

# 60FR PLUNGER PUMP SERVICE MANUAL



## SPLIT MANIFOLD PLUNGER PUMP 60 FRAME [6760, 6761, 6767]

**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. [60FR-10 Qts.] **DO NOT RUN PUMP WITHOUT OIL IN CRANKCASE.** Change initial fill after 50 hours running period. Thereafter, change oil every **3 months or 500 hour intervals.** OILER ADJUSTMENT is vertical to start feed, horizontal to stop feed, dial to adjust flow rate. Additional lubrication may be required with increased hours of operation and temperature.

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

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

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

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

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

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

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

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

Install a **Pulsation Dampening** device mounted directly to the discharge line. Be certain the pulsation dampener (Prrrrr-o-lator) is properly precharged for the system pressure (see individual Prrrrr-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 and also for proper sizing of the nozzle or regulating devices. 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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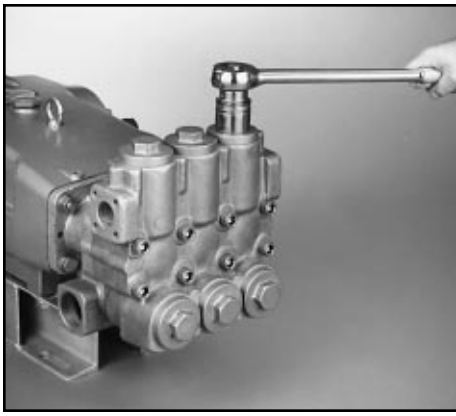


Fig. A

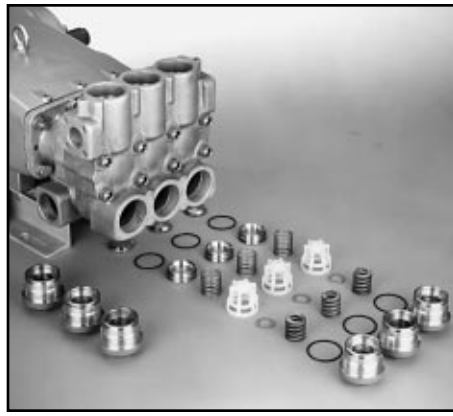


Fig. B

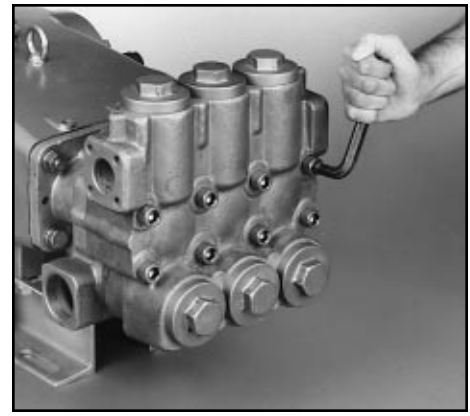


Fig. C

## SERVICING THE VALVES

### Disassembly

1. Remove six (6) M70 Hex Valve Plugs. (Fig. A)
2. Under the Valve Plug is a Coil Spring and Washer. Remove by hand.
3. Then thread an M12 bolt into the top of the Spring Retainer and pull out the valve assembly (including Retainer, Spring, Valve Seat, O-Ring and Back-up-Ring) from the valve chamber. (Fig. B)
4. The valve assembly should remain together. If the valve assembly separates, the parts can easily be removed without any tools except for the Seat. Use a reverse pliers or slip the head of a bolt under the edge of the Valve Seat to remove.

### 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 on the Valve Seat and replace if cut or worn. Lubricate the O-Rings before installing on the Valve Seat.
2. Examine the surface of the Valve and Valve Seat for pitting, grooves or wear and replace if necessary.
3. Examine the Spring for fatigue, scale or breaks and replace.
4. The Valve Assembly comes as one piece in the service kit. Using individual parts, assemble Valve Retainer, Spring, Valve and Seat (with O-Ring and Back-up-Ring) and snap together securely.
5. Lubricate the O.D. of the Valve Assembly and the I.D. of the valve chamber and press Valve Assembly squarely into chamber until completely seated.
6. Replace Washer over top of Retainer, then Coil Spring.
7. Examine the O-Ring on the Valve Plug and replace if cut or worn. Lubricate new O-Ring before installing on Valve Plug. Exercise caution not to cut o-ring on threads of Valve Plug.
8. Lubricate O.D. of Valve Plug O-Ring and thread into Valve Chamber. Exercise caution to avoid extruding O-Ring. Torque to specifications in chart.

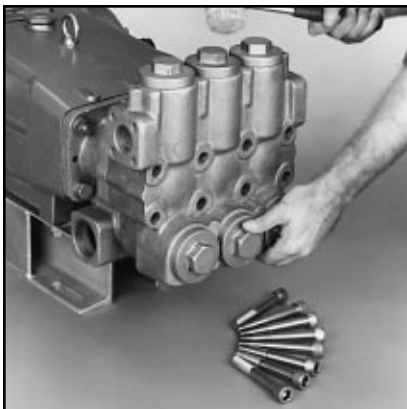


Fig. D

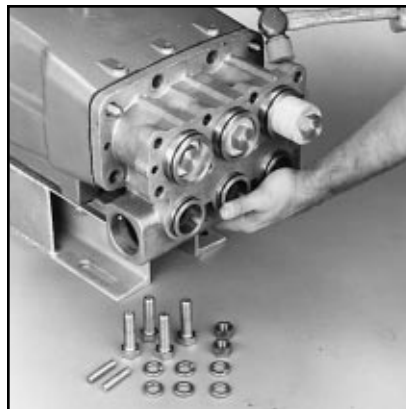


Fig. E



Fig. F

## REMOVING THE DISCHARGE MANIFOLD

1. Remove eight (8) M16 Hex Socket Head Bolts. (Fig. C)
2. To assure alignment use two M16 Studs (PN 88902) as guides while removing manifold. Tap the back side of the Discharge Manifold with a soft mallet and gradually work head from pump. Properly support Discharge Manifold to avoid damage to the Ceramic Plungers. (Fig. D)

## REMOVING THE INLET MANIFOLD

1. Remove the center four (4) M16 Hex Head Bolts and the two (2) M16 Hex Nuts from the Studs.
2. Rotate Crankshaft to separate Inlet Manifold from the Crankcase.
3. Tap the rear of the Inlet Manifold with a soft mallet and gradually work from pump. NOTE: Exercise caution and keep Manifold aligned with Plungers to avoid damage to the Plungers as the Inlet Manifold is removed. (Fig. E)

## SERVICING THE PACKINGS

### Disassembly of the V-Packing

1. Place the **crankcase side** of the Inlet Manifold **down** on the work surface.
2. Remove each V-Packing Cylinder by inserting screwdrivers in opposite sides of the center machined groove and pry away from Inlet Manifold. Then work out by hand. (Fig. F)
3. Next remove Spacer with Coil Springs by hand. Examine the Coil Springs for fatigue or broken springs and replace as needed.
4. Then with reverse pliers remove the Male Adapter, V-Packings and Female Adapter.
5. Remove the Inlet Manifold Spacer from the three bottom ports and examine O-Rings for cuts or wear. Replace as necessary.

### Reassembly of the V-Packing

1. Insert the Female Adapter into the V-Packing Cylinder with the **"V" groove up**. (Fig. H)
2. Next assemble both V-Packings, lubricate the outer surface and insert into the V-Packing Cylinder with the **"V" groove up**. (Fig.H)

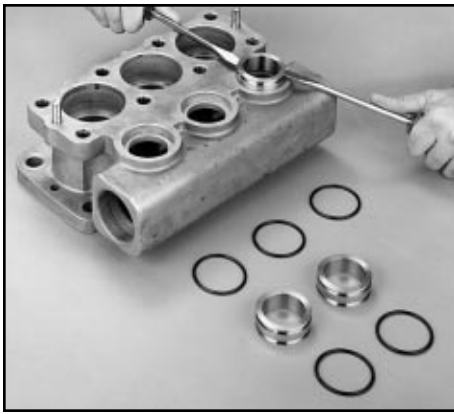


Fig. G



Fig. H

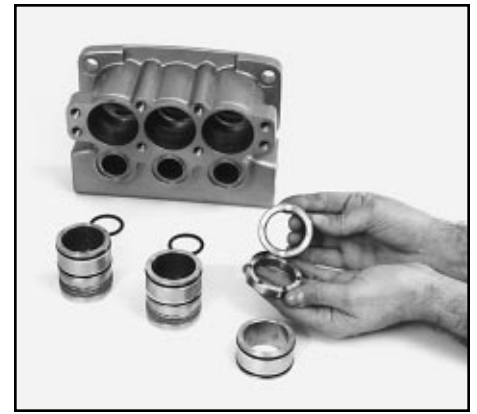


Fig. I

- Next install the Male Adapter into the V-Packing Cylinder with the **notches up**. (Fig H)
- Insert the Spacer with Coil Springs into the Seal Chamber with the **springs facing down**. (Fig I)
- Lubricate outer surface of V-Packing Cylinder and install new O-Ring in groove. Press V-Packing Cylinder with **O-Ring down** into seal chamber until completely seated.  
**NOTE: For certain applications apply liquid gasket to the o-ring crevices and seal surfaces. See Tech Bulletin 053 for model identification.**
- Replace O-Rings and lubricate O.D. of Inlet Manifold Spacers. Press into bottom seal chambers by hand until completely seated.

#### Disassembly of the Lo-Pressure Seal

- With the **crankcase side of the Inlet Manifold up**, examine Lo-Pressure Seals for wear and replace as needed.
- With a screwdriver carefully pry out old seals. (Fig J)

#### Reassembly of the Lo-Pressure Seal

- With the **crankcase side of the Inlet Manifold up**, install new Lo-Pressure Seals into seal chambers with **garter spring facing down**. Press squarely into position.  
**NOTE: For certain applications apply liquid gasket to the o-ring crevices and seal surfaces. See Tech Bulletin 053 for model identification.**

### SERVICING THE PLUNGERS

#### Disassembly

- Remove the Seal Retainers from the Ceramic Plungers.
- Remove the Adapter Front Seal Retainer from the Rear Seal Retainer.
- Remove the used Wick and install new wick.
- Replace Front and Rear Seal Retainer.
- Loosen Plunger Retainer 4 to 5 turns. **Push Plunger towards Crankcase** until Plunger Retainer pops out.
- Unscrew and remove Plunger Retainer, Gasket, O-Ring, Back-up-Ring and Ceramic Plunger.

#### Reassembly

- Replace Keyhole Washer on Plunger Rod.
- Carefully examine each Plunger for scoring or cracks and replace if worn. **NOTE: Ceramic Plunger can only be installed one direction (front to back).** Do not force onto rod.
- Examine Gasket, 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 Gasket, O-Ring then Back-up-Ring.** (Fig K)
- Apply a small amount of Loctite 242 and thread Plunger Retainer onto Plunger Rod. Torque to specifications in chart.
- Slip Seal Retainers over Plungers. Insert smaller diameter first. **NOTE: Line up Wicks with the oil holes in the Crankcase and tabs down towards the Oil Pan.**
- Rotate Crankshaft and line up two outside Plungers.
- Carefully replace Inlet Manifold onto Plungers and press towards Crankcase. Keep manifold aligned to avoid damaging Plungers. To assure alignment use two M16 studs (PN 88902) as guides and remove when manifolds are in place.
- Replace four (4) Hex Head Bolts and two (2) Hex Nuts and torque to specifications in chart.
- Lubricate the exposed O-Rings on the V-Packing Cylinder and valve chamber walls and carefully slip Discharge Manifold over Plungers and snug up to the Inlet Manifold.
- Hand tighten the outer top two (2) Hex Socket Head Bolts first. Then hand tighten the remaining six (6) Hex Socket Head Bolts. Torque per chart and in this sequence.

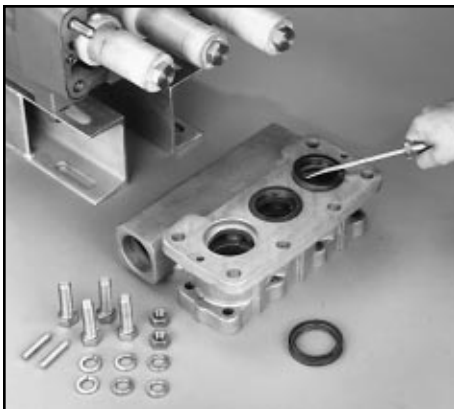
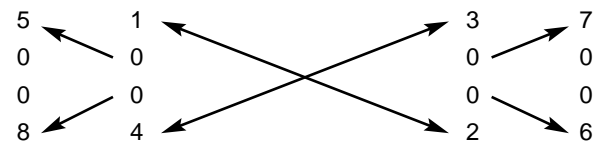


Fig. J

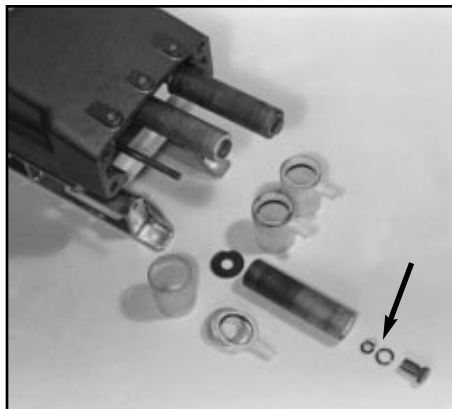


Fig. K

## SERVICING THE CRANKCASE SECTION

1. While Manifolds, 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 factory or your local distributor if Crankcase service is required.

**See Section V 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.

TORQUE CHART					
Pump Item Pump Model	Thread	Tool Size [Part No.]	in. lbs.	ft. lbs.	Nm
<b>Plunger Retainer</b>	M14	M30 Hex	520	43.4	59
<b>Inlet Manifold Bolts</b>	M16	M14 Hex [25053]	565	47.0	64
<b>Discharge Manifold Bolts</b>	M16	M14 Allen [33049]	565	47.0	64
<b>Valve Plugs</b>	M70	M41 Hex	1390	115.7	157
<b>Crankcase Cover/ Bearing Cover Screws</b>	M10	M17 Hex [25083]	220	18.1	25
<b>Connecting Rod Screws</b>	M10	M17 Hex [25083]	395	32.5	45
<b>Bubble Oil Gauge</b>	M28	Oil Gauge Tool [44050]	45	3.6	5

TECHNICAL BULLETIN REFERENCE CHART		
No.	Subject	Models
003	3FR - 68FR Accessory Drive Packages	3FR - 68FR Plunger Models
024	Lubrication of Lo-Pressure Seals	All Models
036	Cylinder and Plunger Reference Chart	All Models
043	Plunger Pump LPS and HPS Servicing	All Plunger Models
052	Plunger Rod and Stud Change - CR Pumps	3FR, 5FR, 15FR, 35FR, 60FR
053	Liquid Gasket	5FR, 7FR, 15FR, 35FR, 60FR
074	Piston and Plunger Pump Torque Chart	All Models
077	Oil Drain Kit	All Models

## INLET CONDITION CHECK-LIST

### Review Before Start-Up

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

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

- Open inlet shut-off valve and turn on water supply to avoid 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 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 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 airtight, 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.
- 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 flooded to 50 PSI (3.5 BAR).
- After prolonged storage, pump should be purged of air to facilitate priming. Disconnect any discharge port and allow fluid to pass through pump.

**INLET ACCESSORIES** are 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 1/4	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	470	150	40	12	3.8	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									

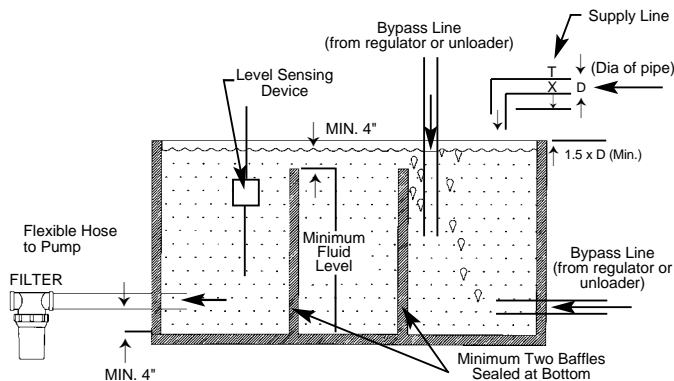
## RESISTANCE OF VALVES AND FITTINGS

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

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"> <li>• Increase line size to the inlet port or one size larger</li> </ul>
Water hammering/ fluid acceleration/ deacceleration	<ul style="list-style-type: none"> <li>• Install C.A.T. Tube</li> <li>• Move pump closer to fluid supply</li> </ul>
Rigid Inlet Plumbing	<ul style="list-style-type: none"> <li>• Use flexible wire reinforced hose to absorb pulsation and pressure spikes</li> </ul>
Excessive Elbows in Inlet Plumbing	<ul style="list-style-type: none"> <li>• Keep elbows to a minimum and less than 90°</li> </ul>
Excessive Fluid Temperature	<ul style="list-style-type: none"> <li>• Use Thermo Valve in bypass line</li> <li>• Do not exceed pump temperature specifications</li> <li>• Substitute closed loop with baffled holding tank</li> <li>• Adequately size tank for frequent or high volume bypass</li> <li>• <b>Pressure feed high temperature fluids</b></li> <li>• Properly ventilate cabinets and rooms</li> </ul>
Air Leaks in Plumbing	<ul style="list-style-type: none"> <li>• Check all connections</li> <li>• Use Teflon tape</li> </ul>
Agitation in Supply Tank	<ul style="list-style-type: none"> <li>• Size tank according to pump output — <b>Minimum 6-10 times system GPM</b></li> <li>• Baffle tank to purge air from fluid and separate inlet from discharge</li> </ul>
High Viscosity Fluids	<ul style="list-style-type: none"> <li>• Verify viscosity against pump specifications before operation</li> <li>• Elevate fluid temperature enough to reduce viscosity</li> <li>• Lower RPM of pump</li> <li>• Pressure feed pump</li> <li>• Increase inlet line size</li> </ul>
Clogged Filters	<ul style="list-style-type: none"> <li>• Perform regular maintenance or use clean filters to monitor build up</li> <li>• Use adequate mesh size for fluid and pump specifications</li> </ul>

## DIAGNOSIS AND MAINTENANCE

PROBLEM	PROBABLE CAUSE	SOLUTION
<ul style="list-style-type: none"> <li>• Low Pressure</li> </ul>	<ul style="list-style-type: none"> <li>• Worn nozzle</li> <li>• Belt slippage</li> <li>• Air leak in inlet plumbing</li> <li>• Pressure gauge inoperative or not registering accurately</li> <li>• Relief valve stuck, partially plugged or improperly adjusted</li> <li>• Worn seat or valves</li> <li>• Inlet suction strainer clogged or improperly sized</li> <li>• Worn V-Packing. Abrasives in pumped fluid, severe cavitation; inadequate water supply, stressful inlet conditions</li> <li>• Fouled or dirty inlet or discharge valves</li> <li>• Worn inlet or discharge valves</li> <li>• Leaky discharge hose</li> </ul>	<ul style="list-style-type: none"> <li>• Replace nozzle of proper size.</li> <li>• Tighten or replace; use correct belt.</li> <li>• Use PTFE liquid or tape.</li> <li>• Check pressure with new gauge and replace as needed.</li> <li>• Clean and reset relief valve to system pressure and correct by-pass. Check supply tank for contamination.</li> <li>• Clean or replace with valve kit.</li> <li>• Use adequate size for inlet pump connection and fluid being pumped. Clean frequently.</li> <li>• Replace Packing, install and maintain proper filter, check line size and flow available to pump. Install a C.A.T.</li> <li>• Clean inlet and discharge valve assemblies.</li> <li>• Replace with valve kit.</li> <li>• Replace hose. Check connections.</li> </ul>
<ul style="list-style-type: none"> <li>• Pulsation, pump runs extremely rough, pressure low</li> </ul>	<ul style="list-style-type: none"> <li>• Faulty Pulsation Dampener</li> <li>• Restricted inlet or air entering inlet plumbing</li> <li>• Stuck inlet or discharge valve</li> </ul>	<ul style="list-style-type: none"> <li>• Check precharge (should be 30-50%) of system pressure or replace as needed.</li> <li>• Check filters and clean as needed. Check fittings and use PTFE liquid or tape for airtight connection.</li> <li>• Clean or replace valve. Check supply tank for contamination.</li> </ul>
<ul style="list-style-type: none"> <li>• Water leakage from under the manifold *Slight leakage</li> </ul>	<ul style="list-style-type: none"> <li>• Worn V-Packings and Lo- Pressure Seals</li> </ul>	<ul style="list-style-type: none"> <li>• Replace with seal kit, check inlet pressure and system temperature, use inlet pressure regulator in inlet line.</li> </ul>
<ul style="list-style-type: none"> <li>• Oil leak between crankcase and pumping section</li> </ul>	<ul style="list-style-type: none"> <li>• Worn crankcase oil seals</li> </ul>	<ul style="list-style-type: none"> <li>• Replace crankcase oil seals, and change crankcase oil.</li> </ul>
<ul style="list-style-type: none"> <li>• Oil leaking in the area of crankshaft</li> </ul>	<ul style="list-style-type: none"> <li>• Worn crankshaft oil seal</li> <li>• Bad bearing</li> <li>• Cut or worn o-ring on bearing case</li> </ul>	<ul style="list-style-type: none"> <li>• Replace damaged oil seals.</li> <li>• Replace bearing.</li> <li>• Replace o-ring on bearing case.</li> </ul>
<ul style="list-style-type: none"> <li>• Excessive play in the end of the crankshaft</li> </ul>	<ul style="list-style-type: none"> <li>• Worn bearing</li> </ul>	<ul style="list-style-type: none"> <li>• Replace bearing, and check for proper belt tension.</li> </ul>
<ul style="list-style-type: none"> <li>• Water in crankcase</li> </ul>	<ul style="list-style-type: none"> <li>• Humid air condensing into water inside of the crankcase</li> <li>• Worn or improperly installed crankcase oil seals</li> </ul>	<ul style="list-style-type: none"> <li>• 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 200 hours.)</li> <li>• Replace seals. Follow proper installation procedure. Contact CAT PUMPS supplier for crankcase servicing.</li> </ul>
<ul style="list-style-type: none"> <li>• Oil leaking at the rear portion of the crankcase</li> </ul>	<ul style="list-style-type: none"> <li>• Damaged or improperly installed oil gauge, crankcase cover or drain plug O-ring</li> </ul>	<ul style="list-style-type: none"> <li>• Replace oil gauge, crankcase cover or drain plug O-ring. Thread in oil gauge and drain plug hand tight to avoid extruding o-ring.</li> </ul>
<ul style="list-style-type: none"> <li>• Loud knocking noise in pump</li> </ul>	<ul style="list-style-type: none"> <li>• Pulley loose on crankshaft</li> <li>• Worn bearing, connecting rod or crankshaft</li> <li>• Stressful inlet conditions</li> </ul>	<ul style="list-style-type: none"> <li>• Check key and tighten set screw.</li> <li>• Consult Cat Pumps supplier for crankcase servicing.</li> <li>• Install C.A.T. (Captive Acceleration Tube).</li> </ul>
<ul style="list-style-type: none"> <li>• Frequent or premature failure of the packing</li> </ul>	<ul style="list-style-type: none"> <li>• Scored plungers</li> <li>• Over pressure to inlet manifold</li> <li>• Abrasive material in the fluid being pumped</li> <li>• Excessive temperature of pumped fluid</li> <li>• Running pump dry</li> <li>• Starving pump of adequate fluid</li> </ul>	<ul style="list-style-type: none"> <li>• Replace plungers.</li> <li>• Reduce inlet pressure per instructions.</li> <li>• Install proper filtration on pump inlet plumbing.</li> <li>• Reduce fluid inlet temperature to specifications.</li> <li>• DO NOT RUN PUMP WITHOUT WATER.</li> <li>• Increase supply line to one size larger than inlet port size.</li> </ul>
<ul style="list-style-type: none"> <li>• Strong surging at the inlet and low pressure</li> </ul>	<ul style="list-style-type: none"> <li>• Foreign particles in the inlet or discharge valve or worn inlet and/or discharge valves</li> </ul>	<ul style="list-style-type: none"> <li>• Check for smooth surfaces on inlet and discharge valve seats. Replace with kit if pitted or worn.</li> <li>• Check supply tank for contamination. Install and regularly clean filter. Do not pump abrasive fluids.</li> </ul>