38PFR PLUNGER PUMP SERVICE MANUAL

38 FRAME BLOCK-STYLE MANIFOLD

3801, 3811, 3821, 3831, 3841
3801K, 3811K, 3821K, 3831K, 3841K

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 [134.4 oz. (4.2 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 safely 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 Hi-Pressure and Lo-Pressure Seals allowing the pumped liquid to cool the backside of the seals. The flushed pump models do not have these weep holes. The flushed pump models have special ports in the Inlet Manifold that can be fitted to an external flushing system. This external flush provides cooling and lubrication for the seals. Contact CAT PUMPS.

STORING AND TRANSPORT: 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). Transport should be in original carton or crate for proper protection. To lift pump use eye bold for **pump only** to stay within design limits. Lifting pump with additional attachments could result in severe personal injury or equipment damage.

⚠ 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.

World Headquarters
CAT PUMPS
1681 - 94th Lane N.E. Minneapolis, MN 55449 - 4324
Phone (763) 780-5440 — FAX (763) 780-2958
e-mail: techsupport@catpumps.com
www.catpumps.com

International Inquiries
FAX (763) 785-4329
e-mail: intlsales@catpumps.com

The Pumps with Nine Lives

CAT PUMPS (U.K.) LTD.
1 Fleet Business Park, Sandy Lane, Church Crookham
FLEET, Hampshire, GU52 8BF, England
Phone Fleet 44 1252-622031 — Fax 44 1252-626655
e-mail: sales@catpumps.co.uk www.catpumps.co.uk

N.V. CAT PUMPS INTERNATIONAL S.A.
Heiveldekens 6A, B-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 6126-9303 0 — Fax 49 6126-9303 33
e-mail: catpumps@t-online.de www.catpumps.de

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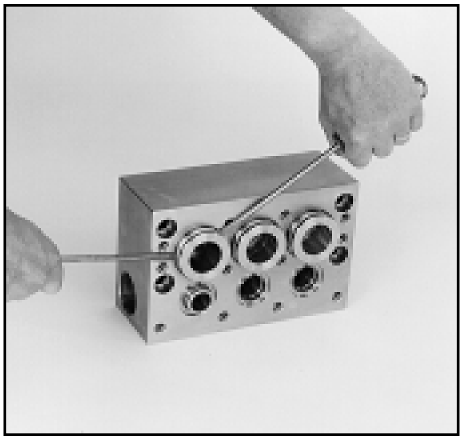
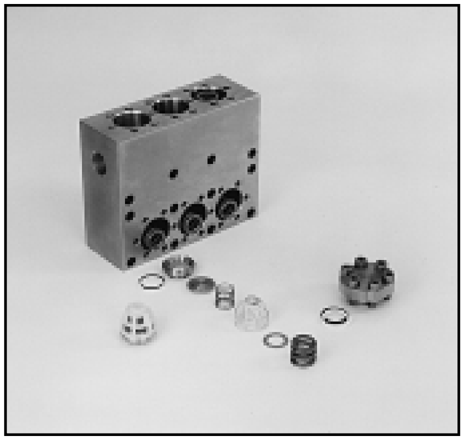
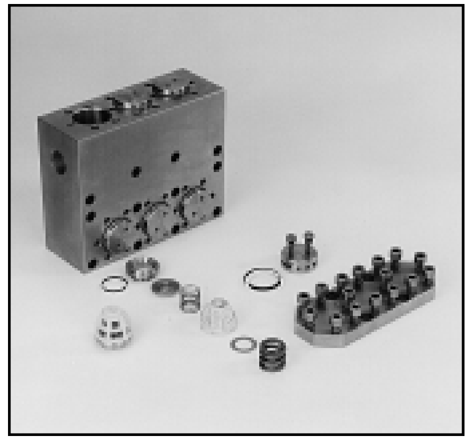


3801, 3811, 3821
Removal of V-Packing Cylinder from Inlet Manifold



3801, 3811
Complete Inlet/Discharge Valve Assembly



3821, 3831, 3841
Complete Inlet/Discharge Valve Assembly

CAUTION: Before commencing with service, shut off drive (electric motor, gas or diesel engine) and turn off water supply to pump. Relieve all discharge line pressure by triggering gun or opening valve in discharge line.

After servicing is completed, turn on water supply to pump, start drive, reset pressure regulating device and secondary valve, read system pressure on the gauge at the pump head. Check for any leaks, vibration or pressure fluctuations and resume operation.

Inspect and service all system accessories on the same schedule as your pump.

SERVICING THE VALVES

Disassembly (discharge and inlet valves)

NOTE: Both the standard and the "K" versions are serviced in the same manner.

1. To service the Valve Assemblies, it is necessary to remove the Valve Plugs (3801/3811) or Valve Covers (3821/3831/3841).
2. Using an allen wrench, remove the Hex Socket Head Screws (HSH) from the top surface of the Valve Plugs (3801/3811) or top surfaces of the Valve Cover (3821/3831/3841).
3. On the models 3801, 3811 remove Valve Plugs.
4. On the models 3821, 3831, 3841, remove Valve Covers, then insert two M6 x 25 threaded screws into the two threaded holes on the top surface of the Valve Plug and gently pull out.
5. Remove the exposed Coil Spring and Washer from the top of the Spring Retainer in each valve chamber.
6. On the models 3801, 3811, using a standard pliers, grasp Spring Retainer tab and pull assemblies from valve chambers.
7. On the models 3821, 3831, 3841, thread an M10 screw (the HSH screws from the Valve Cover can be used) into the top of the Spring Retainer and pull valve assembly out of each valve chamber.

   NOTE: The valve assembly will usually remain together.
8. If the Valve Assembly separates during removal, use a reverse pliers to lift and remove Valve Seats.

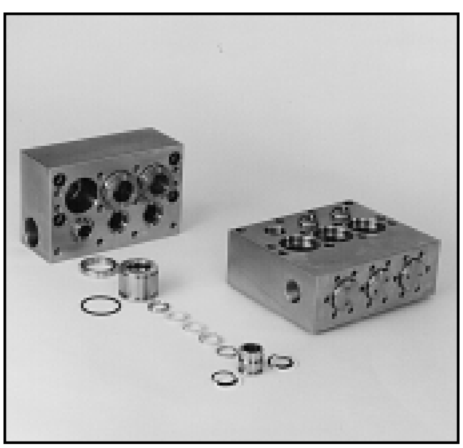
   CAUTION: Exercise caution as the reverse pliers may score seating surface.
9. On the models 3801, 3811, to separate Valve Assemblies, insert screwdriver into Spring Retainer and press the backside of Valve until Seat separates from the Spring Retainer. Each assembly consists of a Spring Retainer, Spring, Valve, Seat, O-Ring and Back-up-Ring.
10. On the models 3821, 3831, 3841, to separate Valve Assemblies, continue threading the M10 screw into the back side of the Valve until the Valve Seat separates from the Spring Retainer. Each assembly consists of a Spring Retainer, Spring, Valve, Seat, O-Ring and Back-up-Ring.

Reassembly

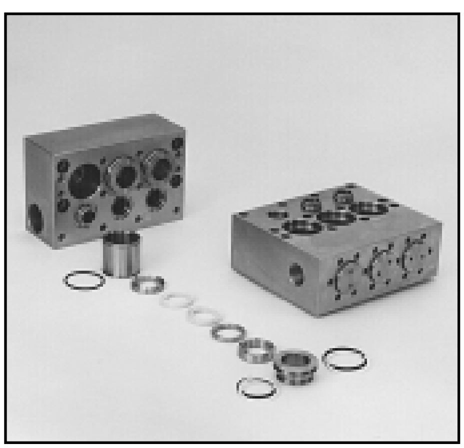
NOTE: For certain applications apply liquid gasket to the O-Ring crevices and seal surfaces. See Tech Bulletin 053 for model identification.

NOTE: EPDM elastomers require silicone-base lubricant.

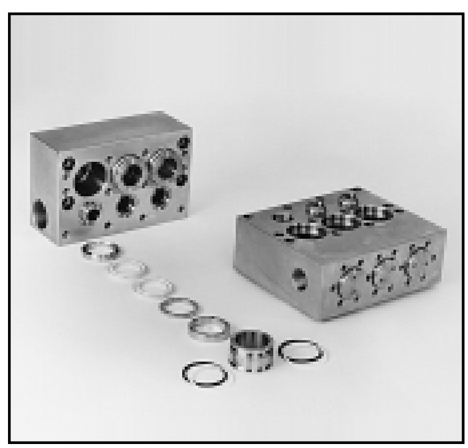
1. Examine Spring Retainers for internal wear or breaks in the structure and replace as needed.
2. Examine Springs and Coil Springs for fatigue or breaks and replace as needed.
3. Examine Valves and Seats for grooves, pitting or wear and replace as needed.
4. Examine Seat O-Rings and Back-up-Rings for cuts or wear and replace as needed.
5. Examine Valve Plugs for external surface scoring or wear and replace as needed.



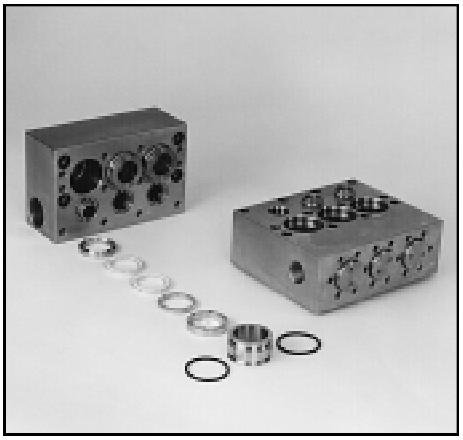
3801
V-Packing Arrangement



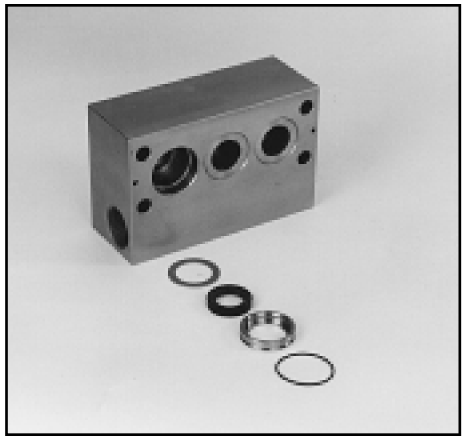
3811, 3821
V-Packing Arrangement



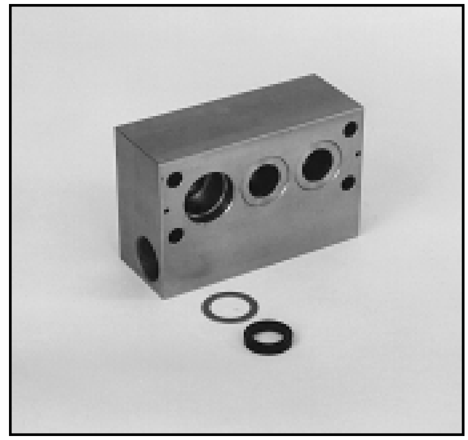
3831
V-Packing and Spacer Arrangement



3841
V-Packing and Spacer Arrangement



3801, 3811, 3821
Lo-Pressure Seal and Adapter



3831
Lo-Pressure Seal and Washer

6. Examine Valve Plug O-Rings and Back-up-Rings for cuts or wear and replace as needed.

   NOTE: A new Valve Assembly will come pre-assembled in the kit. Continue with steps 10 through 16. If servicing from individual parts, follow steps 7 through 16.
7. Install O-Ring first, then Back-up-Ring onto the each Seat.
8. Place the Valve onto the Seat **with dish side down/spring tab up.**
9. Place Spring on Valve and snap the Spring Retainer onto Seat.
10. On the models 3821, 3831, 3841, thread in M10 screw into Spring Retainer. Lower Valve Assembly into the valve chamber and press until completely seated. Remove M10 screw.
11. On the models 3801, 3811, using a standard pliers, grasp Spring Retainer tab and lower Valve Assembly into valve chamber and press until completely seated.
12. Place Washer on top of the Spring Retainer and then the Coil Spring on top of Washer.
13. Install Back-up-Ring first, then O-Ring on Valve Plugs.
14. Press Valve Plugs in valve chambers.

    CAUTION: Exercise caution to avoid extruding or cutting the Back-up-Rings or O-Rings.
15. On the models 3821, 3831, 3841, place Valve Covers over Valve Plugs.
16. Apply anti-seize to HSH screw threads and thread in hand tight. Torque in sequence to specifications in torque chart.

REMOVING THE DISCHARGE MANIFOLD

1. Using an allen wrench, remove the HSH screws.
2. Insert two screwdrivers on opposite sides of the Discharge Manifold and gently pry apart.

   NOTE: Support underside of manifold to avoid possible damage to Ceramic Plungers or Plunger Rods.

   CAUTION: Exercise caution as the screwdrivers may score O-Ring sealing surface.
3. Place the **crankcase side** of the Discharge Manifold **up** on work surface.

REMOVING THE INLET MANIFOLD

1. Using an allen wrench, remove the HSH screws.
2. Rotate the Crankshaft by hand to begin separation of the Inlet Manifold from the Crankcase. Insert two screwdrivers on opposite sides of manifold to assist in separation.

   NOTE: Support underside of manifold to avoid possible damage to Ceramic Plungers or Plunger Rods.
3. Place the **crankcase side** of the Inlet Manifold **down** on work surface.

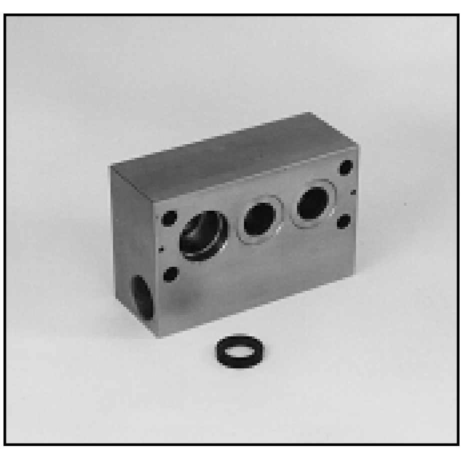
SERVICING THE SEALS

Disassembly

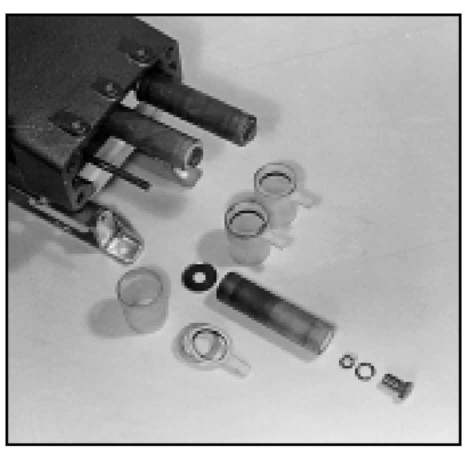
NOTE: Both the standard and the “K” versions are serviced in the same manner.

1. To service the seals and packings, it is necessary to remove both the Discharge Manifold and the Inlet Manifold. Follow disassembly procedures for REMOVING THE DISCHARGE MANIFOLD and REMOVING THE INLET MANIFOLD.

   NOTE: The V-Packing Cylinder (3801, 3811, 3821) or V-Packing Spacer (3831, 3841) Assemblies may stay in the Discharge Manifold or Inlet Manifold.
2. If V-Packing Cylinders (3801, 3811, 3821) or V-Packing Spacers (3831, 3841) stay in the Inlet Manifold, insert two screwdrivers on opposite sides of the V-Packing Cylinder (3801, 3811, 3821) secondary groove and pry from the chamber. On the model 3831, 3841 remove exposed O-Rings and Back-up-Rings and insert two screwdrivers into the groove on opposite sides and pry from valve chamber.



3841
Lo-Pressure Seal



3801, 3811, 3821, 3831
Plunger Arrangement

CAUTION: Exercise caution as the screwdrivers may score o-ring sealing surface.

3. If V-Packing Cylinders (3801, 3811, 3821) or V-Packing Spacers (3831, 3841) stay in the Discharge Manifold remove exposed O-Rings. Insert two screwdrivers into the groove on opposite sides and pry from valve chamber.

   CAUTION: Exercise caution as the screwdrivers may score o-ring sealing surface.

4. On the models 3801, 3811, 3821, separate V-Packing Spacer from V-Packing Cylinder by inserting two screwdrivers on opposite sides of the groove formed between components and pry apart. Remove one Spacer w/Coil Spring, one Male Adapter, two V-Packings (3811, 3821) or three V-Packings (3801) and one Female Adapter from each V-Packing Cylinder.
5. On the models 3831, 3841, remove one Spacer w/Coil Spring, one Male Adapter, two V-Packings and one Female Adapter from each seal chamber.
6. Place Inlet Manifold on blocks **with crankcase side down.**
7. Using reverse pliers, remove Inlet Spacer from each seal chamber.

   CAUTION: Exercise caution as the reverse pliers may damage sealing surface.

8. On the models 3801, 3811, 3821, insert screwdrivers into seal chamber and tap opposite sides of the Washer to drive out Inlet Adapter Assembly and Washer from each chamber. Remove Lo-Pressure Seals from backside of Inlet Adapter.

   CAUTION: Exercise caution as the screwdrivers may damage sealing surface.

9. On the model 3831, remove Lo-Pressure Seal and Washer from each seal chamber.
10. On the model 3841, remove Spacer and Lo-Pressure Seal from each seal chamber.

Reassembly

NOTE: If your pump has been built with special seals and O-Rings, service with same type of special parts. Refer to pump Data Sheet for correct parts or kits.

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.

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

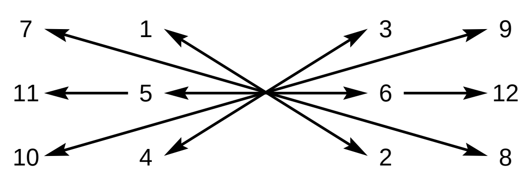
<u>Models 3801, 3811 and 3821</u>

1. Examine Lo-Pressure Seals for wear to the internal ridges and outer surfaces, or for broken springs and replace as needed.
2. Examine Inlet Adapters and Washers for scale build up or wear, and the Inlet Adapter O-Rings for cuts or deterioration and replace as needed.
3. Press new Lo-Pressure Seal into each Inlet Adapter **with the garter spring up**.

   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.

4. Place Inlet Manifold on flat work surface **with crankcase side up**.
5. Place Washer in each seal chamber of the Inlet Manifold.
6. Press Inlet Adapter Assembly into each seal chamber of the Inlet Manifold **with the garter spring down.**
7. Examine the V-Packing Cylinders for scale build-up, wear and O-Rings for cuts or deterioration and replace as needed.
8. Examine Male Adapters and Female Adapters for wear and replace as needed.
9. Examine Spacer w/Coil Springs for scale build up, wear, broken or fatigued Coil Springs and replace as needed.
10. Examine V-Packings for frayed edges or uneven wear and replace as needed.
11. Place V-Packing Cylinder **with large opening facing up** on work surface.
12. Place Female Adapter **with flat side down/"V" side up** inside each V-Packing Cylinder.
13. On the models 3811, 3821, insert two V-Packings, and on the model 3801, insert three V-Packings **with "V" side down** into the V-Packing Cylinder. The "V" will mate with "V" side of the Female Adapter.
14. Place Male Adapter **with "V" side down** inside each V-Packing Cylinder.
15. Position Spacer w/Coil Springs so that the small springs **do not line** up with grooves on top surface of Male Adapter.
16. Examine V-Packing Spacers for scale build up, wear and replace as needed. Examine V-Packing Spacer O-Rings and Back-up-Rings for cuts or deterioration and replace as needed.
17. Install two O-Rings and two Back-up-Rings on V-Packing Spacer **with O-Rings to the outside**. Press V-Packing Spacer into each V-Packing Cylinder.
18. Place Inlet Manifold on flat work surface **with crankcase side down**.
19. Press V-Packing Cylinder Assembly into each seal chamber with V-Packings facing **into the manifold chamber.**
20. Examine Inlet Spacers for scale build up, wear and replace as needed. Examine Inlet Spacer O-Rings and Back-up-Rings for cuts and deterioration and replace as needed.
21. Press Inlet Spacer into each lower manifold chamber.
22. Support the Inlet Manifold from the under side and align manifold with Crankcase Guide Pins. Apply Loctite® 242® to HSH screw threads and thread in hand tight. Torque in sequence to specifications in torque chart.
23. Support the Discharge Manifold from the under side and align with Inlet Manifold holes. Apply anti-seize to HSH screws and thread in hand tight. Torque in sequence to specifications in torque chart.

TORQUE SEQUENCE



<u>Models 3831 and 3841</u>

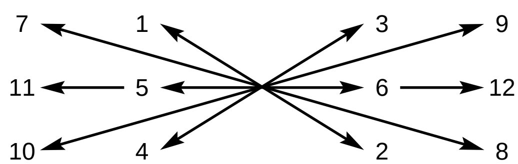
1. Examine Lo-Pressure Seals for wear to the internal ridges and outer surfaces, or for broken springs and replace as needed.
2. On the model 3831, examine Washers for scale build up or wear, and replace as needed.
3. Place Inlet Manifold on flat work surface **with crankcase side up.**
4. On the model 3831, place Washer in each seal chamber of the Inlet Manifold.
5. Press new Lo-Pressure Seal into each seal chamber **with the garter spring down**.

   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. Examine Male Adapters and Female Adapters for scale build-up, wear and replace as needed.
7. Examine Spacer w/Coil Springs for scale build up, wear, broken or fatigued Coil Springs and replace as needed.
8. Examine V-Packings for frayed edges or uneven wear and replace as needed.

9. Place Inlet Manifold on flat work surface **with crankcase side down.**
10. Place Female Adapter **with flat side down/“V” side up** inside each seal chamber.
11. Insert two V-Packings **with “V” side down** into each seal chamber. The “V” will mate with “V” side of the Female Adapter.
12. Press Male Adapter **with “V” side down** into each seal chamber.
13. Position Spacer w/Coil Springs so that the small springs **do not line** up with grooves on top surface of Male Adapter.
14. Examine V-Packing Spacers for scale build up, wear and replace as needed. Examine V-Packing Spacer O-Rings and Back-up-Rings (3831 only) for cuts or deterioration and replace as needed.
15. On the model 3831, install two O-Rings and two Back-up-Rings on V-Packing Spacer with **O-Rings to the outside.** On the model 3841, install O-Rings on each end of V-Packing Spacer.
16. Press V-Packing Spacer into each seal chamber.
17. Examine Inlet Spacers for scale build up, wear and replace as needed. Examine Inlet Spacer O-Rings and Back-up-Rings for cuts and deterioration and replace as needed.
18. Press Inlet Spacers into each lower manifold chamber.
19. Support the Inlet Manifold from the under side and align manifold with Crankcase Guide Pins. Apply Loctite® 242® to HSH screw threads and thread in hand tight. Torque in sequence to specifications in torque chart.
20. Support the Discharge Manifold from the under side and align with Inlet Manifold holes. Apply anti-seize to HSH screws and thread in hand tight. Torque in sequence to specifications in torque chart.

TORQUE SEQUENCE



SERVICING THE PLUNGERS

Disassembly

NOTE: Both the standard and the “K” versions are serviced in the same manner.

1. To service the plungers, it is necessary to remove both the Discharge Manifold and Inlet Manifold. Follow disassembly procedures for REMOVING THE DISCHARGE MANIFOLD and REMOVING THE INLET MANIFOLD.
2. On the models 3801, 3811, 3821, 3831, remove the **two-piece Seal Retainer with wick** from each Plunger Rod.
3. On the model 3841, remove the **one-piece Seal Retainer** and LPS Spacer from each Plunger Rod.
4. Using a Hex tool, loosen the Plunger Retainers about three to four turns.
5. Push the Ceramic Plungers back towards the crankcase to separate from the Plunger Retainers and proceed with unthreading the Plunger Retainers by hand. If resistant, slip M14 or M21 deep socket over Plunger Retainer and gently tap end to free Ceramic Plunger.
6. Remove Plunger Retainers, O-Rings, Back-up-Rings and Gaskets.

   NOTE: Plunger Retainer Studs may stay on Plunger Rods or come off with Plunger Retainers.
7. Remove Ceramic Plungers, Keyhole Washers and Barrier Slingers.

Reassembly

1. Visually inspect Crankcase Oil Seals for deterioration or leaks and contact CAT PUMPS for assistance with replacement.
2. Examine Plunger Retainer Studs, Barrier Slingers and Keyhole Washers for wear and replace as needed.
3. Slide Barrier Slinger over each Plunger Retainer Stud **with concave side away from crankcase.**
4. Slide Keyhole Washer over each Plunger Retainer Stud **with split ends facing downward.**
5. Examine Ceramic Plungers for scoring, scale build-up, chips or cracks and replace as needed. Generally the Ceramic Plungers do not need to be replaced.
6. Slide Ceramic Plunger over each Plunger Rod.

   NOTE: Ceramic Plunger can only be installed in one direction. Do not force onto Plunger Rod.
7. Examine Gaskets, O-Rings and Back-up-Rings for cuts or wear and replace as needed.
8. Examine Plunger Retainers for wear and damaged threads and replace as needed.
9. Install Gasket first, then O-Ring and Back-up-Ring onto each Plunger Retainer.

   NOTE: Lubricate O-Rings and Back-up-Rings for ease in installation and to reduce possible damage.
10. Clean old Loctite from Plunger Retainer Studs using wire brush and Plunger Retainers by twisting cloth into threaded area, then blow out with air gun. Apply Loctite® 242® to exposed threaded end of Plunger Retainer Studs, thread into Plunger Retainer. Torque per chart.
11. Rotate crankshaft by hand so the two outside plungers are extended equally.
12. On the models 3801, 3811, 3821, 3831, slide Seal Retainer with wick over each Plunger Rod.
13. On the model 3841, slide Seal Retainer with drain holes facing up and down, and with small diameter end towards Crankcase over each Plunger Rod. Install LPS Spacer over end of each Seal Retainer.
14. Lightly lubricate Ceramic Plungers, to assist in installing the Inlet Manifold.

   NOTE: If new Ceramic Plungers are installed, operate for 24 hours to allow grease from seals to penetrate plunger surface.
15. Support the Inlet Manifold from the under side and align manifold with Crankcase Guide Pins. Apply Loctite® 242® to HSH screw threads and thread in hand tight. Torque in sequence to specifications in torque chart.
16. Support the Discharge Manifold from the under side and align with Inlet Manifold holes. Apply anti-seize to HSH screws and thread in hand tight. Torque in sequence to specifications in torque chart.

SERVICING THE CRANKCASE SECTION

NOTE: Both the standard and the “K” versions are serviced in the same manner.

1. While manifolds, plungers and seal retainers are removed examine crankcase oil seals for leaking and wear.
2. Check for any signs of leaking at Rear Cover, Drain Plug and Bubble Gauge.
3. Check oil level and check for evidence of water in oil.
4. Rotate crankshaft by hand to feel for smooth bearing movement.
5. Examine crankshaft oil seals externally for drying, cracking or leaking.
6. Contact CAT PUMPS or your local distributor if crankcase service is required. See also Tech Bulletin 035.

Loctite and 242 are registered trademarks of the Henkel Corporation.

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					
3801, 3811	M7	M14 Hex	90	7.2	10
3821, 3831, 3841	M10	M21 Hex	220	12.1	25
Inlet Manifold Screws	M14	M12 Allen [33048]	500	41.6	56
Discharge Manifold Screws	M12	M10 Allen [33047]	355	29.6	40
Valve Plug/ Valve Cover Screws	M10	M8 Allen [33046]	250	21.0	28
Crankcase Cover/ Bearing Cover Screws	M8	M13 Hex [25324]	115	9.4	13
Connecting Rod Screws	M10	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
035	Servicing Crankcase Section	7PFR - 60PFR
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
074	Torque Chart	Piston and Plunger Pumps
077	Oil Drain Kit	All Models (except 2SF/4SF)
083	Winterizing a Pump	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 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 (where compatible).
- ❑ 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 70 PSI (4.9 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 pressures. Consult CAT PUMPS.

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. 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	Steel Pipe—Nominal Dia.							Brass Pipe—Nominal Dia.							Copper Tubing O.D. Type L					
GPM	**1/4**	**3/8**	**1/2**	**3/4**	**1**	**1¹/₄**	**1¹/₂**	**1/4**	**3/8**	**1/2**	**3/4**	**1**	**1¹/₄**	**1¹/₂**	**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

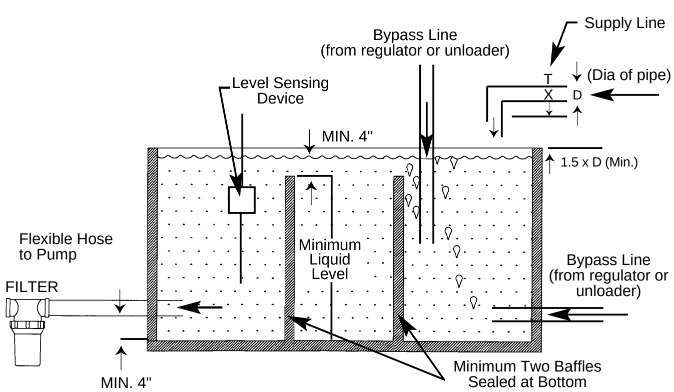
Nominal Pipe Size Inches	Inside Diameter Inches	Equivalent Length of Standard Pipe in Feet: Gate Valve	Globe Valve	Angle Valve	45° Elbow	90° Elbow	180° Close Ret	Tee Thru Run	Tee Thru Branch
1/2	**0.622**	0.41	18.5	9.3	0.78	1.67	3.71	0.93	3.33
3/4	**0.824**	0.54	24.5	12.3	1.03	2.21	4.90	1.23	4.41
1	**1.049**	0.69	31.2	15.6	1.31	2.81	6.25	1.56	5.62
1¹/₄	**1.380**	0.90	41.0	20.5	1.73	3.70	8.22	2.06	7.40
1¹/₂	**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
2¹/₂	**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. $\text{Desired RPM} = \text{Desired GPM} \times \dfrac{\text{Rated RPM}}{\text{Rated GPM}}$

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

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

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

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

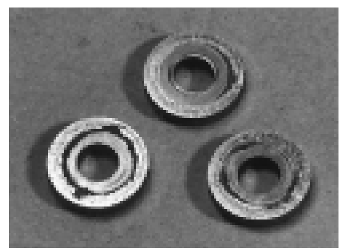
Q. **What size motor pulley should I use?**

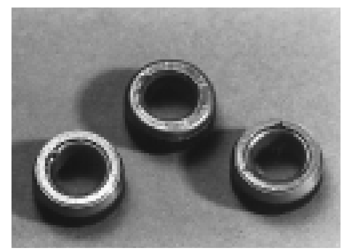
A. $\text{Pump Pulley (Outer Diameter)} \times \dfrac{\text{Pump RPM}}{\text{Motor/Engine RPM}}$ (Consult Engine Mfr.)

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

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

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	• Increase line size to the inlet port or one size larger
Water hammering liquid acceleration/ deacceleration	• Install C.A.T. Tube • Move pump closer to liquid 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 Liquid 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 liquids** • Properly ventilate cabinets and rooms
Air Leaks in Plumbing	• Check all connections • Use PTFE thread tape or pipe thread sealant
Agitation in Supply Tank	• 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	• 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	• 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	•Worn nozzle.	•Replace with properly sized nozzle.
	•Belt slippage.	•Tighten belt(s) or install new belt(s).
	•Air leak in inlet plumbing.	•Tighten fittings and hoses. Use PTFE liquid or tape.
	•Pressure gauge inoperative or not registering accurately.	•Check with new gauge. Replace worn or damaged gauge.
	•Relief valve stuck, partially plugged or improperly adjusted.	•Clean/adjust relief valve. Replace worn seats/valves and o-rings.
	•Inlet suction strainer (filter) clogged or improperly sized.	•Clean filter. Use adequate size filter. Check more frequently.
	•Abrasives in pumped liquid.	•Install proper filter.
	•Leaky discharge hose.	•Replace discharge hose with proper rating for system.
	•Inadequate liquid supply.	•Pressurize inlet and install C.A.T.
	•Severe cavitation.	•Check inlet conditions.
	•Worn seals.	•Install new seal kit. Increase frequency of service.
	•Worn or dirty inlet/discharge valves.	•Clean inlet/discharge valves or install new valve kit.
Pulsation	•Faulty Pulsation Dampener.	•Check precharge. If low, recharge, or install a new dampener.
	•Foreign material trapped in inlet/discharge valves.	•Clean inlet/discharge valves or install new valve kit.
Water leak		
•Under the manifold	•Worn V-Packings or Lo-Pressure Seals.	•Install new seal kit. Increase frequency of service.
	•Worn adapter o-rings.	•Install new o-rings.
•Into the crankcase	•Humid air condensing into water inside the crankcase.	•Install oil cap protector. Change oil every 3 months or 500 hours.
	•Excessive wear to seals and V-Packings.	•Install new seal kit. Increase frequency of service.
Knocking noise		
•Inlet supply	•Inadequate inlet liquid supply.	•Check liquid supply. Increase line size, pressurize or install C.A.T.
•Bearing	•Broken or worn bearing.	•Replace bearing.
•Pulley	•Loose pulley on crankshaft	•Check key and tighten set screw.
Oil leak		
•Crankcase oil seals.	•Worn crankcase oil seals.	•Replace crankcase oil seals.
•Crankshaft oil seals and o-rings.	•Worn crankshaft oil seals or o-rings on bearing cover.	•Remove bearing cover and replace o-rings and/or oil seals.
•Drain plug	•Loose drain plug or worn drain plug o-ring.	•Tighten drain plug or replace o-ring.
•Bubble gauge	•Loose bubble gauge or worn bubble gauge gasket.	•Tighten bubble gauge or replace gasket.
•Rear cover	•Loose rear cover or worn rear cover o-ring.	•Tighten rear cover or replace o-ring.
•Filler cap	•Loose filler cap or excessive oil in crankcase.	•Tighten filler cap. Fill crankcase to specified capacity.
Pump runs extremely rough		
•Inlet conditions	•Restricted inlet or air entering the inlet plumbing	•Correct inlet size plumbing. Check for air tight seal.
•Pump valves	•Stuck inlet/discharge valves.	•Clean out foreign material or install new valve kit.
•Pump seals	•Leaking V-Packings or Lo-Pressure seals.	•Install new seal kit. Increase frequency of service.
Premature seal failure	•Scored plungers.	•Replace plungers.
	•Over pressure to inlet manifold.	•Reduce inlet pressure per specifications.
	•Abrasive material in the liquid being pumped.	•Install proper filtration at pump inlet and clean regularly.
	•Excessive pressure and/or temperature of pumped liquid.	•Check pressure and inlet liquid temperature.
	•Running pump dry.	•DO NOT RUN PUMP WITHOUT LIQUID.
	•Starving pump of adequate liquid.	•Increase hose one size larger than inlet port size. Pressurize and install C.A.T.
	•Eroded manifold.	•Replace manifold. Check liquid compatibility.