2DX, 3DX, 3SP PLUNGER PUMP SERVICE MANUAL

2DX MODELS: 2DX20ES, 2DX27GS, 2DX30GS
2DX05ELS.MIST, 2DX10ES.MIST, 2DX15ES.MIST, 2DX20ES.MIST, 2DX27ES.MIST
3DX MODELS: 3DX25GSI, 3DX30GSI
3SP MODELS: 3SP30G1I, 3SP35GEI

INSTALLATION AND START-UP INFORMATION

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

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

LUBRICATION: Fill crankcase with special CAT PUMP Hydraulic oil per pump specifications [2DX, 3DX-8.5 oz., 3SP-10.15 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.**

DRIVE SELECTION: The pump shaft size is 5/8" hollow shaft on “ES” models, 3/4" hollow shaft on “GEI” and “GS” models, 1" hollow shaft on “G1I” models. The motor or engine driving the pump must be of adequate horsepower to maintain full RPM when the pump is under load. Select the horsepower requirement according to required pump discharge flow and maximum **pressure at the pump!** Consult the manufacturer of gas or diesel engine for proper selection.

MOUNTING: 2DX, 3DX and 3SP models are direct drive. The 2DX and 3DX electric models can be mounted directly to a C-Face motor; the 3SP35GEI model comes with an adapter plate to mount to a C-Face motor. The gas model comes with an adapter plate that mounts to a gas engine. Before mounting pump to electric motor or gas engine, apply PN 6106 antiseize lubricant to pump shaft. Refer to Technical Bulletin 055 for instructions on removing pump from electric motor or gas engine. To minimize piping stress, **use appropriate flexible hose to inlet and discharge ports**.

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. 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.

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

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

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 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.

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.

World Headquarters
CAT PUMPS
1681 - 94th Lane N.E. Minneapolis, MN 55449 - 4324
Phone (763) 780-5440 — FAX (763) 780-2958
e-mail: techsupport@catpumps.com
www.catpumps.com
International Inquiries
FAX (763) 785-4329
e-mail: intlsales@catpumps.com

The Pumps with Nine Lives

CAT PUMPS (U.K.) LTD.
1 Fleet Business Park, Sandy Lane, Church Crookham, Fleet
Hampshire GU52 8BF, England
Phone Fleet 44 1252-622031 — Fax 44 1252-626655
e-mail: sales@catpumps.co.uk
N.V. CAT PUMPS INTERNATIONAL S.A.
Heiveldekens 6A, 2550 Kontich, Belgium
Phone 32-3-450.71.50 — Fax 32-3-450.71.51
e-mail: cpi@catpumps.be www.catpumps.be
CAT PUMPS DEUTSCHLAND GmbH
Buchwiese 2, D-65510 Idstein, Germany
Phone 49 6126-9303 0 — Fax 49 6126-9303 33
e-mail: catpumps@t-online.de www.catpumps.de

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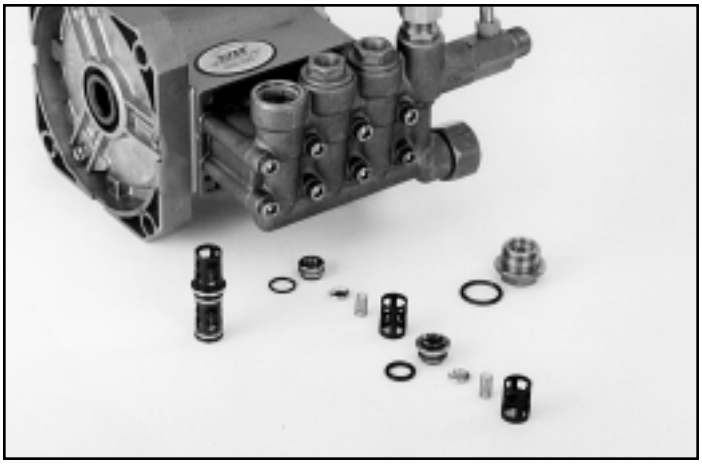
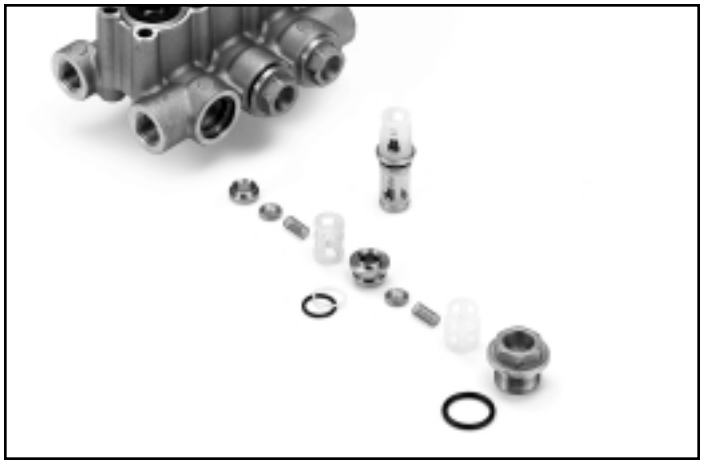


2DX20ES, 2DX27GS, 2DX30GS, 3DX25GSI, 3DX30GSI
Discharge and Inlet Valve Assembly - Stacked Valve design



3SP30G1I, 3SP35GEI
Discharge and Inlet Valve Assembly - Stacked Valve design

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

NOTE: The Discharge and Inlet Valve Assemblies are stacked. Follow these same procedure for both inlet and discharge assemblies.

NOTE: Discharge and Inlet Valve Assemblies may stay together or separate during removal.

NOTE: Spring Retainer may also separate from the Seat during removal.

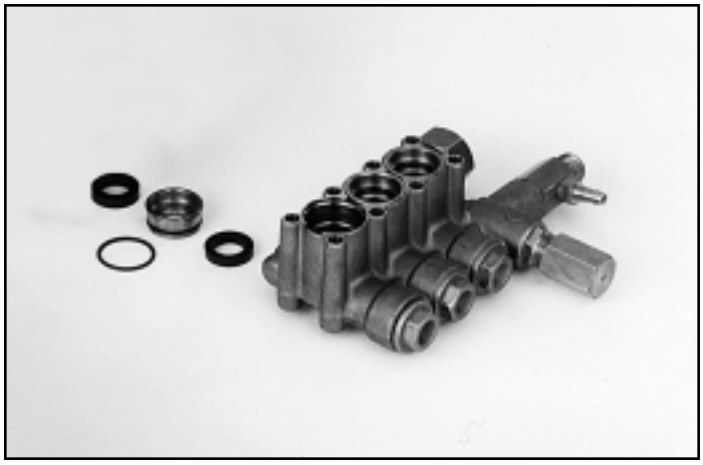
1. Using a Hex tool, remove Valve Plugs at the top of the Manifold Head.
2. Use a reverse pliers to remove stacked valve assemblies from the valve chamber.
3. If the Discharge Valve Assembly separates from the Inlet Valve Assembly, use a reverse pliers to remove it from the valve chamber.

   CAUTION: Exercise caution as the reverse pliers may damage the threads in valve chamber or Spring Retainer.
4. On the models 2DX and 3DX, the Spring Retainer may separate from the Seat. Remove the Spring and Valve from the valve chamber. Thread an M8 screw into the Seat and remove from valve chamber.
5. On the models 2DX and 3DX, separate Valve Assembly by using the same M8 screw and thread into bottom of Seat until screw contacts bottom of Valve. Continue threading in screw until Spring Retainer separates from Seat.
6. On the model 3SP, separate Valve Assembly by inserting screwdriver into Spring Retainer and press the backside of valve until Seat separates from the Spring Retainer.
7. Remove O-Ring from each Seat and Valve Plug.

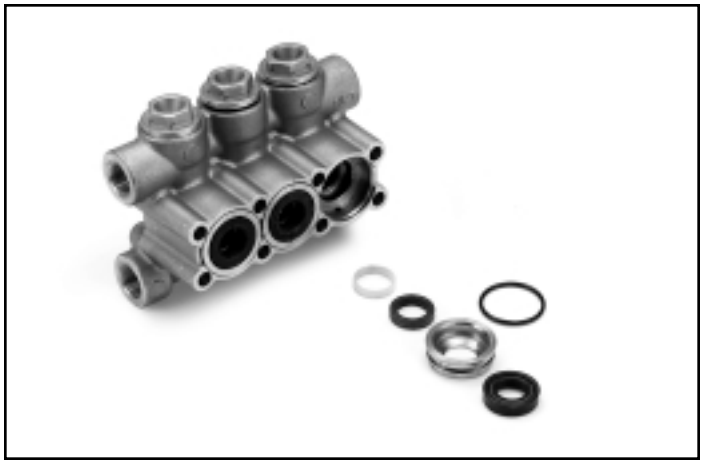
Reassembly

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 and Seats for grooves, pitting or wear and replace as needed.
4. Examine Seat and Valve Plug O-Rings for cuts or wear and replace as needed.

   NOTE: Inlet Valve Seat and O-Ring are different from Discharge Valve Seat and O-Ring. One Valve Kit required per pump.
5. Lubricate and install new O-Ring onto large outside diameter of Seat.
6. On the model 3SP, lubricate and install Back-up-Ring, and then O-Ring onto large outside diameter of Discharge Seat.
7. Place Seat on work surface **with small diameter side up**.
8. Place Valve onto Seat **with concave side down**.
9. Place Spring on Valve.
10. Install Spring Retainer **with deep stepped end over** Spring and snap onto Seat.
11. Snap Discharge Valve Assembly onto the Inlet Valve Assembly and press into valve chamber until completely seated.
12. Lubricate and install new O-Ring onto each Valve Plug.
13. Apply Loctite 242 to threads of each Valve Plug and thread in hand tight. Torque to specifications per chart.



2DX20ES, 2DX27GS, 2DX30GS, 3DX25GSI, 3DX30GSI
Lo-Pressure and Hi-Pressure Seals with Seal Case



3SP30G1I, 3SP35GEI
Lo-Pressure and Hi-Pressure Seals with Seal Case

SERVICING THE SEALS

Disassembly

1. Using an allen wrench, remove the Hex Socket Head (HSH) screws from the face of the Manifold Head.
2. Insert flat head screwdrivers on each side between the Crankcase and Manifold Head. Gently apply pressure to the head to begin separation.
3. Support the Manifold Head from the underside and pull the Manifold Head away from the crankcase.

   CAUTION: Keep the Manifold Head properly aligned with the Ceramic Plungers when removing to avoid damage to the plungers.

   NOTE: The Seal Case may stay in the manifold or on the Ceramic Plungers.
4. Place Manifold Head on work surface **with crankcase side up**.
5. Remove Seal Retainer from each Plunger Rod.
6. Use a screwdriver to pry out the Lo-Pressure Seal from each Seal Case.

   CAUTION: Screwdriver may damage seal during removal.
7. Use reverse pliers to remove Seal Case from each seal chamber.

   NOTE: Insert the reverse pliers into the second lip to avoid damage to the Seal Case.
8. Carefully insert a small screwdriver under the O-Ring and roll the O-Ring off each Seal Case.

   CAUTION: Exercise caution as the screwdriver may score O-Ring sealing surface.
9. On the models 2DX and 3DX, the Hi-Pressure Seals can be easily removed from each seal chamber by hand or with reverse pliers.
10. On the model 3SP, remove V-Packing and Male Adapter from each seal chamber by hand or with a reverse pliers.

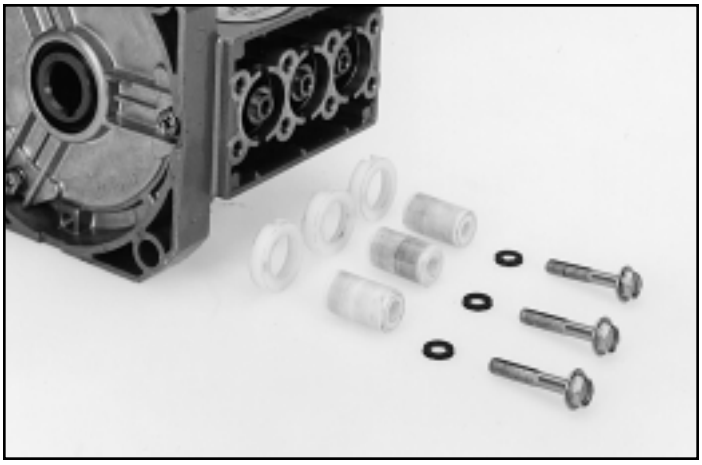
Reassembly

1. Examine the manifold chamber walls for scale buildup or damage.
2. Examine Hi-Pressure Seals or V-Packings for frayed edges or uneven wear and replace as needed.
3. Examine Seal Case O-Rings for cuts or deterioration and replace as needed.
4. Examine Lo-Pressure Seals for wear to the internal ridges, outer surfaces for broken springs and replace as needed.

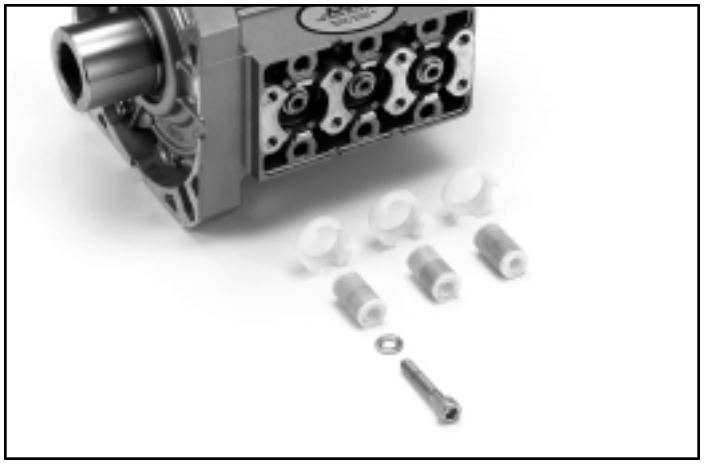
   NOTE: Seals and O-Rings are available in Seal Kits.

5 Examine Seal Retainers for deformation and replace as needed.

6. On the models 2DX and 3DX, lubricate and install new Hi-Pressure Seal by hand into each seal chamber **with the grooved side down.**
7. On the model 3SP, install Male Adapter **with notch side down.** Lubricate and install new V-Packing by hand into seal chamber **with grooved side down.**
8. Lubricate and install O-Ring on each Seal Case. Press small end of Seal Case into each seal chamber.
9. Press new Lo-Pressure Seal into each Seal Case **with the garter spring down.**
10. Examine ceramic plunger for cracks or scale buildup and proceed to SERVICING THE PLUNGERS if worn.
11. On the models 2DX and 3DX, slide Seal Retainer over each Ceramic Plunger **with the drain slots facing the Crankcase** and **the openings to the top and bottom**. Press into the Crankcase.
12. On the model 3SP, slide Seal Retainer over each Ceramic Plunger **with the tabs facing out.** Press into the crankcase.
13. Rotate crankshaft by hand so the two outside plungers are extended equally.
14. Lightly lubricate Ceramic Plungers, then carefully slide the Manifold Head over the Ceramic Plungers, supporting it from the underside to avoid damage to the plungers or seals. Press the Manifold Head up to the Crankcase until flush.
15. Thread HSH screws in hand tight. Torque in sequence to specifications in torque chart.



2DX20ES, 2DX27GS, 2DX30GS, 3DX25GSI, 3DX30GSI
Plunger Arrangement



3SP30G1I, 3SP35GEI
Plunger Arrangement

SERVICING THE PLUNGERS

Disassembly

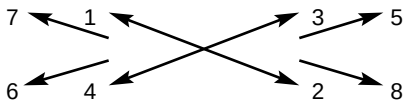
1. To service the Ceramic Plungers, it is necessary to remove the Manifold Head. See **SERVICING THE SEALS, Disassembly, steps 1-3**.
2. Remove Seal Retainer from each Plunger Rod.
3. Using a hex tool, loosen the Plunger Retainer on each Plunger Rod approximately three to four turns.
4. Push the Ceramic Plunger back towards the Crankcase to separate from the Plunger Retainer and proceed with unthreading the Plunger Retainer by hand.
5. On the models 2DX and 3DX, remove the Ceramic Plunger and Seal Washer from each Plunger Retainer.
6. On the model 3SP, remove the Ceramic Plunger and copper Retainer Gasket from each Plunger Retainer.

Reassembly

1. Visually inspect the Crankcase Oil Seals for deterioration or leaks. Contact CAT PUMPS for assistance with replacement. See **SERVICING THE CRANKCASE section.**
2. Examine Seal Washers or Plunger Retainer Gaskets and replace if cut or worn.
3. Examine Plunger Retainers for damaged threads and replace as needed.
4. On the models 2DX and 3DX, install new Seal Washer onto each Plunger Retainer.
5. On the model 3SP, install the new copper Plunger Retainer Gasket onto each Plunger Retainer.
6. Examine the Ceramic Plungers for scoring, scale buildup, chips or cracks and replace as needed. The Ceramic Plungers do not need to be replaced with every seal servicing.
7. Slide Plunger Retainer with Seal Washer or Gasket into flat end of Ceramic Plunger.
8. Apply Loctite 242 to exposed threaded end of Plunger Retainer.
9. Install Ceramic Plunger with Plunger Retainer and Seal Washer over each Plunger Rod shoulder and thread hand tight. Torque to specifications per chart.

   NOTE: Ceramic Plungers can only be installed in one direction. Counterbore end of Ceramic Plunger fits over Plunger Rod shoulder.
10. See **SERVICING THE SEALS, Reassembly, steps 11-15.**

TORQUE SEQUENCE



SERVICING THE CRANKCASE SECTION

1. While Manifold, Plungers and Retainers are removed examine Crankcase Oil Seals for leaking and wear.
2. Check for any signs of leaking at Bearing Cover, Drain Plug or Bubble Gauge.
3. Check oil level and check for evidence of water 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 local distributor if crankcase service is required.

SERVICING THE UNLOADER

2DX and 3DX Models Only

3SP Models refer to individual Unloader Data Sheet

Disassembly

1. Remove brass Adjusting Cap by turning in a **counter-clockwise direction.**
2. Remove exposed Coil Spring and flat Spring Retainer.
3. Using a wrench, remove Piston Retainer by turning in a **counterclockwise direction.**

   NOTE: The Piston Stem and Valve Assembly may fall out when the piston retainer is removed. If so, proceed to step 6., If not, continue with step 4.
4. Use a needle nose pliers to remove Piston Stem and Valve Assembly.
5. Separate Piston Stem from Valve. Secure the Valve near the Valve Retainer. Insert a screwdriver into slotted head of Piston Stem and unthread from Valve.

   CAUTION: Exercise extreme caution to avoid contact and damage to the tapered surface of valve.
6. Examine Seat at the bottom of the unloader chamber for grooves, pitting or wear, replace only as needed.

   CAUTION: Seat will be damaged when removed.

Reassembly

1. If seat is worn or damaged, press new seat into unloader chamber until squarely seated.
2. Examine Piston Stem, Washer, Valve Retainer and Valve for grooves, pitting or wear and replace as needed. Examine O-Rings and Back-up Ring for cuts or wear and replace as needed.
3. Lubricate and install O-Ring over slotted head of Piston Stem, then position Back-up Ring on top of O-Ring.
4. Lubricate and install O-Rings on Valve Retainer.
5. Install Washer and then Valve Retainer with O-Rings onto Piston Stem. Apply Loctite 242 to threads of Piston Stem and screw Valve onto Piston Stem.
6. Lower complete Piston Stem and Valve Assembly into unloader chamber with valve facing downward.
7. Examine Piston Retainer for damaged threads or wear and replace as needed. Examine O-Ring for cuts or wear and replace as needed.
8. Apply Loctite 242 to threads and then hand thread Piston Retainer into unloader by turning in a clockwise direction, and then tighten with wrench.
9. Examine Spring Retainer and Coil Spring for fatigue or breaks and replace as needed.
10. Place Spring Retainer into Piston Retainer, followed by Coil Spring.
11. Thread brass Adjusting Cap onto Piston Retainer by turning in a **clockwise direction.**

PREVENTATIVE MAINTENANCE CHECK-LIST

Check	Daily	Weekly	50 hrs.	500 hrs.*	1000 hrs.**
Clean Filters	x				
Oil Level/Quality	x				
Oil Leaks	x				
Water Leaks	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 1000 hours, check again at 1500 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	Thread	Tool Size [P/N]	Torque in. lbs.	Torque ft. lbs.	Torque Nm
Plunger Retainer	M6	M10 Hex [25082]	55	4.4	6
Manifold Head Screws	M6	M5 Allen	55	4.4	6
Valve Plugs	M20	M19 Hex	520	43.4	59
Bearing Cover Screws	M6	M10 Hex [25082]	50	4.0	6
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
024	Lubrication of Lo-Pressure Seals	All Models
036	Cylinder and Plunger Reference Chart	All Models
043	LPS and HPS Servicing	All Plunger Models
055	Removing Pumps from Gas Engine or Electric Motor	2SF, 2SFX, 2DX, 4SF, 5DX, 6DX
074	Torque Chart	Piston and Plunger Pumps
083	Winterizing a Pump	All Models
086	Ceramic Plunger	2DX

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 or ultra-high pressure. Conditions vary with regulating/unloader valve.
- ❏ Higher temperature liquids tend to vaporize and require positive heads.
- ❏ When using an inlet supply reservoir, size it to provide adequate liquid to accommodate the maximum output of the pump, generally a minimum of 6-10 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 a pressurized inlet to maintain adequate inlet supply.
- ❏ Optimum pump performance is obtained with +20 PSI (1.4 BAR) inlet pressure. 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 over pressurization, control inlet flow, contamination or temperature and provide ease of servicing.

- ❏ A shut-off valve is recommended to facilitate maintenance.
- ❏ A stand pipe can be used in some applications to help maintain a positive head at the pump inlet line.
- ❏ Inspect and clean inlet filters on a regular schedule to avoid flow restriction.
- ❏ A pressure transducer is necessary to accurately read inlet pressure. **Short term, intermittent cavitation will not register on a standard gauge.**
- ❏ All accessories should be sized to avoid restricting the inlet flow.
- ❏ All accessories should be compatible with the solution being pumped to prevent premature failure or malfunction.

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

- ❏ The 2DX and 3DX pumps come with a Regulating Unloader and built-in by-pass channel to route by-pass liquid back to the pump inlet. The 3SP pumps come with a Regulating Unloader and reinforced, flexible hose rated up to 300 PSI. No additioal by-pass hose is required.

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

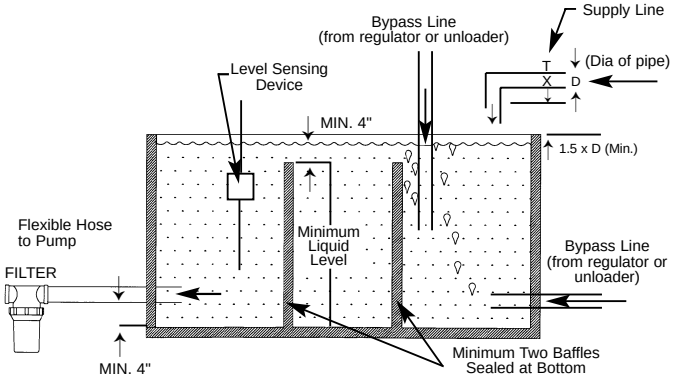
Nominal Pipe Size Inches	Inside Diameter Inches	Equivalent Length of Standard Pipe in Feet: Gate Valve	Globe Valve	Angle Valve	45° Elbow	90° Elbow	180° Close Ret	Tee Thru Run	Tee Thru Branch
1/2	0.622	0.41	18.5	9.3	0.78	1.67	3.71	0.93	3.33
3/4	0.824	0.54	24.5	12.3	1.03	2.21	4.90	1.23	4.41
1	1.049	0.69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

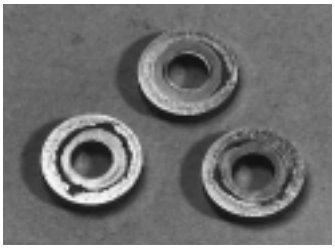
Q. **What size motor pulley should I use?**

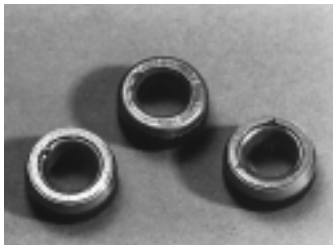
A. Pump Pulley (Outer Diameter) x $\frac{\text{Pump RPM}}{\text{Motor/Engine RPM}}$ (Consult Engine Mfr.)

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.
	•Air leak in inlet plumbing.	•Tighten fittings and hoses. Use PTFE liquid or tape.
	•Pressure gauge inoperative or not registering accurately.	•Check with new gauge. Replace worn or damaged gauge.
	•Relief valve stuck, partially plugged or improperly adjusted.	•Clean/adjust relief valve. Replace worn seats/valves and o-rings.
	•Inlet suction strainer (filter) clogged or improperly sized.	•Clean filter. Use adequate size filter. Check more frequently.
	•Abrasives in pumped liquid.	•Install proper filter.
	•Leaky discharge hose.	•Replace discharge hose with proper rating for system.
	•Inadequate liquid supply.	•Pressurize inlet and install C.A.T.
	•Severe cavitation.	•Check inlet conditions.
	•Worn seals.	•Install new seal kit. Increase frequency of service.
	•Worn or dirty inlet/discharge valves.	•Clean inlet/discharge valves or install new valve kit.
Pulsation	•Faulty Pulsation Dampener.	•Check precharge. If low, recharge, or install a new dampener.
	•Foreign material trapped in inlet/discharge valves.	•Clean inlet/discharge valves or install new valve kit.
Water leak		
•Under the manifold	•Worn V-Packing, Hi-Pressure or Lo-Pressure Seals.	•Install new seal kit. Increase frequency of service.
	•Worn adapter o-rings.	•Install new o-rings.
•Into the crankcase	•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.
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.
•Bearing cover	•Loose bearing cover or worn bearing cover o-ring.	•Tighten bearing cover or replace o-ring.
•Filler cap	•Loose filler cap or excessive oil in crankcase.	•Tighten filler cap. Fill crankcase to specified capacity.
Pump runs extremely rough		
•Inlet conditions	•Restricted inlet or air entering the inlet plumbing	•Correct inlet size plumbing. Check for air tight seal.
•Pump valves	•Stuck inlet/discharge valves.	•Clean out foreign material or install new valve kit.
•Pump seals	•Leaking V-Packing, 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.