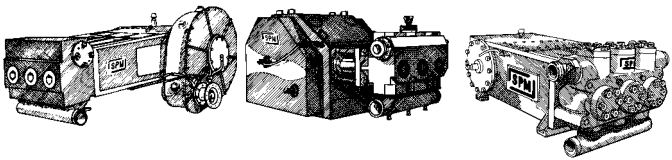
SPM®

Flow Control, Inc.



WELL SERVICE PUMP REFERENCE GUIDE

for all popular brands and models of well service pumps

CONTENTS

Packing Assembly Drawings & Part Numbers.. 3 - 26

High Performance Packing..... 3 - 14

Standard Packing..... 15 - 26

Valve & Seat Cross Reference..... 27 - 31

Plunger Cross Reference..... 32 - 34

Drawings, Well Service Pumps & Fluid Ends.. 35 - 50

Pump Maintenance Records..... 51 - 54

Troubleshooting Guide, Packing..... 56 - 64

Troubleshooting Guide, Plungers..... 65 - 66

Troubleshooting Guide, Valves & Seats..... 67 - 71

Troubleshooting Guide, Pumps..... 72 - 77

Routine Preventive Maintenance, Pumps..... 78 - 80

Fluid End Maintenance Procedures..... 82 - 86

Installation Summary..... 88 - 90

Safety Guide, Well Service Pumps..... 92 - 99

Application Formulae..... 100

Clearance Requirements..... 101

Torque Tables..... 102

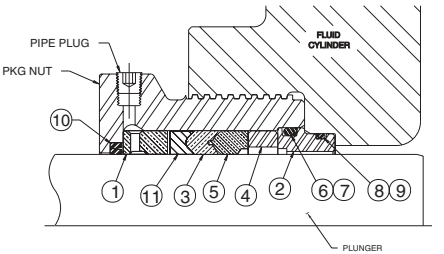
Metric Conversions..... 105



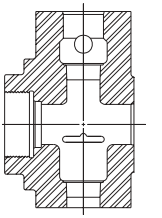
HIGH PERFORMANCE PACKING ASSEMBLY DRAWINGS and PART NUMBERS

HIGH PERFORMANCE PACKING

ITEM	QTY	DESCRIPTION
11	1	PKG ADAPTER
10	1	WIPER RING
9	1	BACK-UP
8	1	O-RING
7	1	BACK-UP
6	1	O-RING
5	1	HEADER RING
4	1	SPACER RING
3	1	PRESSURE RING
2	1	SEAL RING
1	1	LANTERN RING



PACKING ASSEMBLIES
SPM TWS250



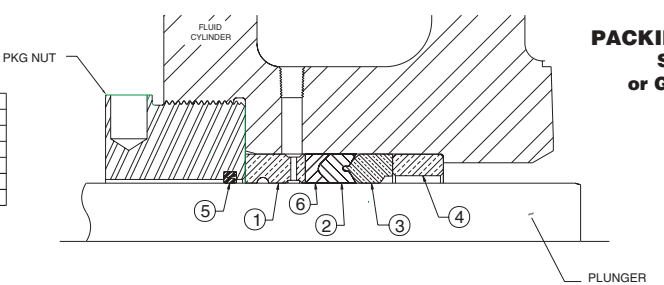
SIZE	COMPLETE ASSEMBLY	SOFT PKG SET
4"	3A105324HP	3A106992HP
3 3/4"	3A105323HP	3A106991HP
3 1/2"	3A105185HP	3A106990HP
3"	3A105322HP	3A106989HP
2 3/4"	3A105315HP	3A106988HP
2 1/2"	3A105321HP	3A106987HP
2"	3A107723HP	3A106986HP

SOFT PKG. SET INCLUDES COMPONENTS #3, 5, 6, 7, 8, 9, 10 AND 11.

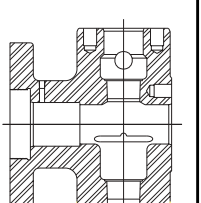
FOR CO2 SERVICE APPLICATIONS, SPECIFY "CO2" AT THE END OF EACH PART NUMBER.

HIGH PERFORMANCE PACKING

ITEM	QTY	DESCRIPTION
6	1	PKG ADAPTER
5	1	WIPER RING
4	1	SPACER
3	1	HEADER RING
2	1	PRESSURE RING
1	1	LANTERN RING



PACKING ASSEMBLIES
SPM TWS400
or GEOQUIP LC350

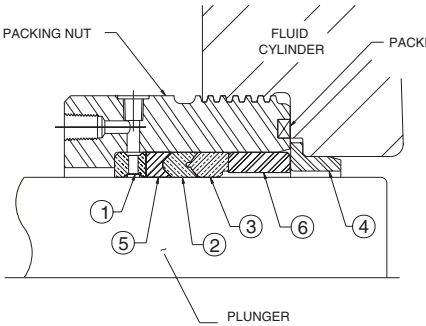


SIZE	COMPLETE ASSEMBLY	SOFT PKG SET
4 1/2"	3A105294HP	3A107007HP
4"	3A106787HP	3A107006HP
3 1/2"	3A105228HP	3A107005HP
3"	3A105370HP	3A106994HP
2 1/2"	3A105369HP	3A106993HP

SOFT PKG. SET INCLUDES COMPONENTS #2, 3, 5 AND 6.

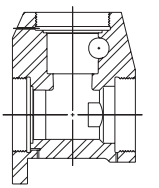
FOR CO2 SERVICE APPLICATIONS, SPECIFY "CO2" AT THE END OF EACH PART NUMBER.

HIGH PERFORMANCE PACKING



ITEM	QTY	DESCRIPTION
6	1	SPACER RING
5	1	PKG ADAPTER
4	1	SPACER
3	1	HEADER RING
2	1	PRESSURE RING
1	1	LANTERN RING

PACKING ASSEMBLIES
SPM TWS500LW (H/V)
ROUGH RIDER 500 (H/V)

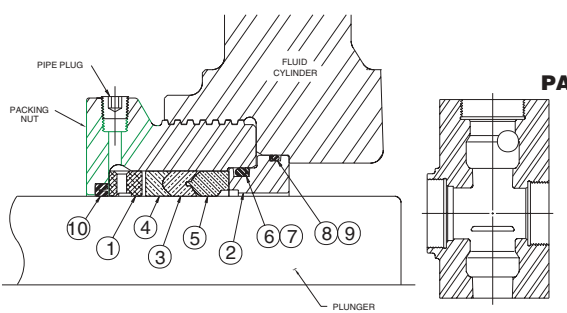


SIZE	COMPLETE ASSEMBLY	SOFT PKG SET
4 1/2"	3A103794HP	3A107001HP
4"	3A103793HP	3A107000HP
3 1/2"	3A103792HP	3A106999HP
2 3/4"	3A105024HP	3A106998HP

SOFT PKG. SET INCLUDES COMPONENTS #2, 3 AND 5.

FOR CO2 SERVICE APPLICATIONS, SPECIFY "CO2" AT THE END OF EACH PART NUMBER.

HIGH PERFORMANCE PACKING



ITEM	QTY	DESCRIPTION
10	1	WIPER RING
9	1	BACK-UP
8	1	O-RING
7	1	BACK-UP
6	1	O-RING
5	1	HEADER RING
4	1	PKG ADAPTER
3	1	PRESSURE RING
2	1	SEAL RING
1	1	LANTERN RING

PACKING ASSEMBLIES
SPM TWS600 SHORT
2-1/2" - 4-1/2"

SIZE	COMPLETE ASSEMBLY	SOFT PKG SET
4 1/2"	3A105297HP	3A107012HP
4"	3A104227HP	3A107011HP
3 1/2"	3A105368HP	3A107010HP
3"	3A104769HP	3A107009HP
2 3/4"	3A105154HP	3A107008HP
2 1/2"	3A104731HP	3A107044HP

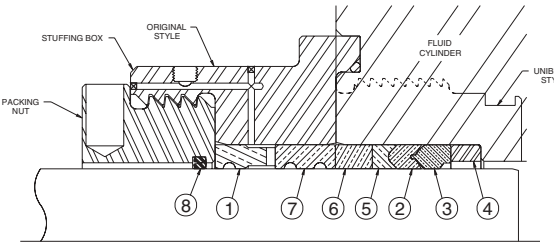
SOFT PKG. SET INCLUDES COMPONENTS #3, 4, 5, 6, 7, 8, 9 AND 10.

FOR CO2 SERVICE APPLICATIONS, SPECIFY "CO2" AT THE END OF EACH PART NUMBER.

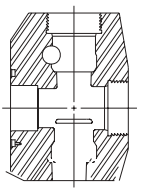
HIGH PERFORMANCE PACKING



ITEM	QTY	DESCRIPTION
8	1	WIPER RING
7	1	FLAT ADAPTER
6	1	SPACER-LONG
5	1	PKG ADAPTER
4	1	SPACER-SHORT
3	1	HEADER RING
2	1	PRESSURE RING
1	1	LANTERN RING



PACKING ASSEMBLIES
SPM TWS600
SPM TWS500LW (V/V)



SIZE	COMPLETE ASSEMBLY	SOFT PKG SET
4 1/2"	3A105263HP	3A107007HP
4"	3A105262HP	3A107006HP
3 1/2"	3A104586HP	3A107005HP
3"	3A105225HP	3A107004HP
2 3/4"	3A104703HP	3A107003HP
2 1/2"	3A104744HP	3A107002HP

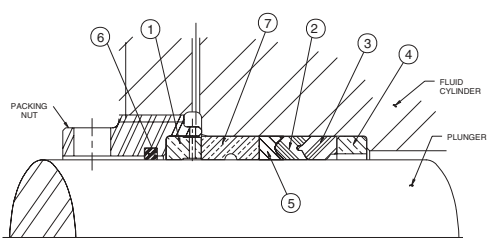
SOFT PKG. SET INCLUDES COMPONENTS #2, 3, 5 AND 8.

FOR CO2 SERVICE APPLICATIONS, SPECIFY "CO2" AT THE END OF EACH PART NUMBER.

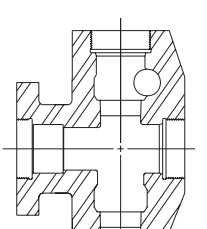
HIGH PERFORMANCE PACKING



ITEM	QTY	DESCRIPTION
7	1	FLAT ADAPTER
6	1	WIPER RING
5	1	PKG ADAPTER
4	1	SPACER
3	1	HEADER RING
2	1	PRESSURE RING
1	1	LANTERN RING



PACKING ASSEMBLIES
SPM TWS900-QWS2500



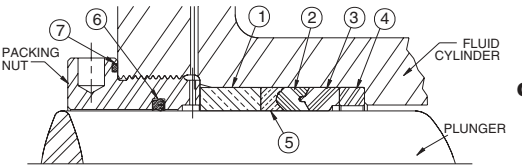
SIZE	COMPLETE ASSEMBLY	SOFT PKG SET
6 3/4"	3A105377HP	3A107020HP
6 1/2"	3A105312HP	3A107019HP
6"	3A105373HP	3A107018HP
5 3/4"	3A105372HP	3A107016HP
5 1/2"	3A104755HP	3A107015HP
5"	3A105180HP	3A107014HP
4 1/2"	3A104367HP	3A107007HP
4"	3A105348HP	3A107006HP
3 3/4"	3A105166HP	3A107013HP
3 1/2"	3A105207HP	3A107005HP

SOFT PKG. SET INCLUDES COMPONENTS #2, 3, 5, AND 6.

FOR CO2 SERVICE APPLICATIONS, SPECIFY "CO2" AT THE END OF EACH PART NUMBER.

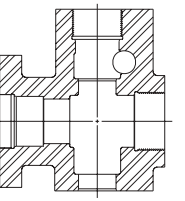
HIGH PERFORMANCE PACKING

ITEM	QTY	DESCRIPTION
7	1	O-RING
6	1	WIPER RING
5	1	PKG ADAPTER
4	1	SPACER
3	1	HEADER RING
2	1	PRESSURE RING
1	1	FLAT ADAPTER



PACKING ASSEMBLIES
OPI,
GEOQUIP (GARDNER DENVER)
CMW (SPM)
OMEGA

SIZE	COMPLETE ASSEMBLY	SOFT PKG SET
7 1/2"	3A102276HP	3A107039HP
7"	3A102275HP	3A107038HP
6 3/4"	3A101251HP	3A107020HP
6 1/2"	3A101250HP	3A107019HP
6"	3A101256HP	3A107018HP
5 3/4"	3A102274HP	3A107016HP
5 1/2"	3A101255HP	3A107015HP
5"	3A101159HP	3A107014HP
4 1/2"	3A101254HP	3A107007HP
4"	3A101253HP	3A107006HP
3 3/4"	3A101276HP	3A107013HP
3 1/2"	3A102273HP	3A107005HP
3"	3A102272HP	3A107004HP
2 3/4"	3A102271HP	3A107003HP

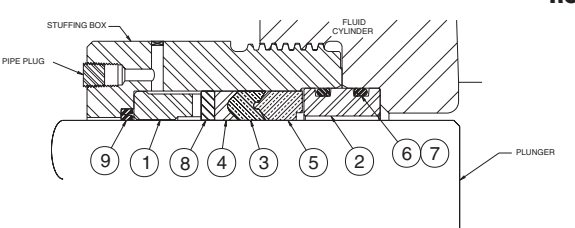


SOFT PKG. SET INCLUDES COMPONENTS #2, 3, 5 ,6 AND 7.

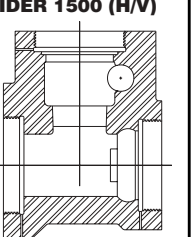
FOR CO2 SERVICE APPLICATIONS, SPECIFY "CO2" AT THE END OF EACH PART NUMBER.

HIGH PERFORMANCE PACKING

ITEM	QTY	DESCRIPTION
9	1	WIPER RING
8	1	SPACER
7	2	BACK-UP
6	2	O-RING
5	1	HEADER RING
4	1	PKG ADAPTER
3	1	PRESSURE RING
2	1	SEAL RING
1	1	LANTERN RING



PACKING ASSEMBLIES
SPM TWS1250LW (H/V)
ROUGHRIDER 1000 (H/V)
ROUGHRIDER 1500 (H/V)



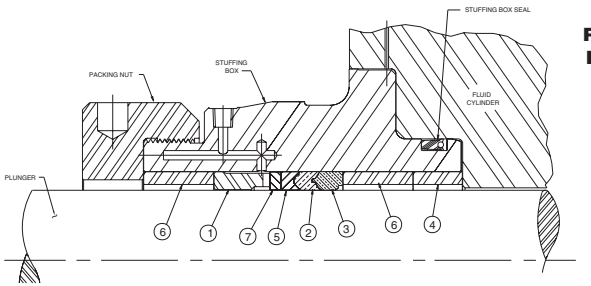
SIZE	COMPLETE ASSEMBLY	SOFT PKG SET
5"	3A106698HP	3A107021HP

SOFT PKG. SET INCLUDES COMPONENTS #3, 4, 5, 6, 7 AND 9.

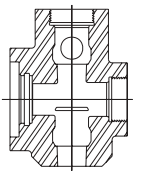
FOR CO2 SERVICE APPLICATIONS, SPECIFY "CO2" AT THE END OF EACH PART NUMBER.

HIGH PERFORMANCE PACKING

ITEM	QTY	DESCRIPTION
7	1	SPACER
6	2	SPACER-LONG
5	1	PKG ADAPTER
4	1	SPACER-SHORT
3	1	HEADER RING
2	1	PRESSURE RING
1	1	LANTERN RING



PACKING ASSEMBLIES
SPM TWS1200LW (V/V)
ROUGH RIDER 1000 (V/V)
ROUGHRIDER 1500 (V/V)



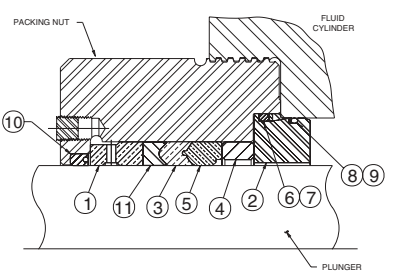
SIZE	COMPLETE ASSEMBLY	SOFT PKG SET
4"	3A102136HP	3A107025HP
3 3/4"	3A102499HP	3A107024HP

SOFT PKG. SET INCLUDES COMPONENTS #2, 3, AND 5.

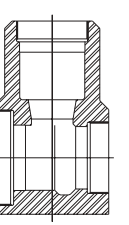
FOR CO2 SERVICE APPLICATIONS, SPECIFY "CO2" AT THE END OF EACH PART NUMBER.

HIGH PERFORMANCE PACKING

ITEM	QTY	DESCRIPTION
11	1	PKG ADAPTER
10	1	WIPER RING
9	1	BACK-UP
8	1	O-RING
7	1	BACK-UP
6	1	O-RING
5	1	HEADER RING
4	1	SPACER RING
3	1	PRESSURE RING
2	1	SEAL RING
1	1	LANTERN RING



PACKING ASSEMBLIES
BJ PACEMAKER



SIZE	COMPLETE ASSEMBLY	SOFT PKG SET
5"	3A104309HP	3A107029HP
4 1/2"	3A104308HP	3A107028HP
4"	3A104307HP	3A107027HP
3 1/2"	3A104306HP	3A107026HP

SOFT PKG. SET INCLUDES COMPONENTS #3, 5, 6, 7, 8, 9, 10 AND 11.

FOR CO2 SERVICE APPLICATIONS, SPECIFY "CO2" AT THE END OF EACH PART NUMBER.

HIGH PERFORMANCE PACKING

PACKING ASSEMBLIES
HALLIBURTON HT-400

ITEM	QTY	DESCRIPTION
7	1	WIPER RING
6	1	SPACER
5	1	O-RING
4	1	HEADER RING
3	1	PKG ADAPTER
2	1	PRESSURE RING
1	1	LANTERN RING

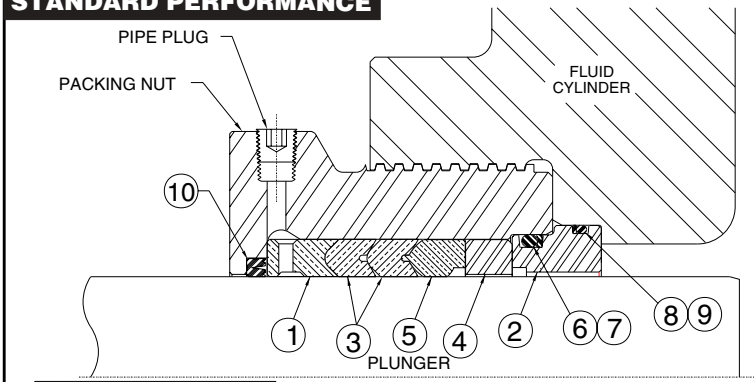
SOFT PKG. SET INCLUDES COMPONENTS #2, 3, 4, 4, AND 7.

FOR CO2 SERVICE APPLICATIONS, SPECIFY "CO2" AT THE END OF EACH PART NUMBER.

SIZE	COMPLETE ASSEMBLY	SOFT PKG SET
5"	3A107981HP	3A108288HP
4 1/2"	3A105358HP	3A107032HP

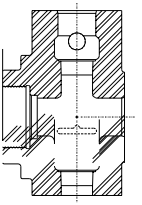
STANDARD PACKING ASSEMBLY DRAWINGS and PART NUMBERS

STANDARD PERFORMANCE



SPM Flow Control, Inc.

PACKING ASSEMBLIES
SPM TWS250

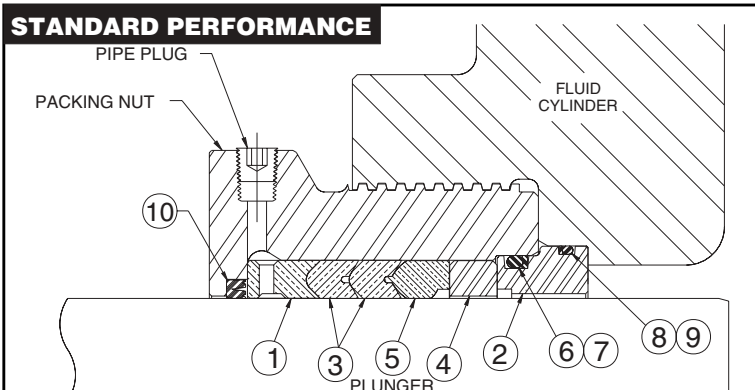


ITEM	QTY	PART NO	DESCRIPTION
10	1	SEE TABLE	WIPER RING
9	1		BACK-UP
8	1		O-RING
7	1		BACK-UP
6	1		O-RING
5	1		HEADER RING
4	1		SPACER RING
3	2		PRESSURE RING
2	1		SEAL RING
1	1		LANTERN RING

RSL/ACID-FRAC CEMENT SIZE	COMPLETE ASSEMBLY	SOFT PKG SET
4"	3A105324	3A109549
3 3/4"	3A105323	3A109548
3 1/2"	3A105185	3A109547
3"	3A105322	3A106989
2 3/4"	3A105315	3A105315
2 1/2"	3A105321	3A106987
2"	3A107723	3A106986

SOFT PKG. SET INCLUDES COMPONENTS #3, 5, 6 ,7, 8 AND 9.

STANDARD PERFORMANCE



SPM Flow Control, Inc.

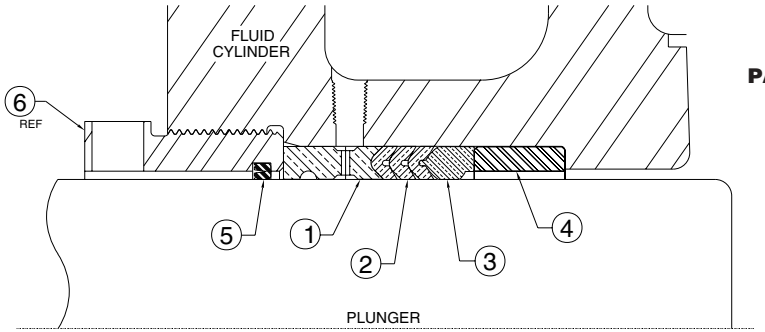
PACKING ASSEMBLIES
SPM TWS250
(CEMENT)

ITEM	QTY	PART NO	DESCRIPTION
10	1	SEE TABLE	WIPER RING
9	1		BACK-UP
8	1		O-RING
7	1		BACK-UP
6	1		O-RING
5	1		HEADER RING
4	1		SPACER RING
3	2		PRESSURE RING
2	1		SEAL RING
1	1		LANTERN RING

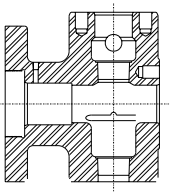
RSL/ACID-FRAC CEMENT SIZE	COMPLETE ASSEMBLY	SOFT PKG SET
4"	3A105324	3A109549
3 1/2"	3A105185	3A109547
3"	3A105322	3A106989
2 1/2"	3A105321	3A106987
2"	3A107723	3A106986

SOFT PKG. SET INCLUDES COMPONENTS #3, 5, 6 ,7, 8 AND 9.

STANDARD PERFORMANCE



PACKING ASSEMBLIES
SPM TWS400
OR
GEOQUIP LC350

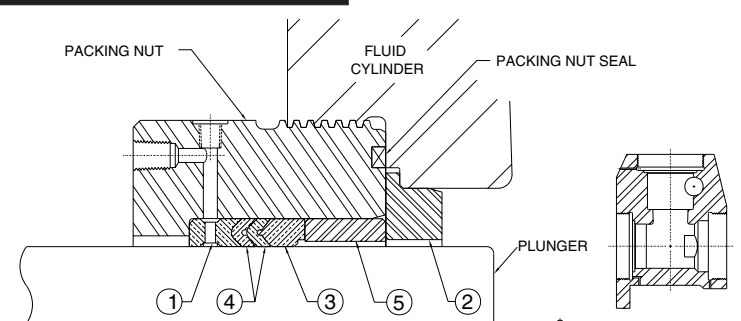


ITEM	QTY	PART NO	DESCRIPTION
6	REF	SEE TABLE	PACKING NUT w/ WIPER GROOVE
5	1		WIPER RING
4	1		SPACER
3	1		HEADER RING
2	3		PRESSURE RING
1	1		LANTERN RING/FEMALE ADAPTER

RSL/ACID-FRAC CEMENT	SIZE	COMPLETE ASSEMBLY	SOFT PKG SET
	4 1/2"	3A105294	3A106997
	4"	3A106787	3A106996
	3 1/2"	3A105228	3A106995
	3"	3A105370	3A106994
	2 1/2"	3A105369	3A106993

SOFT PKG. SET INCLUDES COMPONENTS #2, 3, AND 5.

STANDARD PERFORMANCE



PACKING ASSEMBLIES
SPM TWS500LW (H/V) *
ROUGH RIDER 500 (H/V) *

* HORIZONTAL VALVE STYLE

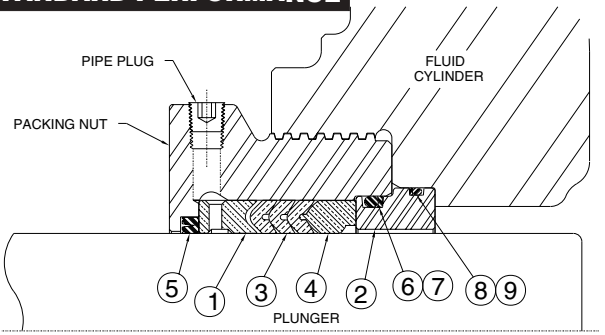
CEMENT	SIZE	COMPLETE ASSEMBLY	SOFT PKG SET
	4 1/2"	3A105349	3A109550

SOFT PKG. SET INCLUDES COMPONENTS #3, AND 4.

ITEM	QTY	PART NO	DESCRIPTION
5	1	SEE TABLE	SPACER RING
4	2		PRESSURE RING (SHORT)
3	1		HEADER RING
2	1		SPACER
1	1		LANTERN RING/FEMALE ADAPTER

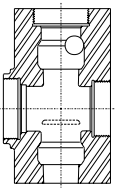
ACID/FRAC	SIZE	COMPLETE ASSEMBLY	SOFT PKG SET
	4 1/2"	3A103794	3A107001
	4"	3A103793	3A107000
	3 1/2"	3A103792	3A106999
	2 3/4"	3A105024	3A106998

STANDARD PERFORMANCE



SPM Flow Control, Inc.

PACKING ASSEMBLIES
SPM TWS600 SHORT
2-1/2" - 3"



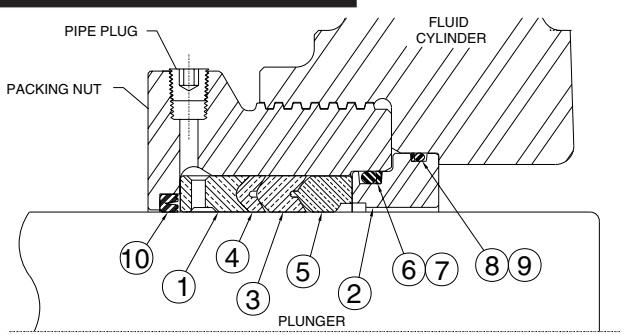
ITEM	QTY	PART NO	DESCRIPTION
9	1	SEE TABLE	BACK-UP
8	1		O-RING
7	1		BACK-UP
6	1		O-RING
5	1		WIPER RING
4	1		HEADER RING
3	3		PRESSURE RING - SHORT
2	1		SEAL RING
1	1		LANTERN RING/FEMALE ADAPTER

ACID/FRAC CEMENT SIZE	COMPLETE ASSEMBLY	SOFT PKG SET
3"	3A104769	3A107366
2 3/4"	3A105154	3A107008
2 1/2"	3A104731	3A107044

ACID/FRAC CEMENT SIZE	COMPLETE ASSEMBLY	SOFT PKG SET
3"	3A104769	3A104769
2 3/4"	3A105154	3A107008
2 1/2"	3A104731	3A107044

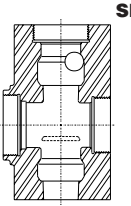
SOFT PKG. SET INCLUDES COMPONENTS #3, 4, 5, 6, 7, 8, AND 9.

STANDARD PERFORMANCE



SPM Flow Control, Inc.

PACKING ASSEMBLIES
SPM TWS600 SHORT
3-1/2" - 4-1/2"



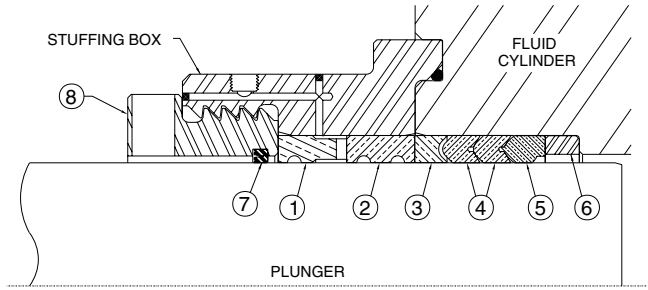
ITEM	QTY	PART NO	DESCRIPTION
10	1	SEE TABLE	WIPER RING
9	1		BACK-UP
8	1		O-RING
7	1		BACK-UP
6	1		O-RING
5	1		HEADER RING
4	1		PRESSURE RING - LONG
3	1		PRESSURE RING - SHORT
2	1		SEAL RING
1	1		LANTERN RING/FEMALE ADAPTER

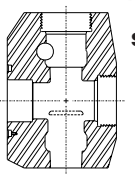
ACID/FRAC CEMENT SIZE	COMPLETE ASSEMBLY	SOFT PKG SET
4 1/2"	3A105297	3A109556
4"	3A104227	3A109555
3 1/2"	3A105368	3A109554

ACID/FRAC CEMENT SIZE	COMPLETE ASSEMBLY	SOFT PKG SET
4 1/2"	3A105297	3A109556
4"	3A104227	3A109555
3 1/2"	3A105368	3A109554

SOFT PKG. SET INCLUDES COMPONENTS #3, 4, 5, 6, 7, 8, 9 AND 10.

STANDARD PERFORMANCE





PACKING ASSEMBLIES
SPM TWS600
SPM TWS500LW (V/V)

ITEM	QTY	PART NO	DESCRIPTION
8	REF	SEE TABLE	PACKING NUT w/ WIPER GROOVE
7	1		WIPER RING
6	1		SPACER
5	1		HEADER RING
4	2		PRESSURE RING
3	1		FEMALE ADAPTER
2	1		FLAT ADAPTER
1	1		LANTERN RING

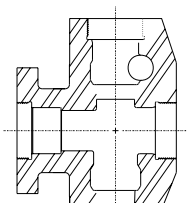
	SIZE	COMPLETE ASSEMBLY	SOFT PKG SET
CEMENT	4"	3A106049	3A109552
	3 1/2"	3A106705	3A109551
ACID/FRAC	4 1/2"	3A105263	3A107869
	4"	3A105262	3A107006
	3 1/2"	3A104586	3A107005
	3"	3A105225	3A107004
	2 3/4"	3A104703	3A107003
	2 1/2"	3A104744	3A109553

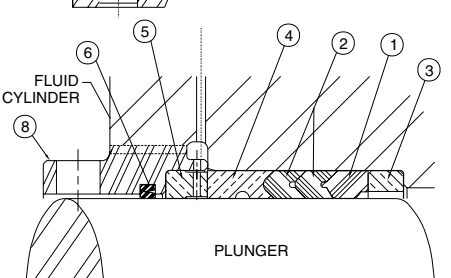
SOFT PKG. SET INCLUDES COMPONENTS #4, 5, AND 7.

STANDARD PERFORMANCE

** CEMENT SERVICE
* VITON SEALS

ITEM	QTY	PART NO	DESCRIPTION
8	REF	SEE TABLE	PACKING NUT w/ WIPER GROOVE
7	1		O-RING
6	1		WIPER RING
5	1		LANTERN RING
4	1		FEMALE ADAPTER
3	1		SPACER
2	2		PRESSURE RING
1	1		HEADER RING





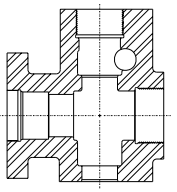
SIZE	COMPLETE ASSEMBLY	SOFT PKG SET
6 3/4"	** 3A105733	** 3A109560
5"	* 3A105180V	* 3A107014V
4 1/2"	* 3A104367V	* 3A109559V
6 3/4"	3A105377	3A107020
6 1/2"	3A105312	3A107019
6"	3A105373	3A107018
5 3/4"	3A105372	3A107016
5 1/2"	3A104755	3A107015
5"	3A105180	3A107014
4 1/2"	3A104367	3A109559
4"	3A105348	3A109558
3 3/4"	3A105166	3A107013
3 1/2"	3A105207	3A109557

PACKING ASSEMBLIES
SPM TWS900, TWS1000, TWS1200, TWS1300, TWS1600, TWS1800, TWS2000, TWS2250, QWS2500

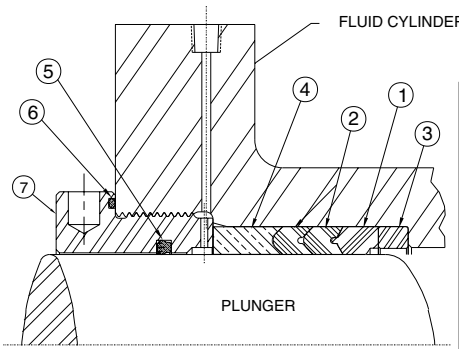
SOFT PKG. SET INCLUDES COMPONENTS #1, 2, AND 6.

STANDARD PERFORMANCE

ITEM	QTY	PART NO	DESCRIPTION
7	REF	SEE TABLE	PACKING NUT w/ WIPER GROOVE
6	1		O-RING
5	1		WIPER RING
4	1		FEMALE ADAPTER
3	1		SPACER
2	2		PRESSURE RING
1	1		HEADER RING



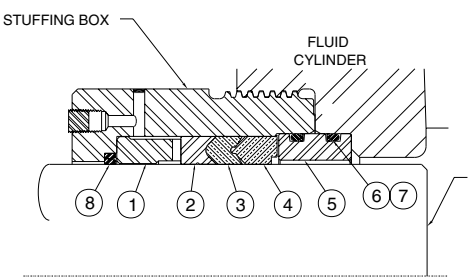
PACKING ASSEMBLIES
OPI, GEOQUIP (GARDNER DENVER)
CMW (SPM)
OMEGA
1300, 1800, 2000
BRAKE HORSE POWER SERIES

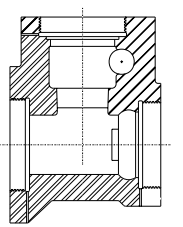


SIZE	COMPLETE ASSEMBLY	SOFT PKG SET
7 1/2"	3A102276	3A107039
7"	3A102275	3A107038
6 3/4"	3A101251	3A109573
6 1/2"	3A101250	3A109572
6"	3A101256	3A109571
5 3/4"	3A102274	3A109570
5 1/2"	3A101255	3A109569
5"	3A101159	3A109568
4 1/2"	3A101254	3A109567
4"	3A101253	3A109566
3 3/4"	3A101276	3A109565
3 1/2"	3A102273	3A109564
3"	3A102272	3A109563
2 3/4"	3A102271	3A109562

SOFT PKG. SET INCLUDES COMPONENTS #1, 2, 5, AND 6.

STANDARD PERFORMANCE





PACKING ASSEMBLIES
SPM TWS1250LW (H/V) *
ROUGH RIDER 1000 (H/V) *
ROUGH RIDER 1500 (H/V) *

* HORIZONTAL VALVE STYLE

ITEM	QTY	PART NO	DESCRIPTION
8	1	SEE TABLE	ROD WIPER
7	2		BACKUP RING
6	2		O-RING
5	1		SEAL RING
4	1		HEADER RING
3	1		PRESSURE RING
2	1		FEMALE ADAPTER
1	1		LANTERN RING

	SIZE	COMPLETE ASSEMBLY	SOFT PKG SET
CEMENT	5"	3A106702	3A109561
ACID FRAC	5"	3A106698	3A107021

SOFT PKG. SET INCLUDES COMPONENTS #3, 4, 6, 7, AND 8.

STANDARD PERFORMANCE

* VALVE OVER VALVE STYLE

PACKING ASSEMBLIES
SPM TWS1250LW (V/V) *
ROUGH RIDER 1000 (V/V) *
ROUGH RIDER 1500 (V/V) *

SOFT PKG. SET INCLUDES COMPONENTS #3, AND 4.

ITEM	QTY	PART NO	DESCRIPTION
6	1	SEE TABLE	SPACER - SHORT
5	2		SPACER - LONG
4	1		HEADER RING
3	1		PRESSURE RING
2	1		FEMALE ADAPTER
1	1		LANTERN RING

ACID/FRAC CEMENT			
SIZE	4"	3A102136	3A107025
	3 3/4"	3A102499	3A107024
		COMPLETE SET	SOFT PKG SET

VALVE and SEAT CROSS REFERENCE

SUCTION AND DISCHARGE VALVE ASSEMBLY

VALVE and SEAT CROSS REFERENCE

VALVE and SEAT CROSS REFERENCE

Pump Mfr.	Pump Model	Plunger Size		Valve Part No.	Seat Part No.	Insert Part No.	Spring
BJ Services	Pacemaker, (Suction)	3"-5"		P105800	P105801	P105764	*
	(Discharge)	3"-5"		P105741	P105751	P105763	*
CMW (SPM)	Clarksville, 1300HP	3.75"-4"		P105741	P105751	P105763	*
		4.50"-5"		P105743	P105753	P105764	*
		5.50"-6"		P105744	P105754	P105765	*
		6.50"-7 .50"		P105745	P105755	P105766	*
Gardner Denver (Geoquip)	LC-350, H-600	3.50"-4.50"		P105742	P105752	P105761	4P100198
	H-880	3.50"-4"		P105741	P105751	P105763	*
	H-1600	4.50"-5"		P105743	P105753	P105764	4P100348
	C-1300,1800	5.50"-6"		P105744	P105754	P105765	4P106813
	J-2000	6.50"-7.50"		P105745	P105755	P105766	4P100281
Gist	GT-78-1000	4"-5.25"		P105741	P105751	P105764	*
		5.50"-7.50"		P105744	P105754	P105765	*
Halliburton	HT-400	3.38" - 4.00"		P107185	P107802	P107186	*
		4.50"		P107181	P107180	P107182	*
		5.00" - 6.00"		P107188	P107187	P107189	4P102382
Oilwell	346P, 46P, 326P			P105740	P105750	P105760	4P102383
	SA-625, -626,-630,-634-5			P105739	P105749	P105759	4P102383
	SA-640-5,SA-650-L			P105741	P105751	P105763	*
	SB-644-5,SA-644-5,-10			P105743	P105802	P105764	*
	SA650-5,-10,SB-650-5					-	-
	Super 48,S-824,SA-824			P105745	P105755	P105766	*
	W-350, W-500	3.50"-4"		P105742	P105752	P105761	*
		4.50"-5"		P105743	P105752	P105764	*
Omega	1000-1300HP	4"-5.25"		P105743	P105752	P105764	*
		5.50"-7.50"		P105744	P105754	P105765	*
	1300-1800HP	3.75"-4"		P105741	P105751	P105763	*
	MW/MWA Fluid End	4.50"-5"		P105743	P105753	P105764	*
	W-1300,-1800,-2000	5.50"-6"		P105744	P105754	P105765	*
		6 .50"-7.50"		P105745	P105755	P105766	*
Gardner Denver (OPI)	350-500 AWS	2.75"-3"		P105739	P105749	P105759	*
		3.50"-4"		P105742	P105752	P105761	*
		4.50"-5"		P105743	P105753	P105764	*
	880 AWS, 1600 BWS	3.50"-4"		P105741	P105751	P105763	*
	1000-1300-1800 AWS	4.50"-5"		P105743	P105753	P105764	4P100235
	1300-1800-2000 CWS	5.50"-6"		P105744	P105754	P105765	4P106813
	GD-2000	6.50"-7.50"		P105745	P105755	P105766	4P100281
	1000-1300WS	4"-5.25"		P105743	P105755	P105764	*
		5.50"-7.50"		P105744	P105754	P105765	*
Pinion	RB-5, RB-6			P105743	P105754	P105764	*

Continued on Page 20

* Call SPM for information

VALVE and SEAT CROSS REFERENCE

VALVE and SEAT CROSS REFERENCE

Pump Mfr.	Pump Model	Plunger Size		Valve Part No.	Seat Part No.	Insert Part No.	Spring
SPM	TWS 250	1.75"-3"		P105739	P105749	P105759	4P101362
		3.25"-4"		P105742	P105752	P105761	4P100198
	TWS 400	2 .50"-3"		P105739	P105749	P105759	4P101362
		3 .50"-4 .50"		P105742	P105752	P105761	4P100198
	TWS 500LW-600	2 .75"		P105739	P105749	P105759	4P101362
		3"-4 .75"		P105742	P105752	P105761	4P100198
	TWS 600S	2 .50"-3"		P105739	P105749	P105759	4P101634
		3.50"-4 .50"		P105742	P105752	P105761	4P100198
	TWS 900	3.50"-4"		P105741	P105751	P105763	4P100338
	TWS 1250LW	4"		P105740	P105750	P105760	4P101860
	TWS 1300-1600-1800-2000-2250; QWS 2000-2500LW	4.50"-5"		P105743	P105753	P105764	4P100348
				P105743	P105753	P105764	4P100235
	TWS 1600LW; QWS 2000-2500LW	5.50"-6"		P105744	P105754	P105765	4P100116
	QWS 2000-2500LW	6.50"-7.50"		P105745	P105755	P105766	4P10028
Western (Rough Rider)	RB-80, RB-81			P105740	P105753	P105764	*
	RR500 Mono Block F.E.			P105742	P105752	P105761	*
	RR1000 Mono Block F.E. VDV	4"		P105740	P105750	P105760	4P102062
	Rough Rider (RR) 1500 VDV	4.50"-5"		P105743	P105753	P105764	4P102062
	RR1000 MONOBLOCK HV	5"		P105743	P105753	P105764	P101860

* Call SPM for information

Pump Manufacturer	Pump Model	Plunger Size	Plunger Part No.
BJ Services	PACEMAKER	3.50"	BJ118178
		3.50" SS	BJ118178
		4.00"	BJ112881
		4.50"	BJ112882
		5.00"	BJ112883
CMW	1300	6.75" SHORT	2P102401
(SPM)		6.75" STD.	3P101432
GARDNER DENVER	1300 THRU 2000	4.00"	3P103963
(OPI)		4.50"	3P103950
OMEGA		5.00"	3P103870
		5.75"	3P103953
		6.50"	3P106832
OPI, OMEGA	500	2.75"	3P107300
		3.00"	3P107301
		3.50"	3P107302
		4.00"	3P107303
		4.50"	3P107304
		5.00"	3P107305
OILWELL	SA640	4.00"	2P102998
SPM	TWS250	1.75"	3P104545
		2.00"	3P104546
		2.25"	3P104547
		2.50"	3P103501
		2.75"	3P103502
		3.00"	3P103503
		3.25"	3P103504
		3.50"	3P103505
		3.75"	3P103506
	TWS400	4.00"	3P103507
		2.50"	3P101397
		2.75"	3P101385
		3.00"	3P101384
		3.50"	3P100968
		4.00"	3P101334
	TWS600	4.50"	3P100853
		2.50"	3P104740
		2.75"	3P101733
		3.00"	3P100325
		3.50"	3P100293
		4.00"	3P100813
	TWS600S	4.50"	3P100181
		2.00"	2P106313
		2.50"	2P104716
		2.75"	2P104717
		3.00"	2P103345

- *Specify Standard 16" Length*
- *Specify Optional 18" Length*
- *Specify Optional 21" Length*

PLUNGERS CROSS REFERENCE

Pump Manufacturer	Pump Model	Plunger Size	Plunger Part No.
SPM	TWS600S	3.50"	2P103344
		4.00"	2P103313
		4.50"	2P103312
	TWS900	3.50"	3P105202
	OPI880	3.75"	3P104144
		4.00"	3P100772
		4.50"	3P100725
		5.00"	3P100366
		5.50"	3P107060
		5.75"	3P107061
		6.00"	3P107062
		4.00"	2P106678
	TWS1000 LW	3.75"	3P103887
	TWS1300	4.00"	3P100339
		4.50"	3P100654
		5.00"	3P100233
		5.50"	3P107060
		5.75"	3P107061
		6.00"	3P107062
		6.50"	3P100258
		6.75"	3P101407
	TWS1600	3.50"	3P105202
		3.75"	3P104144
		4.00"	3P100339
		4.50"	3P100725
		5.00"	3P100366
		5.50"	3P101423
		5.75"	3P101652
		6.00"	3P101424
	TWS1800	3.75"	3P103887
		4.00"	3P100339
		4.50"	3P100654
		5.00"	3P100233
		5.50"	3P107060
		5.75"	3P107061
		6.00"	3P107062
		6.50"	3P100258
	TWS2000	3.75"	3P103887
		4.00"	3P100339
		4.50"	3P100654
		5.00"	3P100233
		5.50"	3P107060
		5.75"	3P107061
		6.00"	3P107062

- *Specify Standard 16" Length*
- *Specify Optional 18" Length*
- *Specify Optional 21" Length*

PLUNGERS CROSS REFERENCE

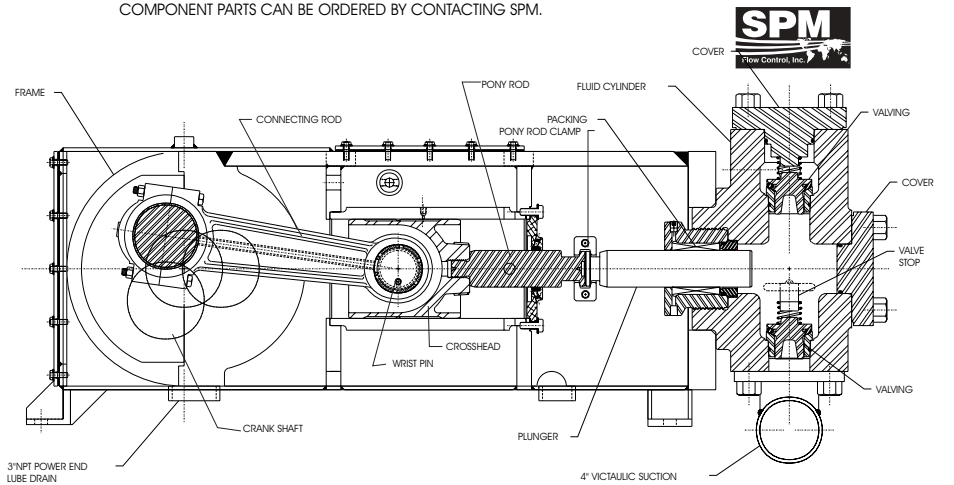
Pump Manufacturer	Pump Model	Plunger Size	Plunger Part No.
SPM	TWS2000	6.50"	3P100258
	TWS2250	3.75"	3P103887
		4.00"	3P100339
		4.50"	3P100654
		5.00"	3P100233
		5.50"	3P107060
		5.75"	3P107061
		6.00"	3P107062
		6.50"	3P100258
	QWS-2000-2500	3.75"	3P103887
		4.00"	3P100339
		4.50"	3P100654
		5.00"	3P100233
		5.50"	3P107060
		5.75"	3P107061
		6.00"	3P107062
		6.50"	3P100258
WESTERN ROUGH RIDER	500 HV MONO	2.75"	2P105019
		3.00"	2P18196
	TWS 500LW	3.50"	1P101925
		4.00"	1P103772
SPM		4.50"	1P101969
	500 SECT	4.50"	1P102014
	500 HV SEC*	3.75"	2P102527
	1000 HV MONO	4.00"	1P102167
	TWS 1000/1250		
	1000 VOV	5.00"	1P102169
	MONO	5.75"	2P102728
	TWS1000/1250	3.75"	2P102489
		4.00"	1P102037
	1500 VOV	5.00"	2P102075
	MONO	5.75"	2P102602

* SEC = Sectional Style

SPM Flow Control, Inc.

WELL SERVICE PUMPS and FLUID ENDS DRAWINGS

COMPONENT PARTS CAN BE ORDERED BY CONTACTING SPM.

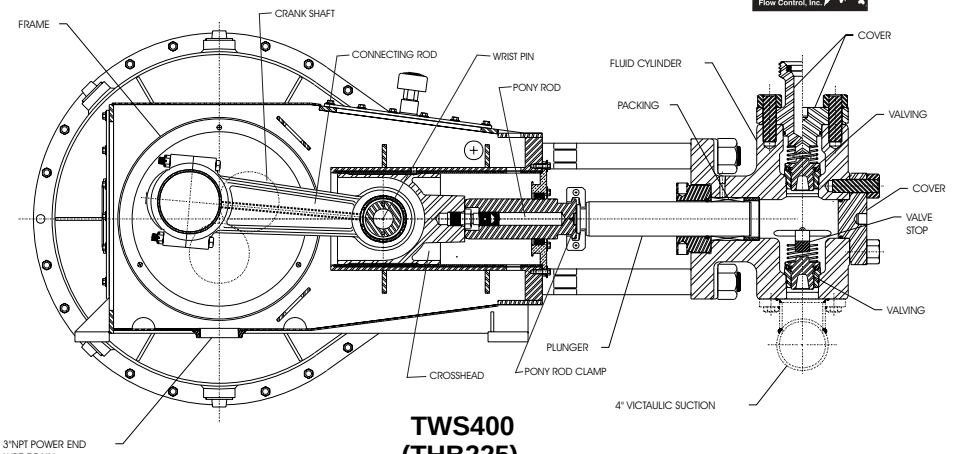


POWER END

TWS250 (THB175)

FLUID END

COMPONENT PARTS CAN BE ORDERED BY CONTACTING SPM.

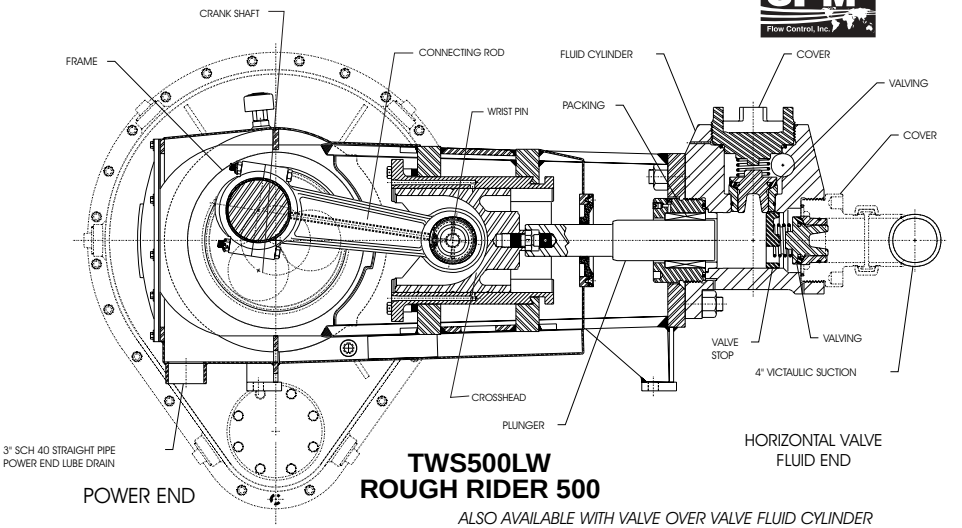


POWER END

TWS400 (THB225)

FLUID END

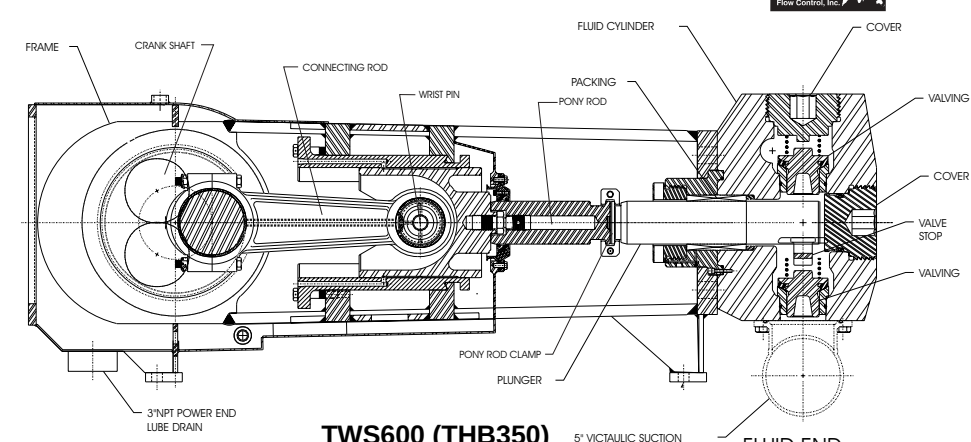
COMPONENT PARTS CAN BE ORDERED BY CONTACTING SPM.



TWS500LW
ROUGH RIDER 500

ALSO AVAILABLE WITH VALVE OVER VALVE FLUID CYLINDER

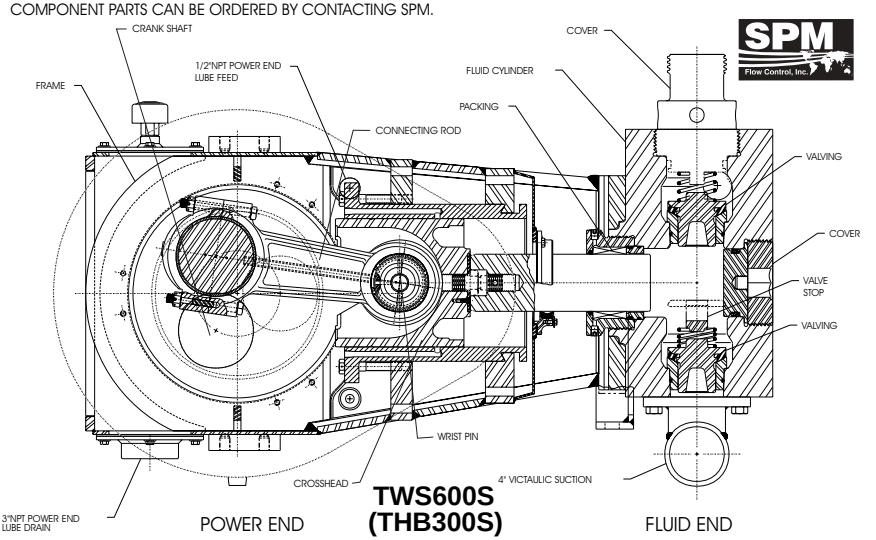
COMPONENT PARTS CAN BE ORDERED BY CONTACTING SPM.



TWS600 (THB350)

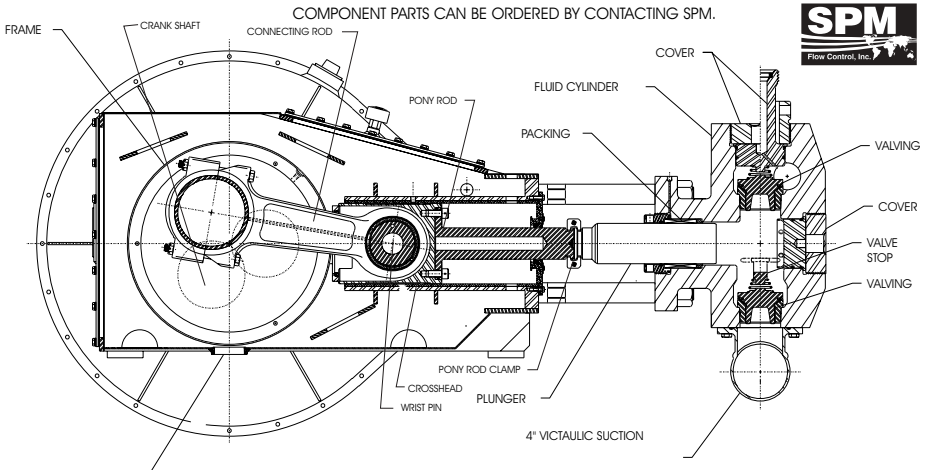
NATIONAL OILWELL SA640 Parts Also Available

COMPONENT PARTS CAN BE ORDERED BY CONTACTING SPM.

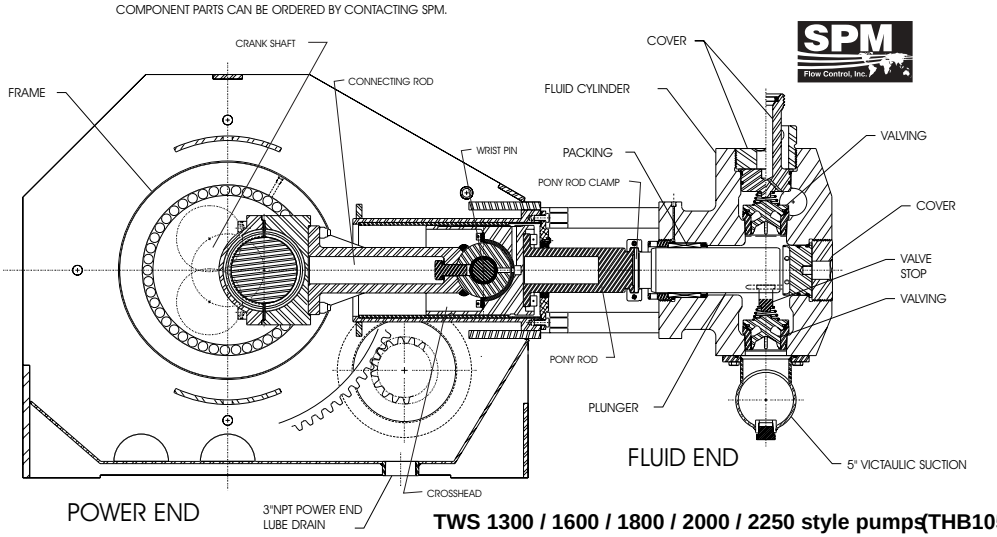


TWS600S
(THB300S)
QWS1000S

COMPONENT PARTS CAN BE ORDERED BY CONTACTING SPM.

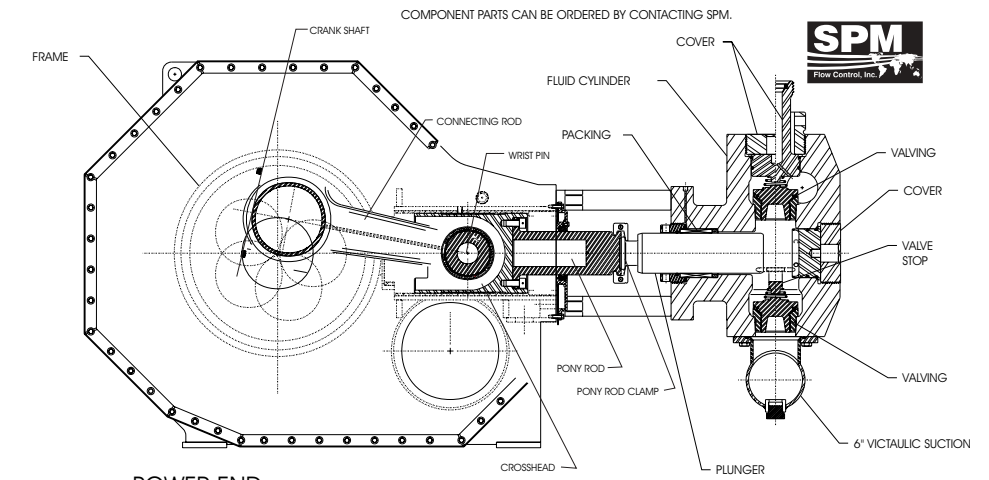


TWS900
(THB550)



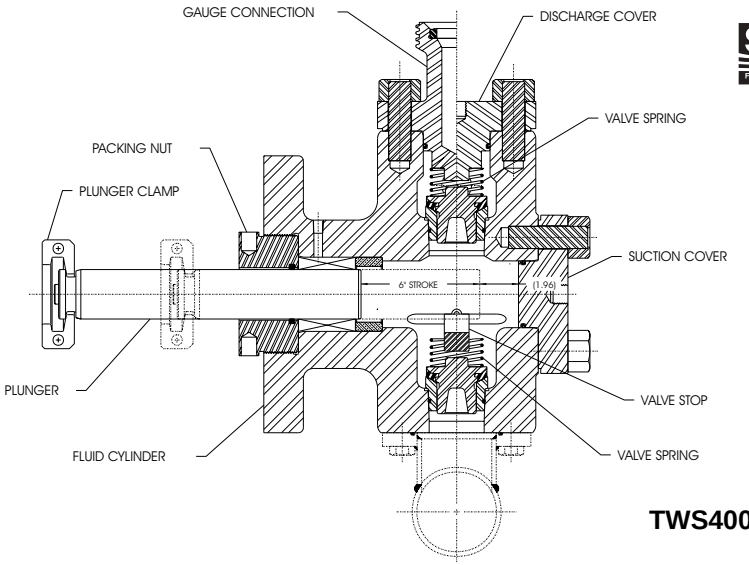
TWS 1300 / 1600 / 1800 / 2000 / 2250 style pumps (THB1050)

Material & sizes may vary. **Parts for CMW, OPI, Gardner Denver, Geoquip, Omega Also Available**

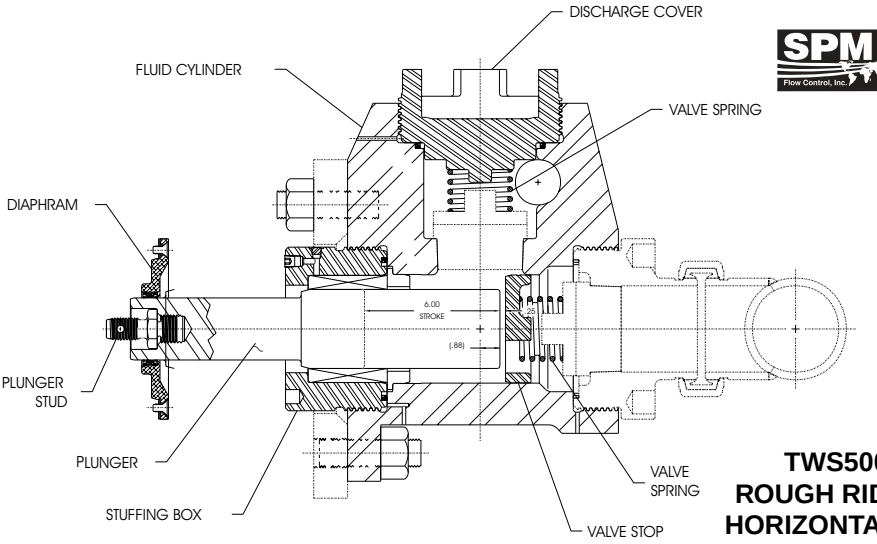


QWS 2500 style pumps (QHB1575)

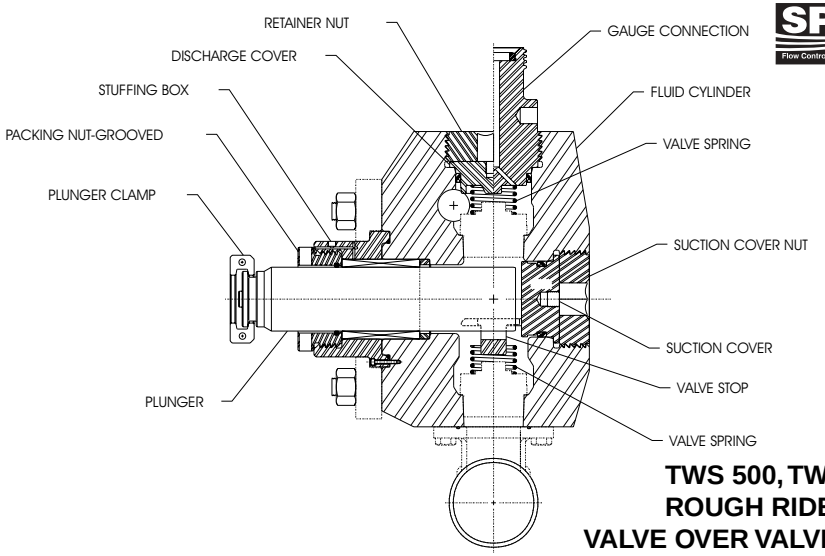
Material & sizes may vary.



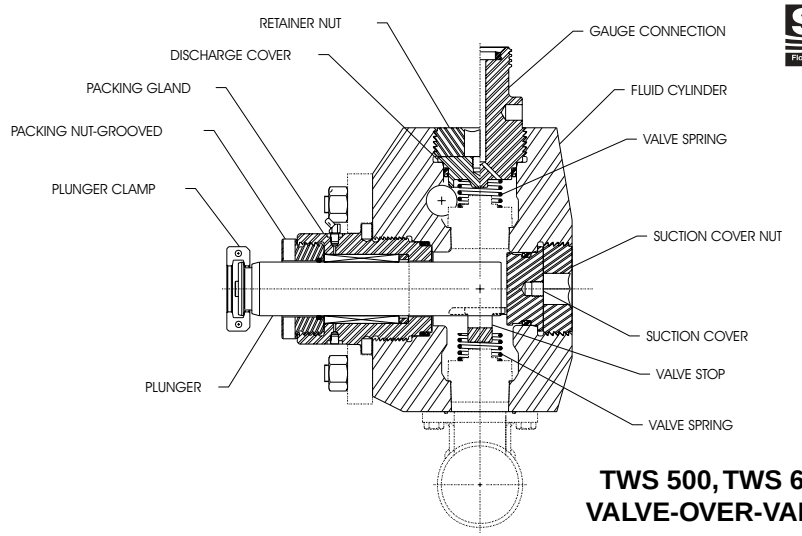
TWS400 FLUID END



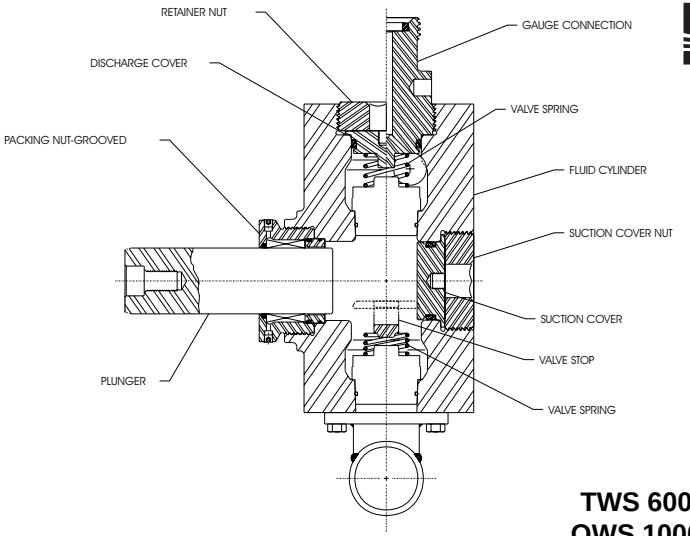
TWS500LW
ROUGH RIDER 500
HORIZONTAL VALVE
FLUID END



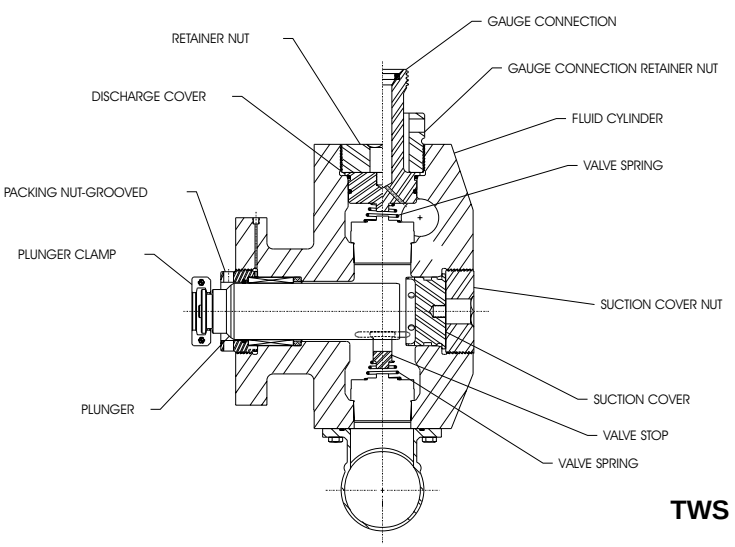
TWS 500, TWS 600,
ROUGH RIDER 500
VALVE OVER VALVE FLUID END



TWS 500, TWS 600 UNIBLOCK
VALVE-OVER-VALVE FLUID END



TWS 600S FLUID END
QWS 1000S FLUID END



TWS 900 FLUID END

QUINTUPLEX HAS FIVE CYLINDERS

TWS 1300-2250, QWS 2000 - 2500
FLUID END

SPM Flow Control, Inc.

PUMP MAINTENANCE RECORDS

PUMP MAINTENANCE RECORD

MAINTENANCE LOGS ALSO AVAILABLE FROM SPM

PUMP DESCRIPTION: | **UNIT NO.**

HORSEPOWER / **SERIAL NO.**	PART NO.	**REPLACEMENT** DATE	**REPLACEMENT** HOURS
PLUNGER			
HEADER RING			
PRESSURE RING			
WIPER RING			
SPACER			
ADAPTER			
LANTERN RING			
SUCTION VALVE			
DIS VALVE			
INSERT (SUC)			
INSERT (DIS)			
SEAT (SUCTION)			
SEAT (DISCHG.)			
VALVE SPRING			

COMMENTS:

REPLACEMENT DATE	**REPLACEMENT** HOURS	**REPLACEMENT** DATE	**REPLACEMENT** HOURS

COMMENTS:



TROUBLESHOOTING GUIDE -

PACKING, PLUNGERS, VALVES & SEATS, and WELL SERVICE PUMPS

TROUBLESHOOTING GUIDE
PACKING

TROUBLE SYMPTOM:

A. Significant leakage upon immediate startup with priming of the pump on individual or all plungers. Appearance of packing new or unused.

PROBABLE CAUSE & SOLUTION:

1. Cause: *Packing in backward.*
Solution: Remove packing. Make sure the seal rings and packing assembly is installed correctly with Vee of the seal rings facing the internal chamber of the cylinder.

2. Cause: *Incorrect size packing.*
Solution: Remove packing and check with plunger for fit. Packing should be snug to tight on the plunger. Verify that the packing size is correct. Contact SPM for any possible size problems.

3. Cause: *Incorrect adjustment.*
Solution: Follow instructions for adjustment instructions.

4. Cause: *Incorrect length of packing assembly.*
Solution: Remove packing. Review drawings and dimensions of packing assembly and stuffing

5. Cause: *Packing very cold or frozen. Packing may be broken or deformed.*
Solution: Remove and replace packing assemblies. Prime pump with warm fluid (water, oil etc.) and run pump until fluid cylinders are warm throughout. If possible, warm pump fluid cylinders with air blowers or heaters before commencing pumping operations.

6. Cause: *Plunger settles on the side of the packing during transport and causes deformation.*
Solution: Remove and replace packing assemblies.

B. Packing running very hot immediately upon start of pumping. Individual or all plungers.

1. Cause: *Fluid cylinder not filled or pump not properly primed. Packing appears burned or scorched. Some deformation of seal rings and brass will have black or dark streaks across the I.D.*
Solution: Remove and replace packing. Make sure that all cylinders are fully primed. Check all valves to make sure they are not stuck and operate properly. Run pump slowly until it is fully primed and operable.

2. Cause: *Metal components in packing assembly incorrect size or eccentric. Some metal*

micrometer for proper size. If micrometer is not available check brass metal rings over the plunger for proper fit both for size and eccentricity, (egg shaped). Never reuse eccentric metal or brass rings. Metal rings should slide freely over the full length of the plunger. Check the plunger for over size dimension and for "roundness". Check plunger for possible tapering caused by improper grinding of surface.

C. Packing becomes very hot immediately after the pump reaches running pressure. Individual or all Plungers.

1. *Cause:* *Insufficient packing lubrication.*
   Solution: Check lubrication reservoir to verify that it is full and the system is operating properly at all plungers. Make sure to use the proper and recommended lubricating oil in sufficient amounts. Larger plungers take more lubricant than small plungers.

2. *Cause:* *Discharge valve stuck open or washed out. This allows discharge pressure to stay on the packing at all times, limiting the packing's ability to relax and become lubricated. This can happen at any time during pumping.*
   Solution: Replace with a good discharge valve.

aligned. Remove plunger from pony rod and check both surfaces for irregularities. If plunger has been resurfaced, or refurbished, check for "squareness" or whether its mating surface is perpendicular to the barrel.

4. *Cause:* *Packing too loose, letting fluid into the voids of the packing causing hydrostatic pressures in excess of operating pressure. Prevalent in multiple ring sets.*
   Solution: Check with SPM for proper adjustment instructions.

5. *Cause:* *Very rough plunger surfaces.*
   Solution: Remove plunger and check finish. Surface should be extremely smooth without grooves, nicks, or scratches. Some feel that an RMS finish of 4 to 5 will be too smooth for lubricant to provide a satisfactory film thus causing heat. A finish above 16 RMS will cause excessive packing wear and heat.

6. *Cause:* *Improper filling of the pump cylinders causing cavitation.*
   Solution: Make sure the pump is operating properly with adequate supercharging. High viscosity fluids or high pump speeds can cause

Composition rings will deteriorate in fluids above 200°F. The temperature in the stuffing box will be much higher due to the additional sliding friction. It may be necessary to use a higher temperature elastomer such as HNBR; or a fluoroelastomer such as Viton, Fluorel or Aflas.

D. Packing running hot after 1 to 2 hours of operation. All or individual plungers.

1. Cause: *Fluid being pumped is corrosive and attacking the packing materials.*

Solution: Determine the exact makeup and composition of the fluid being pumped and the packing material. Contact SPM for materials compatibility. Some common fluids such as #1 diesel, toluene, zylene, over 15% HCL, synthetic gels, kerosene, and naphtha will present problems for low to medium acrylonitrile (buna n) pressure rings. It may be necessary to replace packing rings with a ring molded from a more corrosion or heat resistant material.

E. Short or unacceptable life during

the surfaces.

Solution: Replace damaged packing and adjust packing lube. Lubrication should flow freely to plunger prior to stroking the pump. Although conditions will vary, generally twenty (20) drops per minute lube oil rate is recommended.

2. Cause: *Plunger lubrication system running out of oil.*

Solution: Keep lubrication reservoir supplied with oil at all times and fully operational. Put an alarm on the device to announce low lubrication supply.

3. Cause: *Low suction pressure or inadequate fluid volume to the pump during changeovers from one tank to another. This allows pump to run dry and cavitate.*

Solution: Plan pumping operations to allow for smooth changeovers during course of the job.

4. Cause: *Abrasives causing plunger scoring or excessive plunger wear.*

Solution: Review packing assembly. Consult with SPM for best assembly for abrasive materials. Scoring can result from large dry particles of material from previous jobs breaking off the equipment and going through the pump.

6. Cause: Worn Plungers.

Solution: Remove and replace worn-out plungers. Discard worn plungers.

7. Cause: Worn or grooved stuffing boxes. Stuffing boxes will also wear out, although usually slower than plungers. With stuffing boxes, The wear appears as grooves in the I.D. The deepest groove will be adjacent to the last ring in the stuffing box (ring farthest from pressure).

Solution: Remove and replace stuffing box with a new or rebuilt unit. If stuffing boxes are to be rebuilt, they should be returned to the manufacturer. Extreme care and attention should be given to assuring the surfaces are smooth, parallel and perpendicular to the gland and bottom of the stuffing box.

8. Cause: Corrosive attack on metal or brass components in all cylinders. The metal will appear black, charred, blue, brittle or otherwise deformed.

Solution: Determine the exact composition and chemical makeup of the material being pumped. Higher or stronger concentrations of fluids being pumped will cause greater damage than lower strength materials. Check with SPM and compatibility charts. Close attention should be given to strength and concentration of materials. Replace all

metals look alike. Generally, the higher strength bronze should be used. Standard brass should not be used. It may be necessary to use stainless steel or other material.

9. Cause: Excessive plunger wear during a job. Plunger will appear dull gray in color or show excessive streaks and scoring. A dull gray rough appearance is generally caused by caustic material attack. Excessive streaks and scoring can occur on hardened steel plungers (not coated) due to oxidizing (rust) while sitting between jobs.

Solution: Check with SPM regarding the plungers to determine the specifications on the matrix of the spray metal plunger. It may be necessary to change surface materials. Check with compatibility charts for suitable matrix materials. For standard hardened steel plungers, it will be necessary to remove them from the pump between jobs and coat them with a heavy grease or cosmoline to keep rust from attacking them.

10. Cause: Loose gland and subsequent loose packing.

Solution: When using a spring loaded or header ring packing assembly, the gland should be tightened as tight as possible since it is a metal-to-metal assembly. Occasionally due

is running. Tighten with spanner or bar furnished with the pump. **Use trained personnel only. Make sure to take all safety precautions and use complete safety gear.** Experience will govern how tight is right. On adjustable assemblies, the gland has a tendency to loosen so the gland should be checked at least once an hour.

11. Cause: Broken spring from a spring loaded packing assembly, causing plunger scoring.

Solution: There is too much friction between the packing and plunger causing the packing to "stick" to the plunger, thus crushing or compressing the spring on every stroke. This chucking motion will fatigue the spring wire and cause it to break. There is then danger that the loose spring will score the plunger. Remove packing and plunger. Replace with new plunger and packing assembly. Determine the cause of the rough plunger and if there is any softening of the packing from the fluid being pumped. Also make sure lubricator is operating properly. If this happens often, check with SPM regarding plunger surface material and packing selection.

blown, check the packing lube pressure. It should not exceed 30 psi. The packing lube system should have a 30 psi relief valve, if it is equipped with an air powered lube pump. If it is an air over oil system, the air

TROUBLESHOOTING GUIDE
PLUNGER

TROUBLE SYMPTOM:

A. Extreme wear on stuffing brass, or brass worn eccentric, or egg shaped.

PROBABLE CAUSE & SOLUTION:

1. Cause: Incorrect dimensions on brass. The brass I.D. is too large, letting the packing push the plunger to one side. This allows the packing to extrude through the open side. It also allows the plunger to rub against the brass, causing eccentric wear.

Solution: Remove brass and discard immediately. Replace brass with correct dimensions.

2. Cause: Incorrect "brass" materials.

3. Cause: *Misalignment.*
Solution: Check alignment of crosshead to end of the plunger. Especially check connection between crosshead and pony rod. Inspect threads or clamp ends on the plunger (as it attaches to the pony rod) for burrs, cross-threading or any aggravating factors. Remove burrs or replace non-conforming component.

4. Cause: *Plunger ground eccentric or tapered.*
Solution: Remove plunger from pump and check for roundness and for taper. This can be done by rolling on a "flat" surface. If eccentric, the plunger will "jump" or not roll evenly on the surface. If the plunger is tapered it will roll in a circle with the small end toward the center of the circle. Replace with correct plunger.

5. Cause: *Plunger is hollow with insufficient barrel wall thickness to hold shape at pumping pressures. Indications will reflect an hourglass shape to the plunger and possible eccentric wear on the brass.*
Solution: Check on the maximum pressure allowed per plunger size.

6. Cause: *Large heavy plunger causing it to ride on the bottom of the packing/brass assembly.*

does not support the plunger or packing.
Solution: Disassemble pump and measure the I.D. of the stuffing box. Check the O.D. of the brass rings for correct dimensions. Check with manufacturer for correct dimensions on the brass and stuffing box.

8. Cause: *Pump has been idle for a long period. The weight of the plunger has caused it to distort the packing and contact the brass.*
Solution: Replace packing and brass.

TROUBLESHOOTING GUIDE
VALVES and SEATS

TROUBLE SYMPTOM:

A. Eroded Insert

PROBABLE CAUSE & SOLUTION

1. Cause: *Chemical attack on the insert, usually acid.*
Solution: Determine the exact makeup of the fluid being pumped. Various elastomers are available that will perform in well service fluids today. It may involve higher acrylonitrile content rubber or better polyurethane materials.

B. Swollen Valve Inserts

1. Cause: *Pumped fluid contains a high aromatic, low aniline solvent.*

polyurethane inserts. Use high temperature acrylonitrile rubber inserts for temperatures above 200°F operations. Check with SPM.

C. Washout on the seat taper.

1. Cause: *Improper installation. The pump deck not cleaned and prepared properly. Probably metal burr or some type of particle between seat and pump deck in the taper not allowing the seat to bottom properly.*

Solution: Hand deburr or polish where possible. If wash is severe check with SPM to determine if the fluid cylinder can be repaired by welding. In some low-pressure fluid ends, it is possible to use some metal cast materials to repair the washout. This is only a temporary fix and a permanent repair or replacement should be done as soon as possible.

D. Washout between the valve and seat. Many times the washing will erode away all or part of the valve guide leg.

1. Cause: *Seal failure of the valve insert. Continued running of the pump after the initial seal failure causes severe washing.*

Solution: Pay attention to gauges and smooth operation of the pump. A washed out valve

E. Multiple small washes, uniformly Distributed around the seating surface of the valve (below the insert).

1. Cause: *Insufficient valve lift due to stiff spring. Incorrect adjustment and/or installation of upper valve guide stop. Also incorrectly substituting seats.*

Solution: Use only correct seats and valves. Use appropriate spring with specified spring compression strength. Pay attention to installation and adjustment of valve stops. Check with SPM for correct spring strength and adjustment of upper valve guide stop.

F. Excessive metal wear on the seating surface of the valve and seat. Also valve pounding.

1. Cause: *Excessive valve lift due to a weak spring. Incorrect adjustment and/or installation of upper valve guide stop. Also incorrectly substituting seats.*

Solution: Check with SPM for correct spring compression and strength. Check also for adjustment on upper valve guide stop. Use correct valve and seat combinations.

G. Pitting on the sealing surface of the seat.

1. Cause: *Pumping an extremely corrosive fluid; usually high concentrations of hydrochloric acid.*

Solution: Determine the exact makeup of the fluid being pumped. Check with SPM for metallurgy of valves and seats to determine compatibility. It may be necessary to use different materials.

H. Depressions in the seating surface of the seat; many times referred to as ball bearing indentions or marks.

1. Cause: *Entrapped air in pumped fluid, particularly viscous frac gels. Air bubbles trapped between the valve and seat during closure undergo explosive decompression when the valve opens causing the damage.*

Solution: Review the suction conditions of the pump and the fluids being pumped. It may be necessary to slow pump or increase suction pressure from auxiliary blender or feed pump.

I. Valve seat jumps out of the pump deck.

1.Cause: *Pump deck has not been properly cleaned and prepared when changing out old valve for new valve.*

Solution: Remove old or worn valve seat using the

motion. Clean top to bottom. Take new seat and clean any oil or grease from the taper. Place seat in pump taper bore and drop in place. Take an old valve body and place in the newly installed seat. Strike firmly on top of valve to "seat" the new valve seat in place in the pump deck.

2. Cause: *Pump deck worn "egg shaped" or eccentric in the pump.*

Solution: This is not a common occurrence but it does happen. It is possible it can be repaired. More than likely the cylinder will have to be replaced and discarded. Check with SPM.

K. Insert jumps off the valve body.

1. Cause: *Can be caused by poor suction conditions and incorrect valve springs.*

Solution: Check suction conditions to assure proper filling of the pump. Check the strength of the valve spring. A lighter or heavier spring may be needed. Check with SPM.

2. Cause: *Material being pumped is too hot for the valve insert elastomer.*

Solution: Check specifications on the elastomer. The standard polyurethane insert will perform up to 180°F temperature. Above 180°F

3. Cause: *Material being pumped is corrosive to elastomer in valve insert.*

Solution: Determine the specifications of the material being pumped and the type of elastomer insert being used. Determine compatibility. Select the correct material to be used in the corrosive service.

L. Excessive wear on valve body and seat.

1. Cause: *Improper filling of pump causing valves to pound.*

Solution: Check the suction conditions of the pump with regard to viscosity of materials, abrasive index of the material being pumped and lifted. This wear can also be a function of pump speed in conjunction with these conditions. Check the valve spring

TROUBLESHOOTING GUIDE
PUMPS

TROUBLE SYMPTOM:

A. Abnormally high vacuum at power end lube pump suction inlet (may or may not be accompanied by abnormally low oil pressure).

PROBABLE CAUSE:

1. Extremely cold ambient temperature/dangerously high oil viscosity.

4. Clogged oil reservoir breather.
5. Erroneous gauge reading.

TROUBLE SYMPTOM:

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.)

PROBABLE CAUSE:

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.

TROUBLE SYMPTOM:

C. Abnormally high power end and/or reducer lube oil temperature (may or may

PROBABLE CAUSE:

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 it's maximum horsepower or maximum torque rating.
4. Heat exchanger or oil cooler malfunction.
5. Excessive amount of lube oil around gearing.
6. Internal power end damage or power end wear.
7. Erroneous gauge reading.

TROUBLE SYMPTOM:

D. Leaking power end oil seals.

PROBABLE CAUSE:

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.

TROUBLE SYMPTOM:

E. Leaking fluid end seals.

PROBABLE CAUSE:

1. Seal installed improperly.
2. Seal cut or pinched on installation.

4. Damaged or corroded mating seal surface.
5. Sealing part not properly tightened

TROUBLE SYMPTOM:

F. Fluid knock or hammer.

PROBABLE CAUSE:

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.

TROUBLE SYMPTOM:

G. Low discharge pressure/rough running Pump.

PROBABLE CAUSE:

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.

common charge pump and getting "in phase" with each other.

TROUBLE SYMPTOM:

H. Shavings or metal particles in power frame and/or reducer. Shavings or metal particles in pump lube strainer.

PROBABLE CAUSE:

1. Remnants of manufacturing process. A small amount
   after initial run-in is to be expected and should be considered benign.
2. Evidence of bearing or gearing deterioration.

TROUBLE SYMPTOM:

I. Leaking Covers

PROBABLE CAUSE:

1. Loose cover bolts.
2. Damaged cover gasket.
3. Inadequate cover sealant.
4. Cracked frame causing excessive flexing.

TROUBLE SYMPTOM:

PROBABLE CAUSE:

1. Loose stay rod nuts, due to incorrect torque, causing remaining stay rods to support higher loads.
2. Incorrect stay rod design including thread profile and surface prep.

ROUTINE PREVENTATIVE MAINTENANCE WELL SERVICE PUMPS

Maximum service and trouble-free operation can be obtained from the SPM plunger pump by establishing a thorough preventative maintenance program as follows. This is true for other pump brands as well.

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

During the first 100 hours of new pump operation:

- Change power end lube oil filters every 25 hours or more often if required to prevent filter bypass.
- Change or thoroughly clean the power end lube oil suction strainer after 50 hours of operation and 100 hours of operation.
- Change the power end lube oil after the first 100 hours of operation and clean the lube oil reservoir.

Daily Preventative Maintenance:

- Check the oil level in the power end lube oil reservoir.
- Check the oil level in the plunger lube oil reservoir.
- Check the plunger pump for oil leaks and /or fluid leaks.
- Check the power end lube oil system for leaks.
- Check the plunger lube system for leaks.

Weekly Preventative Maintenance:

- Check all items on "daily" list.
- Check all valves, inserts, valve seats, and springs.
- Check all discharge & suction cover seals.
- Check suction pulsation dampener for correct pre-charge.

Monthly (or every 100 hours) Preventative Maintenance:

- Check all items on "daily" and "weekly" lists.
- Check all fluid cylinder mounting bolts to insure that they are tight.
- Check all plunger pump mounting bolts to insure that they are tight.
- Change power end lube oil filters.
- Check all supplies needed for routine maintenance such as 0-rings, fluid seals, valves, valve inserts, valve seats, valve springs, packing, oil seals, filter elements, etc.

Quarterly (or every 250 hours) Preventative Maintenance:

- Check all items on "daily", "weekly", and "monthly" lists.
- Change the power end lube oil and refill with the proper grade of gear oil for upcoming ambient conditions.
- Change or thoroughly clean the power end lube oil suction strainer.
- Remove and inspect the plungers and packing assembly components. Replace all packing pressure rings and header rings.
- Change or clean the plunger pump's oil breathers and the power end lube oil reservoir breather.

Yearly (or as required) Preventative Maintenance:

- Replace worn plungers and packing brass.
- Replace worn or corroded valve covers, suction valve stops, packing nuts, discharge flanges, pump tools, etc.
- Replace the discharge flange seals and suction manifold seals.
- Replace any defective gauges and instruments. Inspect and repair the power end lube oil pump.

FLUID END MAINTENANCE PROCEDURES

***Note*: Always verify that the system is not under pressure and no pressure is retained in the system. Always be attentive to components and safe handling procedures. Improper handling or working on equipment under pressure can cause serious injury or death. Always use proper safety gear including hand and eye protection and be careful of gears and moving parts.**

A. Replacement of Valves and Seats:

1. Remove and inspect the suction covers and discharge covers from the fluid cylinder. *(Use the SPM 2" hex cover wrench and a 10lb hammer if you are working on a SPM or similar product or when refurbishing a TWS 250 or TWS 400, you will remove the six nuts from the studs that hold the suction and discharge covers on).* Also inspect the threads and seal surfaces of the fluid cylinder.

2. During the replacement of valves and seats, removal of the plungers is not necessary. However, be sure to rotate the pump until the plunger in the cylinder is clear of the valve stop and seat prior to removal.

3. Turn the suction valve stops approximately 90 degrees and remove them from the fluid cylinder along with the valve springs underneath them.

4. Cock each suction valve to one side in order to drain

valve removal tool can be used). Follow the valve manufacturer's recommendation of removing the insert from the valve.

5. Remove the discharge valve springs and discharge valves from the fluid cylinder.

6. Remove each of the discharge valve seats and suction valve seats *(Use the SPM hydraulic seat puller if you are working on a SPM product).* Inspect the taper and seat deck.

7. 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.

8. 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 place a heavy steel bar on top of the valve. Tap the hammer on the top of the bar to push the valve seat into the taper.

9. 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.

10. When reinstalling the suction valve stop, make certain it is turned perpendicular to the plunger and securely seated. For SPM Fluid Ends, the stop must securely seat in the groove.

11. Before reinstalling the discharge and suction covers,

remove the seals from each, clean the covers thoroughly, and install new seals. Make sure that the seals are replaced in the proper position. 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.

12. Apply a coating of oil or very light grease to the suction
and discharge covers before installation. Be sure to tighten them securely.

B. Replacement of Plungers and Packing:

Note: On SPM pumps, If you are replacing plungers or packing on a TWS 250, TWS 500LW, TWS 600S, or the TWS 1250LW, remove the plunger lube fitting from each packing nut. It is unnecessary to remove the lube fitting on other SPM pumps. Always verify each seal, bolt, stud, nut, insert, etc, for wear or damage prior to reinstallation.

1. Loosen each of the packing nuts at least one full turn *(Use the SPM packing nut tool if you are working on a SPM product).*

2. Remove the suction covers as outlined earlier.

3. Unscrew the plunger from the crosshead and pull each plunger out of the fluid cylinder through the suction cover bore *(Use the SPM plunger wrench if you are working on TWS 500LW, TWS 600S, and TWS 1250LW pumps).* Other SPM pump models require the removal of the plunger clamps by using a 3/8" allen wrench to

4. Secure the seal rings with the SPM seal ring retainer or another suitable tool *(The seal rings are only present on the TWS 250 and TWS 600S pumps in the SPM product line).* 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. Inspect the cylinder and nut, including the threads and seal areas.

5. Inspect each plunger for wear, scoring, and corrosion on the hard surface area and damage to the face which mates with the crosshead.

6. Inspect each ring of packing brass for excessive wear, damage, egging, and scoring. Never reuse any packing brass that is egged, scored or damaged.

7. Blow air through the lube port on each packing nut to ensure that the lube passage is unobstructed.

8. 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.

9. Using new packing header rings and new packing pressure rings, reinstall the packing assembly one piece at a time. 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. *(Refer to the packing diagram for the proper sequence and direction upon installation)*

10. On SPM TWS250 and 600S pumps, replace the O-rings and back-up rings in the steel seal rings and dress the 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. If the seals are installed backwards, a leak will occur.

11. Reinstall each packing nut into its proper cylinder, screwing it all the way in until tight, then backing it off one to two turns.

12. Coat the hard surface area of each plunger with a light oil and insert it into the packing. Using a short 4" x 4" piece of wood and a 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 threads or the pony rod depending on the SPM pump model (See section B3.) Carefully align the plunger to the crosshead or pony rod and gently bump the plunger up against it.

13. Tighten the plunger to the proper torque specifications. Refer to the torque table on page 93. *(Use the SPM plunger wrench if you are working on a SPM product).*

14. Tighten each packing nut as tight as possible *(Use the SPM packing nut wrench if you are working on a SPM product).* Note: The packing nut will need to be retightened only once after the pump is reassembled and run under pressure for a short period of time. After that, the packing is completely self-adjusting.

15. Reinstall the packing lube fitting into the packing nut.

INSTALLATION SUMMARY

Valves and Seats (All SPM Pumps and Similar Pumps):

- Replace the O-Rings on the valve seat. (Install O-Ring Dry).
- Hand tighten the valve seat into the taper. (Do not use any grease).
- Place the valve into the seat. Using a steel bar, lightly tap on the bar with a hammer to push the valve seat into the taper.
- Do not mix one manufacturers valve with another manufacturers valve seat. Likewise, do not mix valve inserts with another manufacturers valve.
- Place the spring on top of the valve.
- Place the valve stop on top of the spring.
- Push the suction valve stop down and turn until it is secure and perpendicular to the plunger.
- Remove the seals from each of the discharge and suction covers.
- Clean the covers thoroughly and hand polish with 220 to 240 grit emory cloth.
- Replace each seal.
- Coat with oil or light grease and secure them with a 2 inch hex cover wrench and a 10lb hammer.

Plungers and Packing (THB 175, THB 350, TWS 250, TWS 600S, and Similar Pumps):

- Using new header rings and new packing pressure rings, reinstall the packing assembly one piece at a time. (Coat with a light oil)
- Replace all o-rings and back-up rings in the steel seal rings and dress the seal areas in both the fluid cylinder and the packing nut using 220 to 240 grit emory cloth.
- Install each packing nut into its proper cylinder, screwing it all the way until tight, then back it off one to two turns.
- Coat the hard surface area of each plunger with a light oil and insert it into the packing.
- Using a short 4x4 wooden block and a 12 lb. Hammer, bump the plunger into the packing while holding it as straight as possible.
- Continue bumping the plunger through the packing until the threaded bore approaches the crosshead threads.
- Tighten the plunger to the crosshead. *(Use the SPM plunger wrench if you are working on a SPM product.)*
- Tighten each packing nut as tight as possible *(Use the SPM packing nut wrench if you are working on a SPM product).* The packing nut will need to be retightened only once after the pump is reassembled and run under pressure for a few revolutions.
- Reinstall the packing lube fitting into the packing nut.
- Reinstall the suction covers as outlined in the fluid end maintenance procedures.

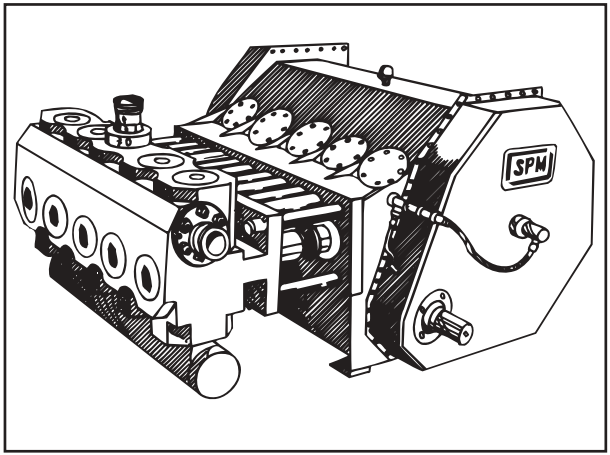
Plungers and Packing (All Other SPM and Similar Pumps):

- Using new header rings and new packing pressure rings, reinstall the packing assembly one piece at a

oil and insert it into the packing.

- Using a short 4x4 wooden block and a 12 lb. Hammer, bump the plunger into the packing while holding it as straight as possible.
- Continue bumping the plunger through the packing until the plunger makes contact with the pony rod.
- Using a 3/8" hex key or socket, install and tighten the plunger clamp screws.
- Tighten each packing nut as tight as possible *(Use the SPM packing nut wrench if you are working on a SPM product)*. The packing nut will need to be retightened only once after the pump is reassembled and run under pressure for a few revolutions.
- Reinstall the packing lube fitting into the packing nut.
- Reinstall the suction covers as outlined in the fluid end maintenance procedures.

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 WHILE IN MOTION OR UNDER PRESSURE CAN CAUSE SERIOUS INJURY OR DEATH! ALWAYS USE PROPER SAFETY GEAR INCLUDING HAND AND EYE PROTECTION AND BE CAREFUL OF GEARS AND MOVING PARTS.

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.

Personal Responsibilities:
Only properly trained personnel should be allowed to maintain and repair well service pumps.

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. Personnel should never be around the pump when the input shaft is turning under power or the unit is under pressure.

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 A relief valve system must always be in place during pump maintenance and/or repair.

B-6 Any fluid cylinder which has been pressured beyond its specified working pressure should be

returned to SPM for disassembly, inspection and recertification.

B-7 Welding, brazing or heating any part of the pump is prohibited. If accessories are to be used they are to be bolted or clamped on. Consult factory.

B-8 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-9 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-10 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-11 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-12 All personnel should maintain a safe distance from the pump when it is rotating as well

pressure is present. Keep hands and clothing clear of unit at all times.

B-14 Any repairs or service (even routine maintenance) performed on the pump must be performed by a 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 qualified 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-15 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-16 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 improper repair of components , 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 Personnel must clear all pumps during operation. There is a clear and ever present danger from gears and other moving parts to loose clothing,
hand, etc., that could lead to serious injury or death. Keep clear of moving or pressurized components.

C-4 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-5 All products should be properly cleaned, greased or oiled after each use and inspected prior to each use.

C-6 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-7 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.

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

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.

SPM PUMP AND FLOW CONTROL APPLICATION FORMULAE

1. Horsepower Formulae:

Hydraulic Horsepower = $\frac{\text{GPM x PSI}}{1714}$

Brake Horsepower = $\frac{\text{GPM x PSI}}{1714 \text{ x ME}}$

2.Fluid Flow Formulae:

GPM = $\frac{(\text{Plunger Diameter})^2 \text{ x } 0.7854 \text{ x stroke length x number of plungers x RPM}}{231}$

GPM = $\frac{\text{BHP x } 1714 \text{ x ME}}{\text{PSI}}$

3. Pressure Formula:

PSI = $\frac{\text{BHP x } 1714 \text{ x ME*}}{\text{GPM}}$

4. Rod Load Formula:

Rod Load (lbs.) = $(\text{Plunger Diameter})^2$ x 0.7854 x PSI

5. Flow Velocity Formula:

Flow Velocity (ft./sec.) = $\frac{\text{GPM x } 0.3208}{\text{Internal Area**}}$

6. Torque Formula:

Torque (ft. lbs.) = $\frac{\text{BHP x } 5252}{\text{RPM}}$

Notes to formulae above:

BHP = Brake Horsepower
GPM = Gallons Per Minute
*ME is usually 0.9 (90%) for SPM pumps. Check with other manufacturers for their specs.
**Internal Area = $(\text{inside diameter})^2$ x .7854

CLEARANCE REQUIREMENTS

Bearings and Bushings

Wrist pins or bushings containing clearances greater than or equal to 0.010-inch should be replaced.

General Rule: 0.001 inch clearance per 1.000-inch diameter of the shaft/wrist pin.
Example: 6.000-inch shaft = 0.006-inch clearance.
3.000-inch wrist pin = 0.003-inch clearance over the bushing.

Crossheads and Crosshead Guides

The clearances vary between pump models.

Pump Model (SPM)	Tolerance Requirements (Inches)	Tolerance not to Exceed (Inches)
TWS250 & TWS400	0.010 to 0.015	0.020
TWS500, TWS600 & TWS600S	0.008 to 0.012	0.014
TWS1000, TWS1250 & TWS1500	0.008 to 0.002	0.014
TWS900, TWS1300 through TWS2250, QWS2000 & QWS2500	0.025 to 0.30	0.035

These rules do not apply to roller type bearings. Check maintenance manual for the clearances on roller bearings.

TORQUE TABLE

ALLOY STEEL STUDS, SAE GRADE 7		
DIA. IN.	DRY THREADS TORQUE-FT. LBS.	LUBRICATED THREADS TORQUE-FT. LBS.
1/4	8.3	6.2
5/16	17.2	12.9
3/8	30.5	23.9
7/16	48.8	36.6
1/2	74.5	55.8
5/8	148.0	111.0
3/4	262.0	196.0
7/8	425.0	318.0
1	635.0	477.0
1-1/8	900.0	675.0
1-1/4	1270.0	955.0
1-3/8	1660.0	1245.0
1-5/8	----	2300.0

CAPSCREWS & BOLTS, SAE GRADE 5		
DIA. IN.	DRY THREADS TORQUE-FT. LBS.	LUBRICATED THREADS TORQUE-FT. LBS.
1/4	6.7	5.1
5/16	13.9	10.4
3/8	24.7	16.5
7/16	39.4	29.6
1/2	60.3	45.2
5/8	120.0	90.0
3/4	212.0	159.0
7/8	315.0	236.0
1	472.0	354.0
1-1/8	633.0	475.0
1-1/4	900.0	675.0
1-3/8	1170.0	877.0
1-5/8	----	----

To obtain the required torque on the 1-3/8” and 1-5/8” studs, use a hammer lug wrench after tightening with a standard wrench. Turn the nut another 30°(just less than 1/8 turn) with the hammer wrench.

TORQUE TABLE

PONY ROD STUDS		
TYPE	LOCATION	TORQUE
TWS400	Cross Head	675 (Thread Lock)
RR500	Cross Head	500-600 (Lubed)
TWS500	Cross Head	675 (Thread Lock)
TWS600	Cross Head	675 (Thread Lock)
TWS600S	Cross Head	675 (Thread Lock)

PLUNGERS		
TYPE	LOCATION	TORQUE
TWS400	Plunger	500-600 (Lubed)
RR500	Plunger	675 (Thread Lock)
TWS500	Plunger	500-600 (Lubed)
TWS600	Plunger	500-600 (Lubed)
TWS600S	Plunger	500-600 (Lubed)

TORQUE CONVERSIONS/METRIC CONVERSIONS

TORQUE CONVERSIONS EQUIVALENTS POUND INCH - POUND FOOT - NEWTON METER

pound foot x 12 = pound inch
pound foot x 1.356 = Newton meter
Newton meter x 8.850 = pound inch
Newton meter x .0.737 = pound foot
pound inch x .083 = pound foot
pound inch x 0.113 = Newton Meter

METRIC TO ENGLISH CONVERSIONS ENGLISH TO METRIC CONVERSIONS

inches x 25.4 = millimeters (mm)
inches x 2.54 = centimeters (cm)
feet x .3048 = meters (m)
yard x .9144 = meters (m)
psi x .0689 = bar
psi x .006894757 = Megapascals (MPa)
psi x 6.894757 = kpa
psi x .0703 = Kilogram force per square centimeter (Kgf/cm^2)
pound force x 4.448 = Newtons
pound · inch x . 113 = Newton · meters (N · m)
pound · foot x 1.356 = Newton · meters (N · m)
millimeter x .0394 = inch (in)
centimeter x .3937 = inch (in)
meters x 3.281 = feet (ft)
meters x 1.0936 = yards (yd)
bar x 14.5 = psi
Megapascals x 145.0 = psi
Kilogram force per square centimeter x 14.22 = psi
Newtons x .2248 = pounds force (lb · f)
Newton · meter x 8.850 = pound · inches (lb · in)
Newton · meter x .737 = pound feet (lb · ft)

SPM®

Flow Control, Inc.

ISO-9001 Certified
Fort Worth
Alice
Odessa
Lafayette
Brighton
Red Deer
Dubai

NQA ISO 9002 CERTIFIED **(ABERDEEN)**

FORT WORTH: 7601 Wyatt Dr. • Fort Worth, Texas 76108 • U.S.A.• Phone: 1-800-342-7458 • (817) 246-2461 • Fax: (817) 246-6324
HOUSTON: 363 N. Sam Houston Pkwy. E. - Suite 1100 • Houston, Texas 77060 • Phone: (281) 820-7807 • Fax: (281) 820-7804
ALICE: 2450 Business Hwy. 281 North • Alice, Texas 78332 • Phone: (361) 661-0900 • Fax: (361) 661-0909
BRIGHTON: 7450 Johnson Rd. - Suites C & D • Brighton, Colorado 80530 • Phone: (720) 494-1805 • Fax (720) 494-7208
LAFAYETTE: 3535 Hwy 90 East • Broussard, Louisiana 70518 • Phone: (337) 837-3161 • Fax: (337) 837-8171
ODESSA: 2419 South Market • Odessa, Texas 79766 • Phone: (432) 580-3887 • Fax: (432) 333-1351
OKLAHOMA CITY: 9204 W. Reno • Oklahoma City, Oklahoma 73127 • Phone: (405) 782-0014 • Fax: (405) 782-0016
ROCK SPRINGS: 253 Industrial Dr. • Rock Springs, Wyoming 82901 • Phone: (307) 362-7727 • Fax: (307) 362-1055
GRANDE PRAIRIE: 104, 11231 - 97 Ave • Grande Prairie, Alberta T8V 5N5 Canada • Phone: (780) 402-3857 • Fax: (780) 402-7081
RED DEER: Unit A, 8060 Edgar Industrial Crescent • Red Deer, Alberta T4N 2R4 Canada • Phone: (403) 341-3410 • Fax: (403) 341-3072
ABERDEEN: Badentoy Ind'l Park, Portlethen • Aberdeen AB12 4YD Scotland • Phone: (44) 1224-783666 • Fax: (44) 1224-784184
SINGAPORE: 545 Orchard Road 15-02 • Far East Shopping Ctr. Singapore 238882 • Phone: (65) 6738-3078 • Fax: (65) 6736-1106
DUBAI: Oilfields Center Supply L.T.D. • Building 22 • P.O. Box 1518, Jebel Ali, Dubai, U.A.E. • Phone: 971-4-8836-368 • Fax: 971-4-8836-485

© 2004 SPM FLOW CONTROL