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SOUTHERN COMPANY

June 20, 2011

Docket Nos.: 50-424
50-425

NL-11-1178

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

Vogtle Electric Generating Plant
Response to Presubmittal Consideration of Steam Generator Alternative Repair
Criteria Requirements Request for Additional Information

Ladies and Gentlemen:

The response to the NRC Presubmittal Consideration of Steam Generator Alternative Repair Criteria Requirements Request for Additional Information dated May 26, 2011, is provided in the Enclosure to this letter.

This letter contains no NRC commitments. If you have any questions, please contact Jack Stringfellow at (205) 992-7037.

Respectfully submitted,

Paula M. Marino

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Vice President - Engineering

PMM/DWM/lac

Enclosure: Response to Presubmittal Consideration of Steam Generator Alternative Repair Criteria Requirements Request for Additional Information

cc: Southern Nuclear Operating Company
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U. S. Nuclear Regulatory Commission
Mr. V. M. McCree, Regional Administrator
Mr. P. G. Boyle, NRR Project Manager - Vogtle
Mr. M. L. Cain, Senior Resident Inspector – Vogtle

Enclosure 1

Vogtle Electric Generating Plant
Response to Presubmittal Consideration of Steam Generator Alternative Repair Criteria Requirements Request for Additional Information

NRC Question:

> "The Nuclear Regulatory Commission (NRC) staff understands that in responding to MPR question 22, Westinghouse made adjustments to the coefficient of thermal expansion (CTE) statistics. One of these adjustments was that the tube and tubesheet CTE sample variances were calculated using the data from only the Westinghouse experiments in order to decrease the spread of data at a given temperature. What is the justification for not considering all the data available? What effect would consideration of all available data have on the calculated variances versus what was considered in the probabilistic H* analysis?"

Response:

To address the independent review question regarding the variance in the CTE, Westinghouse used only the Westinghouse test data to compute the tube and tubesheet sample variances. MPR noted that "other industry data were not used in the calculation because details on the testing used to obtain the data were not available." In their clarification of their question number 22, MPR notes that "MPR performed this comparison for a few different temperatures of tube and tubesheet CTEs and verified the absolute values were conservative" and concluded that "Based on this additional information, MPR believes the original sample statistics used to calculate probabilistic H* were conservative." Westinghouse did not make adjustments to the coefficient of thermal expansion statistics but, rather, used the only available detailed data in a statistically rigorous manner to respond to the independent review questions. This exercise demonstrated that the CTE variability applied in the H* analysis is conservative.

A comment from MPR stated that it was inappropriate to consider measured CTE values from the same specimen at different temperatures to be independent. Therefore, in order to demonstrate to MPR that the baseline results were conservative, Westinghouse performed additional calculations to show that the values for tube and tubesheet CTE standard deviation (2.33% and 1.62%, respectively) were conservative even when used as 95% confidence values. To satisfy this comment, calculations were performed at each test temperature.

The methodology to determine high-confidence standard deviations involves determining the best estimate (50% confidence) standard deviation by the standard formula. This value is then adjusted with a Chi-Squared (χ^2) statistic appropriate to the number of degrees of freedom and confidence (95%) required. In order to perform such calculations accurately, the sample population must be appropriately chosen. In particular, the data must be independent and homogeneous. In order to ensure the homogeneity of the sample population, it was necessary to focus on only the data from the Westinghouse test program because other industry data considered posed several homogeneity issues to the statistical analysis, which are discussed below.

The non-Westinghouse data from other sources included values from handbooks and the ASME code. These data points do not represent specific samples, but appear to be population statistics from an unknown sample population. While the values are likely sample means from valid testing programs, the ASME code

states that the CTE values are not averages, but rather represent "typical" values. It is statistically inappropriate to combine independent samples (such as from Westinghouse's test program) with values from a handbook which represent some known or unknown population statistic of an unknown sample size. To do so would invalidate the calculation of even a best-estimate sample variance.

The inclusion of other data points also poses a homogeneity problem due to measurement variance. Accurate measurement of CTE's, particularly at low temperatures, is difficult and generally includes a significant amount of measurement variance. This was also noted by the expert panel that monitored the Westinghouse test program. Since data obtained from sources outside of Westinghouse's testing program would have different measurement variance, inclusion of data points outside of Westinghouse's test program would have invalidated the calculation of sample variance by making the population inhomogeneous. As part of the test program, Westinghouse required the testing laboratory (Anter) to repeat measurement of the CTE of the same sample 10 times for both tube and tubesheet material specimens. This allowed for a determination of the measurement variance, which could then be adjusted to a high-confidence lower bound. This lower bound instrumentation variance could then be subtracted from the sample variance to determine a high-confidence sample variance which is free of measurement variance. Inclusion of data points from outside of the Westinghouse test program would have precluded the calculation of measurement variance by making the sample population inhomogeneous.

For the reasons above, the non-Westinghouse data were not included in the calculation of high-confidence tube and tubesheet standard deviations in response to MPR's question. The data was originally included because a wide range of values was being considered to determine an appropriate variance to use in Monte Carlo analysis for H*. The expert panel concluded that this was a conservative (albeit statistically non-rigorous) approach, and therefore appropriate to use for the purposes of H* calculations. In response to MPR's question, Westinghouse performed a detailed, statistically rigorous calculation to demonstrate that the values used in the report (2.33% and 1.62%) were conservative. The calculation performed and documented shows that these values are conservative, confirming the judgment of the expert panel.

The values used in the baseline analysis for tubesheet and tube σ_{CTE} are shown in the table below along with the best estimate σ_{CTE} and 95% confidence σ_{CTE} at 600°F.

Material	σ_{CTE} Used in Analysis (%)	Best Estimate σ_{CTE} @ 600°F (%)	95% Confidence σ_{CTE} @ 600°F (%)
Tubesheet (SA 508)	1.62	0.00%	0.71%
Tube (Alloy 600 TT)	2.33	0.51%	0.93%

As can be seen, the values used in the analysis are conservative when compared to the 95% confidence values for σ_{CTE} at 600°F.

Given that the non-Westinghouse data are "typical" values as noted above, and considering that the detailed data supporting these values were undoubtedly obtained under well controlled and rigorous test conditions, it is very likely that if a similar analysis were performed as was performed for the Westinghouse data, similar conclusions would result, demonstrating that the true variance is smaller than the apparent variance. Specifically, the industry data is similarly affected by measurement uncertainty and this uncertainty is included in the definition of "typical".

Including all of the available data which was in the original analysis would invalidate the statistical methodology and provide values which are of little engineering value at high confidence levels, as explained above. Although this may seem to contradict the original analysis, this analysis was based on considerable judgment by materials and metallurgical experts, and accepted by the expert panel and the NRC staff. The expert panel judgment that the values used were conservative is validated by the statistically rigorous and detailed calculations performed.