TWS600S WELL SERVICE PLUNGER PUMP

Generic Operation Instruction and Service Manual

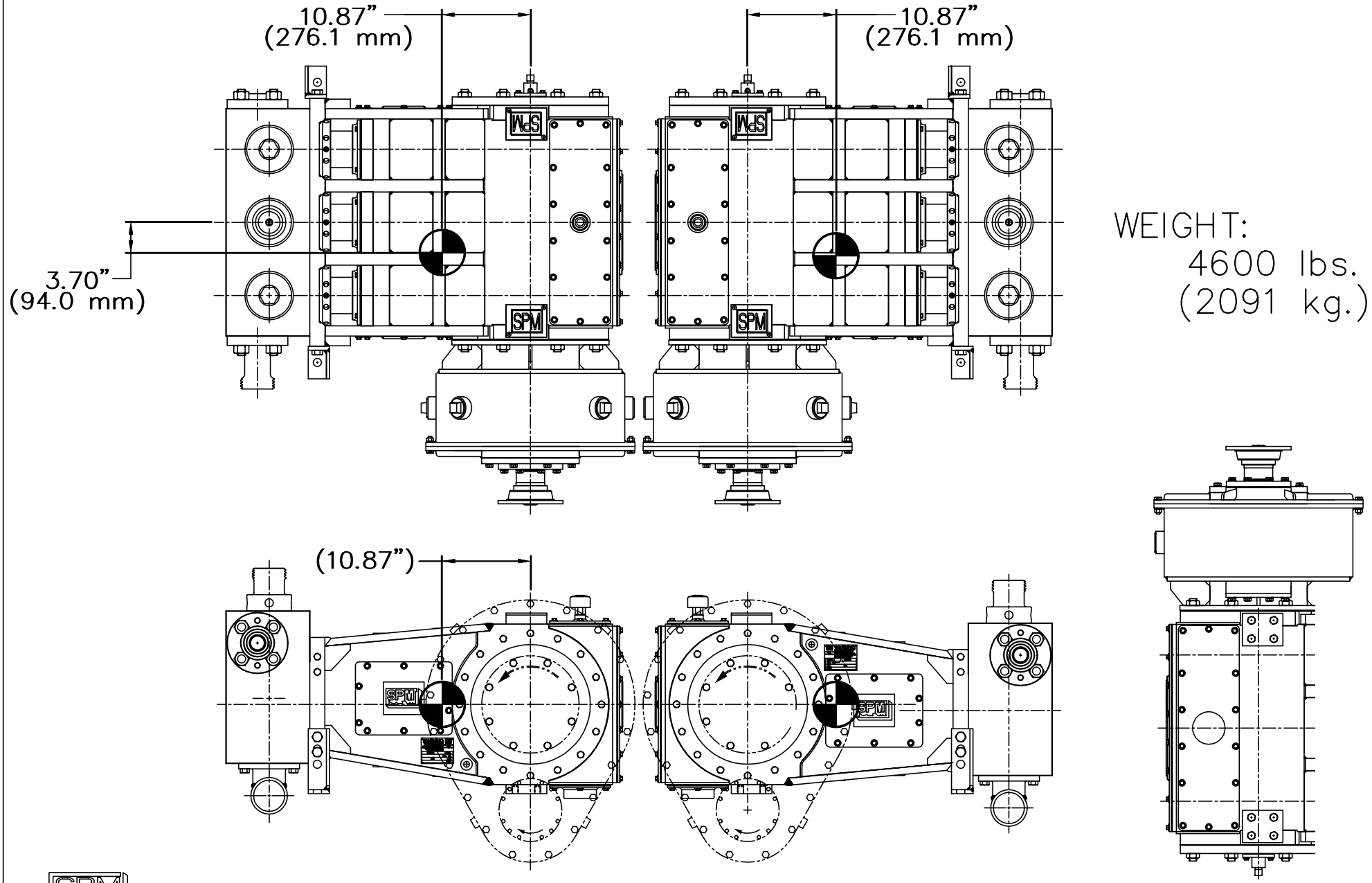
Customer Warning:

The contents of this manual are intended to be a general guide for the proper use and maintenance of the product, and provide general specifications regarding component parts and installation procedures. Be aware that individual pumps vary per customer specification. Each pump manufactured by Weir SPM is assigned a manual that is specific for that pump (by serial number). This manual is NOT a serialized manual and is not intended to be a replacement for the manual that comes with an ordered pump. Please contact Weir SPM Sales or Engineering with the serial number of the pump to obtain the specific manual provided for product.

P/N: 4S113972

Release Date: 07/01/2010

LOCATION OF CENTER OF GRAVITY IS APPROXIMATE



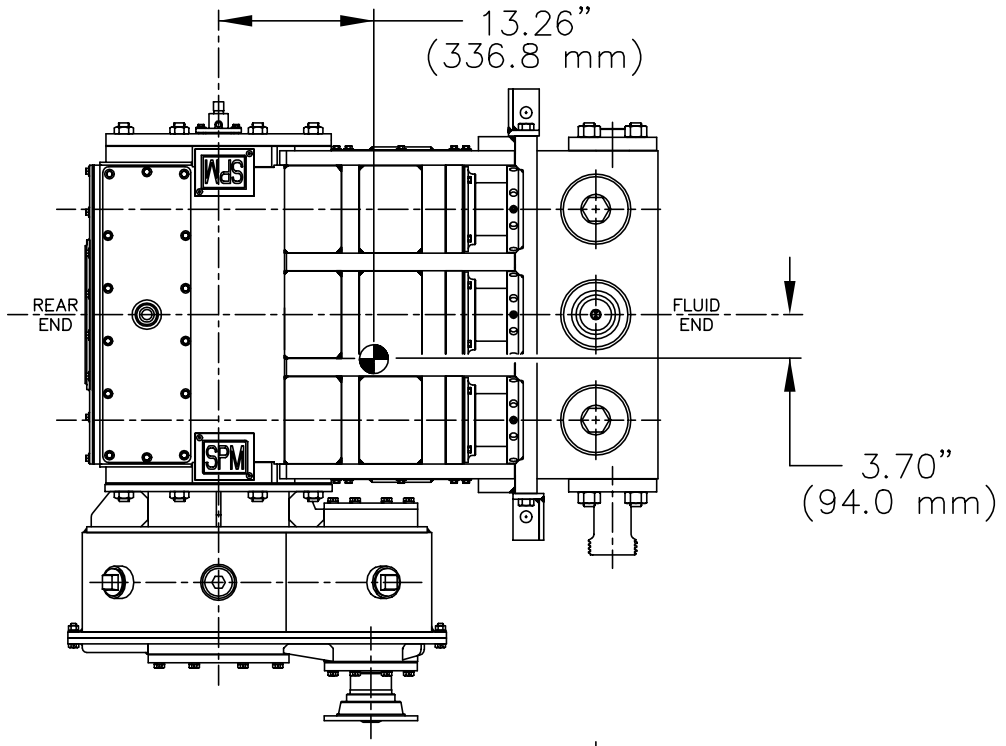
WEIGHT:
4600 lbs.
(2091 kg.)

SPM

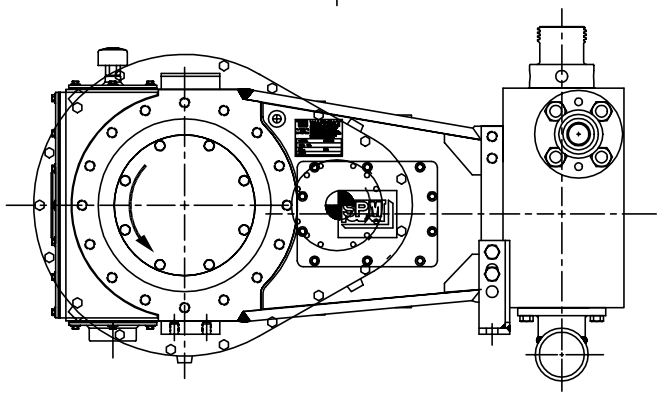
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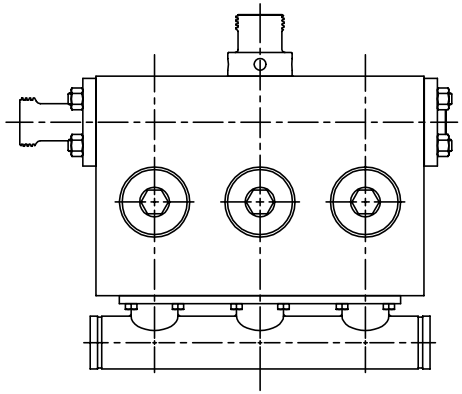
NOTES:

1. GEAR POSITION MAY BE MOUNTED IN ANY POSITION IN 22.5° INCREMENTS
2. DIMENSIONS IN IN.(MM)



WEIGHT : 4,600 lbs.
(2091 kg.)





ITEM	QTY	PART NO	DESCRIPTION

DO NOT SCALE DRAWING

UNLESS OTHERWISE NOTED DIMENSIONS ARE IN INCHES

SPM 7601 WYATT DRIVE FT WORTH TEXAS 76108-2587

linear tol	
fractional	±1/32
.XX	±.01
.XXX	±.005
Angular tol	±30'

All diameters concentric to .010 unless otherwise noted

125 surface roughness all machined surfaces

Scale: 3/32
Date: 6/24/97
Drawn by: JAS
Approved: MDM
Description:

CENTER OF GRAVITY
600 H.P. SHORT PUMP

SHEET 1 OF 2

Material:

Drawing No: 4S104370

REV.	DESCRIPTION	BY	Date

SPM PRODUCT SAFETY GUIDE
FOR
WELL SERVICE PUMPS

It is critical that, since most SPM products generate, control or direct pressurized fluids, those who work with these products be thoroughly trained in their proper application and safe handling. It is also critical that these products be used and maintained properly.

!! WARNING !!

MISUSE, SIDE LOADING, IMPROPER MAINTENANCE, OR DISASSEMBLY UNDER PRESSURE CAN CAUSE SERIOUS INJURY OR DEATH!

The following information is given in good faith and should aid in the safe use of your SPM products. This information is not meant to replace existing Company's safety policies or practices.

1. Hot Surfaces:
   SPM Well Service Pump is capable of pumping fluids with temperatures up to 100C with normal trim. It is the responsibility of the packager to provide adequate guarding around the fluid end as well as the inlet and discharge piping to protect against burn injury.

2. The SPM Well Service Pump operates at very high pressure and features some external moving parts. It is the customer's responsibility to provide adequate warning and protection for personnel for when the unit is operated.

<u>Personal Responsibilities</u>:

A-1 When working on the pump, safety glasses, approved safety shoes and hard hat must be worn. Hammering on any part or component may cause foreign material or steel slags to become airborne.

A-2 Personnel should only hammer on the SPM hammer wrench provided and never directly on the pump itself. Fractures can occur from repeated misuse. Only soft-type hammers should be used.

A-3 Personnel should never hammer on one of the valve retainer nuts or any other pump components when pressure is present.

Personal Responsibilities (Con't):

A-4 When servicing the pump, do not lift any part in excess of 40 lbs. A lift device must be used in these cases. For parts weighting 40 lbs. or less, proper leg type lifts are essential. Do not lift with a back type lift.

A-5 It is a personal responsibility to use the proper tool when servicing the pump. Any special tools required are furnished with the pump when new, and should be kept with the pump for its routine maintenance. It is a personal responsibility to be knowledgeable and trained in the use and handling of these tools for all maintenance of the pump. A pump is made up of internal and external moving parts. All personnel should be located away from the pump while in operation. Only trained personnel should be around the pump, especially during service or operation.

On Location:

B-1 Each pump is clearly marked with a maximum pressure rating. This pressure must not be exceeded or SERIOUS INJURY OR DEATH CAN OCCUR!

B-2 Each pump is clearly marked with a maximum horsepower rating. This horsepower rating should not be exceeded or mechanical damage can occur leading to SERIOUS INJURY OR DEATH!

B-3 The pump's discharge connections should be properly cleaned and lightly oiled before the downstream piping is attached. Any worn, damaged or missing seals should be replaced before engaging the pump's drive.

B-4 The pump's suction connections should be properly cleaned and lightly oiled before the supercharge hoses are attached. Any worn, damaged or missing seals should be replaced prior to pumping. Leaking connections can cause pump cavitation leading to equipment failure and subsequent injury or death.

B-5 Any fluid cylinder which has been pressured beyond its specified working pressure should be returned to SPM for disassembly, inspection and recertification.

B-6 **Welding, brazing or heating any part of the pump is prohibited**. If accessories are to be attached, they are to be bolted or clamped on. Consult factory.

On Location (Con't):

B-7 The use of any SPM well service pump in conjunction with the centrifugal supercharge pump feeding it will limit the maximum flow rating to that of the centrifugal or the well service pump; whichever is lower.

B-8 A complete visual inspection of the pump's power end and fluid end must be made prior to each use. Any leaking seals, broken bolts, leaking hoses or improperly tightened parts must be remedied prior to rotating the pump.

B-9 If a pump is used in a place where permanent piping is to be attached, frame flexing or structure movements must be considered. Do not place the discharge or suction connections in a bind. Inspect all components of such piping structure, including any valves, every 90 days for wash, erosion, corrosion, etc. Replace if worn.

B-10 SPM well service pumps are to be installed and operated in a horizontal position only, as shown in the pump's service manual. Operation in an extreme inclined position could cause equipment failure, leading to injuries due to improper oil flow and/or improperly sealing valves.

B-11 Any repairs or service (even routine maintenance) performed on the pump must be performed by a trained service technician who is qualified to work on high pressure reciprocating plunger pumps. All such service and repairs must be supervised by qualified management personnel or returned to SPM for service. Only SPM replacement parts should be utilized. Failure to do so may result in loss of warranty as well as serious injury or death. SPM provides a Pump Maintenance Mechanic Training School to qualify pump service mechanics.

B-12 SPM well service pumps should never be used to pump gaseous, explosive or uninhibited corrosive fluids. These may result in equipment failure, leading to injury or death.

B-13 Never place hands in area of reciprocating pony rod or plunger path. If work must be done in this area, make sure pump is disengaged from driver prior to initiating activity.

Special Precautions:

C-1 The modifications to or unauthorized repair of any part of an SPM pump, or use of components not qualified by SPM, can lead to pump damage or failure and serious injury or death!

C-2 The pump's fluid end and related piping must always be flushed with clean water after every job. If freezing temperatures are anticipated the fluid cylinder must be completely drained of any fluid. Failure to do this may result in fluid cylinder damage from fluids which have hardened or frozen.

C-3 All SPM threaded components are right hand threaded unless specifically designated otherwise. Any turning counterclockwise will unscrew the assembly. Always make sure any threaded component is made up properly with the proper power torque make-up.

C-4 All products should be properly cleaned, greased or oiled after each use and inspected prior to each use.

C-5 Pressure seal (line pipe) threads are not recommended for pulsating service above 10,000 psi or where side loading or erosion are suspected. Non-pressure seal (round tubing) threads or straight integral connections are recommended under these conditions. In order to achieve the recommended Non-Shock Cold Working Pressure, power-tight make-up is required on threaded connections. Consult the factory for any usage other than normal constant flow working conditions. Integral connections are recommended in lieu of pipe threaded connections for pump applications.

C-6 Each integral union connection is clearly marked with a pressure code (i.e. “1502”, 15,000 psi). This pressure must not be exceeded. This code should also be used with mating unions. Improper mating can result in failures. All integral union connections used must match (according to size, pressure rating, etc.). These connections must also match the service of the designated string they are installed in.

Inspection & Testing:

D-1 Each pump, its drive system, and its fluid piping should be visually checked each time before operating. All worn, damaged or missing parts should be remedied before starting the pump.

D-2 All fluid cylinder mounting nuts must be checked routinely with a certified torque wrench. Loose fluid cylinder mounting nuts can cause the fluid end to separate from the power end resulting in extreme injury or death.

D-3 All studs and stay rods require tightening to the proper torque. Without proper torque, the fluid end will "breathe" against the power end resulting in stud failure, stay rod failure and/or even premature fatigue failure in the power or fluid end. Consult SPM for torque information.

D-4 All covers must be tight and properly torqued. Otherwise, premature fatigue and possible fluid end or component failure can result.

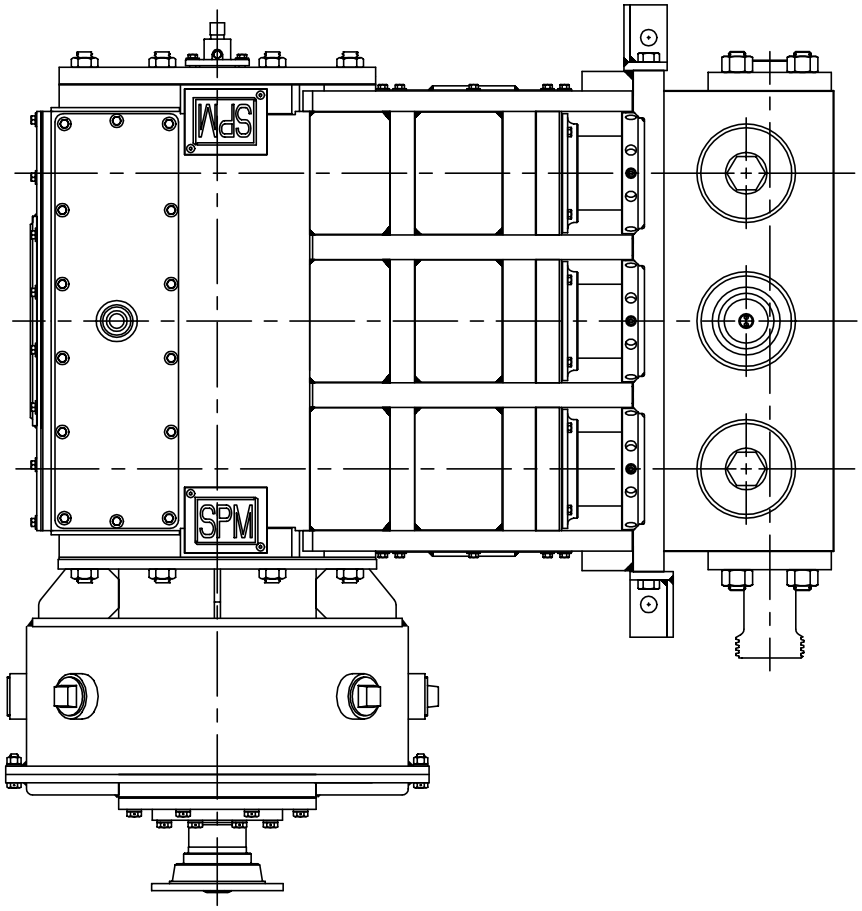
D-5 All fluid cylinders must be disassembled and dimensionally inspected routinely. Any fluid cylinder which exhibits any loss in wall thickness due to washing or corrosion pitting in any area must be returned to SPM for repair and recertification prior to operating again.

D-6 All fluid cylinders must be disassembled and inspected for cracks with a suitable ultraviolet light/magnetic particle inspection device on a routine basis. The operation of any pump with even small surface cracks in any area of the fluid cylinder can result in serious injury or death.

D-7 All fluid cylinders should be hydrostatically tested at least twice each year by a qualified technician. Prior to any pressure testing, all air must be evacuated from the system. Failure to do so could result in PERSONAL INJURY OR DEATH! The maximum test pressure must not exceed the equipment's rated working pressure. The hydrostatic pressure test must be followed with an ultraviolet light/magnetic particle inspection of the internal bores prior to reinstalling and operating under pressure.

92 DB(a)

95 DB(a)



93 DB(a)

98 DB(a)

MEASUREMENTS TAKEN AT FULL POWER AND ONE (1) METER REMOVED FROM UNIT.

SOUND INFORMATION

NEWGRAV6

ATEX Requirements for Equipment Marking
Paragraph 14.1 of EN 13463-1

- **The Markings shall include:**
  - **The name and address of the manufacturer:**

    SPM Flow Control
    7701 Skyline Drive
    Fort Worth, TX 76108

  - **The manufacturers type identification:**

    TWS600s

  - **The year in which the equipment was constructed:**

    See marking on Pump Assembly.

  - **The symbol of the equipment group, category, and anticipated potentially explosive atmosphere type:**

    II 2G

  - **Ignition protection type used and maximum surface temperature:**

    c 100ºC

  - **Serial Number:**

    See markings on Pump Assembly

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Section I

GENERAL INFORMATION

TWS600S PUMP DESCRIPTION

The SPM TWS600S is a reciprocating, positive displacement, horizontal single-acting, triplex plunger pump that is rated at 600 Brake Horsepower input maximum. The TWS600S is designed for intermittent duty well service applications such as acidizing, cementing, fracturing, well killing, gravel packing, etc.

The TWS600S Pump consists of a Power End/Speed Reducer Assembly and a Fluid End Assembly. The Speed Reducer can be installed on either the right hand or left hand side of the pump and can be installed in any one of 17 different input shaft locations to accommodate a number of different pumping unit drive train configurations. Two different fluid cylinders are available to accommodate several plunger sizes for a variety of pressures and volumes.

Optional packing assemblies, valve assemblies, discharge flanges, suction manifolds, etc. are available for a wide variety of unitization arrangements; for the pumping of various specific fluids; and for service in a wide range of ambient conditions. The weight of the pump will vary slightly depending on plunger size and other options but will not vary more than plus or minus 5% of the advertised weight.

The SPM TWS600S basic design and construction details are as follows:

A. Power End Design:

Housing.....	Fabricated steel/stress relieved, line bored.
Crankshaft.....	Machined from one-piece heat treated alloy steel forging. Precision ground vcb journals. Supported by four heavy duty cylindrical main roller bearings.
Connecting Rods.....	Precision machined from high strength, "I-Beam" style ductile iron casting.
Crossheads.....	Precision machined from high strength ductile iron semi-cylindrical casting.
Crosshead Slides.....	Replaceable, semi-cylindrical design. Precision machined from iron casting.
Wrist Pins.....	Precision machined from heat treated alloy steel.
Lubrication.....	Equipped for pressurized lubrication to all moving parts. "Dry Sump" type system .

TWS600S PUMP DESCRIPTION (Con't)

B. Speed Reducer Design:

Housing.....	Fabricated steel/stress relieved, line bored. Parallel shaft type design.
Bull Gear.....	High horsepower AGMA #8 quality helical type gear. Precision machined from high strength alloy steel casting. Induction hardened gear teeth. Supported by two (2) heavy duty tapered roller bearings.
Pinion Gear/Input Shaft.....	High horsepower AGMA #8 quality helical type gear integrally machined on heat treated alloy steel shaft. Induction hardened gear teeth. Supported by two (2) heavy duty tapered roller bearings. Equipped w/Spicer 1800/1810 series companion flange.
Gear Ratio.....	4.61:1 ratio allows direct drive from a 2100 RPM diesel engine/powershift transmission without over-speeding the pump.
Lubrication.....	Equipped for pressurized lubrication to all moving parts. "Dry Sump" type system.

C. Fluid End Design:

Fluid Cylinder.....	Low maintenance "Valve Over Valve" monoblock design. Precision machined from high strength one-piece alloy steel forging.
Plungers.....	Machined from steel w/precision ground hard overlay (60 Rc) acid resistant packing surface.

TWS600S PUMP DESCRIPTION (Con't)

C. Fluid End Design (Con't):

Plunger Packing.....	"Self-adjusting" type packing assemblies. Precision molded fiber reinforced V-type pressure rings. Supported by precision machined bronze adapter rings. Various compositions available for all common well service fluid media such as hydrochloric acid, cement, frac sand slurries, hydrocarbons, toluene, etc. and a wide range of ambient temperatures and fluid temperatures.
Valve Assemblies.....	Wing guided well service type valves w/replaceable urethane or neoprene inserts. Tapered well service type valve seats w/auxiliary seal ring.
Valve Springs.....	Long lasting coil springs engineered for a wide range of well service applications. Designed for spring rates, installed spring loads, and valve cracking pressures unique to well service pumps.
Suction Valve Keepers.....	Low fluid restriction type keepers located out of the high stress plane of the fluid cylinder.
Discharge Flanges.....	Dual outlet (RH & LH) design. Replaceable type discharge flanges precision machined from heat treated alloy steel. Available in male or female with a variety of common well service connections such as LPT and integral hammer union thread connections.
Suction Manifold.....	Dual inlet (RH & LH) design. Replaceable type manifold fabricated from steel, precision machined, and pressure tested. "Quick Disconnect" victaulic "ES" connections on both ends.

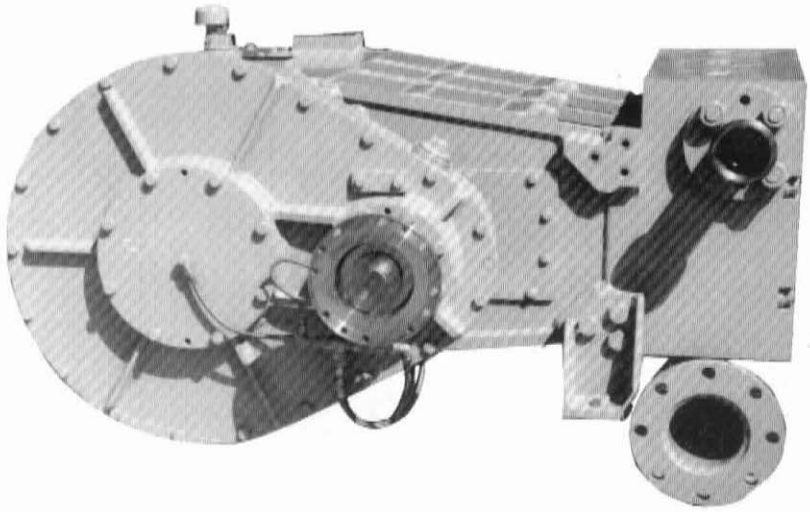
TWS600S PUMP DESCRIPTION (Con't)

C. Fluid End Design (Con't):

Fluid Seals.....	Precision molded high pressure acid resistant fluid seals made from a superior Polyurethane/Molydisulfide seal compound.
Packing Lubrication.....	Equipped for a pressurized oil base packing lube system.

SPM Model TWS 600S PLUNGER PUMP

Rated Max. Brake Horsepower .....600 BHP (447 Kw)
Maximum Rod Load.....100,000# (43,360 kg)
Stroke Length.....6" (152.4 mm)
Gear Ratio.....4.6:1



Length.....50.25" (1276 mm)
Width.....52.93" (1344 mm)
Height.....23.88" (607 mm)
Weight Dry (Approx.).....4,600# (2086 kg)

Performance Data*

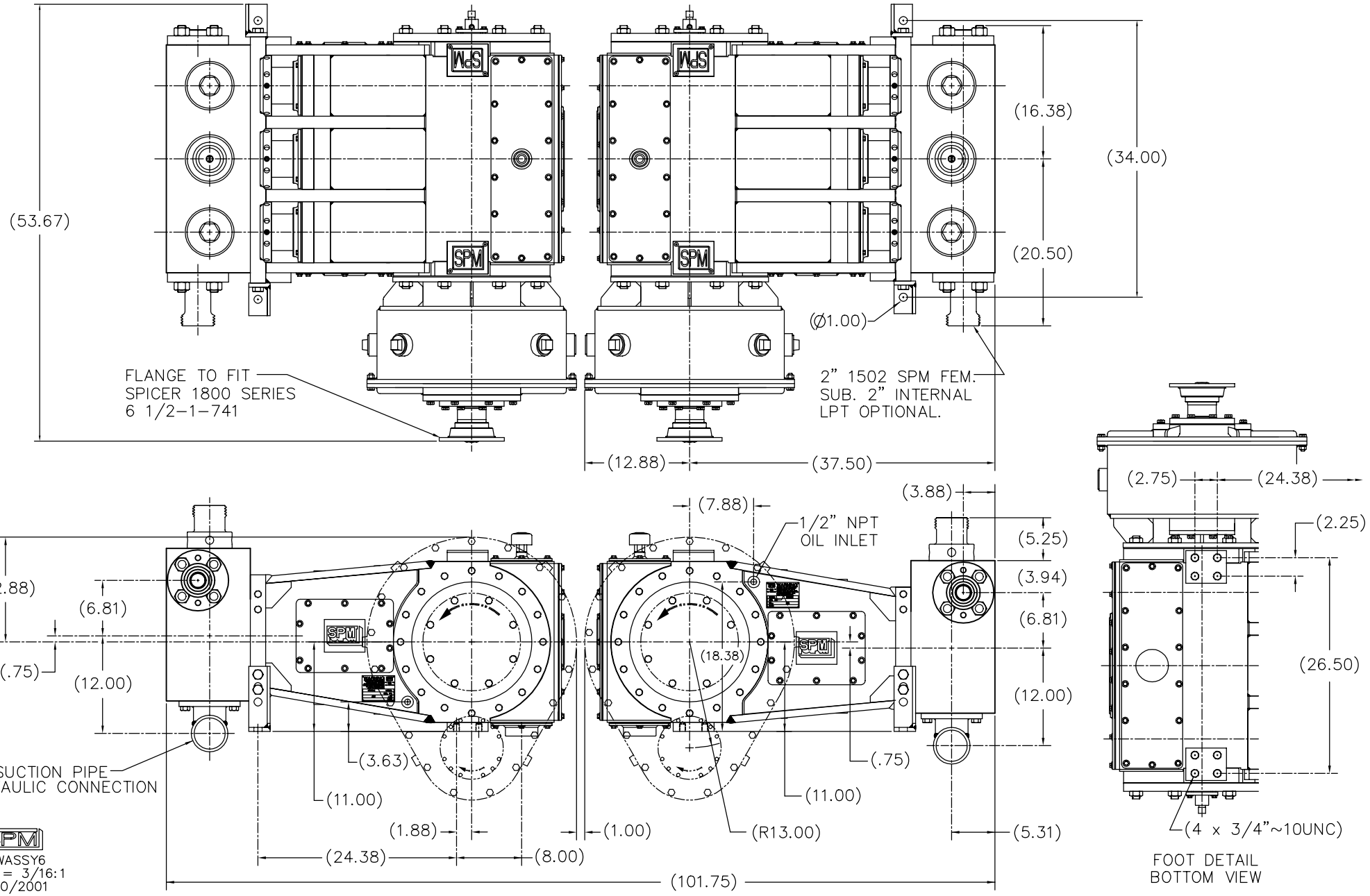
PLUNGER DIAMETER	OUTPUT PER REV	DISPLACEMENT AT PUMP STROKES PER MINUTE / PINION RPM									
		50 / 230		120 / 552		200 / 920		300 / 1380		450 / 2070	
in (mm)	gal/rev (liter/rev)	gpm (lpm)	psi (kg/cm²)	gpm (lpm)	psi (kg/cm²)	gpm (lpm)	psi (kg/cm²)	gpm (lpm)	psi (kg/cm²)	gpm (lpm)	psi (kg/cm²)
2½ (63.5)	.38 (1.4)	19 (72)	20,372 (1436)	46 (174)	20,165 (1421)	76 (290)	12,099 (853)	115 (434)	8,066 (568)	172 (651)	5,377 (379)
2¾ (69.9)	.46 (1.8)	23 (87)	16,836 (1186)	56 (210)	16,665 (1174)	93 (350)	9,999 (705)	139 (526)	6,666 (470)	208 (788)	4,444 (313)
3 (76.2)	.55 (2.1)	28 (104)	14,147 (997)	66 (250)	14,003 (987)	110 (417)	8,402 (592)	165 (625)	5,601 (395)	248 (938)	3,734 (263)
3½ (88.9)	.75 (2.8)	37 (142)	10,394 (732)	90 (341)	10,288 (725)	150 (568)	6,173 (435)	225 (851)	4,115 (290)	337 (1277)	2,744 (193)
4 (101.6)	.98 (3.7)	49 (185)	7,958 (561)	118 (445)	7,877 (555)	196 (741)	4,726 (333)	294 (1112)	3,151 (222)	441 (1668)	2,100 (148)
4½ (114.3)	1.24 (4.7)	62 (235)	6,288 (443)	149 (563)	6,224 (439)	248 (938)	3,734 (263)	372 (1407)	2,489 (175)	558 (2111)	1,660 (117)
INPUT POWER: **BHP** *(Kw)*		**253** *(188)*		**600** *(448)*		**600** *(448)*		**600** *(448)*		**600** *(448)*	

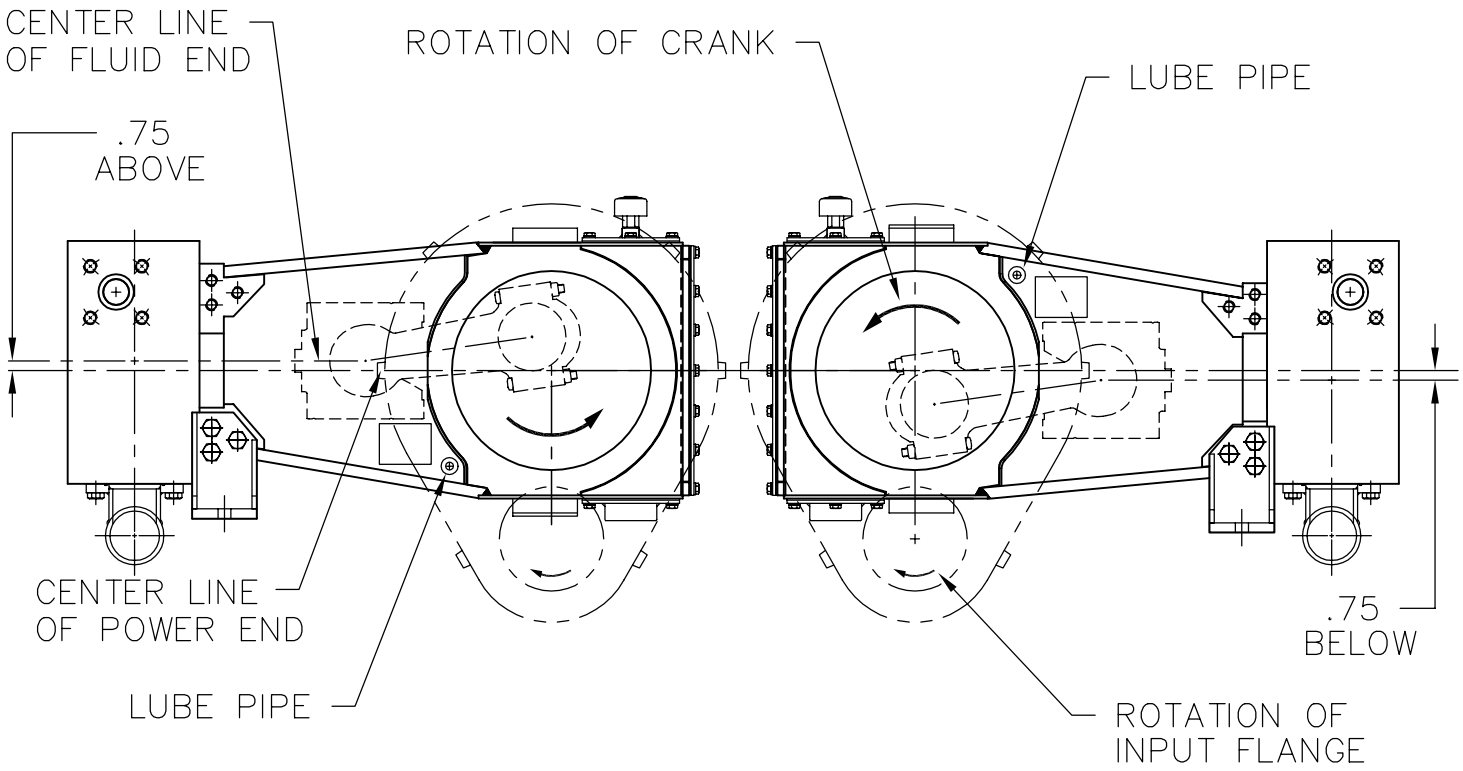
*Based on 90% ME and 100% VE - Intermittent Service Only.

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BROUSSARD: 3535 Hwy. 90 East • Broussard, Louisiana 70518 • U.S.A. • Phone: (337) 837-3161 • Fax: (337) 837- 8171
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INTERNET:
www.spmflo.com

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(53.67)
(16.38)
(34.00)
(20.50)
(Ø1.00)
FLANGE TO FIT
SPICER 1800 SERIES
6 1/2-1-741
2" 1502 SPM FEM.
SUB. 2" INTERNAL
LPT OPTIONAL.
(12.88)
(37.50)
(3.88)
(7.88)
1/2" NPT
OIL INLET
(5.25)
(3.94)
(6.81)
(12.00)
(12.88)
(6.81)
(.75)
(12.00)
(18.38)
4" SUCTION PIPE
VICTAULIC CONNECTION
(3.63)
(11.00)
(.75)
(11.00)
(1.88)
(1.00)
(R13.00)
(5.31)
(24.38)
(8.00)
(101.75)
(2.75)
(24.38)
(2.25)
(26.50)
(4 x 3/4"~10UNC)
FOOT DETAIL
BOTTOM VIEW
SPM
NEWASSY6
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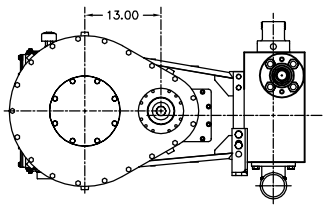
CRANK ROTATION ILLUSTRATION BASED ON
ORIENTATION OF FLUID END AND LUBE PIPE

THE TWS 600–S PUMP IS A UNI–DIRECTIONAL PUMP. CARE MUST BE TAKEN TO ENSURE THAT THE PUMP CRANKSHAFT TURNS IN THE DIRECTION WHICH CAUSES THE LOADED POWER STROKE TO OCCUR AT THE SMALLEST MAXIMUM CONNECTING ROD ANGLE.
THE PUMP CRANK MUST ALWAYS TURN IN THE DIRECTION AWAY FROM THE LUBE PIPE, TOWARD THE REAR OF THE PUMP, AS SHOWN IN THE ABOVE ILLUSTRATION.

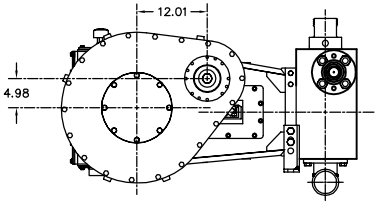
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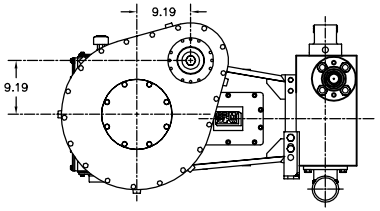
1. ALL POSITIONS USE 600 SHORT GEAR BOX 1A103336 EXCEPT POSITION #17 WHICH REQUIRES 600 STANDARD GEAR BOX 1A100128.



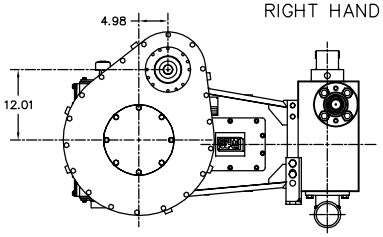
RIGHT HAND 1



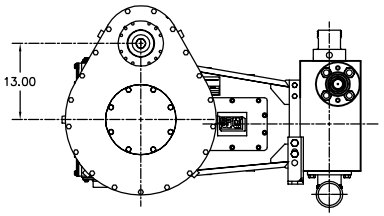
RIGHT HAND 2



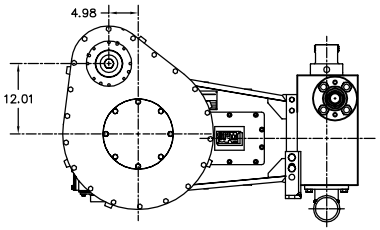
RIGHT HAND 3



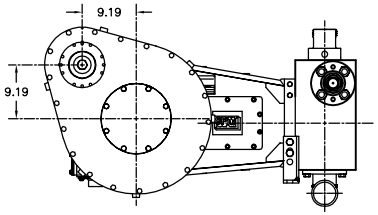
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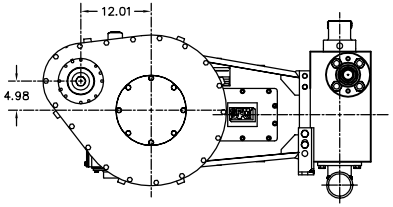
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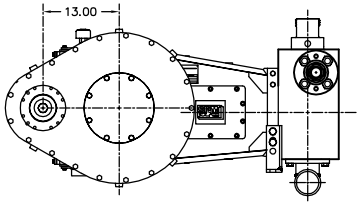
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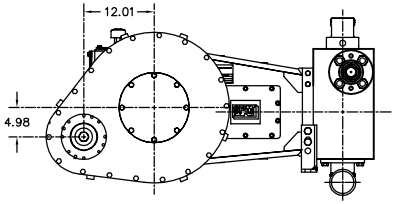
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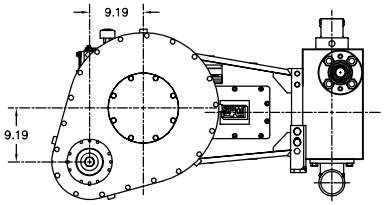
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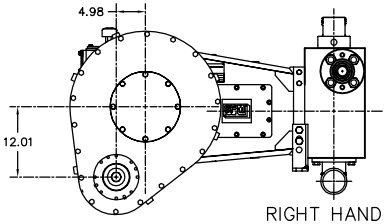
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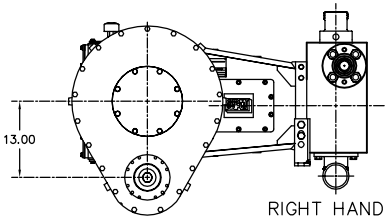
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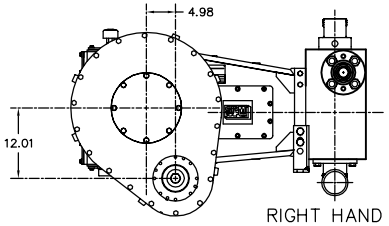
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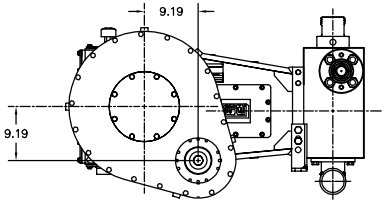
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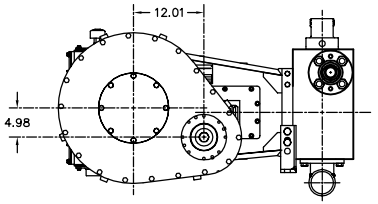
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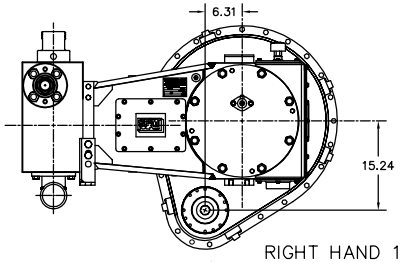
RIGHT HAND 14



RIGHT HAND 15



RIGHT HAND 16



RIGHT HAND 17
(600 STD GEAR BOX ONLY)

600 SHORT PUMP RIGHT HAND

ITEM	QTY	PART NO	DESCRIPTION

DO NOT SCALE DRAWING

UNLESS OTHERWISE NOTED DIMENSIONS ARE IN INCHES

SPM

7601 WYATT DRIVE
FT WORTH TEXAS 76108-2587

linear tol	
fractional	±1/32
.XX	±.01
.XXX	±.005
Angular tol	±.30'

All diameters concentric to .010 unless otherwise noted

Scale: .09:1
Date: 3/20/98
Drawn by: DPH
Approved: MDM

Description:
GEAR BOX INSTALLATION POSITIONS
600 SHORT PUMP

SHEET 1 OF 2

REV.	DESCRIPTION	BY	Date

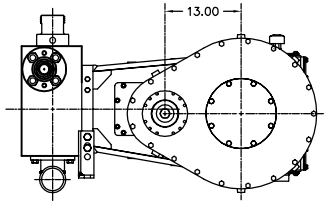
125 surface roughness all machined surfaces

Material:

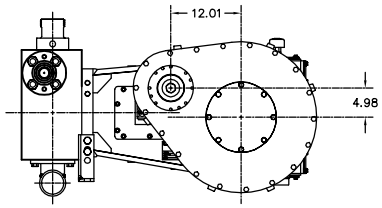
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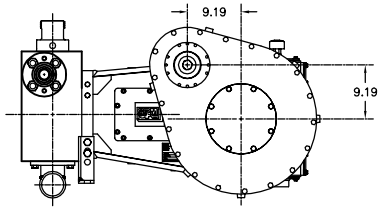
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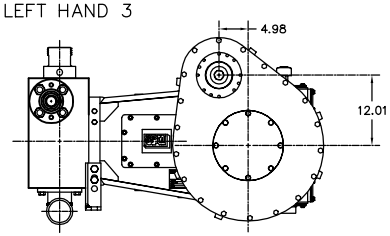
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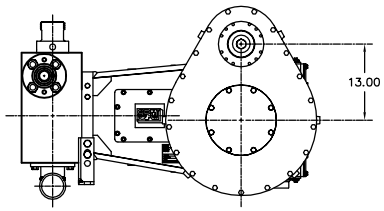
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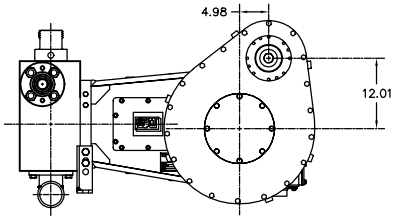
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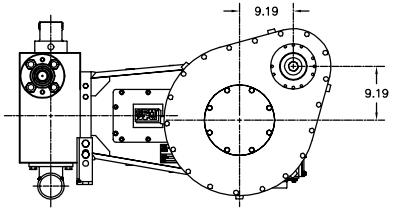
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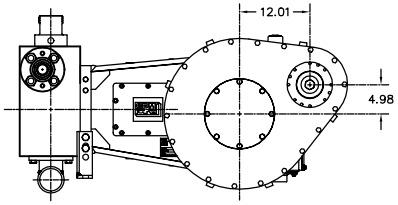
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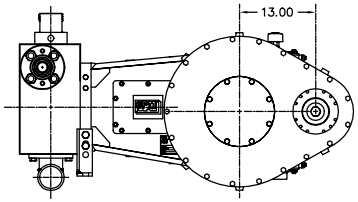
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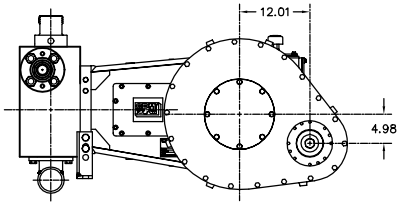
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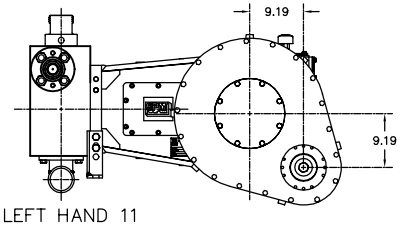
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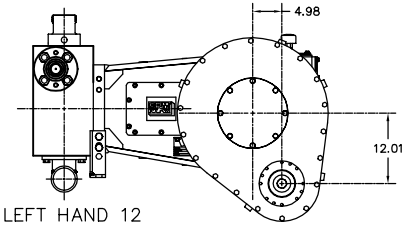
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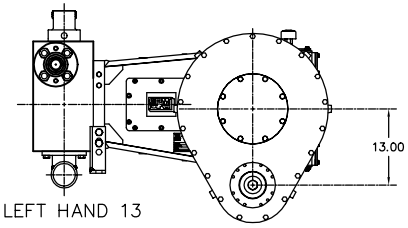
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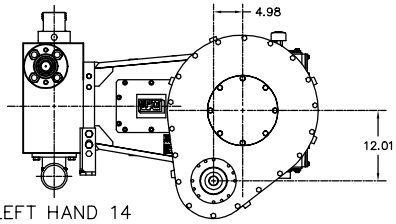
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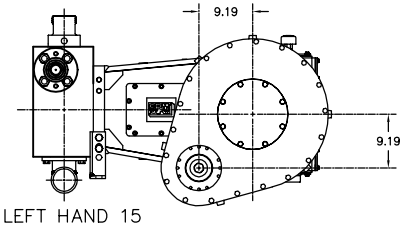
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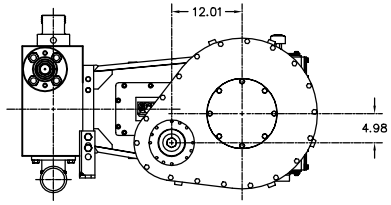
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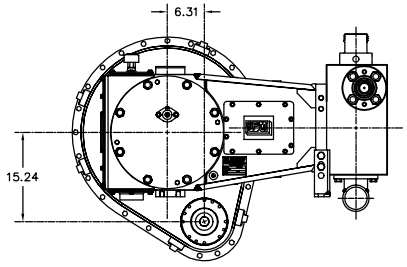
LEFT HAND 14



LEFT HAND 15



LEFT HAND 16



LEFT HAND 17
(600 STD GEAR BOX ONLY)

600 SHORT PUMP LEFT HAND

ITEM	QTY	PART NO	DESCRIPTION

DO NOT SCALE DRAWING

UNLESS OTHERWISE NOTED DIMENSIONS ARE IN INCHES

linear tol	
fractional	±1/32
.XX	±.01
.XXX	±.005
Angular tol	±.30'

All diameters concentric to .010 unless otherwise noted

SPM
7601 WYATT DRIVE
FT WORTH TEXAS 76108-2587

Scale: .09:1
Date: 3/20/98
Drawn by: DPH
Approved: MDM

Description:
GEAR BOX INSTALLATION POSITIONS
600 SHORT PUMP

SHEET 2 OF 2

Material:

Drawing No: 3L106032

REV.	DESCRIPTION	BY	Date

125 surface roughness all machined surfaces

TACH DRIVE/RATE METER CALIBRATION SPECIFICATIONS
SPM TWS500 LW/TWS600/TWS600S

PLUNGER DIAMETER INCHES (MM)	* FLUID DISPLACEMENT					
	PER TACH DRIVE REVOLUTION @ 95% V.E.			PER TACH DRIVE REVOLUTION @ 100% V.E.		
	GPR	BPR	LPR	GPR	BPR	LPR
2½" (63.5)	.0726	.00177	.2747	.0764	.00187	.2892
2¾" (69.9)	.0879	.00209	.3328	.0926	.00220	.3504
3" (76.2)	.1047	.00249	.3961	.1102	.00262	.4170
3½" (88.9)	.1424	.00339	.5391	.1499	.00357	.5675
4" (101.6)	.1860	.00443	.7042	.1958	.00466	.7413
4½" (114.3)	.2355	.00561	.8912	.2479	.00590	.9382

NOTE: THE VOLUMETRIC EFFICIENCY AND RESULTING DISPLACEMENT WILL VARY SLIGHTLY DUE TO OPERATIONAL FACTORS SUCH AS PUMP SPEED, SUPERCHARGE CONDITIONS, AND THE SPECIFIC GRAVITY OF THE FLUID BEING PUMPED.

V.E. = VOLUMETRIC EFFICIENCY OF PUMP
GPR = U.S. GALLONS PER REVOLUTION
BPR = U.S. BARRELS PER REVOLUTION
LPR = LITER PER REVOLUTION

USEFUL PUMP DATA FORMULAS

A. Definition of Symbols Used:

A - Area (sq. in.)
BHP - Brake horsepower
BPM - Barrels per minute (U.S.)
FV - Flow velocity (ft./sec.)
GPM - Gallons per minute (U.S.)
GPR - Gallons per revolution (U.S.)
HHP - Hydraulic horsepower
ID - Inside diameter (inches)
ME - Mechanical efficiency
NC - Number of cylinders (per pump)
PD - Plunger diameter (inches)
PSI - Lbs./sq. in.
RL - Rod load (lbs.)
RPM - Crankshaft revolutions per minute
SL - Stroke length (inches)
T - Torque (ft. lbs.)

B. Pump Data Formulas:

1. To calculate the HHP output when the volume and pressure are known:

$$\frac{GPM \times PSI}{1714} = HHP$$

2. To calculate the BHP input required when the volume, pressure, and mechanical efficiency are known:

$$\frac{GPM \times PSI}{(1714 \times ME)} = BHP$$

3. To calculate the maximum possible pressure when the BHP, flow, and ME are known:

$$\frac{BHP \times (1714 \times ME)}{GPM} = PSI$$

USEFUL PUMP DATA FORMULAS (Con't)

4. To calculate the maximum possible flow when the BHP, PSI, and ME are known:

$$\frac{BHP \times (1714 \times ME)}{PSI} = GPM$$

5. To calculate rod load when the plunger diameter, and pressure are known:

$$PD \times PD \times .7854 \times PSI = RL$$

6. To calculate the maximum possible pressure at a given rod load when the RL rating and plunger diameter are known:

$$\frac{RL}{PD \times PD \times .7854} = PSI$$

7. To calculate the flow in gal/rev or GPM when the plunger diameter, stroke length, and number of cylinders is known:

$$\frac{PD \times PD \times .7854 \times SL \times NC}{231} = GPR$$

$$GPR \times RPM = GPM$$

8. To calculate the fluid flow velocity through a pipe or hose when the GPM and pipe size are known:

$$Pipe\ I.D. \times Pipe\ I.D. \times .7854 = Internal\ Area$$

$$\frac{GPM \times .3208}{A} = Flow\ Velocity$$

9. To calculate the size pipe of hose required to maintain a specified flow velocity when the GPM and desired flow velocity are known:

$$\frac{GPM \times .3208}{FV} = Internal\ Area\ Required$$

USEFUL PUMP DATA FORMULAS (Con't)

10. To calculate the maximum allowable GPM through a specified hose or pipe at a specified flow velocity when the internal area of the pipe and the desired flow velocity are known:

$$\frac{FV \times A}{.3208} = \text{Max GPM}$$

11. To calculate pinion shaft or driveline torque when the input BHP and pinion shaft RPM are known:

$$\frac{BHP \times 5252}{\text{Pinion Shaft RPM}} = \text{Torque}$$

C. Conversion Factors:

Multiply:	**By:**	**To Obtain:**
Barrels (U.S.)	42	Gallons (U.S.)
Gallons (U.S.)	.023809	Barrels (U.S.)
Gallons (U.S.)	231	Cubic Inches
Cubic Inches	.004329	Gallons (U.S.)
Cu. Ft./Sec.	448.831	GPM
GPM	.002228	Cu. Ft./Sec.
Head Feet (water)	.4331	PSI
PSI	2.309	Head Feet (water)
Kilowatts	1.341	Horsepower
Horsepower	.7457	Kilowatts

SHIPPING AND STORAGE

All pumps are shipped dry and must be flushed and filled with the proper lubricant before operating (see Section 2). Pumps may be flushed with diesel or light oil. When pumps are shipped by ocean cargo, care should be taken to crate the pump in a watertight container and ship below deck to prevent salt water contamination.

New pumps are not prepared for long periods of storage and should be put in service as soon as possible. To prepare a pump for a storage after prior use, clean the fluid end and flush it with a good rust preventive. Plug all fluid end discharge and suction openings. Drain oil from power end, thoroughly clean and flush with a good rust preventive that will not clog oil passages. Remove crankcase breather and plug all openings. Coat the pinion extensions and pony rods with a heavy rust preventive. Store pump inside in a warm, dry place.

Pumps that have sat idle for any appreciable period of time (two weeks or more) must have the plungers and valves removed, coated with a light lubricant and reinstalled prior to operating. The elastomeric plunger packing and valve inserts will stick to the matching metal parts and become damaged upon startup if not disassembled and lubricated first.

Section II

INSTALLATION DETAILS

PUMP INSTALLATION HIGHLIGHTS

The proper installation of your SPM well service pump is a must in obtaining long life and trouble free service. Particular attention must be given to the following items:

A. Power Source:
The prime mover (usually a 2100 RPM diesel engine) should not be rated at more than 725 BHP intermittent service in order to avoid overpowering the pump.

B. Drivetrain:
The drivetrain which connects the pump to the engine should include a transmission (5 speed or more) and a mechanical driveline with universal joints and a **slip joint** in order to fully utilize the pump's wide range of pressure and flow capabilities.

A powershift type transmission with integral torque converter and automatic lock-up clutch will provide the most trouble-free means of shifting under pressure. When using an ordinary mechanical transmission with manual clutch, extreme caution must be exercised when clutching and shifting in order to avoid introducing severe shock loads to the pump's input shaft. When using any transmission with a "high gear" or "overdrive" ratio greater than 1.0:1, the "overdrive" gear range must be blocked out in order to avoid overspeeding the pump. When using a transmission with a torque converter and/or a low gear ratio of 5.0:1 or lower, extreme caution should be exercised to avoid over-pressuring the pump when operating in low gear or converter mode.

The mechanical driveline should have a "Diesel Engine Use" torque rating of approximate 1250 to 1700 ft. lbs. (6500 to 8900 ft. lbs. Short Duration) and should have no less than **1" slip capacity**. The manufacturer's recommendations for maximum installed angle, maximum RPM, etc. must not be exceeded.

C. Power End Mounting:
The pump must be securely bolted to the skid or vehicle at all four power end mounting hold locations (Refer to pump installation drawing).

D. Power End Lubrication:
SPM well service plunger pumps are shipped dry, do not include an integral oil pump, and are designed for a pressure lubricated dry sump system. An auxiliary oil reservoir and engine driven oil pump must be provided for proper lubrication. More information pertaining to the power end lube system and power end lube oils is included in this manual.

PUMP INSTALLATION HIGHLIGHTS (Con't)

E. Plunger Lubrication:
SPM well service plunger pumps require a force fed oil plunger lube system. The unit is internally and externally plumbed so that the correct oil source provided by the customer will supply lube to all appropriate surfaces.

SPM supplied hosing (both internal and external) is normally medium pressure Teflon with a stainless steel outer braid. This type hose has the following ratings:

Size	Working	Burst
1/4"	3000 psi	12000 psi
5/16"	2500 psi	10000 psi
3/8"	2000 psi	8000 psi
1/2"	1750 psi	7000 psi
3/4"	1000 psi	4000 psi

More information pertaining to the plunger lube system and plunger lube oils is included in this manual.

F. Supercharging System:
SPM well service plunger pumps require the use of a centrifugal slurry pump supercharging system. More information pertaining to the supercharging requirements is included in this manual.

POWER END LUBE SYSTEM REQUIREMENTS

Providing a well designed trouble-free power end lube system is one of the most important factors in obtaining maximum service and long life from the TWS600S Well Service Plunger Pump. Due to the nature of well servicing operations, the highest pump pressures and highest load conditions occur at very slow pump speeds. This characteristic of well service pump operation necessitates the use of an engine driven lube pump that will deliver maximum lube oil volume at high engine speeds regardless of slow pump speeds. As a result of this operating characteristic and the many different equipment design possibilities, it is not feasible for SPM to provide a power end lube system with the pump. The equipment manufacturer who builds the powered well service unit must provide power end lube system components that are compatible with the specific engine, transmission, etc. being utilized on the unit.

A properly designed power end lube system will meet the following specifications:

1. Oil Reservoir:
   - A. Must be of 50 gallon capacity minimum.
   - B. Suction outlet to be 2" minimum and located as deep as possible.
   - C. Suction outlet and return inlets to be as far apart as possible.
   - D. Return fitting for drainback to be 3" minimum; return fitting for relief valve line to be 1" minimum.
   - E. A serviceable magnet located near the 3" return port is highly recommended.
   - F. Breather/filler cap to be 40 micron/25CFM minimum and should include a built-in strainer to prevent trash from entering the reservoir.
   - G. Dipstick or sight glass to indicate oil level in the reservoir.
   - H. Reservoir must be located below the lowest drain port in the plunger pump and as near the plunger pump as possible (preferably directly underneath).

2. Lube System Suction Piping:
   - A. Must be 2" I.D. minimum throughout so that the suction flow velocity never exceeds 2 to 3 ft. per second.
   - B. Must include a suction strainer w/2" minimum port size, 40 to 100 mesh (400-150 micron) wire cloth, 300 sq. in. minimum element area, 3 to 5 PSI (6 to 10 Hg) built-in bypass, and rated at 50 GPM minimum flow. An in-line canister type strainer is much preferred due to the ease of routine maintenance in cleaning the element.
   - C. A 1½" minimum swing type check valve may be used in the suction line if the lube pump is located above the fluid level in the reservoir.
   - D. The suction line should be as short as possible, should be free from excessive bends, and should be wire reinforced to prevent collapsing. If longer than 10 ft. the resulting friction losses should be compensated for by increasing the line size to 2" I.D. minimum.

POWER END LUBE SYSTEM REQUIREMENTS (Con't)

3. Lube Pump:
   A. Must be a gear type pump rated at **12 GPM minimum at its installed maximum RPM.**
   B. Inlet and outlet ports should be as large as possible w/1½" inlet and 3/4" outlet preferred.

NOTE: If the gear pump suction inlet port is smaller than 1½", a swage connection should be used on the suction port in order to maintain a 2" suction line size as near the gear pump as possible.

   C. A liquid filled vacuum gauge (0 to 30" Hg) should be installed as near the gear pump suction port as possible in order to monitor the suction flow conditions, especially during cold startups in cold weather.
   D. The gear pump may be direct coupled to an accessory drive location on the engine or can be direct coupled to the transmission with a pump-mount type power take-off (PTO). The transmission/PTO mount usually offers the advantage of a lower mounting and improved suction conditions. The lube pump mounting must be a direct coupled positive drive arrangement which operates at engine speed whenever the plunger pump's prime mover is running.

4. Lube System Pressure Lines and Oil Filter:
   A. Pressure lines must be 1" I.D. minimum in order to maintain a flow a velocity of 10 to 12 ft. per second maximum.
   B. Pressure lines should be wire reinforced with a minimum working pressure of 800 PSI.
   C. The oil filter must be rated at 50 GPM/200 PSI minimum, must have a built-in 15 to 25 PSI relief valve, and 25 to 33 micron elements. The filter may be of either the spin-on throw-away element type or the canister enclosed throw-away element type. The filter must be located in an easily serviceable location and a built-in bypass indicator (service indicator) is recommended. A dual element filter rated at more than 50 GPM will decrease the pressure drop associated with filtering 90 weight gear oil and will increase the time interval required between filter element changes. An external relief valve should never be used to protect the filter.
   D. A liquid filled ∅ to 200 PSI oil pressure gauge must be located at the 1/2" NPT lube inlet on the plunger pump. An auxiliary oil pressure gauge is also highly recommended for those units having remote control consoles.

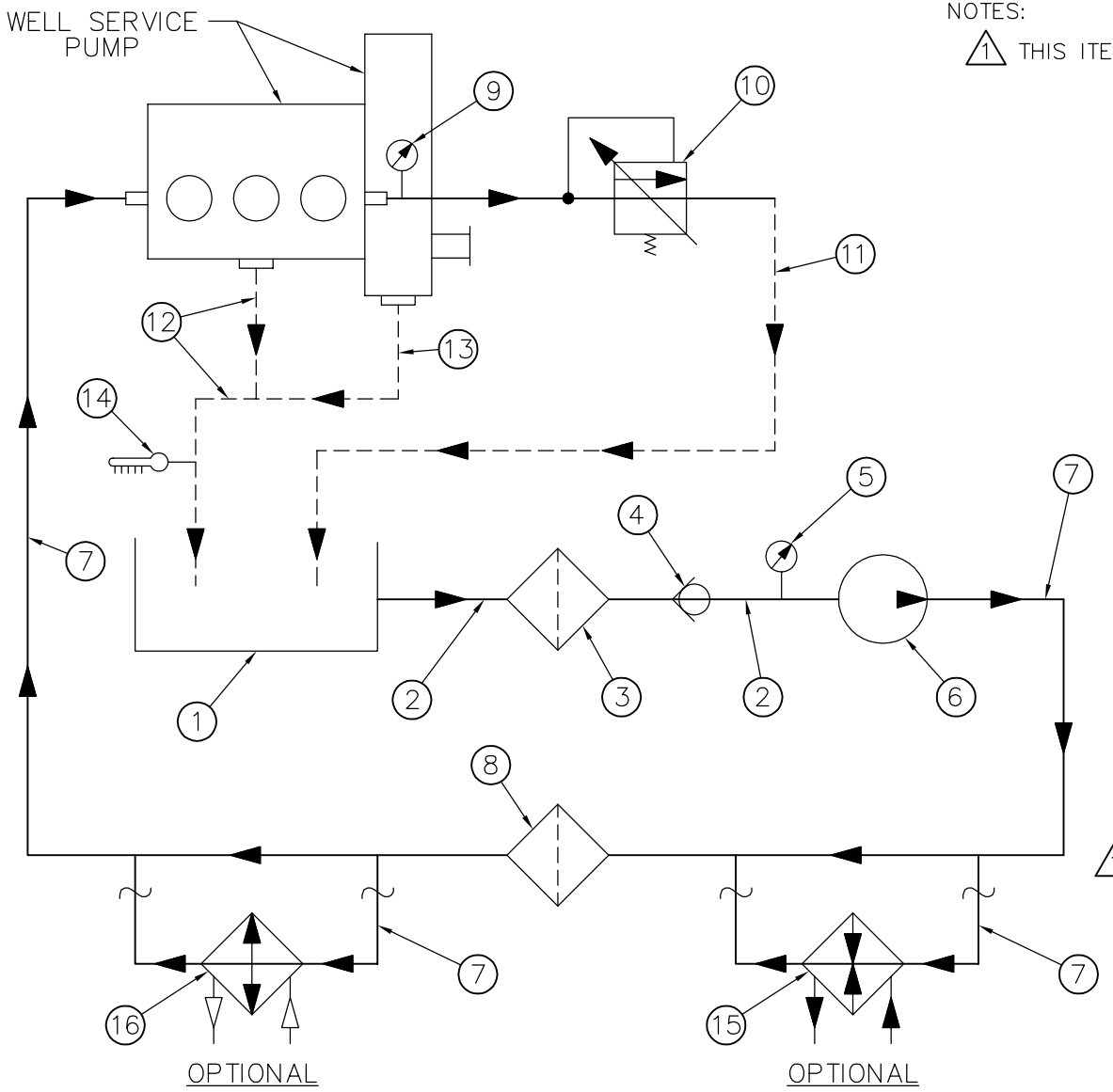
5. Lube System Relief Valve and Relief Return Line:
   A. The system relief valve should be a 3/4" 20 to 25 GPM, 60 PSI minimum/200 maximum, adjustable non-chattering type relief valve.
   B. The relief valve must be located at the plunger pump's 1/2" NPT lube port opposite the lube inlet to insure oil flow throughout the plunger pump before reaching the relief valve.
   C. The relief return line should be 3/4" I.D. minimum, wire reinforced, rated at 800 PSI minimum operating pressure; and should return directly to the reservoir.

POWER END LUBE SYSTEM REQUIREMENTS (Con't)

6. Lube Drain Lines (from plunger pump to reservoir):
   A. The TWS600S is equipped with a 2" NPT drain port in the speed reducer (gearbox) housing and a 3" NPT drain port in the bottom of the power end housing. The drain lines should never be smaller than the drain port in the power end/speed reducer and should be as short as possible. The drain lines should be free of excessive bends and kinks and should flow continuously downhill to the reservoir. If necessary, the 2" drain line from the speed reducer can be teed into a common 3" drain line returning to the reservoir. The lowest 2" NPT drain port in the speed reducer should always be utilized for the drain line in order to prevent the speed reducer from accumulating excess oil.
   B. A 0 to 250F oil temperature gauge should be installed in the primary drain line such that its sensor will be submerged in the return oil from the plunger pump. The temperature gauge should also be located in a place easily accessible for viewing. An auxiliary oil temperature gauge is also highly recommended for those units that have a remote control console.
7. Optional Lube System Equipment:
   A. In extremely hot ambient conditions, an oil cooler may be required to prevent excessive oil temperatures and inadequate oil viscosity. When used, the oil cooler should be of the "air to oil" or "forced air" type and should be located down-stream from the oil filter. The cooler should be rated at 50 GPM/250 PSI minimum, and should have 3/4" minimum inlet and outlet connections. If the well service unit will also be subjected to periods of cold weather, the oil cooler must be plumbed in a manner that will allow the oil to bypass the cooler when cold ambient conditions occur.
   B. In extremely cold ambient conditions, the use of either an electric sump heater or a "tube and shell" heat exchanger may be required to prevent extremely poor lube suction conditions, lube pump damage, and plunger pump damage due to the lube oil becoming too cold and viscous to flow properly. When used, the electric sump heater should be installed near the suction outlet in the oil reservoir and should be capable of heating the oil to approximately 80 to 100 degrees Fahrenheit over an 8 to 12 hour period of time. The sump heater must be thermostat controlled to prevent overheating the oil.

      When using a "tube and shell" type heat exchanger for lube oil heating with engine jacket water, the heat exchanger should be rated at 50 GPM/250 PSI minimum with 3/4" minimum inlet and outlet oil passage connections. The heat exchanger must be plumbed in a manner that will allow it to be easily bypassed in the event the power end lube oil temperature starts to exceed 180 degrees Fahrenheit.

NOTE: Upon request, SPM can provide lube system components that meet or exceed the specifications noted herein. Please contact SPM's Engineering Dept. for any further information pertaining to your specific pump lubrication requirements.



NOTES:

1. THIS ITEM SUPPLIED BY CUSTOMER

SEE PUMP SERVICE MANUAL FOR COMPLETE DETAILS AND RECOMMENDATIONS.

ITEM	DESCRIPTION
16	OPTIONAL OIL COOLER
15	OPTIONAL HEAT EXCHANGER
14	TEMPERATURE GAUGE, 0–250°F
13	SPEED REDUCER DRAIN, PIPE OR HOSE, 2" I.D.
12	POWER END DRAIN LINE, PIPE OR HOSE, 3" I.D.
11	RELIEF RETURN LINE, PIPE OR HOSE, 3/4" I.D.
10	RELIEF VALVE, ADJUSTABLE, 60–200 PSI, 3/4" I.D., 20–25 GPM MIN.
9	PRESSURE GAUGE, LIQUID FILLED, 0–200 PSI
8	FILTER, 50 GPM/200 PSI MIN., 25–33 MICRON ELEMENTS, w/15–25 PSI RELIEF
7	PRESSURE LINE, PIPE OR HOSE, 1" I.D. MIN.
6	PUMP, GEAR TYPE, 25 GPM MIN., ENGINE OR TRANSMISSION DRIVEN
5	VACUUM GAUGE, LIQUID FILLED, 0–30" Hg
4	CHECK VALVE, SWING TYPE, 2" I.D. MIN.
3	SUCT. STRAINER, 50 GPM MIN., 300 SQ. IN. MIN., 40–100 MESH, w/3–5 PSI RELIEF
2	SUCTION LINE, PIPE OR HOSE, 2" I.D. MIN.
1	RESERVOIR, VENTED, 50 GALLON MIN. CAPACITY

REV.	DESCRIPTION	BY	Date
R1	SEE ECN #2800	DPH	3/10 97

DO NOT SCALE DRAWING

UNLESS OTHERWISE NOTED DIMENSIONS ARE IN INCHES

SPM

7601 WYATT DRIVE
FT WORTH TEXAS 76108-2587

linear tol		
	fractional	±1/32
	.XX	±.01
	.XXX	±.005
Angular tol		±30'

All diameters concentric to .010 unless otherwise noted

125 surface roughness all machined surfaces

Scale: NONE
Date: 3/10/97
Drawn by: DPH 1
Approved: MDM

Description: LUBE SYSTEM SCHEMATIC
POWER END
TWS400/500LW/600/600-S

Material:

Drawing No: 3L102104

RECOMMENDED POWER END LUBE OILS

Selecting the proper gear oil for satisfactory power end lubrication is very important to obtaining long life and trouble-free service from the high performance SPM plunger pump. SPM highly recommends the use of one of the modern "synthetic" gear lubricants, which are now available through all major lubricant marketers. Synthetic lubricants exhibit a much more stable viscosity over a wide range of ambient conditions. Synthetics also offer a much improved film strength compared to a conventional gear oil of the same viscosity. The use of synthetic gear lubricants will improve lubricant flow at pump startup, will provide superior wear protection, and will result in higher "hydraulic horsepower" output due to reduced drag and friction between mating parts. **To obtain optimum performance, regardless of the Power End Lubricant selected, the lubricant target operating temperature shall stay below 150° F.**

1. <u>General Service "Synthetic" Power End Lubricants</u>:
   These gear oils must be rated for "extreme pressure" (EP) service, must have a "Viscosity Index" of 135 or higher, must have a "Pour Point" of –35° F or lower, must have a "Timken Test" rating of 50 lbs. or higher (for non-SAE grades only), and must have a "Viscosity" of 80 SUS or higher at 210° F. The plunger pump's operating temperature must not exceed 175° F when using one of these gear oils. Some examples of the various brands of synthetic gear lubricants, which offer extended power end protection, are as follows:

Chevron ……	Clarity Synthetic PMO ISO 220
Chevron ……	Clarity Synthetic PMO ISO 150
Chevron ……	RPM Synthetic Gear Lubricant 75W-90
Citgo ……	Synthetic Gear Lubricant 75W-90
Conoco ……	Syncon 75W-90
Mobil ……	Mobilube SHC 75W-90
Mobil ……	Mobil 1 Synthetic Gear Lubricant 75W-90
Petro-Canada ……	Syngear E 75W-90 EP
Phillips 66 ……	Philguard 75W-90
Shell ……	Spirax "S" 75W-90
Shell ……	OMALA HD 220
Texaco ……	Pinnacle EP 220

2. <u>Alternate Seasonal Non-Synthetic Power End Lubricants</u>:
   A "conventional" non-synthetic gear oil may be used in SPM plunger pumps; however more care must be taken in selecting the proper grade of oil to use for the prevailing ambient conditions during a given season of the year. In all cases, a conventional gear lubricant must contain an "extreme pressure" (EP) additive, must have a "Viscosity Index" of 93 or higher, and must have a Timken Test rating of 45 lbs. or higher (for non-SAE grades only). Following is a list of the various brands and grades of conventional gear lubricants, which may be used "seasonally" as indicated:

RECOMMENDED POWER END LUBE OILS (Con't)

A. Alternate Moderate Service (for spring and fall seasons):
These gear oils are suited for use in moderate ambient temperatures, which range from 32° F to 90° F. These oils must have a "Pour Point" of 0° F or lower and must have a "Viscosity" of 85 SUS or greater at 210° F. The plunger pump's operating temperature must not exceed 175° F when using one of these oils:

Chevron	Gear Compounds EP ISO 220
Citgo	Premium Gear Oil (MP) 85W-140
Conoco	Gear Oil 220
Conoco	Hydroclear EP Gear Oil 220
Exxon	Gear Oil GX 85W-140
Mobil	Mobilube HD 85W-140
Phillips 66	Superior Multipurpose Gear Oil 80W-140
Shell	OMALA Oil 220

B. Alternate High Temperature Service (for summer or tropical climates):
These gear oils are suited for use in climates where the ambient temperature ranges from 40° F to 110° F. These oils must have a "Pour Point" of 20° F or lower and must have a "viscosity" of 124 SUS or higher at 210° F. The plunger pump's operating temperature must not exceed 175° F when using one of these oils:

BP	Energear Hypo-U 85W-140
Chevron	RPM Universal Gear Lubricant 85W-140
Citgo	Premium Gear Oil (MP) 85W-140
Conoco	Universal Gear Lubricant 85W-140
Exxon	Gear Oil GX 85W-140
Mobil	Mobilube HD 85W-140
Phillips 66	Superior Multipurpose Gear Oil 85W-140
Shell	Spirax HD 85W-140
Texaco	Multigear EP 85W-140

C. Alternate Cold Temperature Service (for winter use):
SPM highly recommends the use of a "synthetic" extreme pressure gear oil for any plunger pump being used in an "arctic" environment, however, the gear oils below are suited for cold temperature winter use where the ambient temperature ranges from –15° F to 70° F. These oils must have a "Pour Point" of –20° F or lower and must have a "Viscosity" of 75 SUS or higher at 210° F. The plunger pump's operating temperature must not exceed 130° F when using one of these oils:

Chevron	RPM Universal Gear Lubricant 80W-90
Citgo	Premium Gear Oil (MP) 80W-90
Exxon	Gear Oil GX Extra 75W-90 (outside the US only)
Mobil	Mobilube HD 80W-90
Phillips 66	Superior Multipurpose Gear Oil 80W-90
Shell	Spirax HD 80W-90
Texaco	Multigear EP 80W-90

POWER END LUBE STARTUP AND PERFORMANCE DATA

A properly designed lube system should require adjustments to the system only once - at the well service unit's original startup. Following are SPM's recommended guidelines for making the initial adjustments as well as the lube system's operating specifications.

1. Initial Lube System Adjustments and Specifications:
   A. Fill the power end lube oil reservoir with the proper grade of EP gear oil for the existing ambient conditions. Do not over-fill the reservoir - the proper oil level should always leave approximately 10% air space above the fluid level. For example, only 45 gallons of oil should be used in a reservoir that has a 100% internal capacity of 50 gallons. Disconnect the lube oil suction hose at the lube pump suction inlet and fill the hose w/gear oil to prime the lube pump. Reinstall and tighten the suction hose.
   B. With the plunger pump's transmission in neutral, start the engine and run at idle only. It will take a few minutes to pump oil through the entire system completely filling all lines, filters, etc. during which time a thorough check should be made for oil leaks at hose connections, etc. After all the lines are filled, the system should begin to show pressure on the gauge at the plunger pump's lube inlet. Let the engine run for five more minutes to purge the system of air. Kill the engine and add oil to the reservoir in order to bring it back to the full level.
   C. With the transmission in neutral, restart the engine. Rev the engine up to full RPM gradually while checking both the vacuum gauge at the lube pump suction inlet and the pressure gauge at the plunger pump lube inlet. If the lube oil is warm enough and thin enough, the vacuum reading will not exceed 10" Hg. If the oil is too cool and viscous, the engine RPM should be slowed till the vacuum reading falls to 10" Hg. The oil will eventually warm up just from the friction of traveling through the lube system and through the plunger pump.

      When the vacuum reading no longer exceeds 10" Hg at full engine RPM, adjust the lube system relief valve so that the lube pressure does not exceed approximately 150 to 175 PSI at full engine RPM.

NOTE: The oil filter is usually the lowest pressure rated component in the lube system. The system relief valve setting is made primarily to protect the oil filter and can be a higher setting than 175 PSI as long as it does not exceed the lowest rated component in the system. The plunger pump itself will not be damaged unless the oil pressure exceeds approximately 400 PSI.

Again, check the entire lube system for leaks, kill the engine, and add oil to the reservoir if necessary. The plunger pump should not be rotated until the plunger lube system is installed and operating properly.

POWER END LUBE STARTUP AND PERFORMANCE DATA (Con't)

2. Power End Lube System Operating Specifications:

Power end lube system readings will vary considerably due to the extreme viscosity changes in the gear oil as it warms and thins from a cold startup till it reaches full operating temperature. The system pressure and vacuum variations are caused by the extreme viscosity changes in the oil. The typical SAE 90 wt. gear oil even at room temperature is very viscous (much like molasses), creates much resistance to flow in the system, and creates high system pressures even at very low lube flow rates. Likewise, the typical SAE 90 wt. gear oil at 150F to 175F becomes much less viscous, flows very freely, and creates much less resistance in the system showing up as considerably lower system pressures.

Due to the extreme viscosity changes in the gear oil and due to the many different possible system designs, it is difficult to establish a firm set of system readings which will be highly accurate for every system. Each system will vary somewhat especially in the area of stabilized temperature and pressure readings during full horsepower or full torque plunger pump operation. The system specifications herein should be observed in addition to each unit's "normal" system characteristics after having been put into service. Extreme deviations from "normal" in any unit's system is an important factor in spotting potential problems and avoiding power end damage due to insufficient lubrication.

Maximum Acceptable Vacuum Reading at
Lube Pump Suction Inlet at Any Time
While Operating the SPM Plunger Pump..... 10" Hg.

Maximum Oil Pressure at Cold Startup
and Full Engine RPM..... 175 PSI

Maximum Oil Temperature at Any Time
While Operating the SPM Plunger Pump:
With General Service **SAE 90 Gear Oils**..... 175F
With Cold Weather **SAE 80 Gear Oils**..... 130F
With Hot Weather **SAE 140 Gear Oils**..... 195F

Approximate Normal Oil Pressure at
Stabilized Operating Temperature and
Full Engine RPM..... 70-100 PSI

Minimum Acceptable Oil Pressure at Any Time
While Operating the SPM Plunger Pump
At Full Engine RPM and at Stabilized
Operating Temperature..... 40 PSI

NOTE: Any sudden vacuum, pressure, or temperature deviations from normal (especially if accompanied by any unusual noise, vibration, or smoke) indicate the need to cease pumping operations and investigate the problems before power end damage occurs. (See Trouble Shooting Section of this manual).

PLUNGER LUBE SYSTEM REQUIREMENTS

SPM well service plunger pumps are designed for packing lubrication with oil rather than grease. Exceptionally long packing life can be expected providing proper lubrication is supplied to the plunger packing lube port above each stuffing box. Ample plunger and packing lubrication can be achieved with an inexpensive relatively trouble-free low-pressure air operated "lubricant pump" type system. Mechanically driven plunger lubricators are not recommended due to the well service pump's extreme variations in pump speeds. A properly designed packing lube system will meet the following specifications:

1. Oil Reservoir:
   A. Should be a minimum of 5-gallon capacity.
   B. Should be equipped for the vertical installation of an air-operated pump.
   C. Should be equipped with a sight glass or dipstick.
   D. Should be equipped with a breather/filler cap that has a built-in strainer to prevent trash from entering the reservoir.

2. Air Operated Lubricant Pump:
   A. Vertical air operated 12 oz. per minute / 150 PSI / 40:1 ratio lubricant pump.
   B. Must be equipped with a 1/4" adjustable air pressure regulator in order to adjust the pump speed and packing lubricant flow rate.
   C. Should be installed so that the bottom of the pump is no closer than 1" to the bottom of the reservoir.

3. In-Line Relief Valve:
   It is critical that an in-line relief valve be included in the circuit when plunger wiper rings are used with the packing. Otherwise, excessive lube pressure will damage the wiper.
   A. Should have a cracking pressure of 32 psi.
   B. Must be installed in-line between the lubricant pump and the plunger pump.
   C. Should be equipped with a pressure gauge between the relief valve and lubricant pump.
   D. A return line should be connected from the relief valve to the oil reservoir so that vented oil will return to the oil reservoir.

4. Packing Lubricant Flow Lines:
   A. Should be 1/4" I.D./1250 PSI minimum/fiber or wire reinforced hose to prevent crimping.
   B. Should be a common line from the lubricant pump to the plunger pump at which point it will branch off to each individual packing lube port.

5. Flow Control Needle Valves:
   A. Should be a 1/4" needle valve, which can be locked at any given setting after adjustment.
   B. Must be installed in each lubricant flow line that leads to the individual packing lube ports in the plunger pump fluid cylinder.

PLUNGER LUBE SYSTEM REQUIREMENTS (Con't)

6. High Pressure Check Valves:
   A. Must be rated at or above the well service plunger pump's maximum pressure rating.
   B. Must be installed in the packing lube port so that the direction of flow is into the fluid cylinder.

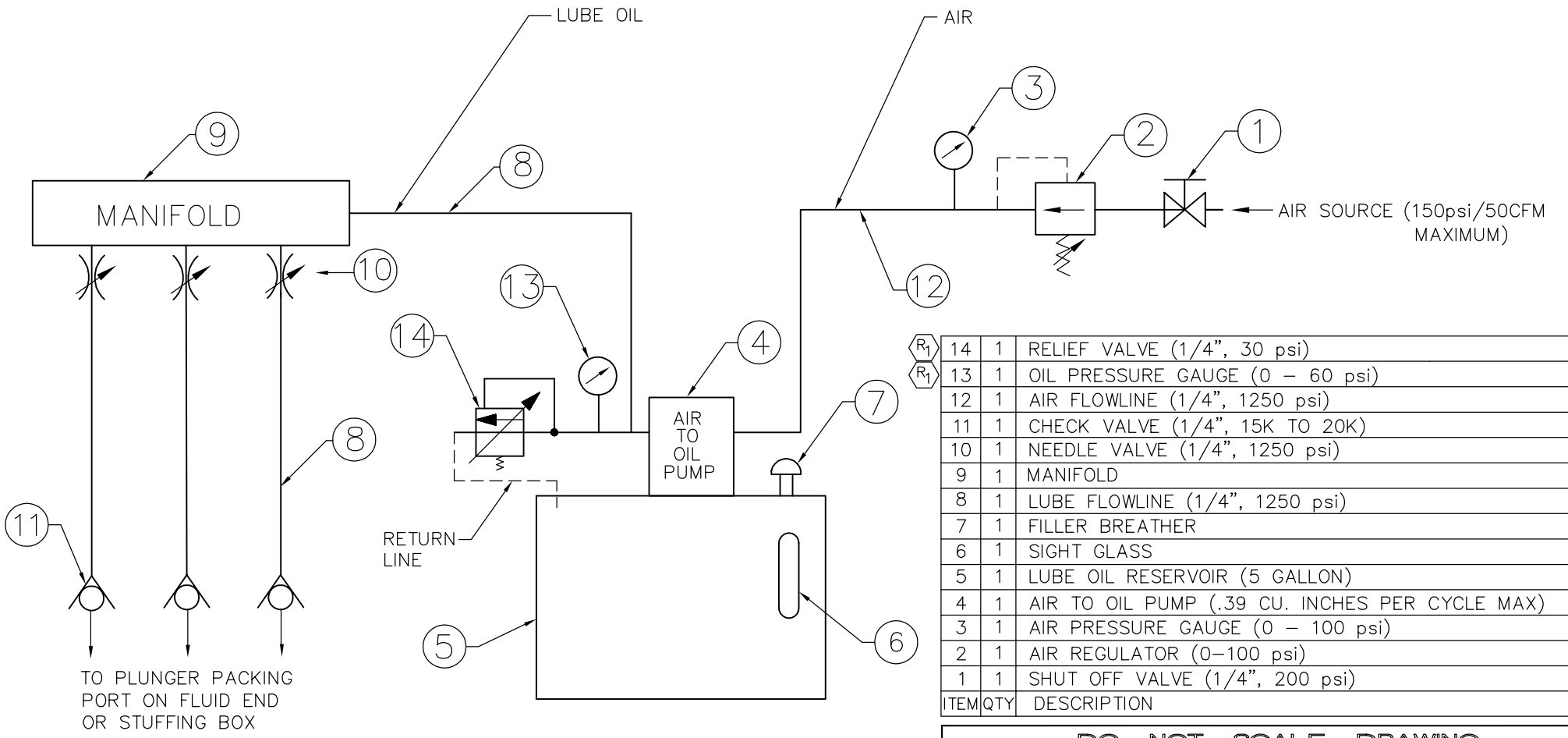
7. Packing Lube System Flow Requirements/Adjustments:
   A. After filling with the proper grade of packing lubricant rock drill oil, and before rotating the well service plunger pump, the lube system should be adjusted to supply oil to each plunger and packing assembly.

   B. SPM recommends a minimum of 1 pint per plunger per hour for adequate packing lubrication. Results from SPM internal tests support this although variables in packaging and field operations may result in higher consumption rates.

Minimum consumption rate 1.0 pint per plunger per hour

   C. Rates as high as 3 times the minimum recommended have been reported, and this should be considered when sizing the lube reservoir.

   D. All pumps with a rod wiper require a 30psi limit to the plunger lubrication system. Adjust the lube relief to 30 psi maximum. Exceeding 30 psi may cause premature failure of the wiper ring.



	ITEM	QTY	DESCRIPTION
R_1	14	1	RELIEF VALVE (1/4", 30 psi)
R_1	13	1	OIL PRESSURE GAUGE (0 – 60 psi)
	12	1	AIR FLOWLINE (1/4", 1250 psi)
	11	1	CHECK VALVE (1/4", 15K TO 20K)
	10	1	NEEDLE VALVE (1/4", 1250 psi)
	9	1	MANIFOLD
	8	1	LUBE FLOWLINE (1/4", 1250 psi)
	7	1	FILLER BREATHER
	6	1	SIGHT GLASS
	5	1	LUBE OIL RESERVOIR (5 GALLON)
	4	1	AIR TO OIL PUMP (.39 CU. INCHES PER CYCLE MAX)
	3	1	AIR PRESSURE GAUGE (0 – 100 psi)
	2	1	AIR REGULATOR (0–100 psi)
	1	1	SHUT OFF VALVE (1/4", 200 psi)

NOTES:

1. GAUGE AND RELIEF VALVE (ITEMS 13 & 14) ARE REQUIRED WHEN USING A PLUNGER WIPER RING WITH THE PACKING.

REV.	DESCRIPTION	BY	Date
R_1	SEE ECN #2864	JAS	2/5/98

DO NOT SCALE DRAWING

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SPM

7601 WYATT DRIVE
FT WORTH TEXAS 76108-2587

linear tol	fractional	±1/32
	.XX	±.01
	.XXX	±.005
Angular tol		±30'

All diameters concentric to .010 unless otherwise noted

125 surface roughness all machined surfaces

Scale: NONE
Date: 12/02/94
Drawn by: MAC
Approved: MDM

Description: PLUNGER LUBE CIRCUIT WITH RELIEF VALVE TRIPLEX PUMPS

Material:

Drawing No: 3A104034

RECOMMENDED PLUNGER LUBE OILS

Selecting the proper plunger lube oil is very important to obtaining long life from the pumps plungers and packing assemblies. The use of a superior plunger lubricant will also reduce horsepower robbing friction, reduce fuel consumption, and increase the net amount of hydraulic horsepower delivered by the pump. SPM highly recommends the use of a modern "machine tool Way Oil" for improved lubrication of the plungers and packing. In an area where a "Way Oil" is not available, a suitable "Rock Drill" oil may be substituted. The following brands of plunger lube "Way Oil" are recommended for use in various ambient conditions as shown:

1. General Service – for ambient conditions frequently above 32 degrees F:

Amoco ……...	Waytac Oil #220
BP …….	Energol SW #220-C
Chevron ……	Vistac Oil #220X
Citgo …….	SlideRite 220
Conoco …….	HD Way Lubricant #220
Exxon ……...	Esso Febis K 220
Mobil ……	Vactra Oil No. 4
Phillips 66 …….……	Phillips Way Lubricant #220
Shell ……..	Tonna V Oil #220
Texaco …….	Way Lubricant #220

2. Cold Temperature Service – for ambient conditions frequently below 32 degrees F:

Amoco ……...	Waytac Oil #68
BP ……...	Energol SW #68-C
Chevron ……	Vistac Oil #68X
Citgo ……	SlideRite 68
Conoco …….	HD Way Lubricant #68
Exxon ……...	Esso Febis K 68
Mobil ……	Vactra Oil No. 2
Phillips 66 …….……	Rock Drill Lubricant EP #80870
Shell ……..	Tonna V Oil #68
Texaco …….	Way Lubricant #68

NOTE:

Lubricants that differ significantly from those shown above are unacceptable and may result in a much shorter plunger and packing life or premature failure of these components.

Proper lubrication is critical during the startup of the plunger pump. The plunger lubricant must begin to flow freely to the stuffing box lube inlet prior to the pump's startup and stroking of the plungers.

Pumps that have sat idle for any appreciable period of time (two weeks or more) must have the plungers removed, be hand coated with plunger lube oil, and reinstalled prior to operation under power. The elastomeric packing rings will eventually stick to the plunger surface and will become damaged upon startup if not re-lubricated as noted above.

RECOMMENDED PLUNGER LUBE OILS (Con't)

When using an SPM air operated plunger lube system, the audible sound of the air operated lubricant pump stroking once every one to two seconds will be an indicator of satisfactory plunger and packing lubrication.

For all styles of packing, the plunger lube is absolutely critical for good packing and plunger life. Failure to provide adequate or appropriate lube will cause the packing to fail and cause damage to mating components.

SPM recommends the use of Rock Bit or Way Oil that meets the following specifications:

ISO Grade	32	68
CPS No.	232500	232511
AGMA Grade	------	2
API Gravity	21.4	25.6
Viscosity, Kinematics		
cSt at 40°C	30.4	64.6
cSt at 100°C	4.9	7.3
Viscosity, Saybolt		
SUS at 100°F	158	338
SUS at 210°F	42.7	50.8
Viscosity Index	74	61
Flast Point, C(F)	170(338)	200(389)
Pour Point, C(F)	-45(-48)	-24(-11)

Lubricants that fail to meet these specifications, and especially "used crankcase oils", are unacceptable.

Startup is a critical time for plunger packing. Lubrication should flow freely to plunger prior to stroking the pump. **Stroking dry plungers can cause the header ring and packing to tear and fail.**

SUPERCHARGING SYSTEM REQUIREMENTS

Due to the high speed design characteristics associated with well service plunger pumps, supercharging the TWS600S is a must. The nature of well service operations (extreme variations in flow rates coupled with the pumping of heavy slurries) requires a well designed supercharge system. The supercharging system must deliver an adequate supply of fluid to the plunger pump's suction manifold at high enough pressures and low enough flow velocities to prevent the pump from starving for fluid while at the same time, maintaining fluid flow velocities high enough to keep solids suspended in the fluid slurry. A well designed supercharging system is extremely important in avoiding the harmful effects of cavitation and insuring trouble-free service from the TWS 600S. A well designed supercharging system will meet the following guidelines:

1. Primary Suction Piping and Hoses:
   These are defined as the piping where the fluid first begins to flow from it's source through gravity flow or atmospheric pressure only. This portion of the system is usually a pipe or hose which connects the fluid reservoir to the charge pump or in some cases to a mixing pump. The flow velocity (based on the plunger pump's maximum flow rating with the size plunger being used) in this portion of the system must not exceed 4 ft. per second in order to flow freely under atmospheric pressure or gravity flow. Other guidelines are as follows:

   A. Hoses must be oil and chemical resistant wire reinforced combination vacuum/discharge hose rated at 30" Hg/60 PSI minimum.
   B. If steel piping is used, all piping runs must be installed so that they are level or progressively higher toward the plunger pump in order to prevent air traps in the system. When used, reducer fittings should be of the eccentric type and installed "belly down" in order to prevent air traps. All welded connections must be air and fluid tight.
   C. All piping or hoses in this portion of the system should be kept as short as possible (10 ft. or less and should be free of excessive bends and turns).

2. Centrifugal Supercharge Pump/Mixing Pump:
   Some well servicing operations require the use of two centrifugals - one for mixing a slurry and the other for supercharging the plunger pump. When two centrifugals are used, they must both meet the following guidelines:

   A. Must be capable of delivering the rated maximum flow of the plunger pump while **maintaining 50 PSI (115 ft. head) at the plunger pump suction inlet.**
   B. Must be sized appropriately to overcome any friction losses in the piping between the centrifugal's discharge and the plunger pump's suction inlet. For example, depending on the length and the layout of the piping, the centrifugal may have to be sized to deliver the required flow at 75 PSI (173 ft. head) at its discharge in order to maintain 50 psi (115 ft. head) at the plunger pump suction inlet.

SUPERCHARGING SYSTEM REQUIREMENTS (Con't)

2. Centrifugal Supercharge Pump/Mixing Pump (Con't):
   C. Must be operated at a speed which will deliver the required flow within the upper 15% of it's efficiency range in order to assure adequate fluid acceleration on demand from the plunger pump.
   D. Must be adequately powered to deliver the plunger pump's fluid requirements based on volume, pressure, and the specific gravity of the fluid or slurry.

3. Secondary Suction Piping and Hoses:
   These are defined as the piping which carries fluid under pressure from the centrifugal pump's discharge to another point in the system. This is the piping which connects the centrifugal charge pump to the plunger pump suction inlet and can also be the piping which connects the centrifugal mixing pump's discharge to a mixing tub inlet. The flow velocity in this portion of the system (based on the plunger being used) should range from 8 to 12 ft. per second. Other guidelines are as follows:

   A. Hoses must be oil and chemical resistant wire reinforced combination vacuum/discharge hose rated at 30" Hg/100 PSI minimum.
   B. If steel piping is used, all piping runs must be installed so that they are level or progressively higher toward the plunger pump in order to prevent air traps in the system. When used, reducer fittings should be of the eccentric type and installed "belly down" in order to prevent air traps. All welded connections must be air and fluid tight.
   C. All piping and hoses in this portion of the system should be kept as short as possible (15 ft. or less) and should be free of excessive bends and turns.

4. Suction Pulsation Dampener:
   Due to the plunger pump's positive displacement design, a naturally occurring fluid rhythm is generated in the supercharge system as the fluid stops and starts underneath each suction valve. The varying pressure signal created by this fluid rhythm reduces the effectiveness of the charge pump unless the pressure signal is dampened out of the system. A suction pulsation dampener will help insure adequate fluid acceleration when each suction valve opens, will help prevent cavitation, and will result in a much smoother operating pump. Guidelines for using a suction pulsation dampener are as follows:

   A. The pulsation dampener should be of the nitrogen charged bladder type rated at 100 PSI minimum.
   B. Should be installed above the fluid flow path so that solids in the fluid cannot settle and pack around the bladder.
   C. Should be installed as close to the plunger pump's suction inlet as possible for maximum effectiveness.
   D. Must be pre-charged according to the manufacturer's recommendations (usually 30% to 40% of the anticipated supercharge pressure).

SUPERCHARGING SYSTEM REQUIREMENTS (Con't)

5. Supercharge Pressure Gauge:
A supercharge pressure gauge should always be used in the system and should meet the following guidelines:

   A. Should be a liquid filled 0 to 100 PSI pressure gauge.
   B. Should be installed as close to the plunger pump suction inlet as possible for maximum accuracy.
   C. Should be used with a gauge snubber or a needle valve which can be adjusted to act as a snubber.

SUPERCHARGING SYSTEM OPERATIONAL PARAMETERS

1. Recommended Supercharge Pressure at plunger pump suction inlet: **50 PSI (115 ft. head) minimum to 80 PSI (185 ft.) head maximum.**

NOTE: The supercharge pressure must always be greater than the vapor pressure of the fluid being pumped.

2. Number of 4" suction hoses required to maintain 4 ft. per second maximum fluid velocity in "gravity feed" portion of the system:

	GPM FLOW	BPM FLOW	NUMBER OF 4" HOSES REQ'D
Up to:	157	3.74	One
Up to:	313	7.45	Two
Up to:	470	11.19	Three
Up to:	626	14.90	Four
Up to:	783	18.64	Five

3. Steel pipe size required to maintain 4 ft. per second maximum fluid velocity in "gravity feed" portion of the system:

	GPM FLOW	BPM FLOW	PIPE SIZE REQ'D
Up to:	156	3.71	4" I.D.
Up to:	250	5.95	5" I.D.
Up to:	353	8.40	6" I.D.
Up to:	626	14.90	8" I.D.
Up to:	979	23.31	10" I.D.

4. Number of 4" suction hoses required to maintain 12 ft. per second maximum fluid velocity in the "pressurized" portion of the system:

	GPM FLOW	BPM FLOW	NUMBER OF 4" HOSES REQ'D
Up to:	470	11.19	One
Up to:	940	22.38	Two

5. Steel pipe size required to maintain 12 ft. per second maximum fluid velocity in the "pressurized" portion of the system.

	GPM FLOW	BPM FLOW	PIPE SIZE REQ'D
Up to:	264	6.29	3" I.D.
Up to:	470	11.19	4" I.D.
Up to:	734	17.48	5" I.D.

6. Flow Velocity Formula:
   A. To calculate the fluid velocity when the GPM and internal area of pipe or hose are known:

      GPM x .3208 divided by Area = Velocity in ft. per sec.

   B. To calculate the maximum GPM to maintain a specified flow velocity when the velocity desired and the internal area of the pipe or hose is known:

      Velocity x Area divided by .3208 = GPM

Section III

PUMP OPERATION AND MAINTENANCE

TWS600S STARTUP AND BREAK-IN PROCEDURE

Each new pump must undergo a brief but thorough startup and break-in procedure in order to verify the field worthiness of the unitized pumping system and in order to allow a gradual "wearing in" of various mating parts in the pump itself. The following guidelines have been established by SPM to minimize startup problems and insure maximum service from the plunger pump:

A. Inspection Prior to Starting Engine:

1. Check to see that all masking tape, rust preventative, etc. has been removed from moving parts such as plungers, pinion shaft, etc.
2. Check to see that the plunger pump is securely bolted to skid or truck frame.
3. Check to see that the driveline is securely fastened to the plunger pump's input shaft and that adequate slip is present in the driveline's slip joint.
4. Check to see that the power end lube oil reservoir was flushed and drained then filled with the proper type of gear oil.
5. Check to see that the plunger lube oil reservoir was flushed and drained then filled with the proper type of rock drill oil.
6. Check to see that the supercharge piping system has been completely flushed and all piping connections are tight.
7. Check to see that the power end lube system startup adjustments and plunger lube system startup adjustments were performed.
8. Check to see that the suction pulsation dampener has been precharged properly.
9. Check to see that the primary suction piping is connected to an adequate supply of cool clean water for testing.
10. Check to see that the plunger pump's discharge piping is safely installed all the way back to the water reservoir. Check to see that all connections are tight and all valves are open.
11. Start the supercharge pump and flush all air from the entire system.
12. Follow the engine manufacturer's recommendations for engine startup and warmup.

B. Warmup Procedure Prior to Rotating the Plunger Pump:

1. While operating the engine at idle and transmission in neutral, check the power end lube pump vacuum reading, the power end lube oil pressure, and the power end lube oil temperature. If the lube pump vacuum reading is less than 10" Hg, gradually increase the engine RPM to determine whether full engine RPM can be reached without exceeding 10" Hg at the power end lube pump suction inlet.
2. Continue running the engine at or below 10" Hg lube pump vacuum as necessary to warm and thin the power end lube oil. The plunger pump should not be rotated until full engine RPM can be achieved without exceeding 10" Hg at the lube pump suction inlet or until the power end lube oil temperature reaches 60F minimum.

C. Plunger Pump Valve Seating Procedure:

1. In order to protect the fluid cylinder from washing before sustained pumping begins, the tapered valve seats must be pressured up and fully seated creating a positive fluid seal.
2. Adjust the test choke for high pressure/low pump RPM. Shift the transmission to 1st gear and slowly increase the throttle setting to achieve 85% of the pump's maximum rated rod load for 2 to 3 minutes or until a series of audible popping noises are heard. This indicates the seats have properly set in the taper. The desired pressure for each plunger size is as follows:

Plunger Dia.	85% Rated Pressure
2½"	15,000 PSI*
2¾"	14,320 PSI
3"	12,030 PSI
3½"	8,840 PSI
4"	6,765 PSI
4½"	5.345 PSI

During this portion of the startup procedure, closely observe the plunger pump for any unusual noise, vibration, fluid leaks, and oil leaks. Record all pertinent information such as elapsed time, ambient temperature, power end lube oil temperature, power end lube oil pressure, supercharge pressure, etc. After returning the engine to idle and transmission to neutral, physically inspect the plunger pump before proceeding further.

D. Break-In Procedure:

1. Adjust the test choke, engine, and transmission to obtain approximately 35% rated rod load, 35% rated pump RPM, and 42% rated horsepower. These settings should be approximately as follows:

Plunger Dia.	Pump RPM	GPM/BPM	PSI	BHP
2½"	143	54/1.33	7,200	250
2¾"	143	66/1.57	5,895	250
3"	143	79/1.88	4,955	250
3½"	143	107/2.55	3,640	250
4"	143	140/3.33	2,785	250
4½"	143	177/4.21	2,200	250

Run the plunger pump at this setting for one hour. During this time, closely observe the plunger pump for any unusual noise, vibration, fluid leaks, and oil leaks. Record all pertinent information such as elapsed time, ambient temperature, power end lube oil temperature, power end lube oil pressure, supercharge pressure, etc. After returning the engine to idle and the transmission to neutral, physically inspect the plunger pump before proceeding further.

2. Adjust the test choke, engine, and transmission to obtain approximately 40% rated rod load, 50% rated pump RPM, and 75% rated horsepower. These settings should be approximately as follows:

Plunger Dia.	Pump RPM	GPM/BPM	PSI	BHP
2½"	225	85/2.10	8,245	455
2¾"	225	104/2.48	6,740	455
3"	225	124/2.95	5,660	455
3½"	225	169/4.02	4,160	455
4"	225	221/5.26	3,185	455
4½"	225	279/6.64	2,515	455

Run the plunger pump at this setting for one hour. During this time, closely observe the plunger pump for any unusual noise, vibration, fluid leaks, and oil leaks. Record all pertinent information such as elapsed time, ambient temperature, power end lube oil temperature, power end lube oil pressure, supercharge pressure, etc. After returning the engine to idle and the transmission to neutral, physically inspect the plunger pump before proceeding further.

3. Adjust the test choke, engine, and transmission to obtain approximately 22% rated rod load, 100% rated pump RPM, and 83% rated horsepower. These settings should be approximately as follows:

Plunger Dia.	Pump RPM	GPM/BPM	PSI	BHP
2½"	450	171/4.19	4,485	500
2¾"	450	207/4.93	3,705	500
3"	450	248/5.90	3,115	500
3½"	450	338/8.05	2,290	500
4"	450	441/10.50	1,750	500
4½"	450	558/13.29	1,385	500

Run the pump at this setting for 30 minutes. During this time, closely observe the plunger pump for any unusual noise, vibration, fluid leaks, and oil leaks. Record all pertinent information such as elapsed time, ambient temperature, power end lube oil temperature, power end lube oil pressure, supercharge pressure, etc. After returning the engine to idle and the transmission to neutral, physically inspect the plunger pump before proceeding further.

4. Adjust the test choke, engine, and transmission to obtain approximately 100% rated rod load, 12½% rated pump RPM, and 47% rated horsepower. These settings should be approximately as follows:

Plunger Dia.	Pump RPM	GPM/BPM	PSI	BHP
2½"	57	21.5/0.53	15,000*	205
2¾"	57	26/0.62	15,000*	250
3"	57	31/0.74	14,155	285
3½"	57	43/1.02	10,400	285
4"	57	56/1.33	7,960	285
4½"	57	71/1.69	6,290	285

Run the pump at this setting for 30 minutes. During this time, closely observe the plunger pump for any unusual noise, vibration, fluid leaks, and oil leaks. Record all pertinent information such as elapsed time, ambient temperature, power end lube oil temperature, power end lube oil pressure, supercharge pressure, etc. Return the engine to idle, the transmission to neutral, and kill the engine.

5. Visually inspect the power end for oil leaks around the plunger seals, pinion seal, lubrication hoses, lube drain hoses, covers, etc.

   Visually inspect the fluid end for fluid leaks around the suction covers, discharge covers, discharge flanges, stuffing boxes, and suction manifold. Visually inspect the plungers for any signs of heating or scoring.

   Remove the power end lube system magnet and inspect for any unusually large particles of metal. Change the lube oil filters.

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* Pressure is limited to 15,000 PSI due to discharge flange and plunger configuration. For higher pressure, contact SPM engineering department.

RECOMMENDED PRACTICE FOR PUMP PACKING

1. Cement Service

Technique:

Usually a remedial process which places a cement slurry near an opening in the well. The fluid is then pumped using hydraulic pressure to force or "squeeze" the slurry against the formation either in open hole, through perforations, or a hole in the casing.

In practice most cement jobs are at relatively low pressure, but high rates requiring modest power to the pump.

Packing: "Rubber Spring Loaded" (See Fig. 1)

Packing for this process is made up of a Header Ring (Item 1), and two 'SS' Style Pressure Rings (Item 2).

Item 1: Header Ring
Made from an 80 durometer homogeneous nitrile, the Header Ring (0783) is designed primarily to be used with 'SSF' and 'ASF' design V-rings where slurries and other large particle containing fluids are being pumped. The design of the Header Ring keeps the product being pumped from working its way into the seal ring area and causing premature failure. At the same time, the Header Ring acts as a spring to create a non-adjustable packing set. This is intended to add greater service life to the packing and cut down on the maintenance time commonly associated with slurry pump applications.

Item 2: Pressure Rings
These components are a double stack height 'SSF' Vee design. They are composed of TFE modified nitrile binder with cotton and synthetic fabric reinforcement (1069).

Recommended for cementing and general fracturing fluids and weak acids. Not recommended for Toluene or Xylene stimulation.

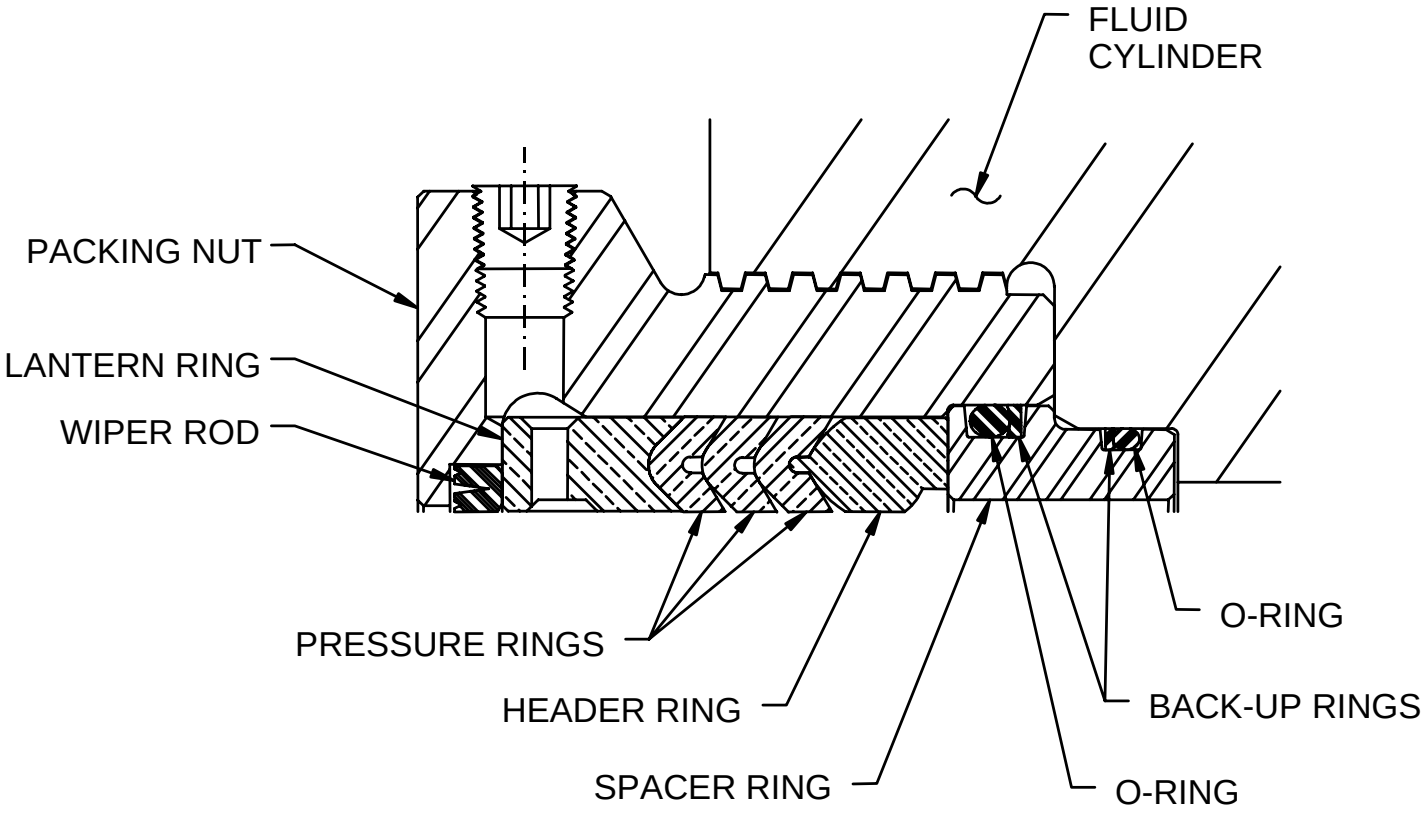


FIGURE 1

RUBBER SPRING LOADED PACKING

RECOMMENDED PRACTICE FOR PUMP PACKING (Con't)

2. Acid/Frac Service

Technique:

Fracturing

Hydraulic fracturing is generally applied to hard tight sandstone reservoirs from which commercial production would not be otherwise feasible. The process consists of hydraulic pressure against the formation by pumping fluid into the well. While splitting the formation by hydraulic pressure, the fluid also will convey sand or other propants into the fissures keeping them open after the pressure is released.

Fluids for this procedure include various combinations of refined oil, crude oil, salt water, acids, emulsifiers, and other additives.

Sand laden fluids in the 8 to 10 pounds per gallon range are common, with higher values being continually achieved.

This procedure generally requires high pressure, high rate operations, which require large amounts of power.

Acid Treatment

Acidizing is the technique where predominantly hydrochloric acid is pumped into the well followed by a water flush. Hydrochloric acid works well on natural or induced fractures of limestone and dolomite. With the dissolving affect of the acids, the formation can be opened to allow better access to the reservoir.

Hydrofluoric acid will dissolve clays and sand like substances, and mixed with hydrochloric acid, it will dissolve the mud deposits in the pore space of a producing formation adjacent to the well.

Usually chemical inhibitors are combined with the acid to prevent corrosion to well components.

2. Acid/Frac Service (Con't)

Packing: "Rubber Spring Loaded" (See Fig. 1)

Item 1: Header Ring

For general fracturing fluids and weak acids the 80 durometer homogeneous nitrile header ring (0783) described in the "Cement Service" section is preferred.

For fluids containing light diesel or aromatics, an 80 durometer acrylic-nitrile header ring (8758) is more suitable.

Neither of the two Header Rings are suitable for Toluene or Xylene stimulation.

Item 2: Pressure Rings

These components are double stack height 'SSF' Vee design. They are different than the ones described in the "Cement Service" section and are composed of a special modified Nitrile binder with special fabric reinforcements (1067).

They are recommended for cementing and all known fracturing and stimulation fluids, and all stimulation acids up to 28% concentration.

TROUBLESHOOTING GUIDE

	TROUBLE SYMPTOM:	PROBABLE CAUSE:
A.)	Abnormally high vacuum at power end lube pump suction inlet (may or may not be accompanied by abnormally low oil pressure).	1. Extremely cold ambient temperature/dangerously high oil viscosity. 2. Clogged lube system suction strainer. 3. Kinked or collapsed lube system suction hose. 4. Clogged oil reservoir breather. 5. Erroneous gauge reading.
B.)	Abnormally low power end lube oil pressure with normal to low vacuum reading at lube pump suction (may or may not be accompanied by high oil temperature).	1. Leak in lube pump suction piping, which allows air to be drawn into the system. 2. Worn or damaged lube pump. 3. Leak in lube pump pressure piping. 4. Low oil level in reservoir. 5. Clogged oil filter element. 6. Faulty lube system relief valve. 7. Extremely hot lube oil temperature/dangerously low oil viscosity. 8. Erroneous gauge reading.
C.)	Abnormally high power end lube oil temperature (may or may not be accompanied by low oil pressure).	1. Extremely warm ambient temperature/dangerously low oil viscosity/incorrect grade of gear oil. 2. Gear oil contaminated with water, trash, or air bubbles. 3. Plunger pump has been operated continuously for too long a period of time at or near its maximum horsepower or torque rating. 4. Heat exchanger or oil cooler malfunction. 5. Erroneous gauge reading. 6. Internal power end damage or power end wear.
D.)	Leaking power end oil seals.	1. Extremely cold ambient temperature/high oil viscosity. 2. Damaged seal surface on mating part. 3. Clogged oil breather/high crankcase pressure. 4. Worn or damaged seal. 5. Contaminated lube oil.

TROUBLESHOOTING GUIDE (Con't)

	TROUBLE SYMPTOM:	PROBABLE CAUSE:
E.)	Leaking fluid end seals.	1. Seal installed improperly. 2. Seal cut or pinched on installation. 3. Mating seal surface not cleaned properly prior to seal installation. 4. Damaged or corroded mating seal surface. 5. Sealing part not properly tightened.
F.)	Plunger and/or packing fluid leak.	1. Packing nut not tightened properly. 2. Worn or damaged packing. 3. Packing installed improperly. 4. Mating seal surface not cleaned properly prior to packing installation. 5. Damaged or corroded mating seal surface. 6. Fluid being pumped is incompatible with the style packing being used.
G.)	Fluid knock or hammer.	1. Air entering supercharge system through loose, worn or damaged connections. 2. Air entering supercharge system through leaking charge pump seals. 3. Fluid being pumped contains gas or vapor. 4. Insufficient supercharge flow or pressure. 5 Valve cocked open/broken valve spring or valve stop. 6. Worn or damaged valve, valve insert, or valve seat. 7. Improperly charged or ineffective suction pulsation dampener.
H.)	Low discharge pressure/rough running pump.	1. Worn or damaged valve, assembly. 2. Insufficient supercharge flow or pressure. 3. Air, gas, or vapor in fluid being pumped. 4. Improperly charged or ineffective suction pulsation dampener. 5. Two or more plunger pumps being supercharged by a common charge pump and being allowed to get "in phase" with each other.

ROUTINE PREVENTIVE MAINTENANCE

Maximum service and trouble-free operation can be obtained from the SPM well service plunger pump by establishing a thorough preventive maintenance program as follows:

A. During The First 100 Hours Of New Pump Operation:
   1. Change power end lube oil filters every 25 hours (or more often if required) to prevent filter bypass.
   2. Thoroughly clean the power end lube oil suction strainer after the first 50 hours and 100 hours operation.
   3. Change the power end lube oil after the first 100 hours operation and clean the lube oil reservoir.

B. Daily Preventive Maintenance:
   1. Check the oil level in the power end lube oil reservoir.
   2. Check the oil level in the plunger lube oil reservoir.
   3. Check the plunger pump for oil leaks and/or fluid leaks.
   4. Check the power end lube oil system for leaks.
   5. Check the plunger lube system for leaks.
   6. Check the supercharge piping for leaks.

C. Weekly Preventive Maintenance:
   1. Check all items on "daily" list.
   2. Check all valves, inserts, valve seats, and springs.
   3. Check all discharge and suction cover seals.
   4. Check suction pulsation dampener for correct pre-charge.

D. Monthly (or every 100 hours) Preventive Maintenance:
   1. Check all items on "daily" and "weekly" lists.
   2. Check all fluid cylinder mounting bolts to insure that they are tight.
   3. Check all plunger pump mounting bolts to insure that they are tight.
   4. Change power end lube oil filters.
   5. Check all supplies needed for routine maintenance such as o-rings, fluid seals, valves, valve inserts, valve seats, valve springs, packing, oil seals, filter elements, etc.

E. Quarterly (or every 250 hours) Preventive Maintenance:
   1. Check all items on "daily", "weekly", and "monthly" list.
   2. Change the power end lube oil and refill with the proper grade of gear oil for upcoming ambient conditions.
   3. Thoroughly clean the power end lube oil suction strainer.
   4. Remove and inspect the plungers and packing assembly components. Replace all packing pressure rings and header rings.
   5. Clean the plunger pump's oil breather and the power end lube oil reservoir breather.

ROUTINE PREVENTIVE MAINTENANCE (Con't)

F. Yearly (or as required) Preventive Maintenance:

1. Replace worn plungers and packing brass.
2. Replace worn or corroded valve covers, suction valve stops, packing nuts, discharge flanges, pump tools, etc.
3 Replace all discharge flange seals and suction manifold seals.
4. Replace any defective gauges and instruments.
5. Inspect (and rebuild if necessary) the power end lube oil pump.

It is difficult to assess wear and tear on a pump based solely on hours operated, due to the variations in duty cycle and types of service. However, roller bearings, rod bearings and gearing may need replacing after approximately **3000 hours**. With these components, signs of extensive wear will generally show up as spalling (or flaking off), of material causing pitting or scoring on the working surfaces. A small amount of this is tolerable on gear faces, but any spalling on a bearing surface is an indication to replace that item as quickly as feasible.

While replacement of these major components is relatively expensive, failure of a main bearing can quite often lead to serious crankshaft and/or power frame damage.

Close observation of the lube oil filters during routine maintenance will generally indicate the condition of roller bearings, gears, and journal bearings. A routine of pulling the inspection covers and observing the condition of the bearings and gears every **500 hours** is recommended.

FLUID END REPAIR PROCEDURES

A. To remove Valves and Seats:

1. Using the SPM 2” hex cover wrench and a 10lb. hammer, remove the suction covers and discharge covers from the fluid cylinder.
2. Turn the suction valve stops approximately 90 degrees and remove them from the fluid cylinder along with the valve springs underneath them.
3. Using an SPM magnetic valve removal tool, cock each suction valve to one side in order to drain any fluid standing over it, and remove the valve from the fluid cylinder. Follow the valve manufacturer's recommendation of removing the insert from the valve.
4. Remove the discharge valve springs and discharge valves from the fluid cylinder.
5. Using an SPM hydraulic seat puller assembly, remove each of the discharge valve seats and suction valve seats.
6. The tapered valve seat bore in the fluid cylinder must be thoroughly cleaned and lightly hand polished with a 220 to 240 grit emory cloth prior to installing new valve seats.
7. Always install a new o-ring seal when reinstalling a valve seat. Do not use any type of grease, sealer, etc.-the valve seat must be installed dry. Upon installing the valve seat hand tight, install the valve in the seat and using a heavy steel bar, hammer the valve seat into the taper.
8. When reinstalling the valves, do not mix one manufacturer's valve with another manufacturer's valve seat. Likewise, do not mix one manufacturer's valve insert with another's valve.
9. When reinstalling the suction valve stop, make certain it is turned perpendicular to the plunger and securely seated in the groove in the cylinder. **Note also the orientation of the valve stop. If the wings on the stop are not symmetrical, they must be pointed towards the suction cover and away from the plunger. (See Engineering Bulletin 1003 for more detail).**
10. Before reinstalling the discharge and suction covers, remove the seals from each, clean the covers thoroughly, and install new seals in the same direction that the old ones came off. Each cover bore in the fluid cylinder must be cleaned thoroughly and lightly hand polished with a 220 to 240 grit emory cloth prior to cover installation.
11. Upon installing the threaded suction and discharge covers with a coating of oil or very light grease, tighten them securely with the 2” hex cover wrench and a 10 lb. hammer.

FLUID END REPAIR PROCEDURES (Con't)

B. To Change Plungers and Packing:

1. Remove the plunger lube fitting from each packing nut.
2. Using the SPM packing nut tool, loosen each of the packing nuts at least one full turn.
3. Remove the suction covers as outlined earlier in "To Remove Valves & Seats".
4. Using the SPM plunger wrench, unscrew the plunger from the crosshead and pull each plunger out of the fluid cylinder through the suction cover bore. Care must be taken to keep contaminants from entering the power end section once the plunger is removed.
5. After securing the seal ring with the SPM seal ring retainer or another suitable tool, completely remove each packing nut from the packing gland thread bore. The seal ring must remain in the cylinder while the packing nut is being removed. Once the packing nut is removed, the seal ring may then be removed from the cylinder. Label each packing nut on removal to ensure that they are installed back into the same bore.
6. Inspect each plunger for wear, scoring, and corrosion on the hard surface area and damage to the face which mates with the crosshead.
7. Inspect each ring of packing brass for excessive wear and scoring.
8. Blow air through the lube port on each packing nut to ensure that the lube passage is unobstructed.
9. Each packing bore, both inside the packing nut and inside the fluid cylinder, must be thoroughly cleaned and lightly hand polished with a 220 to 240 grit emory cloth prior to packing reinstallation.
10. Using new packing header rings and new packing pressure rings, reinstall the packing assembly one piece at a time (refer to the Packing Assembly diagram included in this manual). Each ring should be installed with a coating of light oil only. Care must be taken to avoid damaging the internal and external sealing lips of each packing ring.
11. Replace the o-rings and back-up rings in the seal rings and dress the seal ring seal areas in both the fluid cylinder and packing nut with 220 to 240 grit emory cloth. Reinstall the seal ring as shown in the packing assembly diagram.
12. Reinstall each packing nut into its proper cylinder, screwing it all the way in until tight, then backing it off one to two turns.
13. Coat the hard surface area of each plunger with a light oil and insert it into the packing. Using an aluminum bar and 12 lb. hammer, bump the plunger into the packing while holding it as straight as possible with the packing bore centerline. Continue bumping the plunger through the packing until the threaded bore approaches the crosshead stud; or for solid studded plungers, until the stud approaches the crosshead threads. Carefully align the plunger and crosshead and gently bump the plunger up against the crosshead.
14. Tighten the plunger to the crosshead with the SPM plunger wrench to achieve torque as shown in the installation illustrations.

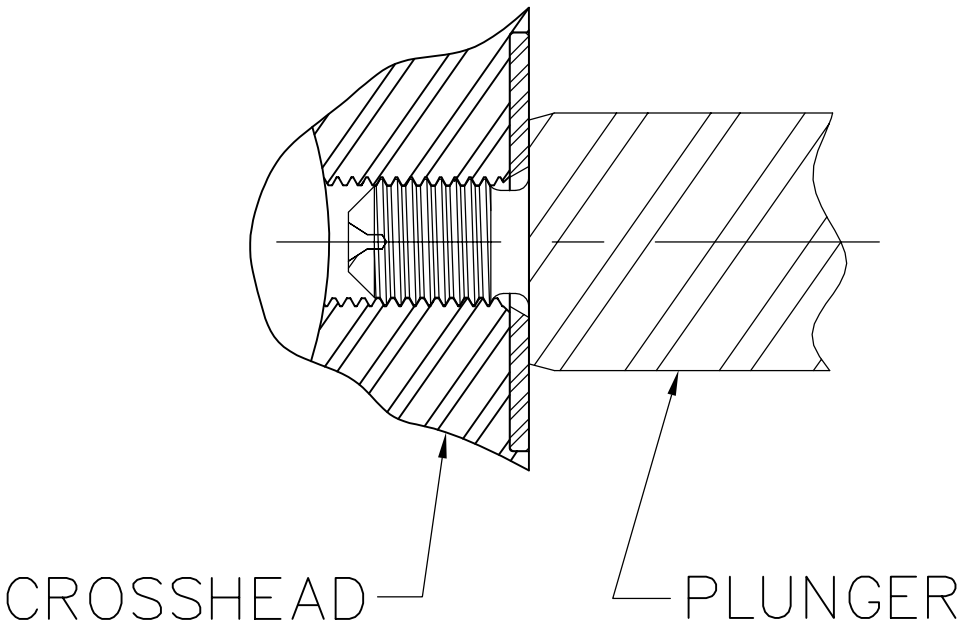
B. To Change Plungers and Packing (Con't):

15. Using the SPM packing nut wrench, packing tighten each nut as tight as possible.

NOTE: The packing nut will need to be retightened only once after the pump is reassembled and ran under pressure for a few revolutions. After that, the packing is completely self-adjusting.

16. Reinstall the packing lube fitting into the packing nut.
17. Reinstall the suction covers as outlined earlier in "To Remove Valves and Seats".

TWS 600–S
2 ½" & 2 ¾" PLUNGERS
INSTALLATION

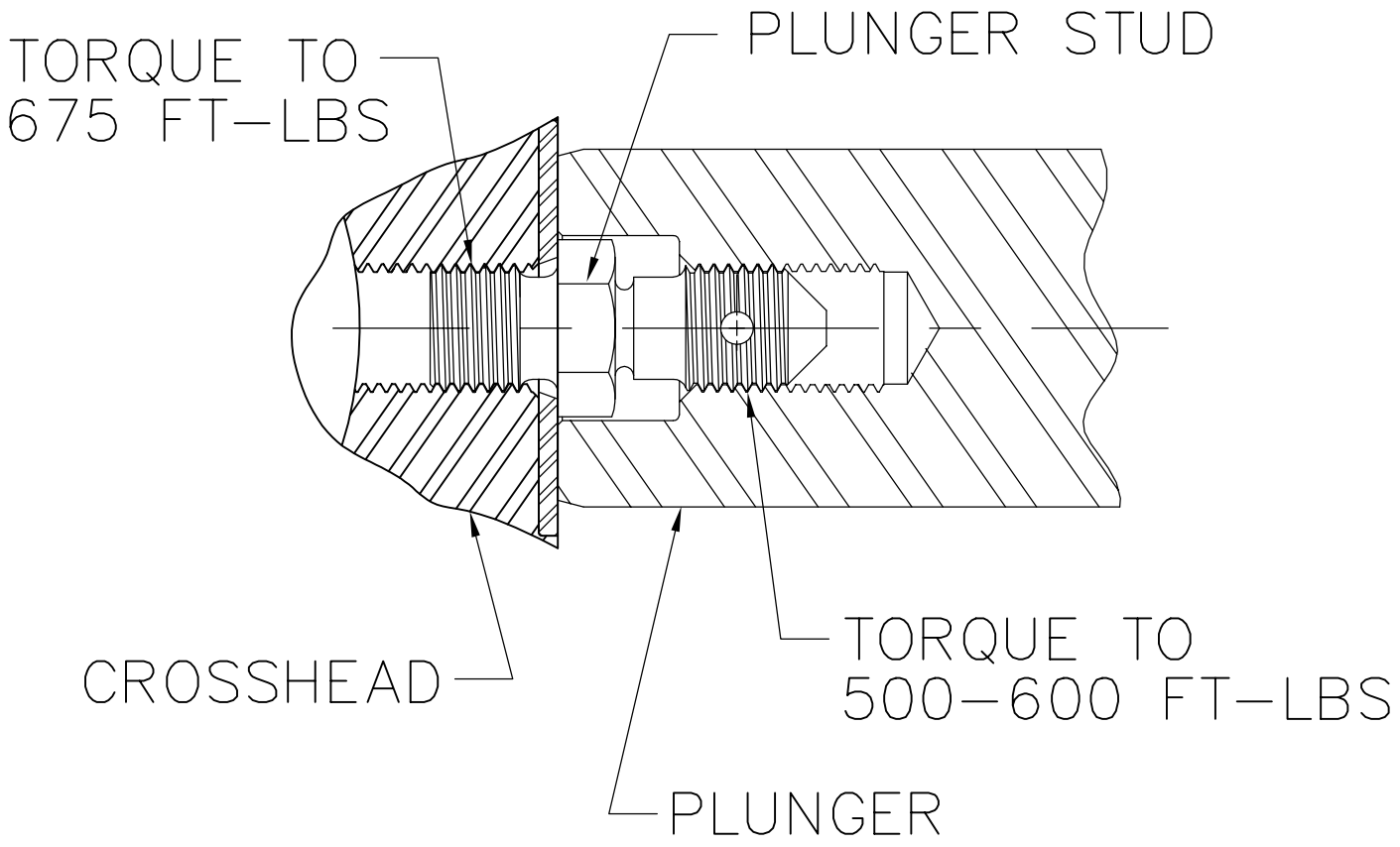


INSTALLATION TORQUE: 500 FT–LB

INSTALL PLUNGER INTO THE CROSSHEAD USING SPM PLUNGER WRENCH. A 3 FT. CHEATER PIPE AND A 170 LB. MAN WILL PROVIDE THE REQUIRED 500 FT–LB. OF TORQUE. WHEN MADE–UP, INSURE THAT THERE IS NO GAP BETWEEN THE PLUNGER AND CROSSHEAD.

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TWS 600–S
3", 3 ½", 4", 4 ½" PLUNGERS
PLUNGER AND PLUNGER STUD INSTALLATION



USING SOCKET, SPM P/N 4P101721, INSTALL BOLT IN CROSSHEAD USING PERMATEX P/N 81789 LOCKNUT THREAD LOCKING COMPOUND.
TORQUE TO 675 FT–LBS.
INSTALL PLUNGER ON OTHER END OF THE BOLT USING SPM PLUNGER WRENCH. A 4 FT. CHEATER PIPE AND A 170 LB. MAN WILL PROVIDE THE REQUIRED 500 TO 600 FT–LB. OF TORQUE (LUBRICATED). WHEN MADE–UP, INSURE THAT THERE IS NO GAP BETWEEN THE PLUNGER AND CROSSHEAD.

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FLUID END REPAIR PROCEDURES (Con't)

C. To Remove Discharge Flanges:

1. Using a 1⅝" wrench, remove the four 1" nuts from each of the two discharge flanges.
2. Remove each discharge flange from the fluid cylinder. Remove the fluid seals from both the inlet side and outlet side of each discharge flange. Closely inspect each discharge flange for internal erosion and corrosion. Inspect the discharge flange threads for wear and damage. The discharge flange seal surfaces should be thoroughly cleaned and lightly hand polished with a 220 to 240 grit emory cloth prior to reinstallation.
3. Inspect the fluid cylinder discharge flange bores for erosion and corrosion. Thoroughly clean and lightly hand polish each bore with a 220 to 240 grit emory cloth prior to reinstalling the discharge flanges.
4. Using new fluid seals and a coating of light oil, reinstall each discharge flange being careful to avoid damaging the seal on the inlet side of the flange. Reinstall the four 1" hex nuts on each flange and evenly tighten them to the proper torque (refer to the Torque Table included in this manual).

D. To Remove the Suction Manifold:

1. Using a 1⅛" wrench, remove the twelve 3/4" capscrews which secure the suction manifold to the fluid cylinder, and drop the suction manifold away from the fluid cylinder.
2. Inspect the suction manifold for internal erosion and corrosion. Remove the three suction manifold o-ring seals and inspect the seal grooves in the manifold for erosion and corrosion. Inspect the face and O.D. of the pipe at each end of the manifold for erosion and corrosion. Note: The SPM manifold incorporates a Victaulic "ES" type connection at each end which will accept either a Victaulic "End Seal Cut Groove" gasket or a Victaulic "Standard Cut Groove" gasket.
   The condition of the pipe face at each end of the manifold is important for sealing purposes only when the "End Seal (ES)" gasket is used.
3. Inspect the bottom face of the fluid cylinder for erosion and corrosion. Thoroughly clean and lightly hand polish the bottom face of the fluid cylinder with a 220 to 240 grit emory cloth prior to reinstalling the suction manifold.
4. Using new o-ring seals, reinstall the suction manifold. Reinstall the twelve 3/4" capscrews and evenly tighten them to the proper torque (refer to the Torque Table included in this manual).

FLUID END REPAIR PROCEDURES (Con't)

E. To Remove The Fluid End:

1. Disconnect the plunger from the crosshead using the SPM plunger wrench as outlined earlier in Section B "To Change Plunger and Packing".
2. Disconnect the plunger lube hoses and whatever discharge piping connections and suction piping connections are necessary for fluid end removal.
3. Remove the four (4) 1" bolts & the four (4) 1⅜" bolts which secure the fluid cylinder to the power end. Remove the fluid cylinder from the power end. *Note that the fluid cylinder is only secured by these 8 bolts and must be supported before the bolts are removed.
4. Examine the mating surfaces of the fluid cylinder and nose plate for signs of damage. Examine mounting bolt threads for signs of damage. Repair or replace as necessary.
5. Clean and lubricate the fluid cylinder mounting bolt threads, and hand tighten the (8) bolts. Using a torque wrench, tighten the four (4) 1" bolts to 500 ft-lbs, and the four (4) 1⅜" bolts to 1300 ft-lbs.
6. Reconnect all hose and piping connections and tighten plunger to crosshead to torque of 250 to 350 ft-lbs.

POWER END REPAIR PROCEDURES

Due to the complexity of the task and the need for special tools and training, SPM does not recommend the complete disassembly of the TWS600S power end or speed reducer in the field. If extensive power end repairs are required, the pump should be returned to the SPM plant where expert service can be obtained on an expedited emergency basis if needed. When field repairs are required, they should be performed in a clean well equipped shop by a trained well service pump technician, and should follow the guidelines below:

A. To Remove and Disassemble the Speed Reducer:

The TWS600S Speed Reducer assembly may be removed from the power end without being disassembled by using a $1^{7}/_{16}$" wrench to remove the eight 7/8" hex nuts which secure the speed reducer to the power end. SPM highly recommends removing the speed reducer intact when at all possible. When speed reducer internal repairs are required, follow the procedure below to inspect or replace the bull gear, pinion shaft, or roller bearings:

1. Remove the unit's mechanical driveline from the pump's input shaft.
2. Remove the power end rear cover and disconnect the lube line to the outboard main bearing.
3. Remove the lubrication hoses from the speed reducer and remove the speed reducer as a complete assembly from the power end. Lay the speed reducer down on it's mounting flange face with the input shaft facing up.
4. Using a 1½" wrench, remove the 1" capscrew which secures the splined companion flange to the input shaft. Remove the companion flange and inspect it for wear.
5. Using a 3/4" wrench, remove the eight 1/2" capscrews which hold the pinion seal retainer to the speed reducer housing. Remove the pinion seal retainer and shims from the speed reducer, remove the oil seal from the retainer, and scrape all old silicone sealer from the retainer.
6. Using a punch and hammer, drive the three 3/4" dowel pins from the outer flange of the speed reducer housing. Using a 3/4" wrench, remove the twenty-four 1/2" capscrews, nuts, and washers which secure the speed reducer cover plate to the housing. Remove the eight 1/2" capscrews which secures the bearing cover to the speed reducer. Remove the bearing cover and shims. Lift the cover plate away. Scrape all old silicone sealer from the speed reducer cover and from the flange on the housing. Using a brass punch and hammer, drive both bearing cups (outer races) from the cover plate and inspect them for wear or damage.
7. Remove the pinion shaft from the speed reducer and inspect both tapered roller bearing cones for wear and damage. If the bearing cones need to be removed from the shaft, do so by carefully heating them with an acetylene torch until they will slip off the shaft. Care must be taken to avoid overheating the shaft itself. Inspect the shaft for wear and damage to the gear teeth, seal surface, and bearing journals.

POWER END REPAIR PROCEDURES (Con't)

A. To Remove and Disassemble the Speed Reducer (Con't):

8. Remove the bull gear from the pump and inspect the gear teeth and both tapered roller bearing cones for wear and damage.
9. Using a 3/4" wrench, remove the eight 1/2" capscrews which hold the rear pinion bearing cap on the speed reducer housing. Remove the bearing cap and scrape all old silicone sealer from it.
10. Turn the speed reducer housing over on the opposite face. Using a brass punch and hammer, drive the tapered roller bearing cups (outer races) out of the speed reducer housing and inspect them for wear and damage.
11. Reassembly of the speed reducer should be performed in the reverse order of the disassembly instructions above. Installation of new tapered roller bearing cones on the pinion shaft or bull gear can be performed by pressing them on or by heating the cone assembly thru any one of several methods. A temperature controlled heating plate, hot oil bath unit, hot air cabinet, or induction heating unit can be used to safely heat the bearings. When heating a bearing for installation, the temperature must not exceed 250 degrees Fahrenheit (121 degrees Celsius). Installation of new tapered roller bearing cups in the housing should be performed by tapping them into the housing with a soft metal bar or by pressing them into the housing.

    Upon reinstallation the bull gear and pinion shaft, it is extremely important to establish the proper bearing "pre-load" (.006" to .010") before operating the pump. This must be accomplished by obtaining end play readings with a dial indicator and removing the appropriate thickness of bearing adjustment shims. Silicone liquid gasket material should not be applied to the bearing retainers until after the bearing pre-load has been set properly. When reinstalling the pump driveline hub on the input shaft, care must be taken to avoid overheating and damaging the pinion oil seal.

B. To Remove the Crankshaft, Connecting Rods, and Crossheads:

1. Remove the speed reducer assembly as outlined previously.
2. Remove the plunger and seal retainers, as outlined previously.
3. Using a 9/16" wrench, remove the 3/8" capscrews which secure the side covers and rear cover to the power end housing.
4. Remove the 1/8" cotter pin from each of the twelve connecting rod bolts. Using a 15/16" wrench, remove the slotted 5/8" hex nuts from each of the twelve connecting rod bolts. Remove the three connecting rod caps taking care to avoid damaging the rod bearing half trapped inside each cap. Shove each connecting rod/crosshead assembly all the way forward taking care to avoid damaging the rod bearing half trapped inside each connecting rod.

POWER END REPAIR PROCEDURES (Con't)

5. Using a 3/4" wrench, remove the 1/2" capscrews which secure the wrist pin retainer plate to the crosshead or using a 9/16" wrench, remove the 3/8" capscrews which secure the wrist pin retainer washers to the wrist pin. Using a slide hammer with 1"-11½" LPT puller thread, pull the wrist pin from the crosshead. Remove the connecting rod from the crosshead and take it out of the power end. Rotate the crosshead 90 degrees and remove it thru the side of the power end. Remove the other two connecting rods and crossheads in the same manner.
6. Reattach each match-marked connecting rod cap to the rod from which it was removed. Note: If the connecting rod bearing halves are to be removed and re-used, they must be tagged so that they can be reinstalled in the same connecting rod or cap.
7. Using a 9/16" wrench, remove the 3/8" capscrews which secure the tack drive housing to the power end. Remove the tack drive assembly.
8. Using a 9/16" wrench, disconnect the lube oil hose which is attached to the main bearing housing inside the power end. Using a $1^{7}/_{16}$" wrench, remove the eight 7/8" nuts which secure the main bearing housing to the power end. Remove the main bearing housing and inspect the bearing for wear.
9. Turn the power end housing over on it's side so that the crankshaft extension is pointed straight up. The power end must be blocked up so that it rests level. Using a 9/16" wrench, remove the 3/8" capscrews which secure the three bearing retainers against the left hand inner main bearing's outer race. Lift the crankshaft from the power end.
10. Using a 9/16" wrench, disconnect all six lube oil hoses from the fittings at the rear of each crosshead guide. Using a 15/16" wrench, remove the two 5/8" capscrews which secure each crosshead guide to the power end housing. Remove all six crosshead guides and inspect them for wear.
11. Reassembly of the power end should be performed in the reverse order of the disassembly instructions shown above.

NOTE: Prior to reassembling the power end, all lubrication hoses and lube passages should be flushed and cleaned thoroughly.

When reinstalling the crosshead slides, care must be taken to avoid torquing the 5/8" capscrews to more than 35 ft.-lbs. torque. Excessive torque can distort the surface of the slide causing crosshead misalignment.

The clearance between the top of the crosshead and top crosshead slide should be checked with the feeler gauge from the side opening of the power frame (not from the rear of the power frame). Clearance between the top crosshead slide and the crosshead should be between .008-.012". If this clearance is not present, the bottom slide should be removed and appropriate shims inserted between the slide and the power frame at both the front and rear slide mounts.

POWER END REPAIR PROCEDURES (Con't)

When reinstalling the crankshaft, care must be taken to shim the left hand fixed type inner main bearing so that it has only .003" to .015" lateral movement. Care must also be taken to shim the main bearing housing and speed reducer in order to maintain .015" to .100" lateral running clearance on the two outer main bearings.

All capscrews, nuts, etc. must be torqued properly upon reassembly (see Torque Table included in this manual).

TORQUE TABLE

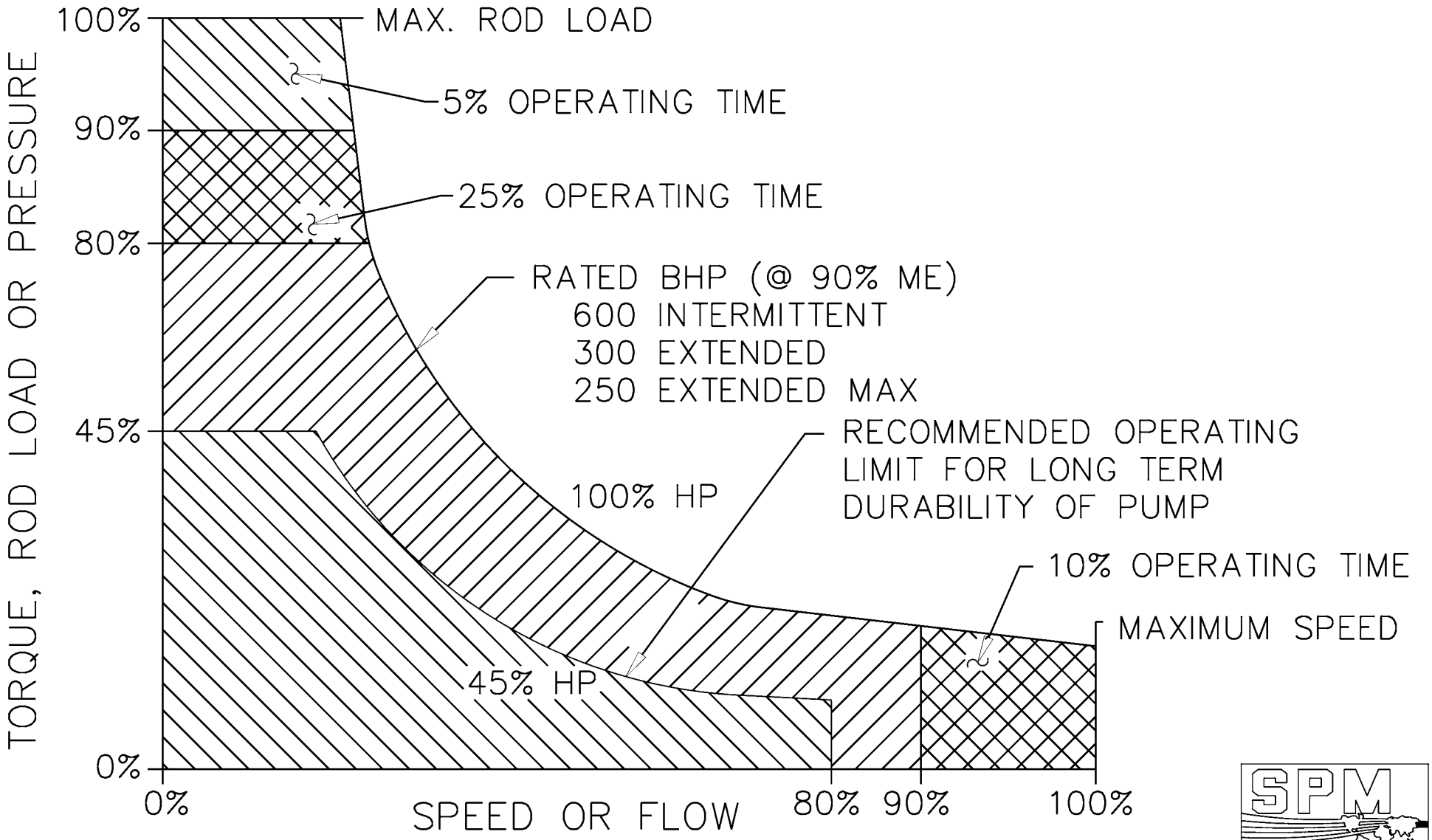
THREAD DIA. & THREAD PITCH	CAPSCREWS, NUTS & BOLTS SAE GRADE 5		ALLOY STEEL STUDS & NUTS SAE GRADE 7	
	DRY THREADS TORQUE (FT. LBS.)	LUBRICATED THDS. TORQUE (FT. LBS.)	DRY THREADS TORQUE (FT. LBS.)	LUBRICATED THDS. TORQUE (FT. LBS.)
1/4-20 UNC	6.7	5.1	---	---
5/16-18 UNC	13.9	10.4	---	---
3/8-16 UNC	24.7	16.5	---	---
7/16-14 UNC	39.4	29.6	---	---
1/2-13 UNC	60.3	45.2	---	---
5/8-11 UNC	110.0	80.0	---	---
3/4-10 UNC	212.0	159.0	---	---
7/8-9 UNC	315.0	236.0	425.0	318.0
1-8 UNC	472.0	354.0	635.0	477.0
1⅛-7 UNC	633.0	475.0	900.0	675.0
1¼-7	900.0	675.0	1270.0	955.0
1⅜-8 NS	---	---	1660.0	1245.0
1⅝-8 NS	---	---	---	2300.0
1¾-8 NS	---	---	---	2400.0

To obtain the required torque on the 1⅜", 1⅝", and 1¾" studs, when a torque wrench is not available, use a hammer lug wrench. After tightening with a standard wrench, turn the nut another 30 degrees (1/12th turn) with the hammer wrench.

Do not use hammer lug wrench to tighten mounting bolts.

PUMP DUTY CYCLE CURVE
TWS600S/THB300S/TEM250S PUMP MODELS

AVERAGE PUMP OPERATION TIME:
INTERMITTENT – 4 HOURS PER DAY – 5 DAYS PER WEEK
EXTENDED – 8 HOURS PER DAY – 5 DAYS PER WEEK
EXTENDED MAX – 16 HOURS PER DAY – 5 DAYS PER WEEK



Flow Control, Inc.

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Section IV

PUMP PARTS INFORMATION

Parts
General Information

SPM stocks a large inventory of genuine "original equipment" replacement parts for each of it's pumps. In order to expedite a parts order and avoid any delays, please provide the following information with your order:

1. The part number and description (refer to drawings and parts lists in this section) of each item ordered.
2. The quantity of each part, kit, or assembly ordered.
3. The model number and serial number of the pump (see identification tags on the fluid end and power end).
4. Your purchase order number.
5. Specify method of shipment, complete shipping address, complete billing address and telephone number at the destination of the shipment.

Parts and service may be ordered through the following locations as well as the SPM web page at www.spmflo.com:

SPM – Fort Worth 7601 Wyatt Dr. Fort Worth, TX 76108 Phone: 1-800-342-7458 Local Phone: (817) 246-2461 Fax: (817) 246-6324	**SPM – Houston** 363 N. Sam Houston Pkwy. E. Suite 1100 Houston, TX 77060 Phone: (281) 820-7807 Fax: (281) 820-7804	**SPM – Lafayette** 106 Pine Park Drive Lafayette, LA 70508 Phone: (318) 233-3533 Fax: (318) 235-7803
SPM – Aberdeen Badentoy Crescent Badentoy Industrial Park, Portlethen, Aberdeen Scotland AB12 4YD Phone: (441) 1224 783666 Fax: (441) 1224 784184	**SPM – Singapore** 545 Orchard Road 15-02 Far East Shopping Ctr. Singapore 238882 Phone: (65) 6738-3078 Fax: (65) 6234-2581	**SPM – Dubai** Oilfields Ctr Supply LTD P.O. Box 1518, Building 22 Jebel Ali, Dubai, U.A.E. Phone: (971)-4-8836-368 Fax: (971)-4-8836-485
SPM – Rocky Mountains 7450 Johnson Dr. Suites C & D Frederick, CO 80530 Phone: (720) 494-1805 Fax: (720) 494-7208	**SPM – Grande Prairie** #104, 11231 – 97 Ave Grande Prairie, Alberta Canada T8V 5N5 Phone: (780) 402-3857 Fax: (780) 402-7081	**SPM – Red Deer** Unit A, 8060 Edgar Industrial Cres. Red Deer, Alberta Canada T4P 3R3 Phone: (403) 341-3410 Fax: (403) 341-3072
SPM – South Texas Business Hwy. 281 North Alice, TX 78332 Phone: (361) 661-0900 Fax: (361) 661-0909	**SPM – Odessa** 2424 E. I-20 Odessa, Tx 79766 Phone: (432) 580-3887 Fax: (432) 333-1351	**SPM – Rock Springs** 253 Industrial Dr. Rock Springs, WY 82901 Phone: (307) 362-7727 Fax: (307) 362-1055
SPM – West Virginia 7645 Highway 19 North jane Lew, WV 26378 Phone: (304) 884-7222 Fax: (304) 884-7622	**SPM – Medicine Hat Canada** 1348 32nd Street S.W. Medicine Hat, Alberta Canada T1B3N7 Phone: (403) 504-8353 Fax: (403) 504-8370	**SPM – Mobile Recertification Unit** 7601 Wyatt Drive Fort Worth, Tx 76108 Phone: (817) 246-2461 Fax: (817) 246-8610

There is a 25 percent restocking charge for any returned, undamaged parts. Returned parts must include an SPM issued "Return Authorization Number" on the shipping label and packing list. Parts must be returned within 90 days of the original shipping date. Returned parts must be shipped prepaid, to the appropriate address, including a copy of the original invoice or delivery ticket.
invoice or delivery ticket.

FLUID END

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6” PACKING ASSEMBLY
6.5” PACKING ASSEMBLY
6.75” PACKING ASSEMBLY

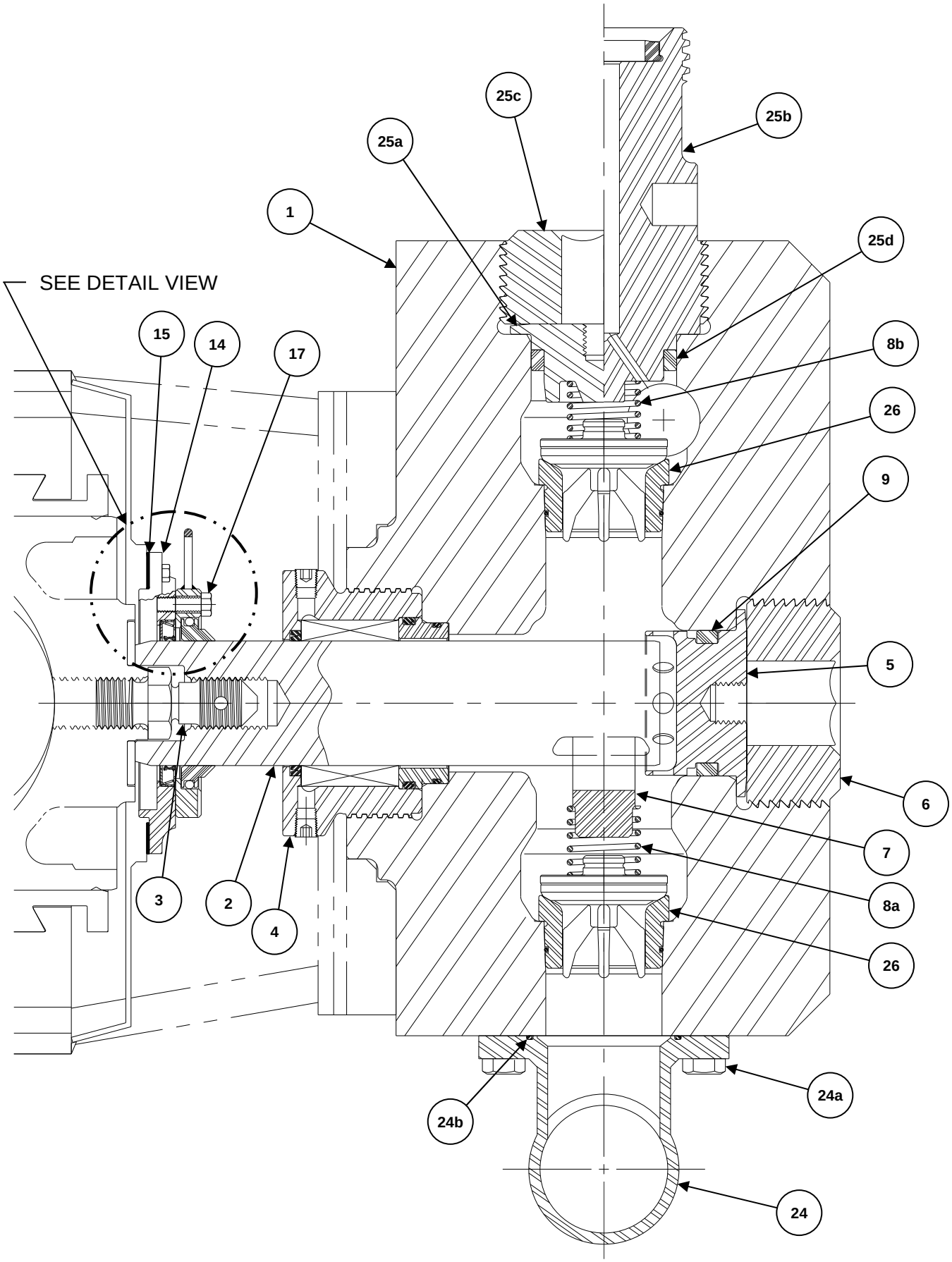


FIGURE 1: FLUID CYLINDER ASSEMBLY

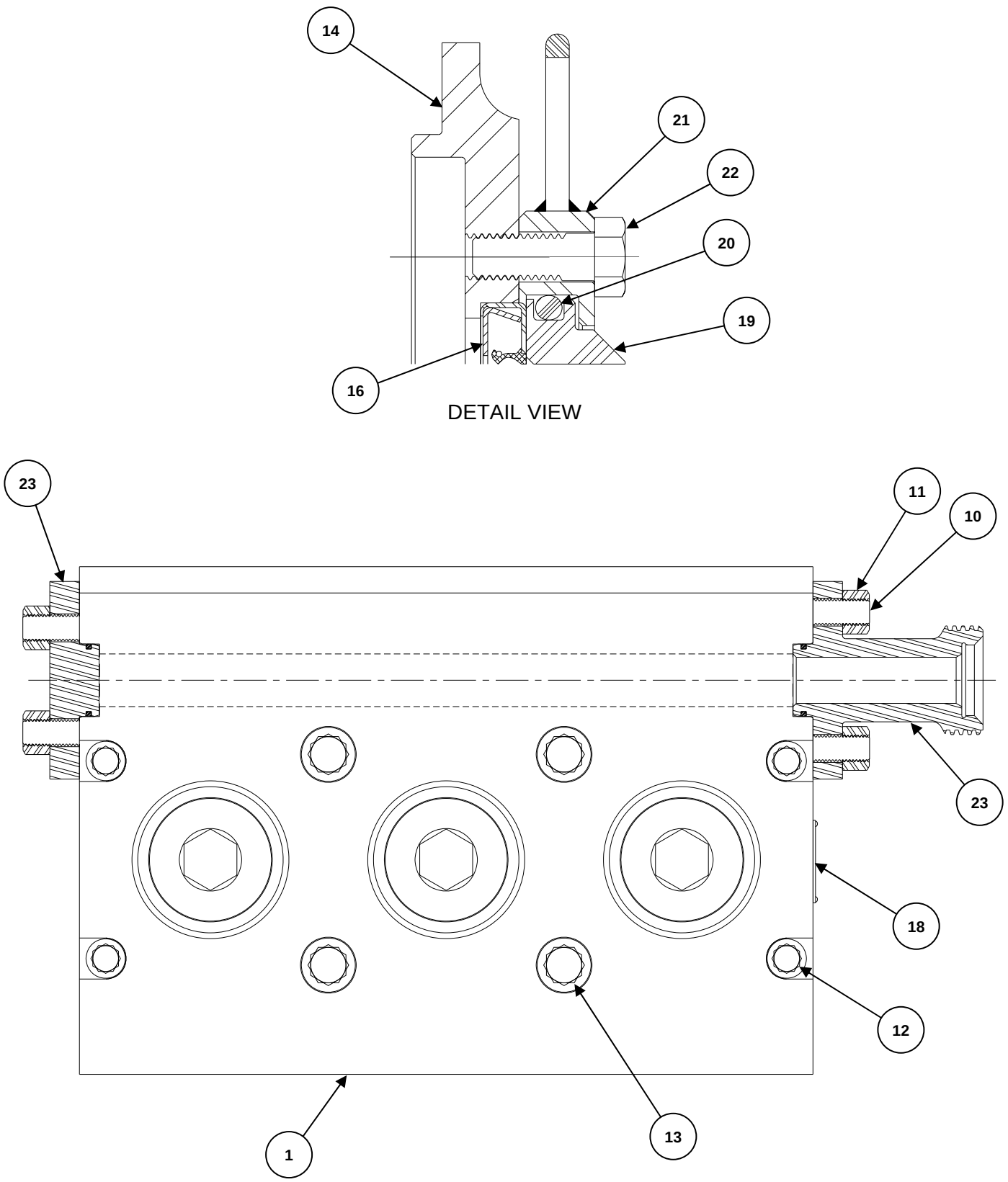


FIGURE 1: FLUID CYLINDER ASSEMBLY

GROOVE STYLE

2.5" FLUID CYLINDER ASSEMBLY – 4A104727

Ref No.	Name of Part	Qty.	Part No.
1	FLUID CYLINDER	1	1P104705
2	PLUNGER, 2.5" (INCLUDES PLUNGER STUD)	3	2P104716
3			
4	PACKING NUT	3	3P104707
5	SUCTION COVER	3	3P104710
6	SUCTION COVER NUT	3	3P104723
7	SUCTION VALVE STOP	3	3P101634
8 a-b	VALVE SPRING	6	4P104721
9	SUCTION COVER SEAL D-RING	3	P109313
10	1"~8NC x 3 1/2 STUD	8	P14896
11	1"~8NC HHN	8	P14897
12	1"~12UN TPFS x 11.00 LG	4	P19430
13	1 3/8"~12UN TPFS x 10.50 LG	4	P19431
14	DIAPHRAM PLATE	3	2P107889
15	DIAPHRAM PLATE GASKET	3	3P103019
16	DIAPHRAM OIL SEAL	3	P107904
17	DIAPHRAM SCREW	12	P14890
18	NAME PLATE	1	4P108169
19	DEFLECTOR	3	2P109696
20	DEFLECTOR O-RING	3	P106968
21	DEFLECTOR HOUSING	3	2P109699
22	DEFLECTOR HOUSING SCREW	9	P12975
23	DISCHARGE FLANGE OPTIONS: (NEXT 5 ITEMS)	---	---
	FLANGE ASSEMBLY, 2" 1502 FEMALE X FEMALE	1	3A102713
	FLANGE ASSEMBLY, 2" 1502 FEMALE X BLANK	1	3A102535
	FLANGE ASSEMBLY, 2" 1502 FEMALE X BLEED OFF	1	3A102797
	FLANGE ASSEMBLY, 2" 1502 MALE X BLEED OFF	1	2A110896
	FLANGE ASSEMBLY, 2" 15K SAFETY IRON	1	2A110921
	NUT KIT, 2" 1502 (INCLUDED WITH MALE FLANGE ASSEMBLY)	1	4A12977
	CLAMP KIT, 2" 15K (REQUIRED WHEN USING SAFETY IRON FLANGE ASSEMBLIES) Not Shown	1	2A25919
24	SUCTION MANIFOLD OPTIONS: (NEXT 5 ITEMS)	---	---
	SUCTION MANIFOLD, 4" VIC (PLAIN)	1	3A102536
	SUCTION MANIFOLD, 4" VIC (W/ VALVE LIFTERS)	1	2A103929
	SUCTION MANIFOLD, 4" 602F (CO2)	1	2A107271
	SUCTION MANIFOLD, 5" VIC (PLAIN)	1	3A103391
	SUCTION MANIFOLD, 5" VIC (W/ VALVE LIFTERS)	1	2A108050
24a	MANIFOLD SCREW (INCLUDED WITH SUCTION MANIFOLD)	12	P10070
24b	MANIFOLD SEAL (INCLUDED WITH SUCTION MANIFOLD)	3	P100203
25	DISCHARGE COVER OPTIONS: (NEXT 3 ITEMS)	---	---
	DISCHARGE COVER ASSEMBLY, PLAIN	1	3A104735
	DISCHARGE COVER ASSEMBLY, CENTER GAUGE	1	3A104733
	DISCHARGE COVER ASSEMBLY, DUAL GAUGE	1	3A106328
25a	DISCHARGE COVER, PLAIN (INCLUDED WITH COVER ASSEMBLY)	3	2P104711
25b	DISCHARGE COVER, GAUGE (INCLUDED WITH COVER ASSEMBLY)	3	2P104719
25c	RETAINER NUT, PLAIN COVER (INCLUDED WITH COVER ASSEMBLY)	3	3P104723
25d	SEAL, DISCHARGE COVER (INCLUDED WITH COVER ASSEMBLY)	3	P109313

26	VALVE ASSEMBLY	1	2A109609PP
	UPPER VALVE W/ INSERT (INCLUDED WITH VALVE ASSEMBLY)	1	2A109608PP
	VALVE SEAT (INCLUDED WITH VALVE ASSEMBLY)	1	2A109605
*	VALVE LIFTER TOOL (INCLUDED WITH SUCTION MANIFOLD)	1	3P103921
*	FLUID END MAINTENANCE TOOLS	1	4A105055
*	VALVE COVER WRENCH	1	4P100160
*	SLIDE HAMMER	1	4A100161
*	PACKING NUT TOOL	1	4P103401

*Items Not Shown

GROOVE STYLE

2.75" FLUID CYLINDER ASSEMBLY – 4A105150

Ref No.	Name of Part	Qty.	Part No.
1	FLUID CYLINDER	1	1P104705
2	PLUNGER, 2.75" (INCLUDES PLUNGER STUD)	3	2P105094
3			
4	PACKING NUT	3	3P104708
5	SUCTION COVER	3	3P104710
6	SUCTION COVER NUT	3	3P104723
7	SUCTION VALVE STOP	3	3P101634
8 a-b	VALVE SPRING	6	4P104721
9	SUCTION COVER SEAL D-RING	3	P109313
10	1"~8NC x 3 1/2 STUD	8	P14896
11	1"~8NC HHN	8	P14897
12	1"~12UN TPFS x 11.00 LG	4	P19430
13	1 3/8"~12UN TPFS x 10.50 LG	4	P19431
14	DIAPHRAM PLATE	3	2P107890
15	DIAPHRAM PLATE GASKET	3	3P103019
16	DIAPHRAM OIL SEAL	3	P107905
17	DIAPHRAM SCREW	12	P14890
18	NAME PLATE	1	4P108169
19	DEFLECTOR	3	2P108312
20	DEFLECTOR O-RING	3	P16388
21	DEFLECTOR HOUSING	3	3P108313
22	DEFLECTOR HOUSING SCREW	9	P12975
23	DISCHARGE FLANGE OPTIONS: (NEXT 5 ITEMS)	---	---
	FLANGE ASSEMBLY, 2" 1502 FEMALE X FEMALE	1	3A102713
	FLANGE ASSEMBLY, 2" 1502 FEMALE X BLANK	1	3A102535
	FLANGE ASSEMBLY, 2" 1502 FEMALE X BLEED OFF	1	3A102797
	FLANGE ASSEMBLY, 2" 1502 MALE X BLEED OFF	1	2A110896
	FLANGE ASSEMBLY, 2" 15K SAFETY IRON	1	2A110921
	NUT KIT, 2" 1502 (INCLUDED WITH MALE FLANGE ASSEMBLY)	1	4A12977
	CLAMP KIT, 2" 15K (REQUIRED WHEN USING SAFETY IRON FLANGE ASSEMBLIES) Not Shown	1	2A25919
24	SUCTION MANIFOLD OPTIONS: (NEXT 5 ITEMS)	---	---
	SUCTION MANIFOLD, 4" VIC (PLAIN)	1	3A102536
	SUCTION MANIFOLD, 4" VIC (W/ VALVE LIFTERS)	1	2A103929
	SUCTION MANIFOLD, 4" 602F (CO2)	1	2A107271
	SUCTION MANIFOLD, 5" VIC (PLAIN)	1	3A103391
	SUCTION MANIFOLD, 5" VIC (W/ VALVE LIFTERS)	1	2A108050
24a	MANIFOLD SCREW (INCLUDED WITH SUCTION MANIFOLD)	12	P10070
24b	MANIFOLD SEAL (INCLUDED WITH SUCTION MANIFOLD)	3	P100203
25	DISCHARGE COVER OPTIONS: (NEXT 3 ITEMS)	---	---
	DISCHARGE COVER ASSEMBLY, PLAIN	1	3A104735
	DISCHARGE COVER ASSEMBLY, CENTER GAUGE	1	3A104733
	DISCHARGE COVER ASSEMBLY, DUAL GAUGE	1	3A106328
25a	DISCHARGE COVER, PLAIN (INCLUDED WITH COVER ASSEMBLY)	3	2P104711

25b	DISCHARGE COVER, GAUGE (INCLUDED WITH COVER ASSEMBLY)	3	2P104719
25c	RETAINER NUT, PLAIN COVER (INCLUDED WITH COVER ASSEMBLY)	3	3P104723
25d	SEAL, DISCHARGE COVER (INCLUDED WITH COVER ASSEMBLY)	3	P109313
26	VALVE ASSEMBLY	1	2A109609PP
	UPPER VALVE W/ INSERT (INCLUDED WITH VALVE ASSEMBLY)	1	2A109608PP
	VALVE SEAT (INCLUDED WITH VALVE ASSEMBLY)	1	2A109605
*	VALVE LIFTER TOOL (INCLUDED WITH SUCTION MANIFOLD)	1	3P103921
*	FLUID END MAINTENANCE TOOLS	1	4A105055
*	VALVE COVER WRENCH	1	4P100160
*	SLIDE HAMMER	1	4A100161
*	PACKING NUT TOOL	1	4P103401

*Items Not Shown

GROOVE STYLE

3" FLUID CYLINDER ASSEMBLY – 4A104768

Ref No.	Name of Part	Qty.	Part No.
1	FLUID CYLINDER	1	1P104705
2	PLUNGER, 3"	3	2P103345
3	PLUNGER STUD	3	4P101714
4	PACKING NUT	3	3P104709
5	SUCTION COVER	3	3P104710
6	SUCTION COVER NUT	3	3P104723
7	SUCTION VALVE STOP	3	3P101634
8 a-b	VALVE SPRING	6	4P104721
9	SUCTION COVER SEAL D-RING	3	P109313
10	1"~8NC x 3 1/2 STUD	8	P14896
11	1"~8NC HHN	8	P14897
12	1"~12UN TPFS x 11.00 LG	4	P19430
13	1 3/8"~12UN TPFS x 10.50 LG	4	P19431
14	DIAPHRAM PLATE	3	2P107891
15	DIAPHRAM PLATE GASKET	3	3P103019
16	DIAPHRAM OIL SEAL	3	P107906
17	DIAPHRAM SCREW	12	P14890
18	NAME PLATE	1	4P108169
19	DEFLECTOR	3	2P109697
20	DEFLECTOR O-RING	3	P10786
21	DEFLECTOR HOUSING	3	2P109700
22	DEFLECTOR HOUSING SCREW	9	P12975
23	DISCHARGE FLANGE OPTIONS: (NEXT 5 ITEMS)	---	---
	FLANGE ASSEMBLY, 2" 1502 FEMALE X FEMALE	1	3A102713
	FLANGE ASSEMBLY, 2" 1502 FEMALE X BLANK	1	3A102535
	FLANGE ASSEMBLY, 2" 1502 FEMALE X BLEED OFF	1	3A102797
	FLANGE ASSEMBLY, 2" 1502 MALE X BLEED OFF	1	2A110896
	FLANGE ASSEMBLY, 2" 15K SAFETY IRON	1	2A110921
	NUT KIT, 2" 1502 (INCLUDED WITH MALE FLANGE ASSEMBLY)	1	4A12977
	CLAMP KIT, 2" 15K (REQUIRED WHEN USING SAFETY IRON FLANGE ASSEMBLIES) Not Shown	1	2A25919
24	SUCTION MANIFOLD OPTIONS: (NEXT 5 ITEMS)	---	---
	SUCTION MANIFOLD, 4" VIC (PLAIN)	1	3A102536
	SUCTION MANIFOLD, 4" VIC (W/ VALVE LIFTERS)	1	2A103929
	SUCTION MANIFOLD, 4" 602F (CO2)	1	2A107271
	SUCTION MANIFOLD, 5" VIC (PLAIN)	1	3A103391
	SUCTION MANIFOLD, 5" VIC (W/ VALVE LIFTERS)	1	2A108050
24a	MANIFOLD SCREW (INCLUDED WITH SUCTION MANIFOLD)	12	P10070
24b	MANIFOLD SEAL (INCLUDED WITH SUCTION MANIFOLD)	3	P100203
25	DISCHARGE COVER OPTIONS: (NEXT 3 ITEMS)	---	---
	DISCHARGE COVER ASSEMBLY, PLAIN	1	3A104735
	DISCHARGE COVER ASSEMBLY, CENTER GAUGE	1	3A104733
	DISCHARGE COVER ASSEMBLY, DUAL GAUGE	1	3A106328
25a	DISCHARGE COVER, PLAIN (INCLUDED WITH COVER ASSEMBLY)	3	2P104711

25b	DISCHARGE COVER, GAUGE (INCLUDED WITH COVER ASSEMBLY)	3	2P104719
25c	RETAINER NUT, PLAIN COVER (INCLUDED WITH COVER ASSEMBLY)	3	3P104723
25d	SEAL, DISCHARGE COVER (INCLUDED WITH COVER ASSEMBLY)	3	P109313
26	VALVE ASSEMBLY	1	2A109609PP
	UPPER VALVE W/ INSERT (INCLUDED WITH VALVE ASSEMBLY)	1	2A109608PP
	VALVE SEAT (INCLUDED WITH VALVE ASSEMBLY)	1	2A109605
*	VALVE LIFTER TOOL (INCLUDED WITH SUCTION MANIFOLD)	1	3P103921
*	FLUID END MAINTENANCE TOOLS	1	4A105055
*	VALVE COVER WRENCH	1	4P100160
*	SLIDE HAMMER	1	4A100161
*	PACKING NUT TOOL	1	4P103401

*Items Not Shown

GROOVE STYLE

3.5" FLUID CYLINDER ASSEMBLY – 4A103347

Ref No.	Name of Part	Qty.	Part No.
1	FLUID CYLINDER	1	1P102978
2	PLUNGER, 3.5"	3	2P103344
3	PLUNGER STUD	3	4P101714
4	PACKING NUT	3	3P103038G
5	SUCTION COVER	3	3P104373
6	SUCTION COVER NUT	3	3P104372
7	SUCTION VALVE STOP	3	3P100176
8 a-b	VALVE SPRING	6	4P100198
9	SUCTION COVER SEAL D-RING	3	P108291
10	1"~8NC x 3 1/2 STUD	8	P14896
11	1"~8NC HHN	8	P14897
12	1"~12UN TPFS x 11.00 LG	4	P19430
13	1 3/8"~12UN TPFS x 10.50 LG	4	P19431
14	DIAPHRAM PLATE	3	2P107892
15	DIAPHRAM PLATE GASKET	3	3P103019
16	DIAPHRAM OIL SEAL	3	P107907
17	DIAPHRAM SCREW	12	P14890
18	NAME PLATE	1	4P108170
19	DEFLECTOR	3	2P107976
20	DEFLECTOR O-RING	3	P106916
21	DEFLECTOR HOUSING	3	3P107973
22	DEFLECTOR HOUSING SCREW	9	P12975
23	DISCHARGE FLANGE OPTIONS: (NEXT 5 ITEMS)	---	---
	FLANGE ASSEMBLY, 2" 1502 FEMALE X FEMALE	1	3A102713
	FLANGE ASSEMBLY, 2" 1502 FEMALE X BLANK	1	3A102535
	FLANGE ASSEMBLY, 2" 1502 FEMALE X BLEED OFF	1	3A102797
	FLANGE ASSEMBLY, 2" 1502 MALE X BLEED OFF	1	2A110896
	FLANGE ASSEMBLY, 2" 15K SAFETY IRON	1	2A110921
	NUT KIT, 2" 1502 (INCLUDED WITH MALE FLANGE ASSEMBLY)	1	4A12977
	CLAMP KIT, 2" 15K (REQUIRED WHEN USING SAFETY IRON FLANGE ASSEMBLIES) Not Shown	1	2A25919
24	SUCTION MANIFOLD OPTIONS: (NEXT 5 ITEMS)	---	---
	SUCTION MANIFOLD, 4" VIC (PLAIN)	1	3A102536
	SUCTION MANIFOLD, 4" VIC (W/ VALVE LIFTERS)	1	2A103929
	SUCTION MANIFOLD, 4" 602F (CO2)	1	2A107271
	SUCTION MANIFOLD, 5" VIC (PLAIN)	1	3A103391
	SUCTION MANIFOLD, 5" VIC (W/ VALVE LIFTERS)	1	2A108050
24a	MANIFOLD SCREW (INCLUDED WITH SUCTION MANIFOLD)	12	P10070
24b	MANIFOLD SEAL (INCLUDED WITH SUCTION MANIFOLD)	3	P100203
25	DISCHARGE COVER OPTIONS: (NEXT 3 ITEMS)	---	---
	DISCHARGE COVER ASSEMBLY, PLAIN	1	3A105151
	DISCHARGE COVER ASSEMBLY, CENTER GAUGE	1	3A105152
	DISCHARGE COVER ASSEMBLY, DUAL GAUGE	1	3A105153
25a	DISCHARGE COVER, PLAIN (INCLUDED WITH COVER ASSEMBLY)	3	3P105149

25b	DISCHARGE COVER, GAUGE (INCLUDED WITH COVER ASSEMBLY)	3	2P103069
25c	RETAINER NUT, PLAIN COVER (INCLUDED WITH COVER ASSEMBLY)	3	3P104372
25d	SEAL, DISCHARGE COVER (INCLUDED WITH COVER ASSEMBLY)	3	P109379
26	VALVE ASSEMBLY	1	2A109375PP
	UPPER VALVE W/ INSERT (INCLUDED WITH VALVE ASSEMBLY)	1	2A109537PP
	VALVE SEAT (INCLUDED WITH VALVE ASSEMBLY)	1	2A109541
*	VALVE LIFTER TOOL (INCLUDED WITH SUCTION MANIFOLD)	1	3P103921
*	FLUID END MAINTENANCE TOOLS	1	4A105055
*	VALVE COVER WRENCH	1	4P100160
*	SLIDE HAMMER	1	4A100161
*	PACKING NUT TOOL	1	4P103401

*Items Not Shown

GROOVE STYLE

4" FLUID CYLINDER ASSEMBLY – 2A103341

Ref No.	Name of Part	Qty.	Part No.
1	FLUID CYLINDER	1	1P102978
2	PLUNGER, 4"	3	2P103313
3	PLUNGER STUD	3	4P101714
4	PACKING NUT	3	3P103037G
5	SUCTION COVER	3	3P104373
6	SUCTION COVER NUT	3	3P104372
7	SUCTION VALVE STOP	3	3P100176
8 a-b	VALVE SPRING	6	4P100198
9	SUCTION COVER SEAL D-RING	3	P108291
10	1"~8NC x 3 1/2 STUD	8	P14896
11	1"~8NC HHN	8	P14897
12	1"~12UN TPFS x 11.00 LG	4	P19430
13	1 3/8"~12UN TPFS x 10.50 LG	4	P19431
14	DIAPHRAM PLATE	3	2P107893
15	DIAPHRAM PLATE GASKET	3	3P103019
16	DIAPHRAM OIL SEAL	3	P107908
17	DIAPHRAM SCREW	12	P14890
18	NAME PLATE	1	4P108170
19	DEFLECTOR	3	2P107975
20	DEFLECTOR O-RING	3	P23372
21	DEFLECTOR HOUSING	3	3P107972
22	DEFLECTOR HOUSING SCREW	9	P12975
23	DISCHARGE FLANGE OPTIONS: (NEXT 5 ITEMS)	---	---
	FLANGE ASSEMBLY, 2" 1502 FEMALE X FEMALE	1	3A102713
	FLANGE ASSEMBLY, 2" 1502 FEMALE X BLANK	1	3A102535
	FLANGE ASSEMBLY, 2" 1502 FEMALE X BLEED OFF	1	3A102797
	FLANGE ASSEMBLY, 2" 1502 MALE X BLEED OFF	1	2A110896
	FLANGE ASSEMBLY, 2" 15K SAFETY IRON	1	2A110921
	NUT KIT, 2" 1502 (INCLUDED WITH MALE FLANGE ASSEMBLY)	1	4A12977
	CLAMP KIT, 2" 15K (REQUIRED WHEN USING SAFETY IRON FLANGE ASSEMBLIES) Not Shown	1	2A25919
24	SUCTION MANIFOLD OPTIONS: (NEXT 5 ITEMS)	---	---
	SUCTION MANIFOLD, 4" VIC (PLAIN)	1	3A102536
	SUCTION MANIFOLD, 4" VIC (W/ VALVE LIFTERS)	1	2A103929
	SUCTION MANIFOLD, 4" 602F (CO2)	1	2A107271
	SUCTION MANIFOLD, 5" VIC (PLAIN)	1	3A103391
	SUCTION MANIFOLD, 5" VIC (W/ VALVE LIFTERS)	1	2A108050
24a	MANIFOLD SCREW (INCLUDED WITH SUCTION MANIFOLD)	12	P10070
24b	MANIFOLD SEAL (INCLUDED WITH SUCTION MANIFOLD)	3	P100203
25	DISCHARGE COVER OPTIONS: (NEXT 3 ITEMS)	---	---
	DISCHARGE COVER ASSEMBLY, PLAIN	1	3A105151
	DISCHARGE COVER ASSEMBLY, CENTER GAUGE	1	3A105152
	DISCHARGE COVER ASSEMBLY, DUAL GAUGE	1	3A105153
25a	DISCHARGE COVER, PLAIN (INCLUDED WITH COVER ASSEMBLY)	3	3P105149

25b	DISCHARGE COVER, GAUGE (INCLUDED WITH COVER ASSEMBLY)	3	2P103069
25c	RETAINER NUT, PLAIN COVER (INCLUDED WITH COVER ASSEMBLY)	3	3P104372
25d	SEAL, DISCHARGE COVER (INCLUDED WITH COVER ASSEMBLY)	3	P109379
26	VALVE ASSEMBLY	1	2A109375PP
	UPPER VALVE W/ INSERT (INCLUDED WITH VALVE ASSEMBLY)	1	2A109537PP
	VALVE SEAT (INCLUDED WITH VALVE ASSEMBLY)	1	2A109541
*	VALVE LIFTER TOOL (INCLUDED WITH SUCTION MANIFOLD)	1	3P103921
*	FLUID END MAINTENANCE TOOLS	1	4A105055
*	VALVE COVER WRENCH	1	4P100160
*	SLIDE HAMMER	1	4A100161
*	PACKING NUT TOOL	1	4P103401

*Items Not Shown

GROOVE STYLE

4.5" FLUID CYLINDER ASSEMBLY – 2A103360

Ref No.	Name of Part	Qty.	Part No.
1	FLUID CYLINDER	1	1P102978
2	PLUNGER, 4.5"	3	2P103312
3	PLUNGER STUD	3	4P101714
4	PACKING NUT	3	3P103027G
5	SUCTION COVER	3	3P104373
6	SUCTION COVER NUT	3	3P104372
7	SUCTION VALVE STOP	3	3P100176
8a	VALVE SPRING	3	4P100198
8b	VALVE SPRING – HEAVY DUTY	3	4P100281
9	SUCTION COVER SEAL D-RING	3	P108291
10	1"~8NC x 3 1/2 STUD	8	P14896
11	1"~8NC HHN	8	P14897
12	1"~12UN TPFS x 11.00 LG	4	P19430
13	1 3/8"~12UN TPFS x 10.50 LG	4	P19431
14	DIAPHRAM PLATE	3	2P107894
15	DIAPHRAM PLATE GASKET	3	3P103019
16	DIAPHRAM OIL SEAL	3	P107909
17	DIAPHRAM SCREW	12	P14890
18	NAME PLATE	1	4P108170
19	DEFLECTOR	3	2P109698
20	DEFLECTOR O-RING	3	P23373
21	DEFLECTOR HOUSING	3	2P109701
22	DEFLECTOR HOUSING SCREW	9	P12975
23	DISCHARGE FLANGE OPTIONS: (NEXT 5 ITEMS)	---	---
	FLANGE ASSEMBLY, 2" 1502 FEMALE X FEMALE	1	3A102713
	FLANGE ASSEMBLY, 2" 1502 FEMALE X BLANK	1	3A102535
	FLANGE ASSEMBLY, 2" 1502 FEMALE X BLEED OFF	1	3A102797
	FLANGE ASSEMBLY, 2" 1502 MALE X BLEED OFF	1	2A110896
	FLANGE ASSEMBLY, 2" 15K SAFETY IRON	1	2A110921
	NUT KIT, 2" 1502 (INCLUDED WITH MALE FLANGE ASSEMBLY)	1	4A12977
	CLAMP KIT, 2" 15K (REQUIRED WHEN USING SAFETY IRON FLANGE ASSEMBLIES) Not Shown	1	2A25919
24	SUCTION MANIFOLD OPTIONS: (NEXT 5 ITEMS)	---	---
	SUCTION MANIFOLD, 4" VIC (PLAIN)	1	3A102536
	SUCTION MANIFOLD, 4" VIC (W/ VALVE LIFTERS)	1	2A103929
	SUCTION MANIFOLD, 4" 602F (CO2)	1	2A107271
	SUCTION MANIFOLD, 5" VIC (PLAIN)	1	3A103391
	SUCTION MANIFOLD, 5" VIC (W/ VALVE LIFTERS)	1	2A108050
24a	MANIFOLD SCREW (INCLUDED WITH SUCTION MANIFOLD)	12	P10070
24b	MANIFOLD SEAL (INCLUDED WITH SUCTION MANIFOLD)	3	P100203
25	DISCHARGE COVER OPTIONS: (NEXT 3 ITEMS)	---	---
	DISCHARGE COVER ASSEMBLY, PLAIN	1	3A105151
	DISCHARGE COVER ASSEMBLY, CENTER GAUGE	1	3A105152
	DISCHARGE COVER ASSEMBLY, DUAL GAUGE	1	3A105153

25a	DISCHARGE COVER, PLAIN (INCLUDED WITH COVER ASSEMBLY)	3	3P105149
25b	DISCHARGE COVER, GAUGE (INCLUDED WITH COVER ASSEMBLY)	3	2P103069
25c	RETAINER NUT, PLAIN COVER (INCLUDED WITH COVER ASSEMBLY)	3	3P104372
25d	SEAL, DISCHARGE COVER (INCLUDED WITH COVER ASSEMBLY)	3	P109379
26	VALVE ASSEMBLY	1	2A109375PP
	UPPER VALVE W/ INSERT (INCLUDED WITH VALVE ASSEMBLY)	1	2A109537PP
	VALVE SEAT (INCLUDED WITH VALVE ASSEMBLY)	1	2A109541
*	VALVE LIFTER TOOL (INCLUDED WITH SUCTION MANIFOLD)	1	3P103921
*	FLUID END MAINTENANCE TOOLS	1	4A105055
*	VALVE COVER WRENCH	1	4P100160
*	SLIDE HAMMER	1	4A100161
*	PACKING NUT TOOL	1	4P103401

*Items Not Shown

PACKING ASSEMBLY DRAWING

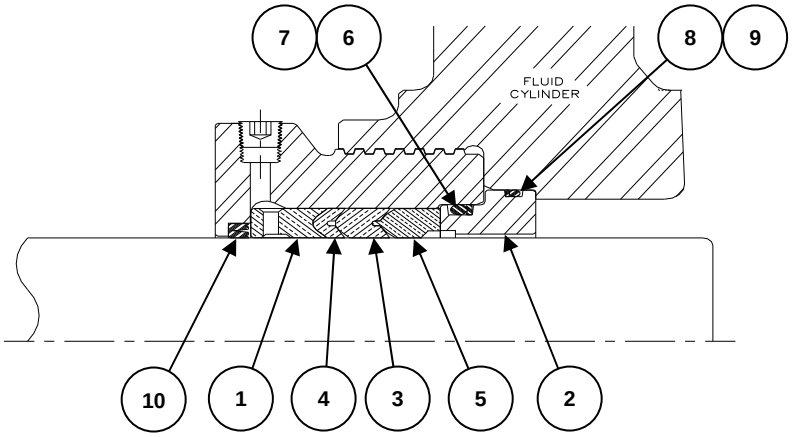


FIGURE 3: PACKING ASSEMBLY DETAIL

2.5” PACKING ASSEMBLY

Ref No.	Name of Part	Qty.	Part No.
1	LANTERN RING	1	3P103534
2	SEAL RING	1	3P103522
3	PRESSURE RING (STANDARD)	--	----
4	PRESSURE RING (SHORT)	3	P104734
5	HEADER RING	1	P103572HP
6	O-RING	1	P102244
7	BACK-UP	1	P103575
8	O-RING	1	P18481
9	BACK-UP	1	P103576
10	WIPER RING	1	P104736

2.75” PACKING ASSEMBLY

Ref No.	Name of Part	Qty.	Part No.
1	LANTERN RING	1	3P103535
2	SEAL RING	1	3P103523
3	PRESSURE RING (STANDARD)	--	----
4	PRESSURE RING (SHORT)	3	P101389
5	HEADER RING	1	P101390HP
6	O-RING	1	P101955
7	BACK-UP	1	P105316
8	O-RING	1	P18481
9	BACK-UP	1	P103576
10	WIPER RING	1	P102207

3” PACKING ASSEMBLY

Ref No.	Name of Part	Qty.	Part No.
1	LANTERN RING	1	3P103051
2	SEAL RING	1	3P103524
3	PRESSURE RING (STANDARD)	--	----
4	PRESSURE RING (SHORT)	3	P103366
5	HEADER RING	1	P100332HP
6	O-RING	1	P103368
7	BACK-UP	1	P103370
8	O-RING	1	P18481
9	BACK-UP	1	P103576
10	WIPER RING	1	P102093

FIGURE 3: PACKING ASSEMBLY DETAIL

3.5” PACKING ASSEMBLY

Ref No.	Name of Part	Qty.	Part No.
1	LANTERN RING	1	3P103050
2	SEAL RING	1	3P103034
3	PRESSURE RING (STANDARD)	1	P100297
4	PRESSURE RING (SHORT)	1	P101741
5	HEADER RING	1	P100298HP
6	O-RING	1	P101519
7	BACK-UP	1	P103349
8	O-RING	1	P103063
9	BACK-UP	1	P103064
10	WIPER RING	1	P102208

4” PACKING ASSEMBLY

Ref No.	Name of Part	Qty.	Part No.
1	LANTERN RING	1	3P103049
2	SEAL RING	1	3P103033
3	PRESSURE RING (STANDARD)	1	P100343
4	PRESSURE RING (SHORT)	1	P101340
5	HEADER RING	1	P100342HP
6	O-RING	1	P103061
7	BACK-UP	1	P103062
8	O-RING	1	P103063
9	BACK-UP	1	P103064
10	WIPER RING	1	P101883

4.5” PACKING ASSEMBLY

Ref No.	Name of Part	Qty.	Part No.
1	LANTERN RING	1	3P103048
2	SEAL RING	1	3P103022
3	PRESSURE RING (STANDARD)	1	P100652
4	PRESSURE RING (SHORT)	1	P100971
5	HEADER RING	1	P100195HP
6	O-RING	1	P103369
7	BACK-UP	1	P103371
8	O-RING	1	P103063
9	BACK-UP	1	P103064
10	WIPER RING	1	P101252

POWER END

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FIGURE 4: TWS600S POWER END, LUBE ASSEMBLY
FIGURE 5: TWS600S GEAR BOX, LUBE ASSEMBLY

POWER END ASSEMBLY DRAWINGS

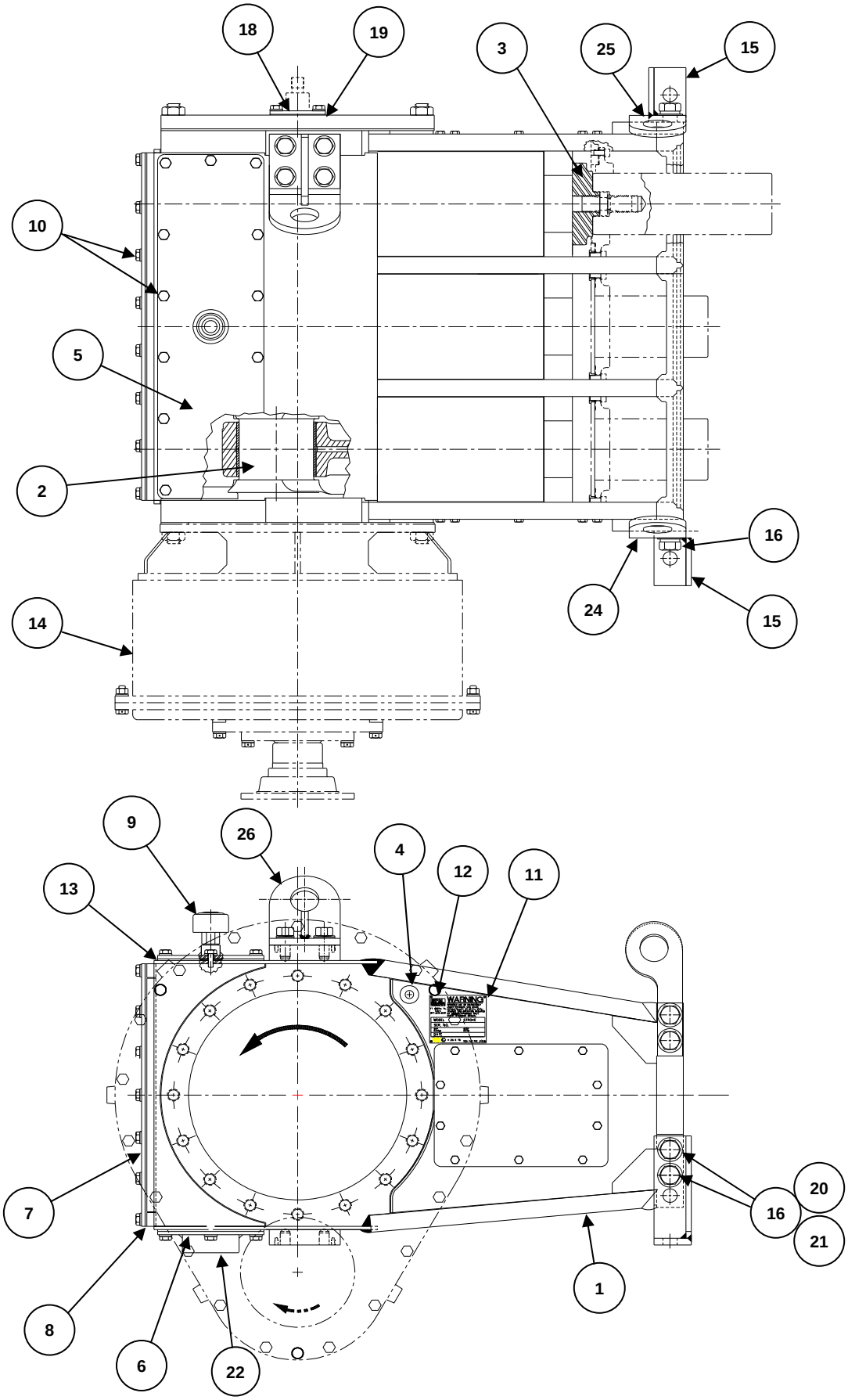


FIGURE 1: TWS600S POWER END, TOP VIEW

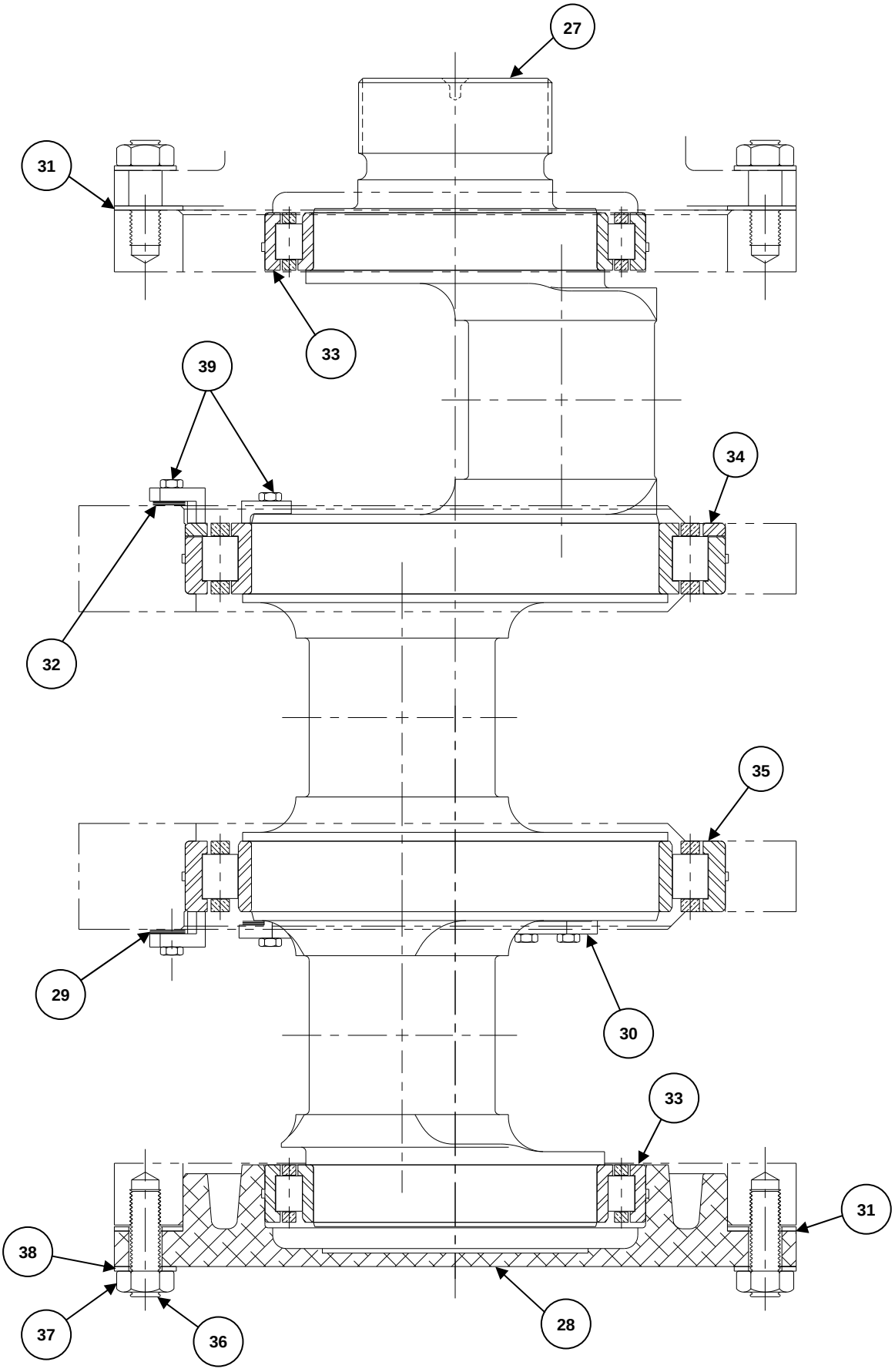


FIGURE 2: TWS600S POWER END CRANKSHAFT ASSEMBLY

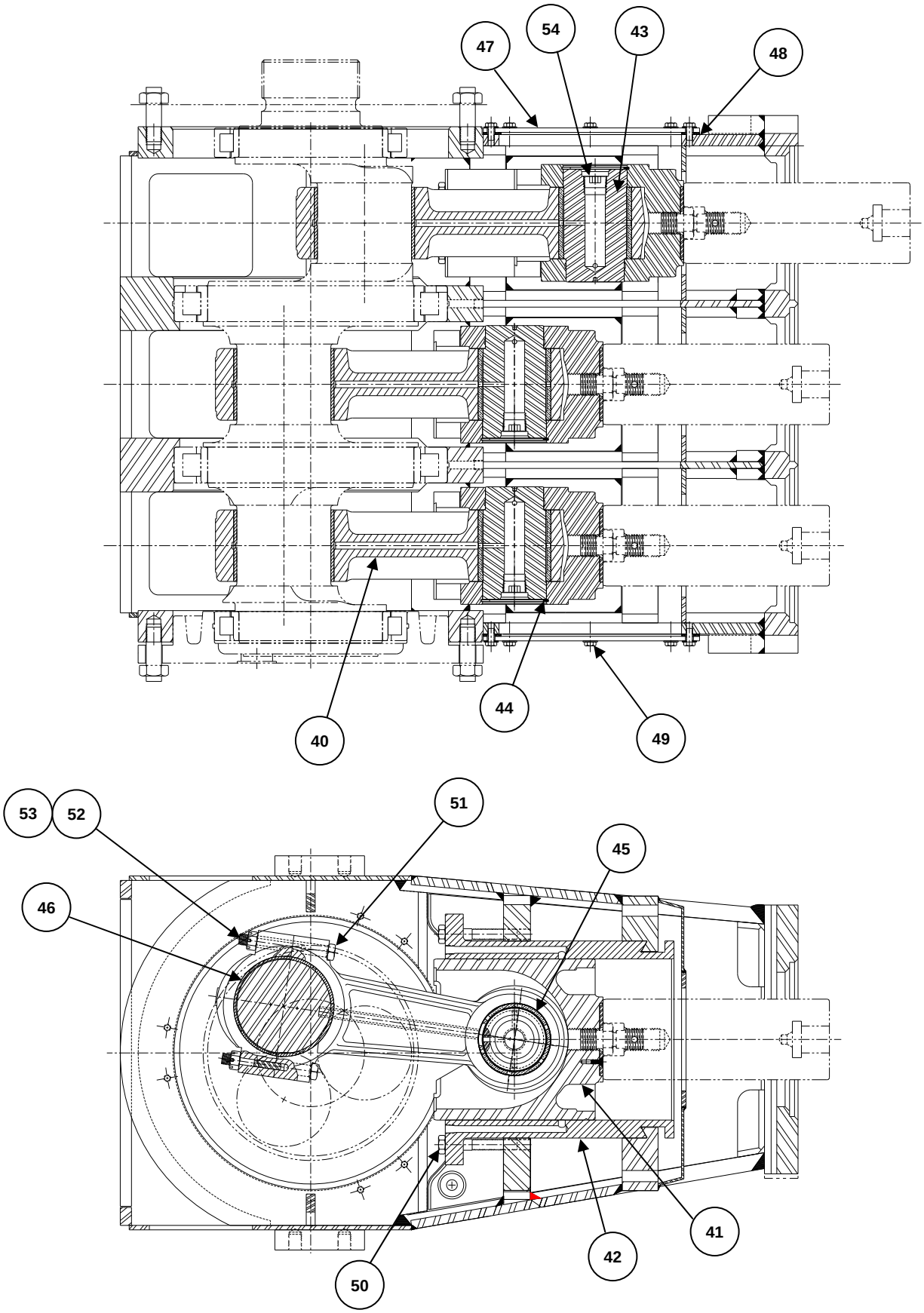


FIGURE 3: TWS600S CONN. ROD/CROSS HEAD ASSEMBLY

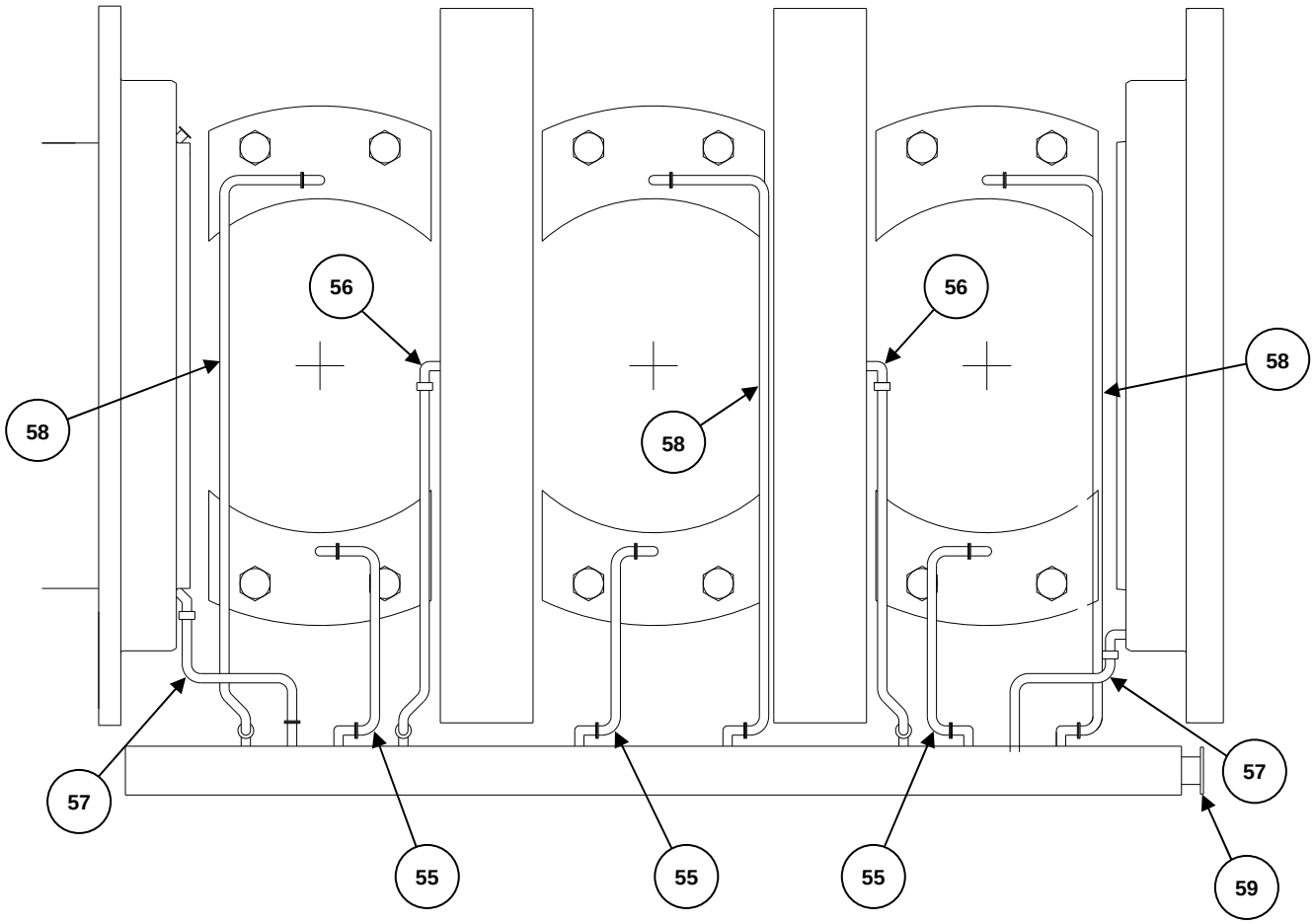


FIGURE 4: TWS600S POWER FRAME LUBE ASSEMBLY

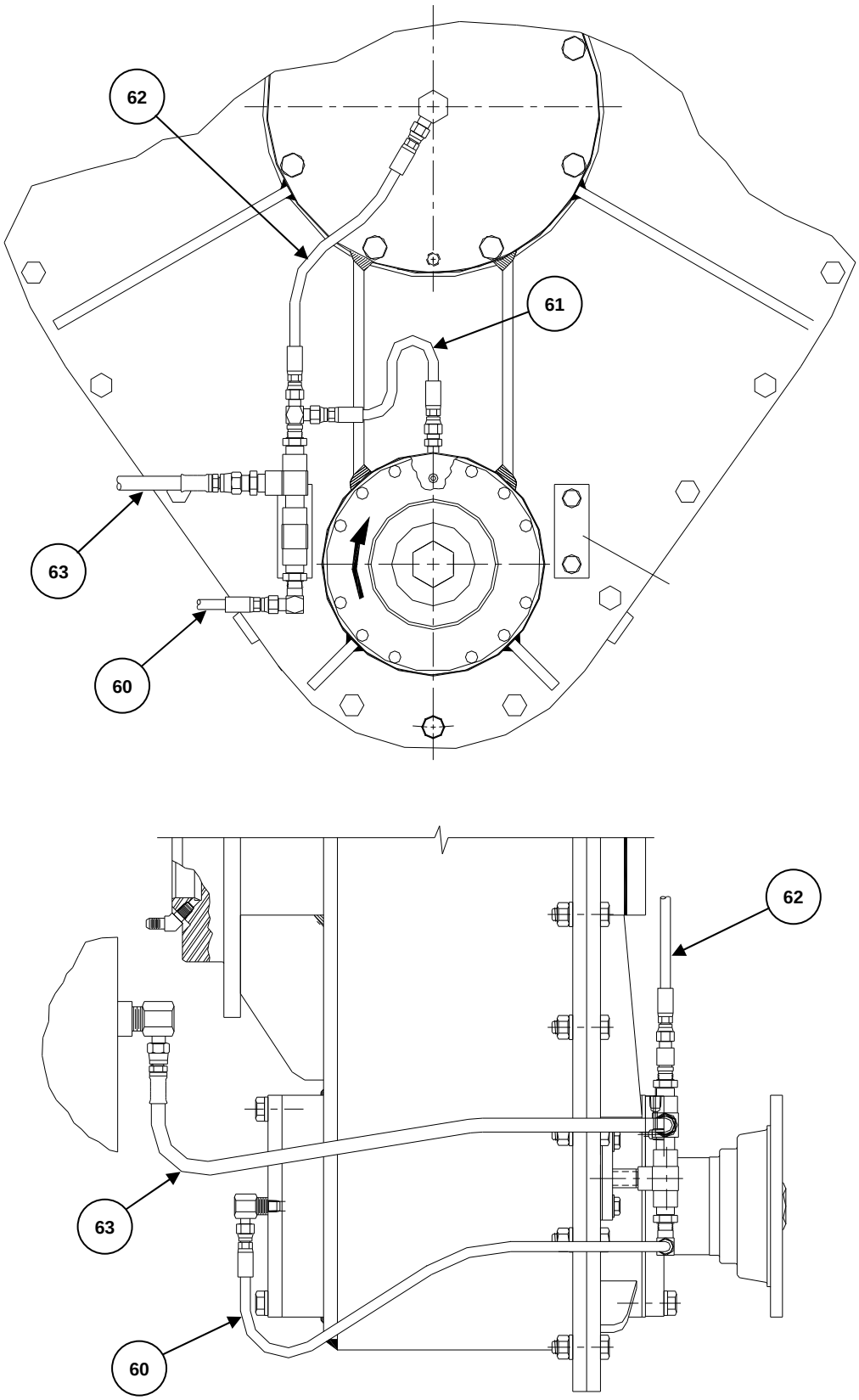
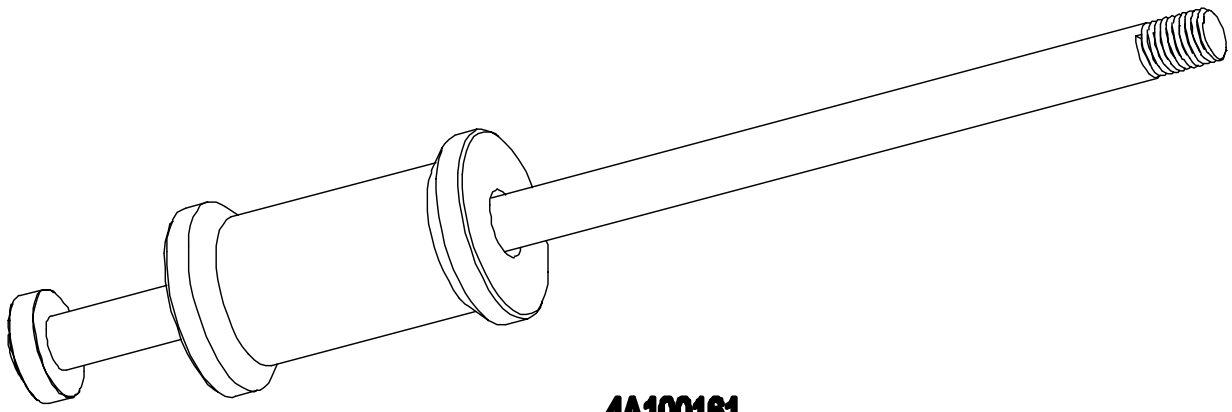


FIGURE 5: LUBRICATION ASSEMBLY TWS600S GEARBOX

REF NO.	DESCRIPTION	QTY	PART NO.
	POWER END ASSEMBLY – FIGURE 1		
1	POWER FRAME MACHINING - STYLE III	1	2P111669
2	CRANKSHAFT ASSEMBLY	1	2A103092
3	CONN ROD/CROSSHEAD ASSEMBLY	1	1A103093
4	POWER FRAME LUBE ASSEMBLY	1	3A100171
5	TOP COVER	1	3P103098
6	BOTTOM COVER	1	3P103099
7	REAR COVER	1	2P103100
8	REAR COVER GASKET	1	2P103101
9	OIL BREATHER	1	P100066
10	3/8”~16UNC FLNG HD x 1.00 LG. – COATED	REF	P111491
11	POWER END NAMEPLATE	1	2P110040
12	DRIVE SCREW	4	P18055
13	TOP/BOTTOM COVER GASKET	2	3P103110
14	GEAR REDUCER LUBE ASSY. (SEE FIGURE 5)	1	2A100170
15	FRONT FOOT - L/H	2	3P103393
16	7/8"~9UNC HHCS x 1.50 LG	4	P19239
17	7/8"~9UNC SHSS x .88 LG (NOT SHOWN)	4	P19942
18	TACH DRIVE COVER	1	4P100093
19	TACH DRIVE COVER GASKET	1	4P100101
20	7/8"FLAT WASHER	REF	P14893
21	7/8" LOCK WASHER	REF	P101680
22	3" PVC PIPE PLUG	1	P108753
23	HARDWARE KIT/TWS600S (NOT SHOWN)	1	2A111837
24	FRONT LIFTING BRACKET – RH	1	2P112520
25	FRONT LIFTING BRACKET – LH	1	2P112521
26	REAR LIFTING BRACKET ASSEMBLY	2	2A112531
	CRANK SHAFT ASSEMBLY – FIGURE 2		
27	CRANKSHAFT	1	1P100080
28	OUTSIDE BEARING HOUSING	1	2P100077
29	BEARING RACE RETAINER - OUTER	6	3P103094
30	BEARING RACE RETAINER - INNER	6	4P100083
31	OUTSIDE BEARING GASKET	2	4P100092
32	SHIM SET	6	4P100084
33	MAIN BEARING - OUTSIDE	2	P100109
34	MAIN BEARING - INSIDE FIXED	1	P100110
35	MAIN BEARING - INSIDE FLOATING	1	P10011
36	STUD	REF	P14878
37	7/8"~9NC HEAVY HEX NUT	REF	P14881
38	7/8" PLAIN WAHER - TYPE 'A'	REF	P14893
39	3/8"~16NC HHCS x .88 LG	REF	P111513

	CONN ROD & CROSSHEAD ASSEMBLY – FIGURE 3		
40	CONN. ROD	3	1P102967
41	CROSSHEAD ASSY - SHORT PIN	3	3A105905
42	CROSSHEAD GUIDE	6	2P102975
43	CROSSHEAD WRIST PIN - SHORT	3	2P105902
44	WRIST PIN RETAINER RING	REF	P105906
45	WRIST PIN BEARING	3	3P100089
46	CONN. ROD BEARING	3	P100108
47	SIDE COVER	2	3P103085
48	SIDE COVER GASKET	2	3P103086
49	3/8"~16NC FLNG x .75 LG - COATED	16	P111490
50	5/8"~11NC HHCS x 4.00 LG	REF	P111698
51	5/8"~11NC HHCS x 5.00 LG – MODIFIED (INCLUDED W/ CONN ROD)	REF	4P100112
52	5/8"~11NC SLOTTED HEX NUT GRD 2 (INCLUDED W/ CONN ROD)	REF	P12967
53	1/8" COTTER PIN (INCLUDED W/ CONN ROD)	REF	P14885
54	PIPE PLUG (INCLUDED W/ WRIST PIN)	REF	P19491
	POWER END LUBE ASSEMBLY – FIGURE 4		
55	HOSE ASSY – 12.00 LG	3	P101857
56	HOSE ASSY – 14.00 LG	2	P109675
57	HOSE ASSY – 24.00 LG	2	P109677
58	HOSE ASSY – 26.00 LG	3	P101851
59	PIPE PLUG (SHIPPING ONLY)	1	P14886
	LUBRICATION ASSEMEBLY – FIGURE 5		
60	HOSE ASSY – 26.00 LG.	1	P101851
61	HOSE ASSY – 12.00 LG.	1	P101857
62	HOSE ASSY – 14.00 LG.	1	P109675
63	HOSE ASSY – 32.00 LG.	1	P110904

ACCESSORIES



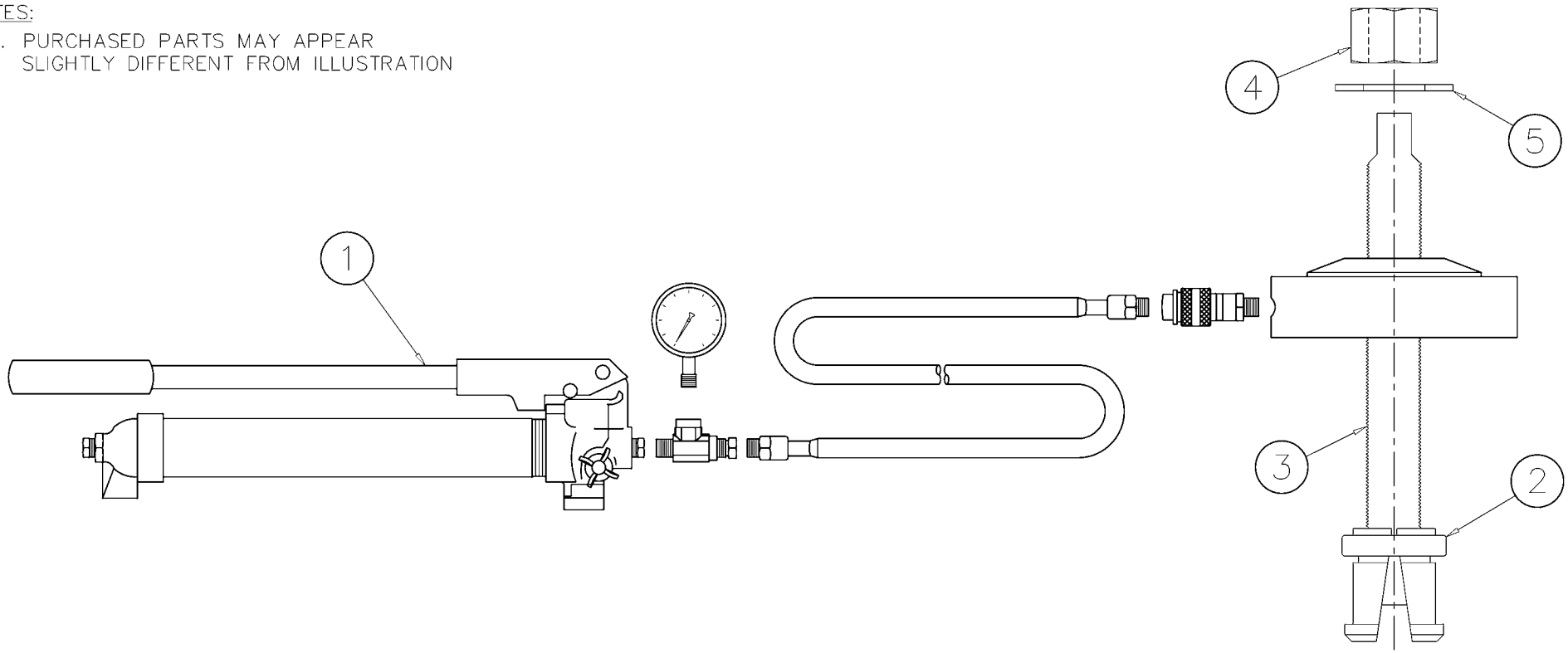
4A100161

SLIDE HAMMER

SPM

NOTES:

1. PURCHASED PARTS MAY APPEAR SLIGHTLY DIFFERENT FROM ILLUSTRATION



ITEM	QTY	PART NO	DESCRIPTION
5	'D'	P108221	BUSHING
4	1	'C'	NUT
3	1	'B'	STEM
2	1	'A'	PULLER HEAD
1	1	4A101823	PUMP & JACK

APPLICATION	ASSY NO.	P/N 'A'	P/N 'B'	P/N 'C'	'D'	HEAD COLOR
6.50–7.50 TWS1300–QWS	4A108228	P108219	P23581	P23580	—	BROWN
5.50–6.00 TWS900–QWS 4.50–5.50 BJS3000	4A108227	P108218	P23581	P23580	—	BLUE
4.50–5.00 TWS900–QWS	4A108226	P23579	P23581	P23580	—	RED
3.50–4.50 TWS400/500/600 3.75–4.00 TWS900–QWS	4A108225	P108142	P23581	P23580	—	GREEN
2.75 TWS 600 2.50–3.00 TWS 400	4A108224	P108217	P108220	P108222	1	YELLOW

REV.	DESCRIPTION	BY	Date

DO NOT SCALE DRAWING

UNLESS OTHERWISE NOTED DIMENSIONS ARE IN INCHES

linear tol	fractional	±1/32
	.XX	±.01
	.XXX	±.005
Angular tol		±30'

All diameters concentric to .010 unless otherwise noted

125 surface roughness all machined surfaces

SPM Flow Control, Inc.

7601 WYATT DRIVE
FT WORTH TEXAS 76108-2587

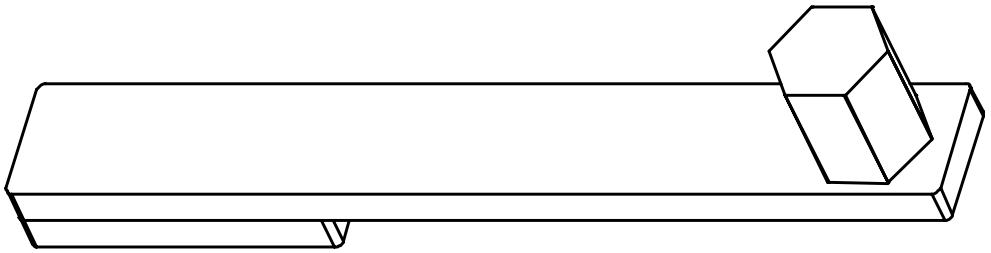
Scale: 1: 4
Date: 8/2/02
Drawn by: DPH
Approved: MDM

Description:

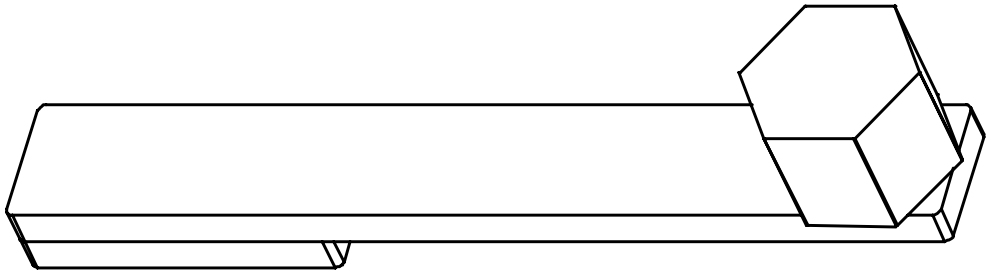
SEAT PULLER ASSY LISTING TWS400–QWS

Material:

Drawing No: 3L108223



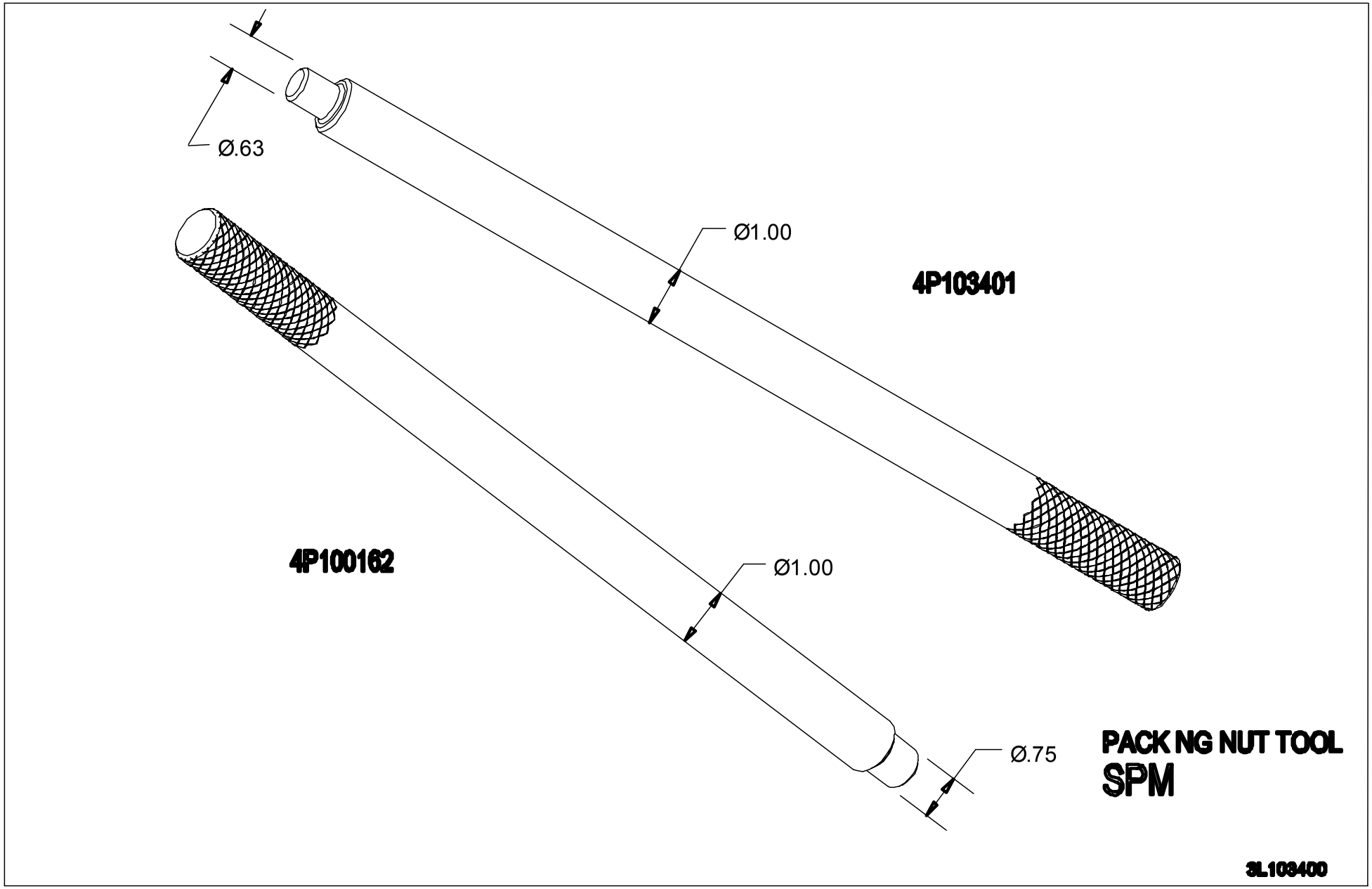
2" HEX
4P100160



3" HEX
4P103644

VALVE COVER REMOVAL TOOL
SPM

3L103639


Ø.63
Ø1.00
4P103401
4P100162
Ø1.00
Ø.75
PACK NG NUT TOOL
SPM
3L103400

Process Instruction	**TWS600S & QWS1000S FLUID END TOOL USE**		
Document #	PUMP-PAS-OPERATIONS-048		
Created By	Carlos Rubio	**Apprv Date**	November 2, 2009
		Rev #	0

Quality **Before using a hard copy of this document, verify document is the latest revision by accessing it in the network from any computer work station (Ref; SP4-2-501 Document Control).**
Clean all parts to remove all dirt, sand, cosmoline and debris. Make sure all measuring equipment is currently calibrated.

Safety Safety glasses & safety shoes (steel toe, metatarsal as required per job) are required at all times. A face shield is additionally required during any use of shop air, grinding & deburring. Shop air shall not be used to dust off one self. Points of operation shall be guarded & in place prior to operating machinery.

Housekeeping Place tools in designated locations, roll up all airlines and sweep area.

Step # Instructions (Major Step, How we do it, Why we do it)

REVISION HISTORY

DOC REVISION	PAGE # REVISED	EFFECTIVE DATE	REV AUTHOR	DETAILS OF CHANGE
0	N/A	11/2/2009	C.A.R.	Initial release.

Approved By	Design Eng. Mgr.	Mfg. Eng. Mgr.	Quality Mgr.		
	Pankaj Patel	Mark Dille	Jon Nance		

Process Instruction	**TWS600S & QWS1000S FLUID END TOOL USE**		
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Housekeeping

Place tools in designated locations, roll up all airlines and sweep area.

Step # Instructions (Major Step, How we do it, Why we do it)

Purpose:
This is a generic visual aid Process Instruction for TWS600S & QWS1000S FLUID END TOOL USE, it also serves as a training guide to reduce process variations.

Scope:
This Process Instruction applies to all SPM locations performing TWS600S & QWS1000S pump assemblies.

Departments Responsible:
Shop Personnel
Sales
Quality Department

Records:
None.

Forms:
None.

Definitions:
P/N- Part Number.
Assy- Assembly.
Doc- Document

Reference Documents:
4P105066- TWS600S Service Manual.
4P109479- QWS1000S Service Manual.

Process Instruction	TWS600S & QWS1000S FLUID END TOOL USE
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Step # Instructions (Major Step, How we do it, Why we do it)

REQUIRED: SAFETY EQUIPMENT, TOOLS & SUPPLIES



Protecting Gloves



Safety Shield



Safety Shoes



Safety Glasses



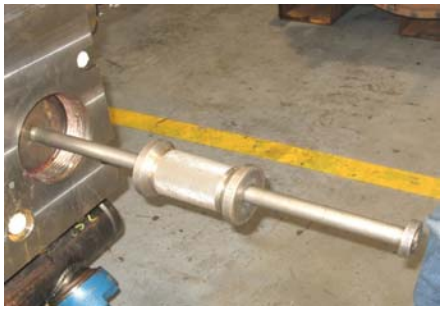
Packing Nut Tool, P/N-4P103401



Plunger Wrench Tool, P/N-2A103265



Handle- Plunger Wrench Tool, P/N-3P107837



Slide Hammer, P/N-2L103667



Valve Cover Removal Tool, P/N-4P100160

Process Instruction Document #	TWS600S & QWS1000S FLUID END TOOL USE		
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Housekeeping

Place tools in designated locations, roll up all airlines and sweep area.

Step # Instructions (Major Step, How we do it, Why we do it)

1





Use packing nut tool (P/N-4P103401) to tighten/loosen Packing Nuts.
To install Plunger, Use the plunger wrench P/N-2A103265 and metal hammer and tap each Plunger until Plunger threads come in contact with Plunger Stud threads.

2





Using Plunger Wrench P/N-2A103265 install Plunger by pushing on the end of the wrench while turning it.
If more leverage is required, use handle, P/N-3P107837.

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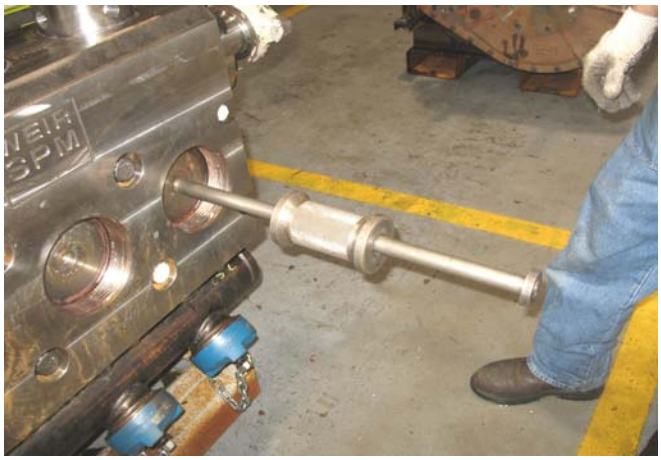
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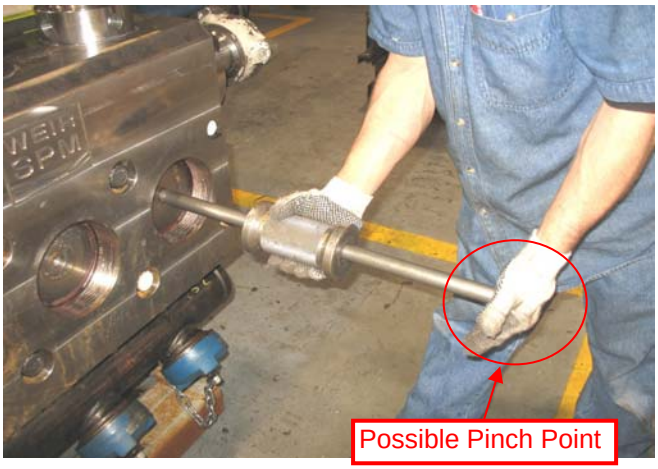
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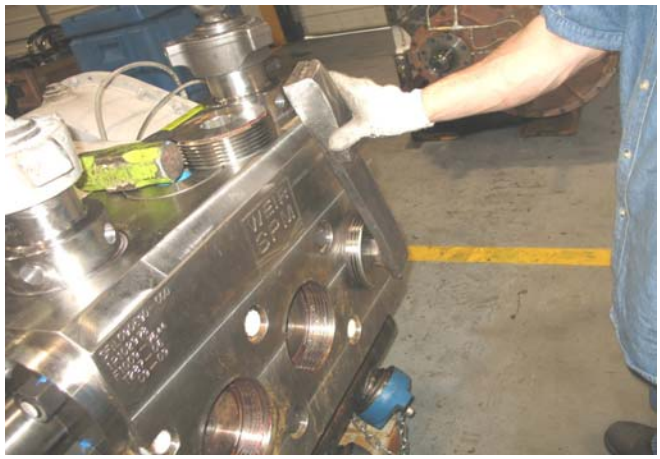
3

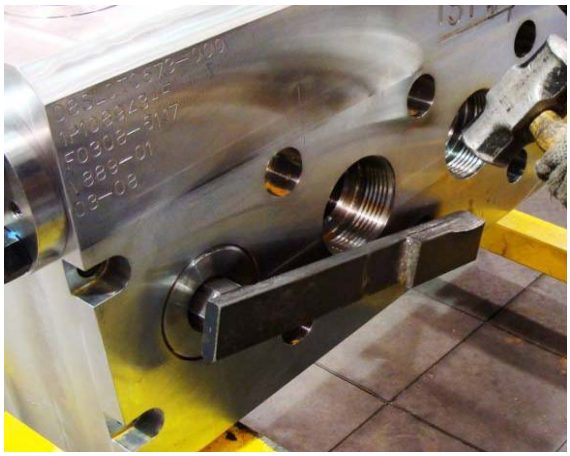




CAUTION: Do not place any part of your body between the sliding and stationary parts of hammer.
To remove Valve Covers from Fluid End Assy use slide hammer, P/N-2L103667.

4





Tighten/loosen Nut using valve cover removal tool P/N-4P100160 and 2-6 Lbs Sledge Hammer.

“REVISED PAGES”

Service Manual: **TWS600-S**
Part Number: **4P105066**
Original date completed: **8/30/99**

ECN No.	REVISION	DATE REVISED	SECTION
	R1 – R2		Previous Revisions
	R3	4/1/00	Power End Repair Procedure
	R4	6/10/02	Pump Inst. Highlights
	R5	9/1/02	Fluid End Repair
	R6	10/10/02	Safety Guide + drawings
4251	R7	2/9/05	Plunger Lube System Requirements
	R8	7/22/05	Supercharging System Operational Parameters
	R9	9/19/05	Supercharging System Requirements
	R10	11/22/05	Pump Duty Cycle Curve
	R11	1/31/09	Torque Table – Added Text “Do not use a hammer lug wrench to tighten mounting bolts.”
5328	R12	7/7/09	PE Lube System Requirements “revised”: *pump rated at 12GPM minimum*……
6122	R13	11/17/2009	Addition of “TWS600S” SOP for Fluid End Tool Use to “Accessories” Section