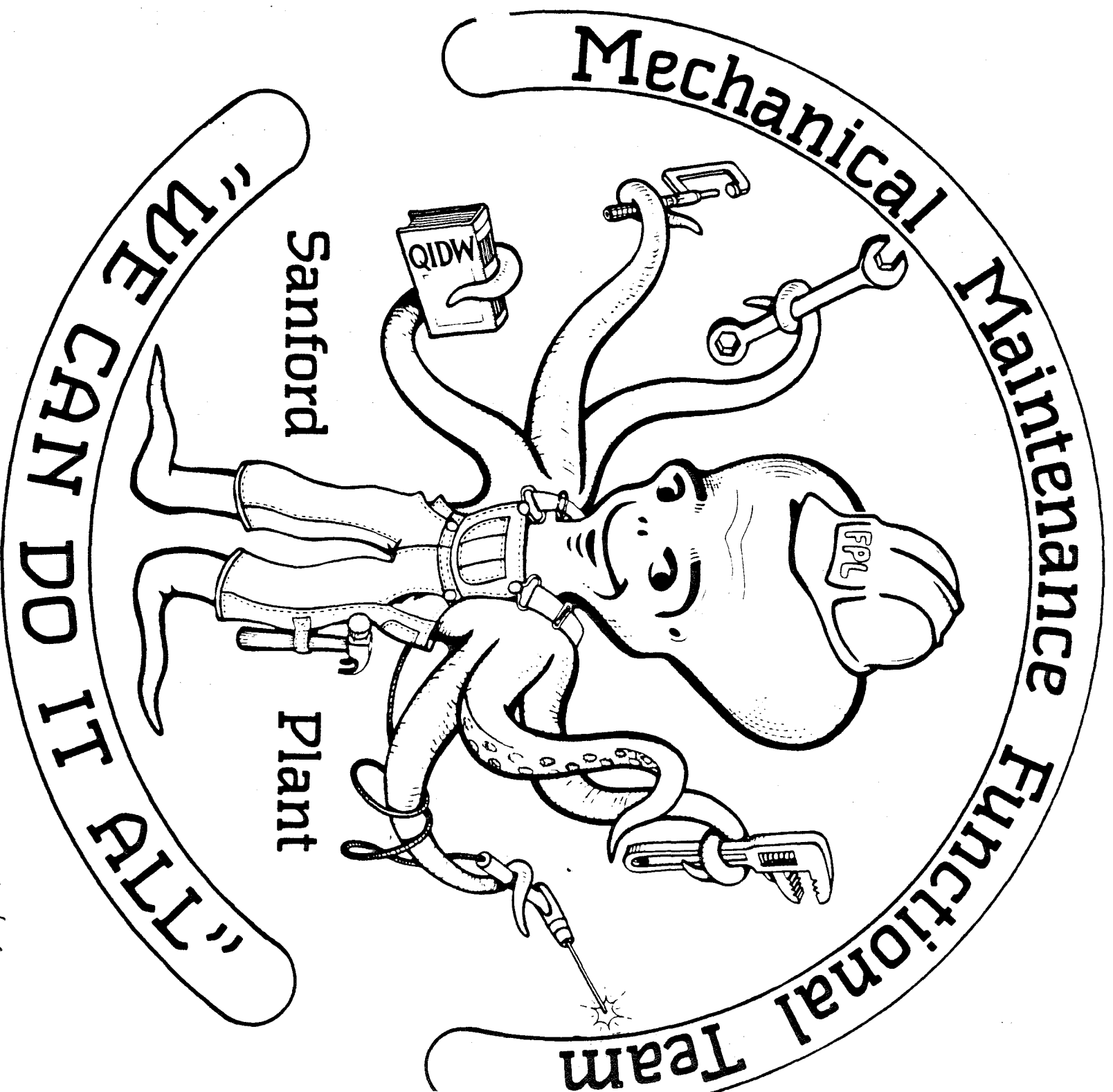




TEAM MEMBERS

BILL BRENNAN T/L
JOHN COSIMINI
BILL GIRARD

PEE WEE OWENS
CHARLIE NEWSOME
LEON STEINMEYER

Facilitator
B.D. Stuart

668-8625

MIKE CARD

1

REASON FOR IMPROVEMENT

MECHANICAL MAINTENANCE FUNCTIONAL TEAM



Qim's
INTERVIEWS
EEI Reports
EXCEPTION Reports

BRAINSTORMING LIST

1. F. W. heaters on #3 Unit
2. Sump Pumps
3. Soot Blowers
4. Soot Blower repair area
5. Root Valve Packing
6. Trap Header in Hotwell (penetration)
7. Plant Walkway Between Units
8. Buildup Condensers (tube sheet)
9. Better Training on Equipment (new & old)
10. Turbine Lube Oil Cooler Leaks
11. Power Control Valve
12. Drum Gage Glass
13. Insulation (cold weather)
14. Debris in Intake

Multivoted 14 to 5
for the theme selection
matrix

THEME SELECTION MATRIX

THEMES	IMPACT ON CUSTOMERS	NEED FOR IMPROVEMENT	FITS DEPT. OBJECTIVE	CAN TEAM IMPLEMENT
UNITS 4 & 5 TURBINE LUBE OIL COOLER HEAD LEAKS	HIGH	HIGH	HIGH	HIGH
UNIT #3 FEEDWATER HTR FAILURES	HIGH	HIGH	HIGH	MEDIUM
BUILDUP ON CONDENSER TUBE SHEET & WALLS	MEDIUM	MEDIUM	MEDIUM	MEDIUM
BETTER TRAINING ON EQUIPMENT	HIGH	MEDIUM	LOW	LOW
FIX SOOT BLOWER REPAIR AREA	HIGH	HIGH	MEDIUM	LOW

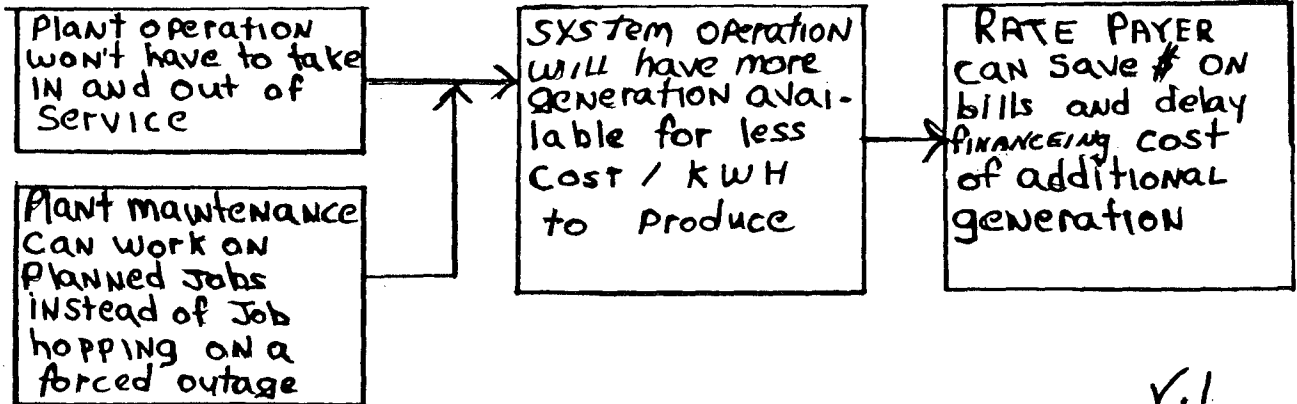
*

DATA GATHERED DID NOT SUPPORT REASON FOR IMPROVEMENT. THE TEAM FOUND THAT AN IMPROVEMENT MODIFICATION HAD BEEN MADE ON UNIT 5, (PWO # 5842) ON 10/5/83. THE SAME MODIFICATION WILL BE IMPLEMENTED ON UNIT 4.

1

REASON FOR IMPROVEMENT

WHO ARE THE CUSTOMERS OF FEEDWATER HEATERS ?



HOW MANY FEEDWATER HEATER FAILURES

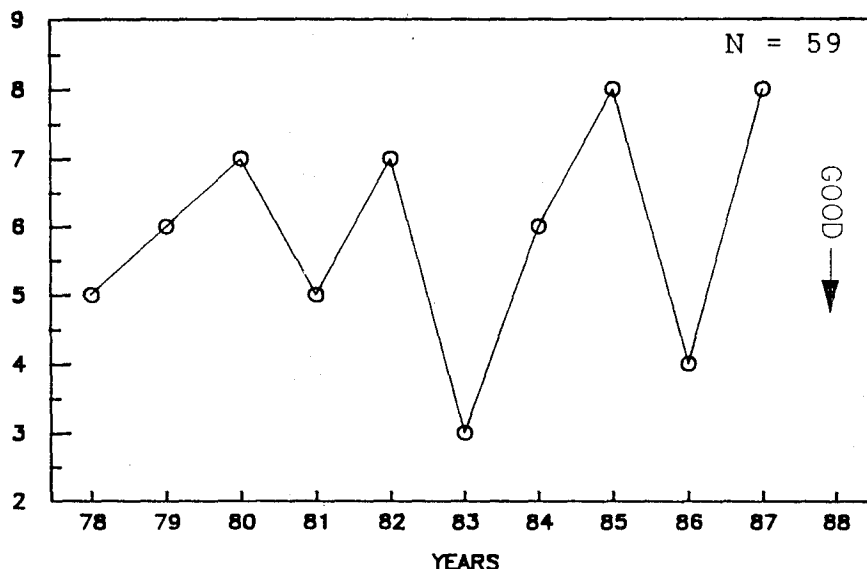
HAVE THERE BEEN ON UNIT 3 ?

PONTENTIAL

PSN 3 F.W. HEATER CAUSED LOAD CURTAILMENTS

GEMS REPORT 9380-101-011188 1/1/78 THRU 12/31/87

OF OCCURENCES



V.2

So WHAT?

2

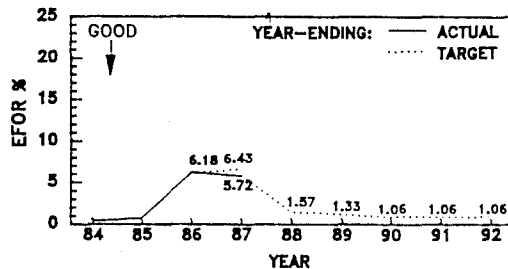
1

REASON FOR IMPROVEMENT

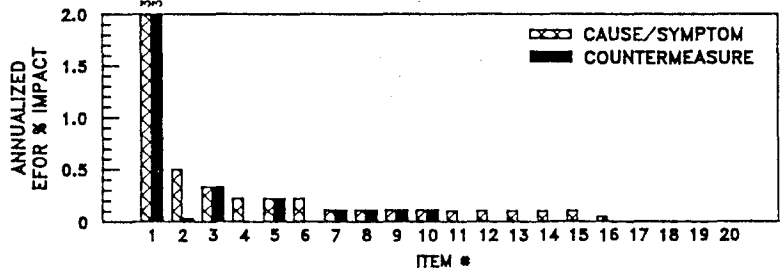
UNIT RELIABILITY RATE PROFILE

PLANT - UNIT: PSN - #3
YEAR: 1988

EQUIVALENT FORCED OUTAGE RATE
TREND LINE & FORECAST



CAUSE & COUNTERMEASURE IMPACT
CURRENT SITUATION STRATIFICATION



ITEM #	OUTAGE CAUSE/SYMBOL/EVENT DESCRIPTION	CATY TYPE ^a	ACTUAL 4 YEAR EFOR% IMPACT	CALC ANNUAL EFOR% IMPACT	COUNTERMEASURE DESCRIPTION	CM TYPE ^a	TARGETED IMPLEMENTATION YR & ANNUAL IMPACT						
							83-87	1988	1989	1990	1991	1992	
1	EXCITER BRUSH RIGGING GROUND	A	0.89	3.20	FYP OVERHAUL, REWIND ARMATURE, HTR INSTL	2	---	3.20					
2	ECONOMIZER OUT TUBE SECTION CRACK	B	0.13	0.46	FIX - QIP TASK TEAM (50%)	2	---	-0.04	-0.04	0.27			
3	BOILER FEED PUMP MECH SEAL LEAKING	B	0.10	0.34	GEMS CODING ERROR ELIMINATION	2	---	0.34					
4	MAIN TX GND-"C" PH. CONTACT, BUS TIE BRKR	A	0.06	0.23			---						
5	COND EXPANSION JOINT LEAKING - 6S FWH	A	0.06	0.23	REPL EXPANSION JOINTS ON 5 & 6 FWH	2	---	0.23					
6	PENDANT OUTLET HEADER CRACK	B	0.06	0.23	SEC SH OUTLET HEADER UPGRADE	2	---		0.23				
7	CONDENSER CATHODIC PROTECTION REWORK	B	0.03	0.12	GEMS CODING ERROR ELIMINATION	2	---	0.12					
8	COND PIPING CORRODED-WTR BOX PRIMING LINE	B	0.03	0.12	GEMS CODING ERROR ELIMINATION	2	---	0.12					
9	CONDENSER TUBES LOSS OF FLOW-HYDROBLAST	B	0.03	0.12	GEMS CODING ERROR ELIMINATION	2	---	0.12					
10	CONDENSER CATHODIC PROTECTION ANODE FAIL	B	0.03	0.12	GEMS CODING ERROR ELIMINATION	2	---	0.12					
11	HP FEEDWATER HEATER TUBES LEAKING	B	0.03	0.11			---						
12	STMTB TRIP-EXH HOOD SPRAY CONT VLV	B	0.03	0.11			---						
13	HP FEEDWATER HEATER GASKET LEAKING	B	0.03	0.11	FIX - QIP TASK TEAM (50%)	2	---		0.05				
14	VAR SWITCHGEAR BREAKER TEST FOR TROUBLE	B	0.03	0.11			---						
15	MAX EXCITATION RELAY ABNORMAL OPER	B	0.03	0.11			---						
16	TURBINE CONTROL OIL SYSTEM	B					---	-0.06					
17	OTHER	-	0.00	0.00	---	-	---						
			1.60	5.72									
TOTAL ANNUALIZED EFOR% DECREASE:								-0.25	4.15	0.24	0.27	0.00	0.00
NET TARGETED ANNUALIZED EFOR%:								6.43	1.57	1.33	1.06	1.06	1.06
ACTUAL YEAR-ENDING EFOR%:								5.72					
DIFF IN EFOR% (TARGETED vs ACTUAL):								-0.71					

^a CATEGORY TYPE:

A - UNPREDICTED FIRST TIME EVENT

B - RECURRING EVENT W/NO CM IMPLEMENTED

C - COUNTERMEASURE FAILURE

* CATEGORY TYPE:

- A - UNPREDICTED FIRST TIME EVENT
- B - RECURRING EVENT W/NO CM IMPLEMENTED
- C - COUNTERMEASURE FAILURE
- D - REPLICATION FAILURE
- E - FUTURE PREDICTED EVENT

APPROVED BY: _____
REVISION DATE: 06/30/88

** COUNTERMEASURE TYPE:

- 1 - IMMEDIATE REMEDY
- 2 - PREVENTION OF RECURRENCE
- 3 - PREVENTION THRU PREDICTION

FILED: 06/30/88

ITEMS # 11 & 13 INDICATE AREAS NEEDING IMPROVEMENT IN FEEDWATER SYSTEM

3

1

REASON FOR IMPROVEMENT

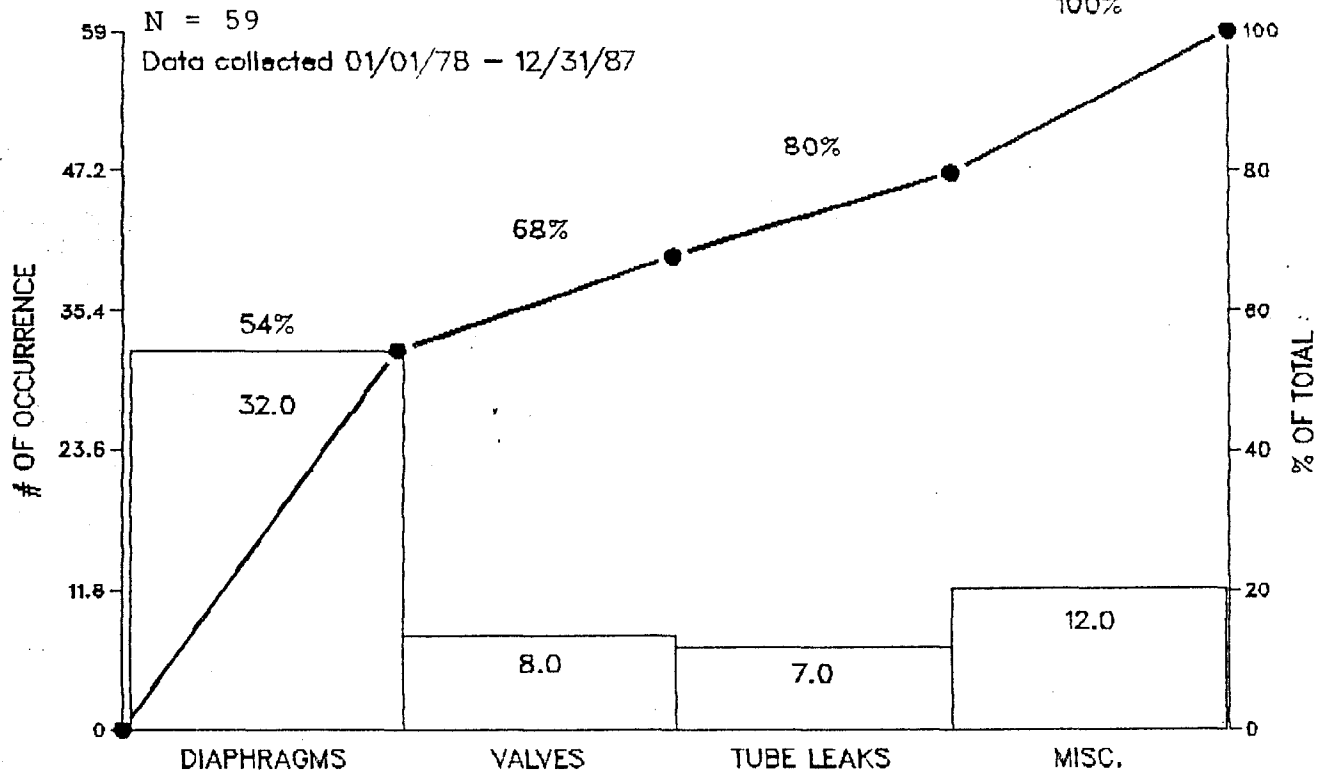
14

TEAM PROJECT PLANNING WORKSHEET													
Theme (Problem Area)		Unit #3 Feedwater Heater Failures											
Team Work Location		Sanford Plant											
Team Name		Work Unit Functional Team											
Duration		Mo/Yr. (1-88) through Mo/Yr. () Total Months ()											
TEAM MEMBERS	Team Information												
	Team members have an avg. of 13.5 yrs with Company.												
	All but 2 members have been on QIP teams before												
MEETING	No.	Date	Time	Att.	No.	Date	Time	Att.	No.	Date	Time	Att.	
	1	1-88	1.2	7									
	2	1-88	1.2	7									
	3	1-88	1.2	7									
OUTLINE OF ACTIVITIES	Schedule (☐ Projected ☐ Actual)												
	No. & Yr.	1-88	2-88	3-88	4-88	5-88	6-88	7-88	8-88	9-88	10-88	11-88	12-88
	Reason for Improvement												
	Current Situation												
	Analysis												
	Counter-measures												
	Results												
	Standardization												
	Future Plans												
* Signifies Presentation Date QID/EER 2/12/87													

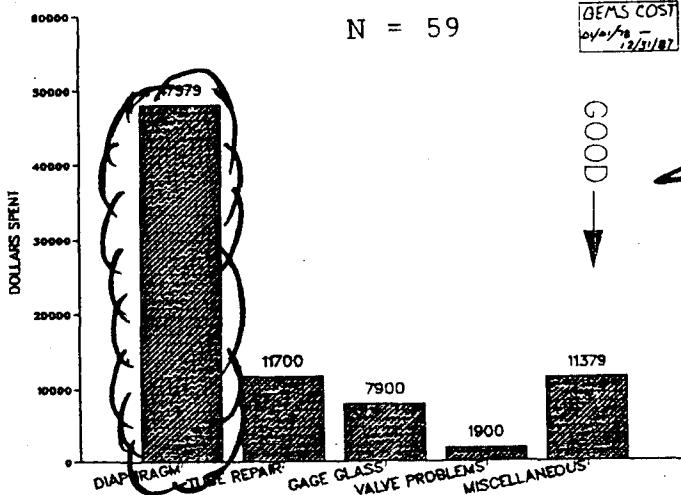
2

CURRENT SITUATION

PSN 3 FW HEATER CURTAILMENT OCCURENCES GEMS REPORT 9380-101-011188 E



TOTAL DOLLARS SPENT ON FEEDWATERHEATER OCCURANCES
TOTAL SPENT \$80,858

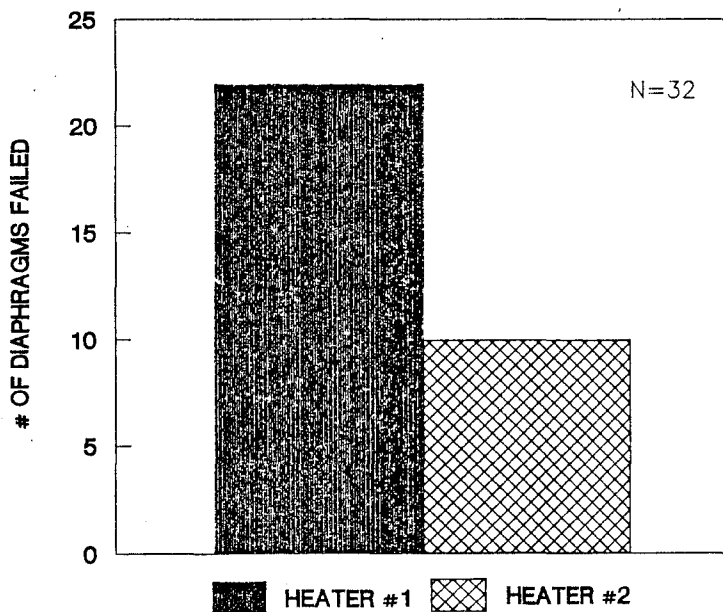


YES, this is definately
the problem we need
to solve.

GOOD
↓

WHICH HIGH PRESSURE HEATER IS HAVING THE MOST DIAPHRAGM FAILURES ??

PSN 3 HIGH PRESSURE F.W. HEATERS DIAPHRAGM FAILURES IN GEMS 1978 TO 1987



#1 HEATER IS HAVING MORE PROBLEMS WITH DIAPHRAGMS, SO LET'S INVESTIGATE WHAT IS WRONG WITH IT.

THE LEAD TEAM WANTED UNIT 3 H.P.F.W. HEATERS TO BE MORE RELIABLE, AND TO REDUCE OR ELIMINATE LOAD CURTAILMENT FAILURES CAUSED BY DIAPHRAGMS. THE LEAD TEAM INDICATED THAT AT 50% REDUCTION IN FORCED OUTAGES DUE TO H.P.F.W. HEATER DIAPHRAGM FAILURES WOULD ASSIST IN MEETING TARGETED EFOR REQUIREMENTS FOR PSN 3.

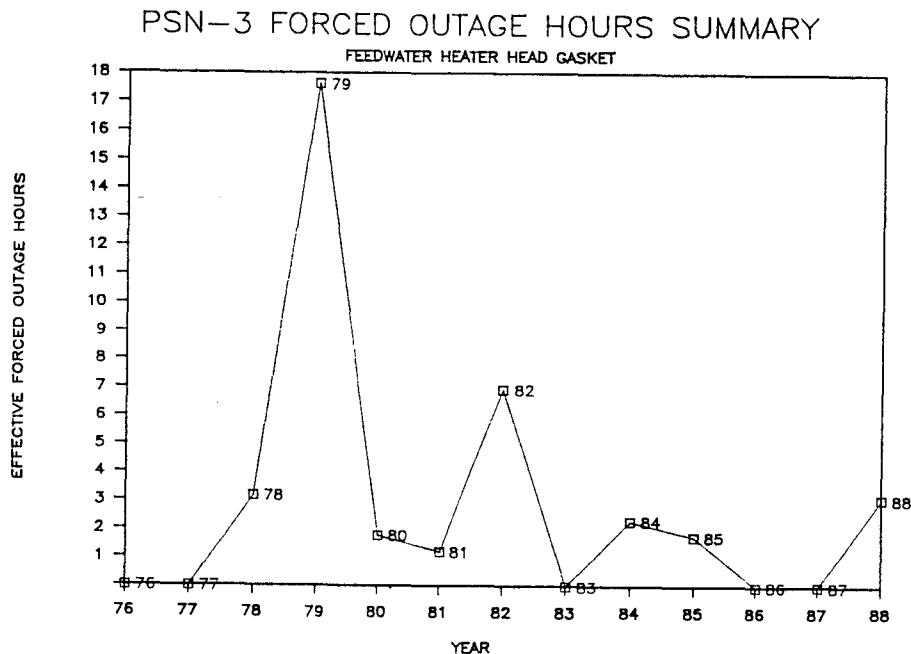
2

CURRENT SITUATION

PROBLEM STATEMENT:

IN THE PAST 9 YEARS THERE HAVE BEEN 22
LOAD CURTAILING DIAPHRAGM FAILURES ON HEATER #1
THESE FAILURES SHOULD BE REDUCED TO A POINT
WHERE THEY MEET OUR EFOR TARGET

✓.7



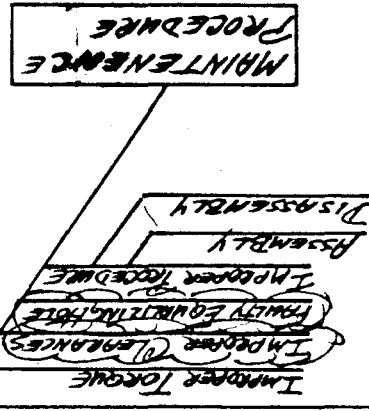
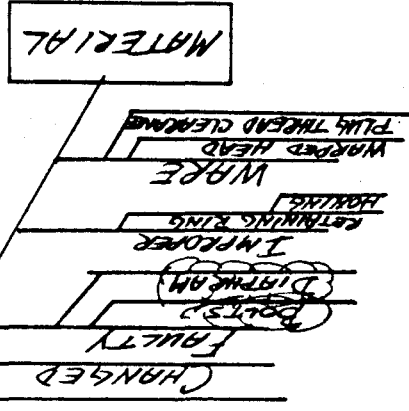
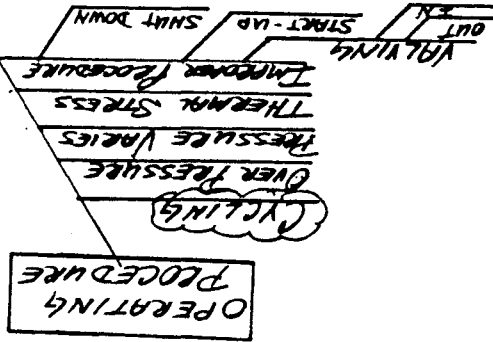
CAN WE MEET THE 50% REDUCTION IN HIGH PRESSURE FEEDWATER HEATER
DIAPHRAGM FAILURES OUR CUSTOMER WANTS ?

$22 \text{ (\#1 FWH)} \div 32 \text{ (\#1 \& \#2 FWH)} = 69\%$
 $\geq 90\%$ IMPROVEMENT IN #1 FWH FAILURES
 WILL GIVE A 50% REDUCTION IN FWH
 DIAPHRAGM FAILURES.

✓.8

Possible Causes:
 1. Pressure Differential
 2. Warped Head
 3. Improper Torque
 4. Faulty Material
 5. Material Change
 6. Improper Procedure

7. Improper Clearances
 8. Faulty Equalizing Hole
 9. Over Pressure
 10. Cycling
 11. Improper Thread Clearance
 12. Thermal Stress



IN THE PAST 9 YRS. THERE HAS BEEN 22 LOAD CURT-AILING DISINTEGRATIONS ON FWH #1. THESE FAILURES SHOULD BE RE-PAIRED TO A POINT OF BETTER RELIABILITY & DEFENDABILITY

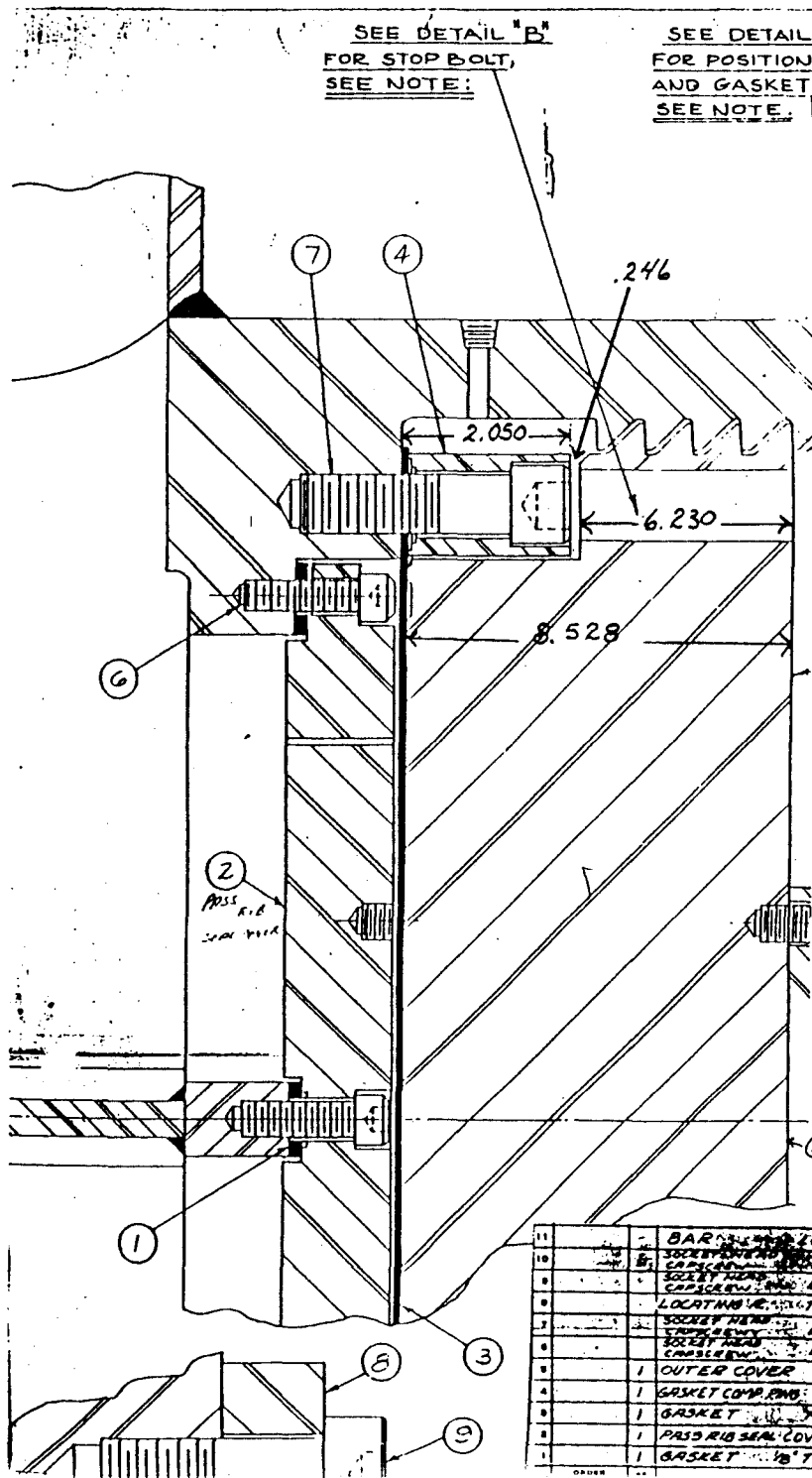
Most Flexible Rod Causes:
 1. Incorrect Diameter Material
 2. Incorrect Bolt Length
 3. Incorrect Interval Clearances
 4. Equalizing Hole Plugged
 5. Cycling Stress

Most Probable	How To Verify	Results
1. Incorrect diaphragm material	Check with stores to insure compliance to manufactures specs.	Proper alloy and thickness in stores
2. Incorrect bolt length	Dissassemble and mic to specs.	No specs. Bolts when properly torqued did not bottom out. Failed diaphragm did not fail between diaphragm and retaining ring
3. Incorrect Internal clearances.	Dissassemble and mic to specs	Found retaining ring surface to be out of spec. But again no diaphragm had failed between ring and diaphragm
4. Equalizing hole plugged	Dissassemble and inspect	Hole clear
5. Cycling stress	WEIBULL ANALYSIS	$R^2 = .87$

AT THIS TIME THE TEAM REALIZED THAT TO ANSWER SOME OF THESE QUESTIONS WE NEEDED TO DISASSEMBLE AND INSPECT AREAS OF #1 FW HEATER.

THE TEAM REQUESTED AND WAS GRANTED A 3 DAY CLEARANCE ON THE HEATER. THE NEXT PAGE SHOWS THE DRAWING AND ITEMS CHECKED.

✓ 10



MEASUREMENTS WERE TAKEN 1-15-69 AND RECORDED ON PRINT BY CAT.

THE TEAM DECIDED THAT THE FOLLOWING MEASUREMENTS BE TAKEN:

1. FLATNESS OF ITEM 4
2. ROUNDNESS OF ITEM 4
3. THICKNESS OF ITEM 4
4. WITH DEPTH GAUGE, CHECK FROM OUTSIDE OF ITEM 4 TO ITEM 3
5. CHECK ITEM 3 SEALING SURFACE ON NTR. BODY
6. CHECK DIMENSIONS OF ITEM 5
7. CHECK DEPTH OF ITEM 5 FROM END OF NTR. BODY BEFORE REMOVAL
8. CHECK ITEM 2 FOR Equalizing hole
9. CHECK THREADS ON PLUG & HEATER
10. PRESSURE TEST HEATER FOR TUBE LEAKS.
11. CHECK PROCEDURE FOR ASSEMBLY WHILE DISASSEMBLING.

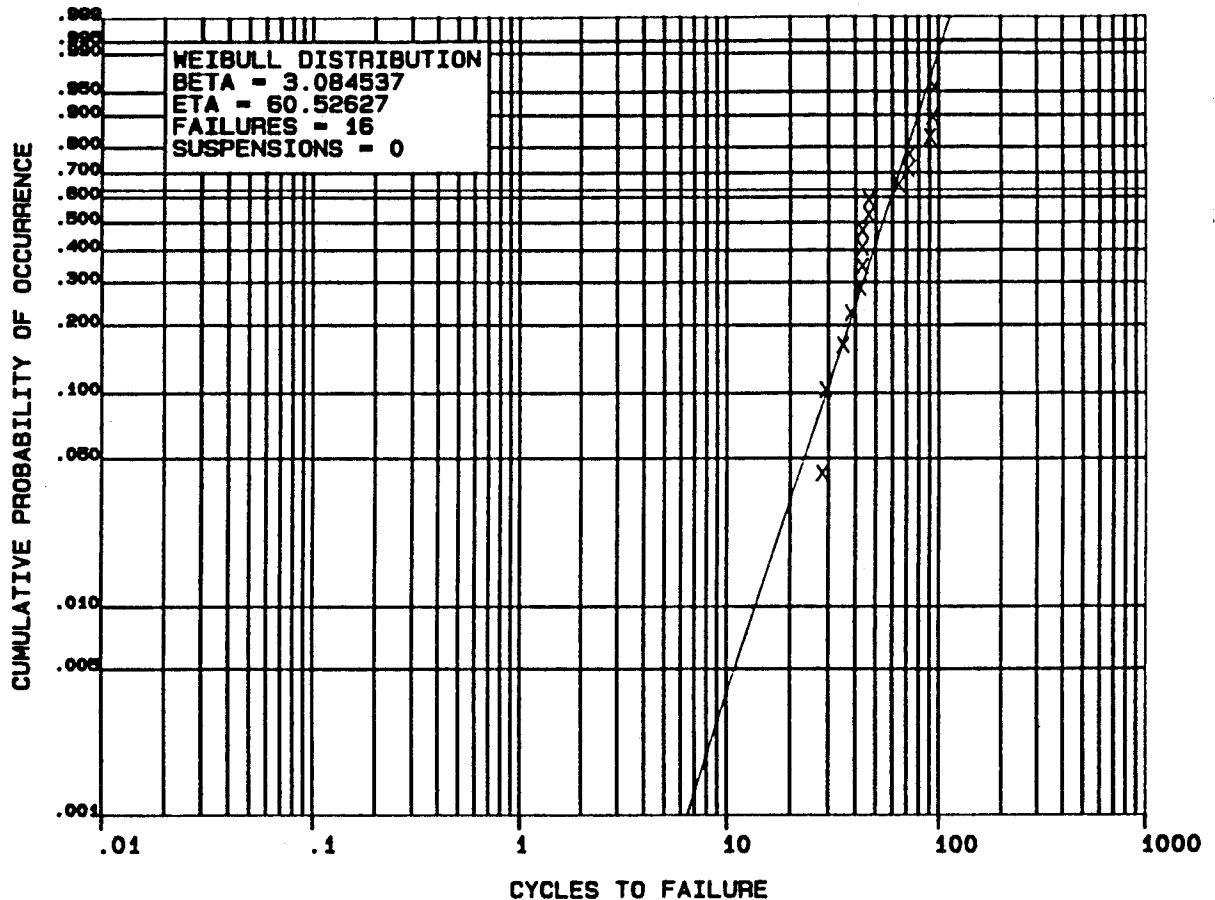
★ THE TEAM FOUND SOME PROBLEMS IN THE HEATER, BUT NONE COULD BE RELATED TO DIAPHRAGM FAILURES

11	BAR	SAE 1112	
10	SOCKET HEAD	A193	
9	SOCKET HEAD	A193	
8	SOCKET HEAD	A193	
7	SOCKET HEAD	A193	
6	SOCKET HEAD	A193	
5	SOCKET HEAD	A193	
4	SOCKET HEAD	A193	
3	SOCKET HEAD	A193	
2	SOCKET HEAD	A193	
1	OUTER COVER	A193	
1	GASKET COMP. RING	A193	
1	GASKET	A193	
1	PRESS RIB SEAL COVER	A193	
1	GASKET	A193	

✓10

3

ANALYSIS

PSN UNIT 3 NO. 1 FWH
DIAPHRAGM FAILURES

THIS WEIBULL SHOWS US THAT WITH DATA PROVIDED FROM 1980 TO 1987 THE AVERAGE FAILURE OCCURED AT 60.5 CYCLES. SO WE CAN SAY THAT AT 92 CYCLES WE ARE 95% CONFIDENT THERE WILL BE A FAILURE. ON 08/30/88 WHEN THE UNIT REACHED 59 CYCLES THE DIAPHRAGM ON #1 HEATER FAILED.

✓ //

//

Date

If cycling is the root cause and it has always failed at the same rate (cycles/diaphragm leak) is this a design problem?

Called manufacturer's design engineer who said "because this was such a bad design problem PSN-3 had the only 2 diaphragm type heaters in the country.

IF WE HAVE THE ONLY ONES IN THE COUNTRY, MAYBE BECAUSE OF IT'S AGE IT SHOULD BE REPLACED.

LET'S CHECK THE CONDITION OF THIS HEATER.

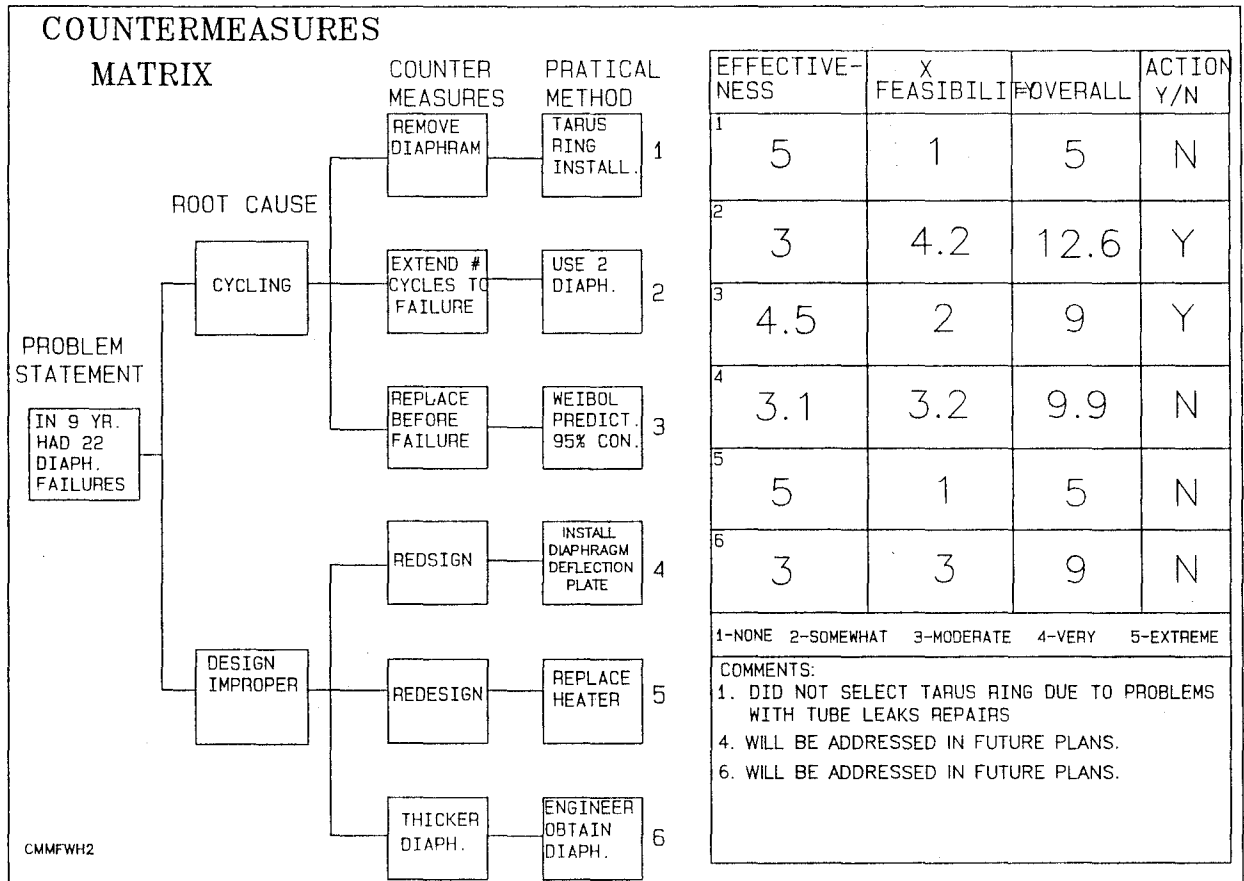
SOUTHWESTERN ENGINEERING PERFORMED EDDY CURRENT TEST ON FWH #1 ON 5/4/87. THE TEST SHOWED THE TUBES WERE IN GOOD CONDITION, AND WOULD NOT AFFECT OPERATION OF THIS HEATER.

Bad design, what can we do?

✓12

4

COUNTERMEASURES



- PROCEDURE WILL BE CHANGED TO INSTALL TWO DIAPHRAGMS OF .049 THICKNESS IN BOTH HIGH PRESSURE HEATERS.
- BY RUNNING TWO DIAPHRAGMS TO FAILURE A CYCLE TO FAILURE RATE CAN BE DETERMINED BY USING A NEW WEIBULL ANALYSIS. THEN THE DIAPHRAGMS CAN BE CHANGED ON A P.M.

How CAN WE DO it?

✓13



COST BENEFIT ANALYSIS H. P. F. W. HEATER DIAPHRAGMS

YEAR	PROJECTED CYCLES/YEAR	REMAIN AS IS REPLACE WHEN FAILS AT AVG. 58 CYCLES	COUNTER MEASURES IMPLEMENTED: TWO DIAPH. EVERY 115 CYCLES	YEARLY SAVINGS
1988	79	\$ 2543	\$ 1967	\$ 576
1989	92	2969	2293	676
1990	131	4382	3345	1037
1991	140	5433	3721	1712
1992	221	8661	6293	2368
1993	274	19550	12248	7302
TOTAL				\$ 13671

* AVERAGE SAVINGS FOR THE NEXT 6 YEARS \$ 2278.50

✓15

USING GEMS REPORTS WITH ACCUMULATED DATA ON INSTALLATION OF 2 DIAPHRAGMS IT IS PROJECTED THAT THE LIFE WILL BE DOUBLED. ALSO, BY USING A WIEBULL ANALYSIS IT CAN BE PROJECTED TO CHANGE DIAPHRAGMS BEFORE FAILURE, UNDER CONTROLLED CONDITIONS, ELIMINATING CURTAILMENT FAILURES.

✓ 14

4

COUNTERMEASURES

COUNTER MEASURES
IMPLEMENTATION
ACTION PLAN

APPROVED BY T.HINES

DATE 7 / 5 / 88

TASK (WHAT)	ASSIGNED TO	DATE ASSIGNED	HOW TO DO	COMPLT. DATE	REMARKS /STATUS
PWO TO OUTAGE FILE TO INSTALL TWO 0.049" DIAPHRAGMS IN FALL 88 OUTAGE	BILL BRENNAN	6/30/88	COMPLETE P.W.O. & COPY TO P-2 FOR FALL 1988 OUTAGE	9/3/88	INSTALLED 2 DIA. WHEN SINGLE FAILED
IMPLEMENT TRACKING ON CYCLES TO FAILURE & DETERMINE WHEN TO REPLACE	BILL BRENNAN	AFTER FALL OUTAGE	G.A.D.S. DATA & WEIBULL CALC. FROM TECH. DEPT.	UPON FAILURE	FIRST SET OF DIAPHRAGMS NEED TO RUN TO FAILURE TO GIVE SUFFICIENT DATA FOR P.M.

✓16

- A. # 1 & 2 F.W. HEATER BOTH EXPERIENCED DIAPHRAGM FAILURES BEFORE THE FALL OUTAGE OF 1988. THE TEAM USED THIS OPPORTUNITY TO INSTALL TWO DIAPHRAGMS IN BOTH F.W. HEATERS.
- B. F.W. HEATERS HAVE NOT FAILED SINCE THE TWO DIAPHRAGMS WERE INSTALLED.

BARRIERS AND AIDS TO IMPLEMENT
COUNTERMEASURES

BARRIERS	AIDS
1. NEED OUTAGE TO INSTALL 2. ADDITIONAL MANPOWER DURING OUTAGE 3. G.E.M.S. NEEDS TO TRACK CYCLES AFTER OVER-HAUL	1. P-2 PLAN FOR FALL OUTAGE 2. TEAM DEVELOP TRACKING PROGRAM

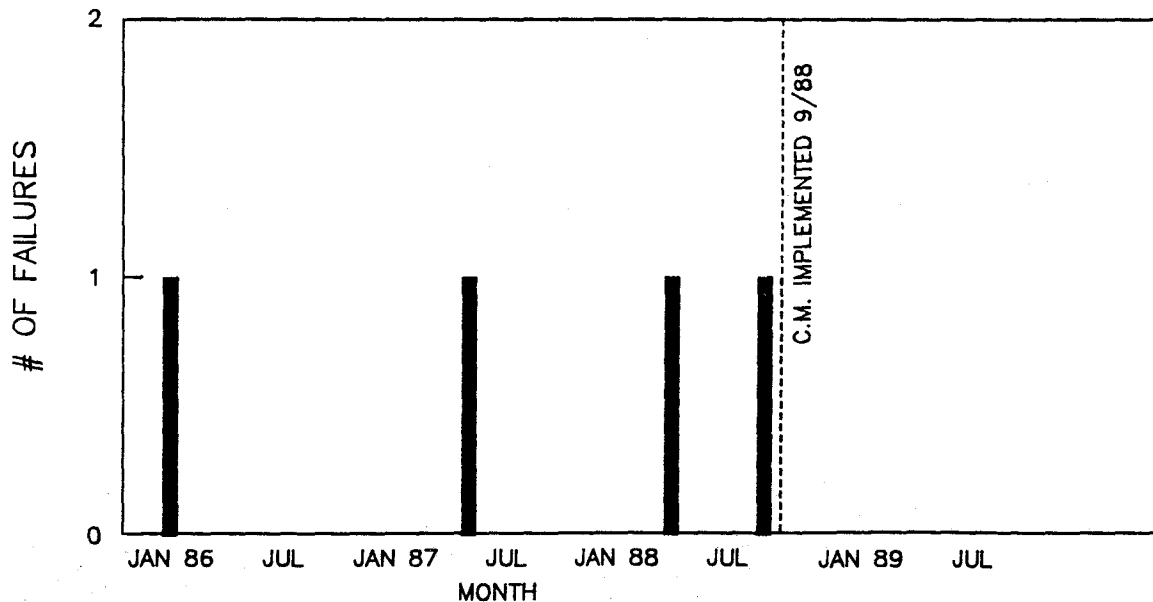
✓17

#1 F.W. HEATER HAS EXPERIENCED 94 CYCLES THIS YEAR, WITH 27 CYCLES SINCE INSTALLTION OF 2 DIAPHRAGMS. THE HEATER IS TO BE CYCLED TO FAILURE, AT THAT TIME THE TEAM WILL DETERMINE THE NUMBER OF CYCLES WHEN DIAPHRAGMS SHOULD BE CHANGED TO AVOID A FORCED OUTAGE.

✓18

✓19

PSN UNIT 3 NO. 1 FEED WATER DIAPHRAGM FAILURES
GEMS DATA 1/1/86 THRU 12/31/88



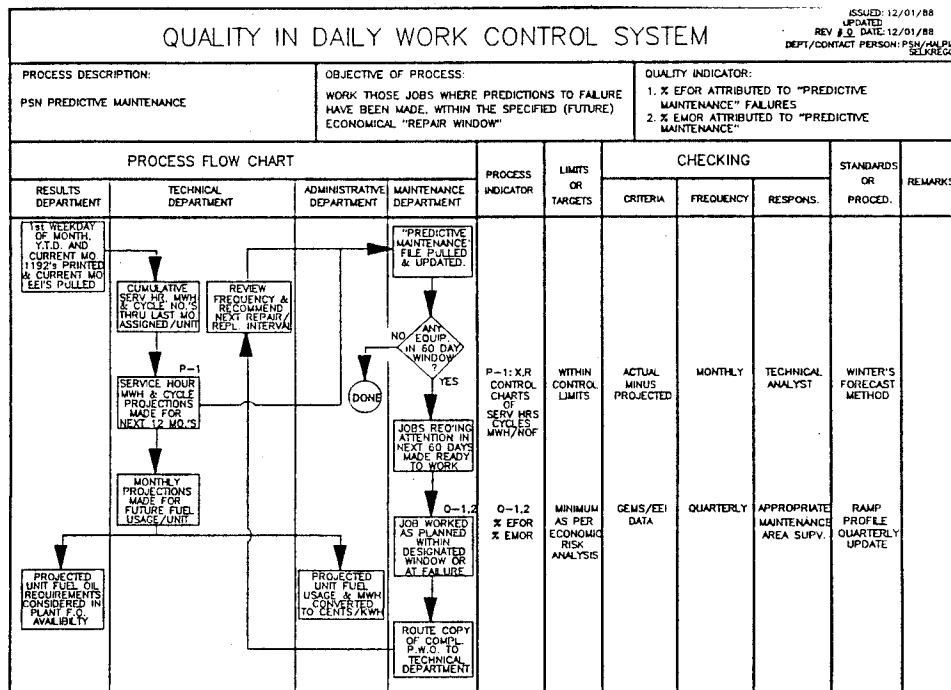
6

STANDARDIZATION

THE TEAM HAS IDENTIFIED SOME CHANGES THAT NEED TO BE MADE TO THE MAINTENANCE PROCEDURE. THE CHANGES ARE: ✓21

- 1.) THE ASSURANCE OF 2 DIAPHRAGMS INSTALLED
 - 2.) NOTING CONDITION OF DIAPHRAGMS AS FOUND AND DOCUMENTING LOCATION OF FAILURE.
 - 3.) INSTALLATION PROCEDURE FOR NEW STYLE TUBE PLUGS. THIS PLUG USES A SWEDGE METHOD TO INSTALL INSTEAD OF WELDING.
- THESE CHANGES HAVE BEEN IMPLEMENTED. ✓22

EVERYTHING HAS BEEN REPLICATED ON #2 F.W. HEATER. NO OTHER REPLICATION POSSIBLE. ✓23



THERE ARE NO REMAINING PROBLEMS ON #1 F.W. HTR. THAT THE TEAM NEEDS TO WORK ON AT THIS TIME.

✓24

THE TEAM WILL ANALYZE TWO COUNTERMEASURES FROM THE COUNTERMEASURES MATRIX.

- 1.) THE USE OF A DIAPHRAGM BACKING PLATE.
- 2.) THE USE OF ONE THICKER DIAPHRAGM. INSTEAD OF USING TWO.

THE TEAM WILL PDCA TO INSURE PROBLEM IS CORRECTED AND FEEDWATER HEATER DIAPHRAGM FAILURE WILL NOT EFFECT UNIT #3 EFOR IN THE FUTURE.

✓25