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SUBJECT: Discusses alternatives to utilizing cast iron bearings in auxiliary feedwater pump motors,per 820610 request for NRC concurrence that high energy line break need hot be postulated during 820610-0730.

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July 12, 1982

Director, Office of Nuclear Reactor Regulation
Attention: Mr. Frank Miraglia, Branch Chief
Licensing Branch No. 3
U. S. Nuclear Regulatory Commission
Washington, D.C. 20555

Gentlemen:

Subject: Docket No. 50-361 and 50-362
San Onofre Nuclear Generating Station
Units 2&3

SCE's letter of June 10, 1982 requested NRC staff concurrence that it is not necessary to postulate a high energy line break in the auxiliary feedwater pump room during the period between June 10, 1982 and July 30, 1982. This request was made to provide time to complete the evaluation of the recent auxiliary feedwater pump motor bearing failure and to determine corrective actions.

A follow-up meeting between SCE and the NRC staff was held on June 24, 1982 to provide a status report on the bearing failure and discuss progress on evaluating alternatives to meet environmental requirements. Based on cost estimates and implementation schedules for the various alternatives discussed below, SCE has chosen augmented in-service inspections on the steam piping in the auxiliary feedwater pump room in conjunction with installation of babbitt bearings consistent with the original design as the best long term solution to this problem. SCE requests NRC staff concurrence with this alternative in lieu of postulating a high energy line break in the auxiliary feedwater pump room. The initial augmented in-service inspection can be accomplished at the first refueling outage and reinspections will be conducted every 10 years thereafter. Before discussing the bearing failure and the basis for this request a brief background on the auxiliary feedwater pump motors is helpful.

San Onofre 2 was originally designed to operate with one steam driven and one motor driven auxiliary feedwater pump. In 1979, in compliance with Branch Technical Position 10.4-9, SCE added one additional motor driven pump to the design to increase the reliability of the auxiliary feedwater system. The motor driven pump was placed in the same room as the steam driven pump since all the supporting electrical and cooling systems were already in place. Based on consideration of space availability and the desire to minimize the impact of this change on system complexity, it was impracticable to place either the new motor driven pump or both motor driven pumps in a room separate from the turbine driven pump.

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The auxiliary feedwater pump motors were manufactured by Siemen-Allis and were originally equipped with babbitt bearings. The pumps are located in the condensate storage tank building. In 1979 a postulated rupture of the turbine driven pump steam supply line (described in Section 3.6A.3.5.2 of the FSAR) indicated that a maximum temperature of 302°F would be reached in the room housing the pumps. Based on this room temperature, analysis indicates that the bearings would experience a temperature of 363°F. The babbit bearings have a maximum operating temperature of 300°F. Therefore, replacement bearings made from cast iron were selected to meet the pipe break criteria. A new lubricating oil compatible with cast iron bearings was also chosen. The revised motor configuration passed the 48 hour endurance test as required in Section 2.C(19)1 of the Operating License.

Recently, a Unit 2 auxiliary feedwater pump motor bearing failure destroyed the motor shaft. It is postulated that the failure was due to misalignment resulting from reassembly following a bearing inspection. This left clearances too small to accept rotor shaft vibration and resulted in contact of non-lubricated seal lands with the shaft. Rapid heat buildup melted the surface of the cast iron and resulted in material transfer and further reduction in clearance. Failure progressed up the shaft until the motor seized and the molten material fused to the shaft.

SCE requested that the motor manufacturer and the bearing consultant determine what changes were necessary to improve motor reliability. Changes to the seal lands and oil distribution slot design were recommended. This would improve bearing vibrational damping and lubrication. However, to improve alignment a change in the motor bearing housing was required. The motor manufacturer has determined the necessary changes to the bearing housing would be too significant for motor qualification by history. Sensitivity of cast iron bearings to misalignment would also make qualification by type testing questionable. Without the housing modifications, high confidence in cast iron bearings is not possible. Since further efforts on using cast iron bearings could very likely lead to reduced system reliability and questionable qualification other alternatives using babbitt bearings were pursued.

Babbitt bearings are a time proven standard design. Misalignment is accommodated by reshaping of the babbit material. The bearings can be field adjusted and are easy to repair. Babbitt bearings typically do not destroy the shaft when a failure occurs. Therefore, SCE believes it prudent to operate the pumps in their original design configuration to ensure high system reliability.

SCE has considered the following alternatives to utilization of cast iron bearings in the existing motors.

1. Install Enclosures Around the Turbine Driven Pump - This alternative would eliminate the potential steam environment for the motor driven pumps. Construction of a wall to withstand the postulated pipe break would require movement of existing equipment and severely compromise the space required to maintain the pumps. Restricted maintainability and HVAC redesign considerations eliminated this scheme from further consideration.

2. Install Control Valves in Steam Piping Outside Pump Room - This alternative was considered as a means to exempt the steam line within the pump room from high energy line break criteria. SCE is considering various alternatives to meter the auxiliary feedwater flow. One alternative under consideration is to automatically control the auxiliary feedwater system. However, the use of the turbine driven pump during hot standby and shutdown as a part of the automatic auxiliary feedwater control system would eliminate the intended exemption. Further, this option adds active components to the existing system and thus reduces reliability. Therefore, this alternative was eliminated.

3. Forced Air Cooling of Motors - Two approaches were evaluated to provide cool air to the motors during the 300°F steam line break environment. The amount of cooling water and the cooler size required to cool sufficient air from 300°F to 150°F at the motor air fan inlet is not technically feasible for this size room. A fan size needed to overcome 5 psig room pressure during a steam line break makes it technically impractical to duct air from a cooler on the roof also. Therefore, this alternative was eliminated.

4. Install Guard Piping Around Steam Line - This alternative increased the turbine nozzle loading due to attachment of the guard piping at the turbine. Problems with turbine reliability and seismic analysis eliminated this alternative from consideration.

5. Relocate Turbine Driven Pump Outside Room - Removing the steam line from the pump room eliminates the potential steam environment for the motor driven pumps. This alternative requires construction of a missile proof building to house the turbine, pump, and chemical treatment equipment. The cost for Unit 2 alone is estimated at $2.4 million with a lead time for installation of 18 months. A 30 week outage is required to implement this alternative. A detailed cost breakdown is shown in Attachment 1.

6. Install Motor Bearing Forced Lube Oil System - Motor bearings would be maintained at 150°F during a steam line break. A skid containing the heat exchanger, oil pump, filter, and controls would be located in the chemical treatment area adjacent to the pump room. The heat exchanger would utilize closed cooling water as the cooling medium. One skid mounted

cooling medium. One skid mounted system enclosed in missile shield grating would be provided per motor. The cost for Unit 2 is estimated at \$1.25 million with a lead time for implementation of 15 months. A 3 week outage is required to install the system. A detailed cost breakdown is shown in Attachment 2.

7. Purchase New Environmentally Qualified Motors - SCE is considering three vendors for replacement motors. The lead time for qualifying and installing a new motor is at least 24 months. The cost for Unit 2 is estimated at \$420,000 and requires a 7 week outage to install the motors. Although this option may be feasible, the long lead times and uncertainty of qualifying a new motor makes this option less desirable than SCE's proposed solution. This alternative is similar to the one taken previously which led to the present bearing failure. A detailed cost breakdown is shown in Attachment 3.

8. Perform Augmented In-Service Inspections - This option could be implemented without adding equipment. The initial inspection on the steam line can be performed during the first refueling outage and reinspections will be conducted every 10 years thereafter. During the period prior to first refueling entry, the steam line inside the pump room will be visually inspected on a daily basis to detect any leaks. Upon leak detection, the steam piping would be isolated. This procedure, based on the leak-before-break concept, reduces the probability that the auxiliary feedwater system is not available.

The options above do not include outage costs even though those options involving considerable construction would be on the critical path during the outage. Based on the options considered, SCE has chosen augmented in-service inspection as the best long term solution to the bearing failure problem.

Augmented in-service inspection is an acceptable method for protecting against postulated piping failures for steam lines. As shown in Attachment 4, the probability of being unable to provide adequate feedwater flow for plant shutdown as a result of a break in the steam supply piping to the steam-driven auxiliary feedwater pump is $< 3.6 \times 10^{-7}$ per year. It is readily apparent that reliability of the auxiliary feedwater system will not be compromised by choosing this alternative.

The basis for interim operation until augmented in-service inspection can be accomplished is as follows:

1. There is a low probability of a pipe break in the 40 feet of high energy line involved.

2. The plant can be shutdown without the auxiliary feedwater pumps by using the main feedwater and condensate pumps.

3. The limited time involved decreases the probability of a significant event occurring.

4. The motors with babbitt bearings have passed the 48 hour endurance test.

5. Stress ratios in the steam line are well below limits.

6. The auxiliary feedwater pump turbine steam line will be visually inspected on a daily basis to detect leaks.

The items above all reduce the probability that the auxiliary feedwater system is not available. Combining the items above, the overall probability of a high energy line break in the steam supply line is extremely small.

If you have any questions or comments, please contact me.

Very truly yours,

M. O. Medford for KPB

cc: Mr. R. H. Engleken, Director, Region V
Office of Inspection and Enforcement

ATTACHMENT 1

Alternative 5

RELOCATE TURBINE/PUMP - CONCEPTUAL COST ESTIMATE

	Material	Labor	Subcontracts	Total
Process Piping	374,000	1,094,000	23,000	1,491,000
Mechanical Equipment	10,000	5,000	28,000	43,000
Electrical/ Instrumentation	69,000	327,000	5,000	401,000
Civil/ Structural	179,000	281,000	-	460,000
Total	632,000	1,707,000	56,000	2,395,000

ATTACHMENT 2

Alternative 6

FORCED LUBE OIL SYSTEM - CONCEPTUAL COST ESTIMATE

	Material	Labor	Subcontracts	Total
Process Piping	136,000	552,000	10,000	698,000
Mechanical Equipment	300,000	10,000	-	310,000
Electrical/ Instrumentation	36,000	164,000	-	200,000
Civil/ Structural	16,000	26,000	-	42,000
Total	488,000	752,000	10,000	1,250,000

ATTACHMENT 3

Alternative 7

NEW MOTORS - CONCEPTUAL COST ESTIMATE

	Material	Labor	Subcontracts	Total
Process Piping	-	-	-	-
Mechanical Equipment	354,000	66,000	-	420,000
Electrical/ Instrumentation	-	-	-	-
Civil/ Structural	-	-	-	-
Total	354,000	66,000	-	420,000

ATTACHMENT 4

PROBABILITY OF PIPE BREAK IN

AUXILIARY FEEDWATER PUMP ROOM

TYPE OF FAILURE	FAILURE PROBABILITY (FAILURES PER FOOT YEAR)	FAILURE PROBABILITY IN AFW PUMP ROOM (FAILURES PER YEAR)
ALL LEVELS OF FAILURE	1×10^{-5} *	4×10^{-4}
CATASTROPHIC OR NEAR CATASTROPHIC FAILURE	9×10^{-7} *	3.6×10^{-5}

Probability of the inability to provide adequate feedwater is the joint probability of a catastrophic failure in AFW pump room and the probability of loss of offsite power = (Probability of a catastrophic failure in the AFW pump room.) x (Loss of offsite power probability) = $(3.6 \times 10^{-5}) \times (< 1 \times 10^{-2})$** = Less than 3.6×10^{-7}.

*References:

1. Draft paper by Hall, R.E., et.al., "Large Bore Pipe Rupture Probabilities as applied to a steam line break," Brookhaven Nat.Lab., Upton, N.Y. 11973.
2. Reactor Safety Study, "An Assessment of Accidental Risk in U.S. Commercial Nuclear Power Plants," U.S. NRC, WASH-1400, NUREG-75/014(Oct.1975).
3. Bush, S.H., "Reliability of Piping in Light Water Reactors," IAEA-SM-218/12,(Oct.1977).

** San Onofre Nuclear Generating Station Units 2 and 3 FSAR Section 8.2.2.3