CP SS PLUNGER PUMP SERVICE MANUAL

3CP STAINLESS STEEL SPLIT MANIFOLD: 3CP1221, 3CP1231, 3CP1241
5CP STAINLESS STEEL SPLIT MANIFOLD: 5CP6221, 5CP6241CS, 5CP6251

INSTALLATION AND START-UP INFORMATION

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

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

LUBRICATION: Fill crankcase with special CAT PUMP oil per pump specifications [3CP-10 oz., 5CP-17 oz.]. DO NOT RUN PUMP WITHOUT OIL IN CRANKCASE. Change initial fill after 50 hours running period. Thereafter, change oil every **3 months or 500 hour intervals.** Additional lubrication may be required with increased hours of operation and temperature.

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

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

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

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

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

INLET CONDITIONS: Refer to complete **Inlet Condition Check-List** in this manual before starting system. DO NOT STARVE THE PUMP OR RUN DRY. Temperatures above 130°F are permissible. Add 1/2 PSI inlet pressure per each degree F over 130°F. Elastomer or RPM changes may be required. See Tech Bulletin 002 or call CAT PUMPS for recommendations.

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

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

Install a **Pulsation Dampening** device on the discharge head or in the discharge line as close to the head as possible. Be certain the pulsation dampener (Prrrrr-o-lator) is properly precharged for the system pressure (refer to individual Data Sheet).

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

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

PRESSURE REGULATION: All systems require both a primary pressure regulating device (i.e., regulator, unloader) and a secondary pressure safety relief device (i.e., pop-off valve, safety valve). The primary pressure device must be installed on the discharge side of the pump. The function of the primary pressure regulating device is to protect the pump from over pressurization, which can be caused by a plugged or closed off discharge line. Over pressurization can severely damage the pump, other system components and can cause bodily harm. The secondary safety relief device must be installed **in-line** between the primary device and the pump **or on the opposite side of the manifold head**. This will ensure pressure relief of the system if the primary regulating device fails. Failure to install such a safely device will void the warranty on the pump.

If a large portion of the pumped liquid is by-passed (not used) when the high pressure system is running, this by-pass liquid should be routed to an adequately sized, baffled supply tank or to drain. If routed to the pump inlet, the **by-pass liquid can quickly develop excessive heat and result in damage to the pump.** A temperature control device to shut the system down within the pump limits or multiple THERMO VALVES must be installed in the by-pass line to protect the pump.

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

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

STORING: For extended storing or between use in cold climates, drain all pumped liquids from pump and **flush with antifreeze solution to prevent freezing and damage** to the pump. DO NOT RUN PUMP WITH FROZEN LIQUID (refer to Tech Bulletin 083).

⚠ WARNING

All systems require both a primary pressure regulating device (i.e., regulator, unloader) and a secondary pressure safety relief device (i.e., pop-off valve, safety valve). Failure to install such relief devices could result in personal injury or damage to the pump or to system components. CAT PUMPS does not assume any liability or responsibility for the operation of a customer's high pressure system.

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3CP1221, 3CP1231, 3CP1241
Discharge Valve Assembly

5CP6221, 5CP6241CS, 5CP6251
Discharge Valve Assembly

3CP1221, 3CP1231, 3CP1241
Inlet Valve Assembly

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

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

SERVICING THE VALVES

Disassembly

1. Remove the Hex Socket Head Screws (HSH) and Lockwashers from the Discharge Manifold.
2. Support the Discharge Manifold from the underside and tap the backside of the Discharge Manifold with a soft mallet to gradually separate from the Inlet Manifold.
3. Place Discharge Manifold on work surface **with crankcase side up.**
4. Remove Inlet Valve Adapters with front and rear O-Rings from the three small diameter lower inlet chambers. These adapters are not held securely in position and may fall out as the Discharge Manifold is removed.
5. Remove the Seats, O-Rings, Valves, Springs and Retainers from each inlet valve chamber.
6. Remove Discharge Valve Adapters with front and rear O-Rings from the three larger diameter upper discharge valve chambers. These Adapters generally remain with the Discharge Manifold as it is removed. When they remain in Discharge Manifold, insert two screwdrivers under the lip on opposite sides of the Adapters and pry the Adapters from the valve chamber.
7. Remove the Seats, O-Rings, Valves, Springs and Retainers from each discharge valve chamber.

   NOTE: The inlet and discharge use the same Retainers, Springs, Seats and Valves. The O-Rings and Valve Adapters are different. Keep parts in order as they are removed.

Reassembly (Discharge)

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

NOTE: EPDM elastomers require silicone-base lubricant.

1. Examine Spring Retainers for internal wear or breaks in the structure and replace as needed.
2. Examine Springs for fatigue or breaks and replace as needed.
3. Examine Valves for grooves, pitting or wear and replace as needed.
4. Position Spring Retainer in each upper discharge valve chamber until they rest on the machined ridge in each chamber. Insert Spring into the Spring Retainer over the plastic center guide. Place Valve over Spring **with concave side down**.
5. Examine Seat O-Rings for cuts or wear and replace as needed. Place O-Ring on lip of Spring Retainer. Carefully square O-Ring in each valve chamber to avoid cutting O-Ring when Seat is installed.
6. Examine Seats for grooves, pitting, or wear and replace as needed. Install Seat **with concave side down in each valve chamber**, so O-Ring fits snugly into groove on Seat.
7. Examine both front and rear O-Rings on the Discharge Valve Adapter for cuts or wear and replace as needed. Lubricate O-Ring and fit into grooves on outside of each Adapter.
8. Carefully press Discharge Valve Adapter into each upper valve chamber **with small diameter side down** until Adapter snaps tightly into position.

5CP6221, 5CP6241CS, 5CP6251
Inlet Valve Assembly

All Models
Seal Arrangement

All Models
Plunger Arrangement

Reassembly (Inlet)

1. Examine Spring Retainers for internal wear or breaks in the structure and replace as needed.
2. Examine Springs for fatigue or breaks and replace as needed.
3. Examine Valves for grooves, pitting or wear and replace as needed.
4. Position Spring Retainer in each lower inlet valve chamber until they rest on the machined ridge in each chamber. Insert Spring into Spring Retainer over the plastic center guide. Place Valve over Spring **with concave side down**.
5. Examine Seat O-Rings for cuts or wear and replace as needed. Place O-Ring on lip of Spring Retainer. Carefully square O-Ring in each valve chamber to avoid cutting O-Ring when Seat is installed.
6. Examine Seats for grooves, pitting, or wear and replace as needed. Install Seat **with concave side down in each valve chamber**, so O-Ring fits snugly into groove on Seat.
7. Examine both front and rear O-Rings on the Inlet Valve Adapter for cuts or wear and replace as needed. Lubricate O-Ring and fit into grooves on outside of each adapter.
8. Carefully press Inlet Valve Adapter into each lower valve chamber **with small diameter side down** until Adapter snaps tightly into position.
9. Slide Discharge Manifold over Ceramic Plunger ends aligning exposed Discharge Valve Adapters with inlet valve chambers and press into position. Tap with a soft mallet until Inlet and Discharge Manifolds are seated.
10. Place Lockwasher on each HSH screw. Apply anti-seize to HSH screw threads and thread in hand tight. Torque in sequence to specifications in torque chart.

SERVICING THE SEALS

Disassembly

1. To service the seals, it is necessary to remove both the Discharge Manifold and the Inlet Manifold. **See SERVICING THE VALVES, Disassembly, steps 1-7.**
2. Remove HSH Screws from inlet manifolds.
3. Rotate Crankshaft to loosen Inlet Manifold.
4. Support Inlet Manifold from the underside and tap the backside of the manifold with a soft mallet to separate Inlet Manifold from Crankcase.
5. Place Inlet Manifold on work surface **with crankcase side down**. Remove Hi-Pressure Seal (HPS) from each seal chamber using a screwdriver.

   CAUTION: Exercise caution as the screwdriver may damage sealing surface.
6. Invert Inlet Manifold with crankcase side up. Remove Lo-Pressure Seal (LPS) from each seal chamber using a screwdriver.

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

Reassembly

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

NOTE: EPDM elastomers require silicone-base lubricant.

NOTE: For standard installation, apply a small amount of oil to the outside edge of LPS, HPS, Inlet Valve Adapter and Discharge Valve Adapter for ease of installation and to avoid damage.

1. Examine Lo-Pressure Seals for wear to the internal ridges, outer surfaces or broken springs and replace as needed.
2. Press Lo-Pressure Seal into each seal chamber in the Inlet Manifold **with garter spring down** until completely seated.

   NOTE: When using alternate materials, the fit of the special materials may be snug and require gently driving the LPS into position with a cylinder of the same diameter to assure a square seating and no damage to the LPS.
3. Examine Hi-Pressure Seal for wear to the internal ridges or outer surfaces and replace as needed.
4. Invert Inlet Manifold with crankcase side down. Press Hi-Pressure Seal into each seal chamber **with metal backing down until completely seated**.
5. Rotate crankshaft by hand so the two outside Plungers are extended equally. Lightly lubricate Ceramic Plungers, to assist in installing the Inlet Manifold.
6. Slide Inlet Manifold over Ceramic Plungers. Apply Loctite-242 to HSH screw threads and thread in hand tight. Torque in sequence to specifications in torque chart.
7. Examine Inlet and Discharge Valve Adapters for scale build up, wear and replace as needed. Examine O-Rings on both the Discharge and Inlet Valve Adapters for cuts and deterioration and replace as needed.
8. Carefully press Discharge Valve Adapter with O-Rings into each upper Discharge Valve Chamber of Discharge Manifold **with small diameter side down** until Adapter snaps tightly into position.
9. Carefully press Inlet Valve Adapter with O-Rings into each lower Inlet Valve Chamber of Discharge Manifold **with small diameter side down** until Adapter snaps tightly into position.
10. Slide Discharge Manifold over Ceramic Plunger ends aligning exposed Discharge Valve Adapters with inlet valve chambers and press into position. Tap with a soft mallet until Inlet and Discharge Manifolds are seated.
11. Place Lockwasher on each HSH screw. Apply anti-seize to HSH screw threads and thread in hand tight. Torque in sequence to specifications in torque chart.

SERVICING THE PLUNGERS

Disassembly

1. To service the plungers, it is necessary to remove both the Discharge Manifold and Inlet Manifold. **See SERVICING THE VALVES, Disassembly, steps 1-7.**
2. Remove Seal Retainer from each Plunger Rod.

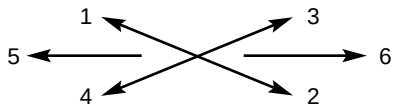
   NOTE: The 5CP models have a PVDF Oil Seal Washer behind the Seal Retainer.
3. Using a wrench, loosen Plunger Retainers approximately three to four turns.
4. Push the Ceramic Plunger back towards crankcase to separate from the Plunger Retainers and proceed with unthreading the Plunger Retainers by hand.
5. Remove Plunger Retainers and Seal Washers.
6. Remove Ceramic Plungers, Keyhole Washers and Barrier Slingers from each Plunger Rod.

Reassembly

1. Visually inspect Crankcase Oil Seals for deterioration or leaks and contact CAT PUMPS for assistance with replacement. **See SERVICING CRANKCASE SECTION.**
2. Examine Plunger Retainers, Keyhole Washers and Barrier Slingers for wear and replace as needed.
3. Examine Seal Washers for cuts or wear and replace as needed.
4. Examine Ceramic Plungers for scoring, scale build-up, chips or cracks and replace as needed. Generally the Ceramic Plungers do not need to be replaced.
5. Slide Seal Washer over each Plunger Retainer.
6. Slide Plunger Retainer with Seal Washer into flat end of Ceramic Plunger.

   NOTE: Ceramic Plunger can only be installed in one direction. Counterbore end of Ceramic Plunger fits over Plunger Rod shoulder.
7. Slide Barrier Slinger over each Plunger Rod **with concave side away from crankcase.**
8. Slide Keyhole Washer over each Plunger Rod **with split ends facing downward**.
9. Apply Loctite-242 to exposed threaded end of Plunger Retainer. Thread into Plunger Rod and torque per chart.
10. On the models 3CP1221, 31 and 41, install Seal Retainers with the holes to the top and bottom, and small tabs facing downward over each Plunger Rod.
11. On the models 5CP6221, 41CS and 51, install Oil Seal Washer first, then the Seal Retainers with the holes to the top and bottom, and small tabs facing downward over each Plunger Rod.
12. Continue with reassembly. **See SERVICING THE SEALS, Reassembly, steps 5-11.**

TORQUE SEQUENCE



SERVICING CRANKCASE SECTION

1. While Manifolds, Plungers and Seal Retainers are removed examine Crankcase Oil Seals for leaking and wear.
2. Check for any signs of leaking at Rear Cover, Drain Plug and Bubble Gauge.
3. Check oil for proper level and for evidence of water or other contaminants in oil.
4. Rotate Crankshaft by hand to feel for smooth bearing movement.
5. Examine Crankshaft Oil Seal externally for drying, cracking or leaking.
6. Consult CAT PUMPS or your local distributor if crankcase service is required.

PREVENTATIVE MAINTENANCE CHECK-LIST

Check	Daily	Weekly	50 hrs.	500 hrs.*	1500 hrs.**	3000 hrs.**
Clean Filters	x					
Oil Level/Quality	x					
Oil Leaks	x					
Water Leaks	x					
Belts, Pulley		x				
Plumbing		x				
Initial Oil Change			x			
Oil Change				x		
Seal Change					x	
Valve Change						x
Accessories					x	

* If other than CAT PUMPS special multi-viscosity ISO68 oil is used, change cycle should be every 300 hours.

** Each system's maintenance cycle will be exclusive. If system performance decreases, check immediately. If no wear at 1500 hours, check again at 2000 hours and each 500 hours until wear is observed. Valves typically require changing every other seal change.

Duty cycle, temperature, quality of pumped liquid and inlet feed conditions all effect the life of pump wear parts and service cycle.

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

TORQUE CHART

Pump Item / Pump Model	Thread	Tool Size [P/N]	Torque in. lbs.	Torque ft. lbs.	Torque Nm
Plunger Retainer	M6	M10 Hex [25082]	55	4.4	6
Inlet Manifold Screws	M8	M6 Allen [30941]	115	9.4	13
Discharge Manifold Screws					
3CP	M10	M8 Allen [33046]	140	12	16
5CP	M12	M10 Allen [33047]	260	22	30
Crankcase Cover Screws	M6	M10 Hex./Phil. [25082]	50	4.0	6
Bearing Cover Screws					
3CP	M6	M10 Hex./Phil. [25082]	50	4.0	6
5CP	M8	M13 Hex [25324]	115	9.4	13
Connecting Rod Screws	M7	M10 Hex [25082]	95	7.96	11
Bubble Oil Gauge	M28	Oil Gauge Tool [44050]	45	3.6	5

TECHNICAL BULLETIN REFERENCE CHART

No.	Subject	Models
002	Inlet Pressure VS Liquid Temperature	All Models
003	Power Unit Drive Packages	3PFR - 68PFR, 10FR - 60FR
024	Lubrication of Lo-Pressure Seals	All Models
036	Cylinder and Plunger Reference Chart	All Models
043	LPS and HPS Servicing	All Plunger Models
053	Liquid Gasket	All Plunger NAB-S.S. Models
074	Torque Chart	Piston and Plunger Pumps
077	Oil Drain Kit	All Models (except 2SF/4SF)
078	Field Retrofit Mounting	5CP
083	Winterizing a Pump	All Models
088	6 Bolt S.S. Manifold	3CP and 5CP

INLET CONDITION CHECK-LIST

Review Before Start-Up

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

INLET SUPPLY should exceed the maximum flow being delivered by the pump to assure proper performance.

- ❏ Open inlet shut-off valve and turn on water supply to avoid starving the pump. **DO NOT RUN PUMP DRY.**
- ❏ Temperatures above 130°F are permissible. Add 1/2 PSI inlet pressure per each degree F over 130°F. Elastomer or RPM changes may be required. See Tech Bulletin 002 or call CAT PUMPS for recommendations.
- ❏ Avoid closed loop systems especially with high temperature, ultra-high pressure or large volumes. Conditions vary with regulating/unloader valve.
- ❏ Low vapor pressure liquids, such as solvents, require a booster pump and C.A.T. to maintain adequate inlet supply.
- ❏ Higher viscosity liquids require a positive head and a C.A.T. to assure adequate inlet supply.
- ❏ Higher temperature liquids tend to vaporize and require positive heads and C.A.T. to assure adequate inlet supply.
- ❏ When using an inlet supply reservoir, size it to provide adequate liquids to accommodate the maximum output of the pump, generally a minimum of 6-10 times the GPM (however, a combination of system factors can change this requirement); provide adequate baffling in the tank to eliminate air bubbles and turbulence; install diffusers on all return lines to the tank.

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

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

INLET PRESSURE should fall within the specifications of the pump.

- ❏ Acceleration loss of liquids may be increased by high RPM, high temperatures, low vapor pressures or high viscosity and may require pressurized inlet and C.A.T. to maintain adequate inlet supply. DO NOT USE C.A.T. WITH SUCTION INLET.
- ❏ Optimum pump performance is obtained with +20 PSI (1.4 BAR) inlet pressure and a C.A.T. for certain applications. With adequate inlet plumbing, most pumps will perform with flooded suction. Maximum inlet pressure is 60 PSI (4 BAR).
- ❏ After prolonged storage, pump should be rotated by hand and purged of air to facilitate priming. Disconnect the discharge port and allow liquid to pass through pump and measure flow.

INLET ACCESSORIES are designed to protect against overpressurization, control inlet flow, contamination or temperature and provide ease of servicing.

- ❏ A shut-off valve is recommended to facilitate maintenance.
- ❏ Installation of a C.A.T. is essential in applications with stressful conditions such as high temperatures, booster pump feed or long inlet lines. **Do not use C.A.T. with negative inlet pressure.**
- ❏ A stand pipe can be used in some applications to help maintain a positive head at the pump inlet.
- ❏ Inspect and clean inlet filters on a regular schedule to avoid flow restriction.
- ❏ A pressure transducer is necessary to accurately read inlet pressure. **(Short term, intermittent cavitation will not register on a standard gauge.)**
- ❏ All accessories should be sized to avoid restricting the inlet flow.
- ❏ All accessories should be compatible with the solution being pumped to prevent premature failure or malfunction.
- ❏ Optional inlet protection can be achieved by installing a pressure cutoff switch between the inlet filter and the pump to shut off pump when there is no positive inlet pressure.

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

- ❏ It is recommended the by-pass be directed to a baffled reservoir tank, with at least one baffle between the by-pass line and the inlet line to the pump.
- ❏ Although not recommended, by-pass liquid may be returned to the inlet line of the pump if the system is properly designed to protect your pump. A PRESSURE REDUCING VALVE must be installed on the inlet line (**BETWEEN** THE BY-PASS CONNECTION AND THE INLET TO THE PUMP) to avoid excessive pressure to the inlet of the pump. It is also recommended that a THERMO VALVE be used in the by-pass line to monitor the temperature build-up in the by-pass loop to avoid premature seal failure.
- ❏ A reinforced, flexible, low-pressure hose rated up to 3000 PSI should be used for routing by-pass back to the pump inlet.
- ❏ 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

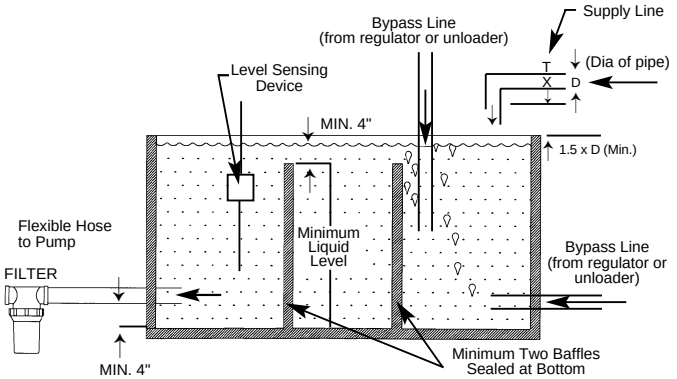
Nominal Pipe Size Inches	Inside Diameter Inches	Equivalent Length of Standard Pipe in Feet: Gate Valve	Globe Valve	Angle Valve	45° Elbow	90° Elbow	180° Close Ret	Tee Thru Run	Tee Thru Branch
1/2	0.622	0.41	18.5	9.3	0.78	1.67	3.71	0.93	3.33
3/4	0.824	0.54	24.5	12.3	1.03	2.21	4.90	1.23	4.41
1	1.049	0.69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

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

TYPICAL RESERVOIR TANK

RECOMMENDED 6 TO 10 TIMES SYSTEM CAPACITY



Handy Formulas to Help You

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

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

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

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

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

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

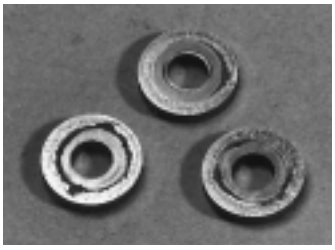
Q. **What size motor pulley should I use?**

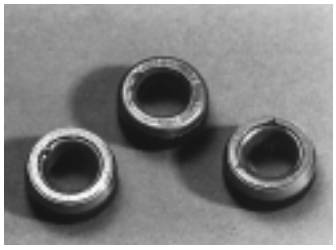
A. Pump Pulley (Outer Diameter) x $\frac{\text{Pump RPM}}{\text{Motor/Engine RPM}}$ (Consult Engine Mfr.)

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

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

Avoid Cavitation Damage





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

CONDITION	SOLUTION
Inadequate inlet line size	• Increase line size to the inlet port or one size larger
Water hammering liquid acceleration/ deacceleration	• Install C.A.T. Tube • Move pump closer to liquid supply
Rigid Inlet Plumbing	• Use flexible wire reinforced hose to absorb pulsation and pressure spikes
Excessive Elbows in Inlet Plumbing	• Keep elbows to a minimum and less than 90°
Excessive Liquid Temperature	• Use Thermo Valve in bypass line • Do not exceed pump temperature specifications • Substitute closed loop with baffled holding tank • Adequately size tank for frequent or high volume bypass • **Pressure feed high temperature liquids** • Properly ventilate cabinets and rooms
Air Leaks in Plumbing	• Check all connections • Use PTFE thread tape or pipe thread sealant
Agitation in Supply Tank	• Size tank according to pump output — **Minimum 6-10 times system GPM** • Baffle tank to purge air from liquid and separate inlet from discharge
High Viscosity Liquids	• Verify viscosity against pump specifications before operation • Elevate liquid temperature enough to reduce viscosity • Lower RPM of pump • Pressure feed pump • Increase inlet line size
Clogged Filters	• Perform regular maintenance or use clean filters to monitor build up • Use adequate mesh size for liquid and pump specifications

DIAGNOSIS AND MAINTENANCE

One of the most important steps in a high pressure system is to establish a regular maintenance program. This will vary slightly with each system and is determined by various elements such as the duty cycle, the liquid being pumped, the actual specifications vs rated specifications of the pump, the ambient conditions, the inlet conditions and the accessories in the system. A careful review of the necessary inlet conditions and protection devices required before the system is installed will eliminate many potential problems.

CAT PUMPS are very easy pumps to service and require far less frequent service than most pumps. Typically, only common tools are required, making in-field service convenient, however, there are a few custom tools, special to certain models, that do simplify the process. This service manual is designed to assist you with the disassembly and reassembly of your pump. The following guide will assist in determining the cause and remedy to various operating conditions. You can also review our **FAQ** or **SERVICE** sections on our **WEB SITE** for more facts or contact CAT PUMPS directly.

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