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Director, Nuclear Regulatory Affairs and
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January 24, 2013 10 CFR 50.4

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555-0001

Subject: **Docket No. 50-361**
Response to Request for Additional Information (RAI 18)
Regarding Confirmatory Action Letter Response
(TAC No. ME 9727)
San Onofre Nuclear Generating Station, Unit 2

References:
1. Letter from Mr. Elmo E. Collins (USNRC) to Mr. Peter T. Dietrich (SCE), dated March 27, 2012, Confirmatory Action Letter 4-12-001, San Onofre Nuclear Generating Station, Units 2 and 3, Commitments to Address Steam Generator Tube Degradation
2. Letter from Mr. Peter T. Dietrich (SCE) to Mr. Elmo E. Collins (USNRC), dated October 3, 2012, Confirmatory Action Letter – Actions to Address Steam Generator Tube Degradation, San Onofre Nuclear Generating Station, Unit 2
3. Letter from Mr. James R. Hall (USNRC) to Mr. Peter T. Dietrich (SCE), dated December 26, 2012, Request for Additional Information Regarding Response to Confirmatory Action Letter, San Onofre Nuclear Generating Station, Unit 2

Dear Sir or Madam,

On March 27, 2012, the Nuclear Regulatory Commission (NRC) issued a Confirmatory Action Letter (CAL) (Reference 1) to Southern California Edison (SCE) describing actions that the NRC and SCE agreed would be completed to address issues identified in the steam generator tubes of San Onofre Nuclear Generating Station (SONGS) Units 2 and 3. In a letter to the NRC dated October 3, 2012 (Reference 2), SCE reported completion of the Unit 2 CAL actions and included a Return to Service Report (RTSR) that provided details of their completion.

By letter dated December 26, 2012 (Reference 3), the NRC issued Requests for Additional Information (RAIs) regarding the CAL response. Enclosure 1 of this letter provides the response to RAI 18.

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NRR

There are no new regulatory commitments contained in this letter. If you have any questions or require additional information, please call me at (949) 368-6240.

Sincerely,

Enclosures:

1. Response to RAI 18

cc: E. E. Collins, Regional Administrator, NRC Region IV
R. Hall, NRC Project Manager, SONGS Units 2 and 3
G. G. Warnick, NRC Senior Resident Inspector, SONGS Units 2 and 3
R. E. Lantz, Branch Chief, Division of Reactor Projects, NRC Region IV

ENCLOSURE 1

SOUTHERN CALIFORNIA EDISON

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

REGARDING RESPONSE TO CONFIRMATORY ACTION LETTER

DOCKET NO. 50-361

TAC NO. ME 9727

Response to RAI 18

RAI 18

Reference 1, Section 11.1, page 52 – SCE proposes to upgrade the vibration and loose parts monitoring system (VLPMS) as a defense-in-depth measure to enhance plant monitoring capability to facilitate early detection of a steam generator tube leak and ensure immediate and appropriate plant operator and management response.

Fluid Elastic Instability (FEI) was identified as a main cause of the tube wear for both the Unit 2 and 3 steam generators. The FEI experienced is due to a combination of the conditions of steam quality, secondary side fluid velocity in the vicinity of the tube bundle, and steam void fraction, and the degree of such fluid elastic instability is related to the damping provided by internal support structures. According to your report, "steam quality directly affects the fluid density outside the tube, affecting the level of hydrodynamic pressure that provides the motive force for tube vibration. When the energy imparted to the tube from hydrodynamic pressure (density times velocity squared, or ρv^2) is greater than the energy dissipated through damping, FEI will occur." However, the proposed plant VLPMS enhancement does not appear to directly monitor steam quality, secondary side fluid velocity, or steam void fraction.

Please provide the following information to address the effectiveness of the enhanced VLPMS:

a. Describe the specific purpose of using the enhanced VLPMS equipment for monitoring steam generator performance. For example, is it to be used for monitoring acoustic noise indicative of flow velocity, steam quality, and void fraction, or for the measurement of metallic noise indicative of vibration of tubes against each other or against tube support structures? Exactly how will this be done? What is the theory of operation? If it will be used to monitor an increase in ρv^2 leading to the onset of FEI, provide a description of the correlation of the velocity of steam voids through the secondary side of the steam generator and the relative changes in characteristics of the signal output from the various VLPMS accelerometers. If it is to be used for detecting actual tube vibration, provide a description of the process that will be used for discerning actual tube vibration noise from background noise, and the required threshold identification criteria that will be applied to reach the conclusion that tube vibration is occurring.

b. Identify the ranges of amplitudes and frequencies of the acoustic noise signals from each accelerometer that are indicative of an approach to the conditions leading to FEI or actual tube vibration, and the reasons for selection of the more sensitive accelerometers. Also, discuss the required response time of the signal processing equipment needed to detect and continuously monitor either fluid velocities within the steam generator or tube impact noise, depending on the intended use of the enhanced VLPMS, and the actual response time capabilities of the equipment, from sensor through processed signal output, that is being proposed for use.

c. Discuss the acceptance criteria (e.g., magnitude of signal, plant power level, etc.) that will be used to establish the setpoints for the alarms described in Section 11 of your report: "The signals from these sensors are compared with preset alarm setpoints." Provide a description of how the alarm setpoints were established, and at what point during the start-up of Unit 2 will these alarm setpoints be calibrated into the VLPMS. If the setpoints have not yet been determined, provide a description of your plan for determining and implementing these settings.

d. Describe the planned operator actions and any changes to the procedures for responding to alarms or signals potentially indicative of tube-to-tube contact, including time limits for analyzing the signals and taking any necessary action including plant shutdown. Describe the lessons learned that have been drawn from the signals of potential metal-to-metal contact experienced in Unit 3 and how these lessons have been factored into current procedures.

e. A description of how you determined that acoustic noise monitoring and predictive signal processing was the best method for monitoring either the onset of FEI or actual tube vibration, including a list of other methods (e.g., time domain reflectivity probes calibrated for steam void propagation monitoring) that had been considered for enhancing steam generator tube monitoring during start-up of Unit 2, and the reasons for their rejection.

RESPONSE

The purpose of the upgraded vibration and loose parts monitoring system (VLPMS) is to provide additional monitoring capabilities for steam generator (SG) secondary side acoustics. The upgraded VLPMS is capable of recording secondary side acoustic signals via accelerometers mounted on the external shell of the SGs at locations near the upper tube bundle and tubesheet. The upgraded VLPMS will be used as a backward looking analysis tool in subsequent inspection outages should unexpected wear be discovered. The upgraded VLPMS will enable SCE to evaluate historical SG secondary side acoustic signal data for events which may help with the understanding of the causes of unexpected tube wear.

The Unit 2 Return to Service (RTS) report describes the upgrades to the VLPMS in Section 11.1 as an additional action to provide monitoring capabilities for secondary side acoustic signals. SCE did not propose the upgrade of the VLPMS as a defense-in-depth measure nor as a means of monitoring steam quality, secondary side fluid velocity, or steam void fraction. Corrective measures to control these secondary side parameters are addressed in Section 8 of the RTS report. The defense-in-depth measures being taken in support of Unit 2 return to service are described in Section 9 of the RTS report.

The theory of operation of the VLPMS data acquisition equipment is provided as follows:

> The Vibration and Loose Parts Monitoring System (V&LPMS) is a stand-alone system designed to perform loose parts detection and vibration monitoring functions. The loose part detection function is designed to fulfill the requirements of the loose parts detection system as set forth in Regulatory Guide 1.133. The design objective of the loose parts detection portion of the V&LPMS is to detect the presence of loose parts in the reactor coolant system (RCS) and annunciate an alarm in the control room when a loose part is detected.
>
> The system consists of loose parts and vibration sensors, preamplifiers and a computerized data acquisition and processing system. The sensors and preamplifiers are located inside the containment and the data acquisition and processing equipment is housed in a cabinet located in the control room cabinet area. The equipment located inside containment consists of piezo-electric sensors, preamplifiers and associated cabling at each of the following natural collection regions of each unit to detect loose parts:

- Upper reactor vessel; vessel head on head lift rig stopper
- Lower reactor vessel; outside wall
- Steam generator E088; outside wall
- Steam generator E089; outside wall

The RCS component vibration monitoring, reactor internal vibration monitoring, and vibration data analysis features are on-demand functions. The on-demand features provided with the VLPMS allow the selection of any two loose parts, vibration or reactor internal vibration channels for vibration monitoring or analysis. The on-demand data acquisition and analysis features also allow a live channel signal or historical data from the historical data file to be selected for time domain and/or frequency domain analysis, displayed, stored and/or printed.

The upgrades to the VLPMS consist of:

- Relocation of existing VLPMS accelerometers (2 per SG) from the support skirt to locations above and below the SG tubesheet. These will remain as VLPMS sensors to meet Regulatory Guide 1.133, "Loose-Part Detection Program for the Primary System of Light-Water-Cooled Reactors"
- Installation of increased sensitivity accelerometers (2 per SG) at locations above and below the tubesheet
- Installation of increased sensitivity accelerometers (2 per SG) on an 8 inch hand hole on the side of the SGs to monitor for secondary side noises at the upper tube bundle

Relocation of the accelerometers enhances the acoustic monitoring of the SG secondary side by placing accelerometers closer to the upper tube bundle.

The new accelerometers have an increased sensitivity of 25 pC/g compared with 10 pC/g for the existing accelerometers. The acceptance criteria used to establish the setpoints for the alarms associated with the upgraded VLPMS accelerometers is the same as used with the Regulatory Guide 1.133 accelerometers. After Unit 2 reaches 70% power, background data is collected and alarm thresholds are established to compensate for high background noise as discussed in Regulatory Guide 1.133, section C.1.b, "System Sensitivity."

Operator actions for VLPMS alarms are controlled by the VLPMS trouble annunciator operations alarm response procedure. Upon an alarm, the VLPMS automatically records data for all of the VLPMS accelerometer channels. The Control Room Shift Technical Advisor is instructed by this procedure to immediately notify the system engineer supervisor for any loose parts channel alarms associated with the SGs. The Control Room Operator documents the VLPMS alarm in the site Corrective Action Program (CAP). The CAP requires an operability determination to be made within 24 hours of event discovery. Each loose parts alarm associated with SGs will be independently reviewed by an offsite vendor.

Following identification of tube-to-tube wear (TTW) caused by Fluid Elastic Instability (FEI) in Unit 3 and two indications of TTW in Unit 2, a review of the VLPMS alarms for the previous operating cycle of both units was performed. No potential metal-to-metal contact alarms were recorded for Unit 2. Potential metal-to-metal contact alarms were recorded for Unit 3. Analysis of data from Unit 3 VLPMS events concluded most of the events were the result of RCS temperature changes. A number of events were not directly associated with RCS temperature changes and were reviewed by on-site as well as independent off site personnel. The independent review concluded these alarms were caused by: "...true metallic impacts and not false indications from electrical noise or fluctuations in background noise." The review found the acoustic signals were similar to those that occur when the SGs shift during RCS temperature transients. None of the VLPMS alarms were attributed to SG tube vibration.

Since the VLPMS is not designed to detect tube to tube contact, the absence of tube vibration related VLPMS alarms is consistent with the capabilities of its design. The approach in the Unit 2 RTS plan is to eliminate the causes of TTW caused by FEI. Reducing power reduces SG secondary side thermal-hydraulic parameters to values within the industry's experience. While the RTS plan does not require a direct method to measure tube vibration, SCE determined it was appropriate to upgrade the existing VLPMS as discussed above.