HOME

PISTON PUMP SERVICE MANUAL

3 FRAME [280, 281, 290, 291]
4 FRAME [331, 333, 335, 430, 431, 435]
5 FRAME [323, 390]
10 FRAME [621, 623, 820, 821, 825, 1010, 1011, 1015]
25 FRAME [1520, 1521, 1525, 2520, 2521, 2525, 2520C]
60 FRAME [6020, 6021, 6024, 6040, 6041, 6044]

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 mechanism could result in personal injury, and/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 [3FR-10 oz., 4FR-21 oz., 5FR-21 oz.,10FR-40 oz., 25FR-84 oz., 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.** [25FR, 60FR] **Oiler adjustment** is vertical to start feed, horizontal to stop feed, 45° to drain reservoir. 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 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.

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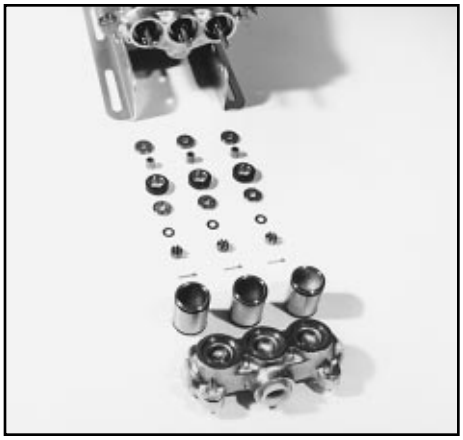


SERVICING THE VALVE ASSEMBLIES

Disassembly

1. Remove the two (2) or four (4) Hex Flange Nuts securing the Discharge Manifold to the crankcase of the pump.
2. Support the Discharge Manifold and tap from the backside with soft mallet. Gradually work free from Cylinders.
3. Valve assemblies will remain in the Manifold. **Pump models with the o-ring groove on the outside of the valve seat require the assistance of a Valve Seat Removal Tool to remove the valve seat.** The Valve, Spring and Retainer will then fall out when the Manifold is inverted.

   Pump models without the o-ring groove on the outside of the Valve Seat permit the Seat, Valve, Spring and Retainer all to fall out when Manifold is inverted.

Reassembly

1. Examine Retainer for wear and replace as needed. Place Retainer in manifold chamber with nylon tab down.
2. Examine Spring for fatigue and replace as needed. Insert Spring into center of Retainer.
3. Inspect the Valves for wear, ridges or pitting and replace as needed.

   Note: Seating side of **Flat Valves** may be lapped on flat surface using 240 grit paper. **Quiet Valves** due to their shape must be replaced. Insert Valve over Spring with **dimpled side up**.

   Note: **Do not mix Quiet Valve and Flat Valve Assemblies.**

4. Examine Valve Seats for wear, pitting or grooves. Lap the **Flat Valve Seats** with 240 grit paper or replace if evidence of excessive wear. **Quiet Valve Seats** must be replaced if worn. Install Seats with **dishside down.**
5. Examine O-Rings and Back-up-Rings on the Valve Seat if used and replace if worn. Always lubricate O-Rings for ease of installation and to avoid damage.

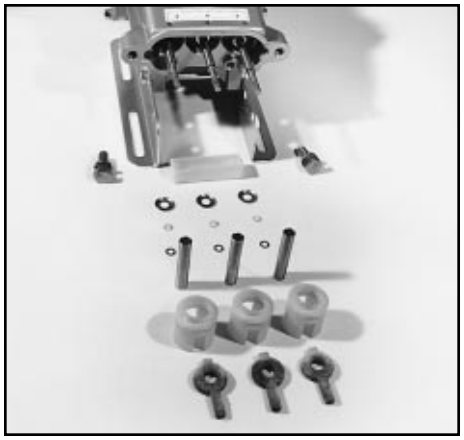
   Note: First install O-Ring in groove on seat towards seating surface, then Back-up-Ring.

   Note: Models without outer groove on seat require the O-Ring to be placed on lip of retainer.

   Note: On Model 390, examine O-Rings on Discharge Valve Adapter and replace if cut or worn. Lubricate O.D. of Adapter O-Rings and press Adapter into Discharge Manifold.
6. Lubricate O-Rings on exposed Cylinder. Exercise caution when slipping Manifold over Cylinders to avoid damaging Cylinder O-Rings. Completely press Manifold over Cylinders.

   Note: On Model 390, Discharge Valve Adapter will press into Cylinders when Manifold is reassembled to crankcase.
7. Replace two (2) or four (4) Hex Flange Nuts and torque per chart.

   Note: Replace all original Shims if used. **When new manifold is used reshim pump**. When starting the pump, check to see that there is no Cylinder motion as this will cause premature failure of the cylinder O-Rings. Center Cylinder motion indicates improper shimming. See Tech Bulletin 017 for more information.



SERVICING THE PUMPING SECTION

■ Standard Piston Pump

Disassembly

1. Remove the Discharge Manifold as described in servicing the Valve Assemblies section.
2. Grasp Cylinders by hand and with an up and down motion, pull Cylinders from Inlet Manifold.

   (Model 390) When removing the Discharge Manifold to service the Piston Assemblies, the Discharge Adapters will generally remain in the discharge ports of the manifold. They can be easily removed with a pliers. Examine the adapter O-Rings and replace if worn or cut. Lubricate the O-Rings and outer surface of the adapters for ease of installation. Install the **smaller diameter, long extension** of the adapter into the discharge manifold ports.
3. Remove Cotterpin, Nut and Washer from Piston Rod.
4. Next remove Retainer, Spacer, Piston-Cup Assembly and Inlet Valve.

   (Model 390) After removing the Inlet Valve, the Inlet Adapters will be visible in the inlet manifold ports. Remove the Adapters with a pliers. Examine the O-Rings and replace if worn or cut. Lubricate the O-Rings and outer surface of the adapter for ease of installation. Install the **smaller diameter, long extension** of the adapter into the inlet manifold ports.

Reassembly

1. Examine Inlet Valve surface for pitting, scale or grooves. Reverse Valve and sand inlet side of Valve using 240 grit paper for clean surface or replace if evidence of excessive wear. Slip onto Rod.
2. Examine Piston seating surface and lightly sand on flat surface using 240 grit paper. If extreme pitting or sharp edges, replace Piston.
3. Examine Cup for wear, cracking, tearing or separation from the Piston. If worn replace and lubricate before installing on Piston.

   Note cup installation: Wipe cup inserter with oil. Slip bac-cup Ring (when used) onto piston. Push Cup over inserter and square with all surfaces. Faulty Cup installation causes premature Cup failure. Some models use a one-piece Piston Assembly.The Cup does not separate from the Piston. Replace entire assembly. Lubricate Piston Assembly and slip Piston-Cup assembly onto Piston Rod with **lip facing discharge.**
4. Next replace Piston Spacer and Retainer on Rod.
5. Replace Washer, thread on Nut and torque per chart.

   Note: Always replace with new **stainless steel Cotterpin** and turn ends under.
6. Examine Cylinder walls for scoring or etching which causes premature wear of Cups and replace as needed.
7. Lubricate Cylinder and replace O-Rings and/or Back-up-Rings if worn or damaged. **Back-up-Rings go to low pressure side of the o-rings.** Carefully slip Cylinder over Rod Ends and push into Inlet Manifold with **Back-up-Ring to the discharge, stroke marking on the inside of Cylinder to the crankcase**.
8. Position Discharge Manifold onto pump as described, replace fasteners and torque per chart.

SERVICING THE PUMPING SECTION

■ Sleeved-Type Piston Models

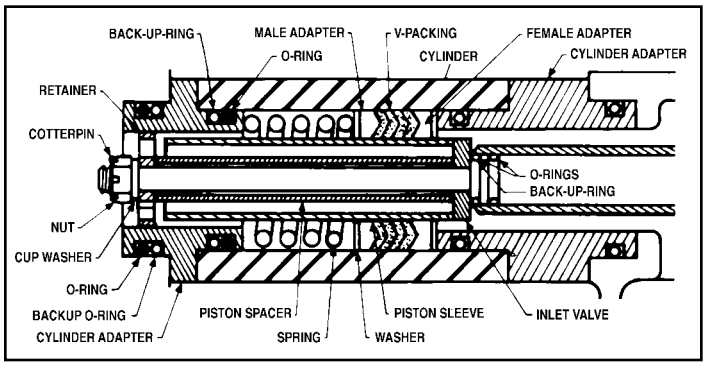
Disassembly

Models 6024-6044 have special cylinder adapters, sleeved-type pistons and V-packings instead of piston-cup assemblies.

1. After removing the Discharge Manifold, slip Cylinders off Piston Rods. It is best to leave the Cylinder Adapters and Springs in the Inlet Manifold as they may score the sleeved-type Pistons when removed. The V-packings will remain in the cylinders.
2. Press worn V-packings from Cylinders.
3. Remove Cotterpins, Slotted Nuts, Washers and Piston Retainers. Pull sleeved-type Pistons from each Piston Rod. Next slip sleeved-type Spacer and Inlet Valve from each Piston Rod.
4. Lubricate and install new O-Rings on Cylinders and Adapters.
5. Inspect Inlet Valve surfaces. If Inlet Valves are worn, lap with 240 grit paper or replace if evidence of excessive damage. If sleeved-type piston inlet surface is worn or the outer diameter is scored, replace it.

Reassembly

1. First install Inlet Valve then sleeved-type Piston onto piston Rod with the **lapped end toward the inlet valve**.
2. Next install the sleeved-type Spacer.
3. Then install new V-packings in the Cylinder in the following order:
   a. Install all parts in one Cylinder, then move to the next Cylinder.
   b. Rotate Crankshaft to extend one Piston Rod completely forward.
   c. Lubricate V-packings and Cylinder I.D. and place **O-ring end of cylinder on work surface**.
   d. Install into Cylinder Female Packing Spacer, black Female Adapter, V-packings, nylon Male Adapter and **Male Packing Spacer with "V" side down.**
   e. Install Spring in outer end of Cylinder and slip Cylinder Assembly over Piston Rod end. Press Cylinder into manifold chamber. The Spring in the Cylinder will be in your palm as the Cylinder Assembly is installed. Use the Spring to hold parts in Cylinder as it is slid over Piston Rod.
4. Remove Spring from Cylinder, install Retainer, conical Washer, Slotted Nut and torque per chart.
5. Install new Cotterpin and bend ends back.
6. Replace Spring in Cylinder.
7. Lubricate inlet and discharge ends of adapter and install Back-up-Rings first, then O-Rings onto adapter. Lubricate O. D. of **small diameter inlet end** of adapter and press into Cylinder.
8. Rotate Crankshaft to extend new Piston Rod. Proceed as above with second and third Cylinders. Proceed with standard Piston Pump Servicing.



■ Hi-Temp Models

Before installing the Inlet Valve in the Model 2520C, be certain the **spacer is installed first**, then proceed with standard Inlet Valve, Roulon Piston Assembly, Piston Spacer, Piston Retainer, Washer, Nut and Cottorpin.

SERVICING SLEEVES AND SEALS

Disassembly

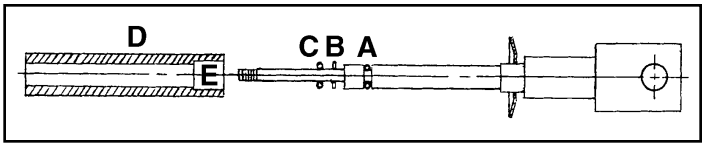
1. Remove Discharge Manifold and Piston Assemblies as described.
2. Remove Inlet Manifold containing seals.
3. Grasp Sleeves and with a pulling and twisting motion remove the Sleeve from the Piston Rod.

   Note: Grasp Sleeve with pliers only if replacing worn Sleeves, as the procedure will mar the Sleeves.
4. Next remove Seal Retainer.
5. Remove and examine O-Rings and/or Back-up-Rings on Piston Rod for wear and replace as needed.

Reassembly

1. Visually inspect that Barrier-Slinger is in position.
2. Lubricate new O-Rings and/or Back-up-Rings and slip onto Piston Rod. Install the first O-Ring (A) in the groove on the Piston Rod. Next position Back-up-Ring (B) against the stepped shoulder. Then install the second O-Ring (C). Exercise caution as you slip the O-Ring over the thread end of the Piston Rod.

Note: The Model 390 pump does not have a sleeve Back-up-Ring and has only one sleeve O-Ring which is installed in the groove on the Piston Rod (A).



3. Examine Sleeves for scoring or etching and replace. **Immerse sleeves** (D) **in oil and carefully twist and push sleeve onto rod with machined counter bore end first** (E).
4. Next install Seal Retainers. If Wicks are used, replace Wicks, thoroughly saturate with oil, place in Seal Retainer and install retainer.
5. Place Inlet Manifold on pair of clearance blocks with **crankcase side down** and drive out old seals.
6. Invert Inlet Manifold with **crankcase side up** and install new Seals. Lubricate O.D. of Seal and install Prrrrm-A-Lube Seal with **garter spring down**. If using blue dot seal, install **blue dot** seal facing up.

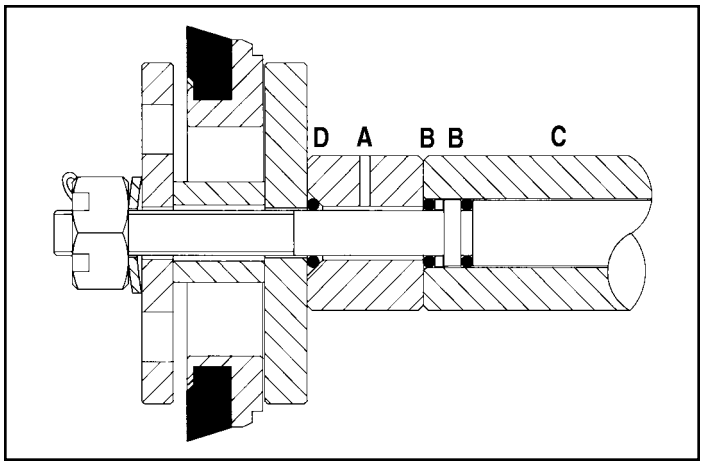
   Note: 25FR and 60FR do not have Prrrrm-A-Lube option. Install with **spring down**.
7. Slip lubricated Seal inserters onto Piston Rod ends, position Inlet Manifold onto pump and remove Seal inserters. Some models secure Inlet Manifold to crankcase. Replace fasteners and torque per chart.
8. Reassemble Piston Assemblies and Discharge Manifold as described.
9. Replace original quantity of Shims on each stud before replacing Discharge Manifold. Refer to Tech Bulletin 017.

■ Hi-Temp Models

On the Model 2520C series, the Seal with the lip, the adapter and the Seal with grease pocket can be driven from the Inlet Manifold.

To install a new Seal assembly, place Manifold on work surface with **crankcase side up**. Install **new seal with lip** in chamber with **garter spring down**. Next examine O-Ring and Adapter and replace either if worn. Lubricate outer surface of Adapter and install new O-Ring. Press Adapter into chamber, **smaller diameter end first**. Next install **grease pocket seal** with **garter spring down**. Then proceed with standard reassembly of pump.

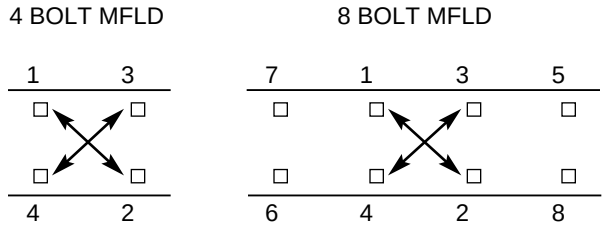
The hi-temp models also have a special vented **Inlet Valve Spacer** (A) Following the installation of the Piston Rod O-Rings (B) and Sleeve (C), slip this vented Spacer onto the Rod with the **tapered end forward.** Then install O-Ring (D) in the tapered groove and proceed with standard Piston Assembly.



SERVICING CRANKCASE SECTION

1. While Inlet Manifold, Sleeves and Seal Retainers are removed, examine Crankcase Seals for wear.
2. Check oil for proper level and for evidence of water in oil or other contaminants.
3. Rotate Crankshaft by hand to feel for smooth bearing movement.
4. Examine Crankshaft Oil Seal externally for drying, cracking or leaking.
5. Consult your local Cat Pumps supplier if Crankcase Service is required.

TORQUE SEQUENCE



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 [P/N]	Torque in. lbs.	Torque ft. lbs.	Torque Nm
PISTON ROD NUT					
284	M4	M8 Hex [25052]	25	2.0	3
280, 290, 323, 333, 390, 430, 10 FR	M6	M10 Hex [25082]	55	4.4	6.2
1020, 1520, 2020	M7	M10 Hex [25082]	115	9.4	13
25 FR	M8	M13 Hex [25324]	115	9.4	13
6020, 6040	M14	M24 Hex [44046]	395	32.5	45
6024, 6044	M10	M17 Hex [25083]	220	18.1	25
MANIFOLD STUD/NUT AND CYLINDER BOLTS					
280, 284, 290, 323, 333, 390, 430	M8	M12 Hex	115	9.4	13
10 FR	M10	M17 Hex [25083]	220	18.1	25
25 FR	M12	M19 Hex	350	28.9	40
6020, 6024, 6040, 6044	M16	M24 Hex [44046]	565	47.0	64
BUBBLE OIL GAUGE					
	M28	Oil Gauge Tool [44050]	45	3.6	5
MOUNTING SCREWS					
280, 290, 333, 430	M8	M13 Hex [25324]	105-120	8.3-9.5	12-13
520, 623, 820, 1010	M10	M17 Hex [25083]	217	17.1	24
25 FR	M12	M19 Hex	300-365	23.7-28.8	34-40
CONNECTING ROD SCREWS					
3 FR, 4 FR, 5 FR	M7	M10 Hex [25082]	95	7.96	11
10 FR, 25 FR	M8	M13 Hex [25324]	130	10.8	15
60 FR	M10	M17 Hex [25083]	395	32.5	45

TECHNICAL BULLETIN REFERENCE CHART

No.	Subject	Models
001	Change from Long to Short Cylinders	10FR
002	Inlet Temperature vs. Inlet Pressure	All Models
003	3FR - 68FR Drive Packages	3FR - 68FR Plunger Models
005	10FR "B" Manifold and Stepped Valve Seat	10FR
008	Motor Pulley Selection Chart	3FR - 25FR
009	Piston Rod and Seal Change	25FR
012	V-Packing Inserters, Sleeve Type Pump	280, 430, 820, 1010, 2520
016	Bac-Cup Piston Assemblies	290, 323, 333, 430, 623
017	Shimming of Discharge Manifolds - Piston Pumps	3FR, 4FR, 10FR, 25FR
020	Quiet Discharge Valve Kits - Piston Pumps	280, 333, 430, 623, 820, 1010
021	Piston Rod, Sleeve and Seal Changes	1020, 1520, 2020
024	Lubrication of Lo-Pressure Seals	All Models
025	Crankcase Oil and Gauge Change - Piston Pumps	333, 430
026	Crankcase Cover and Threaded Style Oil Gauge	280, 290, 333, 430, 10FR
030	Flanged Nut - Manifold	280, 323, 333, 390, 430
033	Crankcase and Rear Cover Change	270, 279, 280, 290
034	Servicing Crankcase Section - Piston Pumps	3FR, 4FR, 10FR, 25FR
036	Cylinder and Plunger Reference Chart	All Models
037	Piston Assembly	323, 333, 623
038	Blue Dot Seal and Wicks	323, 430, 623, 820, 1010
039	Flat Valves Standard	390
042	Crankcase Part Changes	623, 820, 1010
063	25FR Hi-Temp, Cooled Inlet Pump	2520C
064	By-Pass Hose Length	All Unloaders/Regulators
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 cavitating 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 40 PSI (2.8 BAR). Negative suction up to –8.5 PSI (–0.5 BAR) can be achieved with optimum plumbing conditions.
- ❏ 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. 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. 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

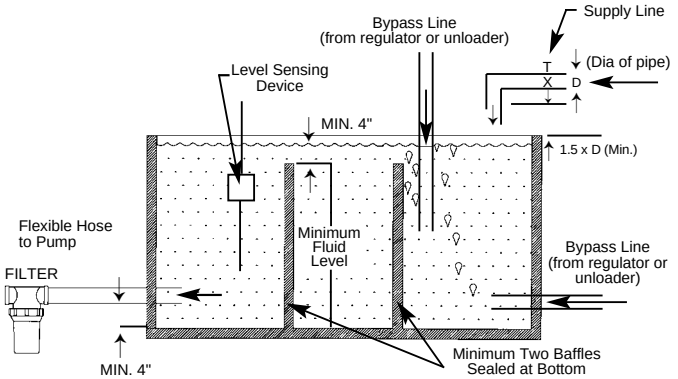
Nominal Pipe Size Inches	Inside Diameter Inches	Equivalent Length of Standard Pipe in Feet: Gate Valve	Globe Valve	Angle Valve	45° Elbow	90° Elbow	180° Close Ret	Tee Thru Run	Tee Thru Branch
1/2	0.622	0.41	18.5	9.3	0.78	1.67	3.71	0.93	3.33
3/4	0.824	0.54	24.5	12.3	1.03	2.21	4.90	1.23	4.41
1	1.049	0.69	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 values, fittings and elevation of lines.

If a sufficient number of values 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 value 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)

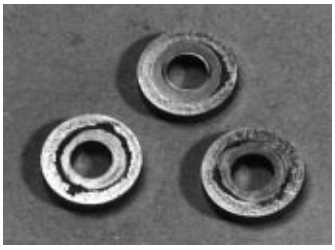
Q. **What size motor pulley should I use?**

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 fluid acceleration/ deacceleration	• Install C.A.T. Tube • Move pump closer to fluid 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 Fluid 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 fluids** • Properly ventilate cabinets and rooms
Air Leaks in Plumbing	• Check all connections • Use Teflon tape
Agitation in Supply Tank	• 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	• 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	• 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
• Pulsation	• Faulty Pulsation Dampener	• Check precharge. If low, recharge it or install a new one.
• Low Pressure	• Worn nozzle • Belt slippage • Air leak in inlet plumbing • Pressure gauge inoperative or not registering accurately • Relief valve stuck, partially plugged or improperly adjusted; valve seat worn • Inlet suction strainer clogged or improper size • Worn Piston assembly. Abrasives in pumped fluid or severe cavitation. Inadequate water supply • Fouled or dirty inlet or discharge valves • Worn inlet or discharge valves • Leaky discharge hose	• Replace nozzle of proper size. • Tighten or replace. Use correct belt type and length. • Disassemble, reseal, and reassemble. • Check with new gauge; replace worn or damaged gauge. • Clean and adjust relief valve; check for worn or dirty valve seats. Repair with Valve Kit. • Clean. Use adequate size. Check more frequently. • Install proper filter. Suction at inlet manifold must be limited. to lifting less than 20 feet of water or –8.5 PSI vacuum. • Clean inlet and discharge valve assemblies. • Replace worn valves, valve seats. • Replace discharge hose and check for air tight connections.
• Pump runs extremely rough, pressure very low	• Restricted inlet or air entering the inlet plumbing • Damaged cup or stuck inlet or discharge valve • Worn inlet seals • Stressful inlet conditions	• Proper size inlet plumbing; check for air tight seal. • Replace worn cups or valves; clean out foreign material. • Install new inlet manifold seals and possibly sleeves. • Pressurize inlet and install C.A.T.
• Cylinder o-ring blown next to discharge manifold	• Pressures in excess of rated PSI or distorted manifold from freezing damage	• Check for plugged nozzle, closed valves or improperly adjusted by-pass valve and replace defective manifold or o-ring. PROTECT FROM FREEZING.
• Leakage at the cylinder o-rings, at the discharge manifold and black powdery substance in the area of the o-ring.	• Loose cylinders. Cylinder motion caused by improper shimming of the discharge manifold	• Remove spacer shims on manifold studs. Do not remove too many shims or the ears of the manifold will be bowed when the manifold is retightened, causing looseness in the center cylinder.
• Water leakage from under the inlet manifold	• Worn inlet manifold seals. Leaking sleeve o-ring	• Install new o-rings and seals as required. Replace scored sleeves.
• Oil leak between crankcase and pumping section	• Worn crankcase piston rod seals • Excess oil from wicks	• Replace crankcase piston rod seals. • Reduce quantity of oil per oiling.
• Oil leaking in the area of crankshaft	• Worn crankshaft seal or improperly installed oil seal retaining packing • Bad bearing	• Remove oil seal retainer and replace damaged gasket and/or seals. • Replace bearing.
• Excessive play in the end of the crankshaft pulley	• Worn main ball bearing from excessive tension on on drive belt	• Replace bearing. Properly tension belt. Use correct type and length.
• Water in crankcase	• May be caused by humid air condensing into water inside the crankcase • Leakage of manifold inlet seals and/or piston rod sleeve o-ring	• Change oil every 3 months or 500 hour intervals using CAT PUMPS Premium Grade Oil, PN 6100 (Case) 6107 (Bottle), (other approved oil every month or 300 hours). • Replace seals, sleeve and o-rings.
• Oil leaking from side of crankcase	• Worn crankshaft seals	• Replace seals.
• Oil leaking at the rear portion of the crankcase	• Damaged or improperly installed oil gauge or worn crankcase rear cover o-ring, or drain plug o-ring	• Replace oil gauge, cover o-ring, or drain plug o-ring as needed.
• Oil leakage from drain plug	• Loose drain plug or worn drain plug o-ring	• Tighten drain plug or replace o-ring.
• Loud knocking noise in pump	• Pulley loose on crankshaft • Broken or worn bearing	• Check key and tighten set screw. • Replace bearing. • Check alignment and belt position.
• Frequent or premature failure of the inlet manifold seals	• Scored rods or sleeves • Over pressure to inlet manifold • Stressful inlet conditions	• Replace rods and sleeves. • Reduce inlet pressure per instructions. • Pressurize inlet and install C.A.T.
• Short cup life	• Abrasive material in the fluid being pumped • Excessive pressure and/or temperature of fluid being pumped • Running pump dry • Front edge of piston sharp • Chrome plating of cylinders damaged causing excessive wear of cups. May be caused by pumping acid solution • Short life on cups on cylinders	• Install proper filtration on pump inlet plumbing. • Check discharge pressure, fluid temperature, or control valve by-pass. • **Do not run pump without water.** • Replace with new piston. • Install new cups and cylinders. Pump only fluid compatible with chrome. Contact CAT PUMPS supplier for UNCH. cylinders. • Stressful inlet conditions. Install C.A.T.
• Strong surging at the inlet and low pressure on the discharge side	• Foreign particles in the inlet or discharge valve or worn inlet and/or discharge valves	• Check for smooth mating surfaces on inlet valves and discharge valve seats. F.V. and inlet valves may be lapped on a very fine oil stone; **Q.V. parts must be replaced**.