COMPUTER APPLICATION IN SUCKER ROD PUMPING MANAGEMENT

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INTRODUCTION

In the geographical areas of North and West Texas, 94 percent of all oil wells produce by means of artificial lift, and most of the artificial lift installations consist of sucker rod pumping equipment. This percentage equates to some 100,000 rod pumping units in this area alone.[1] With these facts in mind, there should be no doubt as to why the proper management and surveillance of pumping equipment are important.

This paper is limited to a discussion of computer application in the management and surveillance of rod pumping equipment. When terms referring to artificial lift equipment are used in the paper, they are in specific reference to sucker rod pumping installations. Methods and techniques cited for the surveillance and analysis of sucker rod pumping installations are from those employed in Exxon Company, U.S.A.'s Midcontinent Division and are applicable in both their automated and nonautomated areas of operation.

In production systems which contain multiple rod pumped wells, it is often difficult to identify problems associated with individual pumping installations. Failure to promptly detect these problems inevitably results in excessive operating costs, premature equipment failure, and lost production. To alleviate these undesirable results, Exxon Company, U.S.A. has developed a series of computer programs to assist in the surveillance of its rod pumping installations. These programs are of two general types. The first provides detailed data on pumping equipment failures and corrosion treatments by individual installations. The second type of programs is technically oriented. The technical programs calculate loading conditions and production capabilities of the pumping equipment. Results from the technical programs are compared to actual equipment ratings and latest well test data as a measure of the equipment's performance. Additional features of the technical programs allow an immediate analysis of the effects of varying equipment configurations or pumping conditions for any given installation.

Since Exxon's approach to artificial lift surveillance is based on technical calculations and the analyses of statistical data, it does not require a significant amount of initial investment or operating expense. The computer surveillance programs are proving to be highly efficient tools in the management of artificial lift production properties. Following sections of the paper will illustrate examples of artificial lift computer reports and data-handling methods.

PROGRAM APPLICATION

One of the primary tools in the management and surveillance of sucker rod pumping installations is a series of sucker rod analysis and equipment surveillance computer programs. The programs are primarily designed to assist in the otherwise time-consuming tasks of identifying installations which require attention and of performing lengthy calculations to determine equipment loadings and producing capabilities under current or modified operating conditions. Specific tasks which are assigned to the series of computer programs include:

1. Detection of installations which are not producing optimum fluid volumes
2. Detection of installations which have

excessive operating costs due to poor equipment performance

3. Identification of artificial lift failures by location and equipment type
4. Identification of the cause of failures, including overloaded equipment, fatigued equipment, metallurgy, or corrosion problems
5. Detection of installations which are being produced with over or undersized equipment
6. Detection of installations which are not pumping efficiently
7. Assistance in the design or redesign of pumping equipment under varying operating conditions
8. Assistance in the design and analysis of corrosion treatment programs.

By shifting a major portion of the technical calculations and equipment surveillance to computer analyses, technical and operating personnel have been able to concentrate their efforts on those rod pumping installations which have potential for improvement.

MAINTENANCE OF COMPUTER DATA FILES

Before computer analyses can be effectively used in solving artificial lift problems, a complete and accurate data base must be available on individual pumping installations. The data, consisting of information which describes the pumping equipment, corrosion treatments and equipment performance, are stored in computer files in such a manner that they can be readily accessed by the computer programs. To insure that the data files are

WELL SERVICE REPORT

CARD CODE (1) 1 DISTRICT ANDREWS (2) 3

FIELD SUPERINTENDENT KING (3-4) 3 6 LEASE CODE (5-9) 5 5 7 6 6

LEASE NAME MEANS S.A. UNIT WELL (10-13) 1 4 1 8 DATE (14-19) 5 MO. 1 3 DAY 7 5 YEAR

DEPTH TO FAILURE: NO. OF RODS (20) 1 (21-23) OR JTS. OF TBG. (20) 2 (21-23) 1 1 9

REMARKS:

FAILING EQUIPMENT (24-25)

01 ROD BODY
02 ROD PIN
03 ROD COUPLING
04 ROD SUB
05 PULL ROD
06 POLISHED ROD
07 ROD PUMP
08 TUBING PUMP
09 HYDRAULIC PUMP
10 DOUBLE DISPLACEMENT PUMP
11 HOLDOWN
12 SEATING NIPPLE
13 PUMP ANCHOR
14 TUBING ANCHOR
15 POWER OIL TUBING
16 TUBING BODY
17 TUBING COUPLING
18 TUBING THREAD
19 GAS LIFT EQUIPMENT
20 NEW INSTALLATION
21 CHANGE
22 WORKOVER
23 ABANDON
24 OTHER
25 TUBING PACKER
26 NONE
27 POLISHED ROD LINER
28 SCALE TREATMENT
29 SWABBING
30 ____________

FAILURE TYPE (26-27)

01 BREAK
02 CRACKED
03 WORN
04 HOLE
05 THREAD LEAK
06 STUCK
07 SPLIT
08 PLUGGED
09 UNSCREWED
10 UNSEATED
11 CUT OUT
12 CROOKED
13 SANDED
14 PARAFFIN
15 LOW PRODUCTION
16 FAILED TO PUMP
17 NO FAILURE
18 RE-SPACE OR LONGSTROKE
19 BOTTOM HOLE PRESSURE TEST
20 ____________

EQUIPMENT CONDITION-RODS (29)

1 PITTED OR WORN
2 PITTED OR WORN - SHOULD BE REPLACED
3 BOXES PITTED, WORN, OR HAMMERED
4 BOXES-SHOULD BE REPLACED
5 REPL'CD RODS OR RODS & COUPLINGS
6 REPL'CD COUPLINGS ONLY
7 CHKD. AND FOUND O.K.

TUBING (30)

1 PITTED OR WORN
2 PITTED OR WORN - SHOULD BE REPLACED
3 COUPLINGS PITT'D, WRN. OR HAMMERED
4 COUPLINGS-SHOULD BE REPLACED
5 REPL'CD TBG. OR TBG & COUPLINGS
6 REPL'CD COUPLINGS ONLY
7 CHKD. AND FOUND O.K.

SCALE AND PARAFFIN (31)

1 SCALE ON DOWNHOLE EQUIPMENT
2 SCALE REMOVAL NEEDED
3 PARAFFIN ON DOWNHOLE EQUIPMENT
4 PARAFFIN REMOVAL NEEDED
5 SCALE AND PARAFFIN
6 SCALE AND PARAFFIN REMOVAL NEEDED
7 CHKD. AND FOUND O.K.

PULL PUMP (28)

1 REPLACE
2 REPAIR
3 NO REPAIR NECESSARY

WELL SERVICE (32) 1

HOURS (33-36) 7.2 DOLLARS (37-40) 4 3 6

CONTRACTOR XXXX (42-43) X X

FIG-1 DATA FORM WELL SERVICE

current, statistical data on equipment failures and corrosion treatments are entered in the computer at least twice a month. Maintenance of the computer files are greatly enhanced through the use of simplified field entry forms. The forms require a minimum of effort to complete, and persons responsible for their completion do not have to be familiar with computer processing illustrated in the following examples.

Figure 1 is an input form for recording data associated with well servicing work. The form is normally completed by the well service unit operator. Cards are punched directly from this form for entry into the computer. The top portion of the form contains data that define the artificial lift installation being serviced and dates the work. This information also serves as tags for the proper sorting of data within the computer files. Additional information on the form defines the item of equipment which failed, cause of failure, condition of the equipment remaining in the well, and information pertaining to well servicing costs. The form has been designed to receive data through simple numeric entries or by circling a descriptive code. In the example, entries relating to well servicing on Well 1418 show: (1) failure of a tubing coupling; (2) type of failure was a thread leak; (3) some tubing couplings required replacing; and (4) servicing costs were $436.

The abbreviated subsurface pump repair forms in the next two figures are of particular significance because of the ease in which a large amount of detailed data is handled. They provide for a complete description of the worn or failing parts. As in the previous example, the top portions of both forms describe location and the date of the work. The subsurface pump is identified by its unique serial number and by its API pump description code. The form illustrated in Fig. 2 pertains to the pump that is pulled from the well. Individual pump parts are listed horizontally across the page, and failure codes are tabulated in columns below each part. Definitions of the failure codes are printed on the left-hand side of the form. As noted in the example, the pump barrel, traveling valve cage, standing valve seat, and standing valve cage were found to be worn or damaged when the pump was disassembled in the repair shop. The form in Fig. 3

SUBSURFACE PUMP SERVICE REPORT

CARD CODE (1) 4 DISTRICT ANDREWS (2) 3

FIELD SUPERINTENDENT KING (3-4) 3 6 LEASE CODE (5-9) 5 5 7 6 6

LEASE NAME MEANS S. A. WELL (10-13) 2 7 1 6 DATE (14-19) MO. 2 DAY 24 YEAR 75

PUMP STATUS (20): PUMP NUMBER (21-26) S 3 9

1 PUMP WAS RUN PUMP SHOP XXXXX (27-28) X X

2 PUMP WAS PULLED API PUMP DES. (29-40) 2 0 1 5 0 R W B C 2 4 0

3 PUMP WAS PULLED AND JUNKED TOTAL PUMP REPAIR COST - DOLLARS (41-44) 2 6 0

FAILURE CODE	(45-46) Liner or Barrel	(47-48) Plunger	(49-50) Valve Rod or Pull Tube	(51-52) T. Plgr. Cage or U.P.T. Cplg.	(53-54) Barrel Extensions	(55-60) Traveling Valve Upper Ball	Traveling Valve Upper Seat	Traveling Valve Upper Cage	(61-66) Traveling Valve Lower Ball	Traveling Valve Lower Seat	Traveling Valve Lower Cage	(67-72) Standing Valve Upper Ball	Standing Valve Upper Seat	Standing Valve Upper Cage	(73-78) Standing Valve Lower Ball	Standing Valve Lower Seat	Standing Valve Lower Cage
Worn	01	01	01	01	01			01			01			01			01
Break	02	02	02	02	02	02	02	02	02	02	02	02	02	02	02	02	02
Split	03	03	03	03	03			03			03			03			03
Cracked	04	04	04	04	04	04	04	04	04	04	04	04	04	04	04	04	04
Grooved or Scored	05	05	05	05	05	05	05	05	05	05	05	05	05	05	05	05	05
Fluid Cut	06	06	06	06	06	06	06	06	06	06	06	06	06	06	06	06	06
Plating Flaked	07	07	07		07												
Beat Out				08		08	08	08	08	08	08	08	08	08	08	08	08
Bent	09	09	09		09												
Thread Damage	10	10	10	10	10			10			10			10			10
Internal Pits	11	11	11	11	11			11			11			11			11
External Pits	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
Other	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19
Re-work and Re-use	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20

FIG- 2 DATA FORM - DAMAGED PUMP

describes the metallurgy of individual parts in the replacement pump. The form has codes to describe the metal, or combination of metals, which are used in each pump component. The form is similar in design to the one used for describing the damaged pump, except codes are used to define metallurgy rather than condition of the parts in the pump. In combination, the two forms provide for a description of the condition and metallurgy on 17 critical pump parts. The pump shop is responsible for completing both forms; and as before, computer cards are punched directly from the forms.

A description of the sucker rod pumping equipment and current well test data is required before technical calculations can be performed. The well test information is routinely stored in the computer as it is received. The description of rod pumping equipment is a one-time entry in the computer from a simple keypunch form, and it only requires updating as actual equipment changes are performed.

PROGRAM REQUIREMENTS

Usable, easy to interpret reports are the ingredients that allow computer analysis to be an effective tool in the management of artificial lift installations. To achieve this end, the analyses programs are designed to include options which allow the report users to sort, rank, exclude, or summarize data to best serve their requirements. Further, a measure of the economic significance of the installation or item of equipment under study is available in the report so that proper work priorities can be set. The methods for running artificial lift programs vary according to their types — statistical or technical. Those programs which work with statistical data are not considered to be time critical and are normally run on a scheduled basis. The programs which perform technical calculations are principally designed to be run for specified installations upon request; however, they may also be run routinely on all installations to assist in the surveillance of equipment performance. The technical programs require a minimum amount of input data, and results are immediately available.

EXAMPLES OF STATISTICAL REPORTS

Figures 4, 5, and 6 are examples of reports developed from historical data in the computer files for individual pumping installations. The reports are statistical in nature, and they are printed on a scheduled basis in the Division computer center and mailed to appropriate management, technical and operational personnel. The examples display data from two of some 200 wells in the Means San Andres Unit Waterflood, Andrews County, Texas. They can be related to earlier figures illustrating methods of data entry.

Figure 4 is an illustration of a well servicing

SAME TYPE HEADING AS FIGURE 2

	(45-46)	(47-48)	(49-50)	(51-52)	(53-54)	(55-60)			(61-66)			(67-72)			(73-78)		
						Traveling Valve						Standing Valve					
						Upper			Lower			Upper			Lower		
PART METALLURGY	Liner or Barrel	Plunger	Valve Rod or Pull Tube	T. Plgr. Cage or U.P.T. Cplg.	Barrel Extensions	Ball	Seat	Cage	Ball	Seat	Cage	Ball	Seat	Cage	Ball	Seat	Cage
Regular Steel, No Hardening	01	01	01	01	01												
Brass or Aluminum Bronze	13	13	13	13	13	13	13		13	13		13	13		13	13	
Brass or Al. Bronze, Chrome Plated	14	14	14	14	14												
Monel	15	15	15	15	15	15	15		15	15		15	15		15	15	
Monel, Chrome Plated	16	16	16	16	16												
Cobalt - Nickel Spray		17															
Cobalt-Nickel Spray, Cor.Resistant Pins		18															
Other	19	19															

LINER OR SLEEVE	JACKET OR TUBE	MATL'S.		Cage Material	Type Guide	VALVE CAGE MATERIALS			
Cast Iron	Regular Steel	20	20	Brass or Al. Bronze	Br. or Al. Bronze	44	44	44	44
	Alloy or Stainless	21	21		Insert	45	45	45	45
	Brass or Monel	22	22		Spray	46	46	46	46
Hard Cast Iron	Regular Steel	23	23		Rubber	47	47	47	47

						OTHER BALL AND SEAT MATERIALS											
Cobalt-Chrome Steel						52	52		52	52		52	52		52	52	
Titanium Carbide						53	53		53	53		53	53		53	53	
Tungsten Carbide						54	54		54	54		54	54		54	54	
Special Stainless, 440C, 440A						55	55		55	55		55	55		55	55	
Used Parts	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56

FIG– 3 DATA FORM– REPLACEMENT PUMP

report. The report is primarily directed to operations and engineering personnel responsible for the performance of artificial lift equipment. As stipulated in the report request, each of the installations required equipment service work at least twice during the preceding 12-month period. Columnar data describe such information as date of the job, depth to subsurface failure, item and type of equipment failure, recent production performance, a general description of the subsurface equipment, and well servicing costs. An examination of the report reveals that Well 1418 required a total of six jobs during the period, due to a variety of equipment problems. Equipment condition codes following the job on May 13, 1975, (see code definitions on input form) give a general description of the subsurface equipment as: (1) rods are in good condition; (2) some tubing couplings showed wear and were replaced; and (3) no paraffin or scale buildup.

The corrosion inhibitor treatment report in Fig. 5 is primarily used by corrosion engineers and operations supervisors. It is designed to recap the well's producing capability, describe the current corrosion treating program, and summarize the number and type of equipment jobs that might be related to corrosion problems. In the example, Well 1418 had a total of five service jobs which could be attributed to corrosion. The current corrosion treatment program for the well consists of circulating 2.0 gallons of the described chemical down the tubing-casing annulus for a period of 0.4 hours three times a week. Annual cost of the chemical treatment is $1154.

Engineers use the subsurface pump repair report, Fig. 6, to obtain data which describe the condition of the damaged pump and metallurgy of components in the replacement pump. The report shows that the original pump in Well 2716 had a pitted barrel, worn traveling valve cage, scored standing valve seat, and pitted standing valve cage. The cost to repair the subsurface pump was $206 and it operated for 212 days. The report also indicates the metallurgy of critical parts in both the damaged pump and in its replacement (refer to Fig. 3 for code descriptions).

A number of programs are designed to uniquely summarize and sort statistical sucker rod pumping data into reports for special studies. An example of one such routine is illustrated in Fig. 7. This special report program summarizes the number of failures on individual subsurface pump parts for a specified operating area. Additional logic in the program totals the number of failures by metallurgical properties for each of the parts. Finally, the resulting data are sorted into a report that not only shows the

WELL SERVICING REPORT

"WELL HAD AT LEAST 2 SERVICING JOBS IN THE LAST 12 MONTHS"

MEANS SAN ANDRES UNIT

WELL	DATE	DEPTH	EQUIPMENT FAILURE	-	EQUIPMENT TYPE	EQUIPMENT CONDITION	PRODUCTION FLUID	PRODUCTION OIL	ROD STRING 7/8	ROD STRING 3/4	PUMP SIZE	JOB COST
1418	1/16/75	-0-	POL ROD	-	BREAK	000	442	101	71	100	1.75	174
	2/13/75	1500	ROD COUP	-	UNSCREWED	700	439	103	71	100	1.75	165
	2/14/75	4275	TBG PUMP	-	WORN	700	439	103	71	100	1.75	205
	4/16/75	1350	ROD BODY	-	BREAK	700	401	96	71	100	1.75	183
	5/13/75	3630	TBG COUP	-	THRD LEAK	757	399	95	71	100	1.75	482
	7/19/75	1400	ROD BODY	-	BREAK	700	595	138	71	100	1.75	223
2716	1/3/75	-0-	PUMP	-	RESPACE	000	90	14	0	177	1.50	82
	2/24/75	4425	ROD PUMP	-	WORN	700	85	15	0	177	1.50	179

FIG. 4 WELL SERVICING REPORT

pump parts which have resulted in the largest number of failures in the area, but also the best type of metallurgy to design into these parts. Considering the volume of data involved, it would not be practical to use any method other than computer analysis for such a study.

EXAMPLES OF TECHNICAL ANALYSES

Looking at another phase of sucker rod pumping management, a technical program was developed which computes the installation's producing capability and compares it to actual performance. The routine also calculates loading conditions and compares them to design ratings on the pumping equipment. With proper application, the program assists in identification of installations that are not pumping efficiently, detection of installations with over or undersized equipment and in designing equipment. When pumping problems are detected through the computer analyses just described, and if the technical staff considers it necessary, the actual loading conditions on the pumping equipment are measured in the field. This method is less expensive than others that continually monitor load conditions on individual units to detect equipment problems because of the investment required to permanently install monitoring equipment.

Figure 8 is an abbreviated pumping analysis request form. Since the required calculation data are stored in computer files, the user need only specify the installations that are of interest to obtain an analysis of current operating conditions. Other options that are available in the program are listed in the example. When the program user needs to perform an analysis under modified conditions or if permanent file changes are required, he enters the proper program function code and only the data that define the changes.

The report in Fig. 9 is an example of a pumping analysis performed under current operating conditions and equipment configurations for Well 88 in the Robertson Clearfork Waterflood Unit. For reference, the result of the well's latest production test is also listed; well test information is likewise

CORROSION TREATMENT REPORT

MEANS SAN ANDRES UNIT

WELL	PRODUCTION		CHEMICAL TREATMENT					ANNUAL NUMBER FAILURES					ANNUAL COST
	FLUID	OIL	TYPE	GALS	FREQ	METH.	HOURS	BODY	PIN	CPLG	PUMP	TBG	CHEMICAL
1418	595	138	7760	2.0	3/W	CIRC	0.4	2	0	1	1	1	1154
2716	85	15	7755	1.5	2/W	CIRC	0.6	0	0	0	1	0	577

FIG. 5 – CORROSION TREATMENT REPORT

SUBSURFACE PUMP REPAIR REPORT

PART CONDITION AND METALLURGY CODES

MEANS SAN ANDRES UNIT

WELL	PUMP NUMBER	DATE	BARREL	PLUNGER	VALVE ROD	TOP CAGE	TRAVELING VALVE			STANDING VALVE			REPAIR COSTS	LIFE DAYS
							BALL	SEAT	CAGE	BALL	SEAT	CAGE		
2716	S39	7/24/74	2	26	1	1	52	52	32	52	52	32	---	---
	S39	2/24/75	XPIT						WORN		SCOR	XPIT	260	212
	S578	2/24/75	14	23	1	13	52	52	44	52	52	44	---	---

FIG. 6 – SUBSURFACE PUMP REPORT

obtained from the computer files. The first line of the pumping analysis report describes the size and load ratings of the equipment along with the latest surveyed fluid level and pumping unit type code. The code in the example specifies that the unit is conventional with an electric motor as the prime mover. The second line describes pumping conditions, shows the latest well test volumes, displays results of the calculations, and dates the latest fluid level survey. The report is designed to print calculated equipment loads under their corresponding ratings for convenience. Looking at the report data, one may determine that the analysis was performed as if the pumping fluid level depth was near the pump seat, 6000 ft; and that under this condition, the unit would be required to have a nonobtainable pumping efficiency of 115 percent to duplicate actual production volumes. This comparison suggests that the pumping fluid level is well above the pump seat, as was confirmed by data from a field survey. Additional report data show that calculated loads do not exceed equipment ratings; thus, there might be an opportunity to increase production simply by altering pumping conditions. The effects of increasing strokes per minute on the pump from the current 11.2 to 14.0 are shown in Fig. 10. The report indicates that it should be possible to increase fluid production in the magnitude of 30 BPD by the modification, from the latest test volume of 173 to the calculated volume of 204 BPD, and that calculated equipment loads are still below the equipment ratings. The indicated

SUMMARY REPORT - SUBSURFACE PUMP COMPONENT PUMP LIFE

BY METALLURGY

PUMP COMPONENT	METALLURGY	NUMBER FIELD FAILURES	AVERAGE LIFE-DAYS
TOP PLUNGER CAGE	ALLOY STEEL	7	190
	ALLOY STEEL - HARDENED	4	93
	BRASS OR AL. BRONZE	2	524
	MONEL	26	244
	REG. STEEL	12	297
	REG. STEEL HARDENED	16	360
	STAINLESS STEEL HARDENED	1	140
	OTHER	3	321
	TOTAL	71	272
UPPER TRAVLING VALVE BALL	ALLOY STEEL - HARDENED	1	291
	COBALT - CHROME STEEL	32	202
	MONEL	27	404
	SPECIAL ALLOY HARDENED	1	86
	TUNGSTEN CARBIDE	1	619
	OTHER	2	336
	TOTAL	64	298

FIG- 7—PUMP COMPONENT LIFE—BY METALLURGY modifications are critically reviewed before being implemented to make certain the change is practical. For example, it might be necessary to down-rate allowable rod stresses, from maximum rating, due to the rods' operating environment or age.

REQUEST FORM

SUCKER ROD PUMPING TECHNICAL ANALYSIS

LEASE NUMBER	WELL NUMBER	FUNCTION	PUMP			FLUID DEPTH	NUMBER OF RODS			TBG SIZE
			SIZE	STK LTH	SPM		8/8	7/8	3/4	

DESCRIPTION OF FUNCTION CODES

0 - Perform analysis for current conditions and equipment.

1 - Perform analysis using specified altered data.

2 - Update computer file data as specified.

3 - Perform analysis on all wells on Lease.

4 - List equipment configuration and pumping conditions for all wells on Lease.

FIG. 8 - TECHNICAL ANALYSIS-REQUEST FORM

**** WELL TEST SUMMARY ****

DATE	ZN	WELL	TRGT	TEST TIME	ROD PUMP DIA	ROD PUMP LTH	ROD PUMP SPM	24 HOUR TEST RATE OIL	24 HOUR TEST RATE SW	24 HOUR TEST RATE SW%	24 HOUR TEST RATE FGAS	FORM GOR	PROD TIME	REMARKS
ROBERTSON CLEARFORK UNIT S/B 173														
1-18-6	1	88	79	2.0	1.5	74	11.2	77	96	55	26	338	24.0	LOW GOR

*** SUCKER ROD ANALYSIS ***

EQUIPMENT SIZE AND RATINGS

WELL NO.	NUMBER OF RODS 9/8	8/8	7/8	3/4	5/8	1/2	TBG DIA	PUMP DPTH	S FL DPTH	MPSI STRS	MINLB TORQ	MLBS BEAM	UNIT TYPE
88	0	0	0	153	91	0	2.0	6100	4300	37.0	228	21.0	1E

ANALYSIS-CURRENT PUMPING COND.

PUMP DATA DIA	LTH	SPM	TEST B/D OIL	TEST B/D FLD	CALC B/D FLD	TEST % EFF	PUMP TIME	MTOR BHP	C FL DPTH	MPSI STRS	MINLB TORQ	MLBS BEAM	DATE--FLD LV SURVEY
1.5	74	11.2	77	173	150	115	24.0	13	6000	32.8	162	14.5	1- 9-76

FIG. 9 TEST & TECHNICAL ANALYSIS-CURRENT CONDITIONS

ROBERTSON CLEARFORK UNIT S/B 173

*** SUCKER ROD ANALYSIS ***

EQUIPMENT SIZE AND RATINGS

WELL NO.	NUMBER OF RODS 9/8	8/8	7/8	3/4	5/8	1/2	TBG DIA	PUMP DPTH	S FL DPTH	MPSI STRS	MINLB TORQ	MLBS BEAM	UNIT TYPE
88	0	0	0	153	91	0	2.0	6100	4300	36.2	228	21.0	1E

ANALYSIS OF NEW PUMPING COND.

PUMP DATA DIA	LTH	SPM	TRGT B/D OIL	TRGT B/D FLD	CALC B/D FLD	TRGT % EFF	PUMP TIME	MTOR BHP	C FL DPTH	MPSI STRS	MINLB TORQ	MLBS BEAM	DATE--FLD LV SURVEY
1.5	74	14.0	77	173	204	85	24.0	18	6000	34.3	189	15.2	1- 9-76

FIG- 10—TECHNICAL ANALYSIS—MODIFIED CONDITIONS

CONCLUSIONS

1. Exxon Company, U.S.A. has developed a series of statistical and technical analyses programs that effectively assist in the surveillance and management of its sucker rod pumping installations. Since initiating the use of computer analyses in the artificial lift management system, failure frequency of subsurface pumping equipment has been reduced by 21 percent.
2. Simplified field entry forms insure that computer files will contain complete and accurate analyses data.
3. Report options, which allow personnel to sort, rank, and summarize data to fit their requirements, are necessary for computer analyses to be effective.

REFERENCE

1. Railroad Commission of Texas, Oil and Gas Division: Monthly Crude Oil Production Report. Oct. 1975.

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