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SUBJECT: LER 90-005-01:on 900510,steam generator feedwater sparger damage.W/901116 ltr.

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Southern California Edison Company

SAN ONOFRE NUCLEAR GENERATING STATION

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R. W. KRIEGER
STATION MANAGER

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November 16, 1990

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

Subject: Docket No. 50-362
Supplemental Report
Licensee Event Report No. 90-005, Revision 1
San Onofre Nuclear Generating Station, Unit 3

Reference: Letter, H. E. Morgan (SCE) to USNRC Document Control Desk, dated July 3, 1990

The referenced letter provided Licensee Event Report (LER) No. 90-005, (Revision 0), for an occurrence involving the feedwater spargers in the steam generators. The enclosed supplemental LER provides additional information concerning the event, causes, and corrective actions. Neither the health and safety of plant personnel or the public was affected by this occurrence. If you require any additional information, please so advise.

Sincerely,

Enclosure: LER No. 90-005, Rev. 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)

IE22
1/1

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 7

Title (4)

STEAM GENERATOR FEEDWATER SPARGER DAMAGE

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)
0 5	1 0	9 0	9 0	--- 0 0 5	--- 0 1	1 1	1 6	9 0	SONGS, UNIT 2	0 5 0 0 0 3 6 1
										0 5 0 0 0		

OPERATING MODE (9): 6

POWER LEVEL (10): 0 0 0

THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10CFR (Check one or more of the following) (11)

___ 20.402(b)	___ 20.405(c)	___ 50.73(a)(2)(iv)	___ 73.71(b)
___ 20.405(a)(1)(i)	___ 50.36(c)(1)	___ 50.73(a)(2)(v)	___ 73.71(c)
___ 20.405(a)(1)(ii)	___ 50.36(c)(2)	___ 50.73(a)(2)(vii)	X Other (Specify in Abstract below and in text)
___ 20.405(a)(1)(iii)	___ 50.73(a)(2)(i)	___ 50.73(a)(2)(viii)(A)	
___ 20.405(a)(1)(iv)	___ 50.73(a)(2)(ii)	___ 50.73(a)(2)(viii)(B)	(Voluntary)
___ 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
R. W. Krieger, Station Manager	7 1 4 3 6 8 - 6 2 5 5

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

SUPPLEMENTAL REPORT EXPECTED (14)

___ Yes (If yes, complete EXPECTED SUBMISSION DATE) | XX | NO

Expected Submission Date (15): Month | Day | Year

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

On 5/10/90, with Unit 3 in Mode 6, during a routine inspection of the tubesheet of the Steam Generators (SGs), metal debris was found on the secondary side of both Unit 3 SGs. The sources of the debris were determined to be from both the feedring at its intersection with the feedwater inlet distribution box and the "T" vent assembly attached to each feedwater inlet distribution box.

On 7/28/90, Unit 2 was shut down for SG secondary side inspections. The condition of the feedring was similar although less extreme than that observed in Unit 3.

The design of the feedring and its support system did not adequately account for all of the loading conditions present in the SGs. This resulted in stress concentration at the welds associated with the transition piece between the feedring and the distribution box, causing cracking of the welds over a period of several years, and erosion and erosion-corrosion of the cracked pieces during power operation. The "T" vent assembly failure resulted from erosion and erosion-corrosion due to localized high velocity flow.

The feedring supports in both units were upgraded to reduce the stress concentration at the feedring/distribution box junction. In addition, the feedring design in both units was upgraded so that the junction between the feedring and distribution box can withstand greater stresses. The upgraded design includes: 1) use of Schedule 120 pipe to replace the transition piece (formerly Schedule 40 pipe), and 2) implementation of an improved weld joint design and weld practices. The "T" vent assemblies were determined to be unnecessary and modifications were completed which removed them. Debris was removed where possible, including the only piece that had caused any wearing of adjacent SG tubes. Although the wear of these tubes was not sufficiently deep to require plugging, as a precautionary measure, these tubes were plugged and staked. The predicted SG tube wear rate from debris that could not be removed was determined to be sufficiently low such that any degraded tubes would be identified (by required eddy current surveillance testing) prior to exceeding the allowable wear limits.

Plant: San Onofre Nuclear Generating Station
Unit: Three
Reactor Vendor: Combustion Engineering
Event Date: 05-10-90

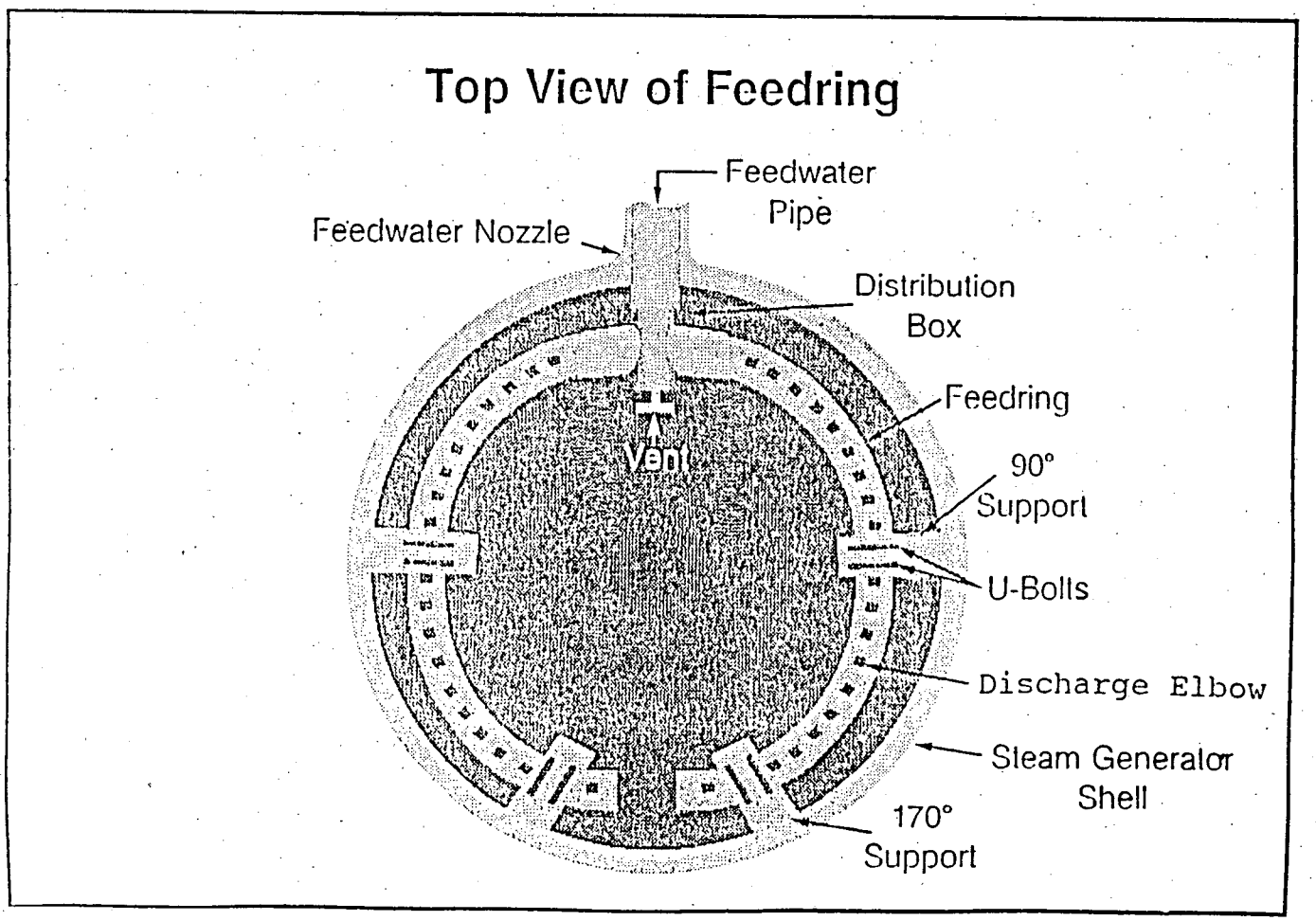
A. CONDITIONS AT TIME OF THE EVENT:

Mode: 6, Refueling

B. BACKGROUND INFORMATION:

San Onofre Units 2 and 3 are each provided with two Steam Generators (SGs) [SG]. The SGs are labeled 2E088 and 2E089 for Unit 2 and 3E088 and 3E089 for Unit 3.

Feedwater enters the SGs through the feedwater nozzle and travels into the feedwater inlet distribution box where it is channeled into the feedring which distributes feedwater around the periphery of the SG. A 3 inch elbow and Tee vent assembly is attached to the upper portion of the innermost (flat) end of each distribution box. In addition to being supported by the feedwater nozzle via the distribution box, the feedring is supported by four supports located within the SG. It is attached to these supports by eight U-bolts, two on each support. The supports are welded to the SG shell. Feedwater exits the feedring via discharge elbows, which are mounted on the top of the feedring and direct feedwater away from the SG shell. See figure below.



Combustion Engineering (CE) originally designed the distribution box without the vent assembly. During the early part of the Unit 2 startup, a test of the Auxiliary Feedwater (AFW) [BA] System in March 1981 caused a partial vacuum within both halves of the feedring in SG 2E088 causing them to collapse. The collapse was due to the inadequate flow area of the discharge elbows and the relatively thin wall Schedule 40 feedring. In 1982, the collapsed feedring was replaced with Schedule 120 pipe. The original distribution box was left in place along with a short section (approximately 9 inches welded to each side of the distribution box) of the original Schedule 40 feedring. The diameter of discharge elbows was also increased (from 1-1/2 inches to 3-1/2 inches) and the vent assemblies were installed. These actions were taken to prevent the formation of a vacuum in either the distribution box or the feedring upon the addition of cold water and therefore, prevent steam bubble induced collapse.

C. DESCRIPTION OF THE EVENT:

1. Event:

On May 10, 1990, with Unit 3 in Mode 6, during a routine inspection of the secondary side of the tubesheet of SG 3E089, several pieces of carbon steel debris were found. A detailed visual inspection of both Unit 3 SG secondary internals was performed. The inspection revealed the following conditions;

- o On SG 3E088, material was missing from the lower portion of each side of the feedring at its intersection with the distribution box.
- o On SG 3E089, material was missing from the lower portion of one side of the feedring at its intersection with the distribution box. The other side of the feedring was intact but surface cracks in the Heat Affected Zone (HAZ) at the toe of the weld that joins the distribution box to the feedring were found.
- o In both SGs, the interior surface of the distribution box showed indication of erosion-corrosion.
- o Several of the U-bolt supports in each SG were stretched and deformed.
- o The vent assemblies on the distribution boxes for each SG were eroded. The top of the "T" section of the vents were missing. These missing parts were found in the SGs.

Based upon these findings, Unit 2 was shut down on July 28, 1990, for a similar inspection. The Unit 2 inspection revealed the following conditions;

- o In both SGs, the feedrings were intact. The missing material observed in the Unit 3 SGs at the intersection of the feedring with the distribution box was not observed in Unit 2. However, limited erosion of the feedring at its intersection with the distribution box was observed.

- o In both SGs, surface cracks were observed in the HAZ at the toe of the weld that joins the feedring to the distribution box (similar to the condition observed on Unit 3).
- o Several of the U-bolt supports were stretched and deformed, and one U-bolt had fractured.
- o The distribution box and vent assemblies were in a condition similar to that observed on Unit 3.

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

None.

3. Sequence of Events:

Not applicable.

4. Method of Discovery:

See Section C.1 above.

5. Personnel Actions and Analysis of Actions:

Not applicable.

6. Safety System Responses:

Not applicable.

D. CAUSE OF THE EVENT:

1. Immediate Cause:

Feedring

After plant shutdown and during plant startup, a thermal cycle is imposed on the feedring each time cold AFW or cold main feedwater is injected into the SGs. In addition, most AFW cycles also include a brief period of significant thermal stratification which produces radial and horizontal bending of the feedring. (Prior to the addition in 1986 of low flow AFW throttle valves, feeding of the SGs was performed in a "Batch" mode, wherein large amounts of cold AFW were periodically added to the SG to meet heat removal requirements and to maintain SG level within a specified band. This method of SG feeding resulted in subjecting the feedring and support system to a greater number of thermal cycles than is the current method since use of the low flow throttle valves permits a constant feed rate to the SG.)

These bending stresses, together with residual stresses from welding and assembly, are believed to have resulted in crack initiation on the outer surface of the feedring at the toe of the weld that joins the feedring to the distribution box. The feedring material at this location consisted of Schedule 40 carbon steel (which as discussed above in Section B, was left in place when the feedring was upgraded to Schedule 120 in 1986) fillet welded to both the inner and outer surface of the distribution box. This joint configuration created stress concentration factors which aggravated the failure mechanism.

The developed cracks then propagated through the feedring wall. High velocity feedwater flowed through the cracks and further eroded the wall, resulting in the eventual thinning and material detachment observed in the Unit 3 SGs.

As discussed above in Section C.1, the Unit 2 SG feedrings were not as severely damaged as those in Unit 3. In 1984, two of the four feedring supports in both Unit 2 SGs were modified resulting in freer movement of the feedrings, thereby reducing the magnitude of the applied stresses. Consequently, crack development in the Unit 2 SG feedrings proceeded at a slower rate than in Unit 3.

U-Bolts

The U-bolts were subjected to excessive loading which resulted from thermal expansion and contraction of the feedring as described above.

Vent Assemblies

The vent assemblies failed due to localized erosion as a result of localized high flow velocities experienced at full power.

2. Root Cause:

The root cause of the degradation of the feedring was inadequate design of the feedring and feedring supports. The design did not take into consideration the in-service thermal stresses that resulted from normal operating conditions. Thermal stresses resulting from the normal process of AFW addition were not adequately accounted for in the original calculations (performed by the equipment supplier) addressing the loads on the feedring and its support system.

The root cause of the failure of the vent assembly was also inadequate design. The potential for localized high velocity resultant erosion-corrosion of the vent was not properly considered.

E. CORRECTIVE ACTIONS:

1. Corrective Actions Taken:

Debris was removed from both Units 2 and 3 SGs where possible. Only one piece (located in Unit 3 SG 3E089) caused wearing of adjacent SG tubes, and was removed. Although the wear of these tubes was not sufficiently deep to require plugging, as a precautionary measure, these tubes were plugged and staked. The predicted SG tube wear rate from debris that could not be removed was determined to be sufficiently low such that any degraded tubes would be identified (by required eddy current surveillance testing) prior to exceeding the allowable wear limits.

Corrective actions taken to resolve the feedring and feedring support degradation consisted of:

a. Modification to the feedring supports including installation of stronger U-bolts and providing greater thermal travel capability, thus minimizing thermal stresses.

b. Replacement of the Schedule 40 section of feedring with Schedule 120 pipe at the distribution box-to-feedring weld.

c. Improvement to the distribution box-to-feedring weld configuration to reduce stress concentration at the HAZ by utilization of a weld-o-let forging between the box and each of the feedring halves.

d. Limitation on batch AFW feeding. The modified AFW system which was implemented in 1986, provided for continuous feeding of the SG. Thus, thermal stresses are minimized.

Corrective actions taken to resolve the vent assembly failure consisted of:

a. Removal of the vent from the design. The supplier no longer requires the vents to satisfy any SG design requirements.

b. Repair of local thinning of the distribution box by weld buildup and removal of local surface discontinuities inside the distribution box.

2. Planned Corrective Actions:

The SG feedrings, distribution boxes, and other appropriate internal components for Units 2 and 3 will be inspected during the Cycle 7 refueling outages. The need for further inspections will be evaluated at that time.

F. SAFETY SIGNIFICANCE OF THE EVENT:

There was no safety significance to this event. The feedring damage described herein did not affect the ability of either plant to operate safely or for equipment important to safety to operate. The potential for a damaging water hammer was not created by the SG conditions. The predicted SG tube wear rate from debris that could not be removed was determined to be sufficiently low such that any degraded tubes would be identified (by required eddy current surveillance testing) prior to exceeding the allowable wear limits. The thermal stresses generated due to unequal feedwater flow distribution were acceptable, and the ability to use AFW remained unchanged.

G. ADDITIONAL INFORMATION:

1. Component Failure Information:

   Not applicable.

2. Previous LERs for Similar Events:

   None.