Public Meeting with the Nuclear Regulatory Commission

Technical Meeting

December 18, 2012

Southern California Edison Commitment

We operate San Onofre Nuclear Generating Station (SONGS) safely and reliably to the highest standards to protect the health and safety of the public and our employees

We will not restart either Unit 2 or Unit 3 until we and the NRC are satisfied it is safe to do

Purpose of Today's Meeting

- Discuss SCE's Return to Service (RTS) plan with Nuclear Regulatory Commission (NRC) staff with a focus on the Operational Assessments (OA)
- Discuss response plans for the Requests for Additional Information (RAIs). Confirm scope and understanding of each request

INTRODUCTIONS

Unit 2 Return To Service Strategy

- Power Reduction to 70%
  - Significantly reduces fluid velocities: less energy causing tubes to vibrate
  - Significantly reduces void fraction: better damping
  - Prevents Fluid Elastic Instability (FEI)
- Preventive Plugging of Tubes
  - Tubes most susceptible to FEI at 100% power
- Multiple independently developed Operational Assessments
- Short Operating Interval
  - Five month window is significantly shorter than analysis allows
  - 100% tube inspection during mid-cycle outage

Unit 2 Return to Service Operational Assessments

- Required by SONGS Technical Specifications, Steam Generator (SG) Program and Industry Guidelines
- Provide assurance that Unit 2's SG tubing will continue to meet structural and leakage integrity during the operating period prior to next planned inspection
- Southern California Edison (SCE) commissioned three independently developed Tube-To-Tube Wear Operational Assessments
  - AREVA
  - Intertek
  - Westinghouse (WEC)

Three Independent TTW Operational Assessments

- Although only one OA is required, SCE used several approaches in a parallel effort to evaluate the new wear mechanism
- SCE used both probabilistic and deterministic methods
- The conservative RTS plan is supported by the results of the three independent OAs

Three Independent TTW Operational Assessments

- AREVA – Support Effectiveness
  - Deterministic analysis indicates FEI will not occur at 70% power
  - Analysis of margin using a probabilistic method that models physics of TTW
  - Margin evaluation produces results consistent with SIPC
- Intertek - Current OA Methodologies
  - Probabilistic method provides empirical insights into the prediction of instability and resulting TTW growth rates
  - Conservatively assumes instability occurs during operation
- Westinghouse – Tube Proximity
  - Evaluates potential for FEI mechanism at 70% power using tube support conditions determined from inspection data including future wear
  - Based on independent analysis of TTW cause and eddy current data

NRC Requests for Additional Information

- NRC to SCE, dated Nov. 30, 2012, SONGS Draft RAIs 1 – 14
- NRC to SCE, dated Dec. 10, 2012, SONGS Draft RAIs 15 - 31

NRC Requests for Additional Information

- RAIs requesting discussion of methodologies
- RAIs requesting additional information including details of analysis
- RAIs requesting clarification of information provided in the Return to Service report

METHODOLOGY RAIS

RAI 3 – Intertek OA
Definition of Wear Index

NRC RAI:

"Regarding Reference 4, describe the sensitivity of the results in Figure 5-4 to the definition of "wear index." If alternate definitions significantly affect the results, what is the justification for the definition being used?"

Response Plan:

- Discuss the approaches to the wear index that were examined:
  - Tube wear at AVBs versus TTW
  - Tube wear at TSPs versus TTW
  - Tube wear at AVBs and TSPs treated as independent parameters
  - Tube wear as the summation of AVB and TSP
- Provide the evaluation of each approach and the justification for the wear index used in the OA

RAI 4 – Intertek OA Wear Index Definition

NRC RAI:

"Regarding Reference 4, does the definition of "wear index" include summing the depths of 2-sided wear flaws at a given AVB intersection? If not, explain why SCE's approach is conservative."

Response Plan:

- Explain the wear index is based on bobbin
- Discuss how the wear index is correlated to the presence or absence of tube-to-tube wear and its application in the OA model
- Explain the change in wear index will depend on the Anti-Vibration Bar (AVB) / Tube Support Plate (TSP) growth rates which are traditionally based on bobbin data
- SCE will provide the justification for the bobbin-based wear index used in the OA

RAI 2 – Intertek OA
Tube-To-Tube (TTW) Growth Rates

NRC RAI:

"The Operational Assessment in Attachment 6, Appendix C (Reference 4), pages 3-2 and 4-12, appears to state that tube-to-tube wear (TTW) growth rates are based on the maximum TTW depths observed in Unit 3 at EOC 16 divided by the first Unit 3 operating period (0.926 years at power). Provide justification for the conservatism of this assumption…."

Response Plan:

- Explain the determination of TTW growth rates was based on 0.926 years at 100% power in conjunction with a set of conservative assumptions to provide a conservative wear rate model for Unit 2
- Provide discussion of how the Unit 3 wear rates were benchmarked and the justification for this approach

RAI 5 – Intertek OA
Non-detected Tube Support Wear

NRC RAI:

"Regarding Reference 4, third paragraph from the bottom of page 4-3, why is non-detected wear only assigned to no degradation detected (NDD) tubes and not to NDD tube/AVB intersections in tubes with detected wear at other intersections?"

Response Plan:

- Explain how the OA does assign non-detected wear to both populations
- Explain how the two tube populations were assigned differently. Explain how NDD tubes with at least a bobbin exam and the tubes with detected wear with at least a bobbin and a rotating coil examination were handled
- Provide the basis for the methods and assumptions used to account for non-detected wear in the OA

RAI 6 – Intertek OA
Tube-To-Wear Probability of Detection

NRC RAI:

"Regarding Reference 4, page 4-5, it seems that depths of undetected flaws are assumed to be associated with probability of detection (POD) < 0.05. Why is this conservative? Is there a possibility that some undetected flaws may be associated with higher values of POD?"

Response Plan:

- Provide discussion of likelihood of significant undetected wear greater than 5% POD level
- Explain the treatment of undetected wear at supports and tube-to-tube contact
- Provide basis for the approach used in the OA

RAI 10 – Primary to Secondary Leakage

NRC RAI:

"Technical Specification (TS) 3.4.13.d allows 150 gallons per day primary to secondary leakage. The Return to Service Report (Enclosure 2 of Reference 1), Section 9.4.1 states, "The plant operating procedure for responding to a reactor coolant leak has been modified to require plant Operators to commence a reactor shutdown upon a valid indication of a primary-to-secondary SG tube leak at a level less than allowed by the plant's TSs. This procedure change requires earlier initiation of operator actions in response to a potential SG tube leak." Does this mean that a reactor shutdown would be commenced upon any valid indication of primary to secondary leakage? Provide a description of the action levels in the procedure. Discuss any additional actions, planned or taken, such as simulator testing, operator training, and/or any evaluations to assess potential impacts of the revised procedure."

RAI 10 – Primary to Secondary Leakage (cont.)

Response Plan:

- Provide the action levels and leakage threshold for plant shutdown in the revised Abnormal Operating Instruction (AOI) and description of action levels
- Discuss the plant response to leakage indications below that threshold, the process used to conclude a valid indication of leakage is present and the decision making process for shutdown. The Operational Decision Making (ODM) process will be described in greater detail in the response to RAI 16
- Discuss actions planned or taken including operator classroom and simulator training, lessons learned from the Unit 3 shutdown, and simulations performed to assess the effectiveness the AOI and operator response

RAI 16 – RCS Activity Limit

NRC RAI:

"Reference 1, Section 9.3, page 50 – Provide additional information concerning the "Operational Decision Making" process and describe how it would be applied if the proposed criterion is exceeded. Provide the procedural action statement"

From Reference 1, Section 9.3:

"The plant procedure for chemical control of primary plant and related systems has been modified to require action if the specific activity of the reactor coolant Dose Equivalent (DE) Iodine (I-131) exceeds the normal range of 0.5 μCi/gm, which is one-half of the TS Limit of 1.0 μCi/gm. In the event that the normal range is exceeded, Operations is required to initiate the Operational Decision Making process to evaluate continued plant operation."

RAI 16 – RCS Activity Limit (cont.)

Response Plan:

- Provide description of the new administrative limit for this activity
- Discuss criteria for notification of on shift Operators to initiate Operational Decision Making (ODM) process
- Discuss ODM process and procedure

RAI 17 – Reactor Coolant Leakage Procedure

NRC RAI:

Reference 1, Section 9.4.1, page 50 – Provide the procedural action levels/statements.

From Reference 1, Section 9.4.1:

The plant operating procedure for responding to a reactor coolant leak has been modified to require plant Operators to commence a reactor shutdown upon a valid indication of a primary-to-secondary SG tube leak at a level less than allowed by the plant's TSs. This procedure change requires earlier initiation of operator actions in response to a potential SG tube leak.

Response Plan:

- This RAI appears to request the same information that will be provided in response to RAI 10

RAI 18 – VLPMS Upgrade

NRC RAI:

"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…."

Response Plan:

- Clarify the upgrade is not a new system and it is not designed to monitor steam generator thermal hydraulic parameters
- Clarify VLPMS upgrade is intended to provide additional capability for secondary side acoustic signals. The upgrade will improve historical reviews of acoustic signals
- Describe the capabilities of the upgraded system and the procedural actions for its use

RAI 19 – Smart Signal

NRC RAI:

"Reference 1, Section 11.2, page 52 – Provide additional details on how the GE Smart Signal System will be used in the context of tube-to-tube wear and/or the circumstances associated with tube-to-tube wear. What information/data will the system be evaluating? For what purpose?"

Response Plan:

- Describe the smart signal system (including the data evaluated) to monitor historical plant process data as a backward looking tool to assist in the investigation of tube-to-tube wear

RAI 27 – MHI Hydrodynamic Force Effects on Contact Forces

NRC RAI:

"Reference 6, Appendix 8, "SG Tube Flowering Analysis", page 8-2 (307 of 474) – MHI concludes, in part, that the tube-to-AVB gaps in the center columns increase due to hydrodynamic pressure by [ ] when the manufacturing tolerance dispersion is not taken into account. MHI also concludes that the gap increase due to hydrodynamic pressure is small when the manufacturing tolerance dispersion is taken into account. Discuss whether this latter finding may simply reflect the hydrodynamic pressures acting to relieve the tube-to-AVB contact forces caused by the manufacturing tolerance dispersion, such that the gaps are relatively unchanged relative to the case were the hydrodynamic pressure is not considered. Reference 6, Appendix 9, "Simulation of Manufacturing Dispersion for Unit-2/3," does not seem to make specific mention of whether the calculated tube-to-AVB contact forces directly considered the effect of the hydrodynamic effect on tube-to-tube contact forces, but the staff understands that they did not. If the staff's understanding is correct, explain how the resulting contact forces are conservative."

RAI 27 – MHI Hydrodynamic Force Effects on Contact Forces (cont.)

Response Plan:

- Describe the analyses used to determine the significance of hydrodynamic forces in the contact force analysis
- Discuss the findings from these analyses which conclude these forces do not have a significant effect on contact force
- Discuss influence of hydrodynamic forces on contact forces and resulting probability of fluid-elastic instability

ADDITIONAL INFORMATION AND ANALYSIS RAIS

RAI 7 – Intertek OA
Active Wear Locations

NRC RAI:

"Regarding Reference 4, page 4-5, what is meant by the words, "each active wear location" in the 1350 NDD tubes? How are the "active wear" locations determined?"

Response Plan:

- The definition of "active wear" locations will be provided and how it is implemented in the NDD tubes
- Discuss the cumulative distribution functions (CDFs) for assigning active wear locations within the NDD tube population

RAI 8 – Intertek OA
Tube Wear at AVB Locations

NRC RAI:

"It is stated in Reference 4, page 4-6, second paragraph that, "It has been observed that the number of AVB supports that develop wear in the second cycle of operation can increase dependent on the number of worn AVB indications at the beginning of the second cycle. These data were used in the OA to add AVB locations at the start of Cycle 17 from a statistical representation of this data." Provide a more complete description of the model used to add AVB locations that will develop wear during the second cycle. Confirm that this model applies to both the 560 tubes with existing tube support wear and the 1350 NDD tubes."

Response Plan:

- Describe the method used to establish the number of additional (predicted to occur during Cycle 17) wear locations in the population of tubes with existing tube support wear
- The method used for the population of NDD tubes will be described in the response to RAI 7

RAI 9 – Intertek OA Benchmarks

NRC RAI:

"It is stated in Reference 4, at the top of page 4-9 that the simulation results of the bench marking process are shown in Figure 4-6. Provide additional detail on what Figure 4-6 is showing and how it relates to the benchmarking process. As part of this additional detail, explain the meaning of the ordinate label "number of observations" in the figure."

Response Plan:

- The Unit 2 TTW initiation model will be explained and how it was developed from Unit 3 TTW wear data. This involved a benchmarking process to use the Unit 3 data to predict the actual Unit 2 NDE results
- Further explanation will be provided to clarify the meaning of the data shown in Figure 4-6 and what it represents from the benchmarking process
- Definition of "number of observations" will be provided

RAI 22 – AREVA OA Explanation of Contact Force Distribution Calculation Terms

NRC RAI:

"Reference 3, page 57 of 129, first full paragraph beginning with the words "Figure 6-1" – The third sentence states, "… it is not practical to use an individual run of the quarter model as a single Monte Carlo trial for contact forces." However, the staff was unable to ascertain from the subsequent discussion exactly what was done as an alternative? Nor was the staff able to discern this from Reference 6, Appendix 9. Provide or cite by reference a more complete description of how the cumulative distributions of contact forces were determined. For example, what is a "run?" What does it mean to "combine runs?" How were zones employed in order to provide a more practical approach? Are all tubes in a given zone assumed to have the same initial clearances, final clearances, and contact forces? Do all AVB #5 in a zone have the same cumulative distribution of contact forces? Is a Monte Carlo performed for each zone?"

RAI 22 – AREVA OA Explanation of Contact Force Distribution Calculation Terms (cont.)

Response Plan:

- Provide an expanded description of how the cumulative distributions of contact forces between tubes and AVBs were determined
- The terms “run”, “combined runs” and “zones” will be defined
- Changes in cumulative distributions of contact forces from zone to zone will be explained

RAI 23 – AREVA OA Provide Figures for U2 Steam Generator 88 and U3 Steam Generator 88

NRC RAI:

"Reference 3 – Provide figures similar to Figures 6-19 and 6-20 for Unit 3, SG E-088, and Unit 2, SG E-088."

Response Plan

- The figures will be provided

RAI 25 – AREVA OA Dents in Agreement with High Contact Forces

NRC RAI:

"Reference 3, page 59 of 129 – There is a statement in the last paragraph that reads, "Patterns of dents and associated high contact forces are in good agreement with the final quarter model calculations." Provide or show this comparison."

Response Plan

- The evaluation supporting this statement will be provided

RAI 31 – Effect of Non-Pressure Loads - Condition Monitoring

NRC RAI:

"In References 7 and 8 (specifically, in Section 7.2 of Reference 7 and in Section 8.0 of Reference 8), AREVA used Revision 3 of the Electric Power Research Institute "Steam Generator Management Program: Steam Generator Integrity Assessment Guidelines," in part, to assess the most limiting structural integrity performance criteria (e.g., the more limiting structural limit determined from (a) the three times the normal operating differential pressure criterion or (b) the safety factor of 1.2 on combined primary loads and 1.0 on axial secondary load criterion). In some cases, it appears that the limits in the Integrity Assessment Guidelines may have been based on specific tests and plant data. Please discuss whether you have confirmed the applicability of the limits in the Integrity Assessment Guidelines (in particular, those related to when non-pressure loads need to be considered) to the SONGS replacement steam generators."

Response Plan:

- The response will compare each type of degradation found in the SGs to the criteria found in the Integrity Assessment Guidelines, including the applicability of non-pressure loads

RAI 26 – AREVA OA Provide Details of Wear Growth Model

NRC RAI:

"Reference 3, page 107 of 129, second to last paragraph – Provide additional details of the wear growth model at the tube supports. Were cumulative probability functions of observed wear rates constructed and randomly sampled when developing the contact force probability distributions at each intersection? Was total gap at each intersection (prior to applying temperature and allowing the model to settle, leading to the development of contact forces) assumed to be the sum of the manufacturing gap and the maximum wear depth?"

Response Plan

- Full details of incorporating wear at AVB locations into the contact force calculations will be provided. Wear locations, wear depths as a function of time, and gap inputs to the contact force model will be discussed

RAI 28 – Westinghouse OA Growth Rate of Unit 3 TTW

NRC RAI:

"Reference 5, Section 2.6.1 – What is the estimated growth rate of the tube-to-tube wear in steam generator 3E0-88, tube R106C78? Describe how it was determined."

Response Plan:

- Explain tube-to-tube wear rates (including tube 3E088, R106C78) were not calculated for tubes in Unit 3
- Explain that in-plane instability was evaluated by benchmarking TTW in Unit 3 tubes:
    - Determined that in-plane instability would occur at a number of tubes including this tube
    - Estimates of tube-to-tube wear rates were not necessary for this evaluation

RAI 29 – Westinghouse OA Case 78

NRC RAI:

“Reference 5, Figures 2-12 and 2-13 – Provide similar figures for Case 78 (all AVBs missing).”

Response Plan:

- Explain Case 78 for all AVBs ineffective at 70% Power was calculated as part of the Westinghouse (WEC) OA. The figures were not included in the WEC OA since no tubes in Unit 2 have Case 78 support conditions
- The figures will be provided in response to this RAI

RAI 1 – 3 x Normal Operating Pressure Differential

NRC RAI:

"The Operational Assessment (OA) in Attachment 6, Appendix A (Reference 2), reports the 3 times normal operating pressure differential as being 4290 psi for 100% power conditions. This is the same value assumed in the Condition Monitoring Assessment provided in Attachment 2. This value is significantly higher than the values ranging from 3972-3975 psi for 100% power reported in Attachment 6, Appendices B, C, and D (References 3-5). Describe the reason for the differences."

Response Plan:

- Each report uses the value of 3xNOPD appropriate to actual (Condition Monitoring) or RTS (Operational Assessment) Reactor Coolant System (RCS) and steam generator (SG) operating conditions that are appropriate to that assessment (Temperatures, Power and SG Secondary Side Pressure)

RAI 1 – 3 x Normal Operating Pressure Differential (cont.)

Response Plan:

- SCE will provide a table listing the RCS and SG parameters used for each report and the basis for the value of 3xNOPD used
- Following completion of the last cycle of operation, the reactor pressure vessel head was replaced and RCS operating temperatures will be restored to nominal (original) design. SCE's assessment of the impact of the temperature increase on Fluid Elastic Instability will be provided

RAI 15 – Retainer bar wear

NRC RAI:

“In Reference 1, Section 8.3.2, page 48 – How will the continued integrity of the non-stabilized, preventively-plugged tubes adjacent to the retainer bars be ensured? “Integrity” in this context refers to the tubes remaining intact and unable to cause damage to adjacent tubes.”

Response Plan:

- Provide a discussion of wear mechanism of tubes adjacent to retainer bars
- Provide a description of stabilizer deployment to ensure integrity of tubes adjacent to retainer bars

RAI 11 – Safety Analysis for Operation at 70% Power

NRC RAI:

“Please submit an operational impact assessment for operation at 70% power. The assessment should focus on the cycle safety analysis and establish whether operation at 70% power is within the scope of SCE’s safety analysis methodology, and that analyses and evaluations have been performed to conclude operation at 70% power for an extended period of time is safe. The evaluation should also demonstrate that the existing Technical Specifications, including limiting conditions for operation and surveillance requirements, are applicable for extended operation at 70% power.”

Response Plan:

- Provide summary of impact evaluations performed for extended operation at 70% power on reactor core design and safety analysis
- Provide table summarizing impact assessment of reload and UFSAR Chapter 15 safety analyses
- Provide table summarizing impact assessment of core design and monitoring technical specification surveillance requirements
- Discuss conclusions of safety analysis methodology, safety analyses, radiological dose consequences, and applicability of Technical Specifications, on extended operation at 70% power

RAI 12 – RCS and Secondary Flow Uncertainty

NRC RAI:

"Operation at a lower power level could introduce additional uncertainty in measuring reactor coolant flow. Please provide a detailed evaluation of RCS flow uncertainty, identify how RCS flow uncertainty is affected by operation at 70% power, and discuss the overall treatment of the RCS flow uncertainty, actual and indicated, in the context of the remaining safety analyses. Provide similar information for secondary flow uncertainty, as well."

Response Plan:

- Provide discussion of detailed RCS flow uncertainty evaluation including how it is affected by operation at 70% power
- Provide discussion of the treatment of RCS flow uncertainty in the context of safety analyses and RCS flow limit requirements of T.S. 3.4.1
- Provide discussions of secondary flow uncertainty evaluations performed for main steam flow, main feedwater flow, and SG blowdown flow parameters

RAI 13 – ECCS Analysis

NRC RAI:

"The installation of new steam generators involved changes to the steam generator heat transfer characteristics, which could affect the performance of the plant under postulated loss of coolant accident conditions. Please explain how the existing ECCS analysis accounts for these changes, and how considerable steam generator tube plugging has been addressed in the ECCS evaluation. Provide the ECCS evaluation that will apply to the planned operating cycle."

Response Plan:

- Provide discussion of the impact evaluation performed for Replacement Steam Generators on ECCS performance analysis
- Provide discussion of the major changes in the planned operating cycle (Unit 2 Cycle 17) and the evaluations performed for their impacts on ECCS performance analysis

RAI 14 – Calculation Dispositions

NRC RAI:

"Provide a summary disposition of the U2C17 calculations relative to the planned reduced-power operation."

Response Plan:

- The summary dispositions of the calculations pertinent to each of the evaluations covered under RAIs #11-13 will be included in their respective responses
- Provide summary of the impacts of reduced-power operation on the Westinghouse/CE plant protection system setpoints including RCP Low-Flow Trip, NR steam generator water level indication and control, and validation of control systems
- Provide summary of RCS internals analysis at reduced-power operation

CLARIFICATION OF RETURN TO SERVICE REPORT RAIS

RAI 20 – AREVA OA Tube Support Clearance

NRC RAI:

"Reference 3, page 17 of 129, refers to tube-to-support design clearance of 2 mils diametral. Confirm that this is the nominal diametral clearance under ambient conditions, or clarify the statement otherwise."

Response Plan

- Explain the design nominal clearance between tubes and AVBs is based on ambient conditions

RAI 21 – AREVA OA Plugged Tubes Considered in Thermal/Hydraulic and Stability Ratio Analysis

NRC RAI:

"Reference 3, page 44 of 129, states that the plugged tubes have an effect on local thermal/hydraulic (TH) conditions upon returning to power and have been included in the stability ratio calculations. The staff interprets this to mean the effect of the plugged tubes on the calculated thermal/hydraulic conditions were considered in the stability ratio calculations and that the stability ratio calculations included the plugged (and stabilized) tubes. Is this correct? Clarify, if not."

Response Plan

- Explain the staff's interpretation is correct

RAI 24 – AREVA OA Clarify Wording Pertaining to Figure 6-20

NRC RAI:

"Reference 3, page 59 of 129, last paragraph – The sentence, "AVBs 2, 3, 11 and 10 near row 27 have sporadic dents in the vicinity of the noses of AVBs 1, 4, 9 and 12" does not appear to make sense. Provide further clarification relative to the discussion of Figure 6-20."

Response Plan

- The sentence will be clarified and explained

RAI 30 – Percentage of Tube Wear vs. Maximum Interstitial Velocity

NRC RAI:

"Reference 1, Figure 8-2 – Provide similar figure for maximum interstitial velocities."

Response Plan:

- A similar figure will be provided for maximum interstitial velocities for SONGS RSGs

There is no timeline on safety