PREVENTIVE MAINTENANCE FOR BEAM PUMPING EQUIPMENT

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INTRODUCTION

A Preventive Maintenance (PM) Program has been established in the southeastern New Mexico portion of Continental Oil Company's production department operation. The PM system has been in operation for 12 months and covers over 2000 separate pieces of major surface equipment.

The concept of preventive maintenance is not new in production operations; however, most operating organizations incorporate PM and operations in one organization. The primary disadvantage of this type of setup is the secondary priority PM receives. Day-to-day operating problems normally receive first priority and PM work is done after the "emergencies" are handled. For that reason, Conoco's "PM" organization has been separated from the "operations" organization.

Preventive maintenance is the systematic inspection, cleaning, lubrication, and servicing of equipment. The objective of PM is to prevent malfunctions and breakdowns, with the result that all mechanical equipment will work as well and as long as it should with minimum repairs.

Operations include those tasks that have to be done to efficiently produce oil and gas wells, to monitor and control oilfield facilities, to answer alarms, and to assure that environmental and safety standards are maintained. An efficient production operation must give equal priority to operational tasks and PM.

This paper deals only with the PM for beam pumping equipment. However, the procedures followed in establishing the PM for the beam pumping equipment are essentially the same for all pieces of equipment included in this project.

PM ORGANIZATION

The PM work for all of the equipment covered is under the direction of a PM foreman. Four two-man crews and a test engineer are assigned to the PM production foreman. Two of these crews handle PM on waterflood equipment, one crew is assigned tank battery equipment, and pumping units are serviced by the fourth two-man team. The test engineer uses specialty test equipment such as vibration analyzers on all equipment in the field.

Each PM team also handles "breakdown" repair work on the equipment assigned to them. Fifty percent of their time is allocated to scheduled preventive maintenance with the remainder of their time reserved for emergency work. The 50 percent scheduling factor was based on refinery and plant experience with PM programs. Major repair work, such as pumping unit bearing repair, is handled by

PUMPING UNITS

PREVENTIVE MAINTENANCE CHECKLIST

Item		Inspection Interval	Routine Servicing or Preventive Maintenance
1.	Check oil level in gearbox	Monthly	R
2.	Check for oil seal leaks		R
3.	Inspect belts for wear		R
4.	Look for foundation movement or cracks		R
5.	Inspect stuffing box and polished rod		R
6.	Clean equipment and location as needed		R
7.	Lubricate wire line		R
8.	Clean breather cap on gearbox		R
9.	Check operation of shutdown switches		R
10.	Inspect wellhead ground		R
11.	Visual inspection of gearbox oil	Semi-annual	P
12.	Lubricate structural bearings		P
13.	Check structural and foundation bolts		P
14.	Check unit for proper alignment		P
15.	Grease brake cable and adjust		P
16.	Check counterbalance		P
17.	Check V-belt drive for alignment and wear		P
18.	Check ladder bolts and ladder condition		P
19.	Check guards on unit		P
20.	Change oil in gearbox	Annual	P

FIGURE 1

local contractors. The PM team inspects each repair job to maintain quality control on contract services.

PM PROCEDURES AND EQUIPMENT MANUALS

The inspection procedures to be followed on each pumping unit are included in a PM "Procedures Manual". This manual includes what to check, how often to check it, and who should perform each inspection. In determining what inspections should be made, manufacturers' recommendations were used as a base and were modified by data from Conoco's maintenance, engineering and marketing departments. Field production foremen then thoroughly reviewed these recommendations and modified them as their experience dictated.

The PM checklist from the "Procedures Manual" for pumping units is shown on Fig. 1. The first ten inspections on this list are denoted "Routine Servicing" (R) and are done by the lease operator. These are the most frequent inspections (monthly), requiring shorter times to complete. These inspections include checking the oil level in the gearbox, looking for obvious oil seal leaks, checking for worn belts, foundations movement, loose

PUMPING UNITS — PREVENTIVE MAINTENANCE SCHEDULE
HOBBS DIVISION - NMM - LITTLEFIELD 1ST HALF OF FEB. 1976

LEASE	LOCATION	EQUIPMENT DESCR.	TYPE INSP.	DATE MAINT. COMPLETED	COMPLETED BY	FILE NO.
REED B	WELL 3	PUMPING UNIT 1	SA	----------	----------	1675
REED B	WELL 7	PUMPING UNIT 1	SA	----------	----------	1681
REED B	WELL 10	PUMPING UNIT 1	SA	----------	----------	1685
REED B	WELL 11	PUMPING UNIT 1	SA	----------	----------	1687
REED B	WELL 12	PUMPING UNIT 1	A	----------	----------	1690
REED B	WELL 13	PUMPING UNIT 1	SA	----------	----------	1691
REED SANDERSON UNIT	WELL 2	PUMPING UNIT 1	SA	----------	----------	1693
REED SANDERSON UNIT	WELL 4	PUMPING UNIT 1	SA	----------	----------	1695
REED SANDERSON UNIT	WELL 5	PUMPING UNIT 1	SA	----------	----------	1697
REED SANDERSON UNIT	WELL 7	PUMPING UNIT 1	SA	----------	----------	1699
REED SANDERSON UNIT	WELL 9	PUMPING UNIT 1	SA	----------	----------	1701
REED SANDERSON UNIT	WELL 13	PUMPING UNIT 1	SA	----------	----------	1703
REED SANDERSON UNIT	WELL 15	PUMPING UNIT 1	SA	----------	----------	1705
REED SANDERSON UNIT	WELL 17	PUMPING UNIT 1	SA	----------	----------	1707
REED SANDERSON UNIT	WELL 19	PUMPING UNIT 1	SA	----------	----------	1709
SANDERSON A	WELL 1	PUMPING UNIT 1	SA	----------	----------	1711
SANDERSON A	WELL 2	PUMPING UNIT 1	SA	----------	----------	1713
SANDERSON A	WELL 3	PUMPING UNIT 1	SA	----------	----------	1715
SANDERSON A	WELL 4	PUMPING UNIT 1	SA	----------	----------	1717
SANDERSON A	WELL 6	PUMPING UNIT 1	SA	----------	----------	1719
SANDERSON A	WELL 7	PUMPING UNIT 1	SA	----------	----------	1721
SANDERSON A	WELL 8	PUMPING UNIT 1	SA	----------	----------	1723
SANDERSON A	WELL 10	PUMPING UNIT 1	SA	----------	----------	1725
SANDERSON A	WELL 11	PUMPING UNIT 1	SA	----------	----------	1727
SANDERSON A	WELL 13	PUMPING UNIT 1	SA	----------	----------	1729
SANDERSON A	WELL 14	PUMPING UNIT 1	SA	----------	----------	1731

FIGURE 2

wellhead grounds, testing shutdown switches, and cleaning the equipment as needed.

The "Preventive Maintenance" (P) procedures in Fig.1 are done by the two-man PM team assigned specifically to pumping units. These inspections are less frequent (semiannual and annual) and require more time to perform. In general, any inspection requiring longer than one man-hour is done by the PM team.

The PM work on a six-month inspection includes a visual inspection of the gearbox oil for contaminants, lubricating the structural bearings with the proper oil or grease, and greasing the brake cable and adjusting the brake. The unit alignment and counterbalance are also checked. Other inspections include tightening the structural and foundation bolts, checking the V-belt drive for alignment and wear, and checking the ladder and guards for wear or looseness.

A gearbox oil change is called for on an annual basis. Currently, the oil in the gearboxes is being spot-tested to see if this interval can be lengthened. This testing is done by the marketing department and includes checking for wear metals, state of additive depletion, and degree of oxidation. Preliminary indications are that the oil will be able to last much longer than one year.

The "Procedures Manual" also contains details of the procedures to be followed for each itemized inspection. A companion "Equipment Manual" has the manufacturers' operating manuals for each piece of equipment to supplement the procedures in the Procedures Manual.

PERSONNEL SELECTION AND TRAINING

Individuals were selected for PM work who demonstrated an aptitude for mechanical work. An inventory of field personnel was made to determine which individuals would be better suited for maintenance work and which would have more of an aptitude for operational work.

Manufacturers' representatives were consulted for training assistance. They provided training sessions demonstrating proper lubrication techniques, details of bearing assembly, and general maintenance techniques.

EQUIPMENT MALFUNCTION REPORT

DATE _____

FOREMAN AREA JRC_____ MKC_____ LEASE NAME _____ WELL NO _____ HEADER NO. _____

INJ PLANT NO. _____ PMP NO _____ BATT NO. _____ TANK NO _____ SEP NO _____ H.T. NO. _____

EQUIPMENT CODE_____ (SEE MASTER LIST OF EQPT)

CAUSE OF MALFUNCTION

	41	42
BREAK	0	1
CALIBRTION	0	2
CORRSN INT	0	3
CORRSN EXT	0	4
DEFECTIVE	0	5
ELEC	0	6
EROSION	0	7
FATIGUE	0	8
FREEZING	0	9
HI TEMP	1	0
ADJUSTMENT	1	1
LUBRCATION	1	2
LEAKAGE	1	3
MISALINED	1	4
OVERLOAD	1	5
HI SPEED	1	6
HI PRESS	1	7
PARAFFIN	1	8
STORM DMGE	1	9
SAND	2	0
SCALE	2	1
STUCK	2	2
TENSION	2	3
VIBRATION	2	4
CONTMNATION	2	5
WEAR	2	6
	2	7

TYPE OF REPAIR (CARD COLM. 43-48)

ADJUSTED	0	1
CALIBRATED	0	2
CLEANED	0	3
LUBRICATED	0	4
OVERHAUL	0	5
REPAIRED	0	6
JUNKED	0	7
NO ACTION	0	8
REPLACED	0	9
	1	0
	1	1
	1	2

FLUID TYPE

	49	50
OIL	0	1
SALT WTR	0	2
FRSH WTR	0	3
SWEET GAS	0	4
SOUR GAS	0	5
AIR	0	6
OTHER	0	7
	0	8
	0	9
	1	0
	1	1

MATERIAL COMPOSITION

	51	52
STEEL	0	1
STNL STEEL	0	2
P.C. STEEL	0	3
LINED STEEL	0	4
CHR PLT STL	0	5
BRASS	0	6
CAST IRON	0	7
COPPER	0	8
ALUM BRONZE	0	9
PLASTIC	1	0
FIBERGLASS	1	1
GLASS	1	2
CONCRETE	1	3
OTHER	1	4
RUBBER	1	5
	1	6
	1	7
	1	8
	1	9
	2	0
	2	1

RESULTS (CARD COLM 53-56)

FIRE/EXPLO	0	1
INJURY	0	2
LOSS OF		
MAJOR EQPT	0	3
O/WTR SPILL	0	4
OIL SPILL	0	5
WTR SPILL	0	6
NO DAMAGE	0	7
OTHER	0	8
	0	9
	1	0
	1	1
	1	2

SIZE (ENTER)

	57	58	59	60
INCHES				
HP				
KVA				
GEAR BOX				

DOWNTIME (HRS) _____ EST RECOV OIL _____

EST LABOR ($) COMP _____ CONTRACT _____

MFG NAME _____

FIGURE 3

SPECIAL EQUIPMENT

The PM team assigned to pumping units utilizes a three-quarter ton truck equipped with a 1500-lb capacity electric hoist, pneumatic grease gun with air compressor, and hand tools necessary to perform the PM inspections. Tools unique to this vehicle include large hammer wrenches necessary to tighten structural and base bolts. A larger truck with gin poles has been proposed to assist in lifting larger belt guards and to hoist oil drums when changing gearbox oil.

PM COMPUTER PROGRAMS

With a system such as this, a workable scheduling and record-keeping system is vital. Two separate in-house computer programs have been developed for this purpose.

The first program does the PM scheduling. A sample of the output from this program is shown in Fig. 2. This output identifies the lease, well number, equipment to be inspected, and type of inspection, i.e. monthly, semiannual, etc., that is due for PM inspections within the next two-week period. The computer gives two weeks of work for each PM team to complete and takes into account the 50% scheduling factor. As the inspections are completed the date is entered on the printout and this information is returned for processing by the computer. The computer will then recall the same inspection for the same equipment to be done at the next appropriate time.

In the event that not all of the two weeks' work is completed, the inspections not done will automatically be scheduled as first priority for the next two-week period.

The second program used helps evaluate mechanical failures and their causes. Malfunction reports are made on any piece of equipment that fails. A copy of this report is shown in Fig. 3. This report identifies, among other things, the equipment that failed, its location, service conditions, materials of construction, and the cause of failure as determined in the field. Since this report is used on all equipment failures and not just pumping units, an "Equipment Master List" is used to identify the equipment that fails. This list is shown in Fig. 4.

Although the malfunction report is now being used, the entire program to assimilate the malfunction information is not completed. When completed, this program will be used to identify problem areas and adjust maintenance inspections and frequencies as required.

RESULTS

The PM program has now been functional for 12 months. Although this is a relatively short period of time for a program such as this to be fairly evaluated, several indicators of the effectiveness of the program are visible.

First, a number of mechanical problems with the pumping units were corrected on the first inspection. These problems included structural bolts missing or loose, grease seals needing replacement, units misaligned, bearings needing repair, and units with improper or inadequate tie-downs. These were

EQUIPMENT MASTER LIST

	EQUIPMENT	CODE
A	ACTUATOR	001
		002
		003
		004
B	BEARING	005
	CRANKPIN	006
	EQUALIZER	007
	SADDLE	008
	OTHER	009
	BELTS	010
	BRAKE	011
	BRIDLE	012
	BEARING, ROLLER	013
	BEARING, CONN. ROD	014
		015
C	CABLE	016
	CATHODIC PROTECTION	017
	CHEM PUMP	018
	CHOKE	019
	COMPRESSOR	020
	CONTROL PANEL	021
	CONTROLLER	022
	COUPLING	023
	CROSS HEAD	024
	CRANK SHAFT	025
	CONN. ROD	026
D	DIAPHRAGM	027
		028
		029
E	ELECTRIC GRND	030
	ENGINE	031
		032
		033
F	F/N DEVICE	034
	FILTER	035
	FIRE TUBE	036
	FUSE	037
	FLUID END	038
	FLUID END HEADS	039
		040
G	GASKET	041
	GAUGE	042
	GEAR BOX	043
	GREASE SEAL	044
		045
H	HEAD-TUBING	046
	HEAD-CASING	047
		048
L	LUBRICATOR	049
	LUBE PUMP	050
		051
M	METER-ORF	052
	METER-PD	053
	METER-TURB	054
	MONITOR BSW	055
	MOTOR	056
	MURPHY HI-LO OIL SW	057
		058
		059

	EQUIPMENT	CODE
P	PACKING	060
	PIPE	061
	PLUNGER	062
	POLISH ROD CLAMP	063
	PROBE	064
	PULSATION DAMPENER	065
	PUMP	066
*	PUMP UNIT TIE DOWN	067
	PONY ROD	068
		069
R	RECORDER	070
	REGULATOR	071
	RELAY	072
		073
		074
S	SAMPLER	075
	SCRUBBER	076
	SHEAVE	077
	SOLENOID	078
	STFNG BOX	079
	STRAINER	080
*	STRUCTURAL DAMAGE	081
		082
		083
T	TANK	084
	TIMER	085
	TRANSFORMER	086
		087
V	VALVE	
	BLOCK	088
	BUTTERFLY	089
	CHECK	090
	GATE	091
	HYD/PNEU	092
	MOTOR	093
	PLUG	094
	THROTTLING	095
	WING	096
	SUCTION	102
	DISCHARGE	103
	BALL & SEAT	104
	VALVE VERIF SWITCH	097
	VAPOR RECOVERY UNIT	098
	VESSEL	
	HEATER TRT	099
	SEPARATOR	100
	GLYCOLATN	101
W	WIRING	105
		106
		107
		108
		109
		110
		111
		112
		113
		114
		115
		116

FIGURE 4

problems that had accumulated over a period of years. Because of the number of problems to be corrected initially, the first six-month inspections actually required nine months to complete. The average time per unit now being spent on the second six-month inspection is considerably less than the first time since the major repair work has already been done. It now appears that only minor adjustment will have to be made to meet the six-month inspection frequency.

A second readily visible benefit of the program is the experience gained by the PM team working with the pumping units. These men, after one year of working strictly with pumping units, can now do a better, more efficient job of servicing the units and can make much better judgments as to the remaining life of unit bearings thus helping to reduce repair and maintenance costs.

The PM team also is doing work that allows the lease operator to concentrate more on operational work.

It has been obvious to us that PM will not stop all mechanical failures. However, with time, we should see a decrease in total failures and in failure frequency.

CONCLUSIONS

PM for beam pumping equipment can be useful in helping to extend the life of the equipment. With the proper field organization, PM work can receive priority as well as day-to-day operational work. The true payout of an effective program will take several years to be realized because of the relatively long (20 years) design life of the equipment.

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