February 2, 2000

Mr. J. A. Scalice
President, TVA Nuclear and
Chief Nuclear Officer
Tennessee Valley Authority
6A Lookout Place
1101 Market Street
Chattanooga, Tennessee 37402-2801

SUBJECT: SEQUOYAH NUCLEAR PLANT, UNITS 1 AND 2 - REQUEST FOR ADDITIONAL INFORMATION ON TOPICAL REPORT WCAP-15128, "DEPTH-BASED SG TUBE REPAIR CRITERIA FOR AXIAL PWSCC AT DENTED TSP INTERSECTIONS" (TAC NOS. MA6434, MA7895, AND MA7899)

Dear Mr. Scalice:

The subject topical report was submitted to the U.S. Nuclear Regulatory Commission (NRC) for review and approval on August 16, 1999, by the Tennessee Valley Authority (TVA) to support a future license amendment for Sequoyah Nuclear Plant (SQN), Units 1 and 2. Subsequently, TVA submitted an SQN-specific license amendment request (No. 99-12) on October 14, 1999, referencing the report. The NRC staff is in the process of reviewing these submittals and has had public meetings and conference calls on the subject.

As discussed during a conference call on February 1, 2000, the NRC staff requires responses to the enclosed Request for Additional Information to complete its review. Mr. James D. Smith of the SQN Licensing Staff stated that TVA would respond to this request by February 18, 2000.

Please have your staff contact me at (301) 415-2010 if there are any questions regarding the enclosed request.

Sincerely,

Ronald W. Hernan, Senior Project Manager, Section 2
Project Directorate II
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Docket Nos. 50-327 and 50-328

Enclosure: Request for Additional Information

cc w/enclosure: See next page

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/RA/
Ronald Hernan, Senior Project Manager
Project Directorate II-3
Division of Reactor Projects - I/II
Office of Nuclear Reactor Regulation

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Enclosure: Request for Additional Information
cc w/enclosure: See next page
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REQUEST FOR ADDITIONAL INFORMATION

TOPICAL REPORT WCAP-15128, "DEPTH-BASED SG TUBE REPAIR CRITERIA

FOR AXIAL PWSCC AT DENTED TSP INTERSECTIONS"

SEQUOYAH NUCLEAR PLANT

DOCKET NOS. 50-327 and 50-328

Introduction

The following clarifications of Westinghouse Topical Report WCAP-15128, Revision 1 "Depth-based SG Tube Repair Criteria For Axial PWSCC at Dented TSP Intersections," submitted by the Tennessee Valley Authority (TVA) to the U.S. Nuclear Regulatory Commission for review and approval, are required for the staff to complete its review.

Chapter 3.0 PULLED TUBE AND LABORATORY SPECIMEN DATABASE

1. Discuss how you treated the uncertainties associated with the destructive examination measurements.

2. The tube pulls from Diablo Canyon and Sequoyah Nuclear Plants were included in the development of the nondestructive examination (NDE) techniques that you will apply in the implementation of this alternate repair criteria (ARC). Discuss the availability of tube pulls from other plants to supplement your database. Discuss the limitations of these NDE techniques if applied to a plant other than Diablo Canyon or Sequoyah.

3. The database of pulled tube specimens and laboratory specimens used for the NDE qualification effort is scattered amongst nine tables, each of which provides different and often extraneous information about the specimens. This inhibits our review of the database upon which you developed your NDE techniques. To facilitate our review, provide one table that contains every specimen used in the development of the bobbin and plus point NDE techniques. Include in the table the specimen identification, how the specimen was used (i.e., for training, for Appendix H qualification, for performance testing), provide destructive examination data (i.e., length, maximum depth, average depth), dent voltage, burst pressure (if available), and leak rate (if available).

Chapter 4.0 NDE DEVELOPMENT

1. The probability of detection developed for the bobbin technique applied for detection of primary-water stress corrosion cracking (PWSCC) at dented tube support plates (TSPs) may be overly optimistic and not truly representative because of the very high overcall rate. The staff believes this aspect of the NDE is extremely demanding of the bobbin coil technique for this application. The limitations of this technique can be minimized if analysts continue to call very conservatively in the field. Discuss how this can be ensured. Discuss also what technique modifications you plan to pursue to improve the detection capability of the bobbin coil probe.

Enclosure

2. Discuss if indications not detected with the bobbin coil and which would be detected with the plus point coil, if they were inspected, could be considered significant flaws. Discuss whether the pulled tube and laboratory specimen data support the statement that significant indications (in terms of leakage or burst probability) can be expected to be detected by the bobbin coil and confirmed by the plus point coil. Discuss whether the data support the observation that indications detected by the bobbin coil and not confirmed through the plus point coil inspection are insignificant.

3. The temperature correction used to combine the Sequoyah and Diablo Canyon growth rates used an "Arhenius equation with a propagation Q value of 32.5 kcal/mol . . . ." Provide the details of the specific equation used to adjust the growth rates for operating temperature. Provide the technical basis for the propagation Q value of 32.5 kcal/mol. Discuss the advantages and disadvantages of each plant using their own plant-specific growth rates. Using growth rates based on plant-specific numbers would be consistent with the approach taken in the ARC for outer diameter stress corrosion cracking (ODSCC) at TSPs (i.e., Generic Letter 95-05). Discuss also why there is no data from Sequoyah Unit 2. This approach of combining the data from Sequoyah Unit 1 and Diablo Units 1 and 2 appears conservative for Diablo Canyon to use (assuming the temperature correction), but it is not conservative for Sequoyah.

4. You stated that the destructive examination profiles are averaged over the plus point coil "effective coil field average" of 0.16 inch for comparison with NDE data. Where did this number come from?

5. The specimens used in your qualification database did not encompass a wide range of dent voltages nor were crack lengths much longer than 1 inch. Discuss the limits you placed on your plus point qualification to address the fact that few specimens were more than 5.0 volts in size or greater than 1 inch in length. Discuss also the limits you placed in the guidelines in general with respect to dent size and geometry, flaw locations and flaw morphology (e.g., multiple vs. separate single axial indications), etc.

6. Provide the staff with the final analyst guidelines and training manual that will be used in the field. Confirm that these guidelines were identical to those used for the NDE performance testing. If not, discuss the differences and their probable effect on the outcome of the performance testing. The guidelines provided in Reference 8-1 of the WCAP topical report provided conflicting information. Appendix A3 has three different examination technique specification sheets (ETSSs) and they differed from one another in significant ways (e.g., cable lengths, frequencies used, rotation settings).

7. The staff notes that a common standard does not appear to be mandated by the analyst guidelines. The staff believes that the analyst guidelines should specifically describe the standard to be used and that this standard should be optimized for this application. Such an optimized standard would include 20, 40, 60, 80 and 100% internal diameter (ID) notches. The phase rotation of the plus point coil is currently

set at approximately 40° on the 100% notch for all frequencies. Because the phase rotation changes with frequency, the phase rotation should be set at the proper value for each frequency. This is critical for shallow ID defects, and thus should be set on a shallow ID notch, such as the 20% notch. The phase shift is approximately linear with depth, and the 20% phase should be set at about 20% of the 100% notch. Clarify your position on the calibration standard and the standard set up for these techniques.

8. From our review, it appears that the best probe in the study was the 0.080-inch-high frequency shielded pancake coil. In fact, the Westinghouse report recommended using this coil when the dent signals are minimal, and the Diablo Canyon ETSSs also stated that some small defects cannot be detected by the plus point and that the 0.080-inch-high frequency pancake coil must be used. Clarify your position on the use of this coil. It appears to the staff that its use should be mandated when the dent sizes are small, and clear guidelines should be developed as to its usage.

9. From our review, it appears also that the use of a high frequency (i.e., 800 kHz) plus point probe improves the detectability of small ID flaws. The use of the plus point is preferred over the 0.080 inch coil discussed in the previous question for larger dent sizes. Because the low frequencies of the mid-range plus point probe are not being used, the staff recommends using the high frequency plus point over the mid range plus point to allow better detectability. Clarify your position on the use of the high frequency plus point probe.

<u>Chapter 5.0</u> <u>BURST PRESSURE ANALYSES</u>

1. Section 5 is difficult to follow as a stand-alone documentation of the burst pressure analysis methodology since it presumes intimate familiarity on the part of the reader with past topical reports on voltage based repair limits for ODSCC and with much of the other background information discussed. Revisions to Section 5 to better explain the background material will facilitate the staff's review by reducing the need for reviewing the source documents of the background material. In addition, it would be helpful to expand the discussion in the bottom paragraph of page 5-6 and continuing on through the first full paragraph on page 5-7 to expedite understanding of how the statistic model was developed.

2. Westinghouse stated during the January 19, 2000, public meeting that it intended to delete Sections 5.4 and 5.5 of the topical report. The staff believes that the topics covered in these sections are an integral component of the proposed methodology and should continue to be addressed in the revised report. Sections 5.1, 5.2 and 5.3 say very little about how uncertainties in the "final predictive equation" (bottom of page 5-5) were modeled, other than to note that Figure 6 confirms that the residuals of the logarithm of the pressure do not contradict the assumption of being from a normal distribution. A complete description of the statistical modeling used to account for the parameter uncertainty of the "final predictive equation" and of the variability or scatter of the measured normalized burst pressures about the regression line indicated by the equation are needed. Sufficient information is needed to allow one to reproduce the results produced by the model. In addition, a

benchmark for comparing results, such as that provided by Figure 5-8 is needed.

3. Describe or reference the basis for the adjustment term for the PTW expression given on page 5-6. (Note, equation numbers would be helpful.)

4. Regarding the database used to develop the regression analysis in Section 5.0, confirm that the model predicted burst pressure for the following points is correctly defined in the database: San Onofre 2 R061C111-09, San Onofre 2 R094C032-07, and Arkansas Nuclear One 2 R016C056. If these values are misrepresented in the database, re-evaluate the regression analysis.

5. Regarding the application of a probabilistic Monte Carlo-based analysis to evaluate the burst behavior of the indicated flaws:

   1. Provide a detailed explanation of how the Monte Carlo program operates. Include in this an explanation of how the distributions for each variable will be developed.

   2. Provide a flow diagram and written description which shows how the depth NDE uncertainty, length NDE uncertainty, and growth rates are incorporated into the analysis. Explain how the distributions for these parameters will be developed and applied. Demonstrate that the application of these factors in the Monte Carlo analysis is not order dependant, or that the order in which they are applied is conservative.

   3. Explain how the random numbers are generated in the Monte Carlo analysis and how the random number generator is qualified for this application.

<u>Chapter 6.0</u> <u>STEAMLINE BREAK (SLB) LEAK RATE ANALYSIS</u>

1. Section 6.2.2 states that material properties including flow stress for the data sets were only sometimes available; otherwise mean properties for I-600 were used. Given that operational assessments are intended to produce conservative estimates of total steam generator (SG) leak rate (e.g., “95/95" estimates), what is the justification for use of mean properties rather than a more conservative assumption (presumably upper bound properties)?

2. Concerning your note in Section 6.2.3, that various combinations of mean or through-wall crack length can be used with varying values of tortuosity and surface roughness to develop the leak models as long at it is normalized to the available data, confirm that the crack morphologies on which the available data were developed are consistent with the flaws found in service. This similarity is necessary to conclude that the choice of modeling parameters will not effect the applicability of the model.

3. The statistical modeling of leak rate uncertainties for a given crack size is not discussed in great detail in Section 6. Sufficient information should be provided, if it

   hasn’t been already, to allow the staff to reproduce the model predictions. Of particular interest to the staff is how well the slope and intercept uncertainty of the regression fit has been modeled.

Chapter 7.0 OVERVIEW OF ARC AND SUPPORTING ANALYSES

1. In the first paragraph of Section 7.5.1, the report states that no leakage is expected for a maximum crack depth less than 85%. Provide the basis for this statement, including any implicit assumptions.

2. Section 7.5.5: The last sentence in the first paragraph appears inconsistent with the last sentence of the second paragraph and with the approach in NRC Generic Letter 95-05. Clarify the approach to be used and justify it to the extent that it is different from that used in generic letter.

3. Section 7.5.6: Reference is made to a “separate PG&E submittal for licensing considerations.” It would be helpful to state that the submittal pertains to a voltage-based ARC for ODSCC at tube support plates.

4. Section 7.5.6, FLB or SLB +SSE: It is stated that compressive stress has the capability to reduce burst capability if stress is sufficiently large, presumably above the yield strength. Given the possibility that the tubes are locked at the tube support plates, what is the potential, if any, for axial compressive stress approaching the yield strength due to differential thermal expansion between the tubes and the shell?

5. Justification for use of the Cecco probe as part of the implementation of the proposed ARC should be provided. Alternatively, the Cecco should be eliminated as an inspection option from WCAP-15128.

6. If Cecco is used for detection in lieu of the bobbin, what is the basis for not inspecting all TSP intersections as would be the case if bobbin is used? In addition, there seems to be a circular inconsistency between the plus point and Cecco inspection requirements. Plus point inspections are to include, in part, all TSP intersections having > 2 volt dents up to the highest TSP for which PWSCC has been detected (by Cecco, presumably) in the prior and current inspection. Ceccos are to be performed for all dented TSP intersections up to the highest TSP for which axial PWSCC has been confirmed by plus point in the prior and current inspections.

7. Section 7.7: The first sentence refers to an optional SLB burst probability calculation which can be performed for indications predominantly inside the TSP. The proposed acceptance criteria would need to be included in the topical report and in the Technical Specification Bases. It is stated that sufficient Monte Carlo samples will be performed to obtain adequate statistical confidence in the SG SLB burst probability. What constitutes an acceptable level of confidence?

8. Section 7.7, first paragraph: The discussion on in-situ pressure tests needs to be clarified to indicate that in-situ pressure testing is not able to demonstrate that the total crack length (inside and out of the TSP) meets 1.43xSLB.

9. Section 7.7, second paragraph: The seven samples referred to in this paragraph do not appear to convincingly demonstrate that all cracks with maximum depths exceeding 98% through wall can be expected to be predicted 100% through wall by NDE analysis. Further, it cannot seem to be preluded that PWSCC with a maximum depth of 98% cannot break through and leak under main steamline break (MSLB) conditions. Staff estimates show that even a 95% through wall crack, 0.25-inches long can pop through and leak under MSLB differential pressure. Finally, it is not clear in view of the above concerns and given the depth measurement uncertainties reported in Section 4 of the WCAP how a 90% depth call with the plus point provides an adequate threshold for performing a detailed leakage assessment.

10. Section 7.7, page 7-11, last sentence of first full paragraph: This last sentence states that methods described below are applied for condition monitoring assessments if the structural limits of Section 7.4 are exceeded for any indication. It is the staff's understanding that the structural limits in Section 7.4 are not sufficient to fully evaluate burst margins for a given crack profile. This sentence also seems to conflict with the methodology summary given at the bottom of page 7-12 and top of page 7-13 and with the flow chart handed out at the January 19, 2000, public meeting.

11. Revisions to the technical specification amendment package are needed to reflect agreements reached at the public meeting on January 19, 2000, to facilitate staff review to support the TVA need date. These include limiting application of the proposed ARC to axial PWSCC indications, or portions thereof, located within the thickness of dented tube support plate. In addition, the proposed maximum depth limit as described in the proposed TS Bases and in WCAP-15128 is to be used for screening purposes only. The proposed TS Bases and WCAP-15128 should be revised to state that for indications where the maximum depth limit is satisfied, the repair bases are then obtained by projecting the crack profile to the end of the next operating cycle and determining the burst pressure and the potential accident-induced leak rate associated with the projected profile based on a detailed structural and leakage analysis of that profile. The WCAP should be revised to include a description of the leakage evaluation. The projected accident leak rate for the subject indication is included in the operational assessment as part of the calculation of total accident induced leak rate (from all indications and degradation mechanisms). Both the burst pressure margins and total accident leakage rate must be acceptable for the subject indication to be left in service.

12. The WCAP should be revised to indicate that accident induced leakage should be evaluated at 95/50 and 95/95 for condition monitoring and operational assessment, respectively, for both total crack length and free span crack length.

Mr. J. A. Scalice
Tennessee Valley Authority

SEQUOYAH NUCLEAR PLANT

cc:
Mr. Karl W. Singer, Senior Vice President
Nuclear Operations

Tennessee Valley Authority
6A Lookout Place
1101 Market Street
Chattanooga, TN 37402-2801

Mr. Jack A. Bailey
Vice President
Engineering & Technical Services
Tennessee Valley Authority
6A Lookout Place
1101 Market Street
Chattanooga, TN 37402-2801

Mr. Masoud Bajestani
Site Vice President
Sequoyah Nuclear Plant
Tennessee Valley Authority
P.O. Box 2000
Soddy Daisy, TN 37379

General Counsel
Tennessee Valley Authority
ET 10H
400 West Summit Hill Drive
Knoxville, TN 37902

Mr. N. C. Kazanas, General Manager
Nuclear Assurance
Tennessee Valley Authority
5M Lookout Place
1101 Market Street
Chattanooga, TN 37402-2801

Mr. Mark J. Burzynski, Manager
Nuclear Licensing
Tennessee Valley Authority
4X Blue Ridge
1101 Market Street
Chattanooga, TN 37402-2801

Mr. Pedro Salas, Manager
Licensing and Industry Affairs
Sequoyah Nuclear Plant
Tennessee Valley Authority
P.O. Box 2000
Soddy Daisy, TN 37379

Mr. D. L. Koehl, Plant Manager
Sequoyah Nuclear Plant
Tennessee Valley Authority
P.O. Box 2000
Soddy Daisy, TN 37379

Mr. Russell A. Gibbs
Senior Resident Inspector
Sequoyah Nuclear Plant
U.S. Nuclear Regulatory Commission
2600 Igou Ferry Road
Soddy Daisy, TN 37379

Mr. Michael H. Mobley, Director
TN Dept. of Environment & Conservation
Division of Radiological Health
3rd Floor, L and C Annex
401 Church Street
Nashville, TN 37243-1532

County Executive
Hamilton County Courthouse
Chattanooga, TN 37402-2801