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A. Edward Scherer
Director
Nuclear Regulatory Affairs

December 26, 2007

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

Subject: **San Onofre Nuclear Generating Station, Unit 3**
Docket No. 50-362
Response to Request for Additional Information Regarding Report of Inservice Inspection of Steam Generator Tubes, Cycle 14

References:

1. Letter from A. E. Scherer (SCE) to Document Control Desk (NRC) dated May 25, 2007, Subject: Docket No. 50-362, Special Report: Inservice Inspection of Steam Generator Tubes, Cycle 14, San Onofre Nuclear Generating Station, Unit 3

2. Letter from N. Kalyanam (NRC) to Richard M. Rosenblum (SCE), dated November 15, 2007; Subject: San Onofre Nuclear Generating Station, Unit 3 – Request for Additional Information Regarding the 2006 Steam Generator Tube Inspections (TAC NO. MD5953)

Dear Sir or Madam:

By Reference 1, Southern California Edison (SCE) submitted the reports required by Technical Specification 5.7.2.c of the inservice inspection of steam generator tubes at San Onofre Nuclear Generating Station Unit 3. Subsequently, by Reference 2, the NRC staff requested certain additional clarifying information. The requested information is provided in the enclosure.

If you have any questions or would like additional information concerning this subject, please contact Ms. L. T. Conklin at (949) 368-9443.

Sincerely,

C E Williams for

Enclosure

cc: E. E. Collins, Regional Administrator, NRC Region IV
N. Kalyanam, NRC Project Manager, San Onofre Units 2 and 3
C. C. Osterholtz, NRC Senior Resident Inspector, San Onofre Units 2 and 3

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ENCLOSURE

REQUEST FOR ADDITIONAL INFORMATION
STEAM GENERATOR TUBE INSPECTION REPORTS
FOR THE 2006 REFUELING OUTAGE
SAN ONOFRE NUCLEAR GENERATING STATION - UNIT 3
DOCKET NUMBER 50-362

1. **Please provide the scope and results of any secondary side inspections (including foreign object search and retrieval) performed during the 2006 outage. In addition, please discuss the scope and results of any inspections performed of the batwings in the stay cavity regions. Please confirm that all detected loose parts were removed from the SG. If loose parts were left in the SG, please discuss whether analyses were performed to assess whether tube integrity would be maintained with the loose parts left in the SG.**

Southern California Edison (SCE) Response

Foreign Object Search and Retrieval (FOSAR)

FOSAR was performed in both Steam Generators (SGs) at the secondary side top-of-tubesheet, including the periphery of the tube bundle, the central untubed "blowdown" lane, and the stay cavity region. For clarity, the stay cavity region search was at the top-of-tubesheet, not upward toward the bottom of the batwings.

The results were that one foreign object was detected and retrieved from the cold leg periphery of SG 89. It was approximately 0.35 inches square and less than 1/32 inches thick. Two indentations gave it the appearance of the letter "E". It was grey in color and non-magnetic. Correlation with eddy current testing results demonstrated that it did not cause tubing degradation. This was documented in the Corrective Action Process for the purposes of documentation, evaluation of potential source, and trending. No source could be positively identified (i.e., not an indication of equipment failure). It was considered likely maintenance debris, and thus was documented as trend input for the site's foreign object exclusion and control program.

Analyses to Assess Tube Integrity With Loose Parts

Two previously unretrievable analyzed objects were again observed and checked unretrievable in the cold leg periphery of SG 88. These objects have an analysis for acceptability for tube integrity documented in the Corrective Action Process. They include a wire-like object (looks like a staple) analyzed in 1999, and a metallic-appearing-object approximately 0.5 inches tall and 0.1 inches thick analyzed in 2004.

Batwings in the Stay Cavity Region

SCE documented evaluation of batwing related 2006 and 2007 industry experience reports in the Corrective Action Process, and the Steam Generator Degradation Assessment.

Tube support locations receive 100% inspection for wear of the tubing. This is typically done by the bobbin probe, except in the U-bend regions of Rows 1 through 3 where this is more effectively done with the rotating plus point probe. This detail is shown in Table 1 of Reference 1 of the cover letter.

SCE obtained the 2006 eddy current raw data corresponding to the batwing related 2006 industry experience. SCE had the benefit of analyst experience with this particular experience because San Onofre Nuclear Generating Station (SONGS) and the industry experience reporter use the same supplier of secondary party data analysis services. The secondary data analysis supplier used the eddy current raw data to produce instructional example graphics, with emphasis on the tube support signals and locations. Key points were annotated on the graphics to maximize their instructional value.

The SONGS Units 2 and 3 Steam Generator data analysis guideline was updated with a summary of the batwing related 2006 industry experience and the instructional eddy current signal graphics discussed in the previous paragraph. This provides all SONGS data analysts with a tool to recognize and evaluate this condition.

Both the eddy current data analysis process and the engineering-level review of the results provide for correlation of eddy current wear indications with the presence of a support. SONGS performs rotating probe inspection of all wear indications (100%). The rotating probe data analyst is specifically required to correlate each wear indication with an immediately adjacent tube support (lattice bar contact point), or identify it as a non-wear indication. The engineering-level review of the results assembles data in a manner that is readily and routinely checked for wear location consistency with normal tube support configuration. There were no non-wear volumetric indications.

Further assurance was demonstrated by a single-purpose re-analysis of eddy current data focused on looking for indication of batwing displacement. A hot leg and cold leg batwing/tube intersection was reviewed in each column of tubing with an adjacent batwing tube support passing through the stay cavity region. There were no indications of batwing displacement.

Finally, the previously described FOSAR at the secondary side top-of-tubesheet provided another data point. No batwing material was found.

With extensive eddy current inspection, and the single-purpose data re-analysis, no displaced batwings were found at SONGS Unit 3 in November 2006. Based on this, a visual inspection of the bottom of the batwings in the stay cavity was not necessary and was not performed.

2. **Please discuss the data quality and as low as reasonably achievable (ALARA) issues that led to plugging two tubes. Please discuss how you confirmed that tube integrity was maintained for these two tubes.**

SCE Response

These two tubes contained a ding at which additional testing was desired to improve rotating plus point probe data quality. The rotating, surface-riding plus point coil can significantly reduce, but not always completely eliminate the interfering variable of geometric change. This additional testing provided the desired data quality. This additional testing provided data showing that the eddy current signal was unchanged from previous rotating plus point probe testing (both locations tested numerous times since 1995). Also, the phase (predominantly horizontal as expected) and voltage amplitude of the interfering variable of geometric change at these locations would not mask degradation.

Additional testing requires inspection resources, and accordingly warrants consideration of the usefulness of recurring additional testing in subsequent inspections (i.e., consideration of preventive plugging). Additional testing is typically done with reduced testing speed (axial movement of the probe and/or coil rotation) and/or use of a different probe with a more robust coil-surface-riding capability. Additional testing of a single tube location requires significantly more personnel radiation exposure than testing of multiple tubes/locations on a normal production basis. Additional testing of a single tube location typically requires additional probe changes. Probe changes increase the potential for spread of radioactive contamination and personnel contamination. Preventive plugging of these two tubes was deemed appropriate because of the likelihood of recurring need for additional inspection resources, including personnel radiation exposure.

Additional detail on each of these two tubes is provided below.

SG	Tube Row	Tube Column	Location	Ding Size (volts)
E-088	97	23	TSH+0.94	6.03

This location has been inspected with the rotating plus point probe each refueling outage since 1995 (7 inspections) because it is within the inspection of 100% of the tubes in the vicinity of the hot leg top-of-tubesheet. In this inspection, data quality was improved by additional rotating probe testing at a reduced speed. This additional testing showed that the eddy current signal at this location remained unchanged from previous testing.

SG	Tube Row	Tube Column	Location	Ding Size (volts)
E-089	94	130	05H+18.35	56.5

This location has been inspected with the rotating plus point probe during 6 of the 7 refueling outages since 1995. This is a result of the size and hot leg location of the ding. In this inspection, data quality was improved by additional rotating probe testing with reduced testing speed (axial movement of the probe and coil rotation) and use of a different probe with a more robust coil-surface-riding capability. This additional testing showed that the eddy current signal at this location remained unchanged from previous testing.

3. **Please discuss the basis for only performing rotating probe inspections of the U-bend region out through row 10 (given that a similarly designed unit has found axial cracking in the U-bend in row 14).**

SCE Response

SCE selected Westinghouse to provide a documented technical basis for inspection of the U-bend region of SONGS' Combustion Engineering designed steam generators with Sawhill Tubular Products tubing. Westinghouse was selected because of their experience in this work for other diverse SG designs. Consistent with Westinghouse's normal practice, the SONGS technical basis is focused on the specific tube bending process used for the SONGS steam generators. This technical basis also considered industry experience with essentially identical steam generators (same tubing manufacturer/bender and same bending practice).

SCE exceeded the documented Westinghouse technical basis for rotating probe inspection, by inspecting beyond row 8 (out to row 10). SCE conservatively performed rotating probe inspections of the U-bend region out through row 10, to conservatively provide additional assurance of appropriate inspection.

4. **In evaluating the nondestructive examination techniques in Table 3 of Reference 1, it does not appear that you inspected for axial and circumferential primary water stress-corrosion cracks in dings or circumferentially oriented outside diameter stress-corrosion cracks in dings. Please confirm that the techniques used to inspect the dings were capable of finding these degradation mechanisms. In addition, please clarify what rows of tubes are considered "low row" U-bends, and please clarify what degradation mechanisms were inspected for in the U-bend region.**

<u>SCE Response</u>

<u>Confirmation of Capabilities of Techniques Used to Inspect Dings</u>

SCE confirms that the SONGS bobbin probe and rotating probe techniques used to inspect the dings were capable of finding axial primary water stress-corrosion cracks (PWSCC) in the dings.

SCE confirms that the SONGS rotating probe technique used to inspect the dings was capable of finding circumferential primary water stress-corrosion cracks in the dings and circumferentially oriented outside diameter stress-corrosion cracks in the dings.

<u>"Low Row" U-bends and Degradation Mechanisms in the U-bend</u>

SCE typically refers to the U-bends in the tubes in Rows 1, 2 and 3 as "low row" U-bends. This reflects site history that PWSCC has been limited to these rows of U-bends and the fact that these bends are a separate inspection category. These bends are a separate inspection category because the normal size bobbin probe used throughout the rest of the tube bundle will not reliably pass through them. These bends have historically received 100% inspection each refueling outage (since the late 1990s) with two different rotating plus point coils (mid-range frequency and high frequency) because axial and circumferential PWSCC has been an existing or potential degradation mechanism. 100% inspection with both coils has continued even after the recent category change from existing to potential. The rotating plus point probe inspection that is already being done is superior to any bobbin probe exam that could be done in these bends. Accordingly, the rotating plus point probe exam in the Rows 1, 2 and 3 U-bend region inspects for axial and circumferential PWSCC, and also for degradation mechanisms for which it is serving as a substitute for the bobbin (volumetric wear due to foreign objects, and axial ODSCC at dings and in the bend).

In Rows 4 through 10 the potential U-bend degradation mechanism inspected for with a rotating plus point probe is circumferentially oriented PWSCC at tube flanks. The first industry experience report of this degradation mechanism was in 2003. This inspection also provides a capability to inspect for axially oriented PWSCC.

5. **Please confirm that Table 4 in Reference 1 contains all crack-like (axial, circumferential, or mixed-mode) indications detected during the SG tube inspections. Please confirm that all crack-like indications were plugged.**

SCE Response

Table 4 contains all crack-like indications detected during steam generator tube inspections. All crack-like indications were plugged.

6. **Several wear indications appear to be outside the tube supports (e.g. row 49, column 129 in steam generator 89). Please discuss whether any wear indication was located outside the tube support. If so, discuss the extent to which the support may have moved due to degradation of the support.**

SCE Response

Wear indications were within the tube supports. The tube example provided by the NRC Staff above is an example of a subtlety in the Combustion Engineering tube support configuration. This subtlety is described below.

Pages 2 and 3 of Appendix 1 in Reference 1 of the cover letter illustrate that the 08, 09 and 10 eggcrate tube support elevations are "partial" (i.e., their presence is row-specific). Tubes at the edge of a partial eggcrate have more support structure than just the normal 2 inch length of eggcrate.

The edge of a partial eggcrate tube includes the terminated ends of the eggcrates (which interface with the tubes over the typical 2 inch length). The edge also includes a 0.75 inch length "scallop bar" above the eggcrate, and another 0.75 inch length "scallop bar" below the eggrate. The purpose of the scallop bars is to physically secure the terminated (cut-off) ends of eggcrates. Thus, the edge a partial eggcrate is a total length of 3.5 inches. For example, the 08H support at the edge of a partial eggcrate spans from a nominal 08H – 1.75 inches to 08H + 1.75 inches. The nominal tube rows at the edge of partial eggcrate are Rows 49 and 50 for eggcrate 08, Rows 84 and 85 for eggcrate 09, and Rows 120 and 121 for eggcrate 10. These are nominal rows because a tube in an additional adjacent row may have a limited interface with a scallop bar because of the closeness of the tubes in a triangular pitch tube bundle, and the curving shape of the scallop bar.