



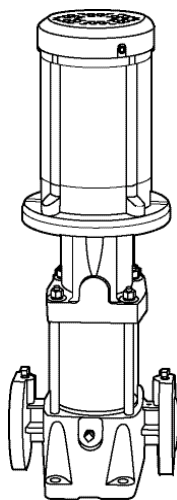
OWNER'S MANUAL

INSTALLATION AND OPERATING INSTRUCTIONS

PVM (IX) 2 - PVM (IX) 16

VERTICAL MULTISTAGE PUMPS

Single and Three Phase 60 Cycle



Record the following information from the motor and pump nameplates for future reference:

Pump Model No. _____

Bill of Material No. _____

Motor Model No. _____

Motor Serial No. _____

H.P. _____ Volts/Hz/Ph _____

Rated Amp Draw _____

Aurora Pump, 800 Airport Road, North Aurora, IL 60542

Preliminary (8/31/06)

TABLE OF CONTENTS

Safety Instructions.....2
 Applications and Operating Ranges.....2-4
 Installation.....4-5
 Electrical.....5-6
 Operation.....6-7
 Maintenance8-11
 Repair Parts12-13
 Troubleshooting Guide.....14
 Warranty14

Carefully read and follow all safety instructions in this manual or on pump.

⚠ This is the safety-alert. When you see this symbol on your pump or in this manual, look for one of the following signal words and be alert to the potential for personal injury.

⚠ DANGER warns about hazards that **will** cause serious personal injury, death or major property damage if ignored.

⚠ WARNING warns about hazards that **can** cause serious personal injury, death or major property damage if ignored.

⚠ CAUTION warns about hazards that **will** or **can** cause minor personal injury or property damage if ignored.

The word **NOTICE** indicates special instructions which are important but not related to hazards.

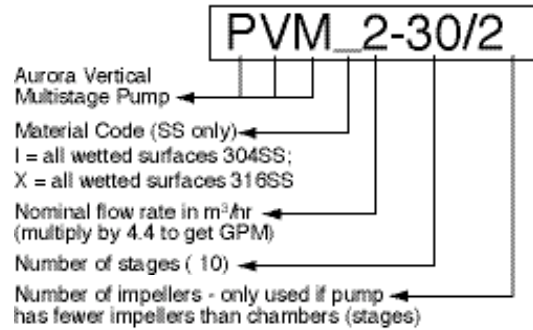
To avoid serious or fatal personal injury and possible property damage, carefully read and follow the safety instructions.

1. Install pump according to all code requirements.
2. Compare pump nameplate data with desired operating range.
3. Pump only liquids compatible with pump component materials (that is, liquids that will not attack the pump).
4. Make sure plumbing is adequate to handle system pressure.
5. Periodically perform maintenance inspection on pump and system components.
6. Wear safety glasses at all times when working on pumps.

INSPECT THE SHIPMENT

The vertical multistage centrifugal inline pump has been carefully inspected and packaged to assure safe delivery. Inspect the pump and fittings and report to the carrier any items which are damaged or missing.

CONFIRM THAT YOU HAVE THE RIGHT PUMP



MODEL #	PART #	MFG. DATE
GPM	FEET	RFM
HP	PRESS. MAX. (PSI)	TEMP. MAX. (F)
BERKELEY PUMPS, GRAND ISLAND, NE 68801		

FIGURE 1 - Model Plate Information

APPLICATIONS AND OPERATING RANGES

Aurora multistage in-line centrifugal pumps are designed for liquid transfer, circulation, and pressure boosting of hot or cold clean water or other thin, non-explosive liquids, not containing solid particles or fibers, which will not chemically attack the pump materials.

Typical applications include:

- Municipal water supply and pressure boosting
- Boiler feed and condensate systems
- Cooling water systems
- Irrigation
- Fire fighting

Maximum Ambient Temperature.....104° F(40° C)
 Liquid Temperature Range.....5° F to 250° F
 (-15° C to +121° C)

Maximum Permissible Operating Pressure Curves.....See Figure 4
 Maximum Inlet Pressure: Table II shows the maximum permissible inlet pressure. However, the actual inlet pressure plus the pressure when the pump is running against a closed valve must always be lower than the "Maximum Permissible Operating Pressure".

Electrical Data:See Motor Nameplate

Dimensions and Port to Port Lengths :See Figures 2A, 2B, 3A and 3B, Pages 3 and 4

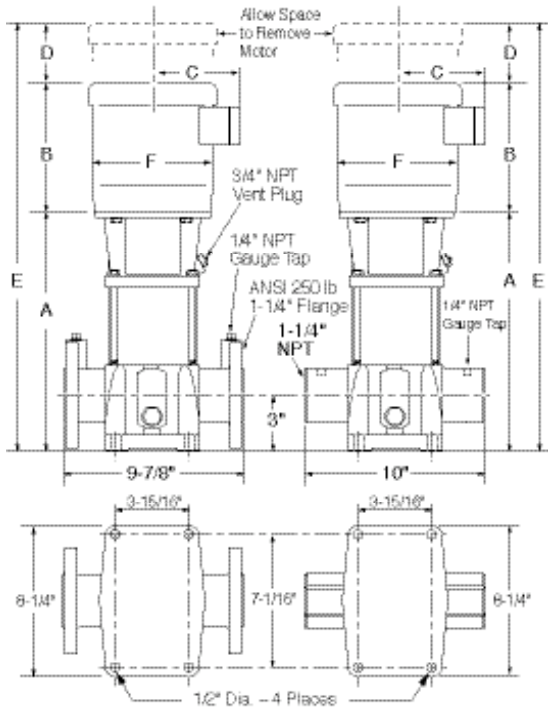


FIGURE 2A - Height, width and baseplate dimensions for PVM2 and PVM4 Series pumps

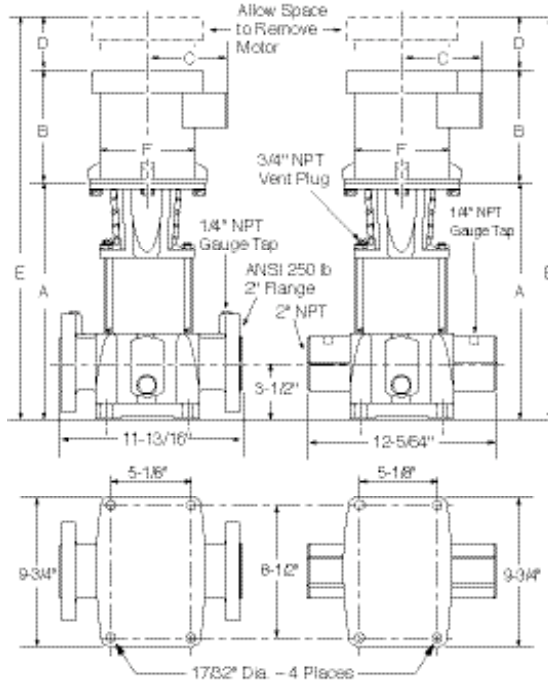


FIGURE 2B - Height, width, and baseplate dimensions for PVM8 and PVM16 Series pumps

TABLE I – Maximum Height and Width Dimensions*

Model Number	Dimension in Inches					
	A	B	C	D	E	F
PVM2-30/2	11-3/8	9-1/4	4-7/8	2	22-5/8	6
PVM2-30	11-3/8	9-7/8	4-7/8	2	23-1/4	6
PVM2-40	12	11-1/8	5-1/4	2	25-1/4	7-1/8
PVM2-50	12-3/4	11-1/8	5-3/4	2-1/8	26	7-1/4
PVM2-60	13-1/2	11-1/8	5-3/4	2-1/8	26-5/8	7-1/4
PVM2-70	14-1/8	12-1/8	5-3/4	2-1/8	28-1/4	7-1/4
PVM2-80	14-7/8	12-1/8	5-3/4	2-1/8	29	7-1/4
PVM2-90	15-15/16	12-5/16	6-7/8	2-7/8	31-1/8	8-1/2
PVM2-100	16-5/8	13-5/8	2-7/8	2-7/8	33-1/4	8-1/2
PVM2-110	17-3/8	12-5/16	6-7/8	2-7/8	32-17/32	8-1/2
PVM2-120	18-1/8	13-5/8	6-7/8	2-7/8	34-5/8	8-1/2
PVM2-130	18-13/16	12-5/16	6-7/8	2-7/8	34	8-1/2
PVM2-140	19-1/2	15-9/32	8	3-3/8	38-5/32	10-9/16
PVM2-150	20-1/4	15-1/4	8	3-3/8	38-7/8	10-5/8
PVM2-160	20-15/16	15-1/4	8	3-3/8	39-9/16	10-5/8
PVM2-170	21-9/16	15-1/4	8	3-3/8	40-9/32	10-5/8
PVM2-180	22-3/8	15-1/4	8	3-3/8	41	10-5/8
PVM4-20/1	11-3/8	9-1/4	4-7/8	2	22-5/8	6
PVM4-20	11-3/8	9-7/8	4-7/8	2	23-1/4	6
PVM4-30	12-3/8	11-1/8	5-1/4	2	25-5/8	7-1/8
PVM4-40	13-1/2	11-1/8	5-3/4	2-1/8	26-5/8	7-1/4
PVM4-50	14-1/2	12	5-3/4	2-1/8	28-5/8	7-1/4
PVM4-60	16	13-5/8	6-7/8	2-7/8	32-1/2	8-1/2
PVM4-80/7	18-1/8	13-5/8	6-7/8	2-7/8	34-5/8	8-1/2
PVM4-80	18-1/8	13-5/8	6-7/8	2-7/8	34-5/8	8-1/2
PVM4-90	19-5/32	15-1/4	8	3-3/8	37-13/16	10-5/8
PVM4-100	20-1/4	15-1/4	8	3-3/8	38-7/8	10-5/8
PVM4-110	21-1/4	15-1/4	8	3-3/8	39-15/16	10-5/8
PVM4-120	22-3/8	15-1/4	8	3-3/8	41	10-5/8
PVM4-130	23-13/32	15-1/4	8	3-3/8	42	10-5/8
PVM4-140	24-1/2	15-1/4	8	3-3/8	43-1/8	10-5/8
PVM4-150	25-1/2	15-1/4	8	3-3/8	44-3/16	10-5/8
PVM4-160	26-5/8	15-1/4	8	3-3/8	45-1/4	10-5/8
PVM8-20/1	15	9-7/8	4-7/8	2	27	6
PVM8-20	15	11-1/8	5-3/4	2-1/8	28-1/4	7-1/4
PVM8-30	17-3/4	13-5/8	6-7/8	2-7/8	34-1/4	8-1/2
PVM8-40	18-7/8	13-5/8	6-7/8	2-7/8	35-1/2	8-1/2
PVM8-50	20-1/8	15-1/4	8	3-3/8	38-3/4	10-5/8
PVM8-60	21-1/4	15-1/4	8	3-3/8	40	10-5/8
PVM8-70	21-5/16	15-1/4	8	3-3/8	39-15/16	10-5/8
PVM8-80	23-5/8	15-1/4	8	3-3/8	42-1/4	10-5/8
PVM8-90	26	15-1/4	8	3-3/8	44-21/32	10-5/8
PVM8-100	26	15-1/4	8	3-3/8	44-5/8	10-5/8
PVM8-110	27-3/16	16-3/8	8-3/4	3-3/8	47	10-5/8
PVM8-120	28-3/8	16-1/2	8-3/4	3-3/8	48-1/4	10-5/8
PVM8-130	29-9/16	16-3/8	8-3/4	3-3/8	49-5/16	10-5/8
PVM8-140	30-3/4	16-3/8	8-3/4	3-3/8	50-1/2	10-5/8
PVM8-150	33-9/16	19-21/32	9-1/2	4-1/4	57-9/16	12-15/16
PVM8-160	33-5/8	19-5/8	9-1/2	4-1/4	57-1/2	13
PVM16-30/2	19-1/2	15-1/4	8	3-3/8	38-1/4	10-5/8
PVM16-30	19-1/2	15-1/4	8	3-3/8	38-1/4	10-5/8
PVM16-40	21-3/8	15-1/4	8	3-3/8	40	10-5/8
PVM16-50	23-1/8	16-3/8	8-3/4	3-3/8	42-7/8	10-5/8
PVM16-60	25-3/8	19-5/8	9-1/2	4-1/4	49-1/4	13
PVM16-70	27-1/8	19-5/8	9-1/2	4-1/4	51	13
PVM16-80	28-7/8	19-5/8	9-1/2	4-1/4	52-7/8	13
PVM16-90	30-3/16	21-3/4	9-3/16	4	55-15/16	11-1/2
PVM16-100	32	21-3/4	9-1/8	4	57-3/4	11-1/2
PVM16-110	33-9/16	21-3/4	9-1/2	3-1/4	58-9/16	12-15/16
PVM16-120	35-3/8	21-3/4	9-1/2	3-1/4	60-3/8	13

* Measurements represent the largest number possible for each Model.

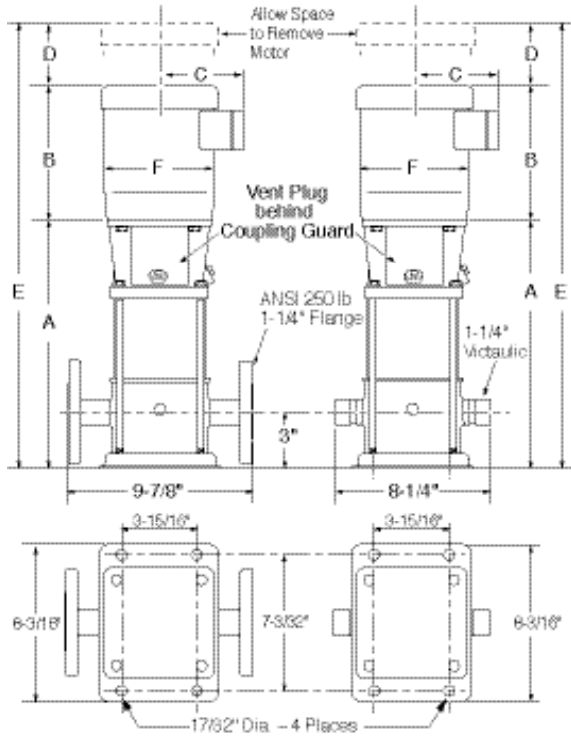


FIGURE 3A - Height, width and baseplate dimensions for PVMI/X2 and PVMI/X4 Series pumps

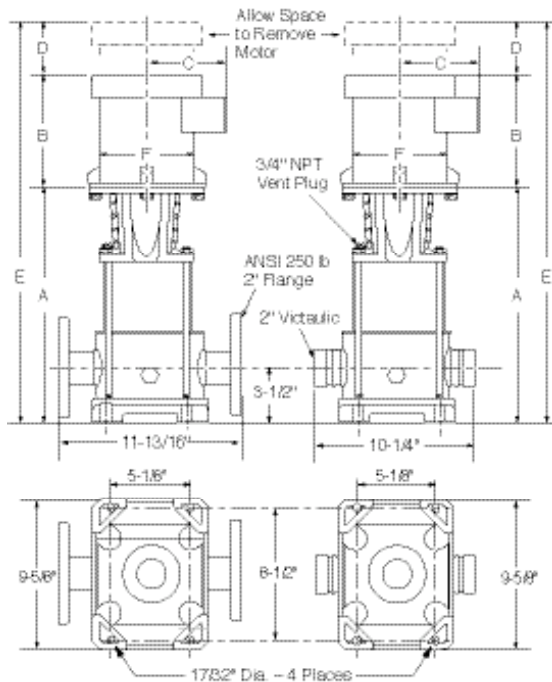


FIGURE 3B - Height, width, and baseplate dimensions for PVMI/X8 and PVMI/X16 Series pumps

TABLE II – Maximum Height and Width Dimensions*

Model Number	Dimension in Inches					
	A	B	C	D	E	F
PVMI/X2-30/2	11-3/4	9-1/4	4-7/8	2	23	6
PVMI/X2-30	11-3/4	9-7/8	4-7/8	2	23-5/8	6
PVMI/X2-40	12-3/8	11-1/8	5-1/4	2	25-5/8	7-1/8
PVMI/X2-50	13-1/8	11-1/8	5-3/4	2-1/8	26-3/8	7-1/4
PVMI/X2-60	13-7/8	11-1/8	5-3/4	2-1/8	27	7-1/4
PVMI/X2-70	14-1/2	12-1/8	5-3/4	2-1/8	28-5/8	7-1/4
PVMI/X2-80	15-1/4	12-1/8	5-3/4	2-1/8	29-3/8	7-1/4
PVMI/X2-90	16-3/8	12-5/16	6-7/8	2-7/8	31-17/32	8-1/2
PVMI/X2-100	17	13-5/8	2-7/8	2-7/8	33-5/8	8-1/2
PVMI/X2-110	17-3/4	12-5/16	6-7/8	2-7/8	33	8-1/2
PVMI/X2-120	18-1/2	13-5/8	6-7/8	2-7/8	35	8-1/2
PVMI/X2-130	19-3/16	12-5/16	6-7/8	2-7/8	34-3/8	8-1/2
PVMI/X2-140	19-15/16	15-1/4	8-1/16	3-3/8	38-9/16	10-5/8
PVMI/X2-150	20-5/8	15-1/4	8	3-3/8	39-1/4	10-5/8
PVMI/X2-160	21-5/16	15-1/4	8-1/16	3-3/8	40	10-5/8
PVMI/X2-170	22-1/32	15-1/4	8-1/16	3-3/8	40	10-5/8
PVMI/X2-180	22-3/4	15-1/4	8	3-3/8	41-3/8	10-5/8
PVMI/X4-20/1	11-3/4	9-1/4	4-7/8	2	23	6
PVMI/X4-20	11-3/4	9-7/8	4-7/8	2	23-5/8	6
PVMI/X4-30	12-3/4	11-1/8	5-1/4	2	26	7-1/8
PVMI/X4-40	13-7/8	11-1/8	5-3/4	2-1/8	27	7-1/4
PVMI/X4-50	14-7/8	12	5-3/4	2-1/8	29	7-1/4
PVMI/X4-60	16-3/8	13-5/8	6-7/8	2-7/8	32-7/8	8-1/2
PVMI/X4-80/7	18-1/2	13-5/8	6-7/8	2-7/8	35	8-1/2
PVMI/X4-80	18-1/2	13-5/8	6-7/8	2-7/8	35	8-1/2
PVMI/X4-90	19-17/32	15-1/4	8-1/16	3-3/8	38-3/16	10-5/8
PVMI/X4-100	20-5/8	15-1/4	8	3-3/8	39-1/4	10-5/8
PVMI/X4-110	21-9/16	15-1/4	8-1/16	3-3/8	40-3/16	10-5/8
PVMI/X4-120	22-3/4	15-1/4	8	3-3/8	41-3/8	10-5/8
PVMI/X4-130	23-13/16	15-1/4	8-1/16	3-3/8	42-1/2	10-5/8
PVMI/X4-140	24-7/8	15-1/4	8	3-3/8	43-1/2	10-5/8
PVMI/X4-150	25-15/16	15-1/4	8-1/16	3-3/8	44-17/32	10-5/8
PVMI/X4-160	27	15-1/4	8	3-3/8	45-3/8	10-5/8
PVMI/X8-20/1	15	9-7/8	4-7/8	2	27	6
PVMI/X8-20	15	11-1/8	5-3/4	2-1/8	28-1/4	7-1/4
PVMI/X8-30	17-3/4	13-5/8	6-7/8	2-7/8	34-1/4	8-1/2
PVMI/X8-40	18-7/8	13-5/8	6-7/8	2-7/8	35-1/2	8-1/2
PVMI/X8-50	20-1/8	15-1/4	8	3-3/8	38-3/4	10-5/8
PVMI/X8-60	21-1/4	15-1/4	8	3-3/8	40	10-5/8
PVMI/X8-70	21-3/8	15-1/4	8-1/16	3-3/8	40	10-5/8
PVMI/X8-80	23-5/8	15-1/4	8	3-3/8	42-1/4	10-5/8
PVMI/X8-90	26-1/8	15-1/4	8-1/16	3-3/8	44-3/4	10-5/8
PVMI/X8-100	26	15-1/4	8	3-3/8	44-5/8	10-5/8
PVMI/X8-110	28-1/2	16-3/8	8-7/8	3-3/8	48-1/4	10-5/8
PVMI/X8-120	28-3/8	16-1/2	8-3/4	3-3/8	48-1/4	10-5/8
PVMI/X8-130	28-1/2	16-3/8	8-7/8	3-3/8	48-1/4	10-5/8
PVMI/X8-140	30-3/4	16-3/8	8-3/4	3-3/8	50-1/2	10-5/8
PVMI/X8-150	33-3/4	19-11/16	9-1/2	4-1/4	57-5/8	12-15/16
PVMI/X8-160	33-5/8	19-5/8	9-1/2	4-1/4	57-1/2	13
PVMI/X16-30/2	19-1/2	15-1/4	8	3-3/8	38-1/4	10-5/8
PVMI/X16-30	19-1/2	15-1/4	8	3-3/8	38-1/4	10-5/8
PVMI/X16-40	21-3/8	15-1/4	8	3-3/8	40	10-5/8
PVMI/X16-50	23-1/8	16-3/8	8-3/4	3-3/8	42-7/8	10-5/8
PVMI/X16-60	25-3/8	19-5/8	9-1/2	4-1/4	49-1/4	13
PVMI/X16-70	27-1/8	19-5/8	9-1/2	4-1/4	51	13
PVMI/X16-80	28-7/8	19-5/8	9-1/2	4-1/4	52-7/8	13
PVMI/X16-90	30-5/16	21-3/4	9-3/16	4	56	11-1/2
PVMI/X16-100	32	21-3/4	9-1/8	4	57-3/4	11-1/2
PVMI/X16-110	33-11/16	21-3/4	9-1/2	3-1/4	58-11/16	12-15/16
PVMI/X16-120	35-3/8	21-3/4	9-1/2	3-1/4	60-3/8	13

* Measurements represent the largest number possible for each Model.

NOTE: PVMI models are 304 stainless steel; PVMI models are 316 stainless steel.

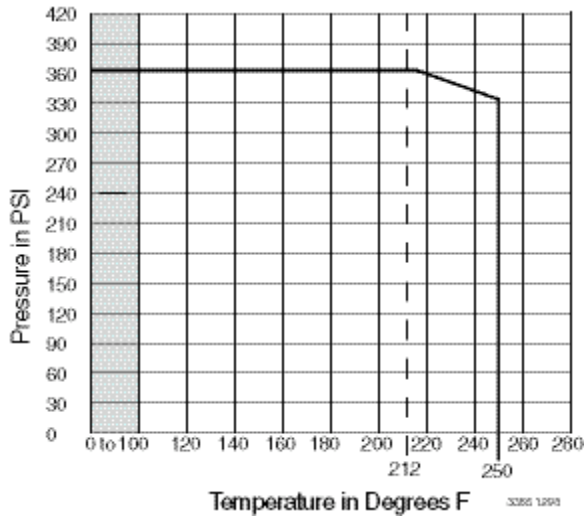


FIGURE 4 - Maximum Permissible Operating Pressure

TABLE III – Permissible Operating Pressures

PVM2-30/2 to PVM2-180
PVM4-20/1 to PVM4-160
PVM8-20/1 to PVM8-160
PVM16-30/2 to PVM16-120

Model Number		Maximum Inlet Pressure (PSI)
PVM2	30/2 - 60	145
	70 - 180	220
PVM4	20/1 - 20	90
	30 - 80/7	145
PVM8	80 - 160	220
	20/1 - 40	90
PVM16	50 - 160	145
	30/2 - 30	90
	40 - 120	145

INSTALLATION

⚠ WARNING Hazardous voltage. Voltage can shock, burn, or cause death. Ground pump motor correctly before connecting to power supply, per article 250-80 of the National Electrical Code (NEC) in the U.S., or the Canadian Electrical Code (CEC), as applicable.

Location

Locate pump in a dry, well ventilated area, not subject to freezing or extreme variations in temperature.

Mount pump a minimum of 6" from any obstruction or hot surface. Install the pump with the motor shaft vertical. Make sure that an adequate supply of cool air reaches the motor cooling fan. Maximum ambient air temperature is 104° F (40° C).

For open systems requiring suction lift, locate the pump as close to the water source as possible.

Foundation

Foundation should be concrete or a similarly rigid foundation to provide a secure, stable mounting base for the pump.

Secure pump to foundation using all bolt holes. Refer to Figures 2 and 3 for bolt plate dimensions. Be sure that all four pads on the base are properly supported.

Shim pump base to make sure that pump is level.

Piping

⚠ WARNING Explosion and burn hazard. Do not run pump with discharge valve closed; the water in the pump may boil, with risk of explosion and steam burns to anyone near. If there is any danger of the pump running against a closed discharge valve, install a pressure relief or by-pass valve in the discharge pipe to allow for minimum liquid flow through the pump. Minimum liquid flow through the pump is needed for cooling and lubrication of the pump (See Table IV). Run the bypass/relief valve and discharge pipe to a floor drain or a tank for collection.

Suction pipe should be adequately sized (See Table V) and run as straight and as short as possible to keep friction losses to a minimum. Pipes, valves, and fittings must have a pressure rating equal to or greater than the maximum system pressure.

TABLE IV – Minimum Pumping Rates

Type	Liquid Temperature +5° F to +250° F
PVM2	1 GPM
PVM4	2 GPM
PVM8	4 GPM
PVM16	8 GPM

TABLE V – Minimum Suction Pipe Sizes

Type	Pipe Size
PVM2	1-1/4" Nominal Diameter, Schedule 40 Pipe
PVM4	1-1/4" Nominal Diameter, Schedule 40 Pipe
PVM8	2" Nominal Diameter, Schedule 40 Pipe
PVM16	2" Nominal Diameter, Schedule 40 Pipe

Pressure check the discharge piping as required by codes or local regulations.

"Inlet" and "Outlet" are marked on the pump base to show the direction of the liquid flow through the pump.

Install anti-vibration mountings on either side of the pump if a minimum noise level is desired.

Install isolation valves in both inlet and outlet pipes near the pump (see Figure 5). This allows for removal of pump for service without draining the system and isolation of the pump in case of a flooded suction condition.

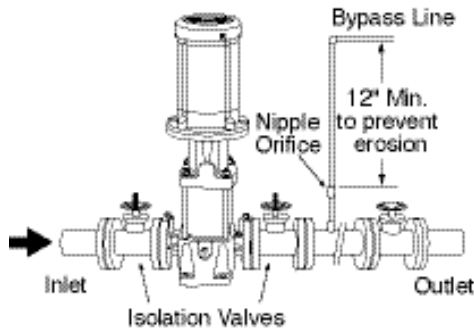


FIGURE 5 - Bypass required if pump might operate with discharge valve closed. See Table IV for minimum required flow through pump to prevent overheating and to ensure lubrication.

If the system pressure is greater than the pumps maximum inlet pressure the limits of the pump can be exceeded if the discharge pressure backs up to the inlet side of the pump. Installation of a check valve in the discharge pipe is recommended to prevent this condition.

Make sure, especially on the inlet side of the pump, that there are no airlocks in the system. See Figure 6 for correct pipe work to avoid airlocks. The suction pipe should be level or slightly rising.

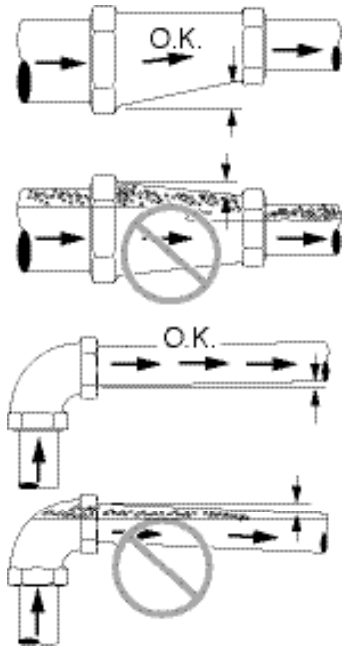


FIGURE 6 - Install Pipe Correctly to Prevent Air Locks

Support all piping independently of the pump so the weight of the piping system does not strain the pump case. Make sure that the expansion and contraction of the piping system from temperature variations cannot put a strain on the pump.

If the system or pump must be drained periodically (especially if the discharge pipe is horizontal or slopes downward away from the pump), install a loop and vacuum valve as shown in Figure 7 to protect the pump against running dry. The highest point of the loop should be at least as high as the lowest point of the motor. This loop/valve combination will allow the pump and the system to be drained independently of one another.

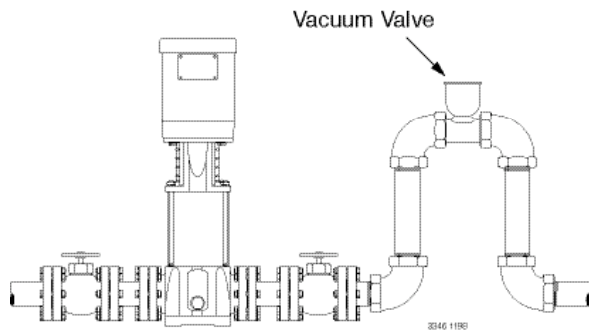


FIGURE 7 - Loop and Vacuum Valve Installation

ELECTRICAL

⚠ WARNING Hazardous voltage. Can shock, burn or cause death. All electrical work should be performed by a qualified electrician in accordance with the National Electrical Code and all local codes and regulations. Make sure that the motor voltage, phase, and frequency match the incoming electrical supply. The proper operating voltage and other electrical information can be found on the motor nameplate. These motors are designed to run up to $\pm 10\%$ of the nameplate-rated voltage. The wiring connection diagram can be found on either a plate attached to the motor or on a diagram inside the terminal box cover.

- If voltage variations are greater than $\pm 10\%$ do not operate the pump.
- Incorrect voltage can cause fire or serious damage to the motor and voids warranty.
- Ground the pump motor correctly before connecting it to the power supply.
- Follow the wiring instructions when connecting the motor to the power lines.

Position of Terminal Box

To turn the motor so that the terminal box faces the right direction, proceed as follows:

1. Disconnect the power to the pump motor.

2. Remove the coupling guards (use a screwdriver).
3. Remove the couplings.
4. Remove the bolts that fasten the motor to the pump.
5. Turn the motor to the required position (in quarter-turn increments).
6. Follow steps 10 - 20 under "Motor Replacement", on Page 9.

Field Wiring

All wiring connections and wiring sizes must meet National Electrical Code and local requirements.

Motor Protection

See the motor nameplate for electrical connection/wiring diagram.

Aurora pumps must be used with the proper size and type of motor starter to ensure protection against damage from low voltage, phase failure, current imbalances, and overloads. The overload should be sized to trip at the full-load current rating of the motor.

OPERATION

Priming

⚠ WARNING Hazardous pressure. Do not run the pump with the discharge valve closed; the water in the pump may boil, causing risk of explosion and steam burns to anyone nearby.

⚠ WARNING Hazardous voltage. Disconnect all power to the pump before servicing or working on the pump. Make sure that the power is locked out and that the pump cannot be accidentally started.

NOTICE: Under no circumstances should the pump be operated without flow through the pump. **Never** operate the pump dry.

Operation of closed systems or open systems with the liquid level above the pump priming plug:

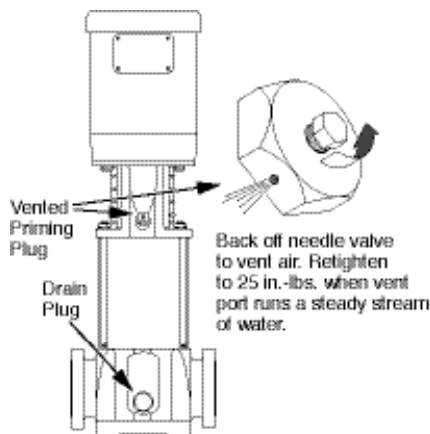


FIGURE 8 - Priming and Drain Plugs

1. Close the discharge isolating valve and loosen the needle valve located in the assembly in the pump head (Figure 8). Do not remove the needle valve.

NOTICE: On PVMI(X)2/4 models, remove the coupling guard for access to the vent plug.

⚠ WARNING Risk of water damage and injury. Watch the direction of the priming plug and make sure that the liquid escaping from it does not injure persons nearby or damage the motor or other components. In hot water installations, pay particular attention to the risk of injury from scalding hot water.

2. Slowly open the isolation valve in the suction pipe until a steady stream of liquid runs out the vent in the priming port.
3. Tighten needle valve to 25 inch-pounds. Completely open isolation valves.

NOTICE: Please turn to "Starting", Page 8, before proceeding any further.

Operation of open systems with the liquid level below the top of the pump:

NOTICE: The suction pipe requires a check valve or isolation valve.

1. Close the discharge isolation valve.
2. Remove the vented priming plug.
3. Pour liquid through the priming port until the suction pipe and the pump are completely filled with liquid.
4. Replace the vented priming plug and tighten it securely.
5. Repeat steps 1-4 until the pump is primed.

NOTICE: Please turn to "Starting", Page 8, before proceeding any further.

Checking Direction of Rotation

NOTICE: Do not disconnect the motor from the shaft to check the direction of rotation. If you remove the coupling, then you must adjust the shaft position when you reinstall it. This must be done before starting the pump.

Arrows on the pump head show the correct direction of rotation. When seen from the motor fan, the pump should rotate *counterclockwise* (↺). For pump motors without a fan remove one of the coupling guards and look at the coupling to determine the direction of rotation. Turn off the pump and replace coupling guard.

NOTICE: Do not check the direction of rotation until the pump has been filled with liquid. See "Priming", at left and above.

1. Switch power off.
2. Remove the coupling guard and rotate the pump shaft to be certain it can turn freely. Replace the coupling guard.
3. Verify that the electrical connections are in accordance with the wiring diagram on the motor.
4. If the fan is visible, turn on and off to verify rotation.
5. To reverse the direction of rotation, first switch OFF the power supply.

- On three-phase motors, switch 2 of the 3 power leads on the load side of the starter. On single-phase motors, see the connection diagram on the motor nameplate. Change the wiring as indicated.

⚠ WARNING Hazardous voltage. Voltage can shock, burn or cause death. Ground the pump motor correctly before connecting to power supply per article 250-80 of National Electrical Code (NEC) in the U.S., or the Canadian Electrical Code (CEC), as applicable.

- Switch on the power supply and recheck the direction of motor rotation.

Starting

- If a suction line isolation valve has been installed, check to be sure that it is completely opened.
- For initial starting, the isolation valve in the discharge pipe should be almost closed.
- Start the pump.
- When the piping system has been filled with liquid, slowly open the discharge isolation valve until it is completely open. Opening the valve too fast may result in water hammer in the discharge pipe. If the pump or system start to rattle, the pump is cavitating; to avoid damage to the pump, reduce the flow through the discharge isolation valve until the rattling stops. If this does not give adequate flow for your installation, call your installer or system designer.
- Record the voltage and amperage of the motor. Adjust the motor overloads if required.
- If pressure gauges have been installed, check and record operating pressures.
- Check all controls for proper operation.

Motor Bearings

For the greasing schedule and greasing procedure of the motor bearings follow the motor manufacturers recommendations.

Calculating Minimum Inlet Pressure:

Minimum inlet pressure is required to avoid cavitation in the pump and is calculated as follows:

$$H = P_b - \text{NPSHR} - H_f - H_v - H_s$$

H = Minimum Inlet Pressure in Feet of Head

P_b = Barometric Pressure in Feet

1 Bar = 29.53 inches of Mercury (Hg)

1 PSI = 2.31 Ft of Head

1 Bar = 33.5 Ft. of Head

NPSHR = Net Positive suction head required. To be read from the NPSHR curve, Figure 9, at the highest flow the pump will be delivering.

H_f = Friction Loss in suction pipe in ft of head

H_v = Vapor pressure in feet of head (See Table VI).

H_s = A safety margin of 1.64 ft of head

Example for PVM8:

- If: Flow = 60 GPM
 P_b = 1 Bar = 29.53 Inches of Mercury*
 (Convert from Bar to Feet of Head)
 1 Inch of mercury = 1.13' feet of water
 T = 100° F
 NPSHR = 10' (See Figure 9)
 H_f = 10' of 2" Steel Pipe @ 11.9' of loss per 100' of Pipe (H_f = 11.9'/10' = 1.19')
 H_v = 2.195' (from Table VI)
 H_s = 1.64' (safety factor from above)

- Then: $H = 33.5' - \text{NPSHR} - H_f - H_v - H_s$
 $H = 33.5' - 10' - 1.19' - 2.195' - 1.64 = 18.475'$
 $H = 18.475' = \text{Minimum Inlet Pressure}$

* 1 Bar = 14.5 PSI x 2.31 Ft of Head = 33.5'

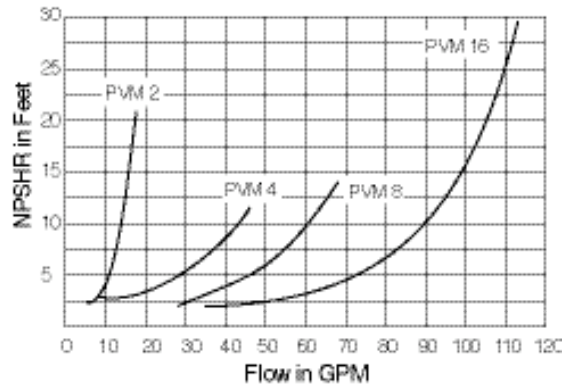


FIGURE 9 - PVM2 through PVM16
 Net Positive Suction Head Requirement (NPSHR)

TABLE VI – Vapor Pressure of Water

Temperature in °F (°C)	Vapor Pressure in PSIA (kPa)	Absolute Pressure in Feet (M) of Water
32 (0)	0.089 (.61)	0.205 (.062)
40 (4.4)	0.122 (.84)	0.281 (.086)
60 (15.6)	0.256 (1.77)	0.592 (.180)
80 (26.7)	0.507 (3.50)	1.172 (.358)
100 (37.8)	0.95 (6.55)	2.195 (.669)
120 (48.9)	1.695 (11.69)	3.914 (1.193)
140 (60.0)	2.892 (19.94)	6.681 (2.036)
160 (71.1)	4.745 (32.72)	10.961 (3.341)
180 (82.2)	7.515 (51.84)	17.36 (5.291)
200 (93.3)	11.529 (79.49)	26.632 (8.117)
210 (98.9)	14.125 (97.39)	32.629 (9.945)
212 (100)	14.698 (101.34)	33.952 (10.349)
220 (104.4)	17.188 (118.51)	39.704 (12.102)
230 (110.0)	20.78 (143.28)	48.002 (14.631)
240 (115.6)	24.97 (172.17)	57.681 (17.581)
248 (120.0)	28.79 (188.51)	66.505 (20.271)

MAINTENANCE

Motor Replacement

For Key Numbers, refer to the Exploded View, Figure 14, Page 14 for PVM2 and PVM4 Series Models, Figure 16, Page 16 for PVMI/X2 and PVMI/X4 Models, Figure 15, Page 15 for PVM8 and PVM16 Series Models, and Figure 17, Page 17 for PVMI/X8 and PVMI/X16 Series Models.

⚠ WARNING **Hazardous voltage.** Disconnect all power to the pump before servicing or working on pump. Make sure that power is locked out and that pump cannot be accidentally started.

1. Disconnect the power to the pump motor.
2. Close the nearest suction and discharge valves.
3. Remove the coupling guards (Key No. 4) by prying them loose with a screw driver.
4. Remove the socket head screws (Key No. 3) and the coupling halves (Key No. 2) from the shaft (Key No. 16A). For additional reference, see Figure 12, Page 10.

NOTICE: Socket head screws are metric. See Table VIII on Page 12 for specific metric driver sizes.

5. Remove the shaft pin (Key No. 5).
6. Remove the capscrews (Key No. 12), flatwashers (Key No.10), and lockwashers (Key No.11) that hold the motor (Key No. 1) and the motor bracket (Key No. 7) together.
7. Pull the old motor up and off of the motor bracket.

NOTICE: Note the location of the conduit box on the motor.

8. Thoroughly clean the surfaces of the mounting flanges on the new motor and the pump end.
9. Install the new motor on the pump with the conduit box in the desired position.
10. Lubricate the capscrews (Key No. 12) with oil.
11. Reinstall the lockwashers, flatwashers, and capscrews that hold the motor and the motor bracket together, then tighten evenly and diagonally. See Table VIII, Page 12 for torque specifications.
12. Reinstall the shaft pin (Key No. 5) in the shaft.
13. Reinstall the coupling halves (Key No. 2) on the pump and motor shaft. Make sure to engage the shaft pin (Key No. 5).

NOTICE: Be sure coupling surfaces are thoroughly clean prior to assembly.

14. Snug up the socket head screws (Key No. 3) until the coupling begins to bind and then loosen 1/2 turn.
15. Draw up the capscrews evenly so the gap between the coupling halves is equal on both sides (See Figure 10A).

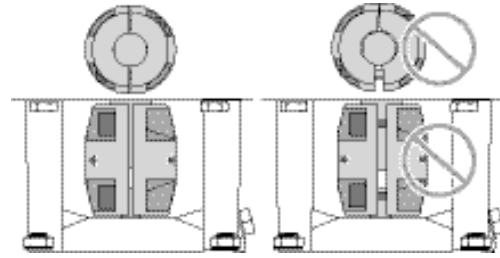


FIGURE 10A - Make Sure that the Coupling Halves are Evenly Tightened

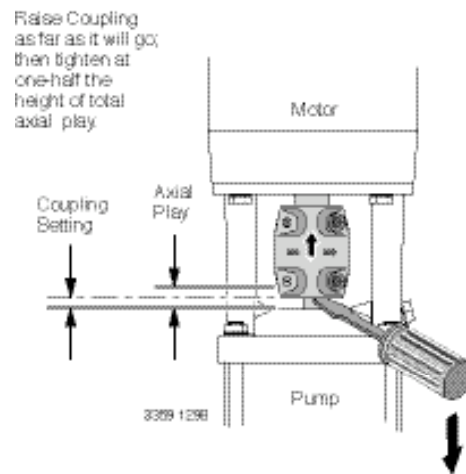


FIGURE 10B - Vertically (axial) Centering the Coupling

16. Insert a screw driver under the coupling (See Figure 10B).
17. Raise the pump shaft to its highest point.
18. Lower the shaft halfway back down the distance you just raised it and retighten the capscrews. See Figure 10.

NOTICE: Torque settings are critical to prevent coupling movement. Refer to Table VIII, Page 12 for torque specifications.

19. Rotate the shaft to make sure that there is no interference. If rubbing is noted repeat steps 16, 17, and 18 above and readjust pump shaft height.
20. Reinstall the coupling guards by snapping them into place.

NOTICE: The guards should be in place before the unit is run.

21. Open the suction and discharge valves. Turn the power back on.

Replacing Pump Stack

For Key Numbers, refer to the Exploded View, Figure 14 on Page 14, for the PVM2 and PVM4 Series Models and Figure 15 on Page 15 for PVM8 and PVM16 Series Models.

WARNING **Hazardous pressure.** Do not run pump with discharge valve closed; the water in the pump may boil, causing risk of explosion and steam burns to anyone nearby.

1. Follow steps 1-8 under “Motor Replacement” section on Page 9; then proceed with step 2 below.
2. Remove the four staybolt nuts, flatwashers, and lockwashers (Key Nos. 8, 9A, and 9B) from the staybolts (Key No. 19).

NOTICE: It is not necessary to remove the staybolts when replacing the stack.

3. Lift the motor bracket (Key No. 7) off of the pump body.

NOTICE: Note the position of the priming plug. The priming plug must be returned to its original position during reassembly.

4. Remove and discard upper sleeve gasket (Key No. 17).
5. Clean gasket seat.
6. Remove and replace round spring ring (PVM2 and PVM4) or stack spring (PVM8 and PVM16) (Key No. 13).
7. Pull the old stack (16A through 16L) out of the stainless steel sleeve (Key No. 18) by pulling straight up on the pump shaft (Key No. 16A).
8. Remove the stainless steel sleeve (Key No. 18).
9. Remove and discard the bottom sleeve gasket (Key No. 17).
10. Clean the gasket seat.
11. Remove and discard the O-Ring (Key No. 21A) from the suction/discharge (Key No. 21 PVM2 and PVM4 only).
12. Cast Iron Models Only: Clean the O-Ring seat and install a new O-Ring (Key No. 21A).
13. Install a new lower sleeve gasket.
14. Install the new stack without the stainless steel sleeve.

NOTICE: Be sure to align either the small priming hole or the suction interconnector pin hole (located on the bottom stage of the stack) properly in the base of the Suction/Discharge (Key No. 21). See Figure 11 (not necessary on PVM1/X models).

15. Use a rubber mallet to tap the stainless steel sleeve (Key No. 18) into place.
16. Install a new mechanical shaft seal (Key Nos. 14A and 14B, or Key Nos 15A through 15G). Refer to “Mechanical Seal Disassembly and Mechanical Seal Reassembly” sections, Pages 11 and 12.
17. Install a new upper sleeve gasket (Key No. 17).

18. Install a new round spring ring or stack spring (Key No. 13).
19. Reinstall the motor bracket (Key No. 7) on the pump body. Align the priming plug (Key No. 6) to its original position.
20. Oil the threads on the staybolts (Key No. 19).
21. Replace the lockwashers, flatwashers, and staybolt nuts (Key Nos. 8, 9A and 9B) and cross-torque the staybolts. See Table VIII, Page 12, for torque specifications.
22. Reinstall the motor (Key No. 1) on the motor bracket (Key No. 7) and turn the motor to the desired terminal box position.
23. Follow steps 10 - 21 under “Motor Replacement”, Page 9. You have now finished changing out the impeller stack.

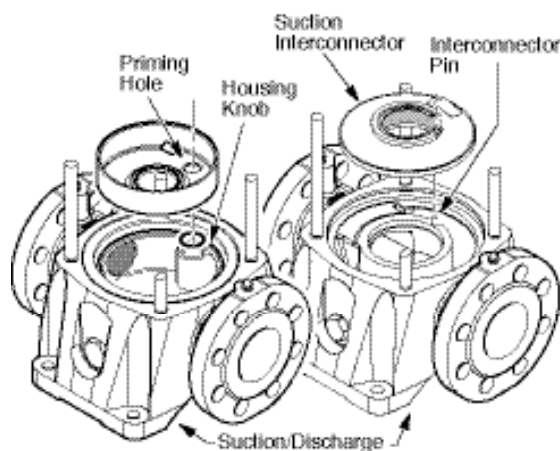


FIGURE 11 - PVM2, PVM4 – Align Small Priming Port. PVM8, PVM16 – Align Interconnector Pin. No alignment is necessary on PVM1/X models.

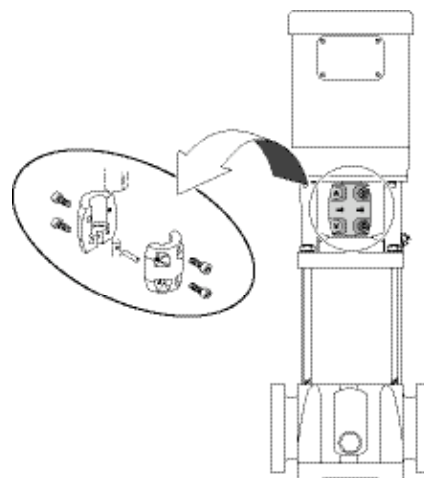


FIGURE 12 - Remove the Socket Head Screws and the Coupling Halves

Seven Part Mechanical Seal/Disassembly:

See Figure 13 for Seal Key Numbers.

See Figures 14 through 17 for Pump Key Numbers.

WARNING Hazardous voltage. Can Shock, burn or cause death. Disconnect power to pump before disassembly.

1. Follow Steps 1-8 under "Motor Replacement" Page 9, and proceed with step 2 below.
2. Remove the four nuts, lockwashers, and washers (Key Nos. 8, 9A, and 9B) from the staybolts (Key No. 19).
3. The shaft seal consists of an O-Ring (Key No. 15A), the stationary half of the mechanical seal (Key No. 15B), the rotating half of the mechanical seal (Key No. 15C), a second O-Ring (Key No. 15D - inside No. 15C), a flat washer (Key No. 15E), a spring (Key No. 15F), and a mechanical drive ring (Key No. 15G), in that order, see Figure 13, below. Turn the pump head upside down and remove the stationary part of the seal (Key No. 15B) from the seal seat in the base of the motor bracket.

NOTICE: Use care not to chip or scratch the seal seat during disassembly and assembly.

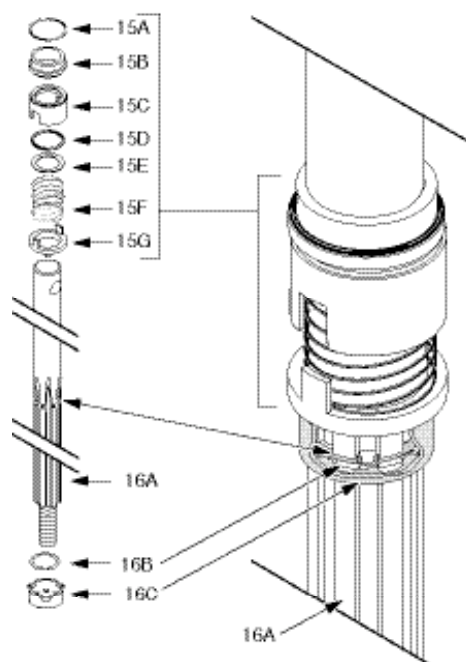


FIGURE 13

4. Clean the seal seat with a wet cloth.
5. Remove the rotating parts of the seal by twisting and pulling up on them until they come off of the shaft (Key Nos. 15C and 15D, 15E, 15F, and 15G). Discard the old seal.

Seven Part Mechanical Seal Reassembly:

NOTICE: Before assembly check and clean all sealing and gasket surfaces with a clean wet cloth. Replace all seals, gaskets, and O-Rings.

1. Turn the motor bracket (Key No. 6) upside down.
2. Moisten the seal seat (in the motor bracket) with a small amount of water.
3. Lubricate the larger diameter O-Ring (Key No. 15A) with a small amount of water and install it on the stationary half of mechanical seal (Key No. 15B).
4. Press the stationary half of the shaft seal (Key No. 15B) with O-Ring (Key Nos. 15A and 15B) into the seal seat of the motor bracket. Use finger pressure only. If a tool is used, protect the seal face from tools with a clean cloth.
- NOTICE:** Be sure the seal is installed evenly to avoid pinching the O-Ring.
5. Lubricate smaller diameter O-Ring (Key No. 15D) with water and press it into the rotating half of the mechanical seal (Key No. 15C).
6. Install the mechanical drive ring (Key No. 15G) on the shaft (Key No. 16A). Be sure the drive ring butts up against the mechanical seal spacer (Key No. 16C).
7. Install the spring (Key No. 15F) up against the drive ring on the shaft.
8. Install the flatwasher (Key No. 15E) on the shaft, against the spring.
9. Install the rotating half of the mechanical seal (Key No. 15C) on the shaft. Align the grooves on the rotating half of the mechanical seal with the teeth on the mechanical drive ring (Key No. 15G).
10. Follow Steps 11 - 23 under "Replacing Pump Stack", Page 10.

Frequency of Starts and Stops

Check pump cycling frequency and make sure that the pump is not starting more than:

TABLE VII – Maximum Number of Cycles

Cycles	Motor HP Rating
20 times per hour	1/2 - 5 HP motors
15 times per hour	7- 1/2 - 15 HP motors
10 times per hour	20 and 25 HP motors

Frost Protection

1. If you do not use your pump during seasons of frost, drain it and add a glycol based antifreeze (50/50 mixture) to avoid damage.



Risk of water damage and injury. Watch the direction of the priming plug and make sure that liquid escaping from it does not injure persons nearby or damage the motor or other components. In hot water installations, pay particular attention to the risk of injury from scalding hot water.

2. Upon restart dispose of spent antifreeze properly.
3. Do not replace the drain plug or tighten the priming plug until you put the pump back in service again.

Regular Maintenance Checks

The following checks should be made at regular intervals:

1. The pump meets required performance and is operating smoothly and quietly.
2. There are no leaks.
3. The motor is not overheating.
4. Remove and clean all strainers and filters in the system.
5. Verify amp draw – check motor amperage.
6. Pump wear rings and shaft require no regular maintenance.

TABLE VIII – Torque Specifications (foot-lbs.) For Cast Iron and Stainless Steel Models

Pump Model Number	Coupling			Motor		Staybolt		Stack Nut	
	Socket Head Screw M6 x 20	Socket Head Screw M8 x 25	Socket Head Screw M10 x 25	Capscrew Hex Head 3/8 x 1-1/2	Capscrew Hex Head 1/2 x 1-1/2	Hex Nut 1/2 - 13	Hex Nut 5/8 - 11	Hex Nut M8	Hex Nut M12
PVM2 Series	15	20	–	30	35	45	–	10	–
PVM4 Series	15	20	–	30	35	45	–	10	–
PVM8 Series	15	20	45	30	35	–	75	–	30
PVM16 Series	–	20	45	–	35	–	75	–	30

TROUBLESHOOTING GUIDE



Hazardous voltage and risk of sudden starts. Disconnect all power to the pump before servicing or working on pump. Make sure that power is locked out and that pump cannot be accidentally started.

PROBLEM	CAUSE
1. Motor does not run when started	<ul style="list-style-type: none"> A. Power failure B. Fuses blown C. Motor starter overload has tripped out D. Main contacts in motor starter are not making contact or the coil is faulty E. Control circuit fuses are defective F. Motor is defective
2. Motor starter overload trips out immediately when power supply is switched on	<ul style="list-style-type: none"> A. One fuse has blown B. Contacts in motor overload relay are faulty C. Cable connections are loose or faulty D. Motor winding is defective E. Pump mechanically blocked F. Overload setting is too low
3. Motor starter overload trips out occasionally	<ul style="list-style-type: none"> A. Overload setting is too low B. Low voltage at peak times
4. Motor starter has not tripped out but the motor does not run	<ul style="list-style-type: none"> A. Check 1 A), B), D,) and E)
5. Pump capacity is not constant	<ul style="list-style-type: none"> A. Pump inlet pressure is too low B. Suction pipe/pump partly blocked C. Pump is sucking air
6. Pump runs but gives no water	<ul style="list-style-type: none"> A. Suction pipe/pump blocked B. Foot or non-return valve is blocked in closed position C. Leakage in suction pipe D. Air in suction pipe or pump E. Motor rotates in the wrong direction
7. Pump runs backwards when switched off	<ul style="list-style-type: none"> A. Leakage in suction pipe B. Foot or non-return valve is defective C. Foot valve is blocked in open or partly open position D. Non return valve leaks or is blocked in open or partly open position E. Discharge valve is defective
8. Leakage from shaft seal	<ul style="list-style-type: none"> A. Pump shaft position is incorrect B. Shaft seal is defective
9. Noise	<ul style="list-style-type: none"> A. Cavitation is occurring in the pump B. Pump does not rotate freely (That is, there is increased frictional resistance) because of incorrect shaft position

**PVM2
PVM4**

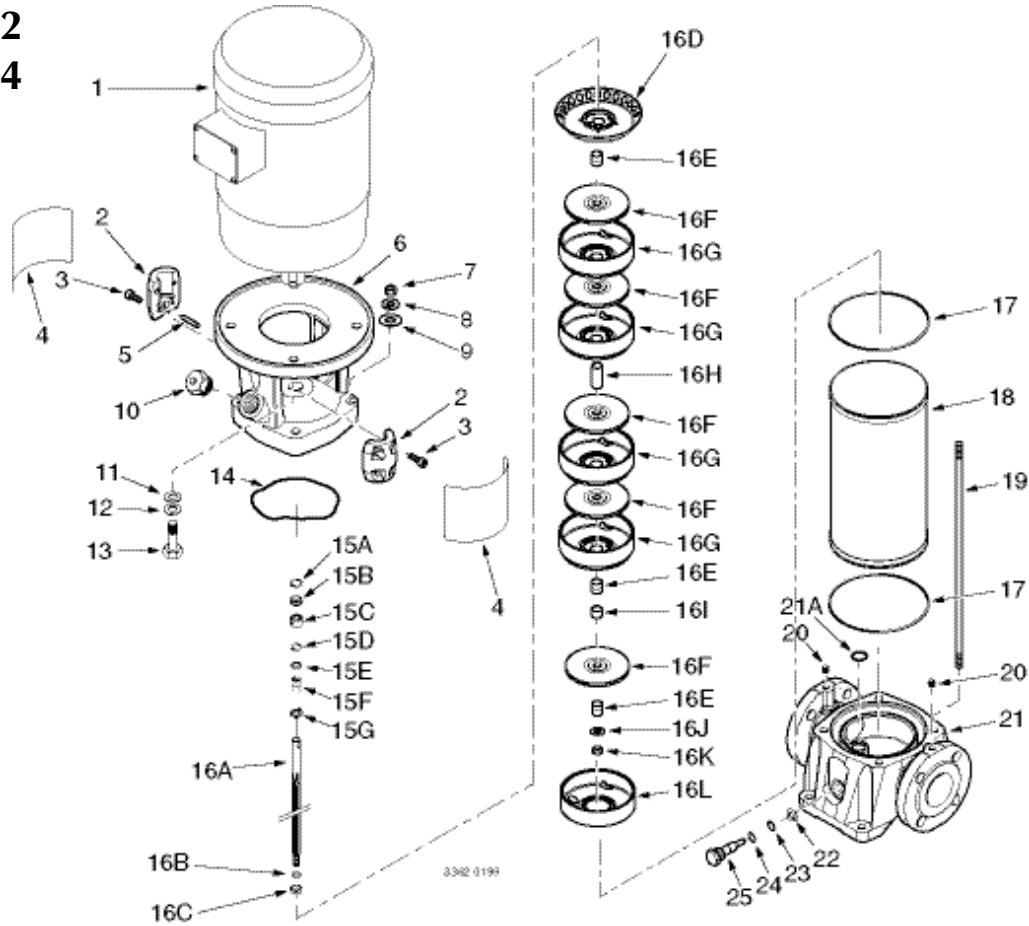


FIGURE 14 - Exploded View PVM2 and PVM4

SEE KIT SECTION FOR STACK KITS, SEAL KITS, GASKETS AND FANGE KITS

Key No.	Description	Key No.	Description
1	Motor	15G	Mechanical Drive Ring
2	Coupling Half	16	Replacement Stack Kit (Incl. Key Nos. 16A thru 16L)
3	Socket Head Screw	16A	Shaft
4	Coupling Guard	16B	Stop Ring
5	Coupling Pin	16C	Mechanical Seal Spacer
6	Vented Priming Plug	16D	Upper Intermediate Chamber
7	Motor Bracket	16E	Spacer
8	Staybolt Nut	16F	Impeller
9A	Staybolt Lockwasher	16G	Diffuser
9B	Staybolt Flat Washer	16H	Spacer
10	Flatwasher	16I	Bearing
11	Lockwasher	16J	Shaft Washer
12	Capscrew	16K	Nut
13	Spring Ring	16L	Chamber without Diffuser
14	Two part Mechanical Seal (Includes 14A and 14B)	17	Sleeve Gasket
14A	Stationary Half of Mechanical Seal	18	Stainless Steel Sleeve
14B	Rotating Half of Mechanical Seal	19	Staybolt
15	Seven Part Mechanical Seal (Includes 15A thru 15G)	20	Pipe Plug
15A	O-Ring, Larger Diameter	21	Suction/Discharge
15B	Stationary Half of Mechanical Seal	21A	O-Ring (Bottom Chamber)
15C	Rotating Half of Mechanical Seal	22	Drain Plug Gasket
15D	O-Ring, Smaller Diameter	23	O-Ring
15E	Flat Washer	24	O-Ring
15F	Spring	25	Drain Plug

PVM8 PVM16

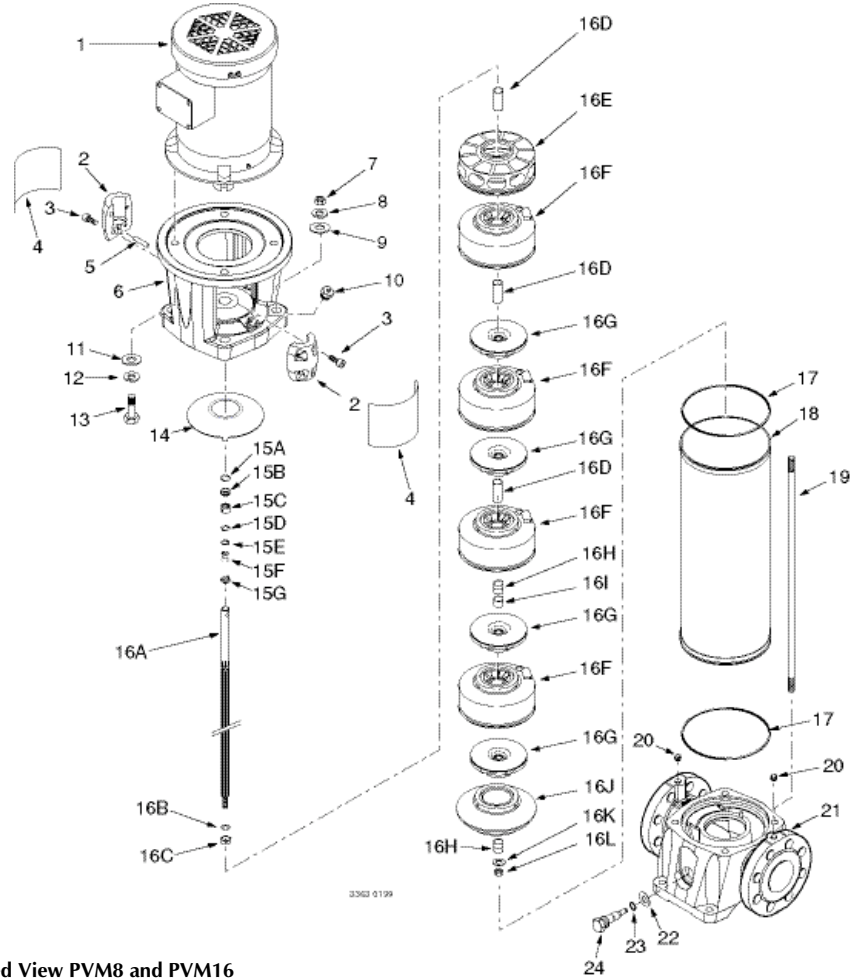


Figure 15 - Exploded View PVM8 and PVM16

SEE KIT SECTION FOR STACK KITS, SEAL KITS, GASKETS AND FANGE KITS

Key No.	Description	Key No.	Description
1	Motor	15G	Mechanical Drive Ring
2	Coupling Half	16	Replacement Stack Kit (Incl.16A thru 16L)
3	Socket Head Screw	16A	Shaft
4	Coupling Guard	16B	Stop Ring
5	Coupling Pin	16C	Mechanical Seal Spacer
6	Vented Priming Plug	16D	Upper Intermediate Chamber
7	Motor Bracket	16E	Spacer
8	Staybolt Nut	16F	Impeller
9A	Staybolt Lockwasher	16G	Diffuser
9B	Staybolt Flat Washer	16H	Spacer
10	Flat Washer	16I	Bearing
11	Lock Washer	16J	Shaft Washer
12	Capscrew	16K	Nut
13	Spring Ring	16L	Chamber without Diffuser
14	Two Part Mechanical Seal (Includes 14A and 14B)	17	Sleeve Gasket
14A	Stationary Half of Shaft Seal	18	Stainless Steel Sleeve
14B	Rotating Half of Shaft Seal	19	Staybolt
15	Seven Part Mechanical Seal (Includes 15A thru 15G)	20	Pipe Plug
15A	O-Ring, Larger Diameter	21	Suction/Discharge
15B	Stationary Half of Mechanical Seal	21A	O-Ring (Bottom Chamber)
15C	Rotating Half of Mechanical Seal	22	Drain Plug Gasket
15D	O-Ring, Smaller Diameter	23	O-Ring
15E	Flat Washer	24	O-Ring
15F	Spring	25	Drain Plug

**PVMI/X2
PVMI/X4**

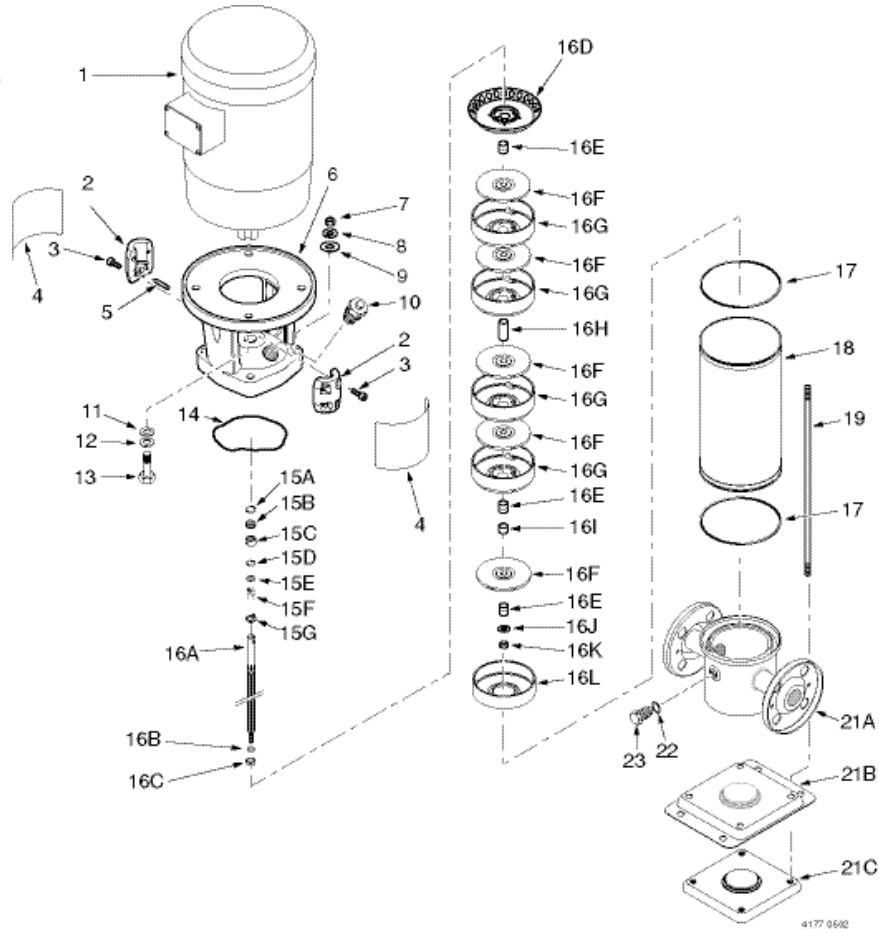


FIGURE 16 - Exploded View PVMI/X2 and PVMI/X4

SEE KIT SECTION FOR STACK KITS, SEAL KITS, GASKETS AND FANGE KITS

Key No.	Description	Key No.	Description
1	Motor	15G	Mechanical Drive Ring
2	Coupling Half	16	Replacement Stack Kit (Incl. Key Nos. 16A thru 16L)
3	Socket Head Screw	16A	Shaft
4	Coupling Guard	16B	Stop Ring
5	Coupling Pin	16C	Mechanical Seal Spacer
6	Motor Bracket	16D	Upper Intermediate Chamber
7	Staybolt Nut	16E	Spacer
8A	Staybolt Lockwasher	16F	Impeller
8B	Staybolt Flat Washer	16G	Diffuser
9	Vented Priming Plug	16H	Spacer
10	Flatwasher	16I	Bearing
11	Lockwasher	16J	Shaft Washer
12	Capscrew	16K	Nut
13	Spring Ring	16L	Chamber without Diffuser
14	Two part Mechanical Seal (Includes 14A and 14B)	17	Sleeve Gasket
14A	Stationary Half of Mechanical Seal	18	Stainless Steel Sleeve
14B	Rotating Half of Mechanical Seal	19	Staybolt
15	Seven Part Mechanical Seal (Includes 15A thru 15G)	21A	Suction/Discharge
15A	O-Ring, Larger Diameter	21B	Base
15B	Stationary Half of Mechanical Seal	21C	Base Reinforcement
15C	Rotating Half of Mechanical Seal	22	O-Ring
15D	O-Ring, Smaller Diameter	23	O-Ring
15E	Flat Washer	24	Drain Plug (Low Pressure Side)
15F	Spring	25	Drain Plug (High Pressure Side)

**PVMI/X8
PVMI/X16**

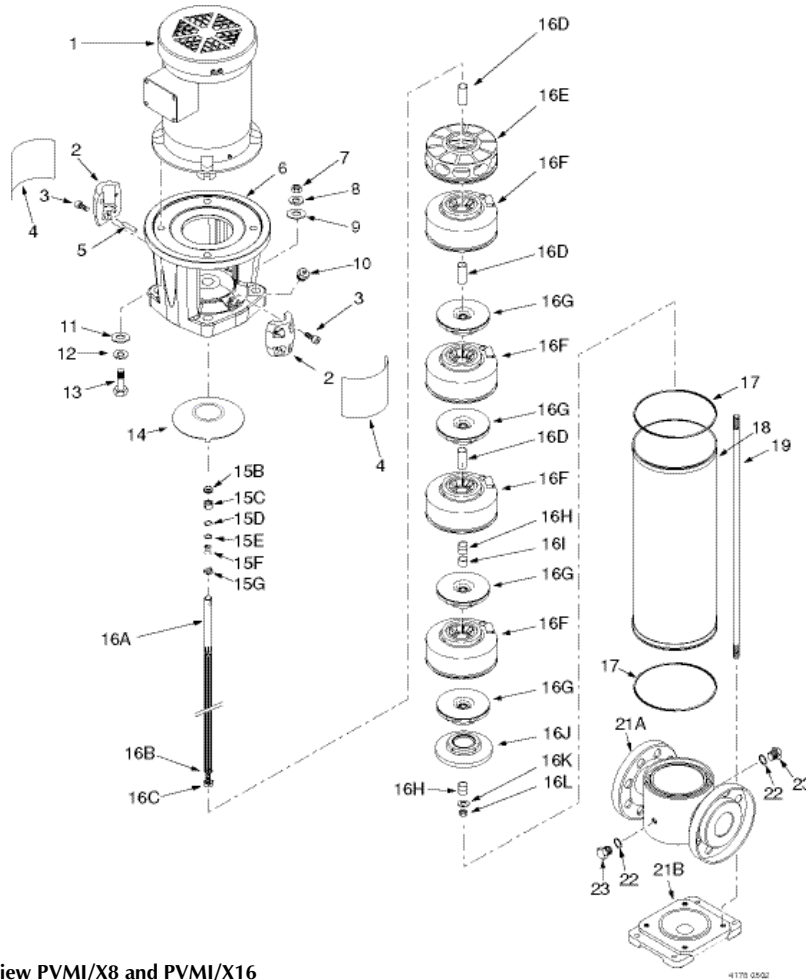


Figure 17 - Exploded View PVMI/X8 and PVMI/X16

SEE KIT SECTION FOR STACK KITS, SEAL KITS, GASKETS AND FANGE KITS

Key No.	Description	Key No.	Description
1	Motor	15G	Mechanical Drive Ring
2	Coupling Half	16	Replacement Stack Kit (Incl.16A thru 16L)
3	Socket Head Screw	16A	Shaft
4	Coupling Guard	16B	Stop Ring
5	Coupling Pin	16C	Mechanical Seal Spacer
6	Vented Priming Plug	16D	Spacer
7	Motor Bracket	16E	Top Diffuser
8	Staybolt Nut	16F	Diffuser
9A	Staybolt Lockwasher	16G	Impeller
9B	Staybolt Flat Washer	16H	Spacer
10	Flat Washer	16I	Bearing
11	Lock Washer	16J	Suction Interconnector
12	Capscrew	16K	Washer
13	Spring Ring	16L	Lock Nut
14	Two Part Mechanical Seal (Includes 14A and 14B)	17	Sleeve Gasket
14A	Stationary Half of Shaft Seal	18	Stainless Steel Sleeve
14B	Rotating Half of Shaft Seal	19	Staybolt
15	Seven Part Mechanical Seal (Includes 15A thru 15G)	21A	Suction/Discharge
15A	O-Ring, Larger Diameter	21B	Base
15B	Stationary Half of Mechanical Seal	22	O-Ring
15C	Rotating Half of Mechanical Seal	23	O-Ring
15D	O-Ring, Smaller Diameter	24	Drain Plug (Low Pressure Side)
15E	Flat Washer	25	Drain Plug (High Pressure Side)
15F	Spring		

