SUBSURFACE PUMP SERVICE REPORTING

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Abstract

One of the most expensive pieces of production equipment to be placed downhole is a sucker rod pump. The performance of this pump can greatly affect the ability of a well to produce. By collecting information about a pump and its components through failures and successes, the operator can determine the optimum pump configuration for a particular well. A longer pump life should substantially reduce operating costs, decrease downtime, and increase production.

Computers placed at the pump repair shop can capture detailed information about the configuration of a pump when it is assembled or when it is repaired, before being placed downhole. Later, as it is inspected after being pulled from the well, information about the condition of each component may be recorded. This data can be assimilated in a variety of ways to determine statistical trends and provide a foundation for an analysis of what works and what doesn't. By coupling this information with other facets, such as chemical treatments, surface unit and control panel information, well tests, etc., a very effective program for reducing failures and lifting costs while increasing production may be implemented.

Introduction

The Subsurface Pump Service Reporting System (SPSR) is computer software developed by Glenn, Prather & Company as an outgrowth of work initially done to track pump component performance for Coastal Management Corporation in Midland, Texas. The intention was to provide the pump company a means to gather data for the operator and reduce the total paperwork and data entry incurred by both the vendor and the operator.

A technical group, consisting of representatives from thirteen oil companies and eleven pump shops meeting in Midland, Texas, were simultaneously working on the standardization of pump repair data structures and the exchange of the data.

After using the original work for Coastal as a guide and an additional two years of development, the SPSR System became a commercially available stand alone (or integrated) system conforming to the Data Exchange Format Standards.

The Subsurface Pump Service Reporting System

SPSR is designed to track subsurface pumps (rod, tubing, progressive cavity, electric submersible, etc.) from the time they are first assembled, through every rebuild, until they are finally junked. Salvaged parts from the junked pump may also be tracked. Information is available about each failed pump and the pump currently installed in the well. Information is also available about pumps held in inventory, including the current location of the pump (e.g. field warehouse, rack number, pump shop, etc.).

Extensive error checking of correct date chronology, validation, and completeness is automatically performed during data entry. Additionally, there are many time saving features to assist in the entry process. Without extensive error checking, data becomes unreliable and not worth the time, money, and effort to capture. Garbage In / Garbage Out can render reports meaningless.

SPSR supports the proposed Data Exchange Format Standard. This data exchange format establishes an Electronic Data Interchange (EDI) standard for pump shop reports so data may be transferred between different software on different systems.

The same software with all the capabilities (data entry, inquiry, reporting, graphing, data transfer, etc.) can be used by both Pump Shops and Operators. Data may be transferred from the Pump Shop to the Operator via diskette, modem, or WAN at any time. The Operator may then utilize the data, along with information from other packages (Chemical Treatment Reporting, Well Service Reporting, Field Technician Reporting, etc.), to provide more complete information on failures.

Sophisticated Queries using Boolean logic for viewing or printing the data in a variety of reports and graphs allows detailed analysis. The same interface is used for selecting the data to process in all queries, reports and graphs. Reports may be displayed on the screen, printed to a printer, or output to a file. While the "standard" reports can allow the spotting of trends, the ability to select the data using various criterion is the pinnacle of the System, providing a means to focus on the problem area.

Using standard reports or the query system, trends can be found in the data. These trends may affect one well repeatedly, many wells, a specific pump, or components of all pumps. Some trends affecting pumps could be external influences, such as human induced (i.e. pump tagging) or metallurgical influences (i.e. corrosion). To observe a trend, most of the time the query or report must select a specific criterion to provide a cross section of the database. This cross section may be for study of a new experimental component, or all wells in a particular reservoir, or components of a specific metallurgy, or to analyze pump run life of failed components and still active components, or etc.

Once a symptom is observed more specific reports may be run that zoom in on the area of interest. Logical inferences, along with other supporting data such as well tests, fluid level data, well servicing records, etc. can lead to the action necessary to remedy the problem.

The most successful implementation involves setting up a computer in the pump shop and having a central individual who actually works on the pumps perform the data entry. It should take only 3-5 minutes per pump. Dirt and grime in the pump shop are not a problem, as long as the main portion of the computer is enclosed in a cabinet.

Although the pump shop personnel may spend some extra time performing data entry in the shop, there are some major advantages. By having the System on the shop floor, a list of the components for that pump with the number of days each component has run is available during the pump inspection. A proactive replacement program for components run for a predefined time period will allow the pump company to make sales and the operator to prevent failures (a win/win situation).

After the pump is pulled from the well and brought into the pump shop, it is dismantled for inspection. During the inspection, failed components are labeled with a failure code indicating the reason for failure. Since all parts are expected to fail sooner or later, a code of "WRN" (worn) indicates "normal" wear and tear. All other failure codes are considered "abnormal" failures. General corrosion or foreign material information, barrel and plunger micrometer readings, and remarks are recorded. If the reason for the pull was specified as "PF" (pump failure) and the reason for pump failure was specified as "PCOMP" (pump components), then the components that were primarily responsible for the failure may be flagged. This information is later used in statistics to raise a red flag for inquiries, since it would indicate a specific problem responsible for the well having to be pulled.

The pump is then rebuilt. All components that were reused or replaced are automatically flagged based upon the failed components. Any parts replaced from customer inventory or converted to a different configuration are entered. Reused components will continue with their days run "odometer", while replaced parts will have the number of days run reset to zero. Each replaced part (and line item) has the discounted net price which is totaled and can serve as an invoice.

Example Case Studies:

These case studies will demonstrate the use of this software in conjunction with other sources of information to determine trends that can lengthen the duration between failures of a well. Once a trend is identified, more specific reports may be run that zoom in on the area of interest. Logical inferences can be made to determine the cause, which in turn, can lead to the action necessary to remedy the problem.

Selected portions of some reports are shown in the Figures at the end of this paper. Other reports were simply too long to include for presentation. However, handouts will be available for presentation.

Case A

In Figure A-1 we have printed a summarized report of all valve rod guides and bushings for operator Triple AAA Petroleum for the Sargasum Reservoir. Notice we have 230 failures associated with 304 stainless steel valve rod guides, with an average component run life of 216 days. Then notice the statistics for 316 stainless steel valve rod guides with an average component life of 428 days. It is known that this reservoir has a high content of H_2S and Chlorides. The 304 stainless appears to be an inferior material to 316 in relation to this reservoir. A comparison can be made between the cost of the 304 and 316 stainless components run in this situation based upon the cost per day run of the life of the part. A comparison can also be made between different components. For instance, a 304 stainless barrel extension may have a considerably longer life than a 304 stainless cage in this reservoir. The operator may use this report to determine the cost per day run and reliability of replacing parts with 316 stainless (or not) and to provide information for justification, if necessary.

Case B

In Figure B-1 we show a graph of failure types for plunger adapters and valve rods for all pumps for all wells for Triple AAA Petroleum. Look at the section displaying failures indicating "BRK", which means broken or parted, and "UNS", which means unscrewed. This can be a problem associated with "fluid pounding".

Other symptoms associated with fluid pound can be beaten out traveling valve cages, and valve rod cutting the valve rod guide. Pump tagging symptoms generally include pounded valve rod guide clutches and in more severe cases, beat out traveling valve cages and/or broken plunger pins.

The next step was to print a report of the wells associated with this problem. This report is not included in the appendix because it shows each well that failed in detail and is somewhat lengthy. Interestingly enough, most all of the wells belonged to a single foreman. This problem was solved with a very minor amount of education (and a surface equipment change).

Case C

In Figure C-1 a report shows all pumps that have barrels that have failed for Triple A Petroleum. Notice pump serial number GPC224 contains an inordinate number of failures. In reviewing the failures, it is discovered that this is a chrome plated thin wall barrel pump in which the chrome is flaking ("FLK") much too often. Using the Query feature of the SPSR System, it was determined which wells had run this pump. Each well that had run this pump in the last three years was analyzed, expecting high H_2S levels, yet none were found. This barrel was a larger bore than other somewhat equivalent pumps that did not have this trouble. A possible hypothesis: the large bore with the thin wall barrel was flexing under pressure causing microscopic cracks that soon lead to flaking. Replace the barrel with a smaller bore or heavier wall barrel on the next pull and the problem is solved.

Case D

A well history for a well (that is too voluminous to be included in this paper) appears to have a problem with sand. After a sand screen was installed and several other attempts, the pump was set higher in the well bore and the problem was solved.

Case E

Figure E-1 shows a pump history for pump serial number GPC236 with failed components. Notice the plunger adapter has failed numerous times due to corrosion. This would likely go completely unnoticed if not for a report such as this. No other parts seem to have a corrosion problem. Notice the material of the plunger adapter ("1018" Steel) and the barrel material ("BRASS"). A galvanic reaction is corroding the steel. Replace the plunger adapter with Monel and the problem is solved.

Conclusion

All industries are moving toward more efficient processes, including the Oil Industry. Companies are becoming leaner and quicker to react. The availability of inexpensive computer equipment has enhanced this trend immensely by decreasing the time it takes to collect and analyze information. Information must be complete, accurate, and timely to be of use. It takes many times longer to fix an entry after it has been entered incorrectly than it takes to enter it correctly the first time. Moving the point of data capture closer to the origin greatly reduces the chance of errors.

The Subsurface Pump Service Reporting System can provide both the front end data capture and play an integral part in the analysis of the performance of subsurface pumps. Having the pump shop collect and maintain the information, then transmit it to the operator for analysis with other pertinent information only makes sense.

Acknowledgments

Special thanks for all who have helped make this project possible with their wealth of knowledge:

Coastal Management Corporation
Axelson, Inc. (Chuck White, Dale Ernest, et al)
DON-NAN Pump & Supply
Gibco Pump & Supply
Highland Pump (James Williams, Ray Foote, et al)
The Subsurface Pump Standards Committee (Russ Ott, Mobil...and many others)
Chevron USA (Greg Pittman, Vernal, Utah)
Oxy USA (Charles Oney, et al)
Hank VanHorn
...and many others. Thank you.

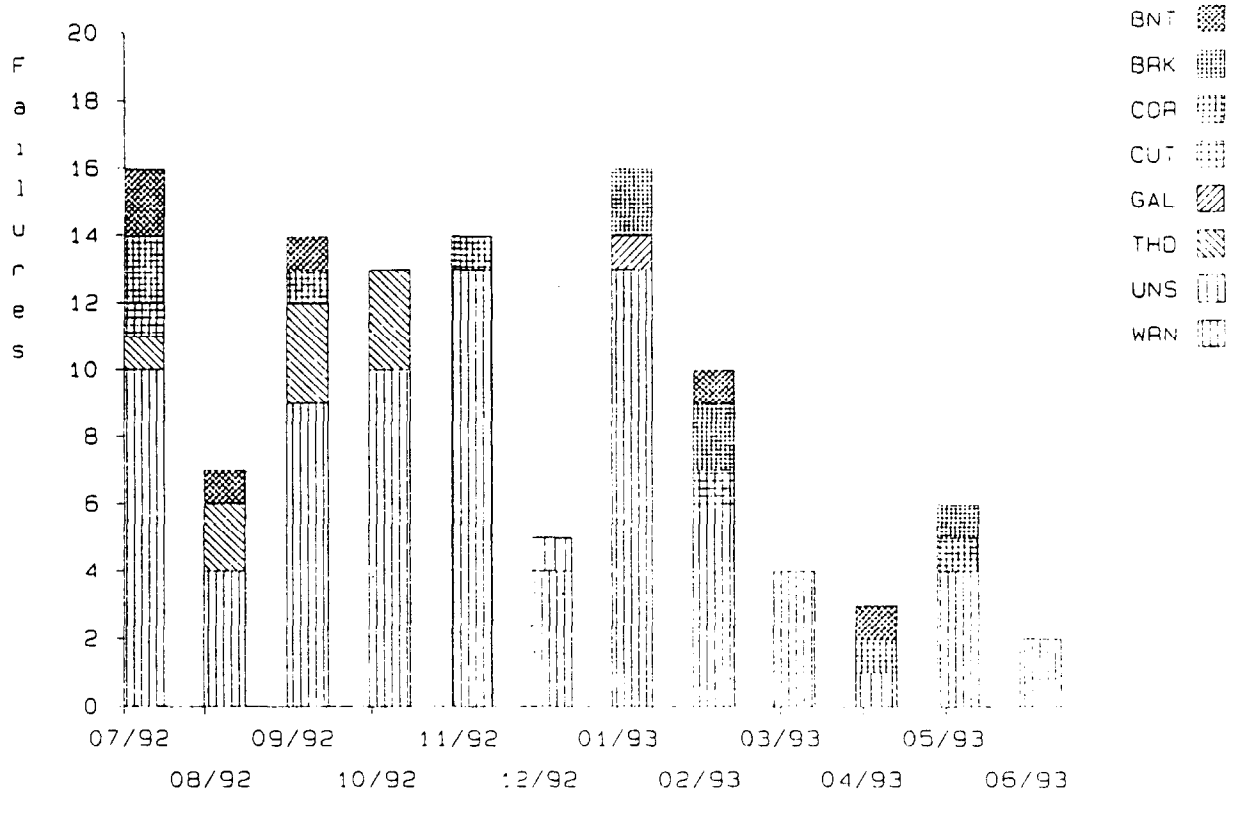
References:

"Subsurface Pump Service Reporting Reference Manual", Glenn, Prather & Company, 1994

Miscellaneous brochures for Subsurface Pump Service Reporting, Glenn, Prather & Company, 1994

Component	Metallurgy/ Surface Condition	Curr # in Serv	# Failed during Period	%	Failure	# Failed during Period	%	New Part Avg Run Life in Days	# Primary Reason for Pump Failure	# of New Parts in Serv or Failed
PLG/VRB Valve Rod Bushing		110			In Service			488+		75*
MONEL	Monel	2			In Service			112+		2*
					BOT Beat Out	11	79%	145	0	8
					WRN Worn-Exceeds Tolerances	3	21%	387	0	2
			14	7%		14	100%	193		10
S304	304 Stainless Steel	74			In Service			470+		38*
					BOT Beat Out	5	3%	89	0	2
					COR Corrosion/Pitting	154	81%	213	0	73
					PND Pounded	17	9%	101	0	11
					WRN Worn-Exceeds Tolerances	13	7%	297	0	9
			189	92%		189	100%	205		95
S316	316 Stainless Steel	34			In Service			550+		38*
					BOT Beat Out	1	50%	145	0	1
					PND Pounded	1	50%	121	0	1
			2	1%		2	100%	133		2
	** Failure Summary PLG/VRB		205	100%		205	100%	203	0	107
PLG/VRGDE Valve Rod Guide		110			In Service			224+		53*
S304	304 Stainless Steel	78			In Service			187+		45*
					BOT Beat Out	6	3%	153	0	3
					COR Corrosion/Pitting	175	76%	224	0	101
					CUT Cut/Grooved/Scored/Abrasn	4	2%	176	0	2
					PND Pounded	14	6%	164	0	9
					WRN Worn-Exceeds Tolerances	31	13%	218	0	17
			230	89%		230	100%	216		132
S316	316 Stainless Steel	32			In Service			314+		45*
					BOT Beat Out	4	14%	200	0	2
					COR Corrosion/Pitting	4	14%	317	0	3
					PND Pounded	3	11%	222	0	1
					WRN Worn-Exceeds Tolerances	17	61%	517	0	9
			28	11%		28	100%	428		15
	** Failure Summary PLG/VRGDE		258	100%		91	100%	238	0	147

Figure A1 - Pumps 'R Us Pump & Supply
Component/Material Performance Analysis
Triple A Petroleum-Sargasum Reservoir
7/01/91 through 6/30/94



07/01/92 - 06/30/93

Figure B1 - Pumps 'R Us Pump & Supply
Failures by Cause–Plunger Adapter/Valve Rod
Triple A Petroleum

Pump Serial #:GPC211	Built/ Prev Rpr	Installed	Failed	Pulled	Days Run	Reas Pull	New Cost	Repair Cost	Per Day Average	
Operator: AAA Triple A Petroleum Lease/Well: Mona Lease/2126 20-125-RHBC-12-4-4	N/A	07/29/92	02/08/93	02/08/93	214	PF		1094.42	14.46	
Pump Serial #:GPC218	Built/ Prev Rpr	Installed	Failed	Pulled	Days Run	Reas Pull	New Cost	Repair Cost	Per Day Average	
Operator: AAA Triple A Petroleum Lease/Well: Mona Lease/2126 20-125-RHBC-16-4	N/A	/ /	07/09/92	07/09/92	N/A	TF		2407.71	*********	
Operator: AAA Triple A Petroleum Lease/Well: Mona Lease/1833 20-125-RHBC-16-4	07/13/92	09/24/92	02/04/93	02/04/93	133	PF		3274.26	24.62	
Pump Serial #:GPC224	Built/ Prev Rpr	Installed	Failed	Pulled	Days Run	Reas Pull	New Cost	Repair Cost	Per Day Average	
Operator: AAA Triple A Petroleum Lease/Well: Mona Lease/7326 25-200-RWBC-20-4	07/13/92	07/14/92	10/07/92	10/07/92	85	TF	3909.82	2449.72	28.82	
Operator: AAA Triple A Petroleum Lease/Well: Duck Lake Unit/1523 25-200-RWBC-20-4	7/08/92	10/17/92	11/30/92	11/30/92	44	PF		3159.10	71.80 Bbl flaked. Plunger scored.	
Operator: AAA Triple A Petroleum Lease/Well: Mona Lease/1729 25-200-RWBC-20-4	11/30/92	01/01/93	03/20/93	03/20/93	78	RF		2634.09	33.77	
Operator: AAA Triple A Petroleum Lease/Well: Mona Lease/1729 25-200-RWBC-20-4	03/20/93	03/20/93	06/13/93	06/13/93	85	TF		2110.29	24.83 Bbl starting to flake...will go ahead and repl	
Operator: AAA Triple A Petroleum Lease/Well: Mona Lease/7126 25-200-RWBC-20-4	06/14/93	06/15/93	09/08/93	09/08/93	85	PF		2908.29	34.22 Barrel flaked. No other problems	
Pump Serial #:GPC236	Built/ Prev Rpr	Installed	Failed	Pulled	Days Run	Reas Pull	New Cost	Repair Cost	Per Day Average	
Operator: AAA Triple A Petroleum Lease/Well: Mona Lease/3235 25-125-RHBC-26-4	N/A	/ /	07/11/92	07/11/92	N/A	PF		7254.88	*********	
Pump Serial #:GPC242	Built/ Prev Rpr	Installed	Failed	Pulled	Days Run	Reas Pull	New Cost	Repair Cost	Per Day Average	
Operator: AAA Triple A Petroleum Lease/Well: Mona Lease/3932 20-125-RHBC-16-4	N/A	10/12/91	07/19/92	07/19/92	281	RF		3462.48	12.32	
Pump Serial #:GPC245	Built/ Prev Rpr	Installed	Failed	Pulled	Days Run	Reas Pull	New Cost	Repair Cost	Per Day Average	
Operator: AAA Triple A Petroleum Lease/Well: Mona Lease/3532 25-200-RWBC-20-4	02/17/93	05/24/93	06/07/93	06/07/93	14	PF		1182.70	84.48	
Pump Serial #:GPC249	Built/ Prev Rpr	Installed	Failed	Pulled	Days Run	Reas Pull	New Cost	Repair Cost	Per Day Average	
Operator: AAA Triple A Petroleum Lease/Well: Duck Lake Unit/1629 25-150-RWBC-16-4	07/06/92	07/13/92	01/26/93	01/26/93	201	PF		3313.35	16.48	

Figure C1 - Pumps 'R Us Pump & Supply
Pump Service Report
Pump Listing of Barrels Failed for Triple AAA Petroleum

Serial #: GPC236	Built/ Prev Rpr	Installed	Failed	Pulled	Days Run	Reas Pull	New Cost	Repair Cost	Per Day Average				
Operator: AAA Triple A Petroleum Lease/Well: Mona Lease/3235 25-125-RHBC-26-4	N/A	06/01/92	07/11/92	07/11/92	41	PF		3254.88	*********	For Mat: Sand;Paraffin		Corros:Light/General	
Component	Metal	Qty	Part #	Description			Repl	Days-Fail					
PLG TPA Top Plunger Adapter	1018	1	YM2XD30FA-1	Top Plunger Cage				0*	COR				
PLG VRB Valve Rod Bushing	S304	1	Y2-1/2D23-1-1/16	Valve Rod Bushing				0*	WRN				
PLG VLVRD Valve Rod	STEEL	24	2-1/2D24-0900	Valve Rod				0*	WRN				
PLG PLG Plunger	COBLT/SPM	1	2XA11SM-6-2	Plunger				0*	COR				
TVP BALL TV Primary Ball	TUNGN	1	BA3NC	TV Primary Ball				0*	CUT				
TVP SEAT TV Primary Seat	TUNGN	1	SB3C	TV Primary Seat				0*	CUT				
TVS CAGE TV Secondary Cage	S304	1	Y2XD16F-1	TV Secondary Cage				0*	COR				
TVS BALL TV Secondary Ball	SILNI	1	BA1N	TV Secondary Ball				0*	CUT				
TVS SEAT TV Secondary Seat	TUNGC	1	SB3C	TV Secondary Seat				0*	CUT				
PLG VRGDE Valve Rod Guide	S304	1	Y2D25-1-875	Valve Rod Guide				0*	COR				
BBL BBLCN Barrel Connector	S304	1	Y2D3-1	Barrel Connector				0*	COR				
BBL XTCPU Extension Coupling-Upper	BRASS	1	YB2XA12-48	Extension Coupling-Upper				0*	COR				
BBL BBL Barrel	BRASS/CP	1	YB2XA5-26C	Barrel				0*	FLK				
SVP CAGE SV Primary Cage	S304	1	Y2D33FF-1	SV Primary Cage				0*	COR				
SVP BALL SV Primary Ball	TUNGN	1	BA5NC	SV Primary Ball				0*	CRK				
SVP SEAT SV Primary Seat	TUNGN	1	SB5C	SV Primary Seat				0*	CRK				
STA ADPT Seat Assy-Adapter	S304	1	Y2L22-2-1/2	Seat Assy-Adapter				0*	COR				
STA MNDRL Seat Assy-Mandrel	S304	1	Y2-1/2T1L	Seat Assy-Mandrel				0*	COR				
STA CUPRG Seat Assy-Cup Ring(s)	S304	2	Y2-1/2T2	Seat Assy-Cup Ring(s)				0*	COR				
STA CUP Seat Assy-Cup(s)	PLAST	3	BJ5P	Seat Assy-Cup(s)				0*	WRN				
STA GAC Seat Assy-Gas Anchor Conn	S304	1	Y2-1/2T3	Seat Assy-Gas Anchor Conn				0*	COR				
Operator: AAA Triple A Petroleum Lease/Well: Mona Lease/3235 25-125-RHBC-26-4	07/11/92	07/13/92	07/28/92	07/28/92	15	TF		43.87	2.92	For Mat: Sand		Corros:None	
Component	Metal	Qty	Part #	Description			Repl	Days-Fail					
PLG TPA Top Plunger Adapter	1018	1	YM2XD30FA-1	Top Plunger Adapter				21*	COR				
STA CUP Seat Assy-Cup(s)	PLAST	3	BJ5P	2-1/4 +70 Seating Cup			New	15N	WRN	28.92			
Operator: BAMBAM BamBam Oil & Gas Lease/Well: Rubbelle-Runka/WTS-44-C 25-125-RHBC-26-4	07/29/92	08/27/92	09/02/92	09/02/92	6	RF		822.13	37.32	For Mat: Sand		Corros:None	
Component	Metal	Qty	Part #	Description			Repl	Days-Fail					
STA CUP Seat Assy-Cup(s)	PLAST	3	BJ5P	2-1/4 +70 Seating Cup			New	6N	WRN	28.92			
Operator: AAA Triple A Petroleum Lease/Well: Mona Lease/3234 25-125-RHBC-26-4	09/02/92	09/04/92	11/20/92	11/20/92	77	TF		756.29	35.92	For Mat: Sand,Paraffin		Corros:Light/General	
Component	Metal	Qty	Part #	Description			Repl	Days-Fail					
PLG TPA Top Plunger Adapter	1018	1	YM2XD10FA-1	Top Plunger Cage			New	77N	COR	146.30			
PLG VRB Valve Rod Bushing	S304	1	Y2-1/2D23-1-1/16	Valve Rod Bushing			New	98N	WRN				
PLG VLVRD Valve Rod	1018	24	2-1/2D24-0900	Valve Rod			New	98N	WRN	192.74			
PLG VRGDE Valve Rod Guide	S304	1	Y2D25-1-875	Valve Rod Guide			New	98N	WRN	112.02			
SVP BALL SV Primary Ball	TUNGN	1	BA5NC	Nickel Carbide Ball				98N	CUT				
SVP SEAT SV Primary Seat	TUNGN	1	SB5C	Carbide Seat				98N	CUT				
STA CUP Seat Assy-Cup(s)	PLAST	3	BJ5P	2-1/4 +70 Seating Cup			New	77N	WRN	27.22			
Operator: AAA Triple A Petroleum Lease/Well: Mona Lease/4131 25-125-RHBC-26-4	11/20/92	02/11/93	04/06/93	04/06/93	54	PF		2742.48	50.79	For Mat: Sand		Corros:Light/General	
Component	Metal	Qty	Part #	Description			Repl	Days-Fail					
PLG TPA Top Plunger Adapter	MONEL	1	CM2XD10FA-1	Top Plunger Cage			New	54N	COR	150.44			
SVS BALL SV Secondary Ball	SILNI	1	BA5N	SV Secondary Ball			New	54*	WRN				
STA CUP Seat Assy-Cup(s)	PLAST	3	BJ5P	2-1/4 +70 Seating Cup			New	54N	WRN	27.78			
Operator: AAA Triple A Petroleum Lease/Well: Mona Lease/3234 25-125-RHBC-26-4	11/20/92	04/06/93	04/06/93	04/06/93	0	PF		0.00	0.00	For Mat: Sand		Corros:Light/General	
Component	Metal	Qty	Part #	Description			Repl	Days-Fail					
STA CUP Seat Assy-Cup(s)	PLAST	3	BJ5P	2-1/4 +70 Seating Cup			New	0N	WRN	0.00			

Figure E1 - Pumps 'R Us Pump & Supply
Pump Service Report
Pump History with Failed Components