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SUBJECT: LER 89-008-01:on 890630,plant shutdown required by Tech Spec due to low pressure SIP mechanical seal failure.

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Southern California Edison Company

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H. E. MORGAN
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November 27, 1989

U. S. Nuclear Regulatory Commission
Document Control Desk
Washington, D.C. 20555

Subject: Docket No. 50-362
Revised Report
Licensee Event Report No. 89-008, Revision 1
San Onofre Nuclear Generating Station, Unit 3

Reference: Letter, H. E. Morgan (SCE) to USNRC Document Control Desk, dated July 31, 1989.

This submittal provides additional information concerning the safety evaluation, cause and corrective action for the referenced Licensee Event Report (LER) which addressed an occurrence involving the completion of a plant shutdown required by Technical Specifications. Neither the health and safety of plant personnel or the public were affected by this occurrence.

If you require any additional information, please so advise.

Sincerely,

HEMorg

Enclosure: LER No. 89-008, Revision 1

cc: C. W. Caldwell (USNRC Senior Resident Inspector, Units 1, 2 and 3)
J. B. Martin (Regional Administrator, USNRC Region V)
Institute of Nuclear Power Operations (INPO)

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LICENSEE EVENT REPORT (LER)

Facility Name (1)	Docket Number (2)	Page (3)
SAN ONOFRE NUCLEAR GENERATING STATION, UNIT 3	0 5 0 0 0 3 6 2	1 of 0 9

Title (4)

PLANT SHUTDOWN REQUIRED BY TECHNICAL SPECIFICATIONS DUE TO LOW PRESSURE SAFETY INJECTION PUMP MECHANICAL SEAL FAILURE

EVENT DATE (5)			LER NUMBER (6)			REPORT DATE (7)			OTHER FACILITIES INVOLVED (8)	
Month	Day	Year	Year	/// Sequential Number	/// Revision Number	Month	Day	Year	Facility Names	Docket Number(s)
				---	---				NONE	0 5 0 0 0
0 6	3 0	8 9	8 9	0 0 8	0 1	1 1	2 7	8 9		0 5 0 0 0

OPERATING MODE (9)	1	THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10CFR (Check one or more of the following) (11)					
POWER LEVEL (10)	0 7 5	___ 20.402(b)	___ 20.405(c)	___ 50.73(a)(2)(iv)	___ 73.71(b)		
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//////////////////////		___ 20.405(a)(1)(ii)	___ 50.36(c)(2)	___ 50.73(a)(2)(vii)	___ Other (Specify in Abstract below and in text)		
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//////////////////////		___ 20.405(a)(1)(iv)	___ 50.73(a)(2)(ii)	___ 50.73(a)(2)(viii)(B)			
//////////////////////		___ 20.405(a)(1)(v)	___ 50.73(a)(2)(iii)	___ 50.73(a)(2)(x)			

LICENSEE CONTACT FOR THIS LER (12)

Name	TELEPHONE NUMBER AREA CODE
H. E. Morgan, Station Manager	7 1 4 3 6 8 - 6 2 4 1

COMPLETE ONE LINE FOR EACH COMPONENT FAILURE DESCRIBED IN THIS REPORT (13)

CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO NPRDS	///////	CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO NPRDS	//////
X	B P	S E A L	X 9 9 9	NO	///////						//////
					///////						//////

SUPPLEMENTAL REPORT EXPECTED (14)		Expected Submission Date (15)	Month	Day	Year
XX Yes (If yes, complete EXPECTED SUBMISSION DATE)	___ NO		0 2	1 5	9 0

ABSTRACT (Limit to 1400 spaces, i.e., approximately fifteen single-space typewritten lines) (16)

At 0806 on 6/27/89, with Unit 3 at 75% power, Low Pressure Safety Injection (LPSI) pump 3P015 was removed from service for Preventive Maintenance (PM). At 0855 on 6/29/89, upon completion of the PM, an Inservice Test (IST) was conducted on 3P015. Excessive mechanical seal leakage was observed necessitating seal replacement. Since seal replacement would require more time than remained in the Technical Specification 3.5.2, Action Statement "a", at 0630 on 6/30/89, unit shutdown was initiated. In accordance with procedures, an Unusual Event (UE) was declared. At 0745 on 6/30/89, the UE was terminated. At 1134, the unit entered Mode 3 and at 1830, entered Mode 4. The mechanical seal was replaced and the pump was returned to service on 7/8/89.

Investigation has determined that the seal failure was caused by oil in contact with the seal o-ring. The source of the oil is unknown, however, it is believed to be from either an overfilling of the lower motor bearing oil reservoir or leakage from the threaded connection between the lower bearing oil gauge fill tube and the lower bearing cartridge.

To prevent reoccurrence the following actions have been or will be taken: 1) an oil deflector has been installed on the LPSI pump which will prevent oil from entering the mechanical seal if leakage from or overfill of the lower motor bearing occurs; 2) similar oil deflectors are being installed on appropriate safety related pumps; 3) this event has been reviewed with appropriate personnel; and 4) procedures and maintenance orders by which oil is added to the LPSI and similar pumps have been modified to provide appropriate precautions to preclude overfilling oil reservoirs.

During a review of this event, discrepancies between the Updated Final Safety Analysis Report (UFSAR) and the configuration of the Unit 3 LPSI pump seal leak-off lines was identified. These seal leak-off lines will be modified to conform to the UFSAR description.

Plant: San Onofre Nuclear Generating Station
Unit: Three
Reactor Vendor: Combustion Engineering
Event Date: 06-30-89
Time: 0630

A. CONDITIONS AT TIME OF THE EVENT:

Mode: 1, 75% Power Operation

B. BACKGROUND INFORMATION:

San Onofre Units 2 and 3 are each designed with two Low Pressure Safety Injection (LPSI) pumps [BP,P] which are normally aligned for the injection mode of the Safety Injection System [BP, BQ]. The main function of the pumps is to inject large quantities of borated water from the Refueling Water Storage Tank (RWST) [TK] (which contains essentially non-radioactive water) into the Reactor Coolant System (RCS) [AB] during a Loss Of Coolant Accident (LOCA). When the RWST is almost empty, a Recirculation Actuation Signal (RAS) is initiated. The RAS is designed to automatically change the mode of operation of the Safety Injection System and the Containment Spray System (CS) [BE]. The RAS shifts the systems' pump suctions from the RWST to the containment sump, stops the LPSI pumps and isolates the minimum flow paths.

The LPSI pumps are equipped with mechanical shaft seals [SEAL] and a leak-off line to collect seal leakage. LPSI pump seals are cooled by water from the pump discharge after it is cooled and cleaned.

Technical Specification (TS) Section 3.5.2, "ECCS [Emergency Core Cooling System] SUBSYSTEMS - Tavg GREATER THAN OR EQUAL TO 350°F," requires both LPSI pumps to be OPERABLE in Modes 1 - 3 (with pressurizer pressure greater than or equal to 400 psia). With one LPSI pump inoperable, the pump must be restored to OPERABLE status within 72 hours or the unit must be placed in at least HOT STANDBY within the next 6 hours and in HOT SHUTDOWN within the following 6 hours.

C. DESCRIPTION OF THE EVENT:

1. Event:

At 0806 on 6/27/89, Unit 3 LPSI pump 3P015 was removed from service for the performance of Preventive Maintenance (PM). At 0855 on 6/29/89, upon the completion of the PM, an Inservice Test (IST) was conducted. During the test, excessive mechanical seal leakage was observed with the pump running. However, when the pump was secured (not running), the seal did not leak. A Non-Conformance Report (NCR) was written documenting the observed condition and establishing 500 cc/min as the maximum leakage allowed for operability of the pump. This value was based on the San Onofre Units 2 and 3 Updated Final Safety Analysis Report (UFSAR) description for expected leakage from a gross seal failure for a LPSI pump.

Following verification of the proper torque of the seal gland bolts, seal leakage was determined to be about 1400 cc/min, thereby necessitating replacement of the mechanical seal. (SCE believes that verification of the torque did not affect the seal leakage rate). Since such a seal change would require more time than that which remained in the TS 72-hour action statement, unit shutdown was initiated in accordance with TS 3.5.2, Action Statement "a", at 0630 on 6/30/89. Concurrently, in accordance with procedures, an Unusual Event (UE) was declared.

At 0745 on 6/30/89, the UE was terminated in accordance with procedures.

At 1134 on 6/30/89, the unit entered Mode 3, followed by Mode 4 at 1830.

2. Inoperable Structures, Systems or Components that Contributed to the Event:

None.

3. Sequence of Events:

DATE	TIME	ACTION
6/27/89	0806	LPSI 3P015 removed from service for PM.
6/29/89	0855	Seal leakage observed during pump IST.
6/30/89	0100 approx.	Proper torque of the seal gland bolts verified. Seal leakage quantified as approximately 1400 cc/min.
6/30/89	0630	Unit shutdown initiated in accordance with TS 3.5.2, Action Statement "a". UE declared.
6/30/89	0745	UE terminated in accordance with procedures.
6/30/89	1134	Unit entered Mode 3.
6/30/89	1830	Unit entered Mode 4.

4. Method of Discovery:

On 6/29/89, during an IST of LPSI pump 3P015, excessive seal leakage was observed.

5. Personnel Actions and Analysis of Actions:

Unit shutdown was properly initiated and completed in accordance with TS requirements. An UE was appropriately declared.

6. Safety System Responses:

Not applicable.

D. CAUSE OF THE EVENT:

1. Immediate Cause:

Investigation has determined that the excessive seal leakage was caused by failure of a seal o-ring. During disassembly of the pump, oil was evident on the external surfaces of the mechanical seal gland and in the vicinity of the Ethylene Propylene Rubber (EPR) o-ring. Oil is known to cause rapid swelling of EPR o-rings. This in turn resulted in catastrophic failure of the carbon insert, leading to the observed seal leakage.

2. Root Cause:

SCE's investigation has identified two probable sources for oil found in the vicinity of the EPR o-ring. The first source of oil could have been caused by an overfilling of the lower motor bearing oil reservoir resulting in the overflow of the oil down the pump shaft onto the o-ring. The investigation has been unable to definitely determine when, or if, the lower motor oil reservoir was overfilled. Overfilling could have occurred following the removal of an oil sample (as part of the PM work being performed on the pump) on 6/27/89. Records show that no oil had been added to the pump between the last IST on 3/25/89 and performance of the PM.

The second probable source of oil found in the vicinity of the o-ring was discovered on 7/21/89. A minor amount of oil leakage was observed at the lower motor bearing housing. The source of this oil is believed to be the threaded connection between the lower bearing oil gauge fill tube and the lower bearing cartridge. Since an oil deflector had been installed on the pump shaft as corrective action to the event being reported in this LER, the leaking oil is not making contact with the seal o-ring and is, therefore, not an operability concern. At the time of the pump PM and IST (6/27/89 - 6/30/89), oil leakage from the lower motor bearing housing was not observed.

E. CORRECTIVE ACTIONS:

1. Corrective Actions Taken:

a) The mechanical seal was replaced and the pump returned to service on 7/8/89.

b) This event has been reviewed with appropriate personnel with emphasis on the need to avoid overfilling oil reservoirs when adding oil to pumps.

c) As a design enhancement, oil deflectors have been installed on Units 2 and 3 LPSI pump P015 and on the Unit 3 CS pump [P] P012. The oil deflector, which is located on the pump shaft, will prevent oil from entering the mechanical seal if leakage from or overfill of the lower motor bearing occurs. Additionally, the oil deflector should prevent water from shaft seal leakage from entering and damaging the lower motor bearing.

d) Appropriate Maintenance Orders used for adding oil to LPSI pumps and pumps which are similar in design to the LPSI (i.e., single-stage, vertical, centrifugal), have been revised to incorporate precautions to avoid overfilling oil reservoirs.

e) Procedures by which oil is added to LPSI pumps and pumps which are similar in design to the LPSI (i.e., single-stage, vertical, centrifugal), have been enhanced to include precautions on overfilling oil reservoirs, as appropriate.

2. Planned Corrective Actions:

Oil deflectors have been fabricated and are presently scheduled for installation on the remaining Units 2 and 3 LPSI and CS pumps by the end of January 1990.

F. SAFETY SIGNIFICANCE OF THE EVENT:

Since it cannot be definitively determined when the seal failure occurred, for purposes of reportability (in accordance with the guidance provided in NUREG 1022), it is presumed to have failed at the time of observance. Since the pump was out of service (for preventive maintenance and IST) at the time the leakage was observed, and since the redundant LPSI pump remained operable, there is no safety significance associated with the inoperability of LPSI 3P015 during the period involved. Furthermore, unit shutdown was properly initiated and completed in accordance with TS 3.5.2, Action Statement "a".

SCE has evaluated the consequences of a LPSI pump seal failure should such a failure have occurred during a limiting design basis accident. The evaluation determined that off-site and on-site doses would have been below the limits of 10 CFR 100 and the 10 CFR 50, Appendix A, "General Design Criteria for Nuclear Power Plants," Criteria 19 (GDC 19) limits. It is thus concluded that this event has no significance to the health and safety of plant personnel or the public. Details of the evaluations are also discussed in Part G.4.

G. ADDITIONAL INFORMATION:

1. Component Failure Information:

The LPSI pump mechanical seals are manufactured by the Durametallic Corporation.

2. Previous LERs for Similar Events:

None.

3. Results of NPRDS Search:

A review of NPRDS industry data did not yield any useful information regarding oil-induced LPSI Pump seal failures.

4. Additional Information:

Safety Evaluation Background Information

San Onofre Units 2 and 3 are each designed with two LPSI pumps which are normally aligned for the injection mode of the Safety Injection System. The main function of the pumps is to inject large quantities of borated water from the RWST (which contains essentially non-radioactive water), into the RCS during a LOCA. When the RWST is almost empty, a RAS is initiated. The RAS is designed to automatically change the mode of operation of the Safety Injection System and the CS System. The RAS shifts the suction for the HPSI, LPSI and CS pumps from the RWST to the containment sump, stops the LPSI pumps, and isolates the minimum flow paths.

The UFSAR analysis of the radiological consequences of an ESF pump (such as the LPSI, CS and HPSI pumps) mechanical seal leakage is based on a gross seal failure resulting from normal degradation which could potentially occur during the course of a design basis event requiring operation of these pumps. As described in UFSAR Section 15.6.3.3.5.1,B.1, "Seal Failure Mechanism," the seal vendor (Durametallic Corporation) determined by test programs that the gross seal failure leak-rate would be less than 500 cc/min and that greater leak rates would be indicative of a catastrophic seal failure (i.e., the seal is cracked or broken). The vendor has recently re-validated that the leakage resulting from a gross seal failure would be less than 500 cc/min. As discussed in a letter from J. B. Martin (USNRC, Region V) to H. B. Ray (SCE), NRC Inspection of San Onofre Units 1, 2 and 3, dated August 29, 1989 (Inspection Report No. 50-362/89-16), leakage of 500 cc/min was not meant to represent a catastrophic failure; and, the observation of higher leakage rates were not considered a source of significant hazard. As a result of the vendor test results and the above discussed corrective action to preclude future oil contamination of the pump seals' EPR o-ring, it is SCE's position that a gross seal failure leak-rate of 500 cc/min resulting from seal degradation during the course of a design basis event remains a valid design basis assumption.

It was discovered during our review of this event that a discrepancy exists between the UFSAR and plant design with respect to the Unit 3 LPSI pumps seal leak-off drain line. The UFSAR states that the leak-off line is piped to the Safety Equipment Building floor drain, however, the leak-off line for both LPSI pumps terminates away from the floor drain. The

leak-off line for all the Units 2 and 3 High Pressure Safety Injection (HPSI) pumps, CS pumps, and the Unit 2 LPSI pumps are routed directly to the floor drain as described in the UFSAR. The design of the seal leak-off drain lines for the Unit 3 LPSI pumps is being modified such that the drain lines will conform to the UFSAR description; thus, a change to the UFSAR is not required. Implementation of this design change should be complete by the end of 1989.

The Unit 3 LPSI seal leak off drain piping configuration (seal leak-off drain lines not being routed directly to the floor drain) could potentially affect the assumptions discussed in FSAR Section 15.6.3.3.5.1,b, concerning the fraction of seal leakage which is available to escape directly to the pump room atmosphere. SCE has reviewed the iodine partitioning described in FSAR Section 15.6.3.3.5.1,b, and concluded that they are appropriate. Namely: 1) The iodine partition factor is 0.01 for seal leakage which flows through the seal leakoff lines to the pump room floor drain and is available for leakage from the ESF building sump; and 2) The iodine partition factor is 0.1 for seal leakage which does not go directly to the pump room floor drain and is thus considered to leak directly from the pump room to the ESF building atmosphere.

Safety Evaluations

SCE's investigation of the safety significance of a LPSI pump seal failure was performed by calculating the offsite and control room doses resulting from a design basis accident accompanied by ECCS pump seal leakage rates of 1400 cc/min and 500 cc/min. The dose consequences described below are based on the leakage outside of containment described in the UFSAR and the above mentioned seal leakage. The methodology and assumptions used for these analyses are the same as those described in UFSAR Section 15.6.3.3.5, except as noted below.

For the 1400 cc/min case, it was assumed that a ECCS pump seal failure occurred at the start of the LOCA and continued to leak at a rate of 1400 cc/min to the pump room floor for a period of thirty days. The pumped fluid is assumed to be recirculated from the containment sump. A partition factor for iodine of 0.1 was taken for all seal leakage (no credit taken for leak-off lines being routed to the floor drains). The control room emergency intake filters were credited for iodine removal in this evaluation (the present FSAR analysis credits the recirculation filters, but not the emergency intake filters). The control room air cleanup system, which includes the emergency intake filter, is subject to the operability and surveillance requirements of TS 3/4.7.5, "Control Room Emergency Air Cleanup System." The results of this calculation show that the 0 to 2 hour Exclusion Area Boundary (EAB) and 0 to 30 day Low Population Zone (LPZ) doses would have been within the limits of 10 CFR 100. Doses to control room personnel would have been within 10 CFR 50, Appendix A, General Design Criteria (GDC) 19 limits.

In the 500 cc/min leakage calculation, it was assumed that an ECCS pump seal failure occurred at the start of the LOCA and continued to leak at a rate of 500 cc/min to the pump room floor for a period of thirty days. The pumped fluid is assumed to be recirculated from the containment sump. A partition factor for iodine of 0.1 was used for all of the seal leakage (no credit taken for leak-off lines being routed to the floor drains). The control room emergency air intake filters were credited in this evaluation. The results showed that all offsite doses would be within all 10 CFR 100 limits and all control room doses would be within all GDC 19 limits.

Since only the Unit 3 LPSI pump seal leak-off lines were not routed to the floor drains as described in the FSAR, the above evaluations provide extremely conservative radiological consequences for a postulated failure of a seal on any of the other ECCS pumps.

With respect to the LPSI pumps, the above analyses are somewhat unrealistic. The LPSI pumps would not normally operate in the recirculation mode pumping from the containment sump. Emergency procedures do provide for the use of the LPSI pumps in this mode; however, these provisions are intended as an option under highly improbable circumstances.

The use of the LPSI pumps for long term cooling is a possibility following a very small break LOCA for which RCS pressure and pressurizer level can be restored. The source terms used for LOCA dose consequences are based on very conservative design basis accident regulatory requirements as opposed to more realistic estimates. Releases resulting from a small break LOCA would be expected to be more limited than those resulting from a large break LOCA.

An evaluation of a scenario in which SDC is initiated at the maximum permitted RCS temperature following a small break LOCA with gross LPSI pump seal leakage is being performed. The results of this evaluation will be addressed in a revision to this LER which is presently scheduled for February 15, 1990.

Miscellaneous Additional Information

The cause of the Unit 3 LPSI pump leak-off lines terminating away from the floor drain was the result of either an error in the original design, or in the translation of the UFSAR commitment into the design. At this point in time, there is no corrective action which could be implemented which would prevent recurrence of similar design discrepancies since:

a. The LPSI design and construction was performed with the quality programs in effect for the original construction of Units 1, 2 and 3. This construction is now complete and these programs are no longer in use.

b. Design and construction is presently either accomplished or controlled by SCE using SCE's programs. As a result, further investigation into the cause of this design discrepancy is not warranted.

Other discrepancies which may exist between the UFSAR and the as-built plant will be identified and corrected as the result of on-going enhancements to the methods by which engineering and technical work is performed. These enhancements are described in SCE's October 3, 1988 letter to the NRC on this subject.

Administrative controls will be implemented which will initiate an engineering evaluation of ECCS pump operability whenever seal leakage is >/= 50 cc/hr and to require that any ECCS pump be considered inoperable when its seal leakage is >/= 500 cc/min.

As part of our evaluation of this event, a review of the San Onofre Units 2 and 3 Leakage Outside of Containment Program has been performed. As a result, the program procedure has been enhanced to provide numerical leakage criteria rather than refer the user to references.

The UFSAR does not provide the radiological doses associated with the 500 cc/min ECCS pump gross seal failure leakage now described in UFSAR. The UFSAR will be revised to provide these doses.