68FR PLUNGER PUMP SERVICE MANUAL

68 FRAME BLOCK-STYLE MANIFOLD [6811, 6821, 6831, 6841, 6861] [6811K, 6821K, 6831K, 6841K, 6861K]

CAUTION: CAT PUMPS are positive displacement pumps. Therefore, a properly designed pressure RELIEF OR SAFETY VALVE MUST BE INSTALLED in the discharge piping. Failure to install such a relief mechanism could result in personal injury or damage to the pump or system. CAT PUMPS does not assume any liability or responsibility for the operation of a customer's high pressure system.

INSTALLATION AND START-UP INFORMATION

Optimum performance of the pump is dependent upon the entire fluid system and will be obtained only with the proper selection, installation of plumbing and operation of the pump and accessories.

SPECIFICATIONS: Maximum specifications refer to individual attributes. It is **not** implied that **all maximums** can be performed **simultaneously**. If more than one maximum is considered, check with your CAT PUMPS supplier to confirm the proper performance and pump selection.

LUBRICATION: Fill crankcase with special CAT PUMP oil per pump specifications [320 oz. (10 Qts.)]. DO NOT RUN PUMP WITHOUT OIL IN CRANKCASE. Change initial fill after 50 hours running period. Thereafter, change oil every **3 months or 500 hour intervals. Oiler adjustment** is vertical to start feed, horizontal to stop feed, dial to adjust flow rate. Additional lubrication may be required with increased hours of operation and temperature.

PUMP ROTATION: Pump was designed for forward rotation to allow optimum lubrication of the crosshead area. Reverse rotation is acceptable if the crankcase oil level is increased slightly above center dot to assure adequate lubrication.

PULLEY SELECTION: Select size of motor pulley required to deliver the desired volume from Horsepower Requirement and Pulley Selection Chart.

MOTOR SELECTION: The motor or engine driving the pump must be of adequate horsepower to maintain full RPM when the pump is under load. Select the electric motor from the Horsepower Requirement Chart according to required pump discharge volume, maximum **pressure at the pump** and drive losses of approximately 3-5%. Consult the manufacturer of gas or diesel engine for selection of the proper engine size.

Mount the pump on a rigid, horizontal surface in a manner to permit drainage of crankcase oil. An uneven mounting surface will cause extensive damage to the pump base. To minimize piping stress, **use appropriate flexible hose to inlet and discharge ports**. Use the correct belt; make sure pulleys are aligned. Excessive belt tension may be harmful to the bearings. Hand rotate pump before starting to be certain shaft and bearings are free moving.

LOCATION: If the pump is used in extremely dirty or humid conditions, it is recommended pump be enclosed. Do not store or operate in excessively high temperature areas or without proper ventilation.

INLET CONDITIONS: Refer to complete **Inlet Condition Check-List** in this manual before starting system. DO NOT STARVE THE PUMP OR RUN DRY.

C.A.T.: Installation of a C.A.T. (Captive Acceleration Tube) is recommended in applications with stressful inlet conditions such as high temperatures, booster pump feed, long inlet lines or quick closing valves.

DISCHARGE PLUMBING: OPEN ALL VALVES BEFORE STARTING SYSTEM to avoid deadhead overpressure condition and severe damage to the pump or system.

Install a **Pulsation Dampening** device mounted directly to the discharge line. Be certain the pulsation dampener (Purrrrr-o-lator) is properly precharged for the system pressure (see individual Purrrrr-o-lator data sheet.)

A **reliable Pressure Gauge** should be installed near the discharge outlet of the high pressure manifold. This is extremely important for adjusting pressure regulating devices and also for proper sizing of the nozzle or restricting orifice. The pump is rated for a maximum pressure; this is the **pressure** which would be **read at the discharge manifold of the pump**, NOT AT THE GUN OR NOZZLE.

A Pressure Regulator or Unloader Valve must be installed to prevent over pressurizing the pump, in the event the discharge or downstream plumbing becomes plugged or is turned off. Severe damage to the pump will result if this condition occurs without a relief valve in the line. **CAUTION: Failure to install such a safety valve will void the warranty on the pump. Discharge regulating devices should be at minimum pressure setting at start-up.** On systems over 2000 PSI SECONDARY PROTECTION is recommended by installing a pop-off valve, safety valve or rupture disc. START SYSTEM WITH ALL VALVES OPEN OR IN THE LOW PRESSURE SETTING.

If a large portion of the pumped liquid is by-passed (not used) when the high pressure system is running, this by-pass liquid should be routed to an adequately sized, baffled supply tank or to drain. If routed to the pump inlet, the **by-pass fluid can quickly develop excesive heat and result in damage to the pump.** A temperature control device to shut the system down within the pump limits or multiple THERMO VALVES must be installed in the by-pass line to protect the pump.

Use PTFE liquid (sparingly) or tape to connect accessories or plumbing. Exercise caution not to wrap tape beyond the last thread to avoid tape from becoming lodged in the pump or accessories. This condition will cause a malfunction of the pump or system.

NOZZLES: A worn nozzle will result in loss of pressure. Do not adjust pressure regulating device to compensate. Replace nozzle and reset regulating device to system pressure.

PUMPED FLUIDS: Some fluids may require a **flush between operations or before storing.** For pumping fluids other than water, contact your CAT PUMPS supplier.

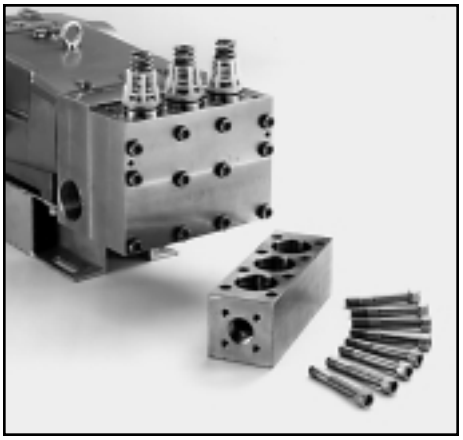
SPECIAL "K" MODELS: Standard pumps have internal weep holes between the V-Packings and Lo-Pressure Seals allowing the pumped liquid to cool the back side of the packings. The "K" models do not have the internal weep holes and do not connect to the inlet side. They have special holes on the sides of the inlet manifold that can be fitted to an external flushing system to provide this cooling and flushing. The "K" models can also withstand high inlet pressures. Consult factory.

STORING: For extended storing or between use in cold climates, drain all pumped fluids from pump and **flush with antifreeze solution to prevent freezing and damage** to the pump. DO NOT RUN PUMP WITH FROZEN FLUID.

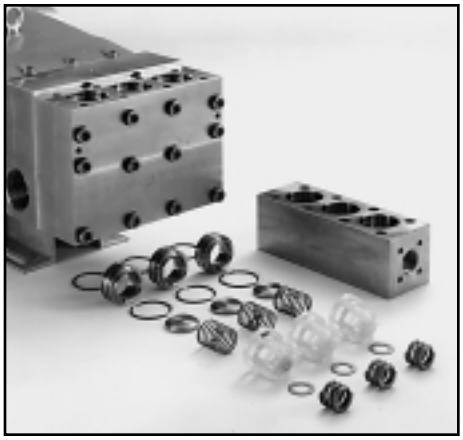
World Headquarters
CAT PUMPS
1681 - 94th Lane N.E. Minneapolis, MN 55449 - 4324
Phone (612) 780-5440 — FAX (612) 780-2958
e-mail: sales@catpumps.com
www.catpumps.com
International Inquiries
FAX (612) 785-4329
e-mail: intlsales@catpumps.com

The Pump with "Nine Lives"

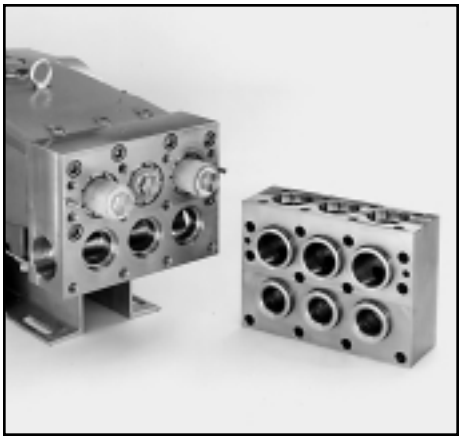
CAT PUMPS (U.K.) LTD.
1 Fleet Business Park, Sandy Lane, Church Crookham, Fleet
Hampshire GU13 OBF, England
Phone Fleet 44 1252-622031 — Fax 44 1252-626655
N.V. CAT PUMPS INTERNATIONAL S.A.
Heiveldekens 6A, 2550 Kontich, Belgium
Phone 32-3-450.71.50 — Fax 32-3-450.71.51
e-mail: cpi@catpumps.be www.catpumps.be
CAT PUMPS DEUTSCHLAND GmbH
Buchwiese 2, D-65510 Idstein, Germany
Phone 49 6126-93030 — Fax 49 6126-930333
e-mail: catpumps@t-online.de www.catpumps.de



6841, 6861
Discharge Block



6841, 6861
Discharge Valve Assemblies



6841, 6861
V-Packing Cylinder=Upper D.M. Chamber
Inlet Valve Assembly=Lower D.M. Chamber

SERVICING THE VALVES - 6861 and 6841

REMOVING THE DISCHARGE BLOCK [Discharge Valves]

Disassembly

1. To service the Discharge Valve Assembly, it is necessary to remove the Discharge Valve Block.
2. Using an allen wrench, remove the 8 Hex Socket Head Bolts from the top of the Discharge Valve Block and remove the Block from the Discharge Manifold.
   NOTE: The valve assemblies may stay with either the Valve Block or the Discharge Manifold.
3. If they stay in the Discharge Manifold, remove the Coil Spring and Washer from the top of the Spring Retainer. Then thread an M12x65 bolt into the top of the Spring Retainer and remove from the valve chamber.
4. If the Valve Assemblies remain in the Valve Block, remove the exposed O-Ring and Back-up-Ring. Then insert two screwdrivers on opposite sides into the Valve Seat groove and pry from the valve chamber.
5. Generally the Valve Assembly will remain together. To separate, thread an M12 x 65 bolt into the top of the Retainer until it comes into contact with the back of the valve and separates the Valve Seat from the Retainer. Each assembly consists of Retainer, Spring, Valve, Seat, O-Rings and Back-up-Rings.

Reassembly

NOTE: For certain applications apply liquid gasket to the O-Ring crevices and seal surfaces. See Tech Bulletin 53 for model identification.

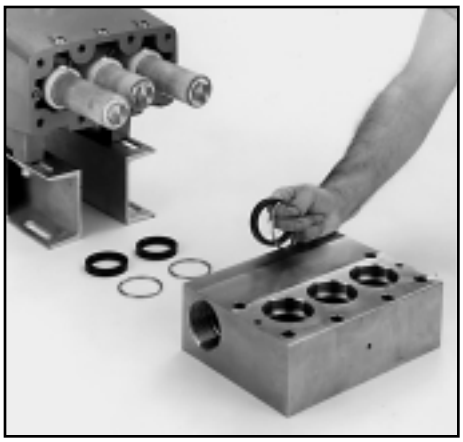
1. Examine the Spring Retainer for internal wear or breaks in the structure and replace as needed.
2. Examine the Spring for fatigue or breaks and replace as needed.
3. Examine the Valve for grooves, pitting or general wear and replace as needed.
4. Examine Valve Seat for grooves, pitting or general wear and replace as needed.
5. Examine the O-Ring and Back-up-Ring on the Valve Seat for cuts or wear and replace as needed.
6. The new Valve Assembly will come preassembled in the kit.
7. NOTE: If servicing from individual parts, place the new Valve Seat with O-Rings and Back-up-Rings on the work surface with the dished side up. Next place the Valve onto the Seat with the **dish side up.** Place the Spring onto the Valve. Then snap the Spring Retainer onto the Seat. Press the Valve Assembly into the valve chamber of the Discharge Manifold.
   NOTE: If servicing only the discharge valve assemblies, place the Coil Spring, then the Washer into the Valve Chamber. Then press the Valve Assembly into the Valve Chamber until completely seated. Then mount the Discharge Valve Block onto the Discharge Manifold. If also servicing the inlet valve assemblies, set the block aside and proceed to "REMOVING THE DISCHARGE MANIFOLD".

REMOVING THE DISCHARGE MANIFOLD [Inlet Valves]

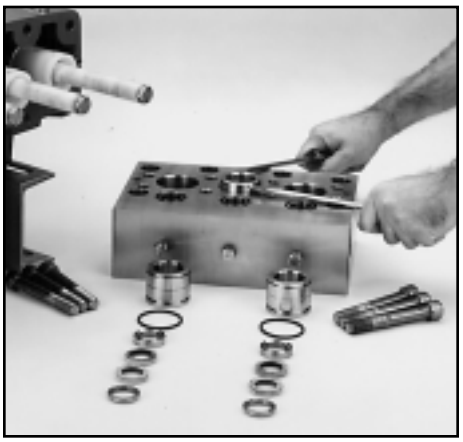
Disassembly

1. To service the Inlet Valves it is necessary to remove the Discharge Manifold.
2. Remove the two outer center M16 Hex Socket Head Bolts.
   NOTE: As an aid in supporting the manifold, replace these two bolts with two M16 x 280 studs (PN 88902).
3. Then remove the remaining M16 Hex Socket Head Bolts.
4. Insert two screwdrivers on opposite sides of the Discharge Manifold to begin separation from the Inlet Manifold.
   NOTE: For ease in handling the Discharge Manifold, thread in two M16 screws in the top outer holes.
   NOTE: If manifold blocks do not separate, insert two M8 x 60 rods into the two M10 holes located on the front face of the Discharge Manifold. Screw in two M10 screws until the two blocks separate.
5. Then grasp the Discharge Manifold from the sides and under these two screws and pull manifold over the support studs.
6. Place the Discharge Manifold on the work surface with the *crankcase side up.*

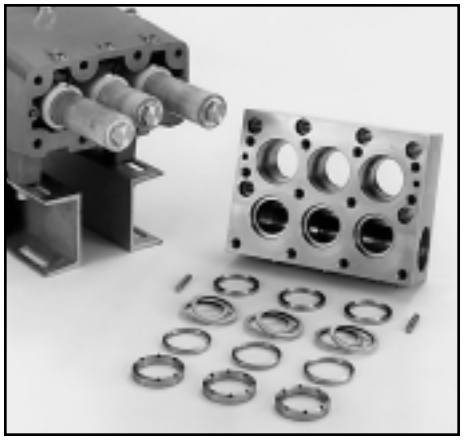
6841, 6861
Inlet Valve Assemblies and V-Packing Spacers



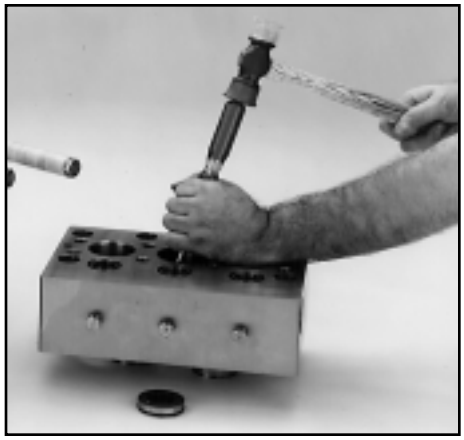
6831, 6861
Inlet Manifold and Lo-Pressure Seals



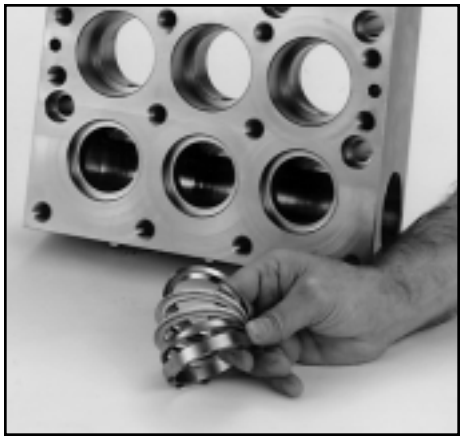
6811, 6821, 6841
Inlet Manifold and V-Packing Cylinder



6861
Inlet Manifold, V-Packings, Spacer with Coil Spring, Male Adapter, Female Adapter.



6861
Lo-Pressure Seal, Inlet Manifold



6861
Inlet Manifold and order of Packings

7. The Inlet Valve Assemblies will usually remain in the three lower chambers of the Inlet Manifold and the Coil Spring and Washer will remain in the Discharge Manifold.

Reassembly

NOTE: For certain applications apply liquid gasket to the O-Ring crevices and seal surfaces. See Tech Bulletin 53 for model identification.

1. The same procedure for serving the Discharge Valves should be followed for the Inlet Valve Assemblies.
   NOTE: If servicing only the valves, remount the Discharge Manifold and Discharge Valve Block or proceed to "SERVICING THE SEALS".

SERVICING THE SEALS - 6861 and 6841

Disassembly

1. To service the seals, it is necessary to remove both the Inlet and Discharge Manifold. Follow above procedure for removing the Discharge Manifold.
2. Both the standard and the "K" versions are serviced in the same manner. Inspect flushing system while servicing seals.

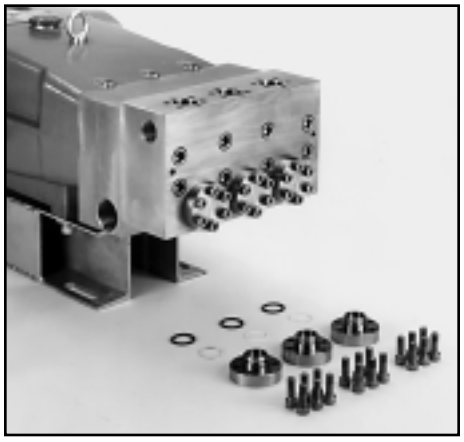
REMOVING THE INLET MANIFOLD

1. Remove the guide pins from the face of the Inlet Manifold.
2. Next remove the two top outer M16 Hex Socket Head Bolts.
   NOTE: As an aid in removing the Inlet Manifold, insert two M16 x 280 studs (PN 88902) in place of the removed screws. These will support the manifold during removal.
3. Remove the remaining M16 Hex Socket Head Bolts.
   NOTE: For ease in handling the Inlet Manifold, insert two of the M16 Hex Socket Head Bolts to act as handles.
4. Then grasp the manifold from the sides and below these screws and pull from the pump, placing the manifold on the work surface with the *crankcase side down*.
   NOTE: The V-Packing Cylinders may stay in the Discharge Manifold or the Inlet Manifold.
5. Insert two screwdrivers on opposite sides and pry the V-Packing Cylinders from the manifold.
6. On the Model 6861, remove the Spacer with Coil Springs from the Inlet Manifold by hand.
7. On the Model 6841, insert the two screwdrivers in opposite sides and carefully pry the V-Packing Spacer with Coil Springs from the cylinder.
8. Remove the Male Adapter, V-Packings and Female Adapter by hand or with a reverse pliers from the manifold (6861) from the cylinder (6841).
9. Place the Inlet Manifold on blocks with the *crankcase side down*.
10. Using a socket to fit the seal chamber, drive out the washer and Lo-Pressure Seal (6861) or Inlet Adapter and Lo-Pressure Seal (6841).
    NOTE: If socket is not available, use a screwdriver and tap on alternate sides of Spacer to work free.
    NOTE: See **Servicing Plungers** and **Servicing Crankcase** before starting reassembly.

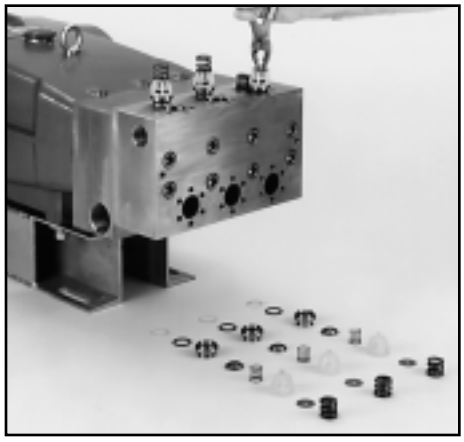
Reassembly

NOTE: For certain applications apply liquid gasket to the O-Ring crevices and seal surfaces. See Tech Bulletin 53 for model identification.

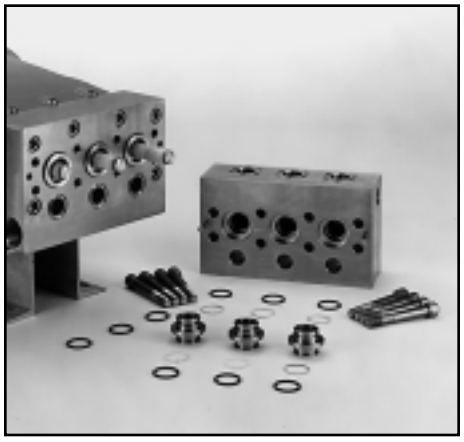
1. Invert the Inlet Manifold with the *crankcase side up*.
2. Place the washer (6861) into the Inlet Manifold.
3. Examine the Lo-Pressure Seal for wear to the internal ridges or broken spring and replace as needed.
4. Press the Lo-Pressure Seal into Inlet Manifold seal chamber with the *garter spring down* (6861).
5. Examine the Inlet Adapter for scale build up or wear and the outer O-Rings for cuts or deterioration and replace as needed (6841).
6. Press the Lo-Pressure Seal into the Inlet Adapter with the garter **spring up**, then press the Adapter into the Inlet Manifold with the **garter spring down** (6841).
7. Invert Inlet Manifold with *crankcase side down*.



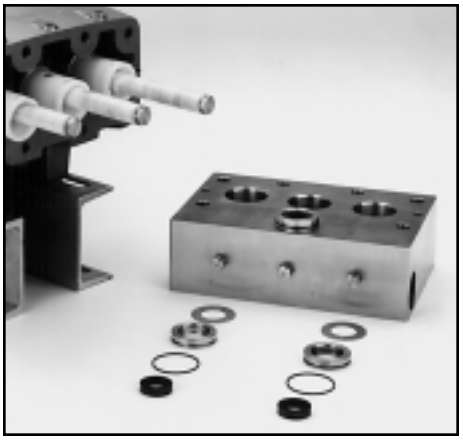
6811, 6821, 6831
Discharge Valve Plugs



6811, 6821, 6831
Valve Assemblies



6811, 6821, 6831
Inlet Manifold and V-Packing Spacers



6811, 6821, 6841
Inlet Manifold, Inlet Adapter and Lo-Pressure Seals

6811, 6821, 6831, 6841
Inlet Manifold and order of Packings

8. On the Model 6841, examine the V-Packing Cylinder O-Ring and replace if cut or worn. Insert the V-Packing Cylinder into the Inlet Manifold chamber with the O-Ring facing down.
9. Examine the Female Adapter for wear and replace as needed.
10. Insert the Female Adapter into manifold chamber (6861) or the V-Packing Cylinder (6841) with the *"V" side up* .
11. Examine the V-Packings for frayed edges or uneven wear and replace as needed.
12. Insert the V-Packings into the inlet manifold chamber (6861) or the V-Packing Cylinder (6841) with the *"V" side up*.
13. Examine the Male Adapter for wear and replace as needed.
14. Insert the Male Adapter into the manifold chamber (6861) or the V-Packing Cylinder (6841) with the *"V" side down*.
15. Next examine the Spacer with Coil Springs for wear or spring fatigue and replace as needed.
16. Insert Spacer with Coil Springs into seal chamber (6861) or the V-Packing Cylinder (6841) with the *springs facing in towards the Male Adapter*.

SERVICING THE VALVES - 6811, 6821, 6831

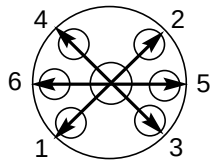
Disassembly

1. Both the Inlet and Discharge Valve Assemblies can be serviced without removing the Discharge Manifold.
2. Using a standard M8 allen wrench, remove the six hex socket head bolts on each of the valve plugs.
3. Lift the Valve Plugs with O-Ring and Back-up-Ring from the valve chambers.
4. Remove the Coil Spring and washer from the top of each Spring Retainer.
5. Generally the Valve Assembly will remain together. With a standard pliers, grasp the Retainer by the top tab and remove each of the Valve Assemblies.
   NOTE: If the Valve Assembly separates when removed (retainer comes out alone), lift the Spring and Valve from the chamber by hand. Insert the head of an M8 x 100 bolt into the valve chamber and under the the Valve Seat and lift out. This procedure will avoid damaging the surface of the Valve Seats.
   NOTE: To separate the valve assembly, insert a screwdriver into the side of the spring retainer behind the valve and apply pressure to the back of the valve.

Reassembly

NOTE: For certain applications apply liquid gasket to the O-Ring crevices and seal surfaces. See Tech Bulletin 53 for model identification.

1. Examine the Spring Retainer for internal wear or breaks in the structure and replace as needed.
2. Examine the Spring for fatigue or breaks and replace as needed.
3. Examine the surfaces of the Valves for pitting, grooves or general wear and replace as needed.
4. Examine the surfaces of the Valve Seats for pitting, grooves or general wear and replace as needed.
5. Examine the O-Rings and Back-up-Rings on the Valve Seat and replace if cut or worn. Lubricate for ease in installing into valve seat groove.
6. Next place the Valve Seat on the work surface with the dished side up. Place the Valve onto the Valve Seat with the **dished side down.** Locate the Valve Spring onto the Valve and place the Spring Retainer over the Spring onto the Valve Seat. **Snap the Valve Seat and Spring Retainer securely together.**
7. Press the Valve Assembly squarely into the valve chamber.
8. Place the Washer and then the Coil Spring on top of the Spring Retainer.
9. Examine the O-Ring and Back-up-Ring on the Valve Plug and replace if cut or worn. Carefully press valve plug into the valve chamber. **Exercise caution not to cut the O-Ring or Back-up-Ring.**
10. Replace the six hex socket bolts on each valve plug and hand tighten using the torque sequence shown. Then torque to specifications in chart. If servicing the seals proceed to "SERVICING THE SEALS".



TORQUE SEQUENCE

SERVICING THE SEALS - 6811, 6821, 6831

REMOVING THE DISCHARGE MANIFOLD

1. Remove the outer two M16 Hex Socket Head Bolts.
   NOTE: As an aid in removing the Discharge Manifold, insert two M16 x 280 studs (PN 88902) in place of the removed screws. These will support the manifold during removal.
2. Remove the remaining upper (M16) and lower (M12) Hex Socket Head Bolts.
3. Tap the rear side of the Discharge Manifold with a soft mallet to begin separation of the discharge manifold from the inlet manifold.
   NOTE: If Manifold blocks do not separate, inset two (M8 x 60) rods into the two M10 holes located at the front of the Discharge Manifold on the pump center line. Screw in two M10 screws until the two blocks are separate.
4. Insert two screwdrivers on opposite sides of the Discharge Manifold to start the separation from the Inlet Manifold.
   NOTE: For ease in handling the Discharge Manifold, insert two of the M16 hex socket head bolts into the two top outer holes to act as handles.
5. Then grasp the manifold from the sides and below these screws and pull from the pump, placing the Discharge Manifold on the work surface with the *crankcase side up*.

REMOVING THE INLET MANIFOLD

1. Remove the Guide Pins from the face of the Inlet Manifold.
2. First remove the top two M16 Hex Socket Head Bolts.
   NOTE: As an aid in removing the Inlet Manifold, insert two M16 x 280 studs (PN 88902) in place of the removed screws. These will support the manifold during removal.
3. Remove the remaining M16 Hex Socket Head Bolts.
   NOTE: For ease in handling the Inlet Manifold, insert two of the M16 hex socket head bolts to act as handles.
4. Then grasp the manifold from the sides and below these screws and pull from the pump.

NOTE: Two screwdrivers on opposite sides may be needed to assist in separating the manifold from the crankcase.
5. Remove the Inlet Manifold.

Disassembly

1. Place the Inlet Manifold on the work surface with the *crankcase side down*.
   NOTE: The V-Packing Spacers may stay in either Discharge or Inlet Manifold.
2. Remove the V-Packing Spacers by hand or by using two screwdrivers on opposite sides of exposed grooves from either the V-Packing Cylinders (6811, 6821) or from the Discharge Manifold if they stayed in these ports during separation (all models).
3. Next with a reverse pliers, remove the Male Adapter, V-Packings and Female Adapter from the V-Packing Cylinder (6811, 6821) or from the manifold chamber (6831).
4. Insert two screwdrivers on opposite sides into the outer groove on the V-Packing Cylinder and pry from the manifold chamber (6811, 6821).
5. Place the Inlet Manifold on blocks with the *crankcase side down*.
6. Using a socket to fit, drive out the Inlet Adapter with Lo-Pressure Seal (6811, 6821) or Spacer and Lo-Pressure Seal (6831).
   NOTE: If socket is not available, use a screwdriver and tap on alternate sides to work free.
7. Separate the Washer from the Inlet Adapter (6811, 6821).
8. Place the Inlet Adapter on the V-Packing Cylinder and with a screwdriver tap out the Lo-Pressure Seal (6811, 6821).
   NOTE: See **Servicing Plungers** and **Servicing Crankcase** before starting reassembly.

Reassembly

NOTE: For certain applications apply liquid gasket to the O-Ring crevices and seal surfaces. See Tech Bulletin 53 for model identification.

1. Invert the Inlet Manifold with the *crankcase side up*.
2. Examine the exterior O-Rings on the Inlet Adapter and replace if cut or worn (6811, 6821).
3. Lubricate the inside of the Adapter. Using a socket to fit, press in the new pre-greased Lo-Pressure Seal with the *garter spring facing up* (6811, 6821).
4. Place the Washer (6811, 6821) or the Spacer (6831) into the Inlet Manifold chamber.
5. Press the Inlet Adapter with O-Ring and Lo-Pressure Seal (6811, 6821) or Lo-Pressure Seal (6831) squarely into the manifold chamber with the *garter spring down*.
6. Invert the Inlet Manifold and place it on the work surface with the *crankcase side down*.
7. Examine the exterior O-Rings on the V-Packing Cylinder and replace if cut or worn (6811, 6821).
8. Press the V-Packing Cylinder, *O-Ring end first,* into the manifold chamber (6811, 6821).
9. Examine the Female Adapter for wear and replace as needed.
10. Lubricate the interior walls of the V-Packing Cylinder (6811, 6821) or the Inlet Manifold Seal Chambers (6831) and insert the Female Adapter with the *"V" side up*.
11. Examine the V-Packings for frayed edges, uneven wear and replace as needed.
12. Insert the V-Packing into the V-Packing Cylinder (6811, 6821) or into the Inlet Manifold (6831) with the *"V" side up*.
13. Examine the Male Adapter for wear and replace as needed.
14. Insert the Male Adapter into the V-Packing Cylinder (6811, 6821) or into the Inlet Manifold (6831) with the *"V" side down*.
15. Examine the O-Ring and Back-up-Ring on the V-Packing Spacer and the spacer for wear and replace as needed.
16. Press the V-Packing spacer into the V-Packing Cylinder.
    NOTE: Press the smaller diameter into the V-Packing Cylinder on Model 6821.

SERVICING THE INLET SPACER 6811, 6821 and 6831

Disassembly

1. After the Inlet Manifold is remounted onto the crankcase, remove the Inlet Spacer from the lower Inlet Manifold chambers. Examine for scale buildup or wear and replace as needed.
2. Examine the front and rear O-Ring and Back-up-Ring for wear and replace as needed.

Reassembly

NOTE: For certain applications apply liquid gasket to the O-Ring crevices and seal surfaces. See Tech Bulletin 53 for model identification.

1. Lubricate and install new Back-up-Ring first then the O-Ring on both front and rear of Inlet Spacer.
2. Press Inlet Spacer into Inlet Manifold.

SERVICING THE PLUNGERS ALL MODELS

Disassembly

1. Remove the Seal Retainers from the Ceramic Plungers.
2. Loosen the Plunger Retainer four to five turns and push the plunger **towards the crankcase** until the Plunger Retainer pops out.

Reassembly

1. Carefully examine the Ceramic Plungers for scoring or cracks and replace if worn. The surface of the ceramic plunger can be cleaned with a scotchbrite pad.
2. Examine Plunger Retainer with stud, O-Ring, Back-up-Ring and Gasket for wear or damage and replace as needed. It is recommended the O-Ring be replaced on schedule with the Lo-Pressure Seal.
3. Lubricate O-Ring for ease of installation. **Install Gasket, O-Ring and then Back-up-Ring** onto the plunger retainer.
4. Apply Locktite 242 to the exposed threads and thread the Plunger Retainer onto Plunger Rod by hand. Torque to specifications in chart. Exercise caution not to over torque.
5. **Models 6841, 6861:** Slip Seal Retainer over Plunger with the **wick end forward.**
   NOTE: The 6811 and 6821 have no wicks.

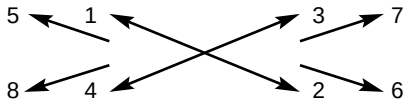
REPLACING THE INLET MANIFOLD ALL MODELS

1. Rotate crankshaft and line up the two outside plungers.
2. Screw two (M16 x 280) studs into top outer holes of crankcase to support the weight of the Inlet Manifold during reassembly.
3. Carefully replace Inlet Manifold over Ceramic Plungers and press into crankcase. Keep manifold aligned to avoid damage to the Plungers.
4. Replace the M16 hex socket bolts and hand tighten. Remove the M16 studs and replace with the standard hex socket screws. Torque in sequence to specifications in torque chart.

REPLACING THE DISCHARGE MANIFOLD ALL MODELS

1. Lubricate the Ceramic Plungers and valve chamber walls.
3. Reinstall the two guide pins into the Inlet Manifold.
4. To support the weight of the Discharge Manifold during reassembly, screw two M16 x 280 studs into the top outer holes of the Inlet Manifold.
5. Slide the Discharge Manifold over the studs and carefully push the manifold over the guide pins up flush with the Inlet Manifold. Exercise caution not to pinch or cut the exposed O-Rings.
6. Replace the M16 hex socket bolts and the lower M12 bolts on the 6811, 6821 into the Discharge Manifold and hand tighten. Remove the two M16 studs and replace the remaining two M16 hex socket bolts.
7. Torque in sequence to the specifications in the torque chart.
8. For Models 6841, 6861 replace the Discharge Valve Block. Replace the M16 hex socket Head Bolts and torque in sequence.

TORQUE SEQUENCE



SERVICING THE CRANKCASE SECTION ALL MODELS

1. While manifold, plungers and seal retainers are removed, examine crankcase seals for wear.
2. Check oil level and check for evidence of water in oil.
3. Rotate crankshaft by hand to feel for smooth bearing movement.
4. Examine crankshaft oil seal externally for drying, cracking or leaking.
5. Consult factory or your local distributor if crankcase service is required.

See Section VI and VII of the Plunger Pump Service Video for additional information.

PREVENTATIVE MAINTENANCE CHECK-LIST

Check	Daily	Weekly	50 hrs.	500 hrs.*	1500 hrs.**	3000 hrs.**
Clean Filters	x					
Oil Level/Quality	x					
Oil Leaks	x					
Water Leaks	x					
Belts, Pulley		x				
Plumbing		x				
Initial Oil Change			x			
Oil Change				x		
Seal Change					x	
Valve Change						x
Accessories					x	

*If other than CAT PUMPS special multi-viscosity ISO68 oil is used, change cycle should be every 300 hours.
**Each system's maintenance cycle will be exclusive. If system performance decreases, check immediately. If no wear at 1500 hours, check again at 2000 hours and each 500 hours until wear is observed. Valves typically every other seal change.
**Remember to service the regulator/unloader at each seal servicing and check all system accessories and connections before resuming operation.

TORQUE CHART

Pump Item / Pump Model	Thread	Tool Size [Part No.]	Torque in. lbs.	Torque ft. lbs.	Torque Nm
Plunger Retainer					
6811, 6821	M10	M21 Hex	220	18.1	25
6841, 6861	M14	M30 Hex	520	43.4	59
Inlet Manifold Bolts	M16	M14 Allen [33049]	620	51.6	70
Discharge Manifold Bolts	M16	M14 Allen [33049]	660	55.0	75
Discharge Manifold Bolts 6811, 6821, 6831 - Lower	M12	M10 Allen [33047]	355	29.6	40
Valve Plug Screws 6811, 6821, 6831	M10	M8 Allen [33046]	250	21.0	28
Valve Block Bolts 6841, 6861	M16	M14 Allen [33049]	660	55.0	75
Crankcase Cover/ Bearing Cover Screws	M10	M17 Hex [25083]	220	18.1	25
Connecting Rod Screws	M10x1.25	M17 Hex [25083]	390	32.5	44
Bubble Oil Gauge	M28	Oil Gauge Tool [44050]	45	3.6	5

TECHNICAL BULLETIN REFERENCE CHART

No.	Subject	Models
003	3 PFR-68 PFR Drive Packages	3FR - 68FR Plunger Models
024	Lubrication of Lo-Pressure Seals	All Models
036	Cylinder and Plunger Reference Chart	All Models
043	Plunger Pump LPS and HPS Servicing	All Plunger Models
053	Liquid Gasket	5FR, 7FR, 15FR, 35FR, 60FR
064	By-Pass Hose Length	All Unloaders/Regulators
074	Piston and Plunger Pump Torque Chart	All Models
077	Oil Drain Kit	All Models

INLET CONDITION CHECK-LIST

Review Before Start-Up

Inadequate inlet conditions can cause serious malfunctions in the best designed pump. Surprisingly, the simplest of things can cause the most severe problems or go unnoticed to the unfamiliar or untrained eye. REVIEW THIS CHECK-LIST BEFORE OPERATION OF ANY SYSTEM. Remember, no two systems are alike, so there can be no **ONE** best way to set-up a system. All factors must be carefully considered.

INLET SUPPLY should be adequate to accommodate the maximum flow being delivered by the pump.

- ❏ Open inlet shut-off valve and turn on water supply to avoid cavitating pump. **DO NOT RUN PUMP DRY.**
- ❏ Avoid closed loop systems especially with high temperature, ultra-high pressure or large volumes. Conditions vary with regulating/unloader valve.
- ❏ Low vapor pressure fluids, such as solvents, require a booster pump and C.A.T. (Captive Acceleration Tube) to maintain adequate inlet supply (where compatible).
- ❏ Higher viscosity fluids require a positive head and a C.A.T. (Captive Acceleration Tube) to assure adequate inlet supply.
- ❏ Higher temperature fluids tend to vaporize and require positive heads and C.A.T. (Captive Acceleration Tube) to assure adequate inlet supply.
- ❏ When using an inlet supply reservoir, size it to provide adequate fluid to accommodate the maximum output of the pump, generally a minimum of 6-10 times the GPM (however, a combination of system factors can change this requirement); provide adequate baffling in the tank to eliminate air bubbles and turbulence; install diffusers on all return lines to the tank.

INLET LINE SIZE should be adequate to avoid starving the pump.

- ❏ Line size must be a minimum of one size larger than the pump inlet fitting. Avoid thick walled fittings, tees, 90 degree elbows or valves in the inlet line of the pump to reduce the risk of flow restriction and cavitation.
- ❏ The line MUST be a FLEXIBLE hose, NOT a rigid pipe, and reinforced on SUCTION systems to avoid collapsing.
- ❏ The simpler the inlet plumbing the less the potential for problems. Keep the length to a minimum, the number of elbows and joints to a minimum (ideally no elbows) and the inlet accessories to a minimum.
- ❏ Use pipe sealant to assure air-tight, positive sealing pipe joints.

INLET PRESSURE should fall within the specifications of the pump.

- ❏ Acceleration loss of fluids may be increased by high RPM, high temperatures, low vapor pressures or high viscosity and may require pressurized inlet and C.A.T. (Captive Acceleration Tube) to maintain adequate inlet supply. DO NOT USE C.A.T. (Captive Acceleration Tube) WITH SUCTION INLET
- ❏ Optimum pump performance is obtained with +20 PSI (1.4 BAR) inlet pressure and a C.A.T. for certain applications. With adequate inlet plumbing, most pumps will perform with flooded suction. Maximum inlet pressure is 50 PSI (3.5 BAR).
- ❏ After prolonged storage, pump should be purged of air to facilitate priming, Disconnect any discharge port and allow fluid to pass through pump.

INLET ACCESSORIES are offered to protect against over pressurization, contamination or temperature and control flow.

- ❏ A shut-off valve is recommended to facilitate maintenance.
- ❏ Installation of a C.A.T. (Captive Acceleration Tube) is essential in applications with stressful conditions such as high temperatures, booster pump feed or long inlet lines. **Do not use C.A.T. with negative inlet pressure.**
- ❏ A stand pipe can be used in some applications to help maintain a positive head in the inlet line.
- ❏ Inspect and clean inlet filters on a regular schedule.
- ❏ A glycerin filled pressure gauge is recommended to monitor the inlet pressure and should be mounted AS CLOSE TO THE PUMP INLET as possible. **Short term, intermittent cavitation will not register on a standard gauge.**
- ❏ All accessories should be sized to avoid restricting the inlet flow.
- ❏ All accessories should be compatible with the solution being pumped to prevent premature failure or malfunction.

BY-PASS TO INLET Care should be exercised when deciding the method of by-pass from control valves.

- ❏ It is recommended the by-pass be directed to a baffled reservoir tank, with at least one baffle between the by-pass line and the inlet line to the pump.
- ❏ Although not recommended, by-pass fluid may be returned to the inlet line of the pump if the system is properly designed to protect your pump. When using this method a PRESSURE REDUCING VALVE should be installed on the inlet line (**BETWEEN** THE BY-PASS CONNECTION AND THE INLET TO THE PUMP) to avoid excessive pressure to the inlet of the pump when a flow sensitive regulating device is used. It is also recommended that a THERMO VALVE be used in the by-pass line to monitor the temperature build-up in the by-pass loop to avoid premature seal failure.
- ❏ A low-pressure, flexible cloth braid (not metal braid) hose should be used from the by-pass connection to the inlet of the pump.
- ❏ Caution should be exercised not to undersize the by-pass hose diameter and length. Refer to Technical Bulletin 64 for additional information on the size and length of the by-pass line.
- ❏ Check the pressure in the by-pass line to avoid over pressurizing the inlet.
- ❏ The by-pass line should be connected to the pump inlet line at a gentle angle of 45° or less and no closer than 10 times the pump inlet port diameter e.g. 1-1/2" port size = 15" distance from pump inlet port.

HOSE FRICTION LOSS

Water* Flow Gal/Min	PRESSURE DROP IN PSI PER 100 FT OF HOSE WITH TYPICAL WATER FLOW RATES Hose Inside Diameters, Inches						
	1/4	5/16	3/8	1/2	5/8	3/4	1"
0.5	16	5	2				
1	54	20	7	2			
2	180	60	25	6	2		
3	380	120	50	13	4	2	
4		220	90	24	7	3	
5		320	130	34	10	4	
6			220	52	16	7	1
8			300	80	25	10	2
10			450	120	38	14	3
15			900	250	80	30	7
20			1600	400	121	50	12
25				650	200	76	19
30					250	96	24
40					410	162	42
50					600	235	62
60						370	93

*At a fixed flow rate with a given size hose, the pressure drop across a given hose length will be directly proportional. A 50 ft. hose will exhibit one-half the pressure drop of a 100 ft. hose. Above values shown are valid at all pressure levels.

WATER LINE PRESSURE LOSS

PRESSURE DROP IN PSI PER 100 FEET

Water GPM	Steel Pipe—Nominal Dia. 1/4	3/8	1/2	3/4	1	1¼	1½	Brass Pipe—Nominal Dia. 1/4	3/8	1/2	3/4	1	1¼	1½	Copper Tubing O.D. Type L 1/4	3/8	1/2	5/8	3/4	7/8
1	8.5	1.9						6.0	1.6						120	13	2.9	1.0		
2	30	7.0	2.1					20	5.6	1.8					400	45	10	3.4	1.3	
3	60	14	4.5	1.1				40	11	3.6						94	20	6.7	2.6	
5	150	36	12	2.8				100	28	9.0	2.2					230	50	17	6.1	3.0
8	330	86	28	6.7	1.9			220	62	21	5.2	1.6				500	120	40	15	6.5
10	520	130	43	10	3.0			320	90	30	7.8	2.4					180	56	22	10
15		270	90	21	6.2	1.6			190	62	16	5.0	1.5					120	44	20
25		670	240	56	16	4.2	2.0		470	150	40	12	3.8	1.7				330	110	50
40					66	17	8.0					39	11	5.0				550	200	88
60						37	17						23	11						
80						52	29						40	19						
100					210	107	48						61	28						

RESISTANCE OF VALVES AND FITTINGS

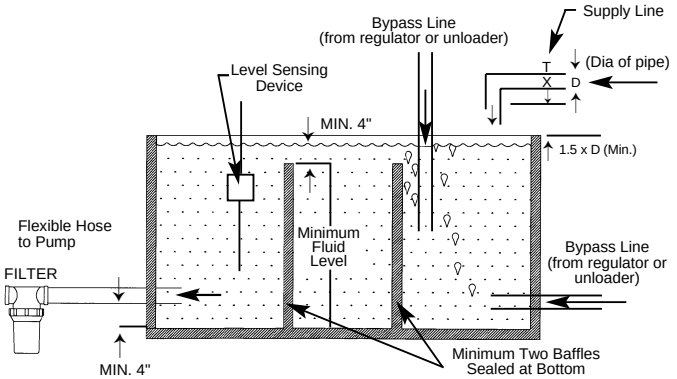
Nominal Pipe Size Inches	Inside Diameter Inches	Equivalent Length of Standard Pipe in Feet: Gate Valve	Globe Valve	Angle Valve	45° Elbow	90° Elbow	180° Close Ret	Tee Thru Run	Tee Thru Branch
1/2	0.622	0.41	18.5	9.3	0.78	1.67	3.71	0.93	3.33
3/4	0.824	0.54	24.5	12.3	1.03	2.21	4.90	1.23	4.41
1	1.049	0.69	31.2	15.6	1.31	2.81	6.25	1.56	5.62
1¼	1.380	0.90	41.0	20.5	1.73	3.70	8.22	2.06	7.40
1½	1.610	1.05	48.0	24.0	2.15	4.31	9.59	2.40	8.63
2	2.067	1.35	61.5	30.8	2.59	5.55	12.30	3.08	11.60
2½	2.469	1.62	73.5	36.8	3.09	6.61	14.70	3.68	13.20
3	3.068	2.01	91.5	45.8	3.84	8.23	18.20	4.57	16.40
4	4.026	2.64	120.0	60.0	5.03	10.80	23.90	6.00	21.60

Arriving at a total line pressure loss, consideration should then be given to pressure loss created by valves, fittings and elevation of lines.

If a sufficient number of valves and fittings are incorporated in the system to materially affect the total line loss, add to the total line length, the equivalent length of line of each valve or fitting.

TYPICAL RESERVOIR TANK

RECOMMENDED 6 TO 10 TIMES SYSTEM CAPACITY



Handy Formulas to Help You

Q. **How can I find the RPM needed to get specific GPM (Gallons Per Minute) I want?**

A. Desired RPM = Desired GPM x $\frac{\text{Rated RPM}}{\text{Rated GPM}}$

Q. **I have to run my pump at a certain RPM. How do I figure the GPM I'll get?**

A. Desired GPM = Desired RPM x $\frac{\text{Rated GPM}}{\text{Rated RPM}}$

Q. **Is there a simple way to find the approximate horsepower I'll need to run the pump?**

A. Electric Brake Horsepower Required = $\frac{\text{GPM x PSI}}{1460}$ (Standard 85% Mech. Efficiency)

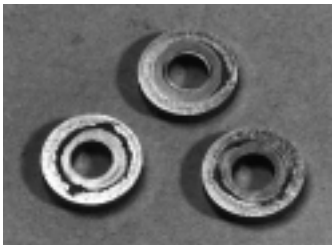
Q. **What size motor pulley should I use?**

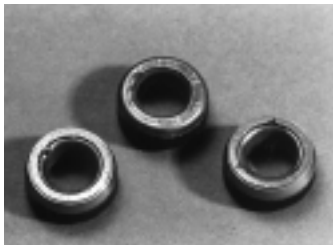
A. Pump Pulley (Outer Diameter) x $\frac{\text{Pump RPM}}{\text{Motor/Engine RPM}}$ (Consult Engine Mfr.)

Q. **How do I calculate the torque for my hydraulic drive system?**

A. Torque (ft. lbs.) = $3.6 \left(\frac{\text{GPM x PSI}}{\text{RPM}}\right)$

Avoid Cavitation Damage





One or several of the conditions shown in the chart below may contribute to cavitation in a system resulting in premature wear, system downtime and unnecessary operating costs.

CONDITION	SOLUTION
Inadequate inlet line size	• Increase line size to the inlet port or one size larger
Water hammering fluid acceleration/ deacceleration	• Install C.A.T. Tube • Move pump closer to fluid supply
Rigid Inlet Plumbing	• Use flexible wire reinforced hose to absorb pulsation and pressure spikes
Excessive Elbows in Inlet Plumbing	• Keep elbows to a minimum and less than 90°
Excessive Fluid Temperature	• Use Thermo Valve in bypass line • Do not exceed pump temperature specifications • Substitute closed loop with baffled holding tank • Adequately size tank for frequent or high volume bypass • **Pressure feed high temperature fluids** • Properly ventilate cabinets and rooms
Air Leaks in Plumbing	• Check all connections • Use Teflon tape
Agitation in Supply Tank	• Size tank according to pump output — **Minimum 6-10 times system GPM** • Baffle tank to purge air from fluid and separate inlet from discharge
High Viscosity Fluids	• Verify viscosity against pump specifications before operation • Elevate fluid temperature enough to reduce viscosity • Lower RPM of pump • Pressure feed pump • Increase inlet line size
Clogged Filters	• Perform regular maintenance or use clean filters to monitor build up • Use adequate mesh size for fluid and pump specifications

DIAGNOSIS AND MAINTENANCE

PROBLEM	PROBABLE CAUSE	SOLUTION
• Pulsation.	• Faulty Pulsation Dampener. • Foreign material trapped in valve.	• Check precharge. If low, recharge it or install a new one. • Clean or replace valve assembly. Clean filters.
• Low Pressure.	• Worn nozzle. • Belt slippage. • Air leak in inlet plumbing. • Pressure gauge inoperative or not registering accurately. • Relief valve stuck, partially plugged or improperly adjusted; valve seat worn. • Inlet suction strainer clogged or improper size. • Worn Packing. Abrasives in pumped fluid or severe cavitation. Inadequate water supply. • Fouled or dirty inlet or discharge valves. • Worn inlet or discharge valves. • Leaky discharge hose.	• Replace with nozzle of proper size. • Tighten or replace. Use correct belt type and length. • Disassemble, reseal, and reassemble. • Check with new gauge; replace worn or damaged gauge. • Clean and adjust relief valve; check for worn or dirty valve seats. Repair with Valve Kit. • Clean. Use adequate size. Check more frequently. • Install proper filter. Check flow available to pump. • Clean inlet and discharge valve assemblies. • Replace worn valves, valve seats and/or discharge hose. • Replace discharge hose with proper rating for system.
• Pump runs extremely rough, pressure low.	• Restricted inlet or air entering the inlet plumbing • Stuck inlet or discharge valve. • Leaking Hi-Pressure seals.	• Install correct size inlet plumbing; check for air tight seal. • Clean out foreign material, replace worn valves. • Repair with Seal Kit.
• Water leakage from under the manifold.	• Worn V-Packings and Lo-Pressure Seals. • Worn male and female adapter. • Excessive wear. Operation beyond normal service schedule.	• Repair with Seal Kit. • Install new male and female adapter. • Initiate more frequent service schedule.
• Oil leak between crankcase and pumping section.	• Worn crankcase piston rod seals.	• Replace crankcase piston rod seals.
• Oil leaking in the area of crankshaft.	• Worn crankshaft seal or improperly installed oil seal or O-ring on bearing case. • Bad bearing.	• Remove bearing case and replace damaged O-ring and/or oil seals. • Replace bearing.
• Excessive play in the end of the crankshaft pulley.	• Worn main bearing from excessive tension on drive belt.	• Replace bearing. Properly tension belt. Use correct type and length.
• Water in crankcase.	• May be caused by humid air condensing into water inside the crankcase. • Worn and leaking V-Packing.	• Change oil every 3 months or 500 hour intervals using special CAT PUMP Premium Grade Oil, (case PN 6100 or bottle PN 6107), other approved oil every month or 300 hours. • Repair with seal kit.
• Oil leaking from under-side of crankcase.	• Worn crankcase seals	• Replace seals.
• Oil leakage from drain plug.	• Loose drain plug or worn drain plug O-ring.	• Tighten drain plug or replace O-ring.
• Loud knocking noise in pump.	• Pulley loose on crankshaft. • Broken or worn bearing. • Inadequate inlet water supply. • Starving pump with too small inlet line.	• Check key and tighten set screw. • Replace bearing. • Check water supply. • Increase supply line to one size larger than inlet port size.
• Frequent or premature failure of the packing.	• Scored plungers. • Over pressure to inlet manifold. • Abrasive material in the fluid being pumped. • Excessive pressure and/or temperature of fluid being pumped. • Running pump dry. • Starving pump of adequate fluid.	• Replace plungers. • Reduce inlet pressure per instructions. • Install proper filtration on pump inlet plumbing and regularly clean. • Check pressure and inlet fluid temperature. Be sure they are within specified range. • DO NOT RUN PUMP WITHOUT WATER. • Increase supply line to one size larger than inlet port size.
• Strong surging at the inlet and low pressure on the discharge side.	• Foreign particles in the inlet or discharge valves or worn inlet and/or discharge valves.	• Check for smooth lap surfaces on inlet and discharge valve seats. Discharge valve seats and inlet valve seats may be lapped on a very fine oil stone.