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

Gentlemen:

Subject: Docket No. 50-361
Special Report: Inservice Inspection of Steam Generator Tubes
San Onofre Nuclear Generating Station, Unit 2

On January 24, 1997, Edison completed an inservice inspection of steam generator tubes at San Onofre Nuclear Generating Station, Unit 2. Reporting Requirement 5.7.2.c of Appendix A, Technical Specifications to Facility Operating License NPF-10, requires the results of steam generator tube inspections be reported to the Nuclear Regulatory Commission.

The enclosed report provides the number of tubes plugged or sleeved, and the results of tube inspections which fall into Category C-3 (as defined in Section 5.5.2.11.c).

The initial inspection results indicate that an additional inspection should be performed after about 12 months of operation. Edison will submit a final assessment of the enclosed inspection results within 180 days of the end of the Unit 2 Cycle 9 refueling outage. Because Unit 2 Cycle 9 is scheduled for about 24 months of operation, Edison is planning a mid-cycle outage to complete this inspection.

If you require any additional information, please so advise.

Sincerely,

for G. T. Gibson
Manager, Compliance

Enclosure:

cc: L. J. Callan, Regional Administrator, NRC Region IV
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SPECIAL REPORT - INSERVICE INSPECTION OF STEAM GENERATOR TUBES

Inspection Program

Planned Inspection Scope

Table 1 summarizes the planned inspection program. In addition, the inspection program included:

a) eddy current profilometry at the top of the tubesheet of a small number of tubes adjacent to "tie rods" where denting has been experienced, and a sampling of hot leg dented tube support intersections.

b) inspection with the Plus-Point Probe of indications by the bobbin probe that were non-quantifiable or distorted.

Inspection Scope Expansion

Table 2 summarizes significant inspection program scope expansion in response to inspection results. In addition:

a) all hot leg eggcrate intersections that were identified by bobbin probe to have a quantifiable indication, were examined with the Plus-Point Probe to verify that the degradation mechanism was volumetric mechanical wear.

b) tubes that were selected for plugging due to tube-to-support wear were examined with the Plus-Point Probe to verify that the degradation mechanism was volumetric mechanical wear.

c) significant numbers of dented tube support intersections were examined with an eddy current profilometry probe to confirm and improve Edison's understanding of the size and shape profile of these intersections.

Results

The most salient point in the inspection of tubing falling into Category C-3 is the continuing progression of circumferential and axial cracking in the vicinity of the explosively formed expansion transition at the top of the inlet (hot leg) tubesheet.

Other tubing degradation was also identified.

a) Most notable was axial cracking at the intersections of tubing and eggcrate supports on the inlet (hot leg) side of the steam generator. This cracking was observed at intersections experiencing denting, and at intersections with no conclusive indications of denting. (Denting is the plastic deformation of tubes resulting from the growth/buildup of corrosion products (magnetite) in the tube-to-tube support structure annuli.)

b) Axial cracking was identified in areas between supports (commonly called "freespan") on the hot leg side of the steam generators.

c) A five-fold increase in denting was identified in the region composed of intersections of supports with tubing on the hot leg side of the steam generators. These support intersections are labeled 04H, 05H, 06H, 07H, and 08H on Figure 1, the steam generator internal location reference guide.

d) Previously identified tubing mechanical wear at tube supports is progressing typically for this steam generator design.

In accordance with "DRAFT" Regulatory Guide 1.121 (Bases for Plugging Degraded PWR Steam Generator Tubes) an assessment of the significance of these various indications will be conducted using:

(a) The "DRAFT" Proposed Steam Generator Rule (50.XX), "Steam Generator Tube Integrity"

(b) The associated "DRAFT" Regulatory Guide X.XX, "Steam Generator Tube Integrity"

(c) Nuclear Regulatory Commission Generic Letter 95-05, "Voltage-Based Repair Criteria for Westinghouse Steam Generator Tubes Affected by Outside Diameter Stress Corrosion Cracking"

Removal of Tubes from Service (by Plugging)

Table 3 illustrates the number of tubes removed from service in each steam generator. Each tube is only accounted for once in this listing, although it may also have an eddy current indication of a type below the point in the listing where it appears.

In-Situ Hydrostatic Testing of Tubing

Table 4 provides a summary of in-situ hydrostatic testing of tubing.

Removal of Tubing Samples from the Steam Generators

Portions of tubes (Row-Column) 94-32, 61-111, and 16-164 were removed from Steam Generator E-089 for destructive examination. Edison will update the Commission on the results of these examinations in the follow-up report discussed in the cover letter.

Supplemental Performance Demonstration: Eddy Current Bobbin Technique

This demonstration will use portions of "DRAFT" Regulatory Guide X.XX, "Steam Generator Tube Integrity". The main purpose of this demonstration is to validate Probability of Detection (POD) performance. These POD data will serve as input to the Edison

submittal on the assessment of the significance of eddy current indications that has been previously discussed in the cover letter.

Input data for this demonstration will include both nondestructive examination and destructive examination results from the tubes removed from Steam Generator E-089 during this present outage. These data will be the "flawed grading units" that have been evaluated against actual flaw geometry. Tube identity will be protected in Data Sets for this demonstration. Data sets will be constructed from these input data and a "pool" of more than 300 tubes removed from service during this current outage. The "pool" will provide the "unflawed grading units" to permit evaluation of POD performance.

A protocol for the supplemental demonstration will address analyst teams, analyst training and testing, and data evaluation. Edison will update the Commission on the results of this demonstration in the follow-up report discussed in the cover letter.

Investigations into Causes and Corrective Measures

An accumulation of corrosion products on the secondary-side of the tubing surfaces had been previously identified. Data from various sources indicated that such deposits might contribute to tubing corrosion. Consequently, Edison convened a panel of expert industry personnel with extensive knowledge in steam generator corrosion and water chemistry control. The panel reviewed the pertinent information and recommended that Edison chemically clean the deposits from the steam generator tubes. The deposits were removed during this refueling outage.

Chemical cleaning of the Unit 3 steam generators is planned for the April 1997 refueling outage. Existing inspection results from both units indicate that Unit 3 may lag Unit 2 by two or more fuel cycles in the onset of some of the tubing-related problems discussed above (i.e., denting and intergranular attack/stress corrosion cracking in the vicinity of the expansion of the tubing at the top-of-tubesheet).

A review of steam generator secondary-side water chemistry control strategy is ongoing for San Onofre Units 2 and 3. Edison has re-convened the expert panel of industry personnel to review new information. This thorough and balanced review will be a significant part of investigation into the cause and further corrective measures for steam generator tubing degradation. Edison will update the Commission on the progress of this review in the follow-up report discussed in the cover letter.

FIGURE 1 -Steam Generator Internal Location Reference Guide

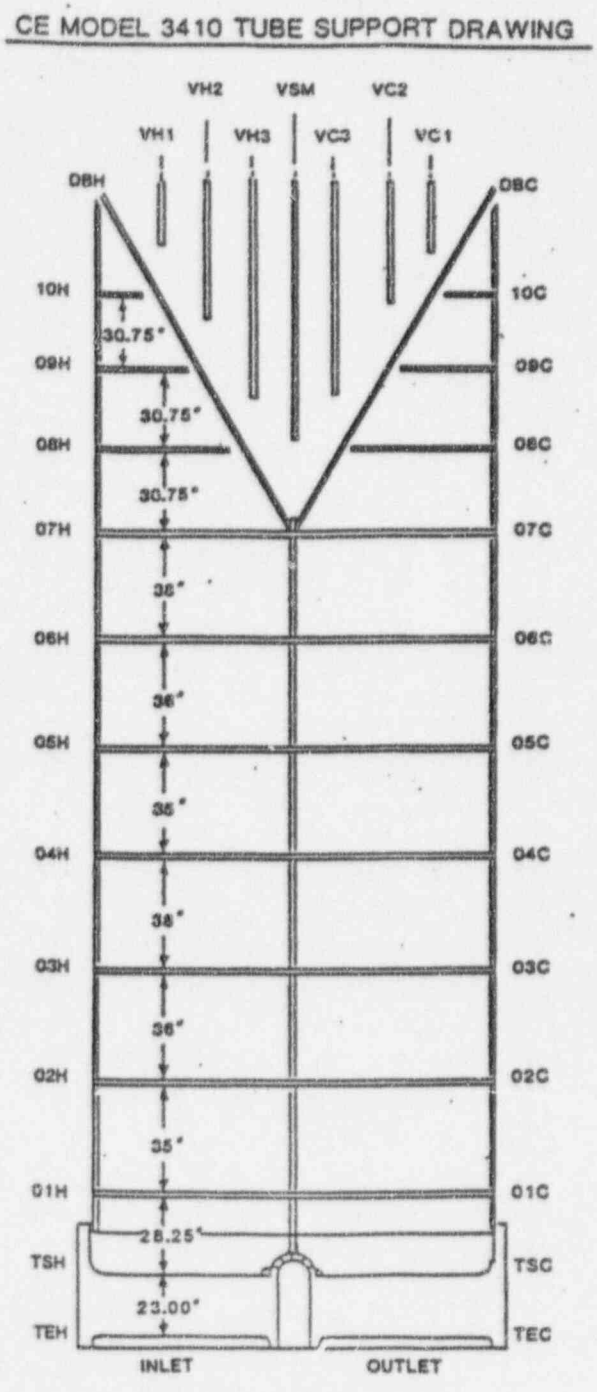

TABLE 1 - Summary of Planned Inspection Program

	Steam Generator E-088 Number of Tubes/Percentage of Tubes	Steam Generator E-089 Number of Tubes/Percentage of Tubes
Full length of tube with the bobbin probe	9051 / 100%	8958 / 100%
Tight radius U-bend regions with the Plus-Point Probe	24 / 20%	24 / 20%
Upper bundle freespan region (based on thermal-hydraulic condition predictions) with the Plus-Point Probe	609/20% of Region	609/20% of Region
Hot leg expansion transition at the top-of-tubesheet with the Plus-Point Probe	9051 / 100%	8958 / 100%
Cold leg expansion transition at the top-of-tubesheet with the Plus-Point Probe	655 / 7%	656 / 7%
Hot leg dents with the Plus-Point Probe	50 / 20%	39 / 20%

TABLE 2 - Summary of Significant Scope Expansion

	Steam Generator E-088 Number of Tubes/Percentage of Tubes	Steam Generator E-089 Number of Tubes/Percentage of Tubes
Plus-Point Probe examination of upper bundle freespan (bounding of indications in 3 tubes)	None	800/Not Applicable
Plus-Point Probe examination of all hot leg dented eggcrate supports	1094 / 100%	733 / 100%

TABLE 3 - Number of Tubes Removed From Service

Indication Orientation/Location	Steam Generator E-088	Steam Generator E-089
Mixed mode (circumferential and axial oriented indications) that intersect in the tube and are near the expansion transition at the hot leg top-of-tubesheet	0	1
Both circumferential and axial oriented indications that do not intersect and are near the expansion transition at the hot leg top-of-tubesheet	5	3
Circumferentially oriented indications near the expansion transition at the hot leg top-of-tubesheet	88	49
Axially oriented indications in the upper bundle (typically above elevation 07H), and not associated with a tube support (freespan)	0	3
As above, but located at a tube support	0	1
Axially oriented indications in the lower bundle (typically below elevation 07H), and not associated with a tube support (freespan)	5	21
Axially oriented indications at a hot leg eggcrate tube support location	2	6
Axially oriented indications at a dented hot leg eggcrate tube support location	4	4
Axially oriented indications near the expansion transition at the hot leg top-of-tubesheet	58	50
Preventive plugging of tubes adjacent to a tie rod	6	0
Indication of wear at a tube support location	2	7
Volumetric indication at a miscellaneous location in a tube	3	4
Preventive plugging based on presence of a foreign object	0	3
Highest growth rate dent	1	0
Miscellaneous preventive plugging	4	2
Total	178	154

TABLE 4 - Summary of In-Situ Hydrostatic Testing of Tubing

STEAM GENERATOR E-088

REGION	TUBE NUMBER ROW-COLUMN	LOC.	GPM LEAKAGE AT NOPD	MSLB	POST-MSL	MAX TEST PRESS
Eggcrate	44-56	07H	0	0	N/A	4746
Lower bundle	11-169	Full Tube	0	0	N/A	4746
Tubesheet	52-70	TSH	0	0	N/A	5292
	53-111	TSH	0	0	N/A	4746

STEAM GENERATOR E-089

REGION	TUBE NUMBER ROW-COLUMN	LOC.	GPM LEAKAGE AT NOPD	MSLB	POST-MSL	MAX TEST PRESS
Eggcrate	13-117	06H	0	0.31	0.051	3200
	92-128	02H	0	0	N/A	4746
	94-110	08H	0	0	N/A	4746
Lower bundle	16-166	Full Tube	0	0	N/A	4746
	15-15	Full Tube	0	0	N/A	4746
	23-15	Full Tube	0	0	N/A	4746
	31-17	Full Tube	0	0	N/A	4746
	82-24	Full Tube	0	0	N/A	4746
	92-34	Full Tube	0	0	N/A	4746
	106-38	Full Tube	0	0	N/A	4746
	110-42	Full Tube	0	0	N/A	4746
	112-36	Full Tube	0	0	N/A	4746
Upper bundle	122-112	Full Tube	0	0	N/A	4746
	122-120	Full Tube	0	0	N/A	4746
Tubesheet	40-56	TSH	0	0	N/A	4746
	59-79	TSH	0	0	N/A	5292
	94-86	TSH	0	0	N/A	4746

Notes:
GPM = Gallons per Minute
NOPD = Normal Operation Pressure Differential
MSLB = Main Steam Line Break Pressure Differential
N/A = Not Applicable
The Test pressure that correlates to 3 times NOPD is 4746 psi for axial flaws and 5292 psi for circumferential flaws.