

PLUNGER PUMP SERVICE MANUAL



**5 FRAME [310, 340, 350, 311, 341, 351, 317, 347, 357]
5 FRAME - OEM [31, 34, 35, 42HS, 43HS, 45]**

7 FRAME [530, 550]

**7 FRAME - OEM [51, 53, 55, 56, 57, 58, 59, 60, 70]
15 FRAME [650, 651, 660, 661, 1050, 1051, 1057]**

CAUTION: CAT PUMPS are positive displacement pumps. Therefore, a properly designed pressure RELIEF OR SAFETY VALVE MUST BE INSTALLED in the discharge piping. Failure to install such a relief mech-

anism could result in personal injury or damage to the pump or system. CAT PUMPS does not assume any liability or responsibility for the operation of a customer's high pressure system.

INSTALLATION AND START-UP INFORMATION

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

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

LUBRICATION: Fill crankcase with special CAT PUMP oil per pump specifications [5FR-18 oz., 7FR-25 oz., 15FR-42oz.]. **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**.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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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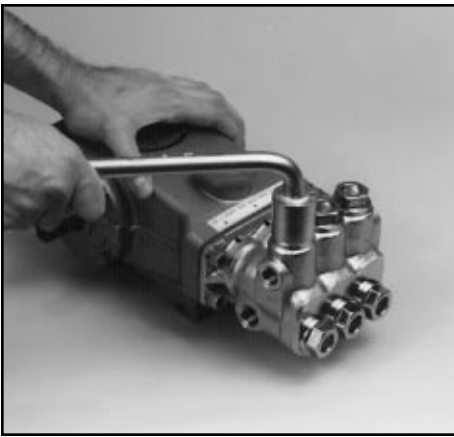


Fig. A

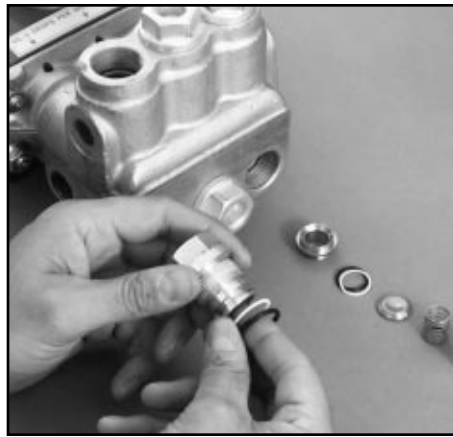


Fig. B

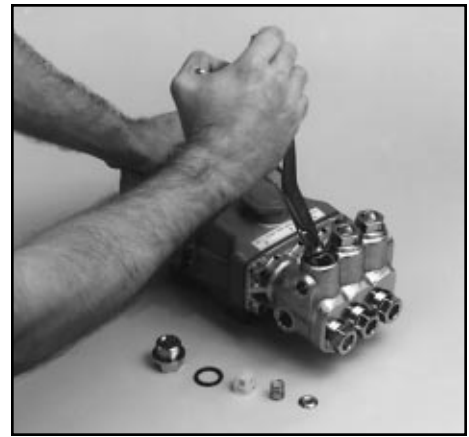


Fig. C

SERVICING THE VALVES

1. Remove the hex Valve Plugs (top discharge, bottom inlet). (Fig. A)
2. Examine the O-Ring under the Valve Plug for cuts or distortion and replace if worn. Lubricate new O-Rings before installing.

NOTE: On Models 43HS, 45, 56, 57, 59, 60, 70 there is an extended Valve Plug with O-Ring and Back-up-Ring. Install the Back-up-Ring, then the O-Ring into the groove at the **end of the Valve Plug**. (Fig. B) See Tech Bulletin #058 for model identification.

3. Grasp Valve Retainer by tab at the top with pliers and remove from valve chamber (Fig. C). Usually the valve assembly will remain together while being removed. To separate the valve assembly, insert a screwdriver into the side of the Retainer and press on the back side of the Valve to begin separation, then between the Retainer and Valve Seat to separate completely. If the valve assembly separates during removal, remove the Spring and Valve with a needle nose pliers. Then, with a reverse pliers, remove the Valve Seat from the manifold chamber.
4. Examine all valve parts for pitting, gouges or general wear and replace with preassembled Valve Assembly in service kit containing Retainer, Spring, Valve, Valve Seat, O-Ring and Back-up-Ring. (Fig. D)

NOTE: Inlet and discharge valve parts are interchangeable. **Two Valve Kits** are needed for complete valve change.

5. Grasp new Valve Assembly by tab at top with pliers, immerse in oil and push into valve chamber. (Fig. E) Be certain Valve Assembly is completely seated in valve chamber.

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

NOTE: For Corrosion Resistant Models remember to install the Coil Spring between the Valve Plug and Retainer. Refer to Tech Bulletin #046 for model identification.

6. Apply Loctite 242 to the threads of the Valve Plug, thread into manifold port and torque per chart.



Fig. D



Fig. E



Fig. F

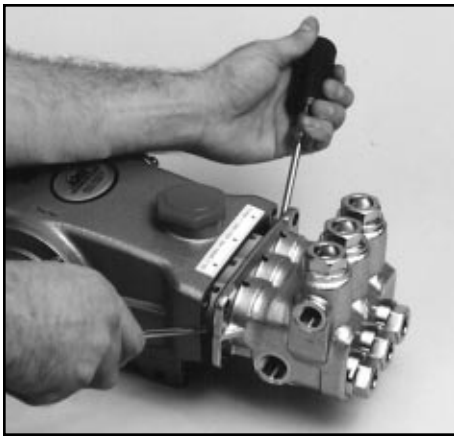


Fig. G

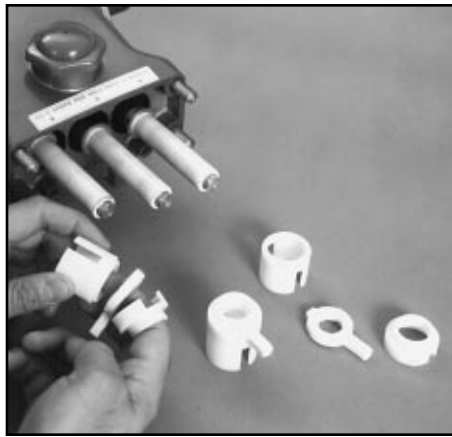


Fig. H

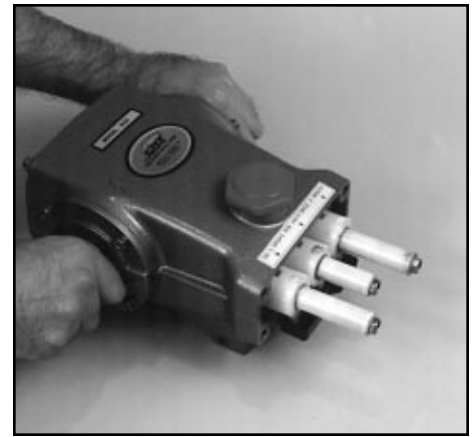


Fig. I

SERVICING THE PUMPING SECTION

Disassembly

1. Using an M8 allen wrench on the 5 Frame pumps, a M14 hex tool on the 7 Frame pumps, or a M17 hex tool on the 15 Frame pumps, remove the two (2) Socket Head Screws, and two (2) Lockwashers or four (4) Flanged Nuts.
 2. Rotate Crankshaft by hand to start separation of Manifold head from crankcase. (Fig. F)
 3. Insert two flat head screwdrivers on opposite sides to further separate Manifold Head from Crankcase or support the underside of the Manifold Head and tap lightly with a mallet on the backside of the Manifold Head. (Fig. G)
- CAUTION: KEEP MANIFOLD PROPERLY ALIGNED WITH CERAMIC PLUNGERS WHEN REMOVING TO AVOID DAMAGE TO EITHER PLUNGERS OR SEALS.
4. Remove Oil Pan and slide out Seal Retainer with Wick. (Fig. H)
 5. Examine Ceramic Plunger for cracks or scoring and refer to Servicing Plungers if replacement is needed.

Reassembly

1. Generally Plungers do not need to be replaced. Clean Plungers and remove any foreign material with a non-abrasive cleaner.
2. Saturate new Wick by soaking in oil, place Wick in Rear Seal Retainer and snap Retainer Adapter onto Rear Retainer. Slip Retainer with Wick over Ceramic Plungers with **tab down and wick out**. (Fig. H) If new Plungers are installed, **do not lubricate Wicks**. Operate for 24 hours to allow grease from seals to penetrate plunger surface, then lubricate wicks.
3. Replace Oil Pan.
4. Turn shaft by hand to line up plungers so end plungers are parallel. (Fig. I)
5. Lightly lubricate the Plungers and carefully slide the Manifold Head onto the plungers supporting from the underside to avoid damaging the plungers. On the high pressure V-Packing models or larger manifolds, it may be necessary to gently tap with a soft mallet until the manifold is flush with the crankcase.
6. Replace two (2) Lockwashers, two (2) Socket Head Screws or four (4) Flanged Nuts and torque per chart.



Fig. J



Fig. K

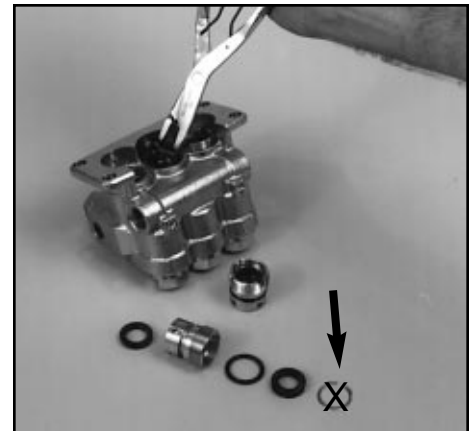


Fig. L

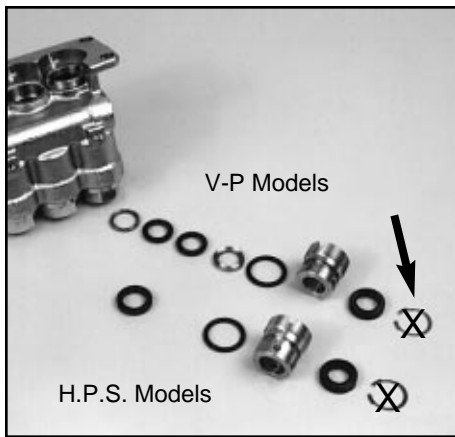


Fig. M



Fig. N



Fig. O

SERVICING THE PLUNGERS

Disassembly

1. Remove the Manifold Head as described in the Servicing the Pumping Section.
2. To service the plungers, first remove the Oil Pan then the Seal Retainers with Wicks. The seal retainer is a two piece item that can easily be separated.
3. Using an M12 hex tool on the 5, 7 and 15 Frame pumps, or an M11 hex tool on the OEM 5, and 7 Frame pumps, loosen the Plunger Retainer about three to four turns. Push the Plunger back to separate it from the Retainer and finish unthreading the Plunger Retainer by hand.
4. Unthread the Plunger Retainer, O-Ring, Back-up-Ring and Gasket. Stud may stay on Plunger Rod or come off with Plunger Retainers. (Fig. J)
5. Remove the Ceramic Plunger, Keyhole Washer and Barrier Slinger from Plunger Rod.

Reassembly

1. Visually inspect Crankcase Seal for deterioration or leaks and contact factory for assistance with replacement. Replace Barrier Slinger if damaged and slide onto Plunger Rod **with concave side away from crankcase**.
2. Examine Ceramic Plunger for scoring or cracks and replace if worn. **Ceramic Plunger can only be installed in one direction (front to back)**. Do not force onto rod.
3. 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 damage to the o-rings. **Install NEW Gasket, then O-Ring, then Back-up-Ring** onto Plunger Retainer.
NOTE: OEM models have a longer Stud for the Plunger Retainer.
4. Apply Loctite 242 to exposed threads of Stud and thread Plunger Retainer onto Plunger Rod. Torque per chart.
5. Install the two-piece Seal Retainer with NEW Wick onto each rod with **tab down and wick out**.
6. Proceed with servicing the seals or remounting of Manifold Head as described.

SERVICING THE SEALS AND V-PACKINGS

Disassembly

1. Remove the Manifold Head as described in Servicing the Pumping Section.
2. Using a reverse pliers, remove the Lo-Pressure Seal from the Seal Case.
3. With **crankcase side of manifold facing up**, unscrew the Seal Case from the manifold using a seal case removal tool. (Fig. K)
4. Remove O-Ring from O.D. of Seal Case.
5. Remove Snap Ring and Lo-Pressure Seal from the Seal Case. Seals are generally removed easily without any tools. (Fig. L) **Discard snap ring on 5FR and 7FR pumps**. See Tech. Bulletin #054 (2-pc. Seal Retainer) for model identification.
6. **Hi-Pressure Seal Models:** The Hi-Pressure Seal is generally easily removed from the manifold without any tools. If extremely worn a reverse pliers may be used. (Fig. M, lower set of seals)
7. **V-Packing Models:** The Female Adapter, V-Packings and Male Adapter are easily removed from manifold without tools. If extremely worn a reverse pliers may be used. (Fig. M, upper set of seals)

Reassembly

V-Packing Models:

1. Lubricate seal chamber in the manifold.
NOTE: For certain applications apply liquid gasket to the O-Ring crevices and seal surfaces. See Tech Bulletin #053 for model identification.
2. Insert Male Adapter **with notches down** and "**v**" side up and press completely into chamber by hand (Fig. N).
3. Lubricate V-Packings and install one at a time with **grooved side down**.
4. Next install Female Adapter with **grooved side down**. (Fig. O)
5. Examine Seal Case O-Ring and replace if worn. Lubricate new O-Rings before installing.
6. Thread Seal Case into manifold and tighten with special seal case tool. See Tech Bulletin #053.

5 Reassembly

Hi-Pressure Seal Models:

1. Lubricate seal chamber in manifold.

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

2. Carefully square Hi-Pressure Seal into position by hand with the **grooved side down** (metal back facing out) (Fig. O).
3. Examine Seal Case O-Ring and replace if worn. Lubricate new O-Ring before installing.
4. Next secure Hi-Pressure Seal into position by threading Seal Case into manifold. Tighten Seal Case with special seal case tool.

Reassembly

Lo-Pressure Seal-All Models:

1. Examine Lo-Pressure Seal for wear or broken spring and replace if necessary.
2. Install Lo-Pressure Seal in seal case with **garter spring down**.
3. Next install Seal Retainer w/wick over plungers with **wick out and tab down**. If new plungers are installed, **do not lubricate wicks**. Operate for 24 hrs to allow grease from seals to penetrate plunger surface, then lubricate wicks. **See Tech Bulletin #054 for more information on new two piece seal retainer. DO NOT install snap ring on 5FR and 7FR. DO install NEW SNAP RING in all 15FR pumps.**
4. Replace Manifold Head onto pump as described under servicing the pumping section and torque per chart.

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 Seals externally for drying, cracking or leaking.
5. Consult factory or your local distributor if crankcase service is evidenced.

See Section I of the Plunger Pump Service Video for additional information.

PREVENTATIVE MAINTENANCE CHECK-LIST

Check	Daily	Weekly	50 hrs.	500 hrs.*	1500 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.

**Remember to service the regulator/unloader at each seal servicing and check all system accessories and connections before resuming operation.

TECHNICAL BULLETIN REFERENCE CHART

No.	Subject	Models
003	3FR - 68FR Drive Packages	3FR-68FR Plunger Models
024	Lubrication of Lo-Pressure Seals	All Models
027	Valve Assemblies for Plunger Pumps	5FR, 7FR, 15FR
032	Shaft Extension and Manifold Port Changes	310, 317, 323, 530, 550
035	Servicing Crankcase Section - Plunger Pumps	5FR, 7FR, 15FR
036	Cylinder and Plunger Reference Chart	All Models
043	Plunger Pump LPS and HPS Servicing	All Plunger Models
045	One-Piece S.S. Plunger Retainer with Stud	5FR, 7FR, 15FR
046	Valve Plug with Coil Spring	317, 347, 357, 1057
047	Blind Bearing - Shaft Cover	Gearbox Plunger Pumps
048	Valve Plug Dimension Change	10FR and 15FR Plunger Pumps
049	S.S. Components - Corrosion Resistant Pumps	3FR, 5FR, 15FR
051	Manifold and Crankcase Changes	7FR Plunger Pumps, OEM
052	Plunger Rod and Stud Change - CR Pumps	3FR, 5FR, 15FR, 35FR, 60FR
053	Liquid Gasket	5FR, 7FR, 15FR, 35FR, 60FR
054	Plunger Pump 2 Piece Seal Retainer	5FR, 7FR
058	Forged Manifold - Extended Valve Plugs - OEM	56, 57, 59, 60
060	Baffle Assembly	8100
061	Installation and Adjustment of Throttle Controller	8100
062	Manifold and Seal Case Changes	650-651
064	By-Pass Hose Length	All Unloaders/Regulators
067	Plunger Retainer Change	3FR, 5FR, 7FR
072	1050 Manifold and V-Packing Change	1050
073	Hi-Temp Pumps	3FR, 5FR, 2SF
074	Piston and Plunger Pump Torque Chart	All Models
077	Oil Drain Kit	All Models

TORQUE CHART

Pump Item Pump Model	Thread	Tool Size [P/N]	Torque in.lbs. ft.lbs. Nm		
PLUNGER RETAINER					
O.E.M. Models	M5	M11 Hex [44044]	55	4.4	6.2
All Standard Models.....	M5	M12 Hex	55	4.4	6.2
MANIFOLD HEAD BOLTS					
.....	M8	M12 Hex	115	9.4	13
5FR 31, 34, 35	M10	M8 Allen [25052]	220	18.1	25
310, 340, 350 311, 341, 351 317, 347, 357					
5FR 42HS, 43HS, 45	M10	M8 Allen [33046]	220	18.1	25
7FR 510, 530, 550	M10	M14 Hex [25053]	220	18.1	25
56, 57, 58, 59, 60, 70					
15FR 650, 651,	M10	M17 Hex [25083]	220	18.1	25
1050, 1051, 1057					
VALVE PLUGS					
5FR 31, 34, 35	M22	M24 Hex [44046]	870	72.3	100
310, 311, 317 340, 341, 347 350, 351, 357 42HS					
5FR 43HS, 45	M25	M24 Hex [44046]	520	43.4	59
7FR 530, 550.....	3/4" SPT	M27 Hex [44045]	870	72.3	100
51, 55, 56, 57, 58 59, 60, 70					
15FR 650, 651.....	3/4" SPT	M27 Hex [44045]	870	72.3	100
1050, 1051, 1057					
CRANKCASE COVER/BEARING COVER SCREWS					
5FR 31, 34, 35	M6	M10 Hex/Phil. [25082]	50	4.0	6
310, 340, 350 317, 347, 357 311, 341, 3 51					
5FR 42HS, 43HS, 45	M6	M10 Hex/Phil. [25082]	50	4.0	6
	M8	M13 Hex [25324]	115	9.4	13
7FR 51, 53, 55, 56, 57,	M6	M10 Hex [25082]	50	4.0	6
59, 60, 70					
15FR 650, 1050	M6	M10 Hex [25082]	50	4.0	6
BUBBLE OIL GAUGE					
All Models	M28	Oil Gauge Tool [44050]	45	3.6	5
MOUNTING BOLTS					
5FR, 7FR	M8	M13 Hex [25324]	115	9.4	13
15FR	M10	M17 Hex [25083]	250	19.7	29

Review Before Start-Up

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

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

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

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

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

INLET PRESSURE should fall within the specifications of the pump.

- Acceleration loss of fluids may be increased by high RPM, high temperatures, low vapor pressures or high viscosity and may require pressurized inlet and C.A.T. (Captive Acceleration Tube) to maintain adequate inlet supply. **DO NOT USE C.A.T. (Captive Acceleration Tube) WITH SUCTION INLET.**
- Optimum pump performance is obtained with +20 PSI (1.4 BAR) inlet pressure and a C.A.T. for certain applications. With adequate inlet plumbing, most pumps will perform with flooded suction. Maximum inlet pressure is 60 PSI (5 BAR).
- After prolonged storage, pump should be purged of air to facilitate priming. Disconnect any discharge port and allow fluid to pass through pump.

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

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

- It is recommended the by-pass be directed to a baffled reservoir tank, with at least one baffle between the by-pass line and the inlet line to the pump.
- Although not recommended, by-pass fluid may be returned to the inlet line of the pump if the system is properly designed to protect your pump. When using this method a **PRESSURE REDUCING VALVE** should be installed on the inlet line (**BETWEEN THE BY-PASS CONNECTION AND THE INLET TO THE PUMP**) to avoid excessive pressure to the inlet of the pump when a flow sensitive regulating device is used. It is also recommended that a **THERMO VALVE** be used in the by-pass line to monitor the temperature build-up in the by-pass loop to avoid premature seal failure.
- A low-pressure, flexible cloth braid (not metal braid) hose should be used from the by-pass connection to the inlet of the pump.
- Caution should be exercised not to undersize the by-pass hose diameter and length. Refer to Technical Bulletin 64 for additional information on the size and length of the by-pass line.
- Check the pressure in the by-pass line to avoid 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.						Brass Pipe—Nominal Dia.						Copper Tubing O.D. Type L						
	1/4	3/8	1/2	3/4	1	1 1/2	1/4	3/8	1/2	3/4	1	1 1/4	1 1/2	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					

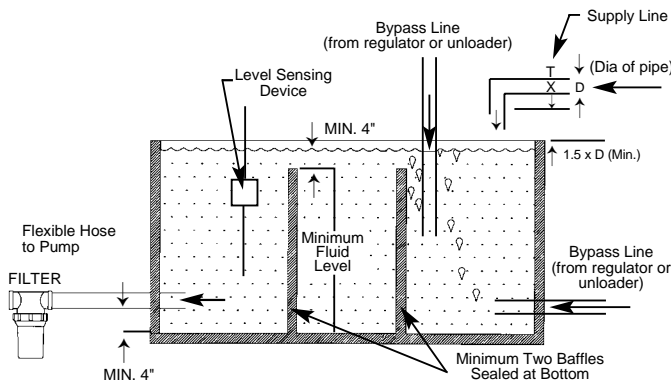
RESISTANCE OF VALVES AND FITTINGS

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	
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. $\text{Electric Brake Horsepower Required} = \frac{\text{GPM} \times \text{PSI}}{1460} \times \frac{1}{\text{Mech. Efficiency}}$ (Standard 85%)

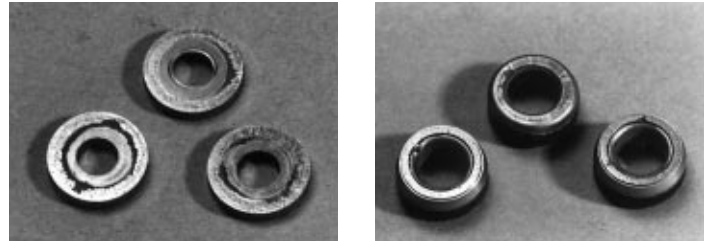
Q. What size motor pulley should I use?

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

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

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

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 fluid acceleration/deacceleration	<ul style="list-style-type: none"> • Install C.A.T. Tube • Move pump closer to fluid 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 Fluid 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 fluids • Properly ventilate cabinets and rooms
Air Leaks in Plumbing	<ul style="list-style-type: none"> • Check all connections • Use Teflon tape
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 fluid and separate inlet from discharge
High Viscosity Fluids	<ul style="list-style-type: none"> • Verify viscosity against pump specifications before operation • Elevate fluid temperature enough to reduce viscosity • Lower RPM of pump • Pressure feed pump • Increase inlet line size
Clogged Filters	<ul style="list-style-type: none"> • Perform regular maintenance or use clean filters to monitor build up • Use adequate mesh size for fluid and pump specifications

DIAGNOSIS AND MAINTENANCE

PROBLEM	PROBABLE CAUSE	SOLUTION
<ul style="list-style-type: none"> • 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 • Worn seat or valves • Inlet suction strainer clogged or improperly sized • Worn seals. Abrasives in pumped fluid, severe cavitation; inadequate water supply, stressful inlet conditions • Fouled or dirty inlet or discharge valves • Worn inlet or discharge valves • Leaky discharge hose 	<ul style="list-style-type: none"> • Replace nozzle of proper size. • Tighten or replace; use correct belt. • Use PTFE liquid or tape. • Check pressure with new gauge and replace as needed. • Clean and reset relief valve to system pressure and correct by-pass. Check supply tank for contamination. • Clean or replace with valve kit. • Use adequate size for inlet pump connection and fluid being pumped. Clean frequently. • Install and maintain proper filter, check line size and flow available to pump. Install a C.A.T. • Clean inlet and discharge valve assemblies. • Replace with valve kit. • Replace hose. Check connections.
<ul style="list-style-type: none"> • Pulsation, pump runs extremely rough, pressure low 	<ul style="list-style-type: none"> • Faulty Pulsation Dampener • Restricted inlet or air entering inlet plumbing • Stuck inlet or discharge valve 	<ul style="list-style-type: none"> • Check precharge of system pressure or replace as needed. • Check filters and clean as needed. Check fittings and use PTFE liquid or tape for airtight connection. • Clean or replace valve. Check supply tank for contamination.
<ul style="list-style-type: none"> • Water leakage from under the manifold *Slight leakage 	<ul style="list-style-type: none"> • Worn Lo-Pressure, Hi-Pressure Seals or V-Packings 	<ul style="list-style-type: none"> • Replace with seal kit, check inlet pressure and system temperature, use Thermo Valve in by-pass line; inlet pressure regulator in inlet line.
<ul style="list-style-type: none"> • Oil leak between crankcase and pumping section 	<ul style="list-style-type: none"> • Worn crankcase seals 	<ul style="list-style-type: none"> • Replace crankcase seals.
<ul style="list-style-type: none"> • Oil leaking in the area of crankshaft 	<ul style="list-style-type: none"> • Worn crankshaft seal • Bad bearing 	<ul style="list-style-type: none"> • Replace damaged seals. • Replace bearing.
<ul style="list-style-type: none"> • Excessive play in the end of the crankshaft 	<ul style="list-style-type: none"> • Worn bearing 	<ul style="list-style-type: none"> • Replace bearing.
<ul style="list-style-type: none"> • Water in crankcase 	<ul style="list-style-type: none"> • Humid air condensing into water inside of the crankcase • Leaking of crankcase seals or seals installed backward 	<ul style="list-style-type: none"> • Change oil every 3 months or 500 hour intervals using special CAT PUMP Premium Grade Oil, PN 6100 (Case) 6107 (Bottle), (other approved oil every month or 300 hours). • Replace seals. Follow proper installation procedure. Contact Cat Pumps supplier for crankcase servicing.
<ul style="list-style-type: none"> • Oil leaking at the rear portion of the crankcase 	<ul style="list-style-type: none"> • Damaged or improperly installed oil gauge, crankcase cover or drain plug O-ring 	<ul style="list-style-type: none"> • Replace oil gauge, crankcase cover or drain plug O-ring. Thread in oil gauge and drain plug hand tight to avoid extruding o-ring.
<ul style="list-style-type: none"> • Loud knocking noise in pump 	<ul style="list-style-type: none"> • Pulley loose on crankshaft • Worn bearing, connecting rod or crankshaft • Stressful inlet conditions 	<ul style="list-style-type: none"> • Check key and tighten set screw. • Consult Cat Pumps supplier for crankcase servicing. • Install C.A.T.
<ul style="list-style-type: none"> • Frequent or premature failure of the packing 	<ul style="list-style-type: none"> • Scored plungers • Over pressure to inlet manifold • Abrasive material in the fluid being pumped • Excessive pressure and/or temperature of fluid being pumped • Running pump dry 	<ul style="list-style-type: none"> • Replace plungers. • Reduce inlet pressure per instructions. • Install proper filtration on pump inlet plumbing. • Check pressure and inlet fluid temperature. Be sure they are within specified range. • DO NOT RUN PUMP WITHOUT FLUID.
<ul style="list-style-type: none"> • Strong surging at the inlet and low pressure 	<ul style="list-style-type: none"> • Foreign particles in the inlet or discharge valve or worn inlet and/or discharge valves 	<ul style="list-style-type: none"> • Check for smooth surfaces on inlet and discharge valve seats. Replace with kit if pitted or worn. • Check supply tank for contamination. Install and regularly clean filter. Do not pump abrasive fluids.