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

Gentlemen:

Subject: **Docket No. 50-362**
Steam Generator Tube Eggcrate Supports
San Onofre Nuclear Generating Station Unit 2

As requested by the NRC Project Manager for San Onofre Units 2 and 3, enclosed is the evaluation of the ability of the San Onofre Unit 2 steam generator tube eggcrate supports to perform their design function.

If you have any questions or would like additional information, please contact me.

Sincerely,

J. L. Rainsberry

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Enclosure

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Enclosure

STEAM GENERATOR TUBE EGGCRATE SUPPORTS EVALUATION

San Onofre Unit 2

Summary

This operability evaluation reflects Southern California Edison's (Edison's) best judgment based on the latest information available at this time. As more information becomes available, or as additional insight into the physical mechanisms involved in Steam Generator (SG) tube eggcrate support degradation is gained, this evaluation will be reviewed for any potential impacts. Updated evaluations will be issued incorporating the preliminary and final root cause assessments of the Unit 3 condition.

A degraded condition was noted on portions of SG tube eggcrate supports in Unit 3. The degradation was detected by remote visual examination and was located at some peripheral locations on some of the eggcrates. The degradation ranged from minor wastage of the eggcrate material to severe thinning in localized areas. In some cases, small portions of the eggcrates were separated from the structure. Assessment of this condition continues and will be completed in conjunction with returning Unit 3 SGs to service.

Inspections were performed to support chemical cleaning of the Unit 2 SGs. The thinning was not observed in Unit 2. The only degraded condition observed in Unit 2 eggcrates was one small area characterized as wastage and pitting. This degradation has been evaluated as insignificant.

Eddy Current Test (ECT) results from the Unit 2, Cycle 9 refueling outage indicate minimal SG tube fretting indications at eggcrate locations, further substantiating that the eggcrates are intact in these areas. The minor tube wear noted is consistent with wear phenomena that have been previously investigated and evaluated. This provides additional assurance that, at the time of inspection, the Unit 2 SG eggcrates were capable of controlling flow induced vibration.

During the chemical cleaning outage, eggcrate and vertical strip thickness measurements were taken in both Unit 2 SGs to confirm the process monitoring of eggcrate conditions during cleaning. Those measurements indicate the eggcrates are within the acceptance criteria established by the chemical cleaning specifications. Thus, operational corrosion of the eggcrates has been minimal as was corrosion during chemical cleaning.

Several mechanisms are being evaluated for the observed degradation of eggcrate material on Unit 3. Currently, a formal root cause determination has not been completed. However, it is clear that chemical cleaning has improved the overall tube bundle thermal hydraulics and helped restore the Unit 2 SGs to their nominal performance design conditions.

Considering the results of visual and ECT examinations performed on Unit 2, and the effectiveness of the chemical cleaning that was performed on Unit 2, there is no indication that the Unit 2 SG eggcrates are structurally degraded or are likely to degrade in the current operating period. Therefore, there is reasonable assurance that the SG eggcrates meet the design requirements and are able to perform their designed safety functions.

Background

The design function of the SG eggcrates is to provide a support structure for SG tubes to (1) minimize flow-induced vibration during normal operating conditions, and (2) maintain acceptable stress levels under accident conditions.

Action Request (AR) 970400975 documents that a pre-chemical cleaning video inspection of the secondary side of Unit 3 SG 3E088 revealed erosion, thinning, and pitting of some eggcrate material. AR 970401129 was created to document the operability of Unit 3 SG 3E089 in the event of findings similar to 3E088 (similar conditions were later substantiated). Since Unit 3 is currently shutdown for refueling, the initial operability of the Unit 3 SGs was established based on providing only a "containment closure" function in accordance with Technical Specification 3.9.3.

Since Unit 2 is currently operating at full power, AR 970401645 was created to assess and document the continued operability of the Unit 2 SG eggcrates in Modes 1 through 6, and to identify and track any additional actions associated with maintaining the Unit 2 SG eggcrates capable of performing their designed safety functions.

Discussion

Unit 2 Pre and Post-Chemical Cleaning Video Inspections

To support Unit 2's Steam Generator Chemical Cleaning (SGCC), video inspections were recorded to check and characterize the level of deposits within the SGs. The post-SGCC inspection was also intended to provide a visual record of SG cleanliness.

Three types of cameras were used for these inspections: one for the top of bundle overview, one for periphery bundle areas, and one for inner bundle areas. A brief description of the methods used for these inspections is provided below.

1. Top of Bundle Overview

This inspection consisted of lowering a large camera from above the tube bundle to provide a general area view of the upper bundle region. This allowed observation of the batwings, vertical support straps and bars, and overall condition of the tubing in the upper bundle area. Then, using a six millimeter videoprobe, the upper portions of the batwings, batwing hoop, and batwing to outmost tube interfaces were examined.

2. Outer Periphery Inspection

A six millimeter videoprobe was inserted in the hot leg near the apex of the bundle. The videoprobe allowed observation of the tubes and eggcrates from the top of the bundle to the sixth eggcrate (counted from the top of the tube sheet). The areas of interest for this type of SGCC inspection were the diverter plate welds, eggcrate support rings, and eggcrate intersection and eggcrate line contact areas to check for deposit remains.

3. In-Bundle Inspection

A small 1.5 millimeter fiber optic camera was utilized to provide an in-bundle observation of tube-to-tube line contacts and eggcrate intersections. The insertion of this camera was generally limited to the tenth eggcrate and the batwing supports, but one time, in the stay cylinder area, the camera was able to penetrate to the seventh eggcrate.

4. Lower Hand Hole Inspection

A miniature Charge Couple Device (CCD) camera and the 1.5 millimeter camera were used for this inspection. The miniature CCD camera was used to inspect the underside of the first eggcrate support in the divider lane, stay cylinder, and a portion of the annulus. The 1.5 millimeter camera was also used to look at the underside of the first eggcrate near the periphery, within the bundle, and in the stay cylinder area. Usually observations could be made up to the second eggcrate.

Unit 2 Pre and Post-Chemical Cleaning Video Inspection Results

The Unit 2 periphery inspections were performed on the hot leg at the apex of the bundle. This represents the area with the highest expected flow velocity. The assessment performed at the time concluded that the eggcrates were in very good to excellent overall condition. A re-review of these videos was conducted

for the areas where thinning of eggcrates was found in the Unit 3 SGs and is documented in an April 23, 1997 Memorandum For File by Mark Mihalik.

These inspections indicate the uppermost eggcrates (i.e., sixth, seventh, eighth, ninth, and tenth) in 2E088 are in very good to excellent material condition. The general appearance is sharp, well-defined edges on the support bars. In contrast, the Unit 3 SG hot leg periphery regions (near the seventh, eighth, and ninth eggcrates) exhibited considerable eggcrate degradation.

One area, on the sixth eggcrate in 2E088, was noted with minor pitting and limited metal wastage. The area affected is approximately 1/4 inch in length. Unlike the conditions noted on Unit 3, however, the pitting was very limited and judged to be insignificant.

The lowest two eggcrates (numbers one and two) in 2E088 were also inspected and were in very good condition. The inspection of 2E089 was limited to the lowest two eggcrates. These were also found to be in very good condition. Due to limitations of the video equipment, eggcrates three, four, and five in either Unit 2 SG were not inspected. The lowest eggcrate and portions of the vertical strips in both Unit 2 steam generators were gaged for thickness. All thicknesses were within predicted values.

Visual inspection of the observed erosion of Unit 3 eggcrates indicates that both Unit 3 SGs are similarly affected. This is to be expected, since erosion of the eggcrate material is considered to be sensitive to secondary side water chemistry and both SGs share a common feedwater system. It is reasonable to expect that the physical condition of 2E089 would be similar to the observed conditions in 2E088 and, therefore, has negligible eggcrate degradation.

The SGCC video inspection was one of three elements used to assess the material condition of the eggcrates for chemical cleaning. Care was exercised before relying on any one element, since all measurements were made remotely. The other two methods used to assess eggcrate structure condition were physical gauge measurements and visual (unaided eye) inspections. The results of these other two inspection techniques and measurements were consistent with one another, and support the conclusions obtained from the videos.

Unit 2, Cycle 9 Refueling Outage SG Tube Eddy Current Test Results

A 100% bobbin probe eddy current test (ECT) of the Unit 2 SG tubes was performed during the Unit 2, Cycle 9 refueling outage. These ECT results indicated minimal SG tube fretting indications at eggcrate locations. Some minor tube wear was noted at batwings and vertical strips, but this is consistent with wear phenomena that have been previously investigated and evaluated. No tube-to-tube fretting was identified. Thus, at the time of inspection, the Unit 2 SG eggcrates were capable of controlling flow-induced vibration.

Steam Generator Chemical Cleaning

Comparing SG performance at full power between Unit 2 and Unit 3 indicates that the two SGs in each Unit exhibited similar performance relative to main steam pressure. Although this trend has been consistent, the Unit 3 SG pressure has trended lower than Unit 2 SG pressure, indicating potentially more fouling in the Unit 3 SGs. Examinations conducted in conjunction with the SGCC activities indicate that the Unit 3 SGs are likely to be more fouled, with more deposits in the tube bundle, than Unit 2 SGs were prior to chemical cleaning.

Chemical cleaning has been successful at removing essentially all of the accumulated deposits within the Unit 2 SG tube bundle region. Currently, a formal root cause determination on the Unit 3 eggcrate condition has not been completed. However, it is clear that chemical cleaning has improved the overall tube bundle thermal hydraulics and helped restore the Unit 2 SGs to their nominal performance design conditions.

Unit 2, Cycle 10 Mid-Cycle Outage

Currently, a mid-cycle outage is planned to allow ECT inspection of Unit 2 SG tubes. Video inspection of the Unit 2 SG eggcrates will be performed if warranted by the final root cause assessment of the Unit 3 condition.

Conclusion

Based on the above evaluation, the Unit 2 SG eggcrate supports are able to perform their designed safety functions, and are operable.