EQUIPMENT FAILURE AND CORROSION CONTROL PROGRAM

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ABSTRACT

This paper discusses the methods currently used by Texaco's Midland Producing Division to monitor and reduce equipment failures and chemical usage. The cost effectiveness of the program is readily apparent having resulted in a 50+ percent reduction in the failure and maintenance cost from the first quarter 1986 to the second quarter 1989.

The items presented in the paper include the methods of reporting, tracking, and reviewing equipment failures and chemical usage. Included in the presentation are examples of surface and subsurface failure reporting forms, equipment failure data base, chemical selection and testing criteria outline, monthly chemical reporting format, quarterly meeting format, and report of special equipment being tested.

INTRODUCTION

During the late 1980's, various groups within the company had successfully utilized a prototype Equipment Failure System (EFS) mainframe program and quarterly meetings to monitor downhole failures. It became readily apparent that use of such a system could result in an improvement throughout the Division. Over the past four years the EFS program and quarterly meetings have been improved and expanded to all the Areas in the Midland Producing Division, resulting in a 50+ percent reduction in downhole failure rates and failure costs from the first quarter 1986 to the second quarter 1989.

The goals of the Equipment Failure Program were threefold: (1) to reduce failures and failure expense, (2) to optimize maintenance repair expense, and (3) to assist in evaluating the chemical program. These goals were accomplished by accurate identification of failure cause, monitoring with the EFS Computer Program and through Quarterly Meetings in the respective Areas.

DISCUSSION

The Equipment Failure System data base is separated into two parts, surface failures and sub-surface failures. Although the sub-surface portion is used by all the Area offices in the Midland Producing Division, the surface failure portion is used only by a few Areas at this time. For purposes of this paper we are going to concentrate mainly on the sub-surface portion.

ACQUISITION AND STORAGE OF FAILURE DATA

The first step in an effective failure control program is the accurate identification of the failure. This is the single most important factor in correcting the problem. In the past many failures were attributed to improper or insufficient chemical treatment when in fact the real problem was a mechanical problem that no amount of additional chemical would eliminate. An example would be corrosion pitting along a rod wear line. This type of failure was often attributed to corrosion and the chemical treatment volume or frequency was increased accordingly. Adding sinker bars, slowing the unit down, or installing a smaller pump are better alternative corrective actions. The corrosion probably would not have occurred if the rod had not scored the tubing, wearing off the inhibitor film.

To assure proper cause identification, many Areas require the Foreman, Engineer, and Chemical Company representative to all examine the failure. If the cause and corrective action is not readily apparent, a piece of the failed equipment is sent to the Texaco Research Lab in Houston for analysis. In addition to requiring all parties to visually inspect the failure, emphasis was placed on correcting the problem before hanging the well back on even if this resulted in one or two days downtime. Foremen also maintain a list of recommended changes to equipment and operating parameters which will be implemented after the next failure for wells that are historically "problem" wells. When a well on the list fails, the Foreman checks with all parties involved to be sure the recommendation for corrective action is still valid.

Once the failure and cause have been identified, the Foreman completes a Sub-Surface or Surface Equipment Failure form (Tables 1 and 1A). Input data for the form includes the lease name, well number, date, depth of failure, failing equipment, well type, location of failure, code for pulling unit and crew, optional comments, and costs including labor, equipment, and maintenance. The forms are sent into the office for review by the Area Corrosion Technician and Field Engineer prior to input into the Equipment Failure System data base.

Data in the EFS data base can be retrieved in a variety of different report formats, both detail lists and summary type. The reports can also be pulled by Division, Area, Sub-Area, lease, or individual well. The most essential reports are the Problem Well Report (Table 2) and Repeat Failure Report (Table 3). The problem well report actually allows the user to define a problem well. Texaco defines a problem well as one that has two or more failures of the same equipment type or four failures of any

type in the last 12 months with at least one of those failures occurring in the current quarter. A repeat failure is defined as two or more failures of the same equipment type occurring within six months, with at least one of them occurring in the current quarter. Wells that appear on these reports are carefully analyzed and evaluated to determine the most cost effective action to reduce the failures and associated costs on these wells.

Another report that is useful lists failures by equipment type, location, and cause (Table 4). With this report contractor performance can also be evaluated. For example, all improper makeup (IMU) failures can be reviewed for a given time period to determine if the make-up procedure of a particular pulling unit crew may be responsible for excessive IMU failures. If this happens, the crew will be reminded of Texaco's recommended rod handling procedures. If the problem is not corrected, their services may be terminated.

In addition to the above, the computer also aids in tracking the performance of particular equipment being tested. By using the comment section, the metallurgy or manufacturer of specific test items can be indicated and compared with other products currently being used (Table 5).

REVIEW OF FAILURE DATA

The information stored in the data base is used to generate reports and graphs for the quarterly meetings on both Area and Sub-Area basis (Tables 6 through 13). Most of the meetings are attended by the Division Corrosion Engineer, Area Manager, Senior Engineer, Production Supervisors and Foremen, Field Engineers, and Field Technicians. The cross-section of personnel that attend the meetings help disseminate information, technology, and techniques between Area offices and provide a forum to discuss the benefits and concerns (regarding solutions to problems) by drawing on the experience and knowledge of other personnel in the Area. The purpose of most of the graphs and tables in the report is for historical comparison and thus serves as an indicator of progress compared to previous quarters.

Much of the emphasis in the meetings focuses on the Problem Wells. The Problem Well Sheet (Table 14) concentrates attention on wells which have an extraordinary number of failures and expenses. Prior to the meeting a Field Technician is sent to each of the problem wells to gather operating data, shoot fluid levels, and run dynamometer cards. During the meeting the data is reviewed and a plan of action is formulated. This action may be an immediate change or one to be performed at the next failure. Examples of immediate action are slowing the unit down, lengthening the stroke, increasing inhibitor or treatment frequency, etc. Examples of action to be taken at the next failure are: reduce the pump size, install a charger valve, install fiberglass rods, etc.

Other ideas and suggestions which arise from the meeting must be further evaluated before implementing. This requires a cooperative "team effort" between Foremen and Engineers.

The effectiveness of the chemical treating program can also be seen at the quarterly meetings. Where the cause of failures on a particular lease or group of leases is described as corrosion, the chemical program is reviewed by the Foreman and Engineer. Together they can determine whether there is insufficient inhibitor being used, if the treating method is incorrect, if wells are being skipped by the vendor, etc. Naturally, leases being over treated will not be identified by this method.

The meetings also help evaluate the need for training of both Texaco personnel and vendor personnel. Several seminars have resulted from suggestions made in the quarterly failure meetings. Some of the seminar topics included downhole pump schools, paraffin treating schools, tubular and vessel coating seminars, dynamometer card interpretation schools, etc. Pulling unit crews have attended rod and tubing handling seminars.

CHEMICAL TREATMENTS

Chemical treatment must be justified before a program is established. The Midland Producing Division does not encourage chemical treatment for "insurance" purposes. Before a treatment program is established, vendors must first run chemical screening tests as outlined in Company guidelines (Table 15). These requirements help assure that the most cost effective chemical is selected, whether it is a corrosion or scale inhibitor, demulsifier, paraffin solvent, biocide, etc. When obtaining a proposal several vendors are solicited for treating recommendations. The one which is considered most cost effective (quality of service and technical competence included) is then selected for the job. NOTE: The lowest cost chemical proposed is not necessarily the one selected.

REVIEW OF CHEMICAL USAGE

Closely related to the failure program is the Chemical Usage Report that is provided monthly by the vendors. This PC-generated report, required from the vendors by Texaco, allows a quick well-by-well look at the chemical treating program (Table 16). Some of the specific information provided on the report is treatment volume, treatment frequency, flush volume, target and actual ppm rates, coupon data, and date of last failure including whether the failure is corrosion related or not. In most cases an entire lease can be reviewed in a couple of minutes to determine if all treatments are within the set limits. A little additional time spent reviewing the form can identify areas where a reduction in chemical usage may be possible and specific wells may be selected to test the feasibility of reducing treatments. Another valuable aspect of the monthly chemical usage report is that it forces the vendor to optimize his recommended program and keeps him more abreast of production changes.

One Area office in the Midland Producing Division currently holds Quarterly Chemical Usage Meetings which are attended by the Division Corrosion Engineer, Area Manager, Senior Engineer, Production Supervisors and Foremen, Field Engineers, and the respective chemical company representative. In these meetings the chemical treating

program on each lease and well is reviewed. The review includes items such as bacteria, oxygen, scale, corrosion, paraffin, emulsions, and surface treating. In several fields the use of chemicals has been totally eliminated as a result of these reviews and subsequent testing. In other locations more effective chemicals or application methods have been found.

REPORT OF SPECIAL EQUIPMENT BEING TESTED

Once each quarter Engineers update a list of non-routine equipment being tested in their Area (Table 17). Examples of items considered reportable are: specific name brands of roller rod guides, special couplings, sand screens, charger valves, coatings, etc. The reports are compiled at the Division level and disseminated back to each Area. In this manner each Area benefits from the experience of the others without spending time and money "re-inventing the wheel."

FUTURE PLANS

Work is currently in progress on a PC version of the EFS data base which will have much more versatility than the existing mainframe version. The PC version will be able to access other data bases, such as production, well status, etc., and generate reports and graphs in a format for presentation at the quarterly meetings. This will result in a significant manpower savings in preparing the quarterly reports.

With the elimination of most of the "repeat failures" and "problem wells," more engineering time will be devoted to the design and metallurgy of specific equipment in order to achieve the most cost effective run times and to reduce power consumption.

Based on the success of the quarterly chemical meeting in the one Area, other Areas in the Division plan to start conducting similar meetings.

SUMMARY

Through the use of a computer data base, team effort, and structured operational procedures, the failure rates and associated costs have been reduced over 50 percent from the first quarter of 1986 through the second quarter of 1989. The Division-wide failure rate is approximately 0.70 failures per pumping well per year and the trend is still downward.

SUB-SURFACE EQUIPMENT FAILURE AND MAINTENANCE REPORT

LEASE OR PROPERTY NAME: PENWELL UNIT

TITLE NO.: 9625430 7

WELL NO.: P - NNNN - CC - SS : P = ; NNNN = 1357 ; CC = ; SS =

RESERVOIR CODE:

DATE: MONTH 04 DAY 01 YEAR 89

FAILURE DATA

FAILING EQUIPMENT
- ROD Sucker Rod
- POR Polish Rod
- HSR Hollow Sucker Rod
- (TBG) Tubing
- GLV Gas Lift Valve
- PMP Pump, Rod
- HPM Hydraulic Pump
- SPM Subm. Cent. Pump
- PKR Packer
- REG Regulator
- ANC Anchor
- CSG Casing
- RDG Sucker Rod Guide
- RMD Remedial
- WR Well Record
- MNT Maintenance
- OTH Other (w/Remarks)

SERVICE
- FG Flowing Gas
- FO Flowing Oil
- GL Gas Lift
- (PO) Pumping Oil
- GI Gas Injection
- WI Water Injection
- WS Water Source
- WD Water Disposal
- PG Pumping Gas

LOCATION OF FAILURE
- (BDY) Body
- UPS Upset
- PIN Pin
- CLP Coupling
- BRL Barrel
- PLG Plunger
- PT Pull Tube or Rod
- VLC Valve Cage
- BS Ball & Seat
- MND Mandrel
- PMP Pump (Subm.)
- MTR Motor (Subm.)
- PRT Protector (Subm.)
- CBL Cable (Subm.)
- OTH Other (w/Remarks)

CAUSE OF FAILURE
- CF Corrosion Fatigue
- INT Internal Corrosion
- EXT External Corrosion
- EMB Embrittlement
- TYD Tensile Yield
- (WEB) Wear
- UNS Unscrewed
- IMU Improper Make-up
- ELE Electrical
- SCL Scale
- SND Sand
- MUD Mud
- PAR Paraffin
- SLT Salt
- OTH Other (w/Remarks)

DEPTH OF FAILURE: 3732

COST OF FAILURE
- LABOR & EQUIPMENT: 1944
- MATERIALS: 109

PREVENTIVE MAINTENANCE DATA

EQUIPMENT
- ROD Sucker Rod
- POR Polish Rod
- HSR Hollow Sucker Rod
- TBG Tubing
- GLV Gas Lift Valve
- PMP Pump, Rod
- HPM Hydraulic Pump
- SPM Subm. Cent. Pump
- PKR Packer
- REG Regulator
- ANC Anchor
- CSG Casing
- (RDG) Sucker Rod Guide
- OTH Other

MAINTENANCE
- RMN Routine Mainten.
- VIN Visual Inspec.
- EIN Electronic Inspec.
- CPA Cut Paraffin
- (UPG) Upgrade
- HYT Hydraulic Test
- STM Steam
- OTH Other (w/Remarks)

COST
- LABOR & EQUIPMENT: 150
- MATERIALS: 2257

EQUIPMENT
- (ROD) Sucker Rod
- POR Polish Rod
- HSR Hollow Sucker Rod
- TBG Tubing
- GLV Gas Lift Valve
- PMP Pump, Rod
- HPM Hydraulic Pump
- SPM Subm. Cent. Pump
- PKR Packer
- REG Regulator
- ANC Anchor
- CSG Casing
- RDG Sucker Rod Guide
- OTH Other

MAINTENANCE
- (RMN) Routine Mainten.
- VIN Visual Inspec.
- EIN Electronic Inspec.
- CPA Cut Paraffin
- UPG Upgrade
- HYT Hydraulic Test
- STM Steam
- OTH Other (w/Remarks)

COST
- LABOR & EQUIPMENT: 150
- MATERIALS: 500

EQUIPMENT
- ROD Sucker Rod
- POR Polish Rod
- HSR Hollow Sucker Rod
- TBG Tubing
- GLV Gas Lift Valve
- (PMP) Pump, Rod
- HPM Hydraulic Pump
- SPM Subm. Cent. Pump
- PKR Packer
- REG Regulator
- ANC Anchor
- CSG Casing
- RDG Sucker Rod Guide
- OTH Other

MAINTENANCE
- (RMN) Routine Mainten.
- VIN Visual Inspec.
- EIN Electronic Inspec.
- CPA Cut Paraffin
- UPG Upgrade
- HYT Hydraulic Test
- STM Steam
- OTH Other (w/Remarks)

COST
- LABOR & EQUIPMENT: 35
- MATERIALS: 1300

REMARKS: Tested tubing. Split 4 jts above SN. Added 9 roller rod guides. Add 4-1 1/2" K bars. Replaced 40 - 7/8" cplg.

SIGNED: Mark Mabe

P.U. CODE: KU-3

TABLE 1

SURFACE EQUIPMENT FAILURE AND MAINTENANCE REPORT

LEASE OR PROPERTY NAME: PENWELL UNIT

TITLE NO.	WELL NO.	GROUP	DATE (MONTH DAY YEAR)
9625430 7	P - NNNN - CC - SS	TB-1	07 21 89

EQUIPMENT

FLN	Flowline, Injec. Line
SEP	Separator
HTT	Heater-Treater
KNO	Knock-Out
LHN	Line Heater
(TNK)	Tank
CHK	Choke
VAL	Valve (Rmks)
MET	Meter
PIP	Piping (Facil., Pits.)
FIL	Filter
DBD	Dry-Bed Dehydrator
ABS	Absorber
CNT	Contactor
FRC	Fractionator
STB	Stabilizer
STL	Still
EXC	Exchanger (Rmks)
BLR	Boiler
RBL	Re-Boiler
RGN	Regenerator
FRH	Fired Heater
ACM	Accumulator
FLT	Flash Tank
SRT	Surge Tank
CNI	Control Instrument
TRB	Turbine
ENG	Engine (Rmks)
EMO	Electric Motor
PMP	Pump (Rmks)
CMP	Compressor
GEN	Generator
PMU	Pumping Unit
BOT	Boat
OTH	Other (Rmks)
WLH	Wellhead

SERVICE

OIL	Oil
GAS	Gas
CND	Condensate
(WTR)	Water
AIR	Air
PHY	Process Hydrcrbn. (Rmks)
CHM	Chemical (Rmks)
GLY	Glycol (Rmks)
AMN	Amine (Rmks)
ABO	Absorption Oil (Rmks)
HTO	Heating Oil
STM	Steam
RFG	Refrigerant (Rmks)
TRT	Treating
SET	Settling
DST	Desalting
A/P	Air/Process
W/P	Water/Process
S/P	Steam/Process
O/P	Heating Oil/Process
P/P	Process/Process
WTI	Water Injection
GSI	Gas Injection
ARI	Air Injection
LSF	Lease Facilities
ELP	Electric Power
PRC	Process Control (Rmks)
PMD	Pump Drive
CMD	Compressor Drive
GND	Generator Drive
PUD	Pumping Unit Drive
BTD	Boat Drive
OTH	Other (Rmks)

LOCATION

BDY	Body
THD	Thread
CPL	Coupling
WLD	Weld
NZL	Nozzle
TBE	Tube
TRY	Tray
BWH	Bolting/Hardware
(SHL)	Shell
MDD	Mud Drum
SMD	Stead Drumn
GSS	Gas Section
OCS	Oil/Condensate Section
WTS	Water Section
HED	Head
CRH	Cross-Head
PSR	Piston Rod
RDP	Rod Packing
PST	Piston
PIR	Piston Rings
CYL	Cylinder/Liners
VAV	Valves (Rmks)
BLT	Belts
SHF	Shaft
PRT	Port
SPP	Spark Plugs
WTP	Water Pump
RAD	Radiator
BRG	Bearing
SMT	Starting Motor
CLH	Clutch
MAG	Magneto
ELS	Electrical Sys.
CLS	Cooling Sys.
HYS	Hydraulic Sys.
LBS	Lubricating Sys.
FIL	Filter (Rmks)
TRC	Turbocharger
IMP	Impeller
GRB	Gear Box
HDH	Hull/Deck/Housing
OTH	Other

CAUSE

(INT)	Internal Corrosion
EXT	External Corrosion
ECL	Excessive Loading
ECP	Excessive Pressure
ECH	Excessive Heat
EMB	Embrittlement
BLS	Blistering
ILB	Improper/No Lub.
IAP	Improper Applic.
WER	Wear
ABR	Abrasion
SND	Sand
SCL	Scale
MUD	Mud
PAR	Paraffin
CAR	Carbon
OTH	Other

TYPE EXPENSE

(FLR)	Failure
MNT	Maintenance
MJO	Major Overhaul

COST

Outside Service: 1800

Company Labor & Equip.: 300

Materials: 1000

REMARKS

Tank & Internal Coating 9 years old. Coating is beginning to peel off. Blasted and recoated tank.

SIGNED

R J Hardaway

TABLE 1A

DATE RUN 01/03/90 SUB-SURFACE EQUIPMENT FAILURE PROBLEM WELL DETAIL LISTING PAGE 9
REPORT NO 969012

DISTRICT 2 MIDLAND | AREA 1 ODESSA | SUBAREA2 PENWELL

PROPERTY NUMBER 96254307 PROPERTY NAME: PENWELL UNIT RESERVOIR CODE: WELL NUMBER 1357 00

FAILURE DATA DATE	EQP	SVC	LOC	CSE	DEPTH	MAINT EQP TYP	COST LAB-EQP	COSTS MATRLS	TOTAL COST	REMARKS
7/07/88	PMP	PO	PLG	WER	3800		480	247	727	CHANGED PUMP. RINGS ON PLUNGER WERE WORN OUT. KU-3
11/17/88	TBG	PO	BDY	INT	3820		2460	140	2600	TBG LEAK. TAG BTM. SHEARED TAC. CO 20' OF SAND W/HYD BLR. REPL TAC & PMP. KU-3
						OTH RMN	550		550	
						ANC RMN	35	392	427	
						PMP RMN	35	443	478	
12/02/88	POR	PO	BDY	OTH	16		464	120	584	CLEAN SMOOTH BREAK W/NO SIGNS OF SEVERE CORROSION. SENT SAMPLE FOR ANALYSIS. KU-846
2/25/89	PMP	PO	BRL	WER	3820		702	2600	3302	INST 2 S/O RDG/ROD. CHG 12 1" CLP,HVY WALL BRASS PUMP BRL COLLPSD (WEAR) PLG CORROSION. KU-3
						RDG UPG		1955	1955	
						ROD RMN		137	137	
4/01/89	TBG	PO	BDY	WER	3732		1944	109	2053	TST TBG. SPLIT 4JASN. INST 9 ADD'L RLR RDG,4 ADD'L 1-1/2 KBARS. REP 40 7/8 CPLS, PMP & ANC. KU-3
						RDG UPG	150	2257	2407	
						ROD RMN	150	500	650	
						PMP RMN	35	1300	1335	
						ANC RMN	100	570	670	
5/16/89	TBG	PO	OTH	OTH	3600		1945	109	2054	TSTD TBG W/PMP TRK-LEAKED. EST. FAIL. @3600. RAN NEW STRNG OF 2-7/8 TBG. CHG PMP & TAC. KU-3
						TBG UPG	400	12768	13168	
						ANC RMN	35	59	94	
						PMP RMN		2800	2800	
									35991	

YEAR ENDING: 6/30/89 WELLS WITH FAILURES EQUAL TO OR GREATER THAN:
2 - ROD; OR 2 - TBG; OR 2 - PMP; OR 2 - HPM; OR 2 - SPM; OR 4 - TOTAL

TABLE 2

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SUBSURFACE FAILURE FILE

FROM 040189 TO 063089
DIVISION: 6 MIDLAND AREA: 1 ODESSA
DISTRICT: 2 MIDLAND SUBAREA: 2 PENWELL

WELL	DATE	FAILURE EQU	SVC	LOC	CSE	DEPTH	MAINT EQP TYP	COST LABOR EQUIP	COST MATRLS	TOTAL COST	CONTROL	REMARKS
PROPERTY: 96254125 ECTOR FEE UNIT II							RESERVOIR CODE:					
9	042489	TBG	PO	CLP	WER	12000		3206	236	3442		2JT OF 1-1/4 10RD IJ SPLIT IN CPL AREA DUE TO WEAR FROM RUNNING TBG. KU-3
							HPM RMN		986	986		
9	051389	TBG	PO	CLP	WER	12000		2972	118	3090	19 DS	TBG UPS & PINS (SEV WER-COULD NOT MAKE UP) NEW STRG 1-1/4" TBG. REPL PMP. KU-3
							TBG UPG	700	46238	46938		
							HPM RMN		986	986		
PROPERTY: 96254307 PENWELL UNIT							RESERVOIR CODE:					
1357	040189	TBG	PO	BDY	WER	3732		1944	109	2053		TST TBG. SPLIT 4JASN. INST 9 ADD'L RLR RDG,4 ADD'L 1-1/2 KBARS. REP 40 7/8 CPLS, PMP & ANC. KU-3
							RDG UPG	150	2257	2407		
							ROD RMN	150	500	650		
							PMP RMN	35	1300	1335		
							ANC RMN	100	570	670		
1357	051689	TBG	PO	OTH	OTH	3600		1945	109	2054	45 DS	TSTD TBG W/PMP TRK-LEAKED. EST. FAIL. @3600. RAN NEW STRNG OF 2-7/8 TBG. CHG PMP & TAC. KU-3
							TBG UPG	400	12768	13168		
							ANC RMN	35	59	94		
							PMP RMN		2800	2800		
2314	042189	TBG	PO	BDY	WER	3555		2490	981	3471		TBG SPLIT 9 JASN. ROD WEAR. BUSTED 8JT TSTG. RAN 4 ADD'L KBARS & 8 ADD'L RLR RDG. REP. PMP. KU-14
							ANC RMN	35	570	605		
							ROD UPG		692	692		
							RDG UPG		1466	1466		
							PMP RMN	35	1265	1300		
2314	061889	TBG	PO	BDY	WER	3447		1524	115	1639	58 DS	REPL TBG STRG. RAN 4 ADD'L KBARS & 8 ADD'L RLR RDG. KU-14
							TBG RMN	300	13594	13894		
							RDG UPG		1498	1498		
							PMP RMN	35	63	98		
							ROD UPG		692	692		
4248	042189	PMP	PO	BS	WER	4264		510	41	551		CHANGED PUMP. KU-6
4248	050689	PMP	PO	OTH	OTH	4278		924	41	965	15 DS	PUMP CHANGE. INSTALLED 6 - 1-1/2" K-BARS. NO REASON FOR FAILURE. KU-14
							ROD UPG		1038	1038		

SUB-AREA REPEAT FAILURE TOTALS

	COUNT	CLE	CM	TOTAL
ROD				
TBG	3	6441	342	6783

NEXT FIN

TABLE 3

EFSB23 - DETAIL/SUMMARY FOR EQUIPMENT BY DDAS
DIVISION: 6 MIDLAND AREA: 2 MIDLAND
DISTRICT: 2 MIDLAND SUB-AREA: 0
TITLE: 96241100 J.E. MABEE A NCT-1
DATE RANGE #1 010189 - 123189 #2 000000 - 000000 #3 000000 - 000000

R C	WELL PNNNNCCSS	DATE	EQP	SVC	LOC	CSE	DEPTH	COST LABOR EQUIP	COST MATERLS	TOTAL	REMARKS
11		081889	ROD	PO	CLP	IMU	24	286	41	327	PONY ROD WAS PARTED; FISHED AND RETURNED TO PROD. (K.U. #4)
28		041089	ROD	PO	CLP	IMU	850	507	18	525	OLD HAMMER MARKS ON CPL. KU 41
63		073189	ROD	PO	CLP	IMU	200	477	18	495	(K.U. #16)
79		033189	ROD	PO	CLP	IMU	900	382	13	395	FISH & HANG ON KU 38
98		031889	ROD	PO	CLP	IMU	1500	1623	29	1652	STRIPPING JOB, REPLACED 6 RODS, KU 31
					ROD	VIN		0	180	180	
98		061589	ROD	PO	CLP	IMU	1400	382	39	421	FISH & HANG ON. KU 34
469		060589	ROD	PO	CLP	IMU	500	412	38	450	KU 34
534		050389	ROD	PO	CLP	IMU	50	380	18	398	CLP APPREARD TO BE RECONDITIONED W/OLD HAMMER MKS PD 156
546		050489	ROD	PO	CLP	IMU	300	382	18	400	KU 4

TABLE 4

DATE RUN 01/03/90 SUB-SURFACE EQUIPMENT FAILURE PROBLEM WELL DETAIL LISTING PAGE 21
REPORT NO 969012

DISTRICT 2 MIDLAND | AREA 1 ODESSA | SUBAREA2 PENWELL

PROPERTY NUMBER 96254307 PROPERTY NAME: PENWELL UNIT RESERVOIR CODE: WELL NUMBER 3313 00

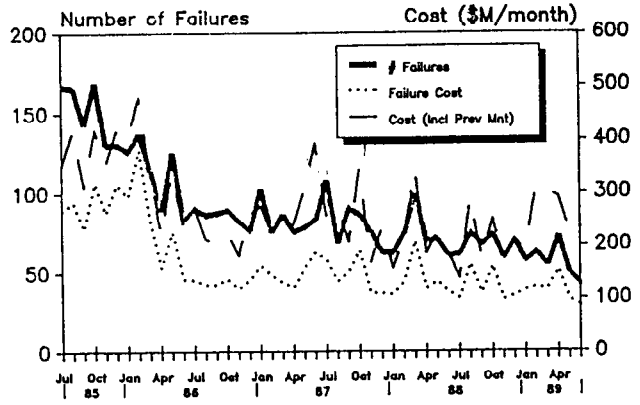
DATE	FAILURE DATA EQP	SVC	LOC	CSE	DEPTH	MAINT EQP TYP	COST LAB-EQP	COSTS MATRLS	TOTAL COST	REMARKS
12/12/88	TBG	PO	BDY	WER	2790		3402	66	3468	TSTD TBG. SPLIT(WEAR W/MODERATE CORR)REP 35-3/4 CLP, RAN 4 NEW 1-1/2" K-BARS, NEW PMP & ANC. KU-3
						TBG RMN		198	198	
						PMP RMN	35	1081	1116	
						ANC RMN	35	135	170	
						ROD UPG		1155	1155	
5/24/89	TBG	PO	BDY	WER	3500		2572	80	2652	RAN NEW STRNG OF 2-3/8 J55 TBG. RAN 11 RLR RDG,REP ALL CPLGS W/RODCOTE CPLGS(WR). REP PMP & ANC. KU14
						TBG UPG	400	9720	10120	
						ROD UPG		2394	2394	
						PMP RMN	35	484	519	
						ANC RMN	35	232	267	
									22059	

YEAR ENDING: 6/30/89 WELLS WITH FAILURES EQUAL TO OR GREATER THAN:
2 - ROD; OR 2 - TBG; OR 2 - PMP; OR 2 - HPM; OR 2 - SPM; OR 4 - TOTAL

TABLE 5

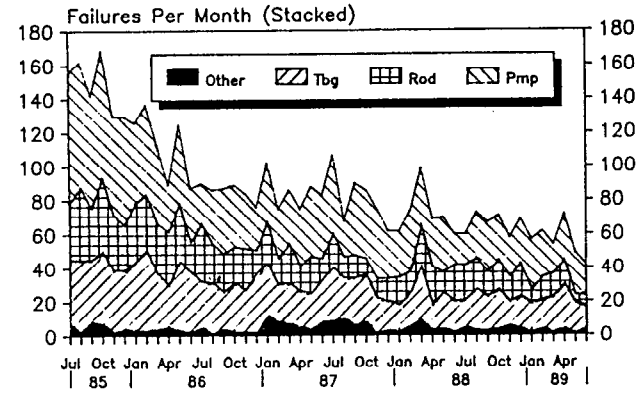
ODESSA AREA

Sub–Surface Failures



ODESSA AREA

Sub–Surface Failures By Equipment Type

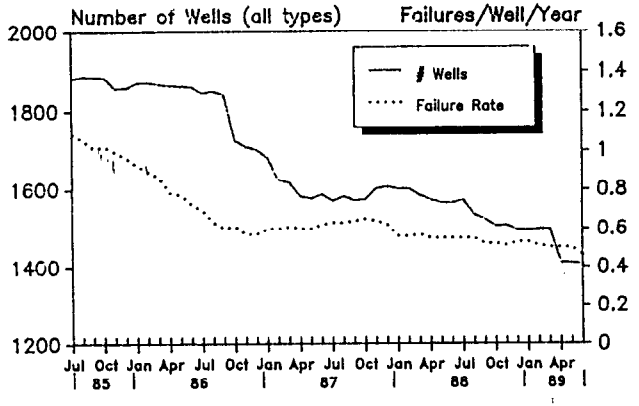


Second Quarter 1989

TABLE 6

ODESSA AREA

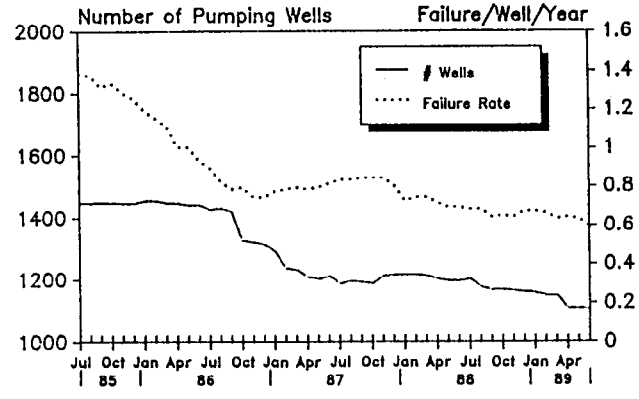
Sub–Surface Failure Rate



Second Quarter 1989

ODESSA AREA

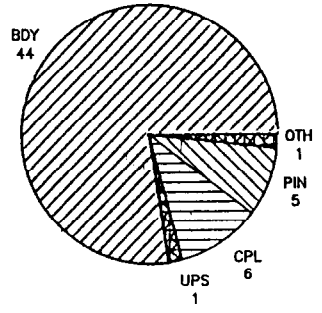
Sub–Surface Failure Rate



Second Quarter 1989

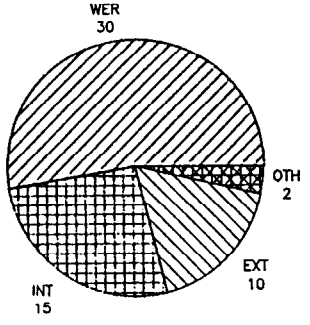
TABLE 7

ODESSA AREA
2ND QTR 1989 TUBING FAILURES



LOCATION

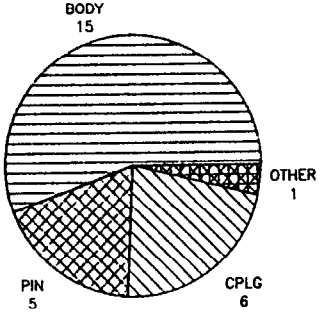
ODESSA AREA
2ND QTR 1989 TUBING FAILURES



CAUSE

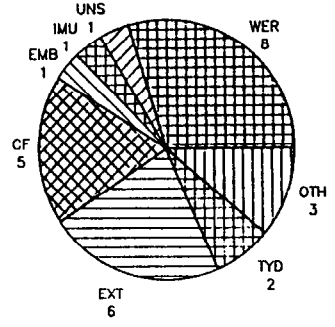
TABLE 8

ODESSA AREA
2ND QTR 1989 ROD FAILURES



LOCATION

ODESSA AREA
2ND QTR 1989 ROD FAILURES



CAUSE

TABLE 9

ODESSA AREA
Chemical Treating Cost

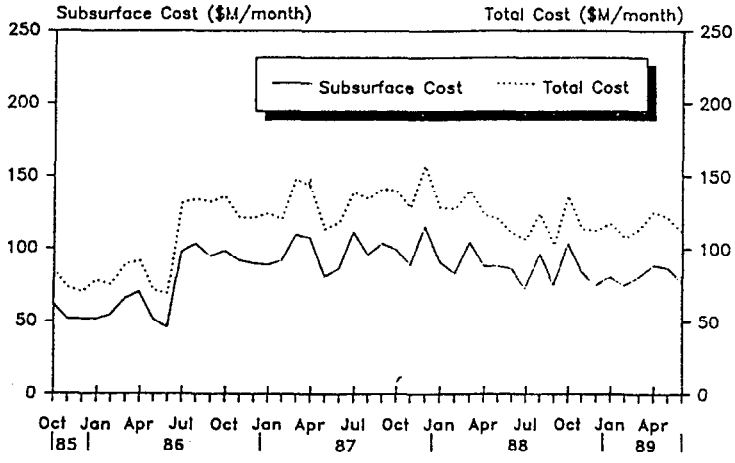


TABLE 10

ODESSA AREA
QUARTERLY SUB-SURFACE EQUIPMENT FAILURE SUMMARY

FAILURES

2ND QUARTER 1989 / 1ST QUARTER 1989

	NUMBER	FAILURE COST $	$ PER FAILURE
Rods	27 / 36	26635 / 50739	986 / 1409
Tubing	57 / 53	136566 / 130474	2396 / 2462
Pump	73 / 77	141571 / 141255	1939 / 1834
ESP	1 / 2	4601 / 18028	4601 / 9014
Other	5 / 3	15009 / 4219	3002 / 1406
Inj/SWD	0 / 2	0 / 5337	0 / 2669
Total	163 / 173	324382 / 350052	1990 / 2023
% Change	-6%	-7%	-2%

ROUTINE MAINTENANCE

2ND QUARTER 1989 / 1ST QUARTER 1989

	NO.	FAILURE COST $	$ PER FAILURE
Rods	21 / 32	39082 / 69820	1861 / 2182
Tubing	41 / 43	215949 / 214784	5267 / 4995
Pump	68 / 77	38908 / 58836	572 / 764
ESP	0 / 3	0 / 10523	0 / 3508
Other	59 / 75	62582 / 69901	1061 / 932
Inj/SWD	0 / 1	0 / 960	0 / 960
Total	189 / 231	356521 / 424824	1886 / 1839
% Change	-18%	-16%	3%

REPEAT FAILURES

2ND QUARTER 1989 / 1ST QUARTER 1989

	NUMBER	FAILURE COST $	$ PER FAILURE
Rods	2 / 5	1043 / 7796	522 / 1559
Tubing	3 / 3	6783 / 5442	2261 / 1814
Pump	4 / 8	7841 / 14999	1960 / 1875
ESP	0 / 0	0 / 0	0 / 0
Other	0 / 0	0 / 0	0 / 0
Inj/SWD	0 / 0	0 / 0	0 / 0
Total	9 / 16	15667 / 28237	1741 / 1765
% Change	-44%	-45%	-1%

TABLE 11

ODESSA AREA
SUBAREA SUMMARY

SUBSURFACE FAILURES BY EQUIPMENT TYPE

2ND QUARTER 1989 / 1ST QUARTER 1989

SUBAREA	RODS	TUBING	PUMPS *	OTHER **	TOTAL
Andector	7 / 4	12 / 4	11 / 11	0 / 0	30 / 19
Concho	7 / 6	8 / 10	12 / 13	1 / 3	28 / 32
Ft.Stktn	1 / 2	5 / 8	8 / 8	0 / 1	14 / 19
Kermit	2 / 5	2 / 2	14 / 14	0 / 2	18 / 23
Orla	6 / 12	4 / 6	10 / 12	1 / 0	21 / 30
Penwell	4 / 7	26 / 23	18 / 19	4 / 1	52 / 50
Total	27 / 36	57 / 53	73 / 77	6 / 7	163 / 173
% Change	-25%	8%	-5%	-14%	-6%

COST PER FAILURE

(Excluding Preventive Maintenance)

2ND QUARTER 1989 / 1ST QUARTER 1989

SUBAREA	RODS	TUBING	PUMPS *	OTHER **	TOTAL
Andector	721 /2831	2275 / 2265	2104 / 1845	0 / 0	5099 / 6941
Concho	1054 /1017	2089 / 2359	2138 / 1781	2830 / 6113	8111 /11269
Ft.Stktn	658 / 589	2084 / 2568	2403 / 2137	0 / 638	5145 / 5932
Kermit	832 / 661	2501 / 3255	1317 / 1375	0 / 5401	4649 /10692
Orla	1088 /1693	3849 / 3116	1981 / 2195	1684 / 0	8601 / 7004
Penwell	1342 /1217	2375 / 2264	1961 / 1849	8099 /13642	13777 /18972
Average	986 /1409	2396 / 2462	1939 / 1834	3268 / 3941	1990 / 2023
% Change	-30%	-3%	6%	-17%	-2%

Remarks: (See individual subarea pages)

* Rod Pumps
** Includes PM's, INJ, SWD

TABLE 12

CHEMICAL TREATING COST
ODESSA AREA
2ND QUARTER 1989

	2ND QUARTER 1989	1ST QUARTER 1989	4TH QUARTER 1988	3RD QUARTER 1988
TOTAL TREATED PRODUCTION				
Oil, Bbl	866,865	855,751	937,348	982,600
Water ,Bbl	7,414,175	7,129,687	8,153,103	8,597,016
Fluid, Bbl	8,281,040	7,985,438	9,090,451	9,579,616
% Change in Total Fluid	4%	-12%	-5%	
Water/Oil Ratio	8.55	8.33	8.70	8.75
Gas Well Gas, MMCF	5,352	6,145	5,061	7,206
TREATING COST *				
Oil Wells, $	310,808	305,687	310,721	292,952
Gas Wells, $	46,045	32,043	51,681	39,020
Total, $	356,853	337,730	362,402	331,972
AVERAGE COST PER				
Bbl Oil, $	0.359	0.357	0.331	0.298
Bbl Fluid, $	0.038	0.038	0.034	0.031
MMCF, $ (Gas wells only)	8.60	5.21	10.21	5.41
Month, $	118,951	112,577	120,801	110,657

* Includes surface & sub-surface

TABLE 13

MIDLAND DIVISION
ODESSA AREA
PROBLEM WELL SUMMARY
2ND QUARTER 1989

PENWELL SUB-AREA

LEASE	PRODUCTION BOPD	BWPD	MCFD	PMP DISP 100%	PMP EFF	SPM	LOS	PUMP TIME	POC Y/N	PMP SIZE	TBG SIZE	ROD DES	SKR BAR	SN DEPTH	FLUID LEVEL	(PREV 12 MOS./CURRENT QTR) ROD	TBG	PMP	OTH	TOT	COST	PROB WELL QTRS	PROBLEMS AND RECOMMENDATIONS
W. E. CONNELL NCT-1 WELL NO. 40	10	86	5.7	231	41	7.0	126	24	N	1.50	2.875	76	-	7970	-	0/0	0/0	2/1	0/0	2/1	1701	2	Pump Wear (10 month run).
W. E. CONNELL NCT-2 WELL NO. 162	45	68	7.9	136	83	7.0	128	20	N	1.25	2.875	86	-	9699	-	0/0	1/0	5/2	0/0	6/2	28637	4	Pump problems. Slowed unit down.
ECTOR FEE UNIT WELL NO. 4	17	221	31.0	408	58	9.6	119	24	N	1.75	2.875	86	16 1.62	6534	3969	4/1	0/0	4/0	0/0	8/1	16679	4	Pump wear. Slowed unit down. Excess rod load. Review for FG rods.
ECTOR FEE UNIT II WELL NO. 5	77	178	90.6		UNIDRAULIC				N					12000		0/0	0/0	0/0	3/1	3/1	19929	1	FES.
ECTOR FEE UNIT II WELL NO. 6	76	256	125.5		UNIDRAULIC				N					12018		0/0	0/0	0/0	2/1	2/1	10360	1	Corrosion. Review corrosion program.
ECTOR FEE UNIT II WELL NO. 9	34	161	77.7		UNIDRAULIC				N					12059		0/0	2/2	0/0	0/0	2/2	55442	1	Replaced tbg string.
PENWELL UNIT WELL NO. 1357	101	148	64.9	304	82	7.0	144	15.5	Y	2.00	2.875	87	10 1.5	3856	3856	0/0	3/2	2/0	1/0	6/2	35991	2	Wear. Ran additional K-bars. Replaced tbg string.
PENWELL UNIT WELL NO. 1362	24	174	21.9	181	110	7.4	144	15.5	Y	1.50	2.875	76	6 1.5	3862	3862	2/0	3/0	2/1	0/0	6/1	36352	4	PMP wear. Clean out w/bailer on next failure.
PENWELL UNIT WELL NO. 1364	63	14	49.6	87	88	7.5	144	7.4	Y	1.50	2.875	76	8 1.5	3831	3831	0/0	2/1	0/0	0/0	2/1	23160	1	Tbg wear. New tbg string. Slowed unit down.
PENWELL UNIT WELL NO. 1367	16	337	8.8	392	90	7.0	144	20	Y	2.00	2.875	87	6 1.5	3831	3831	0/0	3/1	0/0	0/0	3/1	31686	2	Tbg corrosion and wear. New tbg string.

TABLE 14

MIDLAND DIVISION GUIDELINES FOR
CHEMICAL PROPOSALS

I. General Testing Considerations

- A. Compatibility Test
- B. Comparison Test
- C. Timing

II. Corrosion Inhibitors

- A. Failure Analysis
- B. Polymer Breakthrough Analysis (If Applicable)
- C. Wheel Tests
- D. Emulsion Tendency Tests
- E. Supporting Operational Data

III. Scale Inhibitors

IV. Residence Time Distribution

V. Demulsifiers

VI. Water Clarifiers (Reverse Demulsifiers)

VII. Biocides

- A. Bacteria Counts
- B. Time Kill Studies

VII. Parffin Chemicals

IX. Scale Removal Chemicals

X. Combination Products

XI. System Monitoring

TABLE 15

Texaco Inc.
Monthly Chemical Usage Report
June 1989

Vendor - Any Chemical Company
Sales Engineer - Mr. Corrosion
Texaco Engineer - Mr. Engineer

Lease/Well Name	Chemical Name	Chemical Type	Chemical Cost ($/gal)	$Truck or Contin.	Treatment Freq. (stops/mo)	Chemical Usage (gal/mo)	Flush (Bbls)	Total Cost ($/mo.)	Target ppm	Actual ppm	Production BOPD	Production BWPD	Production MCFPD	Monthly Cost Per BO	Monthly Cost Per BF	Coupon MPY (Cur/Prev)	Iron Count	Last Failure (date/*)
ANYLEASE UNIT																		
Batt No 1	P900	PARAFFIN	$8.79	CONT	5	25		$219.75	60	22	200	700	400	$0.04	$0.01			
Batt No 2	D700	DEFOAM	$8.25	AS NEEDED		30		$247.50	60	2	1800	8600	2000	$0.00	$0.00			
	EM4000	EMULSION	$11.84	CONT	18	121		$1,432.64	60	9				$0.03	$0.00			
1287	COR1000	Corrosion	$11.00	$0.82	4	4	2	$67.96	50	49	35	29	6	$0.06	$0.03			12-01-88*
	B3000	Biodisper	$9.50			2			20	24								
1356	COR2000	Corrosion	$9.00	$0.82	4	12	2	$167.92	50	53	39	137	22	$0.14	$0.03	6.7/8.2	10	11-28-88
	B3000	Biodisper	$9.50			6			20	27								
1357	COR1000	Corrosion	$11.00	CONT	2.49	18.675		$224.66	60	59	101	148	6	$0.07	$0.03			10-9-88*
1358	COR2000	Corrosion	$9.00	$0.82	4	8	2	$117.92	50	46	26	109	14	$0.15	$0.03			7-16-88
	P1100	Paraffin	$6.00			4			20	23								
1362	COR1000	Corrosion	$11.00	CONT	1.76	13.2		$158.80	60	59	33	143	28	$0.16	$0.03	.90/.95		11-09-88
										0								
1363	COR2000	Corrosion	$9.00	$0.82	4	8	2	$117.92	50	59	14	92	143	$0.28	$0.04		5	9-22-88
	P1100	Paraffin	$6.00			4			20	30								
1364	COR1000	Corrosion	$11.00	$0.82	4	4	2	$67.96	50	40	72	7	11	$0.03	$0.03	10.36/12.0		3-3-89
	B3000	Biodisper	$9.50			2			20	20								
1365	SI																	

* Indicates A Corrosion Related Failure

TABLE 16

EFS - EQUIPMENT EVALUATION

Installation Type Roller Rod Guides Installation Date 4/89

Reason for Installation Reduce Rod/Tbg Wear

Installed Where Test Lease Well No. 3

Supplier Name/Contact XYZ Corp./Mr. Salesman Phone No. 987-6543

Approximate Equipment Cost 7/8" x 2 7/8" $175

Texaco Contact Mr. Foreman Phone No. 123-4567

1) Quarterly Performance Comments: There were 6 roller rod guides installed in Well No. 3 due to excessive Rod/Tbg wear. There has not been a failure for 2 months.

2) Quarterly Performance Comments: Well No. 3 has gone 5 months without a Rod/Tbg failure. Prior to installing the roller rod guides the well had a Rod/Tbg failure every 45 days.

3) Quarterly Performance Comments: Well No. 3 had a pump failure 7 months after the roller rod guides were installed. The rods and tubing were inspected and showed no signs of wear, however, the wheels on the guides were worn and new wheel kits were installed.

4) Quarterly Performance Comments:

TABLE 17