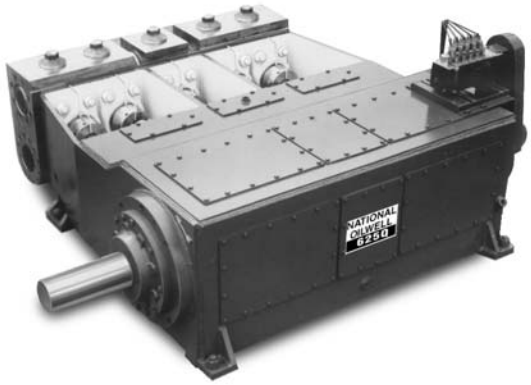
NATIONAL OILWELL VARCO

Reciprocating Plunger Pumps

Installation, Care and Operation Manual



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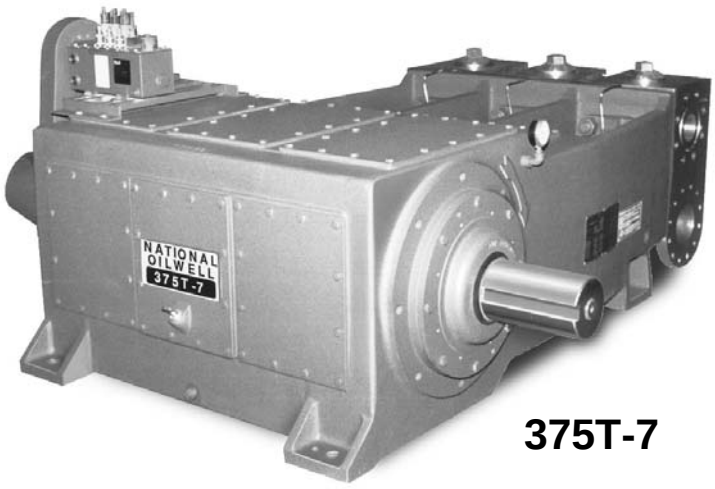

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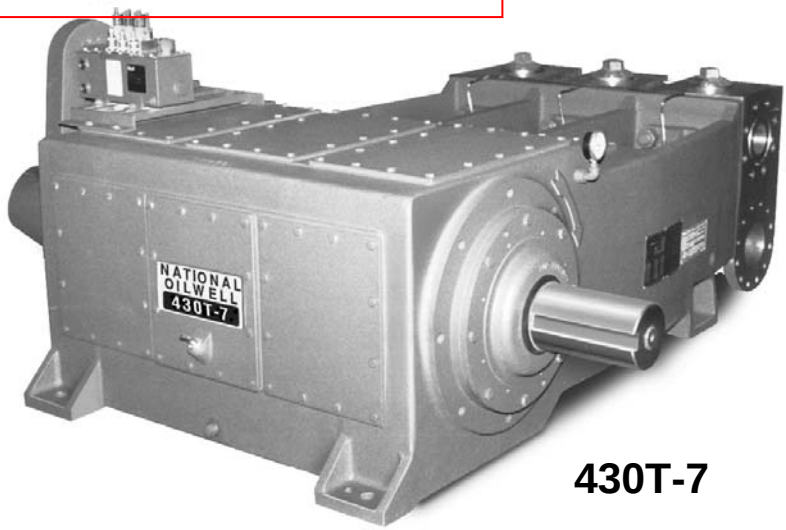

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NATIONAL OILWELL VARCO

SUPPLEMENT FOR
ALL PUMP MANUALS

⚠! WARNING !⚠

PRESSURE

RELIEF

VALVES

⚠! NOTICE !⚠

Our technical publications relative to reciprocating pumps state that pressure relief valves must be installed in the discharge systems from these units. This supplement is issued to emphasize the importance of relieving the discharge system of all pressure which exceeds the rated working pressure applied by the manufacturer to the specific pistons and liners (or plungers and packing) in any particular unit.

! WARNING !

For the protection of persons and property the discharge system from each Reciprocating Pump must be equipped with a device which relieves the system of all pressures which exceed the pressure rating applied by the manufacturer to each particular piston or plunger diameter. Allowances will be made for pressure surges which are inherent with the reciprocating action of piston and plunger pumps. The percentage of pressure allowance appears later in this publication and in the "Standards of the Hydraulic Institute" (13th edition).

The relieving device must provide for instantaneous pressure relief, it may be a valve designed for automatic or manual resetting; however, if preferred, rupture discs or burst discs may be installed.

FAILURE to comply with the procedures outlined in the Warning may result in damage to the pump and related equipment and more importantly may cause serious bodily injury or death!

THE PRESSURE RELIEF VALVE:

1. This valve must be a full opening type.
2. It must have a working pressure rating, equal to or greater than, the maximum working pressure of the pump.
3. The through capacity of the valve, when fully opened, must be sufficient to relieve the full capacity of the pump without excessive overpressure.

RUPTURE DISC OR BURST DISC:

1. These discs must have a diameter which is not less than the pipe size of the pressure relief flange.
2. These discs must have a rupture or burst pressure rating consistent with the specifications tabulated later in this publication.

LOCATION OF THE RELIEF VALVE:

1. The relief valve must be placed in the discharge line as close as possible to the pump fluid end or it may be mounted on the pump discharge manifold.
2. The relief valve must be on the pump side of any discharge strainer.
3. The relief valve must be between the pump fluid end and any valve in the discharge system.
4. There must be no restricting device(s) between the relief valve and the pump fluid end.

THE RELIEF VALVE DISCHARGE LINE:

1. The relief valve discharge line should not terminate in the pump suction line.
2. The line should terminate in the supply tank, if possible.
3. The line must be securely anchored.
4. The line must be the same pipe size as, or may be larger than, the discharge connection on the relief valve.
5. If the line is of great length, this must be taken into consideration in sizing the relief valve.
6. There must be no restrictions or valves in the relief valve discharge line.

NOTE: Follow the foregoing instructions if rupture discs or burst discs are installed.

SUGGESTED SET PRESSURES FOR THE PUMP RELIEF VALVES:

PUMP TYPE:	OPERATING PUMP PRESSURE:
Double Acting – Duplex	Piston Pressure Rating – Plus 25%
Double Acting – Triplex	Piston Pressure Rating – Plus 10%
Double Acting – Quintuplex	Piston Pressure Rating – Plus 10%
Single Acting – Triplex	Piston Pressure Rating – Plus 10%
Single Acting – Simplex	Plunger Pressure Rating – Plus 25%
Single Acting – Duplex	Plunger Pressure Rating – Plus 20%
Single Acting – Triplex	Plunger Pressure Rating – Plus 10%
Single Acting – Quintuplex	Plunger Pressure Rating – Plus 10%
Single Acting – Septuplex	Plunger Pressure Rating – Plus 10%

Note: The above set pressures are to be observed when installing rupture discs or burst discs.

Foreword…

This manual is published as a guide for the normal operation of your **NATIONAL OILWELL VARCO** equipment. Because of the many factors which contribute to the function or malfunction of this machinery, and not having complete knowledge of each factor or combination of factors, we cannot detail all facets of this subject. We must therefore confine the scope of this presentation and when situations encountered are not fully encompassed by complete, understandable instructions, these situations must be referred to the manufacturer.

When other than routine servicing is necessary, it can be most efficiently performed if the unit is removed to an area of adequate space where an over-head crane, hydraulic lift, bearing pullers, impact tools, etc., are accessible.

The dimension and tolerances specified in this publication are those desirable for the most efficient operations of the equipment. When components become worn or when new parts are introduced into a worn unit, it may not be possible or economically feasible to reestablish such strict alignment and correct all dimensional deviations.

Improvements in design, engineering, materials, production methods, etc., may necessitate changes in these products and result in inconsistencies between the content of this publication and the physical equipment. We reserve the right to make these changes without incurring any liability or obligation beyond that which is stipulated in the purchase contract.

The pictures, photographs, charts, diagrams, drawings, verbal contents and specifications are not to be construed as giving rise to any warranty on the part of NATIONAL OILWELL VARCO. National Oilwell Varco makes no warranty, either expressed or implied, beyond that which is stipulated in the purchase contract.

NATIONAL OILWELL VARCO pumps are manufactured by National-Oilwell at the McAlester, Oklahoma plant. The serial number, assigned each pump is stamped on the power end. Please refer to this serial number when ordering parts for the pump.

The right and left sides of the pump are determined by viewing the pump from the back of the power end, looking toward the fluid end. This position is also used to identify the plungers and their related parts as being number one, two and three, beginning at the left side of the pump.

⚠! CAUTION ! CAUTION ! CAUTION ! ⚠

EXERCISE SAFETY IN ALL PERFORMANCES: DO NOT IGNORE ANY WARNINGS; USE ONLY APPROVED METHODS, MATERIALS AND TOOLS. DO NOT PERMIT ANY FUNCTION OF QUESTIONABLE SAFETY; ACCIDENTS ARE CAUSED BY UNSAFE ACTS AND UNSAFE CONDITIONS. SAFETY IS YOUR BUSINESS AND YOU ARE INVOLVED.

⚠! WARNING ! WARNING ! WARNING ! ⚠

BEFORE PERFORMING ANY SERVICE FUNCTION, BE CERTAIN THAT THE UNIT IS SEPARATED FROM ITS POWER SOURCE OR THAT THE POWER SOURCE IS LOCKED-OUT TO PREVENT ANY FORM OF ENERGY FROM ENTERING THE EQUIPMENT. THIS WOULD INCLUDE ELECTRICAL OR MECHANICAL ENERGY INTO OR FROM THE PRIME MOVER(S), PNEUMATIC ENERGY FROM THE COMPRESSOR/AIR SYSTEM, ETC.

! WARNING ! WARNING ! WARNING !

FAILURE TO OBSERVE THE WARNINGS AND NOTES OF CAUTION IN THIS PUBLICATION CAN RESULT IN PROPERTY DAMAGE, SERIOUS BODILY INJURY, OR DEATH.

! ATTENTION - NOTICE - IMPORTANT !

THESE TERMS ARE USED TO DRAW ATTENTION TO ACTION THAT WILL CAUSE DAMAGE TO THE PUMP, COMPONENTS OR ATTACHMENTS.

! WARNING ! WARNING ! WARNING !

BEFORE SERVICING PUMPS:

1. *SHUT DOWN OR DISENGAGE THE PUMP POWER SOURCE.*
2. SHUT DOWN ALL PUMP ACCESSORY EQUIPMENT.
3. RELIEVE OR "BLEED OFF" ALL PRESSURE FROM THE PUMP FLUID CYLINDER(S).

   FAILURE TO SHUT DOWN POWER AND RELIEVE PRESSURE FROM THE PUMP BEFORE SERVICING CAN RESULT IN SERIOUS PERSONAL INJURY AND PROPERTY DAMAGE.

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Revisions effective August 27, 2010 – replaced the word multiplex with reciprocating.

Installation…

I. GENERAL

Careful planning of the plant layout will save considerable time and expense, both initially when the installation is made and later during the operation of the plant. In selecting the location for the pump, consideration should be given to the fact that a positive suction head at the pump inlet contributes toward the pump efficiency. However, the layout of the piping, the arrangement of the fittings, and whatever restrictions are in the suction and discharge lines have even more effect. For this reason, all fittings and valves should be full opening; all bends should be of long radius or should be eliminated when possible. Long radius 45° ells should be used, particularly if installed near the fluid cylinder. The following points outline the basic requirements for an installation that will contribute greatly toward good pump operation.

A. SUCTION LINE

1. The suction line must not be smaller than the suction intake of the fluid cylinder and may be larger. The length of the suction line should be held to a minimum and should run straight from the supply tank to the pump.

2. When bends are required, they should be made with long radius 45° ells. Do not use a bend directly adjacent to the fluid cylinder. Avoid using any 90° bends if at all possible.

3. Provide a full opening gate valve in the suction line adjacent to the supply tank to permit the line to be drained when necessary. Do not use any type of restricting valve.

4. Do not use meters or other restrictions in the suction line. Eliminate any rise or summit in the suction line where air or vapor can collect.

5. Make sure the pulsation dampener is installed and is in proper operating condition.

6. Provide a drain valve in the bottom of the suction line near the pump.

7. When necessary to manifold a number of pumps to a common suction, the diameter of the manifold and suction pipe leading from the supply tank must have a cross-sectional area equal to or greater than the area of the combined individual suction pipes.

8. When a charging or booster pump is used in the suction line, it must have a capacity equal to twice that of the reciprocating output. This is necessary to provide a charging pump with an output great enough to meet the peak volume requirements of the pump during the suction stroke and therefore will not act as a restriction in the line.

9. All piping, both suction and discharge must be solidly and independently supported. The first support must be as close to the pump as practical. This is necessary to prevent placing the pump in a strain and to keep any vibration in the system from acting directly on the pump.

Installation…

I. GENERAL (Continued)...

B. DISCHARGE LINE

1. Use a pulsation dampener or a desurger in the discharge line. It should be placed in the line as near the fluid cylinder as possible and ahead of any bend in the line is made.

2. Do not reduce the size of the discharge line below that of the pump outlet until the line has passed through the desurger, and is away from the pump approximately 20 feet (6m).

3. Any bend in the discharge line should be made with a long radius 45° ell. Do not use a bend directly adjacent to the fluid cylinder, particularly a 90° bend.

4. Provisions should be made for a pressure relief valve in the discharge line. The relief valve should be set to operate at a pressure no greater than 25% above the maximum rated pressure for the plunger size being used. It should be installed in the line ahead of any valve and be piped so that any flow is returned to the supply tank rather than the suction line. This will prevent possible damage to the suction line and suction dampener.

5. A by-pass line should be installed to permit the pump to be started without load. This allows oil to circulate and reach all parts in the power end before they are loaded.

6. Provide a pressure tap in the discharge line for pressure gages and shut down equipment.

C. POWER END

1. The pump must be mounted level and should be grouted in and be free of strain. This applies to a skid mounted pump or a pump mounted directly on a concrete base.

2. The sheave of a belt driven pump must be correctly aligned with the prime mover sheave. Care must be used to prevent over-tightening as this will shorten belt life, place the pump in a strain, often causing undue additional loads on the crankshaft and bearings. Sheave sizes should not be smaller than the minimum approved diameter.

3. When connecting a direct-driven pump, the shafts must be correctly aligned. Couplings should not be expected to compensate for avoidable misalignment. (With Thomas Flexible Couplings - angular misalignment should not exceed one-half degree. Offset misalignment of the center lines of the two shafts should not exceed .015" [.381 mm]. Actually, misalignment should be as small as practical.)

4. Automatic provisions should be made to stop the pump automatically in the event of supply fluid failure. A pump should not be run dry as this causes wear on the packing.

5. Adequate plunger chamber drains have been provided in the pump and should not be plugged. Drain lines should never be reduced in size from the connection provided.

6. The pump has been drained of oil after testing at the factory and **MUST** be filled with the proper oil (see page 10 before starting). The rust inhibiting oil coating inside the power end need not be removed before filling; however, it is recommended that the power end be checked to make sure dirt or contamination has not entered during shipment.

Installation…

I. GENERAL (Continued)…

D. FLUID END

1. The fluid cylinder is shipped assembled to the pump complete with valves and cover plates. The stuffing boxes, plungers, and related items have also been assembled and tested with the pump (unless otherwise specified) and require no further assembly. Before the pump is started, these parts should be checked for tightness as well as for possible damage during shipment.

2. Thoroughly clean the suction line piping before starting the pump. Weld spatter, slag, mill scale, etc., will damage new valves in a short time.

E. PLUNGER PACKING

The recommended style of packing has been installed and run at the plant. It does, however, require further "setting up" as the pump is started and brought up to pressure. Refer to pages 27 through 30 for correct procedure for packing used.

F. PLUNGER PACKING LUBRICATION

1. Automatic packing lubricators are beneficial on all installations and are required on pumps operating at high pressure (1200 psi [85kg/cm^2] and up) to obtain good packing life. On most low pressure installations, grease lubrication is acceptable if care is used to prevent excessive lubrication. It is better to lubricate with a small amount at frequent intervals than to use a large amount infrequently. Use a good quality of No. 2 grade high temperature grease.

2. When an automatic lubricator is used in water and power oil service, use Rock Drill (Air Drill) Oil of proper viscosity. For butane-propane service, use NATURAL castor oil. Set lubricator to feed five to seven drops per minute.

G. SUCTION PULSATION DAMPENERS

Some National-Oilwell plunger pumps are equipped with suction pulsation dampeners. These dampeners do an excellent job when properly charged and should be kept filled during operation. Refer to page 26 for assembly procedures.

Lubrication…

I. GENERAL

The NATIONAL-OILWELL 375T, 430T and 625Q reciprocating plunger pumps are equipped with a full time power end pressure lubrication system that provides forced lubrication to crossheads, crosshead pin bushings, connecting rods and main bearings. The pumps are also equipped with a splash gravity system that acts to supplement the pressure lube system.

A chain driven gear pump provides pressure ranging from 15 to 65 psi depending on pump speed, oil temperature and type of oil. A relief valve set at 65 psi is provided. Oil pump pressures and speeds can be adjusted by changing the oil pump sprocket size as required.

CAUTION – These larger pumps should be operated under no-load conditions at start-up to assure proper power end lubrication. The use of manual pre-lube pumps is an alternative method of assuring proper power end lubrication at start-up.

A. OIL

Use an extreme pressure gear oil. The following chart shows the recommended grades for various temperatures surrounding the pump.

U.S. UNITS OF MEASURE	
Temperature	**AGMA Industrial EP Gear Oil**
+50°F to +155°F	AGMA No. 6 EP or ASTM/ISO Grade No. 320 (Viscosity 1335 to 1632 SSU at 100°F)
+20°F to +100°F	AGMA No. 5 EP or ASTM/ISO Grade No. 220 (Viscosity 918 to 1122 SSU at 100°F)
-20°F to + 60°F	AGMA No. 2 EP or ASTM/ISO Grade No. 68 (Viscosity 284 to 347 SSU at 100°F)

Crankcase Capacity - U.S. Gallons: 375T and 430T = 22; 625Q = 33½

METRIC UNITS OF MEASURE	
Temperature	**AGMA Industrial Gear Oil**
+10°C to +68°C	AGMA No. 6 EP or ASTM/ISO Grade No. 320 (Viscosity 288-352 cSt at 37.8°C)
-7°C to +100°C	AGMA No. 5 EP or ASTM/ISO Grade No. 220 (Viscosity 198-242 cSt at 37.8°C)
-29°C to +16°C	AGMA No. 2 EP or ASTM/ISO Grade No. 68 (Viscosity 61-75 cSt at 37.8°C)

Crankcase Capacity - Liters: 375T and 430T = 83.3; 625Q = 126.8

Oil must pour freely at minimum operating temperature. Change oil every six months or as frequently as operating conditions require to maintain a clean, sludge-free oil of proper viscosity.

Operation…

I. GENERAL

! ATTENTION !

THE FOLLOWING POINTS SHOULD BE CHECKED FOR THE PREVENTION OF TROUBLE OR TO CORRECT TROUBLE THAT MAY ARISE.

A. OPERATION CHECKLIST

1. Pump must be a set level for proper lubrication.
2. Make sure pump is filled with clean oil of the proper viscosity.
3. Do **not** over-speed the pump.
4. Do **not** use a smaller diameter sheave than is recommended for the pump.
5. Make sure all safety shutdown switches are operating properly.
6. Keep all suction and discharge line valves fully open.
7. If a bypass is used to regulate output, make sure it is set properly.
8. Make sure the pressure relief valve is set properly.
9. Do **not** exceed the pressure rating of the pump for the particular plunger size being used.
10. Make sure the suction line is tight as air entering the suction line will cause severe hammering and knocking of the pump.
11. Make sure plunger and intermediate rod connections are tight and locked.
12. Check the plunger packing for correct adjustment.
13. Check the suction and discharge dampeners for proper charge as this is very important for long dampener life and good pump operation.
14. Make sure the hex nuts holding the stuffing boxes in place are tight.

Maintenance…

I. GENERAL

The following points are intended as a guide to be used in setting up a maintenance program. Good preventive maintenance will pay big dividends in the form of reliable service with a minimum of trouble.

A. DAILY MAINTENANCE

1. Check power end oil level daily by means of the dipstick in the rear cover. Do not attempt to check the oil with the pump running. Inspect the oil for dirt or contamination and change if necessary.
2. Lubricate plunger packing frequently. Packing life can be greatly increased by greasing every four hours with a small amount of grease. It is not good practice to grease the packing infrequently with a large amount of grease as this serves to increase the contact pressure of the rear seal ring and can lead to overheating and early packing failure.
3. Check plunger packing for excessive leakage. Replace packing (or fluid seal plungers) as required.
4. Check stuffing box adjusting nuts for tightness.
5. Drain plunger leakage sump tank if required.
6. Flush plunger chamber drain lines with kerosene on power oil pumps and fresh water on salt water pumps. This may be done weekly unless salt and paraffin accumulation is severe.
7. Check both the suction and discharge dampeners for proper charge.
8. Make sure suction and discharge line valves are fully open.
9. Check for leakage between the fluid cylinder and frame or stuffing box and frame. Replace stuffing box to fluid cylinder packing if required.
10. Check all oil seals for leakage.
11. Check belts or clutch for slippage. If either condition exists, correct immediately.

B. MONTHLY MAINTENANCE

1. Drain and refill crankcase every six months or as often as required to maintain a clean, sludge-free oil of the proper viscosity.
2. Clean crankcase air breather with a non-explosive solvent.
3. Check all studs, nuts and capscrews for tightness. Inspect gaskets for leaks; tighten or replace as required.
4. Inspect power end pressure lube pump system for wear and proper operations.
5. Clean pump. Good housekeeping is a prerequisite to good maintenance.

Maintenance…

I. GENERAL (Continued)…

C. STORAGE

If the pump is to be idle for longer than one week, it should be prepared for storage as follows:

1. Drain and clean crankcase thoroughly. Leave drain open and install 90° elbow, pointing downward, to permit air circulation and prevent condensation build-up.
2. Coat all bearings, finished surfaces, and entire inside surface of crankcase with a rust inhibiting oil.
3. Remove plungers and packing, clean and coat with rust inhibiting oil.
4. Remove fluid cylinder valves and suction pulsation dampener, allowing cylinder to be thoroughly cleaned and drained.
5. Coat entire cylinder, valves and parts, with a rust inhibiting oil.
6. Thoroughly inspect pump and rotate crankcase once each month. Recoat with rust inhibiting oil where necessary.

D. START-UP AFTER STORAGE

Any pump that has been in storage, either after field use or as shipped from the plant, will need a thorough inspection to make sure it has not been damaged in any way and that all parts are properly in place.

! ATTENTION !

FAILURE TO OBSERVE THE FOLLOWING POINTS CAN RESULT IN SERIOUS DAMAGE.

1. Remove all covers on both power end and fluid end; thoroughly clean and inspect all parts and finished surfaces.
2. Check all bearings to make sure they are clean and in good condition.
3. Make sure valves, plungers and packing are properly installed and in good condition.
4. Carefully tighten all bolts, nuts, studs and working connections.
5. Fill power end to the proper level with clean oil of the proper viscosity. Make sure oil is poured into the crosshead reservoir and is worked into all bearings.
6. Fill packing lubricator and pump lines full. Check by breaking connection at stuffing box, working lubricator plunger until oil appears.

Maintenance (Continued)...

II. TROUBLE SHOOTING GUIDE

PROBLEM	POSSIBLE CAUSE	CORRECTION
KNOCKING OR POUNDING IN FLUID END AND PIPING	SUCTION LINE RESTRICTED BY: (1, 2, 3, 4)	
	1. TRASH, SCALE BUILD UP, ETC.	LOCATE AND REMOVE
	2. PARTIALLY CLOSED VALVE IN SUCTION LINE	LOCATE AND CORRECT
	3. METERS, FILTERS, CHECK VALVES, NON-FULL-OPENING CUT-OFF VALVES OR OTHER RESTRICTIONS	RE-WORK SUCTION LINE TO ELIMINATE
	4. SHARP 90° BENDS OR 90° BLIND TEES.	RE-WORK SUCTION LINE TO ELIMINATE
	AIR ENTERING SUCTION LINE THROUGH CUT-OFF VALVE	TIGHTEN OR REPACK VALVE STEM PACKING
	AIR ENTERING SUCTION LINE THROUGH LOOSE CONNECTION OR FAULTY PIPE	LOCATE AND CORRECT
	AIR OR VAPOR TRAPPED IN SUCTION LINE	LOCATE RISE OR TRAP AND CORRECT BY STRAIGHTENING LINE, PROVIDING ENOUGH SLOPE TO PERMIT ESCAPE AND PREVENT BUILD-UP
	LOW FLUID LEVEL	INCREASE SUPPLY AND INSTALL AUTOMATIC LOW LEVEL SHUT-DOWN SWITCH
	SUCTION DAMPENER NOT OPERATING	INSPECT AND REPAIR AS REQUIRED
	WORN VALVES	INSPECT AND REPAIR AS REQUIRED
	ENTRAINED GAS OR AIR IN FLUID	PROVIDE GAS BOOT OR SCRUBBER FOR FLUID
	POOR INLET AND OUTLET ARRANGEMENT AT SUPPLY TANK	INLET TO BE AT TOP OF TANK AND BAFFLED TO BREAK-OUT GAS AND PREVENT CHANNELING. OUTLET TO BE 12" FROM BOTTOM OF TANK AND AS FAR FROM INLET AS POSSIBLE, NEVER CLOSER THAN 90°.
	LOOSE PACKING ADJUSTING NUT	TIGHTEN AND/OR REPLACE PACKING
	INADEQUATE SIZED SUCTION LINE	REPLACE WITH INDIVIDUAL SUCTION LINE OF NEXT SIZE LARGER THAN INLET PUMP
	LEAKING PRESSURE RELIEF VALVE THAT HAS BEEN PIPED BACK INTO SUCTION LINE	REPAIR VALVE AND RE-WORK PIPING TO RETURN TO SUPPLY TANK - NOT SUCTION LINE
	BY-PASS PIPED BACK TO SUCTION	REWORK TO RETURN BY-PASSED FLUID BACK TO SUPPLY TANK - NOT SUPPLY LINE
	BROKEN PLUNGER	INSPECT WHEN ROTATING PUMP BY HAND AND REPLACE AS REQUIRED
KNOCK IN POWER END	WORN CROSSHEAD PIN, OR CONNECTING ROD	LOCATE AND REPLACE AS REQUIRED
	WORN MAIN BEARINGS	REPLACE AS REQUIRED
	LOOSE PLUNGER - INTERMEDIATE ROD CROSSHEAD CONNECTION	INSPECT FOR DAMAGE - REPLACE AS REQUIRED AND TIGHTEN
RAPID VALVE WEAR OR FAILURE	CAVITATION (KNOCK AND POUNDING IN FLUID END AND PIPING)	PREDOMINATE CAUSE OF SHORT VALVE LIFE AND IS ALWAYS A RESULT OF POOR SUCTION CONDITIONS. THIS SITUATION CAN BE CORRECTED BY FOLLOWING APPROPRIATE RECCOMENDATIONS AS LISTED UNDER KNOCKING OR POUNDING IN FLUID END AND PIPING.
	CORROSION	TREAT FLUID AS REQUIRED
	ABRASIVES IN FLUID	FILTER AS REQUIRED

Maintenance…

II. TROUBLE SHOOTING GUIDE (Continued)...

PROBLEM	POSSIBLE CAUSE	CORRECTION
SHORT PACKING LIFE	IMPROPER INSTALLATION	INSPECT AND INSTALL PER INSTRUCTION SHEET IN PACKING BOX
	IMPROPER LUBRICATION (EITHER INSUFFICIENT, EXCESSIVE OR INCORRECT TYPE)	CHECK INSTRUCTIONS IN MANUAL AND CORRECT AS REQUIRED
	LUBRICATOR NOT OPERATING	INSPECT AND CORRECT AS REQUIRED
	ADJUSTING NUT LOOSE	INSPECT AND REPACK PER INSTRUCTIONS
	SCALE BUILD-UP ON PLUNGER	TREAT FLUID AS REQUIRED
	WORN OR PITTED PLUNGERS	REPLACE AS REQUIRED
	ABRASIVES IN FLUID	FILTER AS REQUIRED
	PUMP OPERATED WITHOUT FLUID	CHECK SYSTEM FOR FAULTY LOW LEVEL SHUT-DOWN CONTROLS OR CLOSED VALVES AND CORRECT AS REQUIRED.
	ABNORMALLY HIGH FLUID TEMPERATURES	CHECK WITH MANUFACTURER FOR RECOMMENDATION ON TYPE OF PACKING
	WRONG TYPE OF PACKING FOR PARTICULAR FLUID BEING HANDLED	CHECK WITH MANUFACTURER FOR RECOMMENDATION ON TYPE OF PACKING
	CAVITATION (KNOCKING AND POUNDING IN FLUID CYLINDER AND PIPING)	REFER TO KNOCKING OR POUNDING IN FLUIND END
BROKEN OR PITTED CERAMIC PLUNGER	PLUNGER CRACKED AT INSTALLATION	INSTALL NEW PLUNGER USING CARE TO AVOID ANY SHARP BLOW OR FORCE ON PLUNGER
	PLUNGER CRACKED FROM "THERMAL SHOCK"	CHECK SYSTEM TO ELIMINATE ANY SHARP OR SUDDEN TEMPERATURE DIFFERENCES. TEMPERATURE EXTREMES ON THE PLUNGER CAN OCCUR FROM PACKING AS DISCUSSED UNDER "SHORT PACKING LIFE" PROBLEM OR FROM TEMPERATURE CHANGES IN THE FLUID ITSELF.
	PLUNGER PITTED FROM IMPLOSIONS CAUSED BNY EXCESSIVE GAS OR AIR ENTRAINED IN FLUID	CHANGE SUCTION SYSTEM TO ELIMINATE OR CHECK WITH MANUFACTURER REGARDING USE OF SPECIAL PACKING ARRANGEMENT
RAPID WEAR OF HARD-COATED PLUNGER	PACKING FAILURE	CHECK AND CORRECT PER RECOMMENDATIONS UNDER "SHORT PACKING LIFE" PROBLEM
	PLUNGER NOT SUITABLE FOR PARTICULAR SERVICE	CHECK WITH MANUFACTURERE FOR RECOMMENDATION
OIL SEAL LEAKS	PUMP NOT LEVEL	CHECK AND CORRECT AS REQUIRED
	WORN, CORRODED, PITTED, OR OTHERWISE DAMAGED SEALING SURFACE	CHECK AND CORRECT AS REQUIRED
	WORN OR DAMAGED SEALS	CHECK AND CORRECT AS REQUIRED
	OIL LEVEL TOO HIGH	CHECK AND CORRECT AS REQUIRED

Overhaul and Repair…

I. GENERAL

The bearings and other working parts in the power end have been designed for continuous duty and, if properly lubricated, will provide years of trouble-free service. However, after the pump has been in service for a long period of time, the bearings and other working parts will gradually loosen, and if not corrected will lead to more serious trouble. The time to overhaul the pump will vary, depending on the operating conditions, and is therefore a matter that must be left to the good judgment of the operator. Complete disassembly and assembly procedures are discussed in their respective sections.

A. TOOLS REQUIRED

Most of the tools required to overhaul the pump will be found in an ordinary set of mechanics hand tools. The special tools and equipment required and not furnished with the pump include a torque wrench, bearing puller, a hot oil bath capable of reaching a temperature of 300°F (149°C) and a valve servicing kit.

B. CHECK POINTS AND ADJUSTMENTS

1. The crankshaft main bearings nonadjustable, double row tapered roller bearings, factory set for the proper running clearance.

2. The connecting rod bearings are solid aluminum alloy precision ground inserts. The following tolerances are listed as a guide.

	375T, 430T and 625Q
Maximum Clearance	.020” (.508 mm)
Minimum Clearance	.006” (.153 mm)
Crankshaft Journal	7.000” (177.800 mm) 6.998” (177.749 mm)

3. The clearance between the crosshead and crosshead bore in the frame is stamped above the crossheads in the oil reservoir. The minimum allowable clearance is .012" (.305 mm). The maximum allowable clearance, including wear, is .030" (.762 mm).

4. The crosshead pin is pressed into the crosshead.

5. Maximum allowable clearances between the crosshead pin and bushing are listed below. The bushings are pressed into the connecting rod and must be reamed to size.

	375T, 430T and 625Q
Maximum Clearance	.008” (.203 mm)
Minimum Clearance	.002” (.051 mm)
Crankshaft Journal	4.5015” (144.338 mm) 4.5010” (114.325 mm)

Disassembly…

I. POWER END

It is not necessary to remove the fluid end when disassembling the power end. The plungers may be disconnected from the intermediate rods and left in the stuffing boxes. The intermediate rods and seal retainers must be removed.

A. INTERMEDIATE RODS AND OIL WIPER RETAINERS

1. Disconnect the plunger from the intermediate rod.
2. The oil wiper retainer is piloted into the frame and held in place by two capscrews.
3. Using a back-up wrench on the crosshead, unscrew the intermediate rod. Remove the rod and oil wiper retainer as one assembly.

B. CRANKSHAFT ASSEMBLY

1. Remove connecting rod bearing cap and slide connecting rod and crosshead forward. Keep halves of inserts together and marked for replacement in same location.
2. Connecting rod and crosshead must be moved all the way forward with intermediate rods removed, to clear crankshaft.
3. Remove crankshaft bearing oil seal retainers and gaskets.
4. Disconnect oil line to left hand bearing cage.
5. Use puller screws in crankshaft bearing cage “back-out” holes, if necessary, and remove crankshaft assembly with main bearing cage from the left side of the pump. Protect center bearings from damage during removal.

Disassembly…

I. POWER END (Continued)…

C. POWER END SUB-ASSEMBLIES

1. Crankshaft Bearings

   The crankshaft main bearings may be inspected while on the crankshaft and should not be removed unless necessary. A puller is required when replacement is necessary. NOTE: KEEP THE COMPONENT PARTS OF THE BEARINGS TOGETHER IF THEY ARE TO BE REINSTALLED. THEY ARE MATCH MARKED AND MUST BE CORRECTLY ASSEMBLED AS A UNIT. If they are to be destroyed, the correct use of a cutting torch will speed bearing removal.

   a. To remove the right hand main bearing, disassemble the lock nut and lock washer. The outer race and outer cone and roller assembly are pulled together as a unit. Then pull the spacer and inner cone and roller assembly.

   b. To remove the left hand main bearing, pull bearing cage together with the outer race and outer cone and roller assembly. The outer bearing race may be tapped out of the cage with a brass bar. The inner cone and roller assembly may then be pulled.

2. Center Support Bearings

   The crankshaft center support bearings may be inspected while in the frame bore.

   a. To remove support bearings, remove the three bearing retainer clips or snap rings and tap bearing out.

   b. The center support bearing race may be removed by first removing snap ring and then tap inner race off. Avoid any damages to crankshaft surfaces.

3. Crossheads

   625Q pump serial numbers 101 thru 107 are equipped with the old style 90° cut connecting rods and require removal of the crankshaft to remove the crosshead. 625Q pumps have slant cut connecting rods which allow removal of the crosshead and connecting rod thru the cradle chamber end of the pump without removal of the crankshaft.

II. FLUID END

A. FLUID CYLINDER REMOVAL

1. Disconnect piping – stuffing boxes and plungers DO NOT need to be disturbed to remove the fluid cylinder.

2. Remove the hex nuts from fluid cylinder to frame studs.

3. Slide stuffing box retainer to rear.

4. The fluid end is held to the power end by socket head capscrews, one above and one below the stuffing box pilot bores.

5. Disconnect suction and discharge connectors to allow removal of cylinder modules.

Disassembly…

II. FLUID END (Continued)…

B. STUFFING BOXES AND PLUNGER

1. The complete stuffing box and plunger assembly may be removed from the pump as a single unit, but unless the stuffing box or stuffing box seal are being replaced it is not necessary to remove the stuffing box to change packing and plunger. To replace packing and plunger only proceed with steps 2 thru 6 below.

2. Remove the plunger clamps and disconnect the plunger from the intermediate rod.

3. Rotate crankshaft until the intermediate rod is all the way forward (at the end of the discharge stroke). Break the intermediate rod loose from the crosshead one-fourth turn.

! ATTENTION !

USE BACK-UP WRENCH ON THE CROSSHEAD TO PREVENT DAMAGE TO CONNECTING ROD.

4. Rotate crankshaft to move intermediate rod to rear. Unscrew the intermediate rod and the oil wiper retainer capscrews and remove the rod and retainer as one assembly.

5. The plunger can now be slid back out of the stuffing box and removed through the cradle chamber.

6. Remove stuffing box nut and packing.

C. FLUID END VALVES – TAPERED SEAT AND CAGE TYPE

See separate valve section in this manual.

D. SUCTION PULSATION DAMPENER

1. Make sure all charging air is bled off and suction line drained before starting disassembly.

2. Remove capscrews holding the suction dampener and remove dampener and diaphragm.

Assembly…

I. POWER END

A. CRANKSHAFT BEARING RETAINER OIL SEAL

Press oil seal into the retainer with the lip facing the bearing (if used).

B. CRANKSHAFT MAIN BEARINGS

The crankshaft should be clean and free of burrs. The cone and roller assemblies and center bearing inner races are to be heated in an electric oven or oil bath to 300°F (149°C). The use of a thermometer is recommended. BEARING PARTS ARE MATCH MARKED AND SHOULD BE NOTED PRIOR TO HEATING. MAKE SURE PARTS ARE NOT INTERCHANGED.

1. Center Bearings:

   a. With center bearing inner races at proper temperature, install on the crankshaft.

   b. Install crankshaft snap ring for each race.

   c. Install one center frame snap ring for each race.

   d. Position cylindrical roller assembly in frame and drive into the bore with a soft steel hammer.

   e. Install outer snap ring in each bearing support area.

2. Right Hand Bearing (Less Cage):

   a. Heat sprocket and assemble to crankshaft with chamfered side next to shoulder radii.

   b. Drill through the sprocket and into shaft with a 3/16” drill at a 4¾” radius and install 3/16” spring pin. Make certain the pin does not bottom out in the hold so as to hold the bearing cone away from the sprocket.

      NOTE: If proper spring pin is not available, a solid pin of 3/16” or 1/4" diameter can be substituted. This pin is used only to prevent rotation of the sprocket.

   c. With a bearing cone and roller assembly at proper temperature, install on the crankshaft with the thick edge of the taper against the sprocket. (Note: Right hand end of crankshaft is shorter than the left hand end.)

   d. Assemble the bearing spacer and outer race on the crankshaft and against the inboard cone and roller. (Note: The 375T and 430T use an inner and outer spacer and two piece outer race.)

   e. Install outboard cone and roller assembly, thin edge against the bearing spacer.

   f. Tighten the lock nut very securely. Use a dull punch and a large hammer to drive the lock nut. Lock with the washer prong. (This can best be done after the shaft is in the pump).

      MAKE SURE CONE AND ROLLER ASSEMBLIES ARE TIGHT AGAINST THE CONE SPACER AND CRANKSHAFT SHOULDER. BEARING FAILURE WILL OCCUR IF THE BEARINGS ARE NOT PROPERLY TIGHTENED AND SHOULDERED.

Assembly…

I. POWER END

B. CRANKSHAFT MAIN BEARINGS (Continued)...

3. Left Hand Bearing (With Cage):

   a. With bearing cone and roller at proper temperature, install on the crankshaft with the thick edge of the taper against the shoulder.

   b. Assemble the bearing spacer against the inboard cone and roller.

   c. Drive outer race into the bearing cage against bottom shoulder. Note: The 375T and 430T bearing has a two piece outer race with a spacer.

   d. Position the cage assembly with gasket in place against the inboard cone and roller. Note: Make certain the inner spacer is in place.

   e. Install outer cone and roller assembly; thin edge against the bearing spacer.

   f. Assemble lock nuts and lock washer.

   g. Tighten the lock nut very securely. Use a dull punch and a large hammer to drive the lock nut. Lock with the washer prong. (This can best be done after the shaft is in the pump).

      MAKE SURE CONE AND ROLLER ASSEMBLIES ARE TIGHT AGAINST THE CONE SPACER AND CRANKSHAFT SHOULDER OR SPROCKET. BEARING FAILURE WILL OCCUR IF THE BEARINGS ARE NOT PROPERLY TIGHTENED AND SHOULDERED.

      NOTE: THE BEARING RETAINER AND BEARING CAGE ARE MARKED “TOP”.

C. CONNECTING ROD AND CROSSHEAD ASSEMBLY

1. Press the crosshead pin bushing into the connecting rod.

2. Ream bushing to size (refer to page 16 for dimensions). Blue with pin and scrape bushing to remove high spots.

3. Install the crosshead pin. To facilitate assembly, the crosshead may be heated to no more than 300°F (149°C) in an electric oven or oil bath. Make certain the 1/2" plugs are installed and tightened in the ends of the crosshead pins.

   NOTE: Crossheads are marked "TOP" on extension rod end and must be installed correctly.

Assembly…

I. POWER END (Continued)…

D. CRANKSHAFT ASSEMBLY

1. 625Q pump below serial number 108 must have the crosshead assemblies in place prior to installation of the crankshaft.

2. Install the right hand cage and gasket into the frame.

3. Connect right hand pressure lube line to the inside of the right hand.

   CHECK POINT – Before installing crankshaft make certain the crossheads and connecting rods are positioned in the pump if required. (See Disassembly, I. Power End, C. Power End Sub-Assemblies, 3. Crossheads)

4. Install crankshaft with left hand cage gasket in place. Protect center bearings and races from damage.

   NOTE: The 375T and 430T right hand main bearing has a two piece outer race with a looser spacer. When installing the crankshaft make certain the outer spacer is centered accurately and enters the bearing cage.

5. Install left hand pressure lube line to the inside of the left hand cage.

6. Install right and left main bearing retainers. Note they have a top and bottom. If oil seals are used, protect seals from damage when installing. With labyrinth type seals check for clearance around shaft. Seal surface should not touch shaft.

7. Install dirt excluder tightly against face of labyrinth seal. (Dirt excluder is not used with oil seals.)

E. CONNECTING ROD BEARINGS – 625Q (ONLY SERIAL NUMBER 101 THRU 107)

The connecting rod bearings are precision fitting inserts requiring no adjustment. When reinstalling the same inserts, assemble them in pairs at their original location. Make sure the match marks on connecting rod and cap are the same and on the same side.

1. Install rod half of bearing, seat connecting rod on the shaft and install bolts.

2. Install other half of bearing and bearing cap making sure dowel pins in bearings are properly joined. Using torque wrench tighten locknuts to 120 ft./lbs. each.

Assembly…

I. POWER END (Continued)...

F. CONNECTING ROD BEARINGS – 375T, 430T, 625Q (SERIAL NUMBER 108 AND UP)

The connecting rod bearings are precision fitting inserts requiring no adjustment. When reinstalling the same inserts, assemble them in pairs at their original location. Make sure the match marks on connecting rod and cap are the same and on the same side.

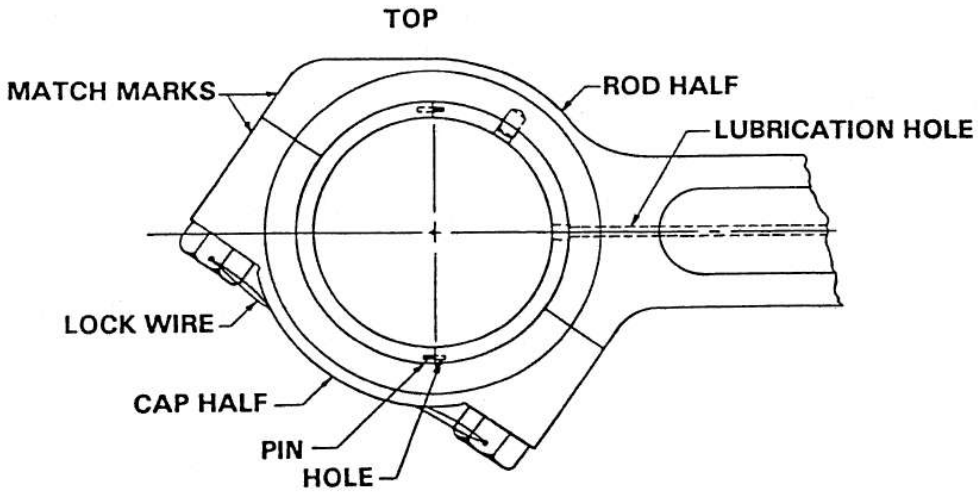


Figure 1

NOTE: IT IS POSSIBLE TO INSTALL THESE BEARING SHELLS INCORRECTLY. PLEASE FOLLOW INSTRUCTIONS CLOSELY.

1. Check bearing halves for pin engagement and fit over the dowel pin in the rod half of the connecting rod. Please note the drawings and match marks.

2. Install both bearing halves on the crankshaft with the dowel pins engaged as shown. Position crankshaft throw to rear.

3. Slide the connecting rod back over the bearing halves with caution and line up the dowel pin into the correct hole in the bearing half.

   CAUTION: DO NOT Drive the connecting rod dowel pin into the aluminum bearing. If it is properly located the pin will seat itself.

4. DO NOT install the cap until you have rotated the crankshaft throw on top and checked with a feeler gauge to make certain the pin is in the hole and the aluminum bearing is seated into the connecting rod metal to metal.

5. Install the cap and four bolts making certain the match marks are correct. Tighten the bolts with caution until you are certain everything is correct. Torque each bolt to 250 ft./lbs. and lock wire in pairs.

6. Rotate the crankshaft to make certain the connecting rod is assembled correctly. If the dowel pin is mislocated it will crush into the aluminum insert and cause a tight spot that will gall and cause premature bearing failure.

Assembly…

I. POWER END (Continued)...

G. INTERMEDIATE RODS AND OIL SEAL RETAINERS

1. Install three rod wipers in the retainer, two with lip facing the power end and one with lip facing the fluid end. On the power end side, one wiper should be pressed in the retainer until it contacts the shoulder. The second wiper on the power end side and the wiper on the fluid end side should be installed with the wiper O.D. face flush with the face of the retainer.

   NOTE: Make sure O.D. of wiper and I.D. of retainer are clean and dry before installation of wipers.

2. Rotate the crankshaft until the crosshead is all the way to rear and install the retainer and rod as a unit. **NOTE:** Make sure retainer gasket is in place prior to installation. Tighten rod in crosshead. Torque to 530 ft./lbs. (dry), 420 ft./lbs. (lubricated). Use a back-up wrench on crosshead to prevent damage to connecting rod.

3. There are oil drain holes to indicate the bottom of intermediate rod retainer.

H. POWER END PRESSURE LUBRICATION GEAR PUMP

1. Install sprocket and key loosely on pump shaft.

2. Mount pump on mounting block in bottom of sump and engage four capscrews with lock washers.

3. Using master link, install sprocket chain between crankshaft drive sprocket and pump sprocket.

4. Secure the pump to mounting block by tightening the four capscrews.

5. Align chain and sprockets correctly and securely tighten setscrew to shaft.

Assembly (Continued)…

II. FLUID END

A. FLUID CYLINDER

1. Clean mating surfaces and pilot bores of the main frame and the right, left and center cylinder modules.
2. Assemble right and left cylinder modules to main frame using socket head capscrews and tighten securely.
3. Clean mating surfaces and pilot bores for both the suction and discharge connectors. "H" Cylinders – Suction Only.
4. Assemble capscrews and seals to connectors. Grease seals before inserting connectors into cylinder bores.
5. Push connectors into the cylinder bore as far as possible. This will provide the clearance for assembly of cylinder center module.
6. Assemble center cylinder module to main frame using socket head capscrews and tighten securely.
7. With flange face seals in place secure suction and discharge connectors to center cylinder module. "H" Cylinders have a discharge manifold that replaces the discharge connectors.

B. STUFFING BOX AND PLUNGER ASSEMBLY

1. Remove all nicks and burrs from stuffing box and pilot diameter, clean and lubricate with a copper base lubricant or equivalent.
2. Assemble packing unit in the stuffing box bore as per instructions included with each set of packing and also described on pages 27 through 30 of this manual.
3. With the stuffing box adjusting nut hand tight, oil and install plunger.

C. STUFFING BOX INSTALLATION

1. Rotate crankshaft until the intermediate rod is at the end of the suction stroke.
2. With the stuffing box packed, plunger installed and seal installed on face of stuffing box, slide the assembly into the pilot bore. Stuffing box retainer may be a part of this assembly or it may be installed separately.
3. Tighten stuffing box hex nuts. Use 850 ft./lbs. of torque. (Equivalent to a 170 lb. man on the end of a 5 ft. extension.)
4. Assemble "quick coupling" clamps between the intermediate rod and plunger. Tighten bolts alternately to prevent "cocking" and torque to 50 ft./lbs. each.
5. Tighten stuffing box adjusting nut. (Adjusting nut should be tightened with the bar furnished with the pump.) The lubricators should be set to feed five to seven drops of oil per minute per plunger (see page 10 for lubrication recommendations).

D. FLUID VALVES - TAPERED SEAT OR CAGE TYPE

See Valve section of this manual.

Assembly…

II. FLUID END (Continued)…

E. SUCTION LINE PULSATION DAMPENER

1. High pressure dampener with aluminum housing.

   a. The dampener is fitted to an adapter that may be either welded into an existing line or be a part of a separate dampener housing. Place a gasket on each side of the diaphragm retaining plate and place on the adapter.

   b. The dampener spacer is then placed on top of the retainer plate with the grooved side up and the flat side against the retainer gasket.

   c. The diaphragm fits into the groove on the spacer with the curved portion of the diaphragm above the spacer.

   d. Apply a continuous 1/8" diameter bead of silicone rubber on the outer edge of the diaphragm after it has been positioned in the spacer. This silicone rubber is readily available at most hardware stores (GE Silicone Rubber or Dow-Corning Silastic). Assemble the body cover within ten minutes after applying the silicone rubber.

   e. Fit the dampener cover over the diaphragm and assemble the capscrews. Tighten these capscrews evenly to approximately 80 ft./lbs. of torque.

   f. Install the sight glasses, one in each side of the cover. Be sure to seat the sight glass packing carefully into the groove on the cover as this must be an air tight connection.

   g. The air check valve has a pipe thread and must be made up into the cover air tight. Use a good pipe thread sealant to promote sealing.

2. Low pressure dampener with plastic housing.

   a. Place diaphragm in plastic dampener body.

   b. Install dampener with special capscrews. Tighten capscrews 10 to 12 ft./lbs. torque.

   c. Install check valve and tighten until snug. Use a thread sealing compound to eliminate air leaks. Use caution when handling or working with dampener. This is a plastic part and can be broken.

F. PIPING INSTALLATION

1. Install flanges on fluid cylinder with special high carbon double heat-treated capscrews furnished with the pump.

2. Install suction and discharge lines to flanges.

Assembly…

II. FLUID END (Continued)…

G. PLUNGER PACKING INSTALLATION

1. 850-N Packing

It is important that the following procedure be observed when replacing old packing to prevent rapid packing wear:

a. Remove front crosshead reservoir cover plate and rotate pump to bring the desired plunger to the forward position.

b. Using back-up wrenches loosen the intermediate rod to crosshead connection.

c. Rotate crankshaft until plunger is all the way back. Remove clamp assembly and slide plunger forward.

d. Remove intermediate rod and intermediate rod seal retainer from as one assembly.

e. Remove plunger and old packing, making sure stuffing box is clean. (Plungers and boxes may be removed as an assembly if desired by rotating pump so intermediate rod is all the way back, thereby disconnecting the plunger and sliding the stuffing box back and out.)

f. Oil each ring with light oil **(DO NOT GREASE)**, and install packing per sketch included with the packing. Make sure the lips on the sealing rings face pressure shown.

g. Install gland and pull down hand tight against packing.

h. Install plungers, then pull adjusting nut down as tight as possible with bar furnished with the pump. **DO NOT USE A CHEATER!!**

i. Install intermediate rod and retainer. Connect plunger and torque intermediate rod and clamps as follows:

Intermediate Rod to Crosshead

Dry Threads – 530 ft./lbs.
Lubricated Threads – 420 ft./lbs.

Plunger Clamp Capscrews

Maximum 50 ft./lbs.

j. For 850-N packing, start pump and operate under pressure, retighten adjusting nut. After pump has been running for two or three hours under pressure, packing will seat itself and the adjusting nut should be tightened as much as possible to eliminate any movement of the packing in the stuffing box. Use the bar furnished with the pump. **Do not use a cheater!**

k. The adjusting nuts should be checked and each tightened for the first two or three days until the packing is completely seated and the adjusting nuts cannot be tightened any further. Use the bar furnished with the pump. **Do not use a cheater!**

Assembly…

II. FLUID END

G. PLUNGER PACKING INSTALLATION (Continued)...

2. 1045 PACKING (also called No. 265)

It is important that the following procedure be observed when replacing old packing to prevent rapid packing wear:

a. Remove crosshead reservoir cover and rotate crankshaft to bring plunger forward.

b. Using back-up wrenches loosen the intermediate rod to crosshead connection.

c. Rotate crankshaft until plunger is all the way back. Remove clamp assembly and slide plunger forward.

d. Remove intermediate rod and intermediate rod seal retainer from pump as one assembly.

e. Remove plunger and old packing, making sure stuffing box is clean. (Plungers and boxes may be removed as an assembly if desired by rotating pump so intermediate rod is all the way back, thereby disconnecting the plunger and sliding the stuffing box back and out.)

f. Starting with the first Phenolic ring, seat each ring individually in the order packaged. Eliminate the No. 1 Phenolic ring when using a sleeve washer with ceramic plungers.

g. Install plunger and make up the adjusting nut tight to insure the entire packing set is properly seated. The nut should be loosened and adjusting hand tight.

h. Install intermediate rod and retainer. Connect plunger and torque clamp and intermediate rod properly as outlined on page 24.

i. Start the pump and run with normal system pressure. Tighten the adjusting nut carefully watching for excessive heat build-up. Continue to tighten the nut until it is a good, snug fit and the nut shows no movement in the threads.

! IMPORTANT !

IF THE ADJUSTING NUT AND LOCKS CANNOT BE MOVED, IMMEDIATELY REMOVE THE PRESSURE FROM THE PUMP, BACK OFF THE NUT ONE-HALF TURN, AND START AGAIN.

j. This packing may or may not leak, depending on the circumstances, and it does not require continuous adjustment. It should be checked and re-tightened the first day or two after installation of new packing, but should require very little attention after this.

k. This packing can be used on hard coated or ceramic plungers without lubrication, but as with any packing, extended life is possible through the use of lubrication. When using a mechanical or drip type lubrication system in water service, use Rock Drill (Air Drill) Oil of the proper viscosity. Drip five to seven drops per minute.

Assembly…

II. FLUID END (Continued)...

G. PLUNGER PACKING INSTALLATION

3. 699 PACKING

For top performance from the soft packing of "Teflon" fiber, read and carry out the following instructions. Use the above method to remove and re-install intermediate rod and plunger.

a. Packing may be butt or diagonal cut. Stagger joints in successive rings at least 90°.

b. Slide rings into stuffing box, but do **not** tap or drive rings into place. Tests have shown that this method gets maximum performance from soft packing of "Teflon" fiber.

c. Tighten stuffing box nut finger tight and start pump. Packing should be leaking – if not, loosen stuffing box nut. Remember, install this soft packing with a minimum of gland pressure to minimize friction and heat build-up.

d. Reduce leakage to desired level by tightening stuffing box nut about 1/6 turn at a time every few minutes.

e. If gland heats up to a temperature that will boil water, back-off stuffing box nut and repeat run-in until temperature remains after nuts are re-tightened.

"Teflon" is DuPont's registered trademark for TFE- Fluorocarbon fiber.

4. SPRING LOADED KEVLAR RECIPROCATING PACKING

- Recommended Packing Procedure -

a. Before re-packing, determine cause of failure.

b. Remove plunger, stuffing box nut, and all internal parts in stuffing box. Remove stuffing box itself if necessary to clean.

c. Clean all parts and determine if parts are worn or reusable. Replace all worn parts.

d. Soak new packing elements in oil. Lubricate all other parts.

e. Note the depth of stuffing box bore. If greater than four inches (4"), install appropriate spacer. See appropriate parts-list for applicable spacer.

f. Install parts into stuffing box in the following order: spacer (if needed), spring, follower (small end first), Kevlar ring and brass ring (with care), (alternate these items three (3) times), and then add the bushing (gland ring).

g. Screw on the nut -- hand tight.

h. Insert plunger into packing assembly.

Assembly…

II. FLUID END

G. PLUNGER PACKING INSTALLATION

4. SPRING LOADED KEVLAR RECIPROCATING PACKING (Continued)…

i. Tighten packing nut. Bushing should seat and shoulder against stuffing box face. Back-off the nut one-half turn.

j. If stuffing box has been removed, re-install assembly onto reciprocating.

k. Connect plunger to intermediate rod and tighten.

l. Insert stop pin into stuffing box nut.

m. Fill lubricator with Rock Drill Oil for normal temperature, steam cylinder oil for high temperature fluids. Fill lubricator lines by pumping it manually. Check its operation.

n. Start pump at slow speed and low pressure if possible, tighten stuffing box nut and insert stop pin in hole. Watch for a short period of time. Oil if needed.

o. Set lubricator to twice normal rate. After 24 hours, resume normal operation. Check stuffing box for excessively high temperatures and abnormal leakage.

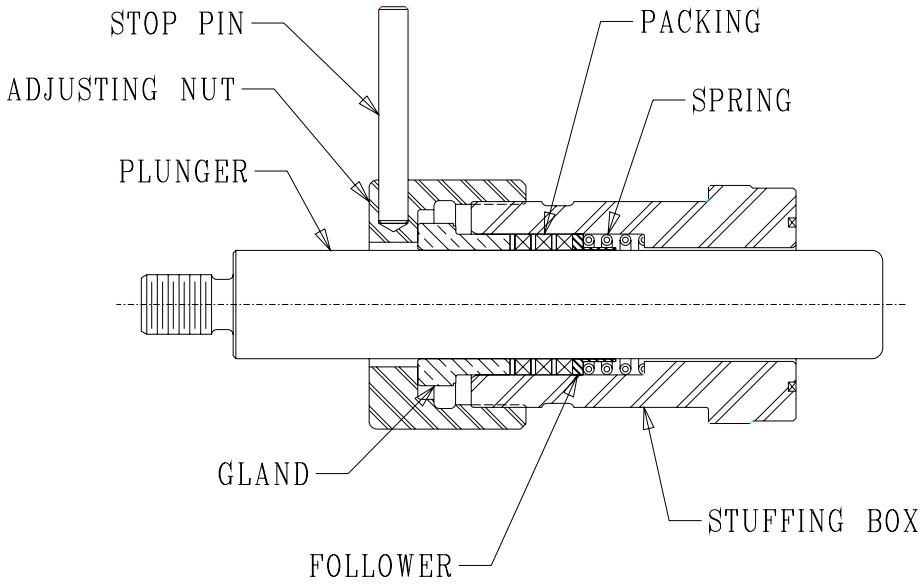


Figure 2

Plunger Pump Valves…

I. OPERATIONAL MAINTENANCE

A. SUCTION AND DISCHARGE

As with any plunger pump, the necessity for having an adequate suction head and proper piping design of both suction and discharge cannot be over emphasized.

! ATTENTION !

NOISY VALVES, DUE TO IMPROPER FILLING, CAN LEAD TO SHORT LIFE AND RAPID MECHANICAL WEAR OF THE POWER END PARTS.

B. VALVE COVERS

⚠ CAUTION ⚠

THE VALVE COVERS, AS USED WITH THE NATIONAL-OILWELL PLUNGER PUMPS, **MUST** BE KEPT TIGHT AT ALL TIMES. DUE TO THE DISCHARGE PRESSURE APPLYING A CONSTANT LOAD TO THE COVERS, IT IS **NOT** POSSIBLE TO CHECK THEIR TIGHTNESS WITH THE PUMP RUNNING OR WITH PRESSURE IN THE CYLINDER.

Bleed-off the discharge pressure and check the tightness of the covers as outlined under the assembly procedure for the type of cover used.

C. VALVE CAGE AND COVER SEALS

1. Cage Type Valves

   There are three identical seals in each valve stack. The seals perform a very important function in this design valve and we recommend that they be changed any time they are removed from the pump.

2. Tapered Seat Valves

   The cover seals should be replaced as required.

D. VALVE SPRINGS

The springs used with the NATIONAL-OILWELL valves are made of inconel alloy or other stainless steel.

! ATTENTION !

THESE SPRINGS SHOULD BE CHANGED APPROXIMATELY ONCE A YEAR IN ORDER TO ASSURE PROPER VALVE ACTION AND ELIMINATE THE POSSIBILITY OF A SPRING BREAK.

Plunger Pump Valves…

I. OPERATIONAL MAINTENANCE (Continued)…

E. VALVE CAGES

The cages are normally made from aluminum, bronze, stainless steel or hardened steel, depending on the type of service. These cages are precision machined to give long, continuous service.

F. VALVE AND SEAT

1. Cage Type Valves:

   There are four basic valve and seat assemblies available, depending on the type of service. They are the disc type, the ball type, the wing-guided type, and the spherical type. These valves can be made available in a variety of materials on special order.

2. Tapered Seat Valves:

   There are three basic valve & seat assemblies available, depending on the type of service. They are the Durabla tapered seat valves, the new Bottom Guided tapered seat valves, and the spherical tapered seats. The valve and seat are available in a variety of materials depending on the type of fluid being pumped.

Plunger Pump Valves…

II. CAGE TYPE VALVES

The NATIONAL-OILWELL cage type valve is a patented design valve. This manual will assist in performing the normal maintenance requirements of the valves.

A. NOMENCLATURE

1. Acme threaded valve cover with center bolt.
2. Retainer.
3. Cover and Cage Seal, Suction or Discharge (interchangeable).
4. Disc Valve Cage, Suction or Discharge (interchangeable).
5. Valve Spring, Suction or Discharge (interchangeable).
6. Stop, Valve Disc, 30° Taper Cut in cage, not used in Ball Valve Cages.
7. Valve Disc or Valve Suction Discharge (interchangeable).
8. Valve Seat, Discharge only - Small bore (I.D.) used to retain Suction Spring.
9. Valve Seat, Suction Only - Large Bore (I.D.) same as Suction Throat Bore.
10. Valve Seat Suction and Discharge (interchangeable).

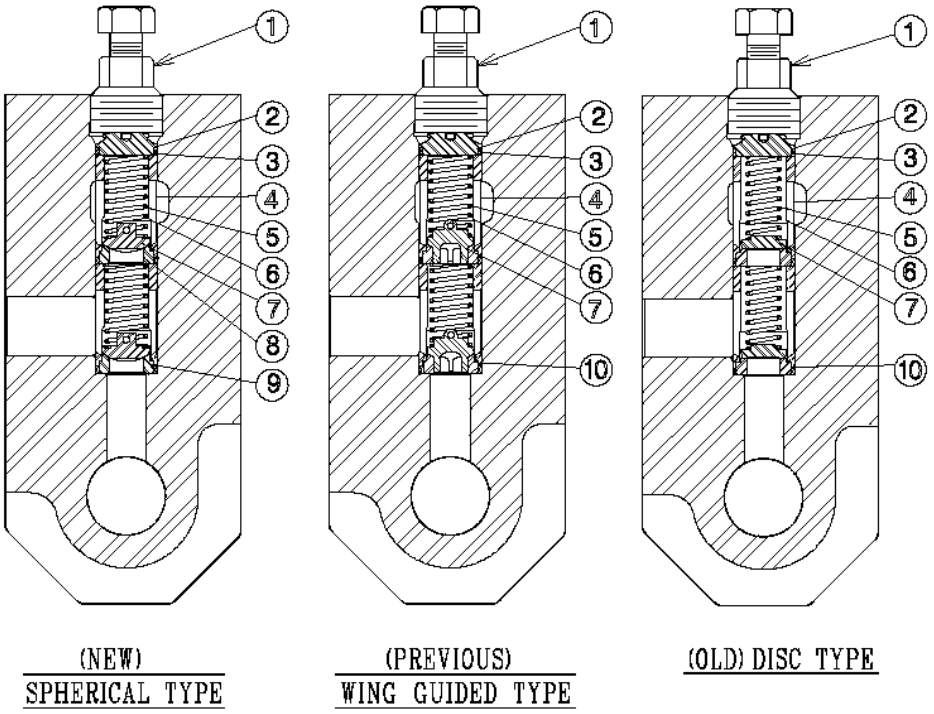


Figure 3

Plunger Pump Valves…

II. CAGE TYPE VALVES (Continued)…

B. VALVE SERVICING TOOLS (charts)

The valve servicing tools referred to on the following pages are listed below:

CAGE TYPE VALVES
(SPHERICAL, BOTTOM GUIDED, BALL, & DISC)

Pump Size	Valve Kit	Cage Puller	Cage Bumper	Seat Drive	Magnetic Retriever
375T-7HCB 430T-7HCB 625Q-7HCB	1715338	1715339	1790085	1790053 G-1790062 G-1715342	1790034
375T-7L, 375T-7M, 430T-7L, 430T-7M, 430T-7H, 625Q-7L, 625Q-7M, 625Q-7H	1712342	1712242	1790080	1790042	1790034

Plunger Pump Valves…

II. CAGE TYPE VALVES (Continued)...

C. DISASSEMBLY PROCEDURE

1. Remove threaded cover. (The covers should be tight enough to require an extension on a 24" pipe wrench to loosen). Inspect threads for wear, which could occur if cover was loose.

2. Remove retainer with hook on a magnetic retriever. Some retainers are tapped with a lifting thread for removal.

3. Remove cover seal from top of cage with hook on magnetic retriever. (This hook is rough ground at the plant and should be finished to a flat sharp edge to be most effective). (Figure 4, page 36).

4. Before removing spring, observe amount of preload. Spring should extend about 1/8" to 3/16" above the top of the cage. It is not recommended that you stretch a spring to secure the correct preload as this causes physical damage to the spring. This should be done only on these cases where a new spring is not available. Remove the spring with hook. (Figure 6, page 36).

5. Remove cage with puller as illustrated. Under normal conditions, these cages are readily removed. If the fluid being pumped makes mineral deposits (gyp) in the cage bore, this will immediately alert the customer that he should start some type of treating program to protect his complete system.

6. Using magnet or hook, remove valve disc. (Figure 6, page 36).

7. Insert valve seat driver in discharge seat and rock back and forth. This action will loosen the seat and allow it to be removed with the hook. (Figure 7, page 36).

8. Assemble upper valve as removed to keep parts together.

9. Remove seal from top of lower cage.

10. Remove spring with hook. **Note:** Notice if spring had proper pre-load.

11. Remove cages using same procedure as No. 4.

12. Using magnet, remove valve disc.

13. Insert valve seat driver in suction seat and rock back and forth. This action will loosen the seat and allow it to be removed with the hook.

14. Assemble lower valve as removed to keep parts together.

15. Remove bottom seal.

16. Inspect cylinder bore with flashlight paying particular attention to sealing areas.

*If necessary, repeat the above steps in the remaining cylinder bores.

Plunger Pump Valves…

II. CAGE TYPE VALVES

C. DISASSEMBLY PROCEDURE (Continued)...

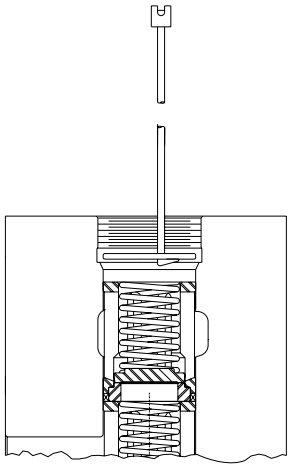


Figure 4

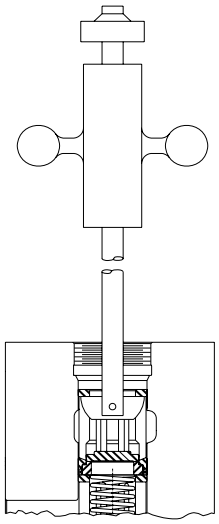


Figure 5

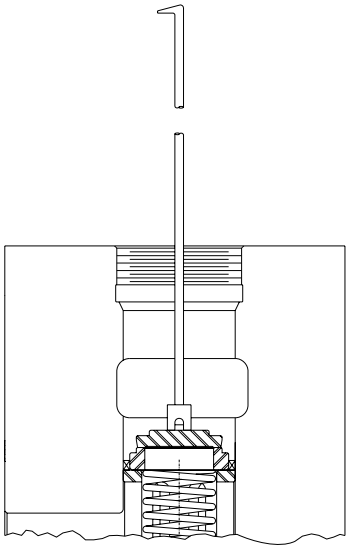


Figure 6

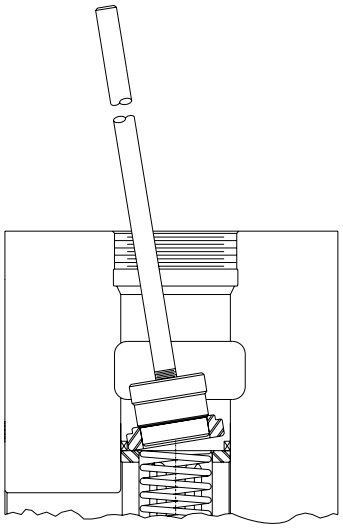


Figure 7

Plunger Pump Valves…

II. CAGE TYPE VALVES (Continued)...

D. VALVE PARTS INSPECTION

1. CAGE (Bottom Guide, Disc, Ball, or Spherical)

The cages used in the National-Oilwell Valve Assembly are precision machined and designed for long trouble-free service. Erratic valve action associated with poor suction conditions can cause accelerated wear on this part.

! ATTENTION !

A LOOSE COVER WILL ALLOW CAGE MOVEMENT AND WILL CAUSE EXTENSIVE DAMAGE TO CAGE AS WELL AS FLUID END.

Each cage that is removed should be inspected at the following points referred to in Figure 8.

a. Inspect for wear in this area. It is best to do this with the valve and seat in the cage, therefore, a more accurate decision can be made. The wear in this area, which can be judged by the sideways movement of the disc, should not exceed 1/2 the width of the seating surface of the disc valve or more than 1/8" to 3/16" for the ball valve. These are **maximum** figures and could result in poor valve action and some loss of efficiency. If in doubt, change the cage.

b. Inspect the valve seat shouldering area for signs of wear or hammering. If this portion of the cage is cracked or battered, the cage should be replaced. This will only happen if the cage is allowed to move in the bore due to loose covers.

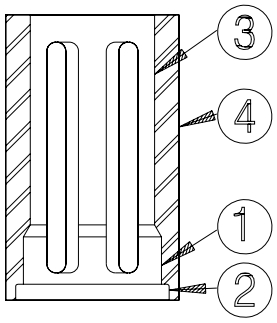


Figure 8

c. Inspect cage bore for excessive spring wear. In most cases this area will wear only if there is poor valve action or extremely corrosive water that attacks the cage material in this wear zone.

d. Inspect O.D. of cage for nicks, burrs or washers. Clean cage thoroughly before replacing.

Plunger Pump Valves…

II. CAGE TYPE VALVES

D. VALVE PARTS INSPECTION (Continued)...

2. VALVE, BOTTOM GUIDED AND SEAT

The standard (-25) NATIONAL-OILWELL bottom guided disc and seat is made from a specialty stainless steel, which is strictly resistant to corrosion. An optional heat treated stainless steel (-4) valve is available for less corrosive fluids that contain solids. The standard valve is non-magnetic, so a loop is provided for removal from the fluid cylinder.

The following inspection points should be observed:

a. The valve seat and sealing surface should be closely inspected for evidence of excessive wear and/or washed areas. The amount of wear can be determined by comparison with a new valve and seat. Worn valves and seats should be replaced.

b. Inspect the valve guides and seat bores for guide wear. Valves with excessively worn or broken guides and grooved seats should be replaced.

c. Inspect the outside surface of the valve and seat for nicks, burrs or washers, and thoroughly clean before assembly.

3. VALVE, SPHERICAL VALVE AND SEAT

The standard NATIONAL-OILWELL spherical valve & seat is made from a specialty stainless steel which is strictly resistant to corrosion. The valve is non-magnetic so a loop may be provided for removal from the fluid cylinder.

The following inspection points should be observed:

a. The valve seat & sealing surface should be closely inspected for evidence of excessive wear and/or washed areas. The amount of wear can be determined with a new valve & seat. Worn valves & seats should be replaced.

b. Inspect the outside surface of the valve & seat for nicks, burrs, or washes, and thoroughly clean before assembly.

Plunger Pump Valves…

II. CAGE TYPE VALVES

D. VALVE PARTS INSPECTION (Continued)...

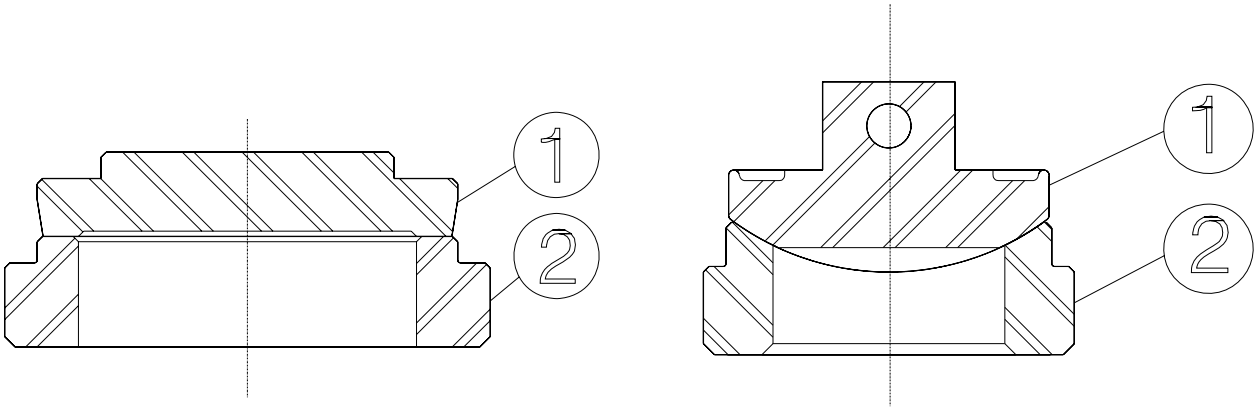
4. VALVE, DISC AND SEAT

The NATIONAL-OILWELL disc-type valve is made from heat treated stainless steel. An optional 316 stainless steel valve is available for severe corrosive service. The 316 stainless steel valve is non-magnetic and cannot be picked up with a magnet. The heat-treated valve is magnetic.

The following inspection points should be observed (See Figure 9):

a. The valve and seat sealing surfaces should be closely inspected for evidence of excess wear and/or washed areas. The amount of wear can be determined by comparison with a new valve and seat or by observing the amount of undercut still remaining on the disc seating surface. If this face is flat, the valve disc and probably the seat should be replaced. Small washes or cuts in the seating surface can sometimes be removed with emery cloth. The seating surfaces should then be ground or polished to a smooth finish. A good field method is to lay the fine emery cloth or crocus cloth on the milled top of the cylinder and polish the disc and seat on this surface.

b. Inspect the outside surface of the disc and seat for nicks, burrs, or washes, and thoroughly clean before assembly.



Disc & Seat **Spherical Valve & Seat**

Figure 9

Plunger Pump Valves…

II. CAGE TYPE VALVES

D. VALVE PARTS INSPECTION (Continued)…

5. VALVE, BALL & SEAT

The NATIONAL-OILWELL ball and seat valve is composed of the same material as the Fluid Packed Supreme Ball and Seat. The seat is reversible and the seating surfaces should indicate if replacement is necessary.

6. SPRINGS

The springs as used in the NATIONAL-OILWELL cage-type valve assemblies are designed for long trouble-free service. If installed correctly with the proper preload and operated under normal conditions, which include a good suction that provides a smooth valve action, these springs will operate for a year or more.

! ATTENTION !

IT IS BEST YOU CHANGE SPRINGS AND DESTROY THE OLD ONES APPROXIMATELY ONCE A YEAR. IF THE SPRINGS FATIGUE AND BREAK, THE RESULTING VALVE ACTION CAN DAMAGE THE CAGE AND VALVE. HERE AGAIN, IF IN DOUBT, CHANGE THE SPRING; THEIR COST IS VERY MODERATE.

7. SEALS, VALVE CAGE

The NATIONAL-OILWELL cage type valves are of a stacked design and depend on the seal at the top, middle and bottom of the stack to isolate the suction and discharge valves and their associated changes in pressure. These seals should be changed every time the valves are removed from the pump. If it is absolutely necessary to re-use these seals, install the best seal in the middle stack, the next best at the bottom and the worst seals on the top covers. Replace used seals with new ones as soon as possible.

Plunger Pump Valves…

II. CAGE TYPE VALVES (Continued)...

E. ASSEMBLY PROCEDURES

1. After all parts have been thoroughly inspected and cleaned, assemble each valve unit on top of the pump **leaving off the seals**. Make certain the seat is shouldered up in the cage and the spring is correctly positioned on the disc. Now, check the spring for correct pre-load which should be with 1/8" to 3/16" of spring extending above top of cage. (See Figure 10, page 43.)

2. Check cylinder bores for nicks, scratches, cuts or washed areas with flashlight. Fluid end should be reworked if these are too deep for seal to work effectively.

3. Place new seal in cylinder bore and push to bottom with hook. Gently tamp the seal into the bottom of the bore. (See Figure 11, page 43).

4. Using handle of seat driver as a guide, drop a suction seat on top of gasket. The handle will prevent the seat from turning over when dropped.

   NOTE: Suction seat has a larger bore (I.D.) than the discharge seat.

5. Insert seat driver in suction seat, and using a hammer, tap the seat into seal until it is solid with bottom of bore. (Check seat, be certain top side is up). (See Figure 12, page 43).

6. Place valve disc on magnet with spring in position on top of valve disc, and lower into place on top of seat. Leave magnet standing in bore.

   NOTE: Valve discs are interchangeable between suction and discharge seats. (See Figure 13, page 43).

7. Insert cage in bore, using handle of seat driver, tap cage gently to the bottom.

   NOTE: The cages fit the bores very closely. Use care when inserting the cage to be sure it is not cocked. Work the cage gently - it will slide into the bore when correctly aligned.

   Lift the valve disc with the magnet to make certain it is not caught under the cage, and using a hammer, gently drive the cage down until solid. (See Figure 14, page 43).

8. Check disc and spring to see that they are free in the cage. Pull magnet loose. (Figure 15, page 43).

9. Using a flashlight, check the spring for correct positioning on valve disc and for proper preload. Check valve disc to be certain top side is up. (See Figure 15, page 43).

10. Place seal in cylinder bore and push to top of suction cage with hook. Gently tap seal into position.

11. Drop discharge seat using handle as described in No. 4.

    NOTE: Discharge seat has a smaller bore (I.D.) than the suction seat.

12. Drive seat solid on top of cage. In some cases, the preload from the suction spring will push the seat up after it is driven - this is normal.

Plunger Pump Valves…

II. CAGE TYPE VALVES

E. ASSEMBLY PROCEDURES (Continued)…

13. Place valve disc on magnet with spring in position and lower into place on top of seat. Leave magnet standing in the bore.

14. Insert cage and drive using the same procedure as No. 7.

15. Inspect using same procedure as No. 7.

16. Check valve assembly with flashlight using same procedure as No. 8.

17. Place seal on retainer and install in cylinder. Screw threaded cover down by hand until threads are fully engaged. Torque center bolts to following values:

PLUNGER PUMP SIZE	TORQUE (Dry)	TORQUE (Lubricated)
375T-7H, 430T-7, 625Q-7	1300 ft-lbs	1060 ft-lbs

Plunger Pump Valves…

II. CAGE TYPE VALVES

E. ASSEMBLY PROCEDURES (Continued)...

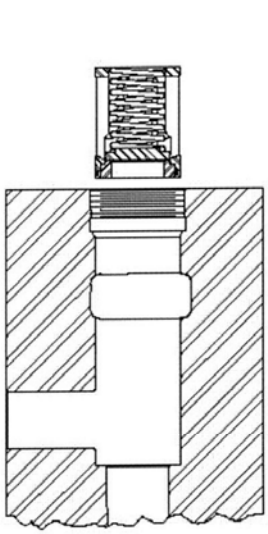


Figure 10

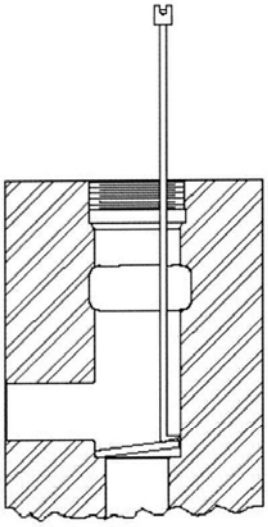


Figure 11

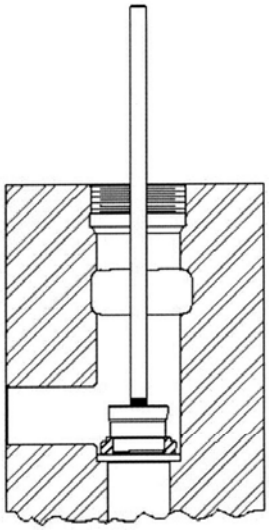


Figure 12

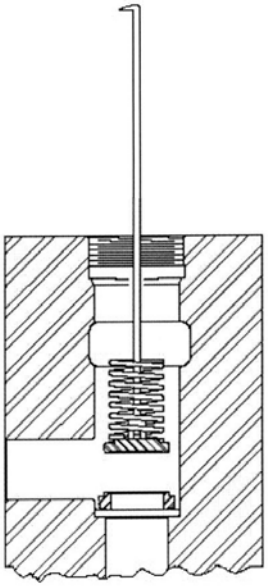


Figure 13

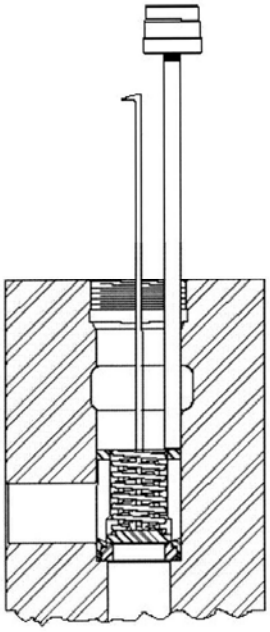


Figure 14

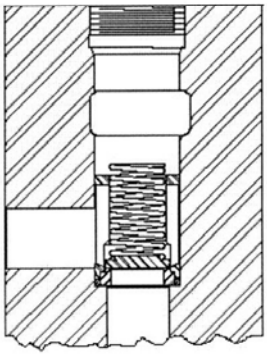


Figure 15

Plunger Pump Valves (Continued)…

III. TAPERED SEAT VALVES

A. DURABLA VALVES

This manual will assist in servicing the tapered seat valve in our National-Oilwell reciprocating pump.

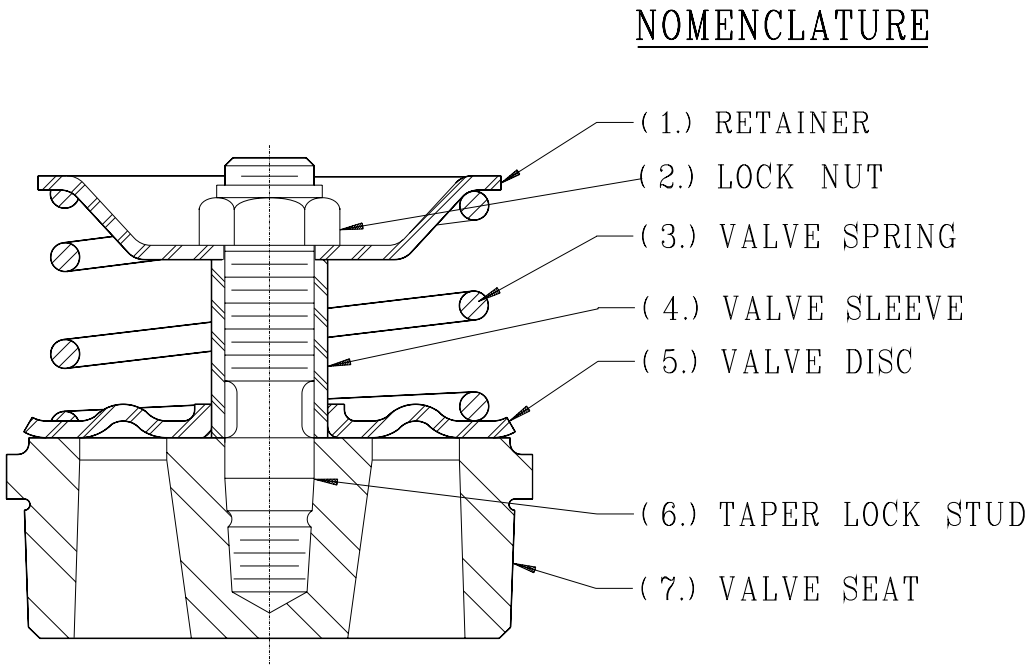


Figure 16

Below is a list of valve service tools for Durabla Valves.

Pump Size	Valve Kit	Valve Puller	Valve Bumper	Seat Driver	Stud Remover	Puller Set Screw
375T-7HCB, 430T-7HCB, 625Q-7HCB	1712296	1710004	1702359	1710268	1710007	1/2" X 1/2" No. 7027307
375T-7M, 375T-7HC, 430T-7M, 430T-7HC, 625Q-7M, 625Q-7HC	1712296	1712204	1702359	1710268	1712205	5/8" X 2" No. 7027397

Plunger Pump Valves…

III. TAPERED SEAT VALVES (Continued)…

B. DISASSEMBLY PROCEDURES

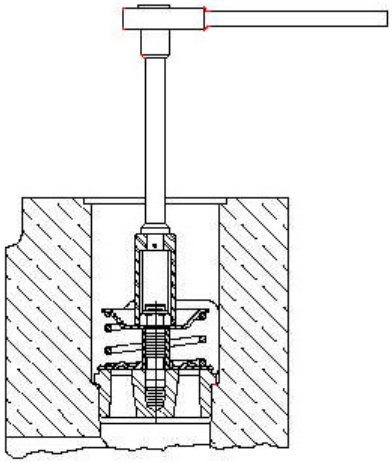


Figure 17

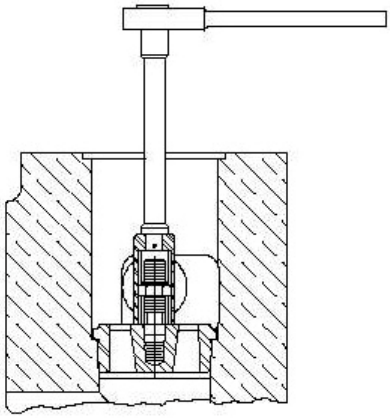


Figure 18

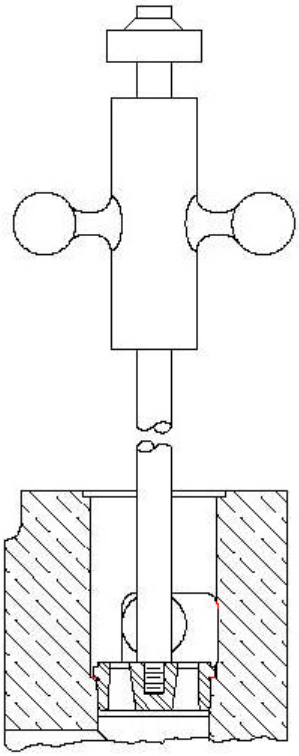


Figure 19

1. PROCEDURES

a. Both suction and discharge valves are removed from the top of the fluid end. It is necessary to pull the discharge valve prior to pulling the suction valve.

b. Remove hex nut, spring retainer, spring, valve disc and sleeve. This leaves only the stud and seat. (See Figure 17).

c. Remove the stud from the seat. Stud is made from stainless steel and is not strong enough to be used to pull the seat. Screw the special long hex nut from the servicing kit on valve stud and firmly lock into place with standard hex nut. With a socket wrench on a special hex nut, remove the stud. (Figure 18).

d. Screw valve-pulling tool into seat and tighten firmly. (NOTE: The threaded extension is a special, high-strength, full-threaded screw). Jar seat loose and remove. (Figure 19).

e. Repeat as needed to pull other valves.

Plunger Pump Valves…

III. TAPERED SEAT VALVES

B. DISASSEMBLY PROCEDURES (Continued)…

2. MECHANICS TOOLS NEEDED

1/2" or 3/8" Socket Wrench
1/2" or 3/8" x 12" Long Extension

SOCKETS (For Above)		
STUD SIZE	**SOCKET SIZE**	
	Lock Nut	**Stud Remover**
3/8"	5/8"	7/8" (Deep)
1/2"	13/16"	1" (Deep)
5/8"	1" (Deep)	1-1/4" (Deep)

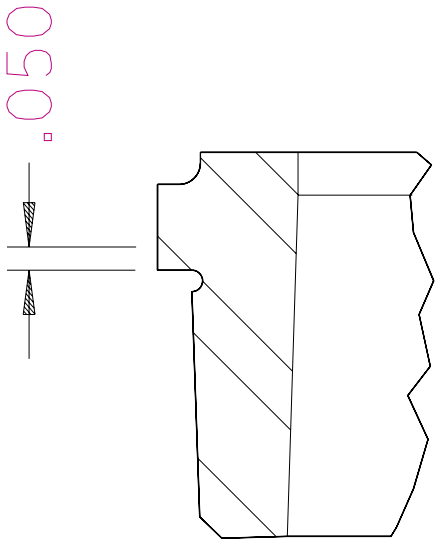


Figure 20
MACHINING OF VALVE SHOULDER

Plunger Pump Valves…

III. TAPERED SEAT VALVES (Continued)...

C. VALVE PARTS INSPECTION

Refer to "Durabla Tapered Seat Valves" Section for valve illustration.

1. RETAINER

The retainer will not need to be replaced very often. It should be inspected for corrosion or to see if it has been warped or bent. If this is the case, replace the retainer because this can cause undue wear on the spring and improper valve action.

2. SPRING

The spring is made from inconel or other stainless steel and will work in most corrosive environments. It should be inspected for wear and/or nicks. If such evidence is apparent, the spring should be replaced.

3. SLEEVE

The wear sleeve is made from a hardened corrosion-resistant stainless steel and is considered an expendable part. It protects the stud from wear and guides the valve disc. It too, should be inspected for excessive wear and replaced or the sleeve can be reversed to put the unworn area at the bottom.

4. DISC

The valve disc is also made from a hardened, corrosion-resistant, stainless steel. It too, should be inspected for excessive wear, cracks, or wash. The center hole should fit the wear sleeve properly; excess clearance can cause erratic valve action.

5. SEAT

The seat is made from corrosion resistant stainless steel. It should be inspected for excessive wear and/or wash on the top seating surface and also on the tapered side. If any of the above conditions exist, replace or repair the studded seat. The National-Oilwell valve seat is a shouldering type seat and, depending on the age and condition of the tapers in the cylinder, the valve seat might become loose. If this happens, the cylinder should be re-machined to the proper tolerances, but as an emergency measure, .050" can be machined from the valve shoulder and the valve should seat tightly.

Plunger Pump Valves…

III. TAPERED SEAT VALVES (Continued)…

D. ASSEMBLY PROCEDURES

(FLUID VALVES - TAPERED SEAT TYPE)

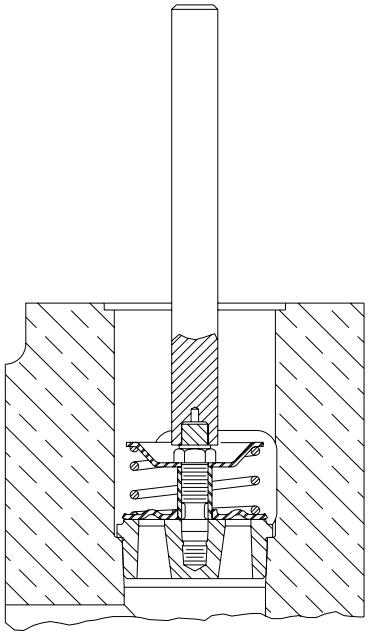


Figure 21

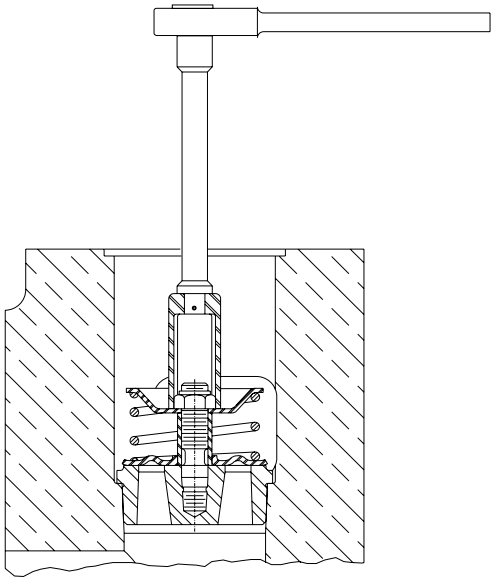


Figure 22

1. PROCEDURES

Assemble valves outside fluid end. Make certain the disc is free to lift. **Clean** and **dry** tapered surfaces of both cylinder and valves. The fluid valves are shouldered and tapered valves, and are installed completely assembled. A special valve servicing kit is available for each pump. Gently install the valve straight up in taper. Center the nylon inserted end of the seating tool on the stud, and drive the valve. See Figure 21. One or two solid blows with a large hammer are usually sufficient. After driving the valve, recheck tightness of locknut. Torque to 70 ft.-lbs., for 5/8" stud, 35 lbs. for 1/2" stud, and 15 lbs. for 3/8" stud. Excessive torque will damage stainless studs.

Bleed the air out of the cylinder prior to replacing the valve covers - this will prevent premature damage to the valves on start-up of the pump.

Plunger Pump Valves…

III. TAPERED SEAT VALVES (Continued)…

E. NEW TAPERED SEAT-BOTTOM GUIDE VALVES

VALVE COMPLETE, Consists of:					
ITEMS INCLUDED		**2-1/2"**	**3"**	**3-1/2"**	**4"**
VALVE (Complete)	Suction	1792500-4	1793000-4	1793500-4	1794000-4
	Discharge	1792502-4	1793002-4	1793502-4	1794002-4
SEAT	Suction	1792501-4	1793001-4	1793501-4	1794001-4
	Discharge	1792503-4	1793003-4	1793503-4	1794003-4
VALVE (Only).....		1790066	1713502	1790067	1790068
SPRING		1792505	1793005	1793505	1794005
RETAINER.....		1792504-26	1793004-26	1793504-26	1794004-26

PULLER KIT, Consists of:				
ITEMS INCLUDED	**2-1/2"**	**3"**	**3-1/2"**	**4"**
PULLER KIT	1792507	1793007	1793507	1794007
PULLER HEAD	1792506	1793006	1793506	1794006
BUMPER	1790080			
BAR	1790081			
WRENCH	1790082			
RETRIEVER	1790034			
SUPPORT	1713109			
NUT	6300160			
FLANGED NUT	6314002			

Plunger Pump Valves…

III. TAPERED SEAT VALVES

E. NEW TAPERED SEAT-BOTTOM GUIDE VALVES (Continued…)

REMOVAL

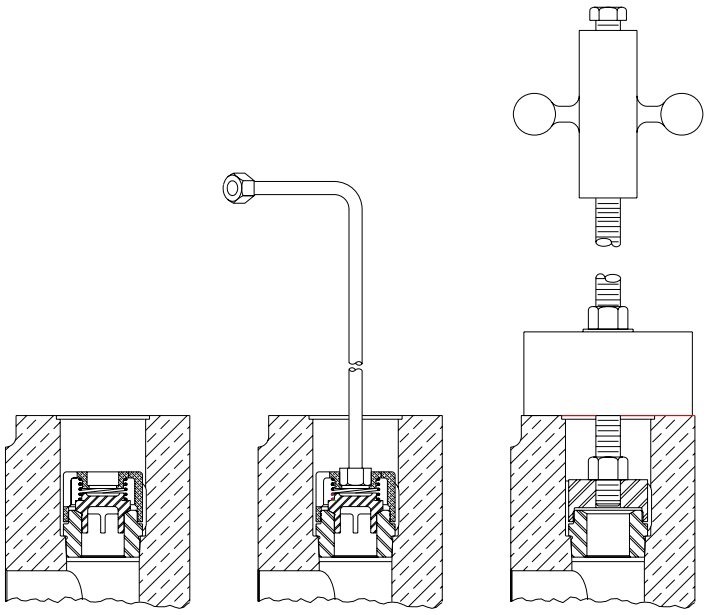


Figure 23 Figure 24 Figure 25

INSTALLATION

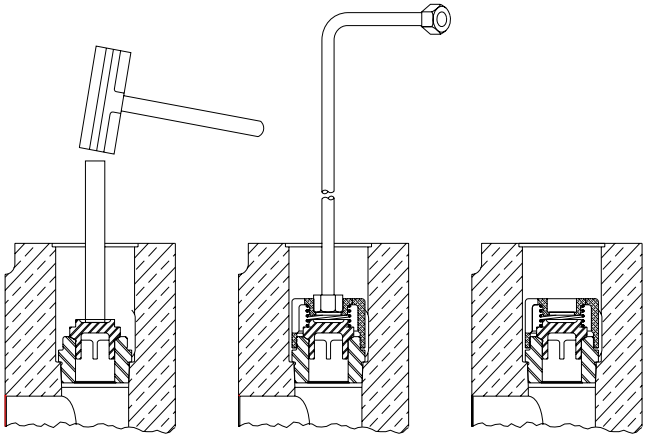


Figure 26 Figure 27 Figure 28

Plunger Pump Valves…

III. TAPERED SEAT VALVES

E. NEW TAPERED SEAT-BOTTOM GUIDE VALVES (Continued…)

1. VALVE REMOVAL PROCEDURE

a. Using hex head wrench as shown in Figure 24, remove retainer and spring. Bottom guided valves can be removed with a magnet or special valve retriever.

b. Screw puller head on valve seat until tightly shouldered. Valve seat can be pulled or bumped as shown in Figure 25.

2. INSTALLATION PROCEDURE

a. Make certain fluid end tapers are clean and dry. Inspect for corrosion or damaged areas to see if repair is required.

b. Clean and dry valve seats tapers and with retainer and spring removed, place seat in place making sure it is straight.

c. With bottom guided valve in place, drive the seat, as shown in Figure 26, until it stops driving.

d. Check bottom-guided valve to be sure it is free in the seat and install spring and retainer. Torque retainer to values shown below using hex head wrench as shown in Figure 27.

TORQUE ft.-lbs.	2-1/2"	3"	3-1/2"	4"
	100	100	100	100

Plunger Pump Valves…

III. TAPERED SEAT VALVES (Continued)…

F. SPHERICAL VALVES

VALVE COMPLETE, Consists of:				
ITEMS INCLUDED		**3"**	**4"**	**5"**
VALVE COMPLETE	SUCTION	1793020-25	1794020-25	1795020-25
	DISCHARGE	1793022-25	1794022-25	1795022-25
SEAT	SUCTION	1793021-25	1794021-25	1795021-25
	DISCHARGE	1793023-25	1794023-25	1795023-25
VALVE (ONLY)		1793027-25	1794027-25	1795027-25
SPRING (SUCTION)		1793025	1794025	1795025
SPRING (DISC)	INNER	1794026	1794026	----------
	OUTER	1794025	1794025	1795025
RETAINER		1793024-6	1794024-6	1795024-6

PULLER KIT, Consists of:			
ITEMS INCLUDED	**3"**	**4"**	**5"**
PULLER KIT	180104127	180104143	180104151
PULLER HEAD	181259300	181259409	181259410
SPACER	181205709	181205709	181205710
WASHER	20220194	20220194	20220327
NUT	75518308	75518308	75510330

Plunger Pump Valves…

III. TAPERED SEAT VALVES

G. SPHERICAL VALVES AND SEATS

Figure 29

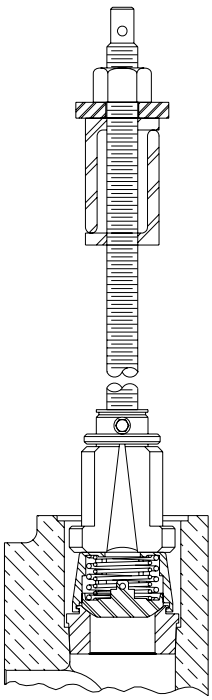


Figure30

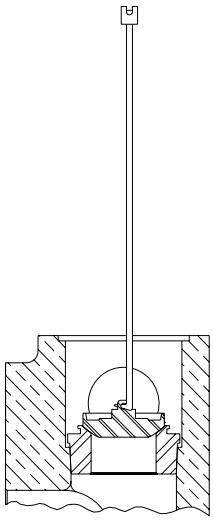


Figure 31

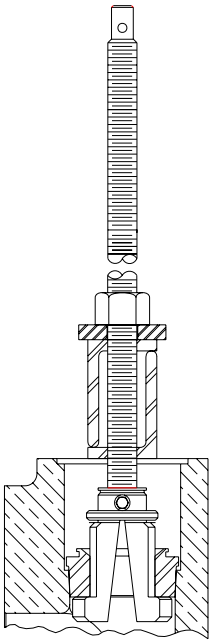


Figure 32

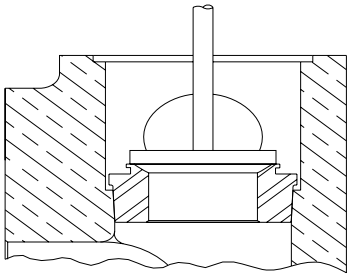


Figure 33

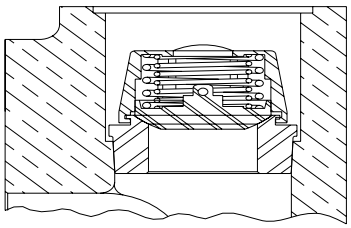


Figure 34

Plunger Pump Valves…

III. TAPERED SEAT VALVES

G. SPHERICAL VALVES AND SEATS (Continued)...

1. VALVE REMOVAL PROCEDURE

a. Both suction and discharge valves are removed from the top of the cylinder. It is necessary to pull the discharge valve prior to pulling the suction valve.

b. Remove the spring retainer by pressing downward on the puller head and turn counter clockwise about 1/8 of a turn or until retainer stops. Remove the retainer with the retriever. See Figure 30.

c. Remove spring(s) and valve with the retriever. See Figure 31.

d. Remove seat by placing the puller head through the seat opening and engage lugs to the underside of the seat. Pull seat or bump seat loose and remove. See Figure 32.

2. INSTALLATION PROCEDURE

a. Make certain cylinder tapers are clean and dry. Inspect for corrosion or damaged areas. Repair or replace as required.

b. Clean and dry spherical seat tapers and with retainer and spring(s) removed, place seat in place making certain it is straight.

c. With a bar and a driver tap seat in place with 2 or 3 strokes. **NOTE!!** Seat does not have to be completely seated. Pump start-up pressure will drive seat home. See Figure 33.

d. Install valve, spring(s), and spring retainer. See Figure 34.

P-55U Pump…

A. OPERATING INSTRUCTIONS

1. BOX SUCTION PUMPS (VACUUM FEED)

- Fill reservoir with oil.
- Loosen union nut on pump outlet.
- Remove the vent screw and fill the sight glass with oil. Prime by manually pumping flushing unit until air free oil is observed from the drip tube and oil level drops in the sight glass.
- Replace vent screw and tighten union nut.
- Maintain oil level in sight glass below the drip tube so drops can be observed.

2. FLOW RATE ADJUSTMENT

- Loosen locknut on flushing unit.
- Turn flushing unit counter-clockwise to increase flow.
- Turn flushing unit clockwise to decrease flow.
- Tighten locknut when desired flow rate is achieved.

3. SIGHT GLASS

In a vacuum type sight feed, it is not uncommon for oil level in the sight glass to drop during operation. Absence of a level indicates air is being taken in with the oil. Some oils, due to viscosity conditions, will release air faster than others. When the quality of air becomes excessive, it can eventually air lock the pump.

For this reason it is recommended that an oil level in the sight glass be maintained.

When level drops, remove the vent screw and fill sight glass to top; replace vent screw and operate flushing unit manually, observing that an oil in the sight glass is free from air. If air is not expelled, it may be necessary to loosen union nut (on pump outlet) and expel air at this point. It is desirable to maintain level below the drip tube so drops can be seen during operation.

4. OVERFILLING OF SIGHT GLASS

In a vacuum type sight feed, it is not uncommon to see a reverse action whereas sight glass fills with oil and the drops cannot be observed. Overfilling is caused by oil absorbing air in the sight glass and normally does not affect the operation of the pump. Remove the vent screw from sight glass and allow level to drop below drip tube. Tighten vent screw and check to see that air free oil from drip tube can be observed in the sight glass. If overfilling continues, it may be caused by plunger wear and oil slippage is being drawn back to sight glass. If this is the problem, the feed setting in drops per stroke will then automatically be reduced by the amount of slippage.

5. RESERVOIR OIL LEVEL (LOSS OF PRIME)

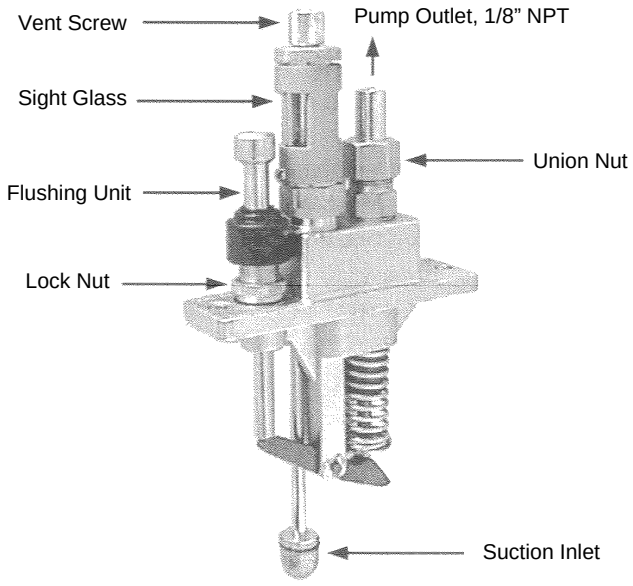
If reservoir runs low on oil (at a point below the suction inlet of the pump) it may be necessary to prime individual pumps after filling, using procedure listed above.

6. PUMP DISPLACEMENT

Maximum output (per stroke):

1/4 Plunger = .018 Cubic Inches
3/8 Plunger = .038 Cubic Inches

The cubic volume for a pint of oil is 28.9 cubic inches and average drop size is .002 cubic inches.



Storage of Pumps…

I. GENERAL

All machinery units require protection from corrosion erosion, natural attrition which causes deterioration of the surface as well as the working parts. Generally, units in operation are frequently inspected, cleaned, painted and lubricated while idle units are often more or less neglected. Any degree of neglect is costly, especially if continued over a sufficient period of time to make restoration of the equipment impossible. It is recommended that preventive measures of protection be established and the following will guide you in the minimum requirement.

A. GENERAL

Preferably, units should be stored in clean, climatically controlled buildings. This would require the minimum inspection, but, since storage in older environments is sometimes necessary, more frequent inspections and additional protection is necessary. The schedule for inspection and protection can be determined only at the point of storage. A protection and storage log is recommended. Tropical areas require the maximum protection; arid regions require the least amount of protection. The frequency of inspection is determined after noting the rate of deterioration. Take positive action immediately when corrosion/erosion appears, do not wait until large areas are covered because usually the larger the area, the deeper the penetration.

B. RECOMMENDED PROTECTION INITIAL STORAGE

1. Drain all oil and thoroughly clean inside of Power Frame.
2. Coat pinion shaft oil seals with grease.
3. Remove breathers for later installation on pump. Seal all breather holes with greased solid pipe plugs. Remove extension rods and diaphragm sealing housing; be sure to protect the rods and housings, storing them separately for later installation on the pump. Seal diaphragms with wooden covers. “Mate” the wood cover and diaphragm faces together, thoroughly coating with Rust Veto 342 or its equivalent.
4. Spray two gallons of Shell VSI 100 vapor phase inhibitor or equivalent into power end of pump.
5. Remove valves and valve springs. Clean and wrap in corrosion inhibiting paper. Remove liners and pistons. Clean and wrap in corrosion inhibiting paper. Clean and dry fluid end bores and thoroughly coat all internal surfaces with Tectyl 506 or equivalent.
6. Thoroughly coat all threads and end of valve cover and screw into fluid end.
7. Protect all external machine surfaces using Rust Veto 342 or equivalent including pump pads.
8. Inspect complete pump and record all details on the Protection and Storage Log.

Storage of Pumps…

I. GENERAL (Continued)…

C. SIX MONTH SERVICING

1. Rotate pump.
2. Renew internal rust inhibitors to specifications and quantities previously stated under the “Initial Storage” section.
3. Before replacing top and side covers, inspect for any internal corrosion.
4. Inspect for soundness of external protection, i.e., rust preventative and paint. Renew as necessary.
5. Enter and record all details on the “Protection and Storage Log”.

D. PRE-INSTALLATION CHECK AFTER STORAGE

1. Repeat six month servicing procedure as stated above.
2. Ensure all necessary parts are complete and in a satisfactory condition for installation on pump.
3. Enter all records and close out the “Protection and Storage Log”.

Owners Record…

NAME _____

LOCATION _____

DATE OF DELIVERY _____ DATE PLACED IN OPERATION _____

PUMP MODEL _____

PUMP SIZE _____ SERIAL NO. _____

PRIME MOVER _____ SERIAL NO. _____

GEAR UNIT _____ SERIAL NO. _____

DRIVE:

DRIVE SHEAVE P.D. _____ DRIVEN SHEAVE P.D. _____ NO. OF GROOVES _____

BELT LENGTH _____ DRIVE SPROCKET _____ CHAIN SIZE _____

CHAIN LENGTH _____ COUPLING (MAKE) _____ COUPLING SIZE _____

PRESSURE _____ VOLUME _____ PUMP SPEED _____ DRIVE SPEED _____

PLUNGERS _____

PACKING _____

PISTONS _____

LINERS _____

VALVES _____

SEATS _____

LUBRICANTS:

CRANK CASE _____

FLUSHING SYSTEM _____

GEAR UNIT _____

LUBRICATOR _____

PRIME MOVER _____

COUPLING _____

NOTES _____

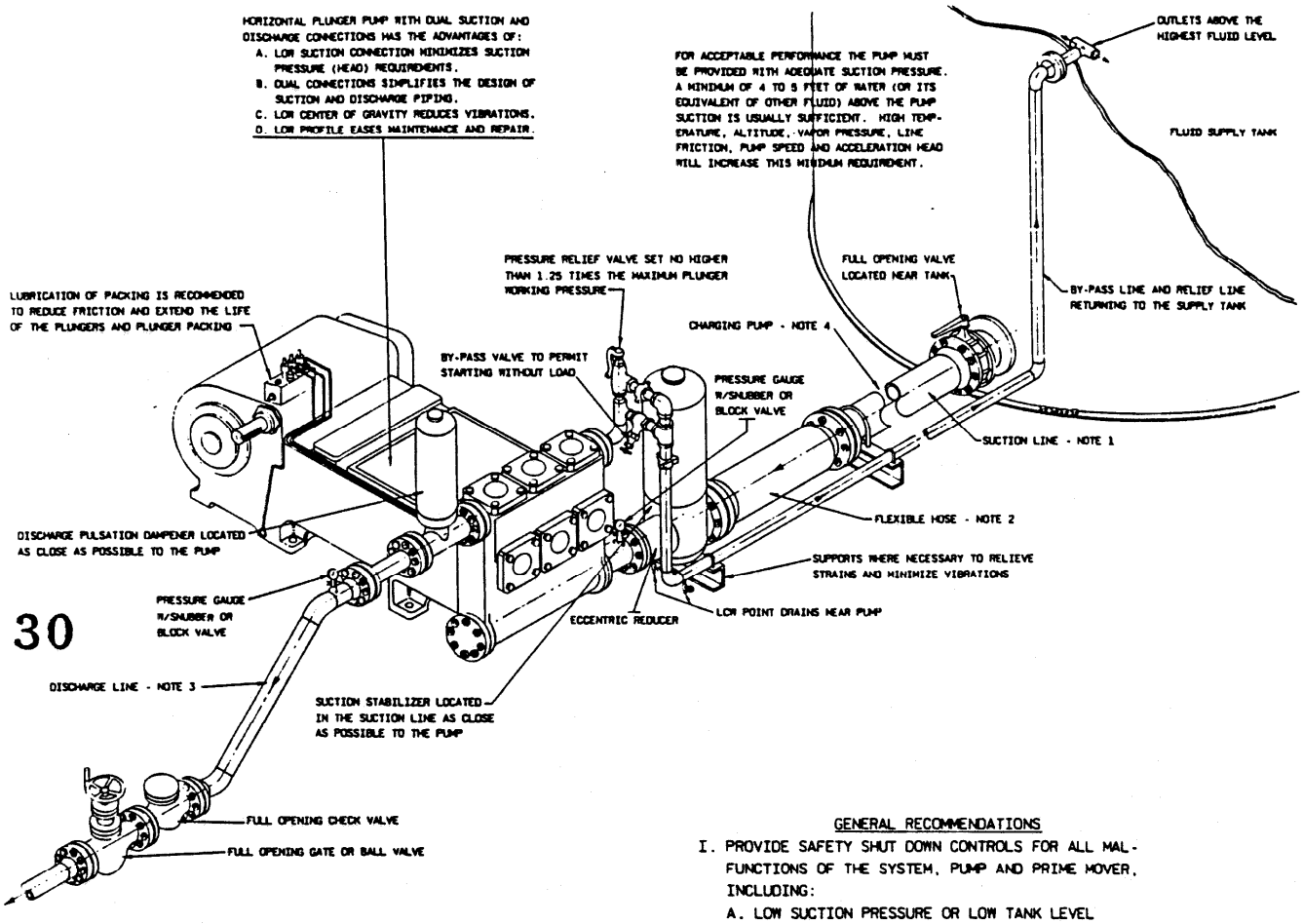
_____

_____

_____

All of the above entries are not applicable to a specific unit; therefore, completion of this form must be confined within the limits of each pump and the specified optional accessory equipment.

Typical Waterflood Pump Installation Suction and Discharge Piping Arrangement…



NOTES

1. A SEPARATE SUCTION LINE IS RECOMMENDED FOR EACH PUMP. THE LINE SHOULD BE A MINIMUM OF ONE SIZE LARGER THAN THE PUMP SUCTION FLANGE OR OPENING TO PROVIDE A MAXIMUM OF 1 TO 2 FEET/SECOND FLUID VELOCITY. IF BENDS ARE NECESSARY USE ONLY 45° LONG RADIUS ELLS. A SLOPE OF 1/4" PER FOOT FROM TANK TO PUMP IS RECOMMENDED.
2. A FLEXIBLE HOSE AND/OR EXPANSION JOINT IN THE SUCTION LINE (ALSO DISCHARGE LINE) PROVIDES FOR THERMAL EXPANSION AND TENDS TO DAMPEN VIBRATIONS.
3. DIRECT THE DISCHARGE LINE, USING 45° LONG RADIUS ELLS, TO GRADE OR BELOW GRADE LEVEL AS SOON AS POSSIBLE TO RELIEVE STRAIN AND REDUCE VIBRATIONS. THE LINE SIZE SHOULD BE SUFFICIENT NOT TO EXCEED A MAXIMUM FLUID VELOCITY OF 8 TO 10 FEET/SECOND.
4. IF CHARGING PUMP IS USED IT SHOULD BE LOCATED NEAR THE SUPPLY TANK. IN ITS SELECTION GIVE CONSIDERATION TO THE FLUID PUMPED, VELOCITY, PLUNGER PUMP VALVING, LINE FRICTION, ETC. SIZE CHARGE PUMP TO 1-1/2 TIMES RECIPROCATING PUMP VOLUME CAPACITY, MINIMUM.

GENERAL RECOMMENDATIONS

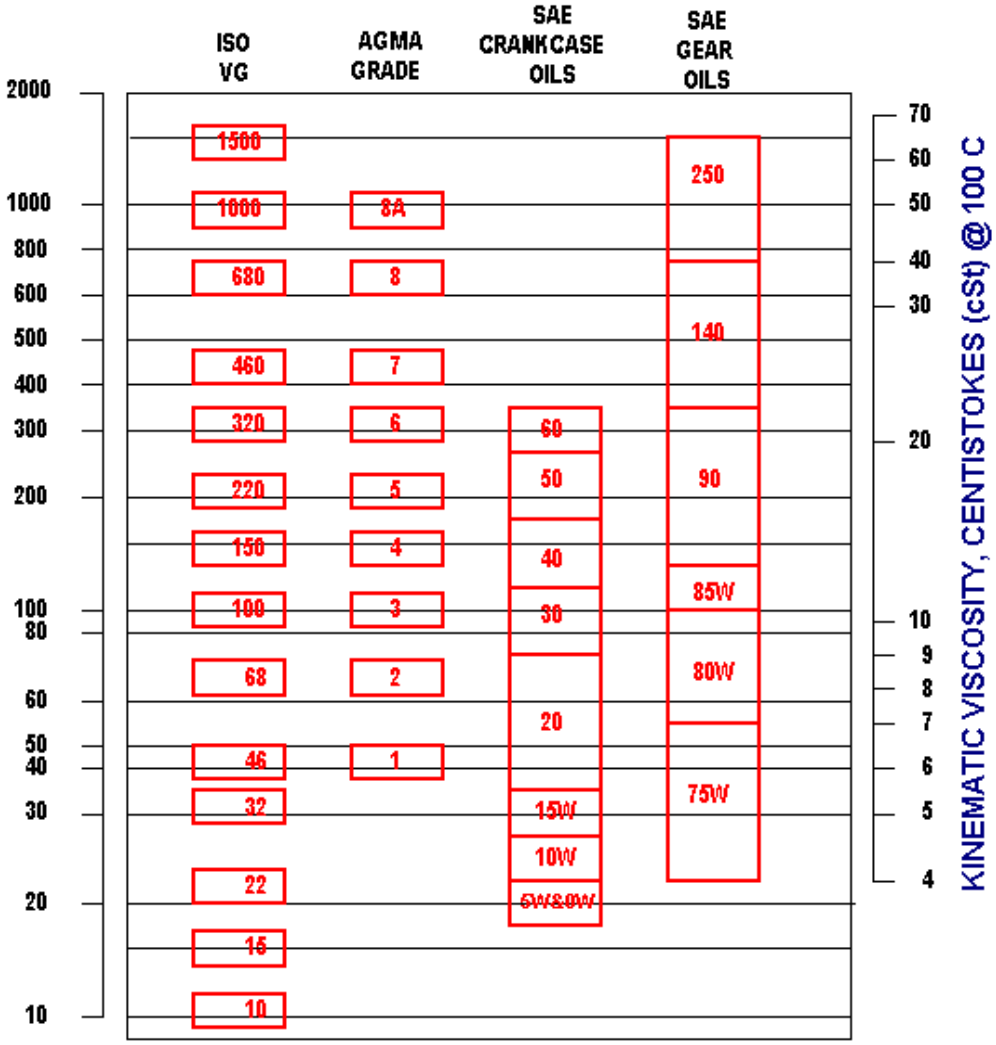
I. PROVIDE SAFETY SHUT DOWN CONTROLS FOR ALL MALFUNCTIONS OF THE SYSTEM, PUMP AND PRIME MOVER, INCLUDING:
   A. LOW SUCTION PRESSURE OR LOW TANK LEVEL
   B. LOW DISCHARGE PRESSURE
   C. HIGH DISCHARGE PRESSURE
   D. LOW OIL PRESSURE OR LOW OIL LEVEL
   E. HIGH TEMPERATURE, EXCESSIVE VIBRATIONS, OVERLOADING OF PRIME MOVER, ETC.

II. FOR SERVICING AND SAFETY PROVIDE ADEQUATE WORK AREA AROUND THE PUMP UNIT.

III. CARE AND OPERATIONS SHOULD INCLUDE CLEANLINESS, DAILY INSPECTIONS, PERIODIC INSPECTIONS, ROUTINE MAINTENANCE AND PREVENTIVE MAINTENANCE.

ISSUE DATE:			
NATIONAL - OILWELL			
TYPICAL WATERFLOOD PUMP INSTALLATION SUCTION & DISCHARGE PIPING ARRANGEMENT			
	SIZE	DRAWING NO.	REV
	C	GSK-3886P	

Viscosity Equivalents...



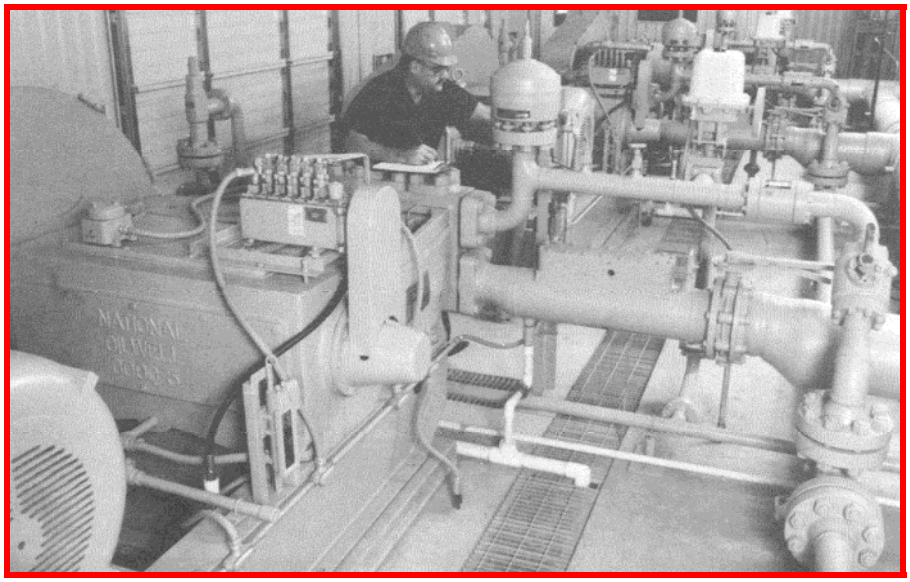
NOTES:

*Assumes 100 VI single grade oils. Read across horizontally.
*SAE grades based upon viscosity at 100 C. ISO and AGMA grades based upon viscosity at 40 C
*Equivalence is in terms only of viscosity. Quality requirements are a separate consideration.
*Viscosity limits are approximate: For precise data, consult ISO, AGMA and SAE specifications.
*W grades define only in terms of 100 C viscosity. For low temperature limits, consult SAE specifications.

*ISO = International Standardization Organization
*AGMA = American Gear Manufacturers Association
*SAE = Society of Automotive Engineers

Notes and Comments:

NATIONAL OILWELL VARCO



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