



UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001
November 23, 2009

Mr. Mark J. Ajluni
Manager, Nuclear Licensing
Southern Nuclear Operating Company, Inc.
40 Inverness Center Parkway
P.O. Box 1295
Birmingham, Alabama 35201

SUBJECT: VOGTLE ELECTRIC GENERATING PLANT, UNITS 1 AND 2 - TRANSMITTAL OF UNRESOLVED ISSUES REGARDING PERMANENT ALTERNATE REPAIR CRITERIA FOR STEAM GENERATORS (TAC NOS. ME1339 AND ME1340)

Dear Mr. Ajluni:

By letter to the U.S. Nuclear Regulatory Commission (NRC) dated May 19, 2009 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML091470701), as supplemented August 28, 2009 (ADAMS Accession No. ML092450101), Southern Nuclear Operating Company, Inc. (SNC, the licensee), submitted a license amendment request to revise the technical specifications (TSs) for Vogtle Electric Generating Plant, Units 1 and 2 (VEGP). The request proposed changes to the inspection scope and repair requirements of TS Section 5.5.9, "Steam Generator (SG) Program" and to the reporting requirements of TS Section 5.6.10, "Steam Generator Tube Inspection Report." The proposed changes would have established permanent alternate repair criteria for portions of the SG tubes within the tubesheet.

On September 2, 2009, in a teleconference between the NRC staff and the licensee, the NRC staff stated that an issue relating to the treatment of tubesheet bore eccentricities had not been resolved and that there was insufficient time to resolve this issue and evaluate the permanent amendment request for the fall 2009, refueling outage at VEGP Unit 1. By letter dated September 11, 2009 (ADAMS Accession No. ML092540511), the licensee revised its amendment request to be an interim change applicable to Unit 1 during refueling outage 15 and the subsequent operating cycle, and to Unit 2 during refueling outage 14 and the subsequent operating cycle.

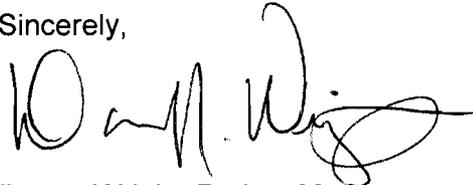
In the September 11, 2009, letter, the licensee also requested the NRC staff to provide the specific questions concerning the tubesheet bore eccentricity issue which must be resolved to support a permanent alternate repair criteria amendment request.

M. Ajluni

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Accordingly, enclosed are the specific questions that are currently identified and remain unresolved concerning the eccentricity issue. This information would be needed for the NRC staff to complete its review of any future permanent alternate repair criteria amendment request.

Sincerely,

A handwritten signature in black ink, appearing to read "Donna Wright". The signature is fluid and cursive, with a large initial "D" and "W".

Donna Wright, Project Manager
Plant Licensing Branch II-1
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket Nos. 50-424 and 50-425

Enclosure:
As stated

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TRANSMITTAL OF UNRESOLVED ISSUES REGARDING
PERMANENT ALTERNATE REPAIR CRITERIA FOR STEAM GENERATORS
VOGTLE ELECTRIC GENERATING PLANT, UNITS 1 AND 2
DOCKET NOS. 50-424 AND 50-425

Background:

By letter dated May 19, 2009 (Reference 1), and as supplemented August 28, 2009 (References 2 and 5), Southern Nuclear Operating Company, Inc., (SNC, the licensee), submitted a license amendment request to revise the technical specifications (TSs) for Vogtle Electric Generating Plant, Units 1 and 2 (VEGP). The request proposed changes to the inspection scope and repair requirements of TS Section 5.5.9, "Steam Generator (SG) Program" and to the reporting requirements of TS Section 5.6.10, "Steam Generator Tube Inspection Report." The proposed changes would have established permanent alternate repair criteria for portions of the SG tubes within the tubesheet.

On September 2, 2009, in a teleconference between the Nuclear Regulatory Commission (NRC) staff and the licensee, the NRC staff stated that an issue relating to the treatment of tubesheet bore eccentricities had not been resolved, and that there was insufficient time to resolve this issue and evaluate the permanent amendment request for the fall 2009, refueling outage at VEGP Unit 1. By letter dated September 11, 2009 (Reference 7), the licensee revised its amendment request to be an interim change applicable to Unit 1 during refueling outage 15 and the subsequent operating cycle and to Unit 2 during refueling outage 14 and the subsequent operating cycle. The licensee also requested that the NRC staff provide the specific questions concerning the eccentricity issue which must be resolved to support a permanent amendment.

Below are the specific questions that are currently identified and remain unresolved concerning the tubesheet bore eccentricity issue. This information is needed for the NRC staff to complete its review of any future request for a permanent amendment.

Unresolved Questions:

1. Provide a complete description of the model used to develop the relationship between eccentricity and scale factor in Section 6.3 of Reference 1. This description should address, but not be limited to addressing, the following questions:
 - a. Provide complete description of Table RAI [request for additional information] 4-3 in Reference 2. Give complete details of the role of the "slice model" in the development of this table. Give complete details of the role of the 2-D lower SG shell axisymmetric model in the development of this table.

Enclosure

- b. Confirm the relevancy of each of the input parameters listed at the top of the table. For example, if the table is entirely based on the "slice model" results, then the assumed shell and channel head temperatures do not seem to be relevant to the results in Table RAI 4-3.
 - c. Explain why there are two values listed for tube/tubesheet interaction values at the top of Table RAI 4-3. Explain the differences between the two values in detail. Explain why one of the values is negative.
 - d. Given that the final eccentricity values shown in Table RAI 4-3 were obtained from the slice model and that the only load considered in the analysis was a temperature loading of the tube and sleeve, explain how it is physically possible for the final eccentricity to be larger than the initial eccentricity. Might this result indicate that the slice model is not valid and, if not, why not?
 - e. Why are the listed contact pressures in Table RAI 4-3 different from those in Table RAI 4-2 for the same level of initial eccentricity? What method of analysis was used to calculate the contact pressures in Table RAI 4-3? What coefficient of thermal expansion (CTE) was assumed for the tubesheet when determining the final eccentricities and contact pressures in Table RAI 4-3? If greater than zero, why weren't consistent assumptions for tubesheet CTE used for developing both Table RAI 4-2 and Table RAI 4-3, and why does the use of a non-zero value for CTE produce conservative values of scale factors in Table RAI 4-4?
 - f. Item five near the top of page 18 of Reference 2 states that the slice model provides the input for using the scale factor relationship (equation RAI 4-1). This differs from the NRC staff's understanding from Section 6.3 of Reference 1 that it is the eccentricities and delta Ds from the 3-D finite element analyses (or the axisymmetric model in previous analyses) that are actually used as input to equation RAI 4-1. Please clarify this apparent discrepancy.
2. On page 9 of Reference 2, it is stated that the polynomial fit between initial eccentricity and scale factor (old eccentricity model) was appropriate for the conditions for which it was developed, but leads to physically impossible results when extrapolated significantly outside its "data basis" such as was the case for the steam line break (SLB) conditions for the Model D-5 SGs. This apparently refers to the fact that the old eccentricity model was based on the application of a temperature loading of 500 degrees F to the slice model, whereas the tube and tubesheet temperatures during SLB for Model D5 SGs is substantially less than this value. The NRC staff has the following questions:
 - a. The slice model used to develop Table RAI 4-2 considered a 500 degree F expansion of the tube and sleeve, but no temperature expansion of the tubesheet. The NRC staff notes that this is not prototypical for either model SG under any condition. What is the rationale for saying that the SLB temperatures for Model D5 SGs are outside the "data basis" for the old eccentricity model, but that the normal operating temperatures for the Model F and D5 SGs and SLB temperature for Model F SGs are consistent with the data basis? This question references

Table RAI 4-2 only, since the NRC staff is unclear about what tubesheet temperature expansion was assumed in Table RAI 4-3 (see question 1.e above).

- b. The data basis for the old eccentricity model does not include pressure loadings. What is the rationale for concluding that actual pressure conditions do not represent an extrapolation significantly outside the data basis?
 - c. The old eccentricity model considered a sleeve to be present, which is not the case for the plants in question. The assumed presence of a sleeve is tantamount to considering a tube which has twice the radial stiffness of an unsleeved tube. What is the rationale for concluding that use of the actual radial stiffness of the un-sleeved tubes does not represent an extrapolation significantly outside the data basis?
 - d. The old eccentricity model, including the third order polynomial expression for the scale factor, was developed for eccentricity values ranging to a maximum value as given in Table 6-20 of Reference 1. This value comes close to bounding the maximum eccentricities calculated by the 3-D finite element models for Model D5 SGs under normal operating and SLB conditions. However, this value is less than half of the calculated eccentricities from the 3-D finite element analysis for the Model F SGs. Whereas the maximum scale factor for Model D5 SGs for SLB just slightly exceeds the maximum value in the "data basis," Table 6-20 in Reference 1, and the maximum value of scale factor for the Model F SLB case is well beyond the "data basis." Why do such wide extrapolations from the data basis for Model F SGs lead to conservative results?
3. Reference 2 at the top of page 19 states, "The results from the "slice" model cannot be linearly scaled to lower temperatures because the method of superposition has been shown during the development of the current H* analysis to not apply to the non-linear combination of materials and loading in the lower SG complex." Is the old eccentricity model based entirely on the slice model and not the axisymmetric model of the lower SG complex? Assuming this understanding is correct; explain why the results of the slice model are not scalable to lower temperatures.
 4. Table RAI 4-1 in Reference 2 is accompanied by the "original Table RAI 4-4." Explain the differences between these two tables. For example, the original Table RAI 4-4 shows an average eccentricity for Model F SGs for normal operating conditions which appear different from the average eccentricity data in Table RAI 4-1.
 5. Regarding Table RAI 4-5 of Reference 2:
 - a. What are the temperature inputs (step five) for each case?
 - b. What are the displacements of the horizontal and vertical edges of the cell model after each of the steps four through nine?

- c. Are the E-bar displacements added to the displacements existing after step five, or do the applied E-bar displacements replace the displacements existing after step five? Why aren't the applied E-bar displacements over-restraining the model? The NRC staff notes that the applied E-bar displacements do not allow for further displacement of the upper and lower edges during steps seven through nine, tending to maximize the contact stresses. Would it be more realistic to apply force boundary conditions (rather than displacement boundary conditions) to the horizontal edges of the cell models such as to achieve the desired eccentricity?
 - d. What are the displacement boundary conditions (applied during step six) that are applied to the sides of the square cell? Free to displace? Zero displacement?
 - e. Provide an expanded version of Table RAI 4-5 which shows the average, maximum and minimum contact pressures as a function of E-bar for steps five through nine as defined in Figure RAI 4-2.
 - f. Contact pressure seems to reach essentially zero for eccentricity values that are only one-fourth of the maximum values calculated by the 3-D finite element model, as shown in Table RAI 4-1, for Model F SGs and one-third for Model D5 SGs. Why does this not imply a loss of contact between the tube and tubesheet at locations where the 3-D finite element model is predicting relatively high eccentricities? A related question pertains to item two on page 21 of Reference 2 which states that eccentricities from the unit cell model are "generally comparable" to those from the 3-D finite element analysis (FEA) model. Explain the apparent discrepancy between the words "generally comparable" and how the unit cell eccentricities in Table RAI 4-5 actually compare to 3-D FEA eccentricities. Explain how the unit cell model adequately addresses the actual range of eccentricities from the 3-D FEA model.
6. Provide information as needed to reconcile Table RAI 4-6 with Table RAI 4-1 in Reference 2. For example, the eccentricities in line one of Table RAI 4-6 for Model F don't match eccentricities in Table RAI 4-1. The NRC staff has the same question about the average delta Ds in the two tables, although in this case the differences are minor. Also, explain why the average contact pressures in line two of Table RAI 4-6 do not match those in Table 6-25 of Reference 1.
 7. The bullet at the bottom of page 19 of Reference 2 states, "To address if tube to tubesheet contact continues for all assumed tubesheet displacements, the appropriate reference condition is the initialized condition (after step four) of the model that simulates a tube expanded in the tubesheet bore." Please clarify this sentence. Is it based on a premise that the residual contact pressures (introduced during steps one through four) are to be ignored? If not, explain why the statement is true. The NRC staff notes that the test of whether tube to tubesheet contact is actually maintained is whether positive contact pressure is maintained all around the circumference of the tube.
 8. The bullet at the top of page 20 states, "To compare the results of the unit cell model with the 3-D FEA model, the appropriate reference condition of the unit cell model is the initial model (step zero) without the tube expansion simulated and thermal loads must be included." Please clarify this sentence. Does this statement refer to the bore diameter

displacements and eccentricities, or does it refer to some other parameter? Do the bore displacements from step one through at least step five (if not step nine, depending on the response to question 5.b above) of the unit cell model reflect the tube expansion process in steps one through four? If not, why? Is it primarily steps five and six that are intended to replicate the finite element analysis? If not, why? If yes, then why is step four not the appropriate reference condition for comparing the displacements from step six for purposes of comparison with the 3-D FEA displacements?

9. Figures RAI 4-5 for Model F and RAI 4-6 for Model D5 SGs shows the relationship between the applied E-bar displacement and the resulting eccentricity of the tubesheet bore. The slope of the relationship changes sharply above the third data point and actually become negative for SLB. The discussion of these figures on page 20 of Reference 2 needs to be clarified or expanded to allow the NRC staff to understand the reason for these trends. For example, for the case of SLB, explain how an increase in the applied E-bar displacement can lead to a decrease in tubesheet bore eccentricity when all other variables, including temperature and pressure are held constant. This explanation should include the unit cell displacement diagrams showing both the E-bar displacements and the bore displacements for incrementally different values of E-bar above the third data point.
10. Item one on page 21 of Reference 2 states, "The delta Ds from the 3D FEA model are significantly less than the corresponding delta Ds from the unit cell model from the unloaded to fully loaded condition ...". Explain how this supports the conclusion in item one that the unit cell model displacement and contact pressure results conservatively represent the reference 3D FEA results. The NRC staff notes that the delta Ds from the unit cell model include the effects of pressure acting on the inside surface of the tube, whereas the 3-D FEA results do not. How do the incremental bore delta Ds from steps five and six of the unit cell model compare with the results from the 3-D FEA analysis? Does this comparison support the conclusion in item one?
11. Should the words "bore eccentricities" in the first line of the last paragraph on page 28 of Reference 2 read "E-bar displacements"? If not, why?
12. From the bottom of page 28 to page 33 of Reference 2, the text appears to discuss a new eccentricity analysis. This question does not need a response for Model F, Model 44F, and Model 51F SGs, provided this new eccentricity analysis will continue to play no role in the H* analyses for these SG models. The NRC staff has the following questions concerning this analysis.
 - a. What are the specific objectives of the analysis?
 - b. Specifically, how is the analysis different from the analyses performed in the Model D5 White Paper (Reference 4)?
 - c. Describe the analysis in detail.
 - d. Provide a table of results similar to RAI 4-5 in Reference 2, but expanded to include the information requested in question 5.e above.

- e. The assumed delta T at the top of page 29 for the case of the Model D5 SLB does not appear to be consistent with what is assumed in the reference analysis in Reference 3 or with what is assumed in Reference 4. Explain this apparent discrepancy.
 - f. Why does the analysis discussed in the first paragraph on page 29 consider a location 2 inches below the top of the tubesheet rather than the top of the tubesheet where the eccentricities are generally higher? Why is consideration of the 2-inch location conservative from the standpoint of evaluating the eccentricity effect?
 - g. The term "Figure RAI 4-10" is used for two different Figures; on page 31 and page 32. This RAI will refer to the figure on page 32 as Figure RAI 4-10a for clarity. The second paragraph on page 29 refers to Figure RAI 4-8 which appears to be an incorrect figure number. Is Figure RAI 4-9 the correct figure?
 - h. Regarding Figure RAI 4-9, it is unclear what the horizontal axis represents since the terms "relative tubesheet displacement, e (in)" is ambiguous. Is it eccentricity, $D_{max} - D_{min}$, or E_{bar} ?
 - i. Is it correct that in the legend for Figure RAI 4-9, "H* Results – Old Fit" refers to the old eccentricity model discussed in Section 6.3 of Reference 1, "H* Results – New Fit" refers to the new eccentricity model discussed in Reference 4, and "Model D5 FEA Trend" refers to the most recent model discussed on pages 28 to 34 of Reference 2? If incorrect, provide the correct information.
 - j. The third paragraph on page 19 states that Figure RAI 4-9 shows contact pressure ratio as a function of E_{bar} . Should "RAI 4-9" read "RAI 4-10"?
 - k. Explain in detail how each of the curves in Figures RAI 4-9 and RAI 4-10 were determined.
13. Provide an updated version of Table RAI 4-7 (Reference 2) showing the contact pressure reduction and final contact pressure as a function of eccentricity based on the "old eccentricity model" (Reference 1, Section 6.3), "new eccentricity model" (Reference 4), and the latest eccentricity model (Reference 2). The table should include both Model F and Model D5 SGs for normal operating and SLB conditions. The eccentricity cases should be those that can be cross-referenced with the updated versions of RAI 4-5 of Reference 2 requested in questions 5.e and 12.d above.
14. The calculated H* distances in Reference 1 took no credit for residual contact pressure due to the hydraulic tube expansion process. Although calculated H* distances for the case where credit is taken for the residual contact pressure was provided in Reference 5, the NRC staff did not rely on these calculations when approving the interim H* amendment in Reference 6. Is it necessary to take credit for residual contact pressure to support a conclusion that the tubes remain in contact with the tubesheet for the full circumference of the tubes at all locations for normal operating and accident conditions? If so, provide rationale that there is sufficient residual contact pressure to support such a conclusion.

References:

1. Southern Nuclear Operating Company, Inc. (SNC), letter NL-09-0547, "Vogtle Electric Generating Plant License Amendment Request to Revise Technical Specification (TS) Sections 5.5.9, "Steam Generator (SG) Program" and TS 5.6.10, "Steam Generator Tube Inspection Report" for Permanent Alternate Repair Criteria," May 19, 2009, NRC ADAMS Accession No. ML091470701. This letter also transmitted Westinghouse Electric Company (WEC) report, WCAP-17071-P (Proprietary) and WCAP-17071-NP (Non-Proprietary), Rev. 0, "H*: Alternate Repair Criteria for the Tubesheet Expansion Region in Steam Generators with Hydraulically Expanded Tubes (Model F)," April 2009; NRC ADAMS Accession Nos. ML091470699 (Introduction through Chapter 5 - Proprietary), ML091470700 (Chapter 6 to end - Proprietary), and ML091470698 (Non-Proprietary).
2. SNC letter NL-09-1375, August 28, 2009, responding to VEGP RAI No. 4, NRC ADAMS Accession No. ML092450333 and transmitting WEC letter SGMP-09-109-P Attachment "Response to NRC Request for Additional Information on H*; RAI #4; Model F and Model D5 Steam Generators," dated August 25, 2009, NRC ADAMS Accession Nos. ML092450334 (Proprietary) and ML092470144 (Non-Proprietary).
3. Westinghouse Electric Company report, WCAP-17072-P and WCAP-17072-NP, Rev. 0, "H*: Alternate Repair Criteria for the Tubesheet Expansion Region in Steam Generators with Hydraulically Expanded Tubes (Model D5)," May 2009, NRC ADAMS Accession Nos. ML091670159 (Introduction through Section 6.2.2.2.2 - Proprietary), ML091670160 (Section 6.2.2.2.3 through Section 6.2.5.3 - Proprietary), ML091670161 (Section 6.2.6 through Appendix), and ML091670172 (Non-Proprietary). This report was submitted by Luminant Generation Company LLC letter CP-200900748, June 8, 2009, NRC ADAMS Accession No. ML091670154.
4. Westinghouse report, LTR-09-66-P, LTR-09-66-NP, "White Paper: Low Temperature Steam Line Break Contact Pressure and Local Tube Bore Deformation Analysis for H*," May 13, 2009, NRC ADAMS Accession Nos. ML092610441 (Proprietary) and ML092610440 (Non-Proprietary).
5. SNC letter NL-09-1265, August 28, 2009, responding to VEGP RAIs and transmitting WEC letter LTR-SGMP-09-100-P and LTR-SGMP-09-100-NP, "Response to NRC Request for Additional Information on H*; Model F and D5 Steam Generators," dated August 12, 2009, NRC ADAMS Accession Nos. ML092450102 (Proprietary) and ML092450101 (Non-Proprietary).
6. NRC letter to Southern Nuclear Operating Company, "Vogtle Electric Generating Plant, Units 1 and 2, Issuance of Amendments Regarding Technical Specification (TS) Section 5.5.9, "Steam Generator Program," and TS 5.6.10, "Steam Generator Inspection Report," for Interim Alternate Repair Criteria," September 24, 2009, NRC ADAMS Accession No. ML092170782.

7. SNC Letter NL-09-1411, "Vogtle Electric Generating Plant License Amendment Request to Revise Technical Specification (TS) Sections 5.5.9, "Steam Generator (SG) Program" and TS 5.6.10, "Steam Generator Tube Inspection Report" for Interim Alternate Repair Criteria," September 11, 2009, NRC ADAMS Accession No. ML092540511.

M. Ajluni

- 2 -

Accordingly, enclosed are the specific questions that are currently identified and remain unresolved concerning the eccentricity issue. This information would be needed for the NRC staff to complete its review of any future permanent alternate repair criteria amendment request.

Sincerely,

/RA/

Donna Wright, Project Manager
Plant Licensing Branch II-1
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket Nos. 50-424 and 50-425

Enclosure:
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