35PFR PLUNGER PUMP SERVICE MANUAL

35 FRAME SPLIT MANIFOLD: 3507 and 3517

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 Data Sheet for complete specifications, parts list and exploded view.

LUBRICATION: Fill crankcase with special CAT PUMP oil per pump specifications [4.2 Qts.- 4.0 L]. DO NOT RUN PUMP WITHOUT OIL IN CRANKCASE. Change initial fill after 50 hours running period. Thereafter, change oil every **3 months or 500 hour intervals**. **Oiler adjustment** is vertical to start feed, dial to adjust flow rate. Additional lubrication may be required with increased hours of operation and temperature.

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

PULLEY SELECTION: Select size of motor pulley required to deliver the desired flow from Horsepower Requirement and Pulley Selection Chart (refer to Tech Bulletin 003 or individual Data Sheet).

MOTOR SELECTION: The motor or engine driving the pump must be of adequate horsepower to maintain full RPM when the pump is under load. Select the electric motor from the Horsepower Requirement Chart according to required pump discharge 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.

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.

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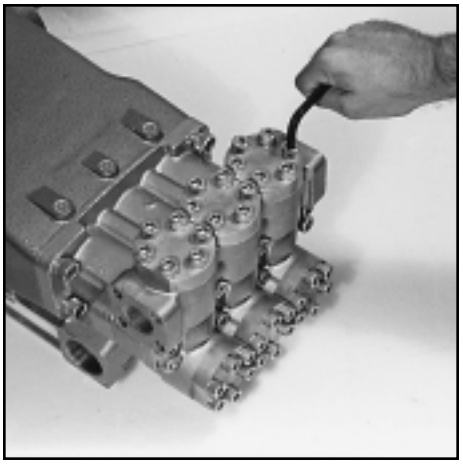
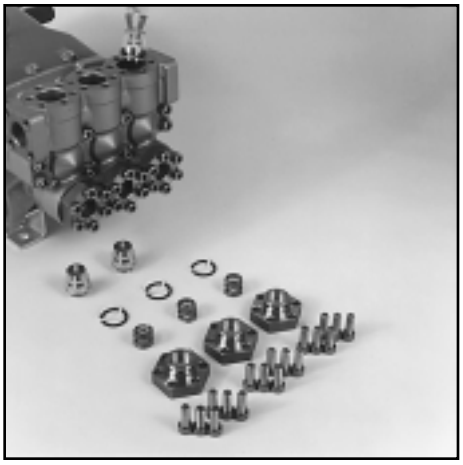
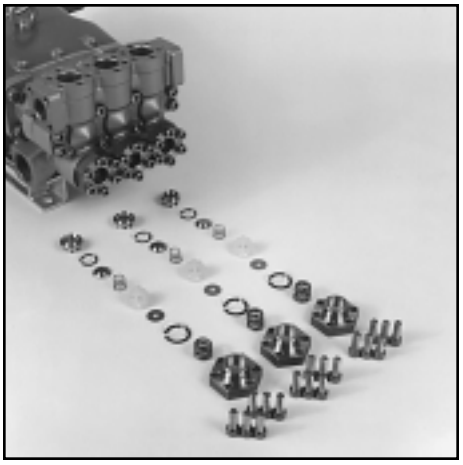


Removing Valve Plug screws



Removing Valve Assembly



Complete Inlet and Discharge Valve Assembly

SERVICING THE VALVES

Disassembly

1. Using a standard M8 allen wrench, remove the six (6) M10 hex socket screws on each of the Valve Plugs and remove plugs. Inlet and Discharge Valves may be serviced at different schedules.
2. Remove the Coil Springs from the valve chambers.
3. Using a standard pliers, grasp the Spring Retainer by the top tab and remove Valve Assembly. The flat Washer will rest on top of the retainer.

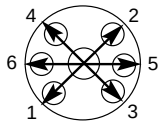
   NOTE: Normally the Valve Assembly will remain together. To separate the Valve Assembly, place a screwdriver into the side of the Spring Retainer and press on the back of the Valve until the Spring Retainer and Seat separate. If assembly separates, lift Spring and Valve from chamber by hand, using valve seat removal tool or the head of a M10x100 bolt. Insert under lip of the Valve Seat and lift out. This procedure will avoid damaging the surface of the Valve Seat.

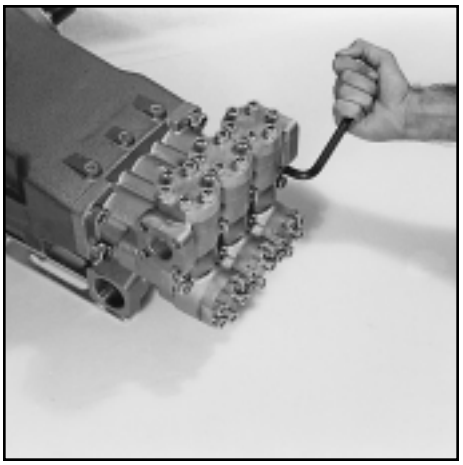
Reassembly

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

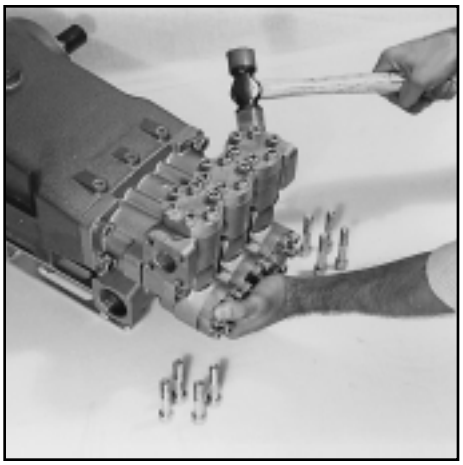
1. Examine the O-Rings and Back-up-Rings on the Seat and replace if cut or worn.
2. Examine the surface of the Valve and Seat for pitting, grooves or wear and replace if necessary.
3. If servicing from individual parts, place the Seat with O-Ring and Back-up-Ring on work surface with o-ring side down. Place Valve onto Seat with the raised side up. Place the Spring over the raised backside of the Valve. Securely snap the Spring Retainer into the Seat. The Valve Assemblies come preassembled in the valve kit.

   NOTE: Inlet and discharge valve parts are interchangeable. Two valve kits are needed for complete valve change.
4. Press Valve Assembly squarely into chamber.
5. Place Washer and Coil Spring on top of Retainer.
6. Examine the O-Ring and Back-up-Ring on Valve Plug and replace if cut or worn. Press Valve Plug into valve chamber. Exercise caution not to cut O-Ring or Back-up-Ring.
7. Reinstall six (6) M10 hex socket screws on each Valve Plug and hand tighten using torque sequence. Then torque all screws per chart.

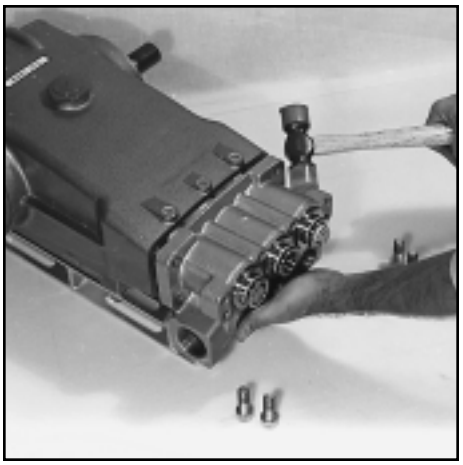




Removing Discharge Manifold screws



Removing the Discharge Manifold



Removing the Inlet Manifold

Removing the V-Packing Cylinder

Removing the V-Packing Spacer from the Cylinder

Removing the Female Adapter, V-Packing and Male Adapter

REMOVING DISCHARGE MANIFOLD

1. Remove the eight (8) M12 hex socket head screws.
2. Tap the back side of the Discharge Manifold with a soft mallet and gradually work from pump.
3. Remove the O-Rings from lower Inlet Manifold chamber.

REMOVING THE INLET MANIFOLD

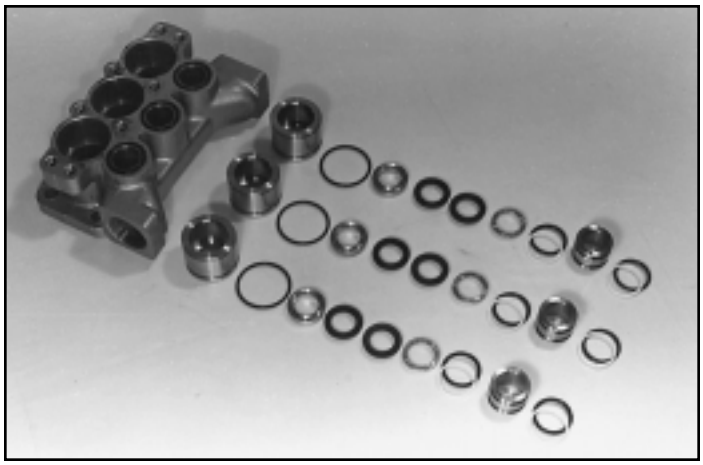
1. Remove the four (4) M14 hex socket head screws.
2. Rotate Crankshaft to separate Inlet Manifold from the Crankcase.
3. Tap the rear of the Inlet Manifold with a soft mallet. Support from underside and gradually work from the pump. Exercise caution and keep manifold aligned with Plungers to avoid damaging them as the manifold is removed.

SERVICING THE PACKINGS

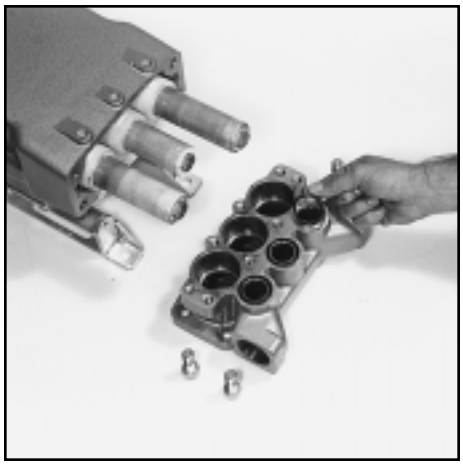
Disassembly of the V-Packings

The V-Packing Cylinder may remain in either the Inlet or Discharge Manifold and generally may be removed by hand or with a reverse pliers.

1. Place the **crankcase side** of the Inlet Manifold **down** on the work surface.
2. Remove the V-Packing Cylinder by inserting screwdrivers into the exposed grove on opposite sides and pry out of the chamber.
3. Using a reverse pliers remove the V-Packing Spacer from the center of the V-Packing Cylinder. The V-Packing Spacers may remain in the V-Packing Cylinder or Discharge Manifold. If in the Discharge Manifold, insert screwdrivers into groove on opposite sides of Spacer and pry out.
4. Remove the Male Adapter, V-Packings and Female Adapter from the V-Packing Cylinder.

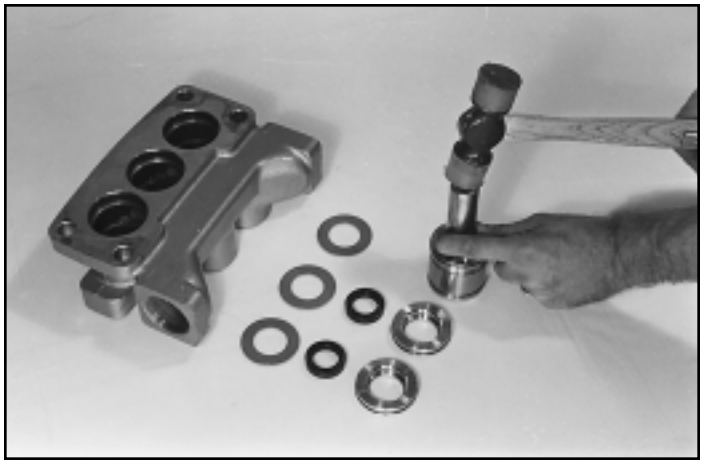


Complete Female Adapter, V-Packing and Male Adapter Assembly



Removing the Inlet Manifold O-Ring

Removing the Inlet Adapter from the Inlet Manifold



Removing the Lo-Pressure Seal from the Inlet Adapter

Reassembly of V-Packings

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.

1. Examine the exterior O-Rings on the V-Packing Cylinder and replace if cut or worn.
2. Inspect I.D. of V-Packing Cylinder for pitting or grooves and replace as needed.
3. Insert the new Female Adapter into the V-Packing Cylinder with the **"V" side up**. (see Tech Bulletin 053).
4. Assemble the three (3) V-Packings (Model 3507), two (2) V-Packings (Model 3517) and insert into the V-Packing Cylinder with **"V" side up**.
5. Insert Male Adapter into V-Packing Cylinder with **notches up**.
6. Examine O-Ring and Back-up-Ring on V-Packing Spacer and replace if cut or worn.
7. Insert **smaller diameter** end of V-Packing Spacer into V-Packing Cylinder.
8. Invert the Inlet Manifold with **crankcase side down.** Press the V-Packing Cylinder containing V-Packing Spacer and V-Packings into manifold chambers until completely seated.

Disassembly of Lo-Pressure Seal

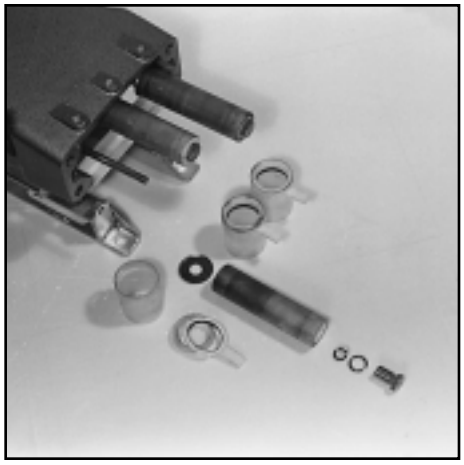
1. Place the Inlet Manifold on blocks with **crankcase side down**.
2. Use a screwdriver or the head of the M10 x 100 bolt to drive out Lo-Pressure Seal and Inlet Adapter.
3. Separate stainless steel Washer from Inlet Adapter.
4. Place Inlet Adapter on V-Packing cylinder and drive out Lo-Pressure Seal using a socket sized to fit.

Reassembly Lo-Pressure Seal

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

1. Place **crankcase side of Inlet Manifold facing up**, insert Washer into manifold chamber.
2. Examine O-Ring on Inlet Adapter and replace if cut or worn.
3. Place Inlet Adapter with **o-ring side down** and insert new pre-greased Lo-Pressure Seal into the Inlet Adapter with **garter spring facing up.** Press squarely into position (see Tech Bulletin 053).

   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. Insert Inlet Adapter and Lo-Pressure Seal with **garter spring facing down** and press squarely into manifold chamber.



Complete Plunger Assembly

SERVICING THE PLUNGERS

Disassembly

1. Remove the Seal Retainers from the ceramic plungers.
2. Remove the used Wick.
3. Loosen Plunger Retainer 3 to 4 turns. Push Ceramic Plunger towards crankcase until Plunger Retainer pops out. If resistant, slip M14 or M21 deep socket over Plunger Retainer and gently tap end to free Ceramic Plunger.
4. Unthread and remove Plunger Retainer, Gasket, O-Ring and Back-up-Ring.
5. Remove Ceramic Plunger from Plunger Rod.
6. Barrier Slinger and Keyhole Washer will remain on the Plunger Rod. Remove and examine for wear.

Reassembly

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

1. With these plunger items removed, examine the Crankcase Oil Seals for wear or deterioration and replace as needed.
2. Replace Barrier Slinger and Keyhole Washer on Plunger Rod.
3. Carefully examine each Plunger for scoring or cracks and replace if worn.

   NOTE: Ceramic Plunger can only be installed one direction (larger I.D. out).

   NOTE: If new plungers are installed, operate for 24 hours to allow grease from seals to penetrate plunger surface, then lubricate wicks.

4. Examine O-Ring and Back-up-Ring on Plunger Retainer and replace if cut or worn. Lubricate O-Ring for ease of installation and to avoid damaging O-Rings.

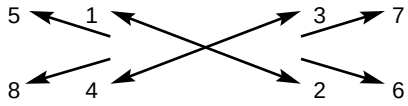
   NOTE: First install O-Ring, then Back-up-Ring, then Gasket. Apply Loctite 242 to Plunger Retainer threaded end and thread onto Plunger Rod. Torque per chart.

5. Rotate crankshaft so the two outside Plungers are extended equally.
6. Install Seal Retainers onto the Plungers with new wicks. Insert smaller diameter first.

   NOTE: Line up Wicks with the oil holes in the crankcase and tabs in the Oil Pan.

7. Lightly lubricate plungers to assist in installing the Inlet manifold. Support the Inlet Manifold from the underside and carefully slide over the Plungers. Press completely into Crankcase.
8. Apply Loctite 242 to the four (4) M14 HSH screws and torque per chart.
9. Install new O-Rings at bottom inlet ports of manifold. Support the Discharge Manifold from the underside and slip over V-Packing Spacers.
10. Apply Loctite 242 to the eight (8) M12 HSH screws, thread hand tight and torque per chart in this sequence.

    Torque in order diagonally the center four (4) screws then the outer four (4) screws all hand tight then repeat series to specs.



SERVICING THE CRANKCASE SECTION

1. While manifold, plungers and seal retainers are removed, examine crankcase seals for wear.
2. Check oil level and 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 evidenced.

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 [Part No.]	Torque in. lbs.	 ft. lbs.	 Nm
Plunger Retainer Model 3507	M7	M14 Hex [25053]	90	7.2	10
Plunger Retainer Model 3517	M10	M21 Hex	220	18.1	25
Inlet Manifold Screws All Models	M14	M12 Allen [33048]	480	39.8	54
Discharge Manifold Screws All Models	M12	M10 Allen [33047]	355	29.6	40
Valve Plug Screws All Models	M10	M8 Allen [33046]	220	18.1	25
Crankcase Cover/ Bearing Cover Screws All Models	M8	M13 Hex [25324]	115	9.4	13
Connecting Rod Screws All Models	M10	M17 Hex [25083]	395	32.5	45
Bubble Oil Gauge All Models	M28	Oil Gauge Tool [44050]	45	3.6	5
Mounting Bolts All Models	M14	M22	570	47.4	68

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	Lubrica ion of Lo-Pressure Seals	All Models
035	Servicing Crankcase Section	7PFR - 60PFR
036	Cylinder and Plunger Reference Chart	All Models
041	Oil Gauge and Crankcase	3520 and 3535
043	LPS and HPS Servicing	All Plunger Models
052	Plunger Rod and Stud	3PFR, 5PFR, 15PFR, 35PFR, 60PFR
053	Liquid Gasket	All Plunger NAB-S.S. Models
064	By-Pass Hose Sizing	All Unloaders/Regulators
068	S.S. V-Packing Spacer and O-Rings	3507
069	Forged Extended Manifolds	35PFR
074	Torque Chart	Piston and Plunger Pumps
077	Oil Drain Kit	All Models (except 2SF/4SF)
080	Extended Discharge Manifold	3507 and 3517
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 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 to 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.

INLET ACCESSORIES are designed to protect against overpressurization, 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.

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 overpressurizing the inlet.
- ❏ The by-pass line should be connected to the pump inlet line at a gentle angle of 45° or less and no closer than 10 times the pump inlet port diameter e.g. 1-1/2" port size = 15" distance from pump inlet port.

HOSE FRICTION LOSS

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

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

WATER LINE PRESSURE LOSS

PRESSURE DROP IN PSI PER 100 FEET

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

RESISTANCE OF VALVES AND FITTINGS

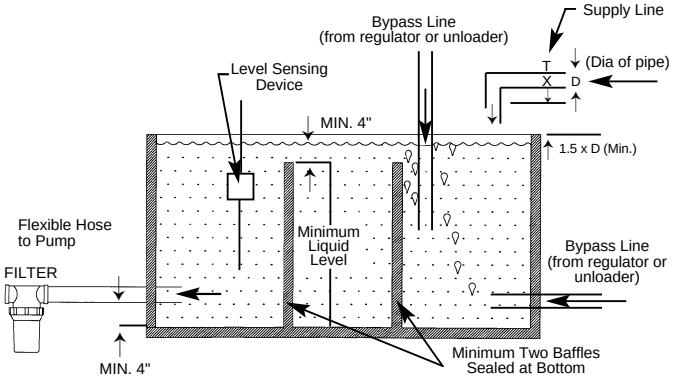
Nominal Pipe Size Inches	Inside Diameter Inches	Equivalent Length of Standard Pipe in Feet: Gate Valve	Globe Valve	Angle Valve	45° Elbow	90° Elbow	180° Close Ret	Tee Thru Run	Tee Thru Branch
1/2	0.622	0.41	18.5	9.3	0.78	1.67	3.71	0.93	3.33
3/4	0.824	0.54	24.5	12.3	1.03	2.21	4.90	1.23	4.41
1	1.049	0.69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

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

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

TYPICAL RESERVOIR TANK

RECOMMENDED 6 TO 10 TIMES SYSTEM CAPACITY



Handy Formulas to Help You

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

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

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

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

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

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

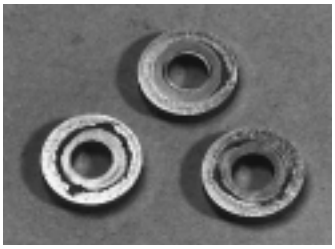
Q. **What size motor pulley should I use?**

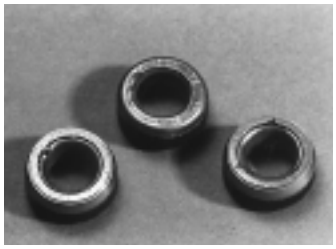
A. Pump Pulley (Outer Diameter) x $\frac{\text{Pump RPM}}{\text{Motor/Engine RPM}}$ (Consult Engine Mfr.)

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

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

Avoid Cavitation Damage





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

CONDITION	SOLUTION
Inadequate inlet line size	• Increase line size to the inlet port or one size larger
Water hammering 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.