UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

NOV 1 - 1985

MEMORANDUM FOR: George Knighton, Chief, Licensing Branch No. 3, Division of Licensing

FROM: Olan D. Parr, Chief, Auxiliary Systems Branch, Division of Systems Integration

SUBJECT: REPORT OF AUXILIARY FEEDWATER SYSTEM (AFWS) COMPONENT OUTAGES, SONGS 2/3

References:
1. NUREG/CR-2153, "San Onofre Nuclear Generating Station, Units 2 and 3, Auxiliary Feedwater System Reliability Study Evaluation."
2. Henley, Ernest J. and Kumamoto, Hiromitsu, "Reliability Engineering and Risk Assessment," pp 164-167.

At the Commission meeting on full power authorization for San Onofre Nuclear Generating Station, Unit 3 (SONGS 3) on September 16, 1983, questions were raised regarding the need for adding PORVs for CE plants and the reliability of the auxiliary feedwater system. As a result, a condition was placed in the SONGS 3 full power license requiring the utility to provide information regarding outage times for the auxiliary feedwater system for the first cycle of operation.

The licensee provided the first report relating to these outages on November 9, 1983, covering the period from September 16 through October 15, 1983. Subsequent reports were provided monthly. Each of these reports contain information regarding outages of AFW components in the areas of preventive maintenance, corrective maintenance, surveillance testing and component investigation.

Units 2 and 3 have similar AFW systems. The enclosed sketch (Figure 1) provides an outline of the important features of the basic system. There are three pumps; two driven by motors and one driven by a steam turbine. Each motor driven pump supplies water to one of the two steam generators while the turbine driven pump can supply water to either or both steam generators.
Note that the steam line, steam inlet valve and turbine for the steam driven pump (P140) is not shown on the figure nor are the valves and piping in the suction side of the pumps.

Contact:
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The staff reviewed the overall outages for the first three reports which covered the period from September 16, 1983 through December 15, 1983 and reported the results of that review at a Commission meeting on March 3, 1984. The staff indicated that the outages were of the order of a factor of four greater than those used in the reliability analysis[1] for SONGS 2/3. The reliability analysis utilized the following maintenance outage times - for pumps, 19 hours in a 4 1/2 month operating period of 3285 hours (0.58%); for valves, 7 hours in a 4 1/2 month operating period (0.21%).

We have now reviewed the utility's data covering the period September 16, 1983 - April 15, 1985. These data have been tabulated in seven time periods, the first six periods (1-6) were of three months duration and the last period (7) was of one month duration. The pump outage data for SONGS 2/3 has been tabulated in Table 1 and the valve outage data in Table 2. Table 3 contains the outage time for other components, as indicated. As previously stated, the utility reported the outages separated into four areas, preventative maintenance, corrective maintenance, surveillance testing and component investigation. In our evaluation these four inputs were lumped together, as maintenance outages. In Table 4 the pump and valve outage is provided in a slightly different way by considering the outages for each valve and pump separately for the total time (periods 1-7) in comparison with those in periods 2-6. These outage data are tabulated as percentages of the total operating time during the periods considered. Since the reliability analysis only considers individual component outages as part of a fault tree, we will be better able to make a direct comparison of these data with those outages considered in the reliability analysis, 0.58% for individual pumps, 0.21% for individual valves.

Before considering the data, we must consider the possibility that reduction in outages may be attributed either to improved maintenance or to the bathtub curve.[2]. The bathtub curve refers to the failure rate of critical hardware, throughout an operational lifetime. A relatively high early failure rate, known as the burn-in period, is found, which may be caused by improper assembly, improper installation or defective component parts. This is followed by a fairly constant "prime of life" period where failures occur randomly. Finally, there is the wearout phase where components are failing at greater and greater rates as the useful component life is attained and exceeded. It is desirable to put components into service after the initial burn-in period and to replace them before the wearout period is reached.

In reviewing the data for the AFW pumps (Table 1), outages can be seen for the first reporting period (9/16-12/15/83) which exceed those found for any period thereafter (51.9 hours for Unit 2 or 1.2% of the operating time and 69.8 hours for Unit 3 or 1.1% of the operating time). Thereafter, outages for the AFW pumps decrease in both absolute values and in percentage of operating time. The overall outages for the AFW pumps 0.52% for Unit 2, 0.41% for Unit 3 (averaged over the reporting period) were found to be less than the value (0.58%) used in the reliability analysis although individual pump outages, e.g., 51.9 hours for pump 140 (3.6%) in Unit 2 during the first period markedly exceed that used in the reliability analysis (0.58%). This would seem reasonable given that the first few months of operation (the burn-in period) normally uncover the early failures.

For the AFW valves (Table 2) similar circumstances can be seen to those encountered for the pumps with one significant exception - for Unit 2 there were no valve outages in the first period. With that exception, the first valve outages noted (46.1 hours or 0.34% of the operating time for Unit 2, 134 hours, 0.55% for Unit 3) were the greatest, both in absolute value and in percentage of operating time. While these values exceeded the percentage value (0.21%) used in the reliability analysis, the overall values, 0.11% for Unit 2, 0.15% for Unit 3 were less than those used in the reliability analysis.

Outages for components other than pumps and valves (Table 3) occurred only in the first period (9/16-12/15/83). It would appear from this table that the corrective maintenance or repair in these cases, once made, was effective, so much so that further maintenance was not required during the period involved in this report. Therefore, we can conclude that the need for maintenance for the components involved in the outages reported in Table 3 improved markedly since no maintenance was required for these components thereafter. This would tend to strengthen the bathtub curve hypothesis but would be quite insufficient to prove the hypothesis.

However, a truer comparison may be made by utilizing the data in Table 4. While the data in Tables 1-3 show us the direction things are going, the averages may not be used as a valid comparison with the data used in the reliability analysis since the analysis utilizes only individual component outages in development of a fault tree. Utilization of the Table 4 data shows the following components to have maintenance outages in excess of those used in the analysis.

Unit 2
Periods 1-7

Pump 140(0.97%)
Valve 4716 (0.65%)

Periods 2-7

Valve 4716 (0.80%)

Unit 3
Periods 1-7

Valve 4714 (0.39%)
Valve MU 681 (0.33%)
Suction Vent Valve (0.59%)

Periods 2-7

None

Considering the data in Table 4 and assuming that Period 1 either represents the early burn-in portion of the bathtub curve or is not representative of the data as a whole, only the outage for valve 4716 (0.80%) is in excess of the maintenance outage value used in the reliability analysis. We conclude, therefore, that the outages for maintenance have lessened with time, and that, based upon the outages shown for periods 2-7 and considering the values for maintenance outages shown for all components in those periods, the actual component reliability is consistent with that used in the reliability analysis for SONGS 2/3.

Olan D. Parr, Chief
Auxiliary Systems Branch
Division of Systems Integration

Enclosures:
As Stated

cc w/enclosure:
R. Bernero
L. Rubenstein
J. Wilson
N. Wagner
H. Rood

SAN ONOFRE NUCLEAR GENERATING STATION, UNITS 2 & 3
AUXILIARY FEEDWATER SYSTEM

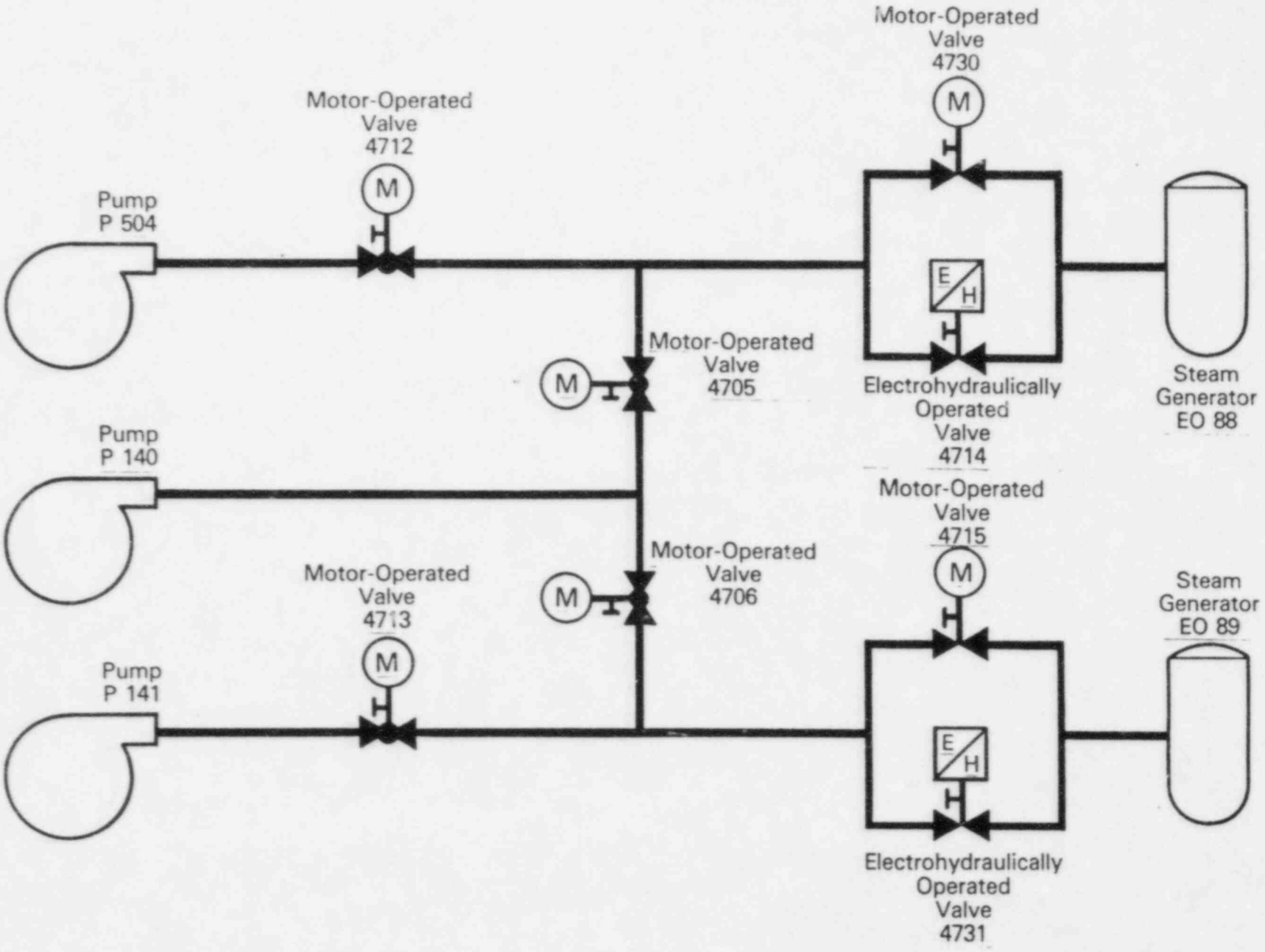

Figure 1

TABLE 1
SAN ONOFRE
AFW PUMP MAINTENANCE OUTAGES

UNIT 2

Period	1	2	3	4	5	6	7
From	9/16/83	12/16/83	3/16/84	6/16/84	9/16/84	12/16/84	3/16/85
To	12/15/83	3/15/84	6/15/84	9/15/84	12/15/84	3/15/85	4/15/85
Outages hours							
Pump 140	51.9	11.1	0	4.9	0	0	6.3
Pump 141	0	0	17.0	0	0	0	0
Pump 504	0	0	0	29.0	0	0	0
Total	51.9	11.1	17.0	33.9	0	0	6.3
Hours in Modes 1,2 and 3	1448	1501	2201	1451	868	0	217
% Outage for all pumps	1.2	0.2	0.3	0.8	0	--	1.0

Overall Outage % - 0.52

UNIT 3

Period	1	2	3	4	5	6	7
Outages hours							
Pump 140	17.7	0	9.8	4.0	0	0	0
Pump 141	16.9	0	10.5	6.0	0	0	0
Pump 504	35.2	0	0	0	18.0	0	0
Total	69.8	0	20.3	10.0	18.0	0	0
Hours in Modes 1, 2 and 3	2208	817	2121	1349	1394	1103	652
% Outage for all pumps	1.1	0	0.3	0.2	0.4	0	0

Overall Outage % - 0.41

Pump outages used in reliability analysis
19 hours in 4 1/2 months (3285 hours of operation) = 0.58%

TABLE 2
SAN ONOFRE
AFW SYSTEM VALVE OUTAGES, UNIT 2

Period	1	2	3	4	5	6	7
From	9/16/83	12/16/83	3/16/84	6/16/84	9/16/84	12/16/84	3/16/85
To	12/15/83	3/15/84	6/15/84	9/15/84	12/15/84	3/15/85	4/15/85
Valve Outages, Hours							
V4705	0	0	5.8	0	0	0	0
V4706	0	0	0	0	0	0	0
V4712	0	0	0	0	0	0	0
V4713	0	0	0	0	0	0	0
V4714	0	0	7.8	0	0	0	0
V4715	0	0	0	0	0	0	0
V4716	0	42.9	0	7.3	0	0	0
V4730	0	3.2	0	0	0	0	0
V4731	0	0	0	9.5	0	0	0
Total valve outages, hours	0	46.1	13.6	16.8	0	0	0
Hours in Modes 1, 2 and 3	1448	1501	2201	1451	868	0	217
% Outage, all valves	0	0.34	0.07	0.12	0	-	0

Overall Outages, % = 0.11

TABLE 2 CONTINUED
AFW SYSTEM VALVE OUTAGES, UNIT 3

Period	1	2	3	4	5	6	7
Valve Outages, Hours							
V4705	0	0	0	0	0	0	0
V4706	12.3	0	0	0	0	0	0
V4712	2.6	0	0	0	0	0	0
V4713	0	0	0	0	0	0	0
V4714	34.6	0	0	3.0	0	0	0
V4715	0	0	0	0	0	0	0
V4716	12.6	0	0	0	0	0	0
V4730	0	0	0	0	0	0	0
V4731	0	0	0	5.5	0	0	0
MU 681	15.1	0	17.0	0	0	0	0
SVV(1)	56.8	0	0	0	0	0	0
Total valve outages, hours	134.0	0	17.0	8.5	0	0	0
Hours in Modes 1, 2 and 3	2208	817	2121	1349	1394	1103	652
%Outage; all valves	0.55	0	0.07	0.06	0	0	0

Overall outage, % = 0.15

Valve outages used in SONGS 2/3 reliability analysis = 7 hours in 4 1/2 months (3285 hours of operation) or 0.21%

(1) Suction vent valve, pump 140 train

TABLE 3
OTHER COMPONENT OUTAGES

UNIT 2

Period	1	2	3	4	5	6	7
From	9/16/83	12/16/83	3/16/84	6/16/84	9/16/84	12/16/84	3/16/85
To	12/15/83	3/15/84	6/15/84	9/15/84	12/15/84	3/15/85	4/15/85
Outages, in hours:	12.8(1)						
	43.2(2)						
	8.5(3)						
	2.5(4)						

(1) To recalibrate turbine speed indicator for pump 140
(2) To repair leaks in steam trap system for pump 140
(3) Time surveillance test of breaker, pump 141 train
(4) Timer surveillance test on 4KV train B bus, pump 504 train

UNIT 3

Period	1	2	3	4	5	6	7
From	9/16/83	12/16/83	3/16/84	6/16/84	9/16/84	12/16/84	3/16/85
To	12/15/83	3/15/84	6/15/84	9/15/84	12/15/84	3/15/85	4/15/85
Outages, in hours:	8.6(5)						
	13.3(6)						

(5) To set timing on breaker for pump 141
(6) To calibrate tachometer for pump 140

TABLE 4
PUMP AND VALVE OUTAGES
(AS PERCENTAGES OF OPERATIONAL TIME IN MODES 1-3)

Unit 2

	Periods 1-7	Periods 2-7
Pump 140	0.97	0.36
141	0.22	0.27
504	0.38	0.46

Unit 3

Pump 140	0.32	0.19
141	0.34	0.22
504	0.55	0.24

VALVE OUTAGES

	Unit 2			Unit 3	
	Periods 1-7	Periods 2-7		Periods 1-7	Periods 2-7
V4705	0.07	0.09	V4706	0.12	0
V4714	0.10	0.12	V4712	0.03	0
V4716	0.65	0.80	V4714	0.39	0.04
V4730	0.04	0.05	V4716	0.13	0
V4731	0.12	0.15	V4731	0.06	0.07
			MU 681	0.33	0.22
			SVV	0.59	0

Pump Outages - reliability analysis = 0.58%
Valve Outages - reliability analysis = 0.21%

These results indicate that the maintenance outage percentages assumed in the San Onofre 2 and 3 AFW reliability analysis are consistent with the actual maintenance outage percentages observed over the first cycle of operation.

Victor Stello, Jr.
Acting Executive Director
for Operations

Enclosure:
As stated

cc: SECY
OPE
OGC

Distribution:
Docket File 50-361/362
NRC PDR
Local PDR
EDO Reading
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F. Miraglia
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*Previously concurred on by:

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1/15/86	1/16/86	1/30/86	2/6/86	2/10/86	1/ /86

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555

OFFICE OF THE SECRETARY

IN RESPONSE, PLEASE REFER TO: M830916A

September 16, 1983

Action: Denton, NRR
Cys: Dircks
Roe
Rehm
Stello
DeYoung
GCunningham
Martin, RV

MEMORANDUM FOR: William J. Dircks, Executive Director for Operations

FROM: Samuel J. Chilk, Secretary

SUBJECT: STAFF REQUIREMENTS - DISCUSSION/POSSIBLE VOTE ON FULL POWER OPERATING LICENSE FOR SAN ONOFRE-3, 10:00 A.M., FRIDAY, SEPTEMBER 16, 1983, COMMISSIONERS' CONFERENCE ROOM, D.C. OFFICE (OPEN PORTION)

The Commission met to be briefed by staff on the readiness of San Onofre Unit 3 to exceed 5 percent power. The Commission also heard from David Fogarty, Executive Vice President and Ken Baskin, Vice President, Southern California Edison Company. (A portion of this meeting was held in closed session.)

The Commission:

1. by a vote of 5-0 agreed to accept the backup EOF as proposed by Southern California Edison; letter to licensee 9-16-83

2. by a vote of 5-0 authorized staff to allow Unit 3 to exceed 5 percent when staff felt it appropriate; (NRR) license issued 9-16-83

3. by a vote of 5-0 specified a license condition requiring Southern California Edison to report to the NRC all component failures relating to the auxiliary feedwater system reliability. The scope of reporting would also include maintenance and operator errors which are significant to evaluating auxiliary feedwater reliability. The staff will evaluate the data submitted and report back to the Commission in one year.
(NRR) (SECY Suspense: 10/1/84)

The staff noted that a report on the need for PORVs in CE reactors is due the Commission December 15, 1983. (NRR) 830132

cc: Chairman Palladino
Commissioner Gilinsky
Commissioner Roberts
Commissioner Asselstine
Commissioner Bernthal
Commission Staff Offices
PDR - Advance
DCS - 016 Phillips