V DUAL SEAL PLUNGER

SERIES OF METERING PUMPS

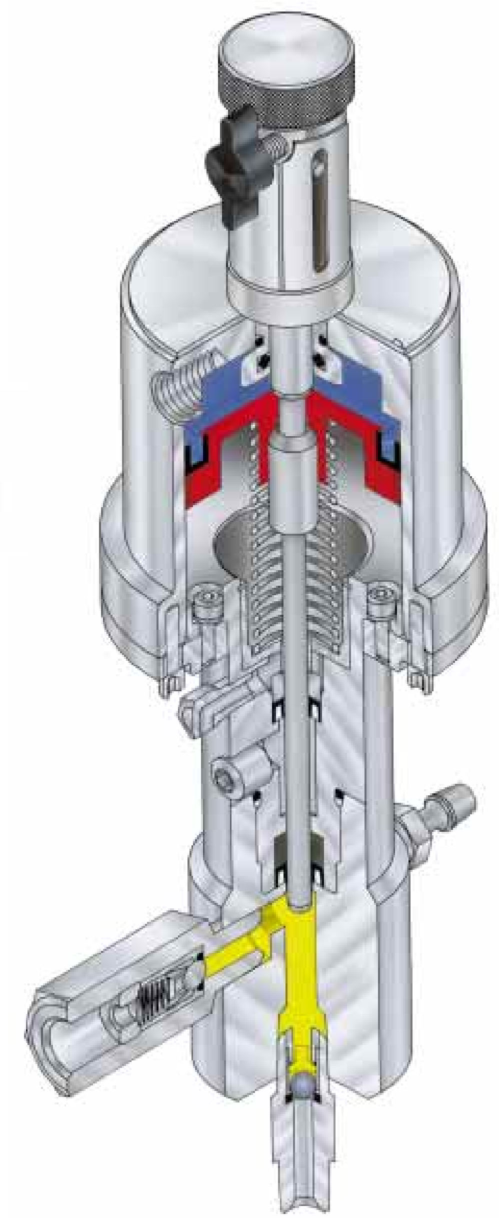
INSTALLATION, OPERATION, AND MAINTENANCE MANUAL

WILLIAMS INSTRUMENT INCORPORATED

MILTON ROY

V DUAL SEAL PLUNGER

SERIES OF METERING PUMPS



PART NUMBER DESIGNATION

CR P1000V800 A PE

Control Method

C: Controller
CR: Controller - Relay
S: Solenoid Valve
SR: Solenoid Valve - Relay

Basic Model[2]

P125V125	**P500V225**	**P750V400**[1]
P250V225	**P500V300**	**P1000V400**[1]
P250V300	**P500V400**[1]	**P1000V600**[1]
		P1000V800[1]

Plunger Material

A: 17-4 ph
B: 316 SS
CR: Ceramic

Seal Material

PE: Polyethylene (UHMW)
TC: Teflon® Composite
TG: Teflon® Graphite
V: Viton®
BR: Buna N
K: Kalrez®
EPR: Ethylene Propylene

NOTE: [1] The 400, 600 and 800 motor cylinders are only available with the CR (controller-relay) or SR (solenoid-relay) control methods.

TABLE OF CONTENTS

SECTION 1.0: FUNCTIONAL DESCRIPTION

1.1 PHYSICAL DESCRIPTION

The letters **CP** at the beginning of a pump assembly model number mean that the model consists of a controller (C) and pump (P) **For example:** CP125V125, CP250V225, CP250V300, CP500V225, and CP500V300. The letters **CRP** mean that the model also has a relay (R). **For example:** CRP500V400, CRP750V400, CRP1000V400, CRP1000V600, and CRP1000V800.

Some pumps use different relay sizes:

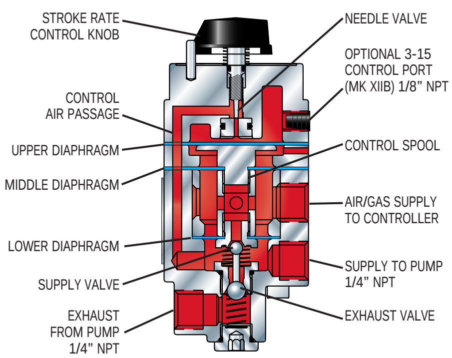
- CRP500V400, CRP750V400, CRP1000V400, and CRP1000V600 pumps use the PO3-6S relay.
- CRP1000V800 pump uses the PO4-6S relay.

1.1.1 Controller

The controller, consisting of an upper and lower chamber separated by a sliding spool, uses a capillary tube with a needle valve to transfer the supply air/gas from the lower to the upper chamber. While the controllers differ in their seals, MK XII using diaphragm seals and MK X, using U-cup seals, their operation is essentially the same. When the sliding spool is in its highest position, a pilot plug closes a vent

Control Methods For The Pump

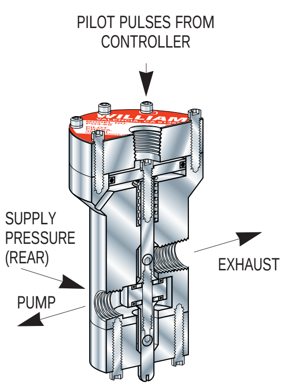
1. Oscillamatic® Controller



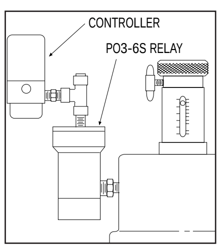
The MK XIIA Controller operates on the same operating principal as the MK X Controller. The MK XIIA has the same upper and lower chambers, but are separated with flexible diaphragms rather than sliding seals. A capillary tube, controlled by a needle valve, transfers the air/gas supply to the pump from the lower to the upper chamber.

When the spool is in the highest position, a pilot plug closes a vent and opens the supply air/gas to the pump. When the spool is in its lowest position, the pilot plug prevents the supply air/gas from entering the pump, and opens the air/gas vent to let it exhaust the pump. The spool then returns to its highest position to repeat the process.

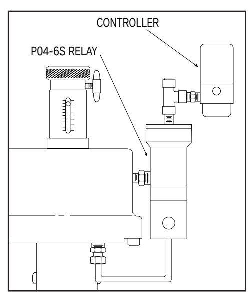
2. Controller-Pneumatic Relay Combination



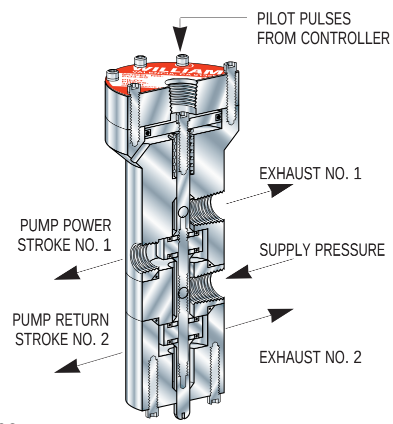
SINGLE ACTING P03-6S



PUMP INSTALLATION
CRP500V400,CRP750V400 CRP1000V400 CRP1000V600



PUMP INSTALLATION
CRP1000V800

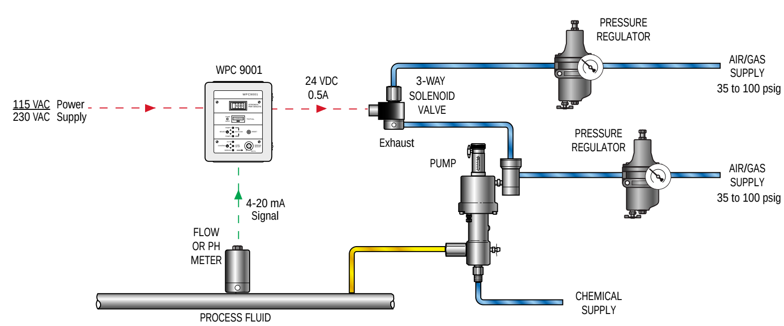


DOUBLE ACTING P04-6S

The PNEUMATIC RELAY is a pilot operated valve designed to provide the higher air or gas flow rates necessary for PNEUMATIC DRIVE CYLINDER diameters greater than 3 inches. The PNEUMATIC RELAY is actuated by the pulses produced by the CONTROLLER. A single acting PNEUMATIC RELAY is used with pumps that have return springs as illustrated to the left. The air or gas pressure is required to return the PISTON-PLUNGER ASSEMBLY on the CRP1000V800. Therefore a double acting PNEUMATIC RELAY is required, illustrated to the right.

3. Solenoid Valves

The pumps can be automated by replacing the CONTROLLER with a 3-way electro-pneumatic SOLENOID VALVE. The SOLENOID VALVE can be cycled in order to achieve the desired pump output. Flow tracking can be accomplished by having a FLOWMETER or PH METER signal interpreted by our WPC9001 or a PLC. The typical arrangement for a WPC-9001 installation is shown at right.



and moves the supply air/gas to the pump or relay. In the spools lowest position, the reverse is true; the pilot plug prevents supply air/gas from entering pump or relay, and opens the vent to let it exhaust. The spool then returns to its highest position and repeats the cycle.

1.1.2 Relays

A relay is a pilot operated servo valve. Air/gas pressure from a controller forces a piston and one or more attached poppet valves to move. Then, when the controller removes the pressure, a spring forces both the piston and poppet valve(s) in the reverse direction.

Relay models differ in operation. The PO3-6S relay has one poppet valve that connects the supply air/gas to the pump and blocks the exhaust when the controller applies air/gas pressure to the relay piston. When the controller removes pressure from the piston, the poppet valve stops the supply air/gas and connects the pump to the exhaust.

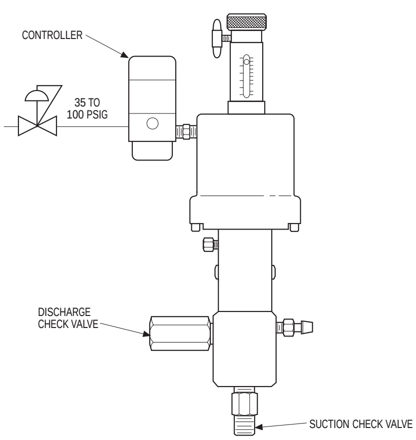
The PO4-6S relay, used on pumps that do not have a motor return spring, drives the air piston both up and down with the air/gas pressure. This relay has two poppet valves. The upper valve operates in the same way as the PO3-6S relay valves, while the lower valve operates in the opposite order. That is, when the upper valve applies air/gas pressure to the pump, the lower valve exhausts it, and when the upper valve exhausts the air/gas, the lower valve applies pressure to the opposite side of the piston.

1.1.3 Pumps

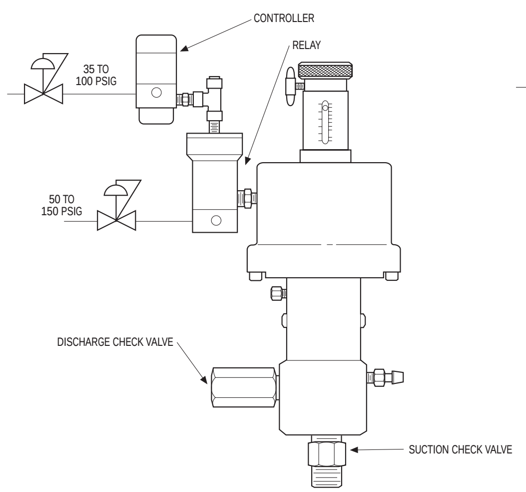
The pneumatic V Series metering plunger pump consists of a body, fluid chamber, and a motor cylinder or air chamber, separated by a piston/plunger assembly and seals. In the fluid chamber, the inlet (suction) and discharge (outlet) ports have check valves that control the direction of the fluid flow. In the motor cylinder, the air/gas supplied from the controller or relay enters and exhausts through a pipe nipple that connects the controller or relay to the motor cylinder.

At the time the controller or relay exhausts the air/gas, if the pump has a motor return spring, fluid pressure in the fluid chamber and the motor return spring force the piston plunger upwards. If the pump has no motor return spring, supply pressure from a relay enters beneath the piston to help force the piston/plunger assembly upwards. In either case, the plunger assembly stops when the piston contacts the end of the stroke adjuster.

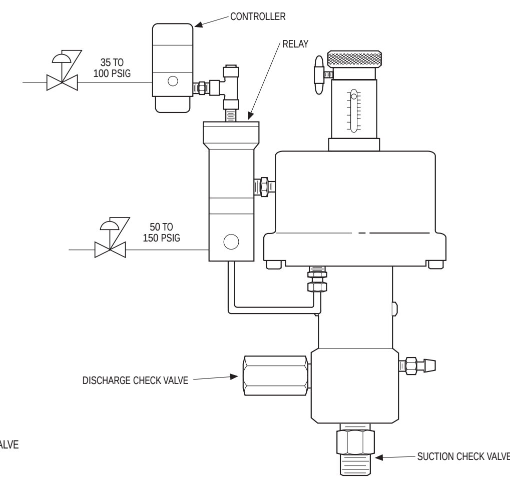
The piston face area where the air/gas pressure is applied is much greater than the plunger face area, which works against the pressure of the process fluid. This area ratio, called the **amplification ratio**, allows the pump to work against process fluid pressures much greater than the air/gas supply pressure.
Note: process pressure + 200psi / required air supply = amplification ratio



TYPICAL CP125V, CP250V, CP500V (WITH 125, 225 & 300 CYLINDERS)



TYPICAL CRP500V400, CRP750V400, CRP1000V400 & 600 (WITH PO3-6S RELAY)



TYPICAL CRP1000V800 (WITH PO4-6S RELAY)

1.2 CAPABILITIES

1.2.1 Controllers and Relays

Controllers and relays will require separate supply sources, and fortunately will operate with air or any gas, such as carbon dioxide, nitrogen or natural gas.

WARNING: TO PREVENT INJURY, MAKE SURE THAT ANY FLAMMABLE GAS SUCH AS NATURAL GAS IS PROPERLY VENTED FOR SAFETY.

CAUTION: If the gas could possibly damage the standard elastomeric material, please contact your distributor or Williams Instrument Incorporated for advice.

To increase the process fluid flow rate, two or more pumps can be multiplexed: their inlets and outlets connected in parallel.

1.2.1.1 Controller Supply Pressure

Controllers will operate with the following supply pressures:

	Maximum		Minimum	
	psi	bar	psi	bar
MK XII	100	6.9	35	2.4
MK X	100	6.9	35	2.4

To establish the proper air/gas supply pressure for the controller or relay, add 200 psig or 13.8 barg to the process pressure the pump is working against. Then use the performance graphs located in section 1.2.2.2.

Remember for a controller-relay combination the controller supply pressure need only be set at the minimum pressure of 35 psig or 2.4 barg. The relay supply would be established in the above procedure or refer to section 1.2.1.2.

CAUTION: To prevent damage to the controller, always use a regulator between the supply and the controller when the air/gas supply pressure is more than the maximum rating of your controller.

1.2.1.2 Relay Supply Pressure

Relays, which require a separate air supply, operate with supply pressures between 35 psig (2.41 bar) and 150 psig (10.3 bar). The supply pressure must be 35 psig minimum or equal to or greater than the process pressure plus 200 psi, divided by the pump amplification ratio. (EXAMPLE: CRP1000V400 @ 1000 PSI + 200 PSI divided by 15.38 = 78 air supply required. Refer to section 1.1.3 for the amplification ratio formula) When using a controller/relay combination, hold the air/gas supply pressure to the controller to the minimum value of 35 psig, and the relay at 35 psig minimum.

CAUTION: To prevent damage to the relay, always use a regulator between the supply and the relay when the supply pressure is more than 150 psig (10.3 bar).

1.2.2 Pumps

1.2.2.1 Flow Pressure Performance Table:*

MODEL @ AIR/GAS SUPPLY PRESSURE	MAX VOLUME GPH/LPH	VOLUME PER STROKE CC	STROKE LENGTH INCH	STROKES PER MINUTE (RANGE)	MAX DISCHARGE PRESSURE PSIG / BARG	MAX AIR CONSUMPTION 100 PSIG SCF PER DAY	6.9 BAR SCM PER DAY	150 PSIG SCF PER DAY	10.3 BAR SCM PER DAY
CP125V125 @ 100 PSI/6.9 BAR	.07 / .27	.1	.5	1-45	8650 / 596.4	180	5		
CP250V225 @ 100 PSI/6.9 BAR	.57 / 2.16	.8	1	1-45	7200 / 496.4	1150	32		
CP250V300 @ 100 PSI/6.9 BAR	.57 / 2.16	.8	1	1-45	13,100 / 903.2	2100	59		
CP500V225 @ 100 PSI/6.9 BAR	2.26 / 8.55	3.2	1	1-45	1750 / 120.7	1150	32		
CP500V300 @ 100 PSI/6.9 BAR	2.26 / 8.55	3.2	1	1-45	3250 / 224.1	2100	59		
CRP500V400 @ 100 PSI/6.9 BAR @ 150 PSI/10.3 BAR	2.26 / 8.55 2.26 / 8.55	3.2 3.2	1 1	1-45 1-45	6300 / 434.4 9200 / 634.3	3584	101	5250	149
CRP750V400 @ 100 PSI/6.9 BAR @ 150 PSI/10.3 BAR	5.00 / 18.9 5.00 / 18.9	7.0 7.0	1 1	1-45 1-45	2600 / 178.3 4000 / 275.8	3584	101	5250	149
CRP1000V400 @ 100 PSI/6.9 BAR @ 150 PSI/10.3 BAR	9.08 / 34.37 9.08 / 34.37	12.7 12.7	1 1	1-45 1-45	1520 / 104.8 2300 / 158.6	3584	101	5250	149
CRP1000V600 @ 100 PSI/6.9 BAR @ 150 PSI/10.3 BAR	9.04 / 34.22 7.00 / 26.50	12.6 9.8	1 1	1-45 1-35	3400 / 234.4 4700 / 324.0	7190	203	10210	289
CRP1000V800 @ 100 PSI/6.9 BAR @ 150 PSI/10.3 BAR	8.81 / 33.35 6.82 / 25.81	12.3 9.5	1 1	1-45 1-35	6300 / 434.4 9100 / 627.4	12342	349	18150	514

***This data should only be used to provide you with an initial size selection. You must refer to the actual performance graphs in order to verify your pump selection.**

1.2.2.2 Using The Graphs*

Use the following Performance Flow Curves* in order to:

1) Determine the flow capability of the pump you have selected. If you have sized the pump too close to the upper or lower stroke rate limit, you may wish to change to a different pump size. Of course you can also change your flow for a given stroke rate by adjusting the stroke length. Example:

These Settings Will Produce The Same Pump Flow Rate	
STROKE RATE	STROKE LENGTH
10 20 40	1" (100%) 1/2" (50%) 1/4" (25%)

2) Determine the air pressure necessary to provide the desired pump discharge pressure.

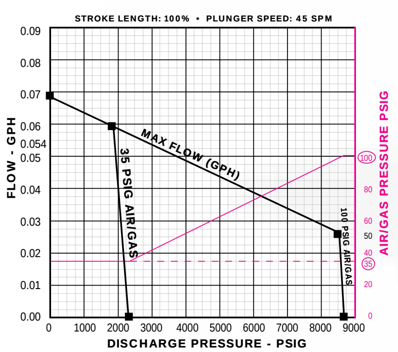
A) The flow curves show the maximum flow/pressure limit of the pumps. The upper near horizontal line represents the maximum flow capability (45 SPM @ 100% stroke). The near vertical lines represent the maximum discharge pressure at the corresponding air/gas pressure. The area under the curve represents the entire flow/pressure range for the pumps.

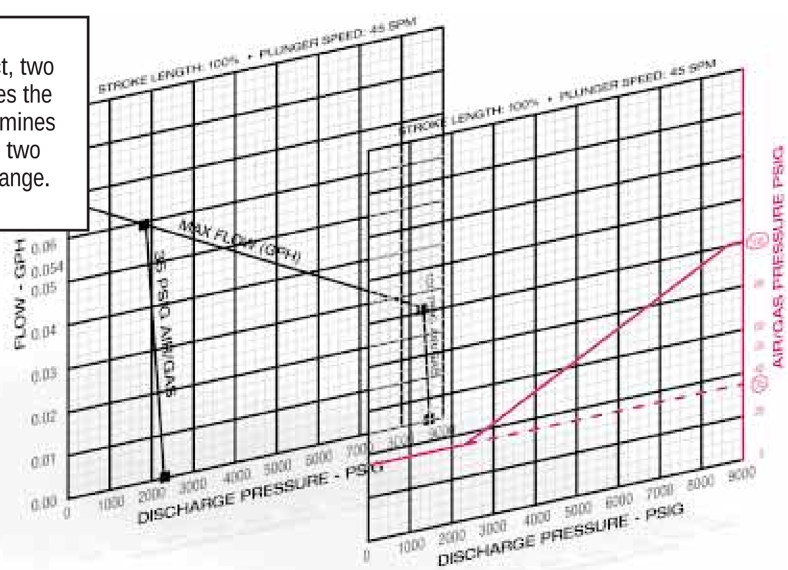
B) THE GRAY CURVE defines the relationship between air/gas supply pressure and discharge pressure. For each discharge pressure there is a minimum air/gas supply pressure required. **Always add 200 PSI to your discharge pressure in order to ensure positive injection.** Find the discharge pressure on the horizontal axis and follow it up to the red curve. At that point, read your air/gas pressure requirements on the right axis in PSIG. The minimum air/gas supply pressure will produce discharge pressures found to the left of the 35 PSIG limit line.

The required air/gas supply pressure can be read off the graph by first adding 200 psi to the discharge pressure. Then locate the psi on the discharge pressure axis and follow it up until it intersects the red line. Follow this point to the air/gas supply pressure axis on the right and you will find the appropriate air/gas pressure necessary to operate the pump.

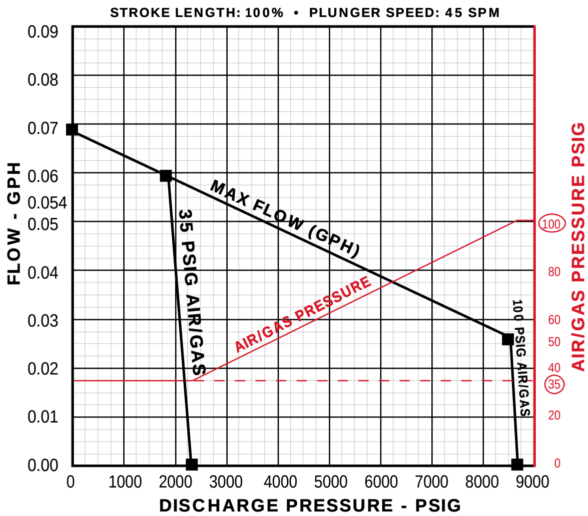
Reading The Graphs

The performance curve graph illustrated here is, in fact, two graphs overlayed upon each other. The first, determines the air/gas pressure, illustrated in gray. The second, determines your discharge pressure, shown in black. Where these two overlayed graphs intersect define your optimum flow range.



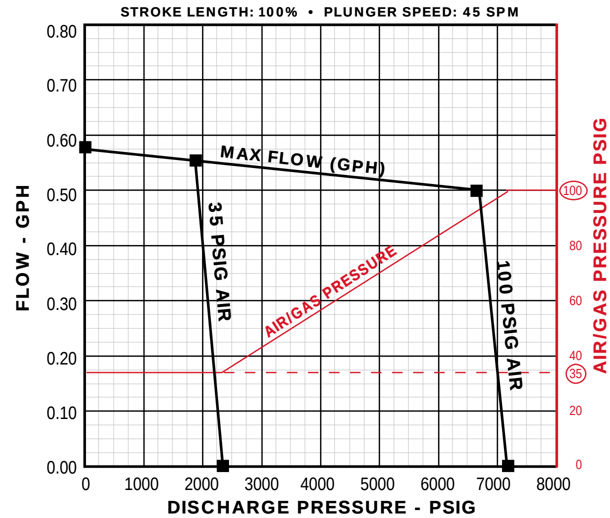


Performance Flow Curves



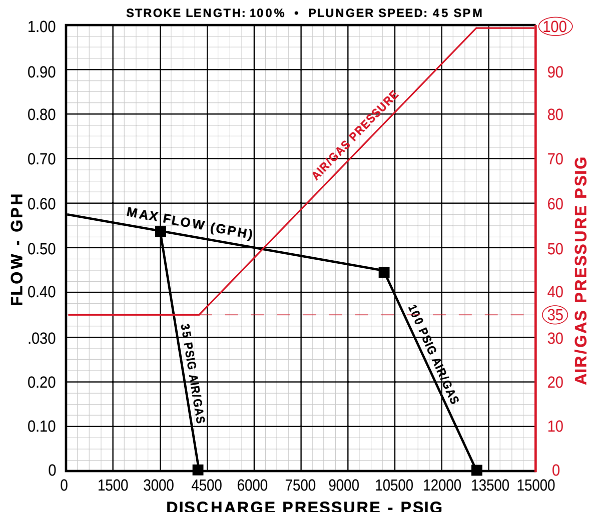
CP125V125

Discharge Pressure PSI	0	500	1000	1900	5000	8500
Gph	.069	.066	.063	.059	.043	.025
Air Pressure PSI	35	35	35	35	62	98



CP250V225

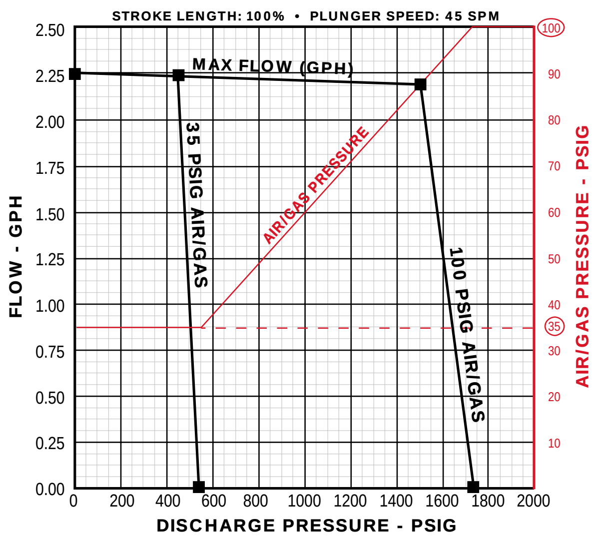
Discharge Pressure PSI	0	500	1000	1900	5000	6600
gph	.57	.565	.557	.552	.520	.502
Air Pressure PSI	35	35	35	35	70	90



CP250V300

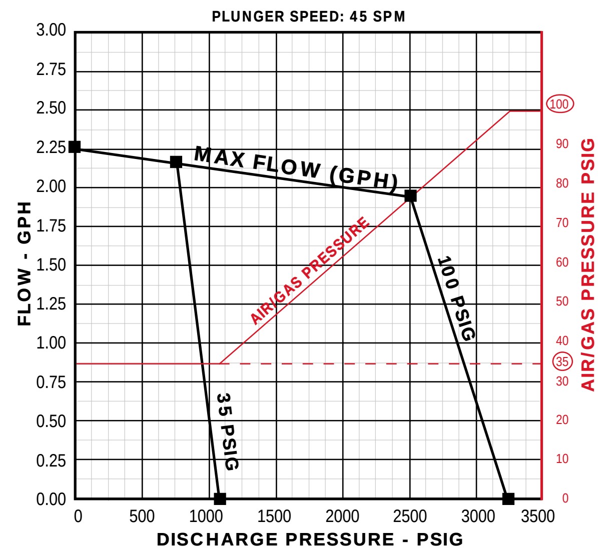
Discharge Pressure PSI	0	1000	3000	6000	10000	11000
gph	.522	.502	.462	.402	.321	.301
Air Pressure PSI	35	35	35	47	77	85

Performance Flow Curves (cont.)



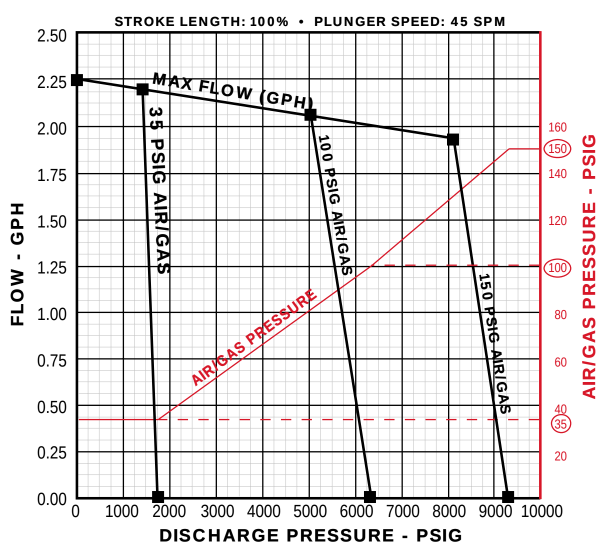
CP500V225

Discharge Pressure PSI	0	200	450	1000	1400	1500
gph	2.26	2.26	2.26	2.23	2.21	2.21
Air Pressure PSI	35	35	35	60	82	88



CP500V300

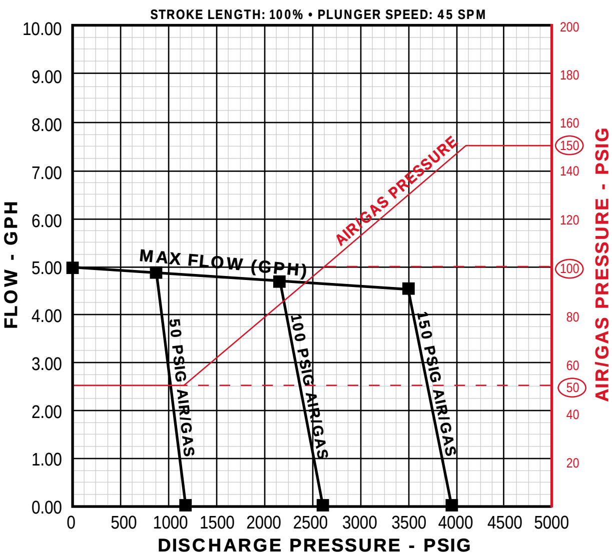
Discharge Pressure PSI	0	500	800	1500	2000	2500
gph	2.26	2.20	2.16	2.08	2.2	1.96
Air Pressure PSI	35	35	35	48	62	77



CRP500V400

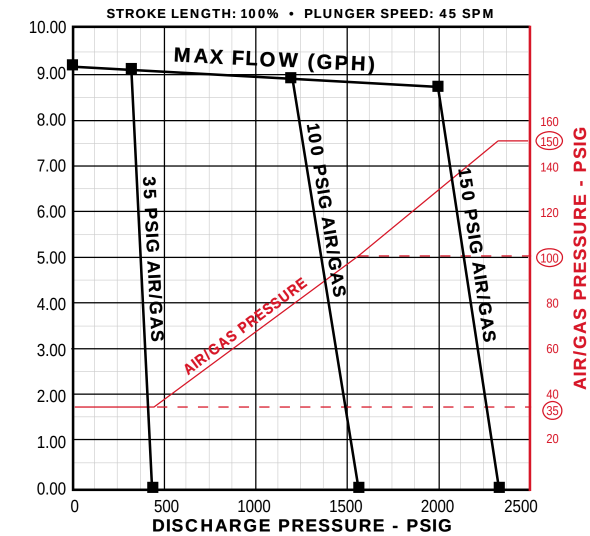
Discharge Pressure PSI	0	1500	3000	5000	7000	8100
Gph	2.26	2.20	2.15	2.07	1.99	1.96
Air Pressure PSI	35	35	52	80	110	130

Performance Flow Curves (cont.)



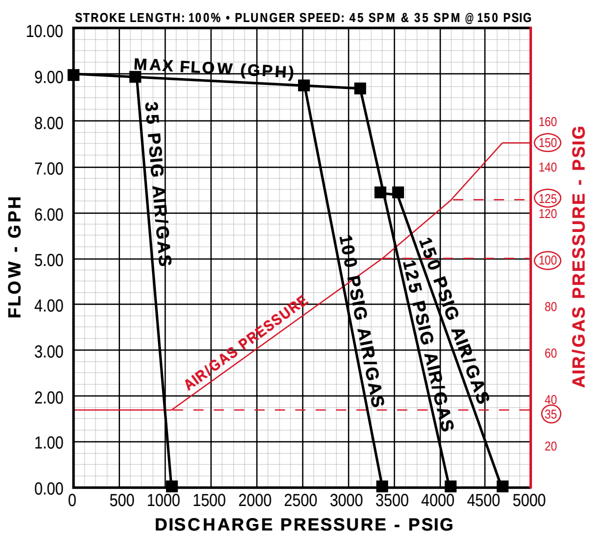
CRP750V400

Discharge Pressure PSI	0	500	1500	2000	3000	3500
gph	5.00	4.90	4.80	4.70	4.60	4.50
Air Pressure PSI	35	35	60	80	115	130



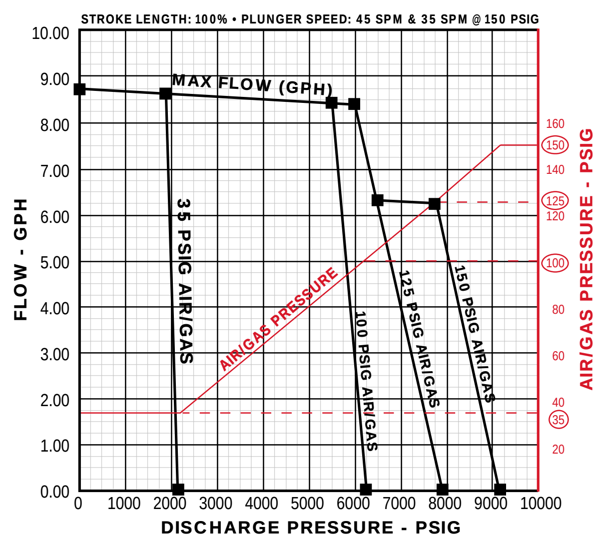
CRP1000V400

Discharge Pressure PSI	0	315	1000	1200	1750	2000
gph	9.12	9.12	8.99	8.89	8.88	8.85
Air Pressure PSI	35	35	66	78	112	130



CRP1000V600

Discharge Pressure PSI	0	600	2000	2500	4000	4500
Gph	9.05	9.00	8.84	8.79	1	1
Air Pressure PSI	35	35	60	75	120	140



CRP1000V800

Discharge Pressure PSI	0	1000	1950	5500	7300	8500
gph	8.86	8.79	8.72	8.46	6.25	3
Air Pressure PSI	35	35	35	88	120	140

1.2.2.3 Plunger & Seal Material

1.2.2.3.1 Plunger Material Selection

The materials available vary in hardness and chemical compatibility. We offer three materials based on our many years of industry experience with various chemicals. Hardness is a key property when selecting the proper plunger material. Our experience has shown that the harder plunger materials not only provide longer plunger life, they also provide greater seal life. A hard plunger is a must when pumping a chemical that is prone to crystallization or if the chemical is contaminated. Of course both of the preceding conditions will affect seal life. Below is a table that compares the chemical compatibility and hardness properties of each material.

DESIGNATION	MATERIAL	HARDNESS	CHEMICAL COMPATIBILITY
CR	Ceramic	Between Sapphire and Diamond on the Mohs' Scale	Excellent Chemical Inertness in all Acids, Bases, Solvents
A	17-4 ph	40 Rc	General Corrosion-resistant Stainless Steel Limited Acid Resistance
B	316 SS	28 Rc	Excellent Corrosion-resistant Stainless Steel Limited Acid Resistance

We recommend the use of ceramic because of its extreme hardness and excellent chemical inertness.

1.2.2.3.2 Seal Material Selection

The seal material must be chosen to satisfy both the chemical compatibility and the pressures/temperatures at which you are operating Below is a general guideline for seal material selection.

MATERIAL	SEAL TYPE	TEMP RANGE	SUGGESTED PRESSURE RANGE	COMMENTS
TG Teflon® Graphite	Mechanical (Spring Loaded)	-30 to 180°F -34 to 82°C	1000 to 10,000 psi 207 to 690 bar (High Pressure)	Tough material with excellent wear resistance. Excellent chemical inertness. Good for all types of chemicals, acids, bases or solvents. Recommended for use with the harder ceramic plunger and higher pressures.
TC Teflon® Composite	Mechanical (Spring Loaded)	-30 to 180°F -34 to 82°C	100 to 5000 psi 6.9 to 207 bar (Low Pressure)	Tough material with excellent wear resistance. Excellent chemical inertness. Good for all types of chemicals, acids, bases or solvents.
PE UHMW Polyethylene	Mechanical (Spring Loaded)	-30 to 180°F -34 to 82°C	100 to 3000 psi 6.9 to 207 bar	Tough material with excellent wear resistance. Good for water and alcohol based chemicals. Not recommended for solvents.
V Viton®	O-ring	-10 to 200°F -23 to 93°C	100 to 750 psi 6.9 to 52 bar	Soft material with fair wear resistance. Broad chemical compatibility but its not to be used with ethyl or methyl alcohols. Suggested only for hard to seal fluids in low pressure applications when PE or TC will not seal.
BR Buna N	O-ring	-40 to 200°F -40 to 93°C	100 to 750 psi 6.9 to 52 bar	Soft material with fair wear resistance. Limited chemical compatibility. Used mainly in Methanol pumping at low pressure.
K Kalrez®	O-ring	32 to 200°F 0 to 93°C	100 to 750 psi 6.9 to 52 bar	Soft material with fair wear resistance. Excellent chemical compatibility. Used when Viton® is not compatible and PE or TC will not seal.
EPR Ethylene Propylene	O-ring	-40 to 200°F -40 to 93°C	100 to 750 psi 6.9 to 52 bar	Material has very good abrasion resistance. Excellent chemical resistance to phosphate esters, good to excellent to mild acids, alkalis, silicone oils and greases, ketones and alcohols. Not recommended for petroleum oils or di-esters.

Selecting the proper seal material for your application is important. We suggest using the harder plastic seals (PE, TC or TG) whenever possible because they provide excellent wear life. The elastomers (V, BR, K or EPR) offer enhanced sealing at low pressure because they are soft and more compliant than the plastics. However, the elastomers do not provide the same toughness or wear resistance.

1.3 GENERAL OPERATING SEQUENCE

1.3.1 Controller

1.3.1.1 MK XII Controller

The spool spring forces the spool upward to its highest position and unseats the top of the pilot plug from the upper seat. The exhaust spring forces the pilot plug upward and seats it on the lower seat. This blocks the air/gas exhaust port.

When high pressure air/gas enters the supply port, it passes around and through the spool and past the open upper seat to the motor cylinder port.

High pressure air/gas passes through the control passage in the controller, past the valve stem, and into the valve body upper chamber which causes pressure to build up in the chamber. Because the surface area of the upper U-cup diaphragm is much larger than that of the middle U-cup diaphragm, the downward force on the spool is greater than the upward force. This pressure pushes the spool down until the pilot plug seats itself on the upper valve seat, shutting off the air/gas supply. As the spool continues to move down, it pushes the pilot plug until the plug is unseated from the lower valve seat and allows the air/gas to exhaust through the lower valve from both the motor cylinder and the valve body volume chamber.

When the pressure in the chamber is low enough, the spool spring starts pushing the spool upward. The exhaust spring pushes the pilot plug upward, and the controller returns to its initial position.

1.3.1.2 MK X Controller

When the spool moves to the full upward position, supply air/gas enters the motor cylinder. A spool spring forces the spool upward to its highest position and as it moves, it unseats the top of the pilot plug from the spool seat. At the same time, an exhaust spring moves the pilot plug also upward until it seats on the lower seat, blocking the air/gas exhaust port.

Then when high pressure air/gas enters the supply port, it passes around and through the spool, past the now-open spool seat, to the motor cylinder port. Air in the motor cylinder port also passes slowly through a capillary tube, past the needle valve stem, and into the upper valve body volume chamber, causing pressure to build in this chamber.

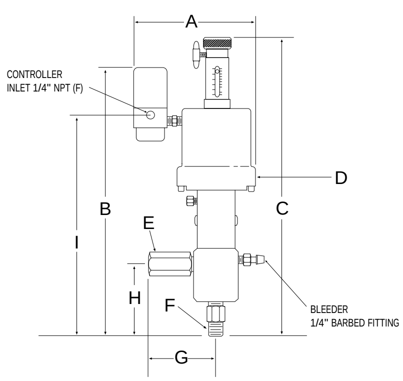
Because the surface area of the upper U-cup is much larger than the surface area of the middle U-cup, a downward force is exerted on the spool. This force pushes the spool down until the pilot plug seats itself on the spool seat, shutting off the air/gas supply. As the spool continues to move down, it continues to push the pilot plug until it unseats itself from the lower valve seat. This action vents the air/gas through the lower valve seat from both the motor cylinder and the valve body volume chamber.
As the pressure in the motor cylinder and valve body volume chamber reduces, the spool spring starts pushing the spool upward, the exhaust spring pushes the pilot plug upward, and the controller returns to its initial up position.

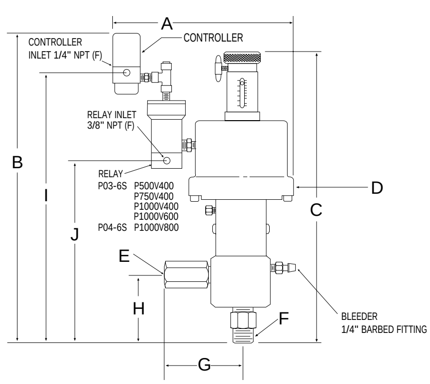
1.3.2 Relays

1.3.2.1 PO3-6S Relay

When there is no pilot pulse (high pressure air or gas) entering the top of the relay from the controller, the piston spring pushes the piston and the poppet assembly upwards until the O-ring on top of the poppet presses against the upper body section, sealing the pump port from the exhaust port. The space below the poppet provides a path between the supply and pump ports.

Physical Specifications





Model	Plunger Diameter (In.)	Piston Diameter (In.)
CP125V125	1/8	1 1/4
CP250V225	1/4	2 1/4
CP250V300	1/4	3
CP500V225	1/2	2 1/4
CP500V300	1/2	3
CRP500V400	1/2	4
CRP750V400	3/4	4
CRP1000V400	1	4
CRP1000V600	1	6
CRP1000V800	1	8

Model	A Inch/mm	B Inch/mm	C Inch/mm	D Diameter (IN)	E Connector	F Connector	G Inch/mm	H Inch/mm	I Inch/mm	J Inch/mm	WT LBS/KG
CP125V125	4.50/114.3	9.25/235	8.12/206.2	$1\frac{7}{8}$”47mm	$\frac{1}{4}$” NPT (F)	$\frac{1}{4}$” NPT (M)	$1\frac{3}{4}$”45mm	$1\frac{3}{4}$”45mm	$6\frac{1}{4}$”159mm	n/a	7.0/3.2
CP250V225	6.00/152.4	11.68/296.7	11.00/279.4	$2\frac{1}{2}$”63.5mm	$\frac{1}{4}$” NPT (F)	$\frac{1}{4}$” NPT (M)	$2\frac{9}{16}$”65mm	$2\frac{11}{16}$”68mm	$8\frac{7}{8}$”214mm	n/a	9.0/4.1
CP250V300	6.25/158.8	11.68/296.7	11.00/279.4	$3\frac{1}{4}$”82.5mm	$\frac{1}{4}$” NPT (F)	$\frac{1}{4}$” NPT (M)	$2\frac{9}{16}$”65mm	$2\frac{11}{16}$”68mm	$8\frac{7}{8}$”214mm	n/a	9.0/4.1
CP500V225	5.50/139.7	12.00/304.8	11.00/279.4	$2\frac{1}{2}$”63.5mm	$\frac{1}{4}$” NPT (F)	$\frac{1}{2}$” NPT (M)	$2\frac{5}{8}$”67mm	$2\frac{13}{16}$”69mm	$8\frac{9}{16}$”217mm	n/a	10.0/4.5
CP500V300	6.00/152.4	12.00/304.8	11.00/279.4	$3\frac{1}{4}$”82.5mm	$\frac{1}{4}$” NPT (F)	$\frac{1}{2}$” NPT (M)	$2\frac{5}{8}$”67mm	$2\frac{13}{16}$”69mm	$8\frac{9}{16}$”217mm	n/a	10.0/4.5
CRP500V400	9.12/232	16.00/406	11.00/279.4	$4\frac{1}{4}$”108mm	$\frac{1}{4}$” NPT (F)	$\frac{1}{2}$” NPT (M)	$2\frac{5}{8}$”67mm	$2\frac{13}{16}$”69mm	$12\frac{3}{4}$”324mm	$9\frac{7}{16}$”240mm	15.0/6.8
CRP750V400	9.75/247.6	16.25/412.7	11.31/287.2	$4\frac{9}{16}$”116mm	$\frac{1}{2}$” NPT (F)	$\frac{3}{4}$” NPT (M)	$3\frac{5}{8}$”92mm	3”76mm	13”332mm	$7\frac{9}{16}$”240mm	16.7/7.5
CRP1000V400	10.50/266.7	19.00/482.6	14.12/358.6	$4\frac{3}{8}$”111mm	$\frac{1}{2}$” NPT (F)	$\frac{3}{4}$” NPT (M)	4”102mm	$3\frac{3}{8}$”86mm	$14\frac{5}{8}$”365mm	$8\frac{7}{8}$”225mm	29.0/13.2
CRP1000V600	12.50/317.5	19.00/482.6	14.12/358.6	$6\frac{3}{8}$”162mm	$\frac{1}{2}$” NPT (F)	$\frac{3}{4}$” NPT (M)	4”102mm	$3\frac{3}{8}$”86mm	$17\frac{3}{4}$”451mm	$12\frac{1}{4}$”214mm	35.5/16.1
CRP1000V800	14.50/368.3	19.00/482.6	14.12/358.6	$8\frac{3}{8}$”213mm	$\frac{1}{2}$” NPT (F)	$\frac{3}{4}$” NPT (M)	4”102mm	$3\frac{3}{8}$”86mm	16”406mm	11”279mm	47.6/21.6

When the controller sends a pilot pulse, the high pressure gas on top of the piston overcomes the piston spring force, and pushes the piston and the poppet assembly downward until the O-ring on the bottom of the poppet presses against the lower body section, sealing the pump port from the supply pressure. The space above the poppet provides a path between the pump and exhaust ports.

1.3.2.2 PO4-6S Relay

When there is no pilot pulse (high pressure air or gas) entering the top of the relay from the controller, the piston spring pushes the piston and two poppets attached to the piston upwards until the O-ring on top of the upper poppet presses against the upper body section and at the same time the O-ring on the lower poppet presses against the middle body section. The upper poppet O-ring seals the number one pump port from the number one exhaust port; the space below provides a path between the supply and the number one pump ports. The lower poppet O-ring seals the number two pump port from the supply port; the space below provides a path between the number two exhaust and pump ports.

When the controller sends a pilot pulse, the high pressure gas on top of the relay piston overcomes the piston spring force and pushes the piston and two poppets assemblies downward. The piston and two poppets assemblies move down until the O-ring on the bottom of the upper poppet presses against the middle body section and the O-ring on the bottom of the lower poppet presses against the lower body section. The upper poppet O-ring seals the number one pump port from the supply port; the space above provides a path between the number one pump and exhaust ports. The lower poppet O-ring seals the number two pump port from the number two exhaust port; the space below provides a path between the number two pump port and the supply port.

1.3.3 Pump Motor (Air Chamber)

The motor forces the piston plunger to move alternately into and out of the pump chamber. When the controller sends the supply air/gas into the motor chamber through the nipple connector, the pressure on the piston and diaphragm overcomes the combined force of the process fluid pressure on the piston plunger and plunger return spring, and pushes the plunger into the fluid chamber. When the external controller exhausts the air/gas, the piston plunger return spring and process fluid pressure push the piston plunger out of the fluid chamber.

1.3.4 Pump (Fluid Chamber)

The pump operating cycle consists of fluid being discharged and suctioned into the fluid chamber. During discharge, the piston plunger moves into the pump fluid chamber, decreasing the volume of the chamber and raising the pressure in the chamber fluid. This higher pressure closes the suction check valve and opens the discharge check valve, sending the fluid into the discharge line.

During the suction part of the cycle, the piston plunger moves out of the fluid chamber, increasing the volume of the chamber and lowering the pressure of the chamber fluid. This lower pressure opens the suction check valve and a spring closes the discharge check valve, sending fluid from the suction line into the fluid chamber.

SECTION 2.0: INSTALLATION OF PUMP AND CONTROLLER

2.1 GENERAL

Always install separate pressure regulators in the air/gas supply lines for the controller and the relay. Also, for the most efficient performance of your pump assembly, we recommend the following:

- A dryer and a dump valve in the air/gas supply line to remove any moisture from the supply air/gas.
- Isolation valves (ball type) on inlet and discharge lines of the pump and in the air/gas supply line to simplify maintenance.
- A check valve where the pump discharge line joins the main process line to prevent process fluid back flow.
- An inlet filter, with filtration approximately 25 microns, on pump suction line.
- A flow meter or a rate setting gauge in the suction line or process fluid discharge line, if you need precise flow rate adjustment or recording.

2.2 PUMP ASSEMBLY

Position the pump assembly with enough space around it to allow easy access to all components for maintenance. Install the assembly with the pump inlet/suction check valve pointing straight down. The pump will not work as efficiently in any other position since the inlet/suction check valve has no spring.

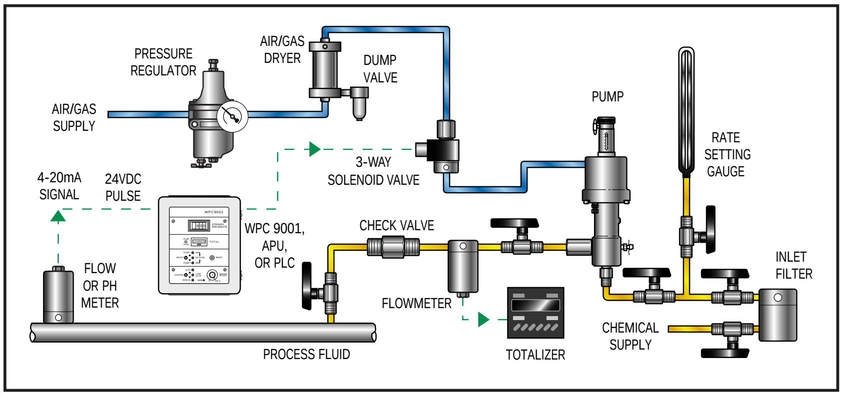
NOTE: The pump assembly can be installed directly in the process line piping without any additional support brackets.

CONTROLLER SPECIFICATIONS

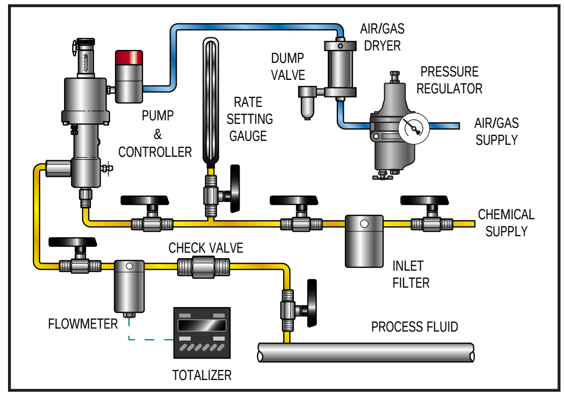
MODELS	SUPPLY PRESSURE	BODY MATERIAL	STROKES (SPM)	ELASTOMER	SPOOL STYLE
MK XIIA	35-100 PSI (2.4-6.9 Bar)	316 ss	1 - 45	Neoprene	Diaphragm
MK X	35-100 PSI (2.4-6.9 Bar)	316 ss	1 - 45	Buna/TFE, Viton®/TFE	U-Cup

2.3 TYPICAL INSTALLATION

Below you will find a schematic for a typical “V” plunger pump installation. The key ingredients for a successful installation are: ***1:*** Clean, dry regulated air for the controller ***2:*** A flooded inlet supply ***3:*** An inlet filter ***4:*** A rate setting gauge ***5:*** A line check valve at the point of injection ***6:*** Isolation valves for maintenance on each component.



Flow Tracking Controller Configuration



Standard Pneumatic Controller Configuration

2.4 SUPPLY RESERVOIR

Position the supply reservoir so that the liquid level will not be less than six inches above the inlet check valve (flooded suction). While you can locate the reservoir at any height above the inlet check valve (net positive suction head), the limit is 100 psig net positive suction head, which is the cracking pressure of the discharge check valve. We do not recommend using the pumps in a suction lift position since they were not designed for such operation.

2.5 RELIEF VALVE

A safety relief valve is not necessary if the downstream piping can withstand the maximum pressure the pump can generate at the available air supply pressure. The maximum discharge pressure the pump can generate can be taken from the performance graphs in section 1.2.2.2. When this pressure is reached the pump will stop. Example: A CP250V225ATC operating at 35 psig is capable of generating 2520 psig. The pump will stop pumping when the 2520 psig is reached.

SECTION 3.0: STARTUP, OPERATION, SHUTDOWN, AND STORAGE

3.1 GENERAL

While these procedures for startup, operation, shutdown, and storage are simple, following them carefully and correctly will improve the performance and increase the life of your pump assembly. **CAUTION: To avoid damaging the controller valve stem, do not make a habit of turning the pump ON and OFF with the stroke rate control. Use the recommended ball valve in the air/gas supply line.**

3.2 STARTUP

These startup procedures will produce a flow rate close to what you want. For a more precise flow rate, monitor with a flow meter while making the final adjustment.

3.2.1 Air/Gas Supply

Before starting up your pump assembly, make sure that the primary air/gas supply, compressor, tank of gas, or other source, is turned OFF. Also, set the pressure regulator(s) to ZERO pressure.

3.2.1.1 Supply Pressure: The air/gas supply pressure must be large enough to produce a pump discharge pressure 200 psi higher than the process pressure. Therefore, if the process pressure is 2800 psig, the air/gas supply should provide a pump discharge pressure of 3000 psig. To set the supply pressure properly, use the performance graphs in 1.2.2.2.
NOTE: With a controller/relay combination, the controller supply pressure should be at the minimum value, 35 psig (Ref. 1.2.1.1) and the relay supply pressure set per the above procedure. Remember, the controller is now supplying the relay and the relay is supplying the pump. Refer to section 1.2.1.2 for the relay supply pressures.

***3.2.1.2 Supply Piping*:** Since supplying the proper air volume to the pump is critical for its operation, avoid long runs of small diameter tubing, as follows:

- Locate the main air/gas supply header as close to the pump as possible.
- Use no more than five feet of 1/4” tubing to supply air/gas to the controller.
- Always locate the controller or relay on the pump.
- Use no more than ten feet of 1/2” tubing to supply air/gas to the relay.
- If a solenoid valve controls the pump, locate it no more than two feet away and use 1/2” tubing to supply air/gas to the pump.

3.2.2 Controller Stroke Rate

The controller is preset at the factory to provide each pump the maximum number of strokes per minute at 35 psig (Ref. 1.2.2.1 Performance Table). This setting falls at 100 on the controller scale. At ZERO on the scale, the pump will not cycle and there will be no output.

To calibrate the controller stroke rate, follow this procedure:

1. Rotate the stroke rate knob on the controller clockwise (CW) to ZERO on the stroke rate reference scale.
2. Turn the main air/gas supply to the regulator(s) to ON, and adjust the regulator to the desired pressure. (see 3.2.1.1 for determining pressure.)
3. Set the flow rate for your application by using the controller's stroke rate knob in combination with the pump's stroke adjuster. (Ref. 1.2.2.1 Performance Table)

If necessary, adjust the controller stroke rate knob as follows:

1. Loosen the set screw and remove the knob.
2. Adjust the valve stem to the desired rate by hand by turning the stem clockwise (CW) to decrease the stroke rate or counterclockwise (CCW) to increase the rate. Use a timer, such as a stop watch, to determine the actual stroke rate.
3. Attach and set the knob at the desired position on the scale (100 on scales for 45 spm, for example).

3.2.3 Pump Stroke Length

The adjuster scale for the pump's stroke length is factory set so that a ZERO reading equals ZERO stroke length. Calibrate the scale as follows:

1. Turn the stroke adjuster tee set screw counterclockwise until the stroke adjuster knob is unlocked.
2. Turn the stroke adjuster knob counterclockwise as far as it can go. The piston/plunger will be fully bottomed in the pump.
3. Loosen the two screws holding the data plate; move the data plate until the middle of the pin is at ZERO on the scale. Tighten the two screws.
4. Turn the stroke adjuster knob until the middle of the pin is at the desired stroke length on the scale.
5. Tighten the tee knob clockwise until the stroke adjuster knob is locked.

3.3 OPERATION

3.3.1 Bleeder Plug

Shortly after the pump assembly begins operating, the metered liquid should begin flowing through the pump. To bleed air trapped in the pump chamber, turn the bleeder plug CCW about a quarter turn. When the liquid is flowing steadily with each pump stroke from the end of the bleeder plug, turn it CW until the flow stops. It is best to close the bleeder plug when the pump is discharging and before the suction stroke.

NOTE: To catch the escaping liquid, slip a length of 1/4” plastic or rubber tubing over the hose barb of the bleeder plug.

3.3.2 Stroke Rate

Set the operating stroke rate, as follows:

1. Set the stroke rate knob to a mark on the scale that will produce a stroke rate close to the one you want. Keep in mind that the scale reading is only an approximate percent indication of the actual rate; generally the pump maximum stroke rate will be set at 100 on the scale. **NOTE: At the ZERO setting on the controller stroke rate scale, the pump will not stroke, but as you rotate the knob toward 100, the rate will increase to the maximum strokes per minute for each pump.** (Ref. 1.2.2.1 Performance Table) To set the stroke rate correctly, you must time the exhausts as they leave the bottom of the controller.
2. Count the number of pump strokes during a one minute interval, using a timer such as a stop watch to determine the actual stroke rate.
3. Adjust the knob to correct the stroke rate as needed. Confirm by timing the stroke rate.
4. Repeat the above steps until you get the correct stroke rate. EXAMPLE: To get a stroke rate of 22 strokes per minute, set the knob to 50 which should produce approximately 25 strokes per minute. Then reduce the rate by resetting the knob to 48. If this produces 21 strokes a minute, move the knob to 49, which should be very close to the 22 strokes per minute you want. Confirm the rate by timing it.

3.4 SHUTDOWN AND STORAGE

To shut down the pump assembly, set the pressure regulator(s) to ZERO, and turn the air/gas supply to OFF.

To store the pump assembly or if it will not be used for a long time, do the following:

1. Remove pump from the system.
2. Flush out the pump chamber and check valves with water or solvent; drain and then blow the pump dry with compressed air.

CAUTION: To prevent damage to the pump when you clean it, be sure to use a solvent compatible with the metered fluid that will not damage the pump seals. For a recommended solvent, contact your distributor or Williams Instrument Incorporated.

3. Cap off the suction and discharge check valve ports.
4. You may leave the pump, controller, and relay assembled, but make sure to store them in a dry, protected place.

SECTION 4.0: MAINTENANCE

4.1 GENERAL

This section contains procedures for disassembly and assembly of the controller, pump, and check valves, plus procedures for preventive and corrective maintenance. To maintain the reliability, durability, and performance of your pump assembly and related components, it is essential to follow these procedures exactly and carefully.

For consistent, reliable performance, replace any O-rings, U-cups, or other seals that you remove. Order replacement seal kits with detailed instructions from your distributor or Williams Instrument Incorporated.

Whenever you disconnect any air/gas or fluid piping, cover all open ports in the pump assembly to prevent dirt from entering.

4.2 DISASSEMBLY AND ASSEMBLY

4.2.1 Required Tools and Materials

Necessary tools will vary by pump assembly model but the following are typical:

- Adjustable wrench: 12”
- Belt-spanner or web wrench
- Open-end wrenches: various sizes
- Hex wrenches: 7/64”, 1/8”, 9/64”, 3/16”, and 5/32”, 1/4”, 3/8”
- Socket wrenches: various sizes with 2” extension
- Flat-blade Screwdrivers: 1/8” (2 required) and 1/4”
- MK X Screwdriver in 3/16” hex Socket Drive (Drawing 1)
- Brass or plastic O-ring pick (1)
- Torque wrench (15 in-lb to 122 in-lb range)
- Bench vise
- Silicone grease, (Williams G321M4), or synthetic grease (Williams GS102149)
- Teflon tape 1/4”
- Thread sealing compound

NOTE: See 4.3 Preventive Maintenance for inspection and replacement of parts identified throughout these procedures.

4.2.2 Controllers

4.2.2.1 Mark XII Controller

Refer to the Mark XII Controller Parts List. To disassemble, do the following:

1. Remove red cap. (Fig. 1)

Figure 1

2. The Mark XII has (4) four socket head cap screws holding the controller together. Use a 5/32” hex wrench to remove. Separate upper valve body from the lower section. (Fig. 2 & 3)

Figure 2

Figure 3

Figure 4

Figure 5

Fig. 6

3. Lift off the upper body and diaphragm. Lift out the inner diaphragm assembly. Set aside. (Fig. 4 & 5)

4. Lift out the spool spring. (Fig. 6)

5. Turn lower controller body upside down. Use a 3/16” hex wrench to unscrew bottom plug. Remove the bottom plug, lower spring and pilot plug. (Fig. 7 & 8)

Fig. 7

Fig. 8

6. Return controller body as before and unscrew lower seat with a 3/16” hex wrench. Remove lower seat. (Fig. 9 & 10)

Fig. 9

Fig. 10

7. To disassemble the inner diaphragm and spool assembly, first remove outer sleeve and mid ring by sliding past the diaphragms towards the upper seat. (Fig. 11, 12 & 13) Use a small screw

Figure 11

Figure 12

Figure 13

driver or hex wrench placed through the inner spacer holes and with a 9/16" wrench unscrew the upper seat and lower diaphragm. (Fig. 14) Place the top

Figure 14

diaphragm stop (and inner sleeve with screw driver/hex wrench) into a soft jaw vice with a vee notch. Lightly clamp top diaphragm stop. Unscrew inner sleeve. (Fig. 15) Remove the mid diaphragm from the top diaphragm stop. (Fig. 16)

Figure 15

Figure 16

Remove the lower diaphragm from the upper seat. (Fig. 18)

8. Clean all metal parts. Inspect and or replace all three diaphragms. To reassemble, push the mid diaphragm onto the top diaphragm stop. Push the lower diaphragm onto the upper seat. Thread the inner spacer onto these (2) two diaphragm assemblies. With a screw driver and 9/10" wrench, tighten securely, but *not* enough to pucker the diaphragms. Install the mid ring, counter bore first, onto the diaphragm assembly past the lower diaphragm and then past the mid diaphragm. Some maneuvering of the diaphragms will be needed. Install the outer sleeve by sliding past the lower diaphragm. Insure the narrow seat on the sleeve goes against the mid diaphragm and the wider seat is against the lower diaphragm. Some maneuvering of the lower diaphragm will also be needed. The inner assembly is now complete. (Fig. 17 & 19)

9. To install the inner assembly into the lower controller body, be sure to

Figure 17

Figure 18

Figure 19

reinstall the lower seat and spool spring. Make sure the capillary holes in the upper diaphragm, the mid ring and the mid diaphragm are in line with the capillary hole of the lower body. Use a small awl or hex wrench to thread together. Install (1) one of the (4) body screws from the under side through the loose parts and through the top diaphragm. Now remove the awl and place on top of the assembly the upper controller body. Insure its capillary hole is inline with the others. Loosely thread together the (1) one body screw. Install remaining (3) three screws and torque all to 28 - 32 inch pounds.

4.2.2.2 MK X Controller

Refer to the MK X Controller parts list.

Disassemble the controller as follows:

1. Unscrew the controller and remove it from the pump.

2. Clamp the lower end of the controller body in a bench vise, (Fig. 20) using protected jaws to avoid scratching the surface.

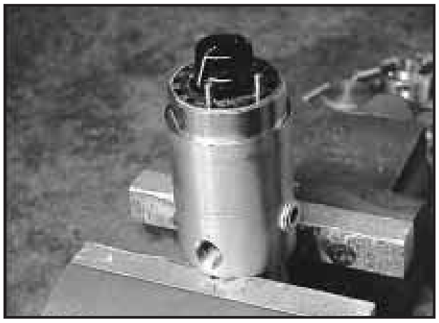


Figure 20

3. Use an adjustable wrench on the flats at the top of the valve body assembly to unscrew and remove the needle valve assembly (upper body). (Fig. 21 & 22) Lay aside.

Figure 21

Figure 22

4. Lift out the spool with the three attached U-cups and the spool O-ring. (Fig. 23)

5. Lift out the spool spring. (Fig. 24)

6. Use the Williams special blade screwdriver and unscrew the lower seat.(Fig.25)

Figure 23

Figure 24

Figure 25

7. Lift out the pilot plug and exhaust spring. (Fig. 26)

Figure 26

8. Remove the body O-ring that keeps the capillary tube separate. (Fig. 27)

Figure 27

To reassemble the controller, reverse the above procedure. Be sure to replace all rubber components. Flare the U-cup out with your finger before installing the spool and apply a small amount of silicone grease or synthetic grease to the sides of the U-cups and the upper/lower body inside diameters.

4.2.3 Relays: PO3-6S and PO4-6S

Refer to the appropriate Parts List. Disassembly instructions 1 through 9 apply to all relays, instructions 10 and 11 apply only to the PO3-6S, and instructions 12 through 17 apply to the PO4-6S.

1. Use a 9/64" hex wrench to remove the top cap screws (Fig. 28 & 29). Turn screws CCW.

Figure 28

Figure 29

2. Separate the top cap with data plate from the upper body section. (Fig. 30)

Figure 30

3. Put a 7/64" hex wrench through the side of the relay into the upper body exhaust port and into the hole in the upper poppet stem. (Fig. 31)

Figure 31

4. Use a 9/64” hex wrench to remove the piston lock screw (Fig. 31)

5. Pull out the piston, O-ring, and spring. (Fig. 32 & 33)

Figure 32

Figure 33

6. Use a 5/32” hex wrench to remove the bottom cap screws. (Fig. 34 & 35)

Figure 34

Figure 35

7. Separate the lower body section from the upper body section. (Fig. 34 & 36)

Figure 36

8. Again, put the 7/64” hex wrench through the hole in the upper poppet stem. (Fig. 37)

Figure 37

9. Use a flat-blade screwdriver to unscrew the lower poppet stem. (Fig. 37)

10. PO3-6S: Pull out the upper poppet and poppet body; the poppet stem connector bolt will remain in one of the stems.(Fig. 38)

Figure 38

11. PO3-6S: Put a screwdriver in the holes of the poppet O-ring retainers and pry them off. (Fig. 39 & 40)

Figure 39

Figure 40

NOTE: You can now reassemble the PO3-6S relay by coating the poppet stems, seals, and mating surfaces with silicone grease, and then reversing the above procedure.

To continue disassembling the PO4-6S, do the following:

12. PO4-6S: At this point, repeat step 8, however, if the lower and middle poppet stems should separate, modify the rest of this procedure accordingly. (Fig. 41 & 42)

Figure 41

Figure 42

13. PO4-6S: Separate the upper poppet stem from the middle stem and the poppet body. The poppet stem connector bolt will remain on one of the stems. (Fig. 43)

Figure 43

14. PO4-6S: Use the flat-blade screwdriver to unscrew the lower poppet stem.

15. PO4-6S: Pull out the middle stem and poppet body. The poppet stem connector bolt will remain in one of the stems. (Fig. 43)

16. PO4-6S: Put a 7/64" hex wrench or screwdriver in the holes of the poppet O-ring retainers and pry them off. (Fig. 39) Then use the screwdriver to pry out the O-rings.

Figure 44

NOTE: Reassemble the PO4-6S relay by coating the poppet stems, seals, and mating surfaces with silicone grease, and then reversing the above procedure.

4.2.4 P125, P250, P500, P750 & P1000 Pumps

4.2.4.1 Changing Plunger Seals

1. Disassembly:

a. Unscrew the pump body from the fluid cylinder. The primary seal is visible in the pump body. The plunger will protrude from the pump body, through the seal. (Fig. 45, 46, 47 & 48)

Figure 45

Figure 46

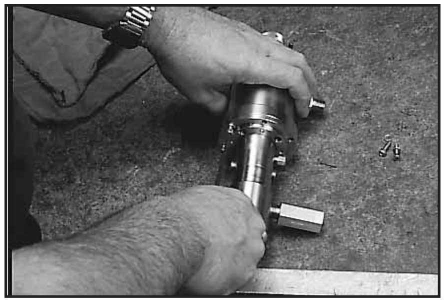


Figure 47

Figure 48

b. Remove the motor cylinder by unfastening the 4 to 10 screws (depending on the pump model) holding the motor cylinder to the faceplate. (Fig. 49)

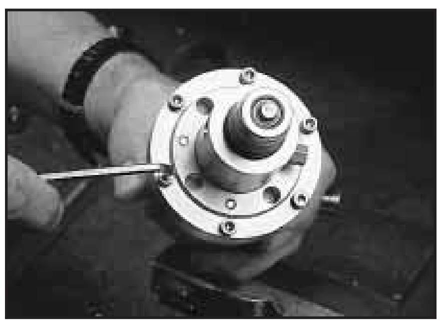


Figure 49

c. Remove the piston plunger guide ring and return spring. (Fig. 50 & 51)

Figure 50

Figure 51

d. Now remove the retaining ring and spring seat. The secondary seal (and associated backup ring if O-rings are being used), will be found beneath the spring seat. (Fig. 52 & 53)

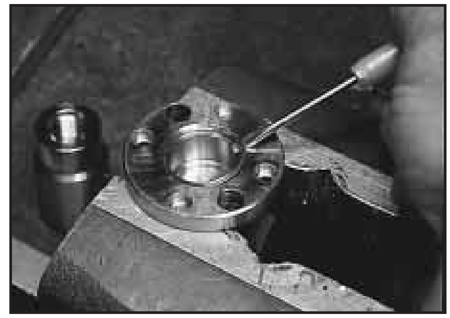


Figure 52

Figure 53

The primary and secondary seals can be removed from the pump body assembly using either the piston-plunger or a brass (or plastic) pick. Be careful not to scratch the metal sealing surfaces during the extraction process. The piston-plunger can be inserted alternately into each end of the pump body assembly to push out the opposing seal (and backup ring if present). The brass or plastic pick can be used to hook the seal (and backup ring) to pull them out. Caution must be used to make certain that the sealing surfaces are not scratched during the removal of the seal and back up ring. (Fig. 54, 55, 56, 57 & 58)

Figure 54

Figure 55

Figure 56

Figure 57

Figure 58

e. Remove both 1/8” NPT plugs in the pump body so that all the old grease and any dirt or debris can be cleaned/flushed from the pump body. (Fig. 59)

Figure 59

f. Thoroughly clean all internal pump surfaces. Then inspect all metal sealing surfaces such the seal gland and plunger for scratches, nicks or irregularities. Such conditions could lead to leakage or excessive seal wear if not corrected. Replace parts that exhibit wear.

g. Install the new seals in accordance with the illustrations shown. Use illustration I if your are installing the spring loaded U cup type seals, and illustration II if you are installing O-ring type seals. In each case the seals and back up rings can be easily be pushed in place using only your fingers. Make certain the order and position in which the components are installed matches the illustration shown. Also make certain the seal assemblies are installed completely, none of the seal assembly should protrude. **NOTE: APPLY A LITTLE GREASE FROM GS102149 GREASE TUBE TO THE SEALS. BACK UP RINGS AND ALL THREADS BEFORE INSTALLING.** (Fig. 60, 61, 62, 63, 64 & 65)

Figure 60

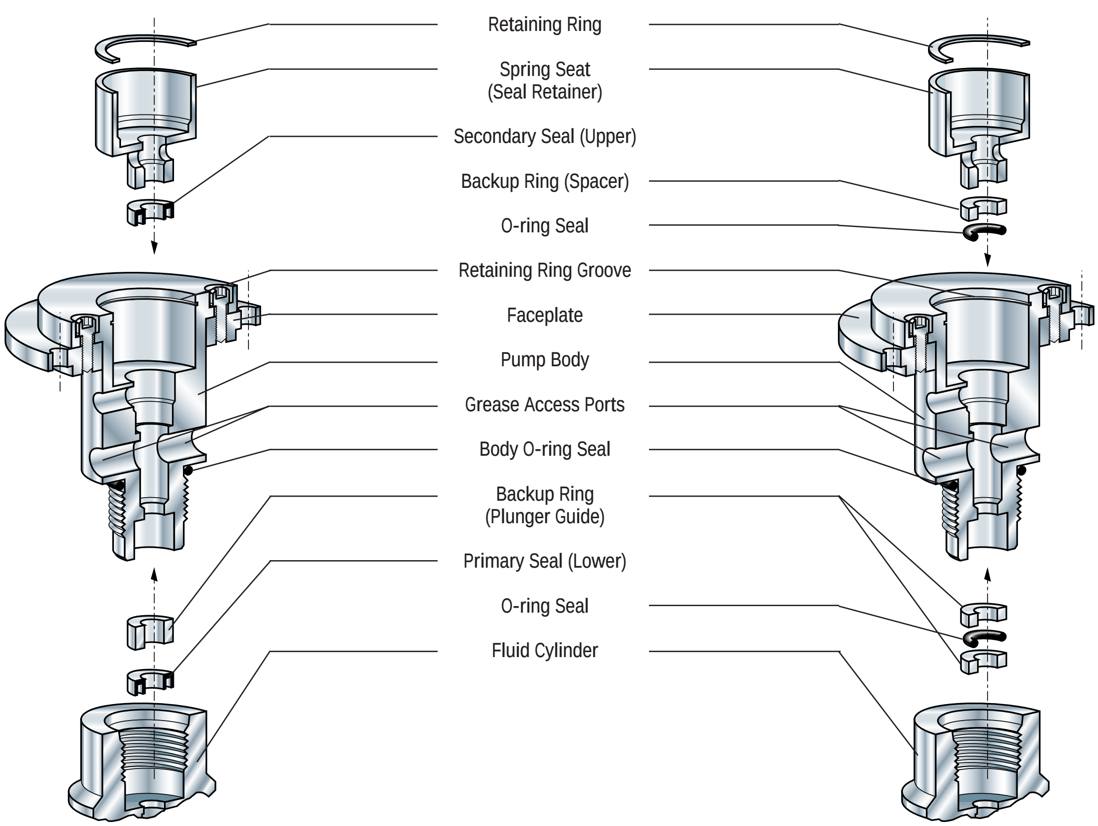


Illustration I **Illustration II**

Figure 61

Figure 62

Figure 63

Figure 64

Figure 65

2. REASSEMBLY

a. Replace spring seat and retaining ring. **NOTE: The spring seat may be used as the secondary seal installation tool.** Place the seal face down in the cavity and push it into place with spring seat. (Fig. 66 & 67)

Figure 66

Figure 67

b. Thread the fluid cylinder to the pump body. The parts are designed to be tightened using a strap type wrench with the following torque values:

PUMP MODEL	TORQUE (Ft-lbs)
P125V (all)	50
P250V (all)	50
P500V 225	50
P500V 300	100
P500V 400	100
P750V 400	100
P1000V (all)	100

c. Now apply Williams GS102149 synthetic grease to the plunger, and the piston U-cup.

d. Install the spring in the spring seat. Then simultaneously insert and rotate the plunger through the spring into the pump body seals. It may be necessary to open the bleeder plug during this procedure to vent any fluid in fluid cylinder.

e. Now, apply synthetic grease (GS102149) to the internal surface of the motor cylinder. Wrap the piston guide ring around the piston, and while holding it in place, slide the motor cylinder over the piston, the U-cup and guide ring. Align the holes in the motor cylinder with the face plate and tighten the 4 to 10 screws removed during the disassembly process. Assembly screw torque is 25 in-lbs.

f. Lubricate the seals as follows:

1. Both 1/8” NPT plugs should have been removed during the disassembly of the pump to facilitate cleaning. If this was not done, please do it now.
2. Thread the tube of grease (GS102149) that came with the seal kit into one of the lubrication access ports. (Fig. 68)

Figure 68

3. Now, squeeze the grease into the lubrication cavity. Hold your finger over the opposite lubrication cavity access hole, alternately removing it to allow air to escape and to feel the grease pressurize the lube cavity. (Fig. 69)

Figure 69

4. When all the air have been expelled from the lubrication cavity and only grease is exiting the opposite access hole, the cavity is full.
5. Apply Swagelok SWAK thread sealant to both 1/8” NPT plugs and replace in pump housing. (Fig. 70)

Figure 70

4.2.4.2 Complete Pump Rebuild:

Although there are some differences between the pumps, they are disassembled and reassemble in approximately the same way. The procedures describe the differences. Refer to the appropriate parts list, for the pump you are rebuilding.(Fig. 70)

Figure 71

Disassemble the pumps as follows:

1. Clamp the pump at the fluid cylinder in a vice. Use jaw protectors to avoid scratching the pump. (Fig. 72)

Figure 72

2. Use the belt-spanner wrench to loosen the body from fluid cylinder. Clamp on the body or the motor cylinder. Continue turning the assembly by hand until the two parts separate. (Fig. 73)

Figure 73

NOTE: The fluid cylinder of the pump can remain installed on the plumbing if only the pump and not the check valves are to be serviced. Also, since the body and the fluid cylinder are made as a matched set, keep them together. do not substitute parts from other pumps of the same model.

3. Use the appropriate hex wrench to remove the socket-head cap screws and washers fastening the motor cylinder to the body. If the pump has a piston return spring it will push the two pieces apart (exception: CRP1000V800); if not, separate the motor cylinder from the body and faceplate.
4. Remove the piston/plunger assembly, piston U-cup (piston O-ring on the P1000V800), piston guide ring and the piston return spring (on all pumps except the P1000V800). The piston guide ring will fall away from the piston. Remove the piston U-cup (piston O-ring on the P1000V800). (Fig.74&75)

Figure 74

Figure 75

NOTE: Before doing the next step, put a piece of tape or other mark on the outside surface of the cylinder faceplate to align it with a body part for reassembly.

5. Use the 5/16” open end wrench to unscrew and remove the vent plug, and the 3/16” hex wrench to unscrew and remove the two grease chamber plugs. Use the appropriate hex wrench to unscrew and remove the cap screws and split washers fastening the cylinder faceplate to the body. Slide the faceplate off the body. On the P1000V800, remove the two faceplate O-rings. (Fig. 76, 77, 78 & 79)

Figure 76

Figure 77

Figure 78

Figure 79

6. On the P250 and P500, use a small screwdriver or punch to push the filter plugs from the cylinder faceplate. (Fig. 80, 81 & 82)

Figure 80

Figure 81

Figure 82

CAUTION: Do not remove the face plate plug from the P1000V800. The filter plug retainers are permanently pressed into place at the factory. DO NOT REMOVE THEM.

7. Use a pick if necessary to remove the body seal O-ring, the primary plunger seal, and the plunger seal backup ring from the body. The piston-plunger can also be used to push out the primary seal and backup ring by reinstalling it in the body faceplate assembly.(Fig. 83, 84 & 85)

Figure 83

Figure 84

Figure 85

8. Clamp the body in the bench vise, faceplate side up.

9. Use a pick or small screwdriver to lift the end of the spring seat retainer from the groove in the body. While holding the end free, slide the other pick between the retainer and the body until the retainer is loose. (Fig.86 & 87)

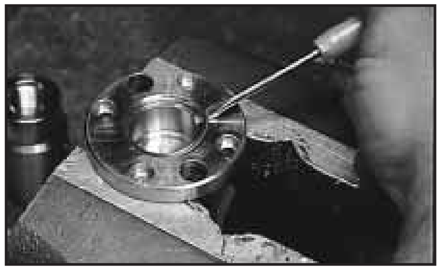


Figure 86

Figure 87

10. Remove the spring seat. On the P1000V800 remove the two spring seat O-rings. (Fig. 88 & 89)

Figure 88

Figure 89

11. Use a pick if necessary to remove the secondary plunger seal located beneath the spring seat or remove the seal by installing the plunger in the opposite end of the body-faceplate assembly and pushing the seal out. (Fig. 90 & 91)

Figure 90

Figure 91

12. Use the appropriate socket wrench (3/4" or 7/8") to unscrew the nut that secures the piston stop and remove the stroke adjuster assembly from the motor cylinder. (Fig. 92, 93 & 94)

Figure 92

Figure 93

Figure 94

13. Clamp the fluid cylinder in the vise. Use the adjustable wrench to unscrew and remove the inlet check valve, discharge check valve, and bleeder plug. Before reassembling the pump, clean all chambers, motor cylinder, and cylinder faceplate with an approved solvent. Contact your distributor or Williams Instrument Incorporated for a recommended solvent. Also, lubricate all O-rings and U-cups with silicone grease or synthetic grease. (Fig. 95, 96, 97, 98 & 99)

Figure 95

Figure 96

Figure 97

Figure 98

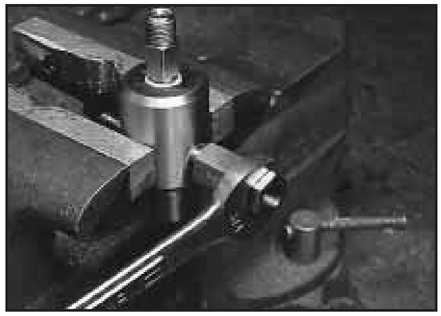


Figure 99

Reassemble the pump as follows:

1. On all pumps except the P125 and P1000V800, install the filter plugs in the body.

2. On all pumps except the P125, slide the cylinder faceplate over the body and line up the mounting holes. Make sure that the marked side of the faceplate aligns with the outside of the pump. On all pumps except the P125 and P1000V800 also line up the vent holes in the faceplate with the filter plugs.

3. Install the screws with split lockwashers and torque them to the values in the table.

PUMP	TORQUE (in-lb)
P125	15 - 20
P250	15 - 20
P500	15 - 20
P750	15 - 20
P1000	28 - 32

4. Clamp the body in the bench vise with the faceplate end up.

5. For the P250, P500, P750, and P1000V600, install a new plunger seal in the upper area of the body by facing the open side of the seal down **toward** the grease chamber and using the spring seat to push the seal in. For the P125, push the seal in by hand or use a special tool made for this purpose (part no. WT201192).

6. On the P1000V800, put the two spring seat O-rings on the spring seat and put the spring seat in the body. On all pumps except the P1000V800, align the hole in the side of the spring seat with the vent plug and use the 5/16" open end wrench to install the plug.

7. Separate one end of the retaining ring and put it in the groove inside the body. Use a finger to work the rest of the ring into the groove until the other end is in place.

8. Remove the body from the bench vise. At the threaded end of the body install the body seal O-ring and the plunger seal backup ring followed by the plunger seal. Face the open side of the seal **away** from the grease chamber.

9. Place the fluid cylinder in the vise with the body mating end facing up. Use the adjustable wrench to screw in the suction check valve (ball end or hex plug end into the pump), discharge check valve, and bleeder plug. Arrows on the check valves indicate flow direction. Use thread sealant and teflon tape on the suction and discharge check valves.

10. Apply synthetic grease to the body threads and body seal O-ring. Screw the body into the fluid cylinder until it is hand tight, then tighten with the web or belt-spanner wrench per the following torque values.

PUMP MODEL	TORQUE (Ft-lbs)
P125V (all)	50
P250V (all)	50
P500V 225	50
P500V 300	100
P500V 400	100
P750V 400	100
P1000V (all)	100

11. On all pumps except the P1000V800, put one end of the piston return spring in the spring seat. Install the piston U-cup (piston O-ring on the P1000V800) on the piston. Face the open side of the U-cup **away** from the plunger.

12. Apply synthetic grease liberally to the piston/plunger assembly and inside the motor cylinder; install the piston/plunger assembly, without the piston guide ring, into the body.

13. Put the piston guide ring on the piston; while holding the ends of the guide ring together with a finger or thumb, slide the motor cylinder over the piston.

14. Push the motor cylinder down to the cylinder faceplate; align the motor cylinder mounting holes.

15. Install all the screws with split lockwashers.

16. Use the 9/64" hex wrench on the P125, P250, P500, and P750 and the 1/4" hex wrench on the P1000, to torque the socket-head cap screws and split lock washers to the values in the table.

PUMP	TORQUE (in-lb)
P125	15 - 20
P250	15 - 20
P500	15 - 20
P750	15 - 20
P1000	118 - 122

17. To lubricate the seals for running, hold a finger over one vent hole and insert the end of the synthetic grease tube into the other vent hole. Squeeze synthetic grease into the grease chamber until you feel it pressing against your finger. Vent all the air. Wipe off excess synthetic grease, apply thread sealing compound to the vent plugs, and replace them.

4.2.5 Discharge Check Valves: All Pumps

Although there are several sizes of discharge check valves, they are all disassembled and reassembled the same way. Refer to the appropriate parts list. Disassemble the check valve as follows:

1. Clamp the check valve body in the vise.
2. Use the appropriate hex wrench to unscrew and remove the retainer.
3. Remove the body from the vise and dump out the spring, ball seat, ball, sleeve, and Teflon® O-ring (Fig. 100)

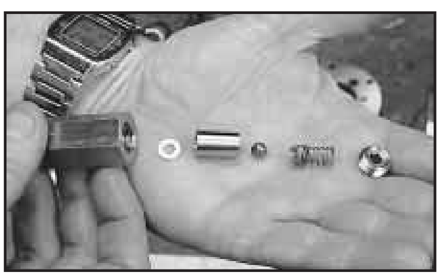


Figure 100

4. Remove the Teflon® O-ring from the sleeve.
5. Inspect all the parts and replace them if they are worn.

Reassemble the check valve as follows:

1. Put the Teflon® O-ring in the sleeve and drop the sleeve, O-ring first, into the body.
2. Drop the ball into the body.
3. Put the small end of the spring in the spring cavity on the wide end (**not** the slotted end) of the ball seat. Drop the two parts, ball seat first, into the body.
4. Drop the retainer, spring cavity first, if it has one, into the body and use the appropriate hex wrench to torque to the values in the table.

PUMP	TORQUE (in-lb)
P125	230 - 240
P250/500	230 - 240
P750/P1000	118 - 122

4.2.6 Suction Check Valves: All Pumps

Although there are several sizes of check valves with minor construction differences, they are all disassembled and reassembled the same way. The procedures describe the differences. Refer to the appropriate parts list. Disassemble the check valve as follows:

1. Clamp the check valve body in the vise.
2. Use the appropriate hex wrench to unscrew and remove the retainer. (Fig. 101)

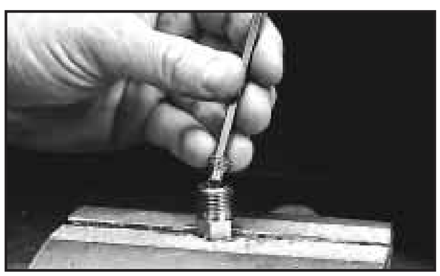


Figure 101

3. Remove the body from the vise and dump out the ball, sleeve, and O-ring. **NOTE: On the P125 and P250 you may need a pick or small tool to remove the Teflon® O-ring inside the body.** (Fig. 102)

Figure 102

4. On the P500, P750 and P1000, remove the Teflon® O-ring from the sleeve. (Fig. 103)

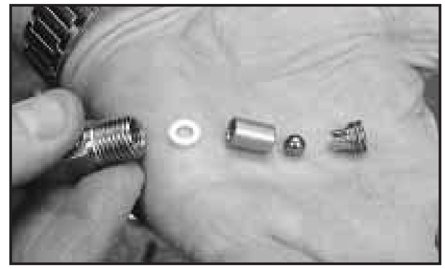


Figure 103

Reassemble the check valve as follows:

1. On the P500, P750 and P1000, put the Teflon® O-ring in the sleeve and drop the sleeve, O-ring first, into the body. On the P125 and P250, drop the O-ring into the body, followed by the sleeve, the end with a shoulder first.
2. Drop the ball into the body.
3. On the P125 and P250, use the appropriate hex wrench to screw the retainer into the body. On the P125 and P250, tighten until you feel the Teflon® O-ring resistance, then tighten another 1/4 to 1/3 turn to compress the O-ring. On the other pumps, tighten securely. No Loctite #277 is required.

4.3 PREVENTIVE MAINTENANCE

4.3.1 Periodic Maintenance

4.3.1.1 Once a week: Perform the following procedures:

1. Check for process fluid leaking from the plumbing.
2. Check for process fluid leaking from the pump's vent hole, cylinder faceplate, and body O-ring.
3. Check for air/gas leaks.
4. Check for loose fittings and screws.

4.3.1.2 At least once a month: Unscrew the plug from the top of the tee fitting between the relay and the controller; put a few drops of Williams SF96-100 silicone oil in the hole.

4.3.1.3 At least every six months: Inspect the piston-plunger assembly and seals. Replace the seals and check the plunger for wear; replace the piston/ plunger assembly if it is scored, rough, or discolored.

4.3.1.4 At least every twelve months: Perform the following procedures:

1. Disassemble and inspect the pump inlet and outlet check valves. Replace worn parts.
2. Inspect the piston/plunger assembly, piston return spring (on all pumps except the P1000V800), and all seals. Replace the piston/plunger assembly and the seals.

4.3.2 Cleaning and Lubrication

Whenever the pump assembly is disassembled: Clean all inside and outside surfaces with an approved solvent, and blow them dry with compressed air. **CAUTION: To prevent damage to the pump when you clean it, use a solvent that is compatible with the process fluid and that will not damage pump seals. Contact your distributor or Williams Instrument Incorporated for a recommended solvent.**

4.4 TROUBLESHOOTING

4.4.1 Proper Pump Use

When a pump is either not working or working incorrectly, the trouble can be in two basic areas: the pneumatic or the fluid ends of the pump. However, since factors other than the pump can affect its operation, first check that the pump is being used properly. To help you determine this, use the following checklist:

1. Is the air/gas supply available in sufficient volume and at the proper pressure?
2. Is the air/gas supply of clean instrument quality, not dirty or wet?
3. Is a pressure regulator in use to maintain a constant air supply?
4. Is the tube or pipe size of the air/gas supply line correct for your pump model?
5. Is the pump correct for the nature and characteristics of the material(s) it handles: composition, viscosity, necessary line pressure, etc.?
6. Is the process fluid container–drum, day tank or large storage tank–clean and free of contaminants?
7. Is the filtration adequate? Disassemble and inspect.
8. Is the size of the process fluid line correct for the pump?
9. Is the distance between the pump and supply air/gas correct?
10. Is the pump operating within acceptable minimum and maximum temperature limits?
11. Is the pump being used for more than one purpose? Plunger seals are affected by this.
12. Is the proper cleaning fluid being used to flush out the pump?
13. Is there a current and accurate service/maintenance/breakdown record for the pump?

4.4.2 Proper Amount of Use

While answers to the questions on the above checklist will provide considerable information about how the pump is being used, it is equally important to determine if it is overworked.

Fortunately, you can use the amplification ratio of the pump (ref. 1.1.3 Pumps) and the process pressure (the pressure the pump plunger is working against) to check this. Use the following example:

- Example: process pressure is 2800 psi.
- Add 200 psi to the example process pressure. This additional 200 psi will insure that the chemical is positively injected: 2800 psi + 200 psi = 3000 psi.
- To set the air/gas supply pressure use the performance graphs in 1.2.2.1.

From this information you can determine if the pump is working properly. In the above example, if the supply pressure had been 100 psi instead of 35, it would have been excessive, resulting in premature failure of the pump's moving parts and sealing capabilities.

4.4.3 Troubleshooting Guide

The Troubleshooting Guide on the following pages identifies the most common problems, their possible causes, and corrective action for each problem.

TROUBLESHOOTING GUIDE

PROBLEM	POSSIBLE CAUSE(S)	CORRECTIVE ACTION
CONTROLLER NOT OSCILLATING	• Foreign material in controller	• Put finger over exhaust port; alternately seal & vent port to clear exhaust valve.
	• No air/gas supply	• Connect pressure gauge to port opposite supply line; verify required supply pressure.
	• Supply pressure too high or too low	• Reset regulator to proper pressure.
	• Too much pressure drop in air/gas line	• Increase connecting tube size or clean air lines.
	• Stroke rate valve open too much	• Disconnect air/gas supply. Rotate stroke rate knob CCW to peg, wait 5 seconds, & rotate knob CW until it stops. **DO NOT FORCE KNOB.** Reconnect supply & rotate knob CCW until oscillations start. Adjust stroke rate to proper strokes per minute according to Specification Sheet; loosen knob set screw, rotate knob CCW to peg, & tighten screw.
	• Leak between valve body & controller body	• Loosen; then retighten the connection between valve & controller body. If dirty, disassemble, wipe clean and reassemble.
	• Continuous air flow from controller exhaust port (Pilot plug not seating properly)	• Inspect & replace damaged lower seat and pilot plug.
	• Air flowing from equalizer hole on side of lower control body	• Inspect & replace ruptured or improperly seated seals. Put finger over exhaust port; alternately seal & vent port to clear exhaust valve.
	• Broken pilot plug, exhaust spring, or spool return spring	• Replace damaged parts.
	• Excessive water in controller	• Install an air/gas dryer or separator in supply line.
RELAY NOT OPERATING	• Broken piston return spring	• Replace return spring. See page 15
	• Poppet stem loosened from connector bolt	• Tighten poppet stem to connector bolt. See page 15
	• Air blow-by caused by poorly sealed O-rings	• Improve quality of air supply and clean dirt from unit. Replace O-rings if damaged.
	• Inadequate air supply	• Check air regulator for proper pressure.
PLUNGER NOT STROKING	• Controller control knob set at ZERO	• Turn knob to proper setting on dial.
	• Air/gas supply turned OFF	• Open valve to allow air supply to flow to controller.
	• Broken motor return spring	• Replace return spring.
	• Plunger stuck due to tight or dry seal	• If seal is swollen, check its chemical compatibility with process fluid; replace with compatible seal material. • If seal is dry, lubricate & fill reservoir with grease.
	• Plunger bottomed	• Readjust plunger stroke length. Replace return spring if broken.
	• Excessive grease between cylinder and faceplate	• Remove excess grease. Piston seal may be leaking; check and replace if necessary.
	• Air/gas supply pressure too low to overcome process line pressure	• Increase supply pressure to controller or relay.
	• Discharge or suction line plugged	• Clean the lines.

PROBLEM	POSSIBLE CAUSE(S)	CORRECTIVE ACTION
PLUNGER NOT STROKING (Cont.)	• Air/gas flow to controller too low (controller locked up and will not cycle)	• Install a larger capacity regulator or supply line. Vent supply side of controller and try to start pump at slowest speed; increase speed slowly if controller starts to cycle.
	• Motor cylinder-air piston blow-by	• Check piston seal; replace as needed. Check motor cylinder surface for damage from dirt or sand; install clean filters on bottom of cylinder faceplate. Replace cylinder if necessary.
LOW PUMP OUTPUT	• Viscosity of the chemical being pumped too high.	• Review and enlarge size of supply and discharge lines to improve flow of chemical.
	• Pump mounted too high to suck adequate supply of chemical to fluid cylinder	• Remount pump to create a flooded suction (six inch minimum).
	• Pump appears sluggish in stroking. Piston not returning all the way.	• Remount pump as close to controller and relay as possible to allow the controller and relay to exhaust quickly. Check for ice in exhaust port.
	• Suction lift condition inadequate.	• Change tank elevation to get flooded suction if change not possible, add foot valve at end of suction line, and increase suction line diameter.
	• Blocked suction filter	• Clean or replace filter element.
	• Supply and discharge lines too small. See pump sluggish	• Install correct tubing size.
	• Erratic controller operation	• Rebuild, clean and lubricate controller; add air inlet filter or air/gas dryer.
	• Check valves leaking or contaminated. Loss of pump capacity	• Rebuild, replace damaged parts.
	• Improper chemical supply	• Make sure top of chemical supply tank is vented to atmosphere or pressurized.
PROCESS FLUID IN GREASE CHAMBER OR LEAKING FROM BODY OR CYLINDER FACEPLATE VENT HOLE	• Premature wear on plunger seals from excessive pump speed	• Calculate proper speed and air supply pressure. (Refer to amplification ratio principle.) Replace seals and plunger.
	• Foreign material in process fluid	• Check to see if chemical supply is clean; if not, install chemical filter in supply line.
	• Seals incorrectly assembled or damaged during installation	• Refer to instructions for installing seals.
	• Plunger nicked, burred or scratched	• Replace plunger and seals.
PROCESS FLUID IN GREASE CHAMBER OR LEAKING FROM BODY OR CYLINDER FACEPLATE VENT HOLE (cont.)	• Seal or plunger materials not compatible with process fluid	• Refer to compatibility charts; contact distributor or Williams Instrument Incorporated
	• Crystallized chemical on plunger scoring seal	• Maintain lubricant and decrease time between inspections.
	• Lubricant incompatible with process fluid	• Change lubricant; contact distributor or Williams Instrument Incorporated
NO PUMP DISCHARGE	• Suction check valve or discharge check valve not seating	• Clean or replace check valves.
	• Suction or discharge line clogged	• Inspect line for closed connections or valves.
	• Air entering suction line	• Tighten fittings; Inspect and replace sealants.
	• Pump vapor locked	• Open bleeder plug and prime pump.

SECTION 5.0
PARTS LIST & REPAIR KIT ORDERING REFERENCE

5.1 CONTROLLER

CONTROLLER	PARTS LIST	REPAIR KIT
MK - XII	PL - MK - XII (1)	OS 72
MK - X	PL - MK - X	OS 62-BR/TFE (2) OS 52-V/TFE (3)

NOTES:
(1) The MK XII is standard on the V series pump.
(2) The standard material for the seals or diaphragms is Buna rubber (MK X only).
(3) The optional material for the seals or diaphragms is Viton® (MK X only).

5.2 RELAYS

RELAY	USED ON (PUMP)	PARTS LIST	REPAIR KIT
PO3-6S	P500V400 P750V400 P1000V400 P1000V600	PL-PO3-6S	PO3-6K
PO4-6S	P1000V800	PL-PO4-6S/8S	PO4-6K

SECTION 6.0
LIMITED WARRANTY

WILLIAM INSTRUMENT, INC. will repair or replace any pump due to defects in material or workmanship for a period of up to three years from the date of shipment. Product failure due to any other reason including, but not limited to misuse, negligence, accident, normal wear and usage, or improper installation and operation, will not be remedied under this warranty. This warranty is valid only if the repairs are performed by WILLIAMS INSTRUMENT, INC. and returned to the factory for inspection (freight prepaid) within the warranty period. No claim for labor or consequential damages will be allowed.

NOTES

WILLIAMS
INSTRUMENT INCORPORATED
MILTON ROY

(800) 235-3421
(661) 257-2250 • Fax: (661) 257-7963

www.williamspumps.com

VIOM Manual PRINTED 10-99