

68PFR PLUNGER PUMP SERVICE MANUAL



68 FRAME BLOCK-STYLE MANIFOLD

6811, 6821, 6831, 6841, 6861
6811K, 6821K, 6831K, 6841K, 6861K

INSTALLATION AND START-UP INFORMATION

Optimum performance of the pump is dependent upon the entire liquid 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. Refer to individual pump Data Sheet for complete specifications, parts list and exploded view.

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**. 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 flow from Horsepower Requirement and Pulley Selection Chart (refer to Tech Bulletin 003 or individual Data Sheet).

DRIVE 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 flow, 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.

MOUNTING: 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.** Temperatures above 130°F are permissible. Add 1/2 PSI inlet pressure per each degree F over 130°F. Elastomer or RPM changes may be required. See Tech Bulletin 002 or call CAT PUMPS for recommendations.

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

Install a **Pulsation Dampening** device on the discharge head or in the discharge line as close to the head as possible. Be certain the pulsation dampener (Prrrrr-o-lator) is properly precharged for the system pressure (see individual 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.**

Use PTFE thread tape or pipe thread sealant (sparingly) 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.

PRESSURE REGULATION: All systems require both a primary pressure regulating device (i.e., regulator, unloader) and a secondary pressure safety relief device (i.e., pop-off valve, safety valve). The primary pressure device must be installed on the discharge side of the pump. The function of the primary pressure regulating device is to protect the pump from over pressurization, which can be caused by a plugged or closed off discharge line. Over pressurization can severely damage the pump, other system components and can cause bodily harm. The secondary safety relief device must be installed between the primary device and pump. This will ensure pressure relief of the system if the primary regulating device fails. Failure to install such a safety device will void the warranty on the pump.

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 liquid can quickly develop excessive 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.

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

SPECIAL FLUSHED INLET MANIFOLD 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" flushed inlet manifold 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 flushed inlet manifold models can also withstand high inlet pressures. Consult CAT PUMPS.

STORING: For extended storing or between use in cold climates, drain all pumped liquids from pump and **flush with antifreeze solution to prevent freezing and damage** to the pump. **DO NOT RUN PUMP WITH FROZEN LIQUID** (refer to Tech Bulletin 083).

WARNING

All systems require both a primary pressure regulating device (i.e., regulator, unloader) and a secondary pressure safety relief device (i.e., pop-off valve, safety valve). Failure to install such relief devices could result in personal injury or damage to the pump or to system components. CAT PUMPS does not assume any liability or responsibility for the operation of a customer's high pressure system.

Products described hereon are covered by one or more of the following U.S. patents 3558244, 3652188, 3809508, 3920356, 3930756 and 5035580

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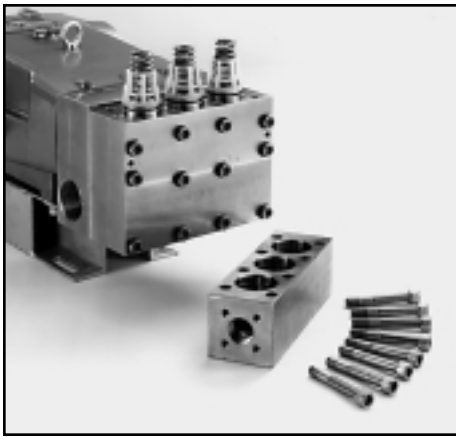
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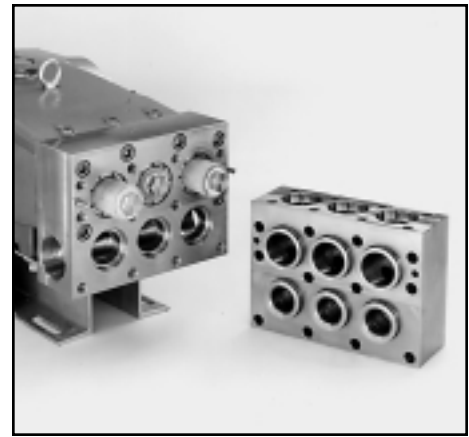
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6841, 6861
Discharge Block



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

- To service the Discharge Valve Assembly, it is necessary to remove the Discharge Valve Block.
- 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.
- 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.
- 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.
- Generally the Valve Assembly will remain together. To separate, thread an M12x65 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 053 for model identification.

NOTE: EPDM elastomers require silicone-base lubricant.

- Examine the Spring Retainer for internal wear or breaks in the structure and replace as needed.
- Examine the Spring for fatigue or breaks and replace as needed.
- Examine the Valve for grooves, pitting or general wear and replace as needed.
- Examine Valve Seat for grooves, pitting or general wear and replace as needed.
- Examine the O-Ring and Back-up-Ring on the Valve Seat for cuts or wear and replace as needed.

- The new Valve Assembly will come preassembled in the kit.
- NOTE: If servicing from individual parts, place the new Valve Seat with O-Rings and Back-up-Rings on the work surface with the dish side up. Next place the Valve onto the Seat with dish side down/spring tab 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".

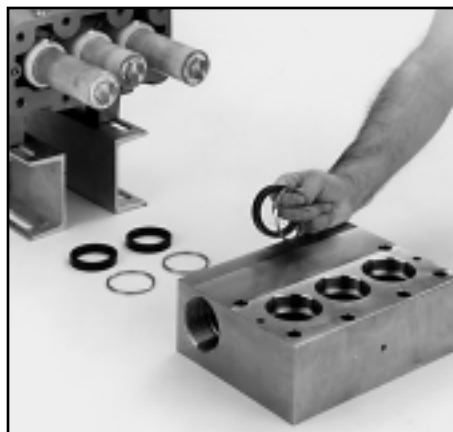
REMOVING THE DISCHARGE MANIFOLD [Inlet Valves]

Disassembly

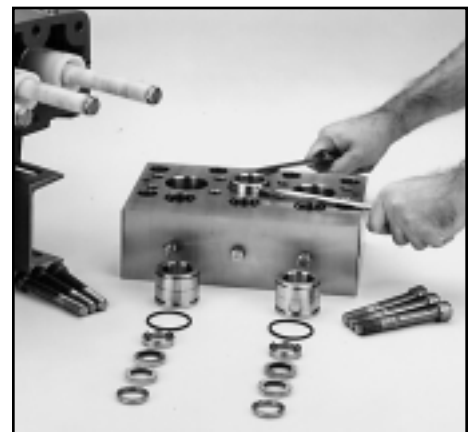
- To service the Inlet Valves it is necessary to remove the Discharge Manifold.
- Remove the two outer center M16 Hex Socket Head Bolts.
NOTE: As an aid in supporting the manifold, replace these two bolts with two M16x280 studs (PN 88902).
- Then remove the remaining M16 Hex Socket Head Bolts.
- Insert 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 M8x60 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.
- Then grasp the Discharge Manifold from the sides and under these two screws and pull manifold over the support studs.
- Place the Discharge Manifold on the work surface with the **crankcase side up**.
- 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.



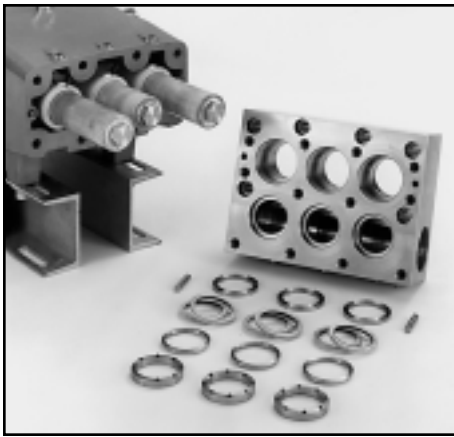
6841, 6861
Inlet Valve Assemblies and V-Packing Spacers



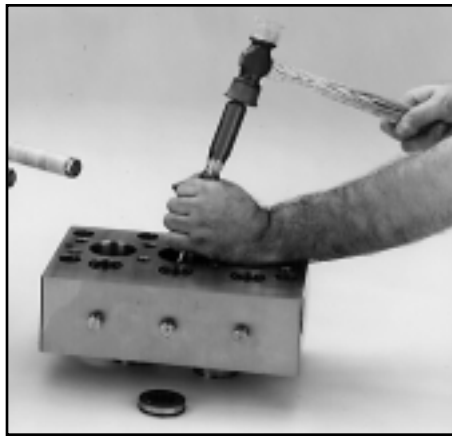
6831, 6861
Inlet Manifold and Lo-Pressure Seals



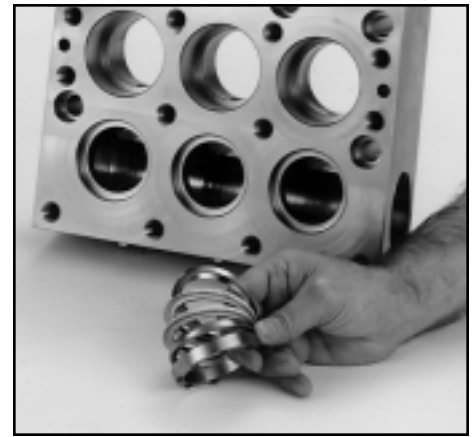
6811, 6821, 6841
Inlet Manifold and V-Packing Cylinder



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 V-Packings and Adapters

Reassembly

NOTE: For certain applications apply liquid gasket to the O-Ring crevices and seal surfaces. See Tech Bulletin 053 for model identification.

1. The same procedure for servicing 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.

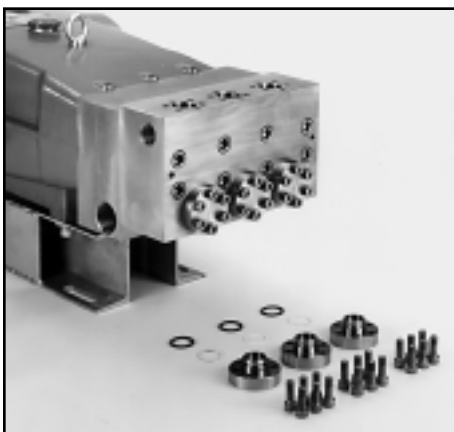
Reassembly

For standard installation, apply a small amount of oil to the outside edges of the LPS, HPS, VP, MA, FA for ease of installation and to avoid damage.

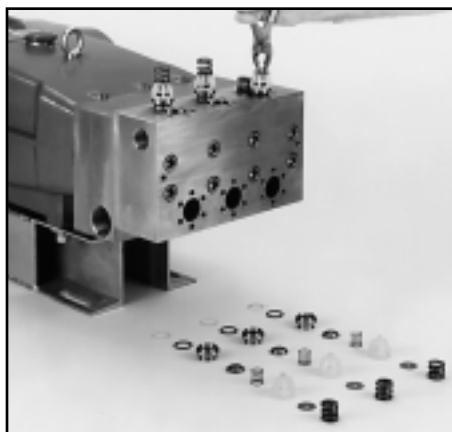
NOTE: For certain applications apply liquid gasket to the O-Ring crevices and seal surfaces. See Tech Bulletin 053 for model identification.

NOTE: EPDM elastomers require silicone-base lubricant.

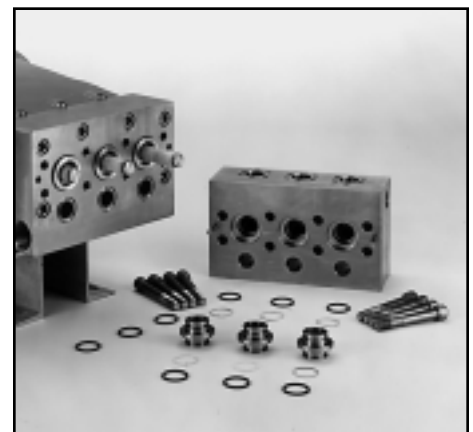
1. Invert the Inlet Manifold with the **crankcase side up**.
2. Place the washer (6861) into the Inlet Manifold.
3. Examine the Lo-Pressure Seal for wear to the internal ridges or broken spring and replace as needed.
4. Press the Lo-Pressure Seal into Inlet Manifold seal chamber with the **garter spring 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).
NOTE: When using alternate materials, the fit of the special materials may be snug and require gently driving the LPS into position with a cylinder of the same diameter to assure a square seating and no damage to the LPS.
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**.



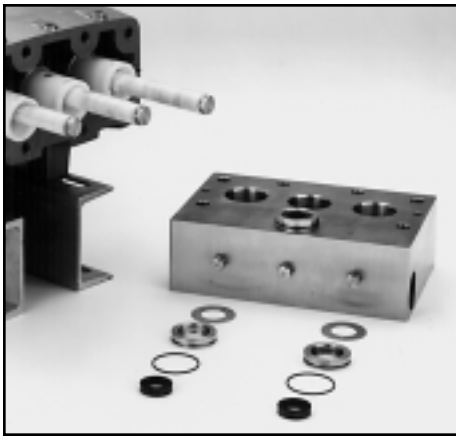
6811, 6821, 6831
Discharge Valve Plugs



6811, 6821, 6831
Inlet and Discharge 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 the manifold chamber (6861) or the V-Packing Cylinder (6841) with the **flat side down**.
11. Examine the V-Packings for frayed edges or 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” groove down**. The “V” will mate with the “V” side of the Female Adapter.
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 M8x100 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.

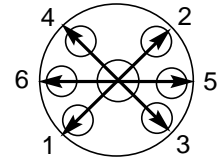
Reassembly

NOTE: For certain applications apply liquid gasket to the O-Ring crevices and seal surfaces. See Tech Bulletin 053 for model identification.

NOTE: EPDM elastomers require silicone-base lubricant.

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 dish side up. Place the Valve onto the Valve Seat with **dish side down/spring tap up**. 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, insert 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

- 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.
- 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).
- 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).
- Insert two screwdrivers on opposite sides into the outer groove on the V-Packing Cylinder and pry from the manifold chamber (6811, 6821).
- Place the Inlet Manifold on blocks with the **crankcase side down**.
- 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.
- Separate the Washer from the Inlet Adapter (6811, 6821).
- 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

For standard installation, apply a small amount of oil to the outside edges of the LPS, HPS, VP, MA, FA for ease of installation and to avoid damage.

NOTE: For certain applications apply liquid gasket to the O-Ring crevices and seal surfaces. See Tech Bulletin 053 for model identification.

NOTE: EPDM elastomers require silicone-base lubricant.

- Invert the Inlet Manifold with the **crankcase side up**.
- Examine the exterior O-Rings on the Inlet Adapter and replace if cut or worn (6811, 6821).
- 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).
- Place the Washer (6811, 6821) or the Spacer (6831) into the Inlet Manifold chamber.
- 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**.
- Invert the Inlet Manifold and place it on the work surface with the **crankcase side down**.
- Examine the exterior O-Rings on the V-Packing Cylinder and replace if cut or worn (6811, 6821).
- Press the V-Packing Cylinder, **O-Ring end first**, into the manifold chamber (6811, 6821).
- Examine the Female Adapter for wear and replace as needed.
- 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 **flat side down**.
- Examine the V-Packings for frayed edges, wear and replace as needed.
- Insert the V-Packing into the V-Packing Cylinder (6811, 6821) or into the Inlet Manifold (6831) with the **“V” groove down**. The “V” will mate with the “V” side of the Female Adapter.
- Examine the Male Adapter for wear and replace as needed.
- Insert the Male Adapter into the V-Packing Cylinder (6811, 6821) or into the Inlet Manifold (6831) with the **“V” side down**.
- Examine the O-Ring and Back-up-Ring on the V-Packing Spacer and the spacer for wear and replace as needed.
- 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

- 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.
- 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 053 for model identification.

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

SERVICING THE PLUNGERS - ALL MODELS

Disassembly

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

Reassembly

- 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.
- 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.
- Lubricate O-Ring for ease of installation. **Install Gasket, O-Ring and then Back-up-Ring** onto the plunger retainer.
- 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.
- Models 6841, 6861:** Slip Seal Retainer over Plunger with the **wick end forward**.
NOTE: The 6811, 6821 and 6831 have no wicks.

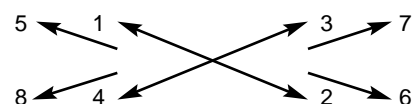
REPLACING THE INLET MANIFOLD ALL MODELS

- Rotate crankshaft and line up the two outside plungers.
- Screw two (M16 x 280) studs into top outer holes of crankcase to support the weight of the Inlet Manifold during reassembly.
- Carefully replace Inlet Manifold over Ceramic Plungers and press into crankcase. Keep manifold aligned to avoid damage to the Plungers.
- 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

- Lubricate the Ceramic Plungers and valve chamber walls.
- Reinstall the two guide pins into the Inlet Manifold.
- 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.
- 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.
- Replace the M16 hex socket bolts and the lower M12 bolts on the 6811, 6821 and 6831 into the Discharge Manifold and hand tighten. Remove the two M16 studs and replace the remaining two M16 hex socket bolts.
- Torque in sequence to the specifications in the torque chart.
- 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 CAT PUMPS 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 require changing every other seal change.
- Duty cycle, temperature, quality of pumped liquid and inlet feed conditions all effect the life of pump wear parts and service cycle.
- ** Remember to service the regulator/unloader at each seal servicing and check all system accessories and connections before resuming operation. Refer to video for additional assistance.

TORQUE CHART

Pump Item Pump Model	Thread	Tool Size [P/N]	Torque in. lbs. ft. lbs. Nm		
Plunger Retainer					
6811, 6821, 6831	M10	M21 Hex	220	18.1	25
6841, 6861	M14	M30 Hex	520	43.4	59
Inlet Manifold Screws					
	M16	M14 Allen [33049]	620	51.6	70
Discharge Manifold Screws - UPPER					
6811, 6821, 6831, 6841, 6861	M16	M14 Allen [33049]	660	55.0	75
Discharge Manifold Screws - LOWER					
6811, 6821, 6831	M12	M10 Allen [33047]	355	29.6	40
Valve Plug Screws					
6811, 6821, 6831	M10	M8 Allen [33046]	250	21.0	28
Valve Block Screws					
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
002	Inlet Pressure VS Liquid Temperature	All Models
003	Power Unit Drive Packages	3PFR - 68PFR, 10FR - 60FR
024	Lubrication of Lo-Pressure Seals	All Models
036	Cylinder and Plunger Reference Chart	All Models
043	LPS and HPS Servicing	All Plunger Models
053	Liquid Gasket	All Plunger NAB-S.S. Models
064	By-Pass Hose Sizing	All Unloaders/Regulators
074	Torque Chart	Piston and Plunger Pumps
077	Oil Drain Kit	All Models (except 2SF/4SF)
083	Winterizing a Pump	All Models
084	Eye-Bolt Relocation	60FR, 60PFR, 68PFR

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 exceed the maximum flow being delivered by the pump to assure proper performance.

- Open inlet shut-off valve and turn on water supply to avoid starving pump. **DO NOT RUN PUMP DRY.**
- Temperatures above 130°F are permissible. Add 1/2 PSI inlet pressure per each degree F over 130°F. Elastomer or RPM changes may be required. See Tech Bulletin 002 or call CAT PUMPS for recommendations.
- Avoid closed loop systems especially with high temperature, ultra-high pressure or large volumes. Conditions vary with regulating/unloader valve.
- Low vapor pressure liquids, such as solvents, require a booster pump and C.A.T. to maintain adequate inlet supply.
- Higher viscosity liquids require a positive head and a C.A.T. to assure adequate inlet supply.
- Higher temperature liquids tend to vaporize and require positive heads and C.A.T. to assure adequate inlet supply.
- When using an inlet supply reservoir, size it to provide adequate liquid 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 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 liquids may be increased by high RPM, high temperatures, low vapor pressures or high viscosity and may require pressurized inlet and C.A.T. to maintain adequate inlet supply. **DO NOT USE C.A.T. 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 rotated by hand and purged of air to facilitate priming. Disconnect the discharge port and allow liquid to pass through pump and measure flow.
- "K" versions are suitable for high inlet pressure. Consult CAT PUMPS.

INLET ACCESSORIES are designed to protect against over pressurization, control inlet flow, contamination or temperature and provide ease of servicing.

- A shut-off valve is recommended to facilitate maintenance.
- Installation of a C.A.T. 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 at the pump inlet line.
- Inspect and clean inlet filters on a regular schedule to avoid flow restriction.
- A pressure transducer is necessary to accurately read inlet pressure. **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.
- Optional inlet protection can be achieved by installing a pressure cut off switch between the inlet filter and the pump to shut off pump when there is no positive inlet pressure.
- "K" versions are suitable for high temperatures and containment of harmful liquids. Consult CAT PUMPS for optional flushing and cooling accessory.

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 liquid may be returned to the inlet line of the pump if the system is properly designed to protect your pump. When a pulsation dampener is used, a PRESSURE REDUCING VALVE must 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. 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 064 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.						Brass Pipe—Nominal Dia.						Copper Tubing O.D. Type L					
	1/4	3/8	1/2	3/4	1	1 1/4	1/4	3/8	1/2	3/4	1	1 1/4	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					

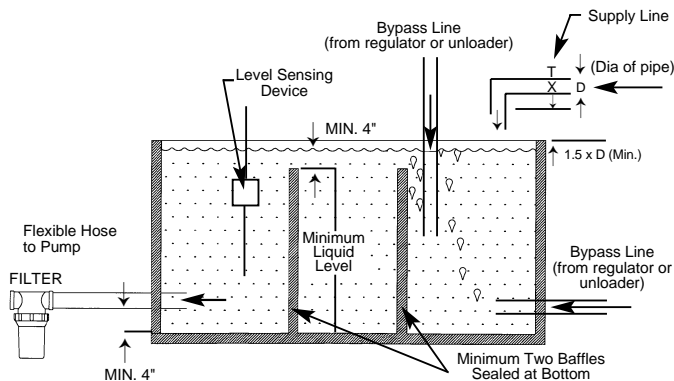
RESISTANCE OF VALVES AND FITTINGS

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	
1 1/4	1.380	0.90	41.0	20.5	1.73	3.70	8.22	2.06	7.40	
1 1/2	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	
2 1/2	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?

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

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

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

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

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

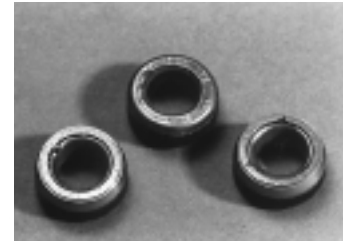
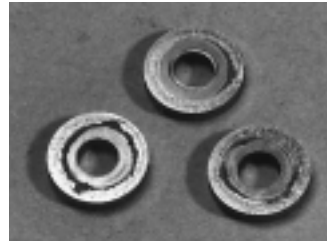
Q. What size motor pulley should I use?

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

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

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

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	<ul style="list-style-type: none"> • Increase line size to the inlet port or one size larger
Water hammering liquid acceleration/deacceleration	<ul style="list-style-type: none"> • Install C.A.T. Tube • Move pump closer to liquid supply
Rigid Inlet Plumbing	<ul style="list-style-type: none"> • Use flexible wire reinforced hose to absorb pulsation and pressure spikes
Excessive Elbows in Inlet Plumbing	<ul style="list-style-type: none"> • Keep elbows to a minimum and less than 90°
Excessive Liquid Temperature	<ul style="list-style-type: none"> • 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 liquids • Properly ventilate cabinets and rooms
Air Leaks in Plumbing	<ul style="list-style-type: none"> • Check all connections • Use PTFE thread tape or pipe thread sealant
Agitation in Supply Tank	<ul style="list-style-type: none"> • Size tank according to pump output — minimum 6-10 times system GPM • Baffle tank to purge air from liquid and separate inlet from discharge
High Viscosity Liquids	<ul style="list-style-type: none"> • Verify viscosity against pump specifications before operation • Elevate liquid temperature enough to reduce viscosity • Lower RPM of pump • Pressure feed pump • Increase inlet line size
Clogged Filters	<ul style="list-style-type: none"> • Perform regular maintenance or use clean filters to monitor build up • Use adequate mesh size for liquid and pump specifications

DIAGNOSIS AND MAINTENANCE

One of the most important steps in a high pressure system is to establish a regular maintenance program. This will vary slightly with each system and is determined by various elements such as the duty cycle, the liquid being pumped, the actual specifications vs rated specifications of the pump, the ambient conditions, the inlet conditions and the accessories in the system. A careful review of the necessary inlet conditions and protection devices required before the system is installed will eliminate many potential problems.

CAT PUMPS are very easy pumps to service and require far less frequent service than most pumps. Typically, only common tools are required, making in-field service convenient, however, there are a few custom tools, special to certain models, that do simplify the process. This service manual is designed to assist you with the disassembly and reassembly of your pump. The following guide will assist in determining the cause and remedy to various operating conditions. You can also review our **FAQ** or **SERVICE** sections on our **WEB SITE** for more facts or contact CAT PUMPS directly.

PROBLEM	PROBABLE CAUSE	SOLUTION
Low pressure	<ul style="list-style-type: none"> •Worn nozzle. •Belt slippage. •Air leak in inlet plumbing. •Pressure gauge inoperative or not registering accurately. •Relief valve stuck, partially plugged or improperly adjusted. •Inlet suction strainer (filter) clogged or improperly sized. •Abrasives in pumped liquid. •Leaky discharge hose. •Inadequate liquid supply. •Severe cavitation. •Worn seals. •Worn or dirty inlet/discharge valves. 	<ul style="list-style-type: none"> •Replace with properly sized nozzle. •Tighten belt(s) or install new belt(s). •Tighten fittings and hoses. Use PTFE liquid or tape. •Check with new gauge. Replace worn or damaged gauge. •Clean/adjust relief valve. Replace worn seats/valves and o-rings. •Clean filter. Use adequate size filter. Check more frequently. •Install proper filter. •Replace discharge hose with proper rating for system. •Pressurize inlet and install C.A.T. •Check inlet conditions. •Install new seal kit. Increase frequency of service. •Clean inlet/discharge valves or install new valve kit.
Pulsation	<ul style="list-style-type: none"> •Faulty Pulsation Dampener. •Foreign material trapped in inlet/discharge valves. 	<ul style="list-style-type: none"> •Check precharge. If low, recharge, or install a new dampener. •Clean inlet/discharge valves or install new valve kit.
Water leak		
•Under the manifold	<ul style="list-style-type: none"> •Worn V-Packings or Lo-Pressure Seals. •Worn adapter o-rings. 	<ul style="list-style-type: none"> •Install new seal kit. Increase frequency of service. •Install new o-rings.
•Into the crankcase	<ul style="list-style-type: none"> •Humid air condensing into water inside the crankcase. •Excessive wear to seals and V-Packings. 	<ul style="list-style-type: none"> •Install oil cap protector. Change oil every 3 months or 500 hours. •Install new seal kit. Increase frequency of service.
Knocking noise		
•Inlet supply	<ul style="list-style-type: none"> •Inadequate inlet liquid supply. 	<ul style="list-style-type: none"> •Check liquid supply. Increase line size, pressurize or install C.A.T.
•Bearing	<ul style="list-style-type: none"> •Broken or worn bearing. 	<ul style="list-style-type: none"> •Replace bearing.
•Pulley	<ul style="list-style-type: none"> •Loose pulley on crankshaft 	<ul style="list-style-type: none"> •Check key and tighten set screw.
Oil leak		
•Crankcase oil seals.	<ul style="list-style-type: none"> •Worn crankcase oil seals. 	<ul style="list-style-type: none"> •Replace crankcase oil seals.
•Crankshaft oil seals and o-rings.	<ul style="list-style-type: none"> •Worn crankshaft oil seals or o-rings on bearing cover. 	<ul style="list-style-type: none"> •Remove bearing cover and replace o-rings and/or oil seals.
•Drain plug	<ul style="list-style-type: none"> •Loose drain plug or worn drain plug o-ring. 	<ul style="list-style-type: none"> •Tighten drain plug or replace o-ring.
•Bubble gauge	<ul style="list-style-type: none"> •Loose bubble gauge or worn bubble gauge gasket. 	<ul style="list-style-type: none"> •Tighten bubble gauge or replace gasket.
•Rear cover	<ul style="list-style-type: none"> •Loose rear cover or worn rear cover o-ring. 	<ul style="list-style-type: none"> •Tighten rear cover or replace o-ring.
•Filler cap	<ul style="list-style-type: none"> •Loose filler cap or excessive oil in crankcase. 	<ul style="list-style-type: none"> •Tighten filler cap. Fill crankcase to specified capacity.
Pump runs extremely rough		
•Inlet conditions	<ul style="list-style-type: none"> •Restricted inlet or air entering the inlet plumbing 	<ul style="list-style-type: none"> •Correct inlet size plumbing. Check for air tight seal.
•Pump valves	<ul style="list-style-type: none"> •Stuck inlet/discharge valves. 	<ul style="list-style-type: none"> •Clean out foreign material or install new valve kit.
•Pump seals	<ul style="list-style-type: none"> •Leaking V-Packings or Lo-Pressure seals. 	<ul style="list-style-type: none"> •Install new seal kit. Increase frequency of service.
Premature seal failure		
	<ul style="list-style-type: none"> •Scored plungers. •Over pressure to inlet manifold. •Abrasive material in the liquid being pumped. •Excessive pressure and/or temperature of pumped liquid. •Running pump dry. •Starving pump of adequate liquid. 	<ul style="list-style-type: none"> •Replace plungers. •Reduce inlet pressure per specifications. •Install proper filtration at pump inlet and clean regularly. •Check pressure and inlet liquid temperature. •DO NOT RUN PUMP WITHOUT LIQUID. •Increase hose one size larger than inlet port size. Pressurize and install C.A.T.
	<ul style="list-style-type: none"> •Eroded manifold. 	<ul style="list-style-type: none"> •Replace manifold. Check liquid compatibility.