended.

### **8.3.14 Inadequate lubrication**

#### **Pneumatic Actuation**

Normally the UHV'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<sup>10</sup>, to the inside of the cylinder. Cycle the valve several times and reapply the grease.

#### **Manual Actuation**

Normally the UHV'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 manual screw, but could result to damaged components and failure. Actuate the manual knob to the fully open position and apply a film of a high quality lubricant for metal/metal interfaces, such as Dow Corning 1122 grease, to the base of the manual screw. Cycle the valve several times to distribute grease and reapply if necessary.

### **8.3.15 Inadequate air pressure – Pneumatic Actuation Only**

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

### **8.3.16 Inadequate air flow – Pneumatic Actuation Only**

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

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<sup>10</sup> Fomblin is a registered trademark of Montefluos, Ausimont Group, Montedison Specialty Chemicals

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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.

#### **8.3.17 Solenoid valve failure – Pneumatic Actuation Only**

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 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 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.

#### **8.3.18 Stem Weld Failure**

Such a failure may only be repaired at the factory due to the special fixture required for complete disassembly of the actuator assembly.

Before shipping your Ultra High Vacuum valve to the factory, please observe the following procedure:

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## 9. RETURN TO FACTORY FOR REPAIR OR SERVICE

### 9.1 Call the factory

The HPS® Customer Service Department or any MKS Service Center will prepare a Returned Material Report (RMR). Consequently, when the item is received, disposition will occur 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, phone number and e-mail address?
- > 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.

### 9.2 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.

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## 10. WARRANTY

### 10.1 COVERAGE

The Vacuum Products Group of MKS Instruments, Inc. (“HPS® Products”) warrants Ultra High Vacuum Series valves to be free from defects in materials and workmanship for a period of ONE YEAR from the date of shipment by HPS® Products or its authorized representative to the original purchaser (“Purchaser”). Any product or parts of the product repaired or replaced by HPS® Products under this warranty are warranted only for the remaining 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® Products’ current prices for parts and labor, plus any transportation for any repairs or replacement.

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

### 10.2 WARRANTY PERFORMANCE

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

Vacuum Products Group, 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 malfunctions due to failure to provide reasonable and necessary maintenance in accordance with HPS® operating instructions.

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> 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® Products, 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**

MKS Instruments Inc. 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 MKS Instruments Inc.. Any statements made by any persons including representatives of MKS Instruments Inc., which are inconsistent or in conflict with the terms of the warranty shall not be binding on MKS Instruments Inc. unless reduced to writing and approved by an authorized officer of MKS Instruments Inc..

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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