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OCT 24 2016

Docket Nos.: 50-348 50-424
50-425

NL-16-2223

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

Joseph M. Farley Nuclear Plant, Unit 1
Vogtle Electric Generating Plant, Units 1 and 2
Response to Request for Information Regarding
Proposed Inservice Inspection Alternative VEGP-ISI-ALT-11, Version 2.0 and
Proposed Inservice Inspection Alternative FNP-ISI-ALT-19, Version 2.0

Ladies and Gentlemen:

By letter dated August 4, 2016, Southern Nuclear Operating Company (SNC) proposed an inservice inspection (ISI) alternative for the Vogtle Electric Generating Plant (VEGP), Units 1 and 2 and for the Joseph M. Farley Nuclear Plant (FNP) Unit 1. The ISI alternatives propose to eliminate the reactor pressure vessel threads in flange examination requirement for the remainder of the inservice inspection intervals for the respective units. By letter dated September 15, 2016, the Nuclear Regulatory Commission (NRC) sent a request for additional information (RAI). The enclosure contains the SNC response to the RAI. Please note that although the RAI was sent concerning the VEGP alternative, due to the generic nature of the requests the responses provided also apply to FNP Unit 1 except as noted.

This letter contains no NRC commitments. If you have any questions, please contact Ken McElroy at 205.992.7369.

Respectfully submitted,

C R Pierce

C. R. Pierce
Regulatory Affairs Director

CRP/RMJ

Enclosure: Response to Request for Additional Information

cc: Southern Nuclear Operating Company
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RType: Farley=CFA04.054; Vogtle=CVC7000

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Enclosure

Response to Request for Additional Information

NRC RAI-1

Table 1 compares the VEGP, Units 1 and 2 plant-specific data with the values used in the Electric Power Research Institute (EPRI) Nondestructive Evaluation Report (the EPRI report). Please provide the plant-specific heatup rate for the NRC staff to compare with the assumed 100 degrees Fahrenheit (°F)/hour heatup rate that was used in the EPRI report.

SNC RESPONSE

Both Vogtle Electric Generating Plant (VEGP) and Joseph M. Farley Nuclear Power Plant (FNP) Pressure and Temperature Limits Reports (PTLR) specify RCS temperature rate-of-change limits as:

a) A maximum heatup rate of 100°F in any 1-hour period.
b) A maximum cooldown rate of 100°F in any 1-hour period.

NRC RAI-2

Page E1-3 states, "The preload was calculated as detailed in VEGP Units 1 and 2 RPV manual." This statement is then followed by the calculation of the bounding preload taken from the EPRI report. Please provide the preload that was calculated in the VEGP, Units 1 and 2, RPV manual and applied to both units to date.

In addition, does the operation experience of VEGP Units 1 and 2 indicate, for various reasons, that the bolt-up contingencies exceeded 1.1?

SNC RESPONSE

According to VEGP Manual, operating bolting preload at 2,500 psi is 1,302,758 lbs. Stud minimum cross sectional area is 35.43 in^2, which results in an equivalent stud stress of 36,770 psi. According to FNP Manual, operating bolting preload at 2,500 psi is 957,154 lbs. Stud minimum cross sectional area is 25.18 in^2, which results in an equivalent stud stress of 38,010 psi. A preload stud stress of 42,338 psi was used in the analysis documented in the EPRI report, which bounds the values for VEGP and FNP.

To optimize efficiency, the studs at VEGP are tensioned in sequential sets during bolt-up. Consequently, the first set of studs, for a short period of time, had experienced slightly greater than 110% of the specification. However, the preload on these studs are brought down to within specification as soon as the subsequent sets of studs were tensioned to specification, because the tensioning of the subsequent studs relax the preload in the first set of studs. During normal operation, the bolt-up flange configuration is within specification and there is no known instance of as-left preload exceeding 100% during plant operation history. The assessment for FNP will be sent at a later date when boltup data is available.

NRC RAI-3

Figure 4 (referenced on page E1-4 of the application) is missing. Please confirm that the missing figure is meant to be Figure 6-8 of the EPRI report or supply the missing figure.

SNC RESPONSE

The missing Figure 4 on page E1-4 of the submittal is meant to be Figure 6-8 of the EPRI report.

EPRI Nondestructive Evaluation Report (Enclosure 3 of the Application)

NRC RAI-4

Table 2-1 of the EPRI report summarized threads in flange components at seven domestic pressurized-water reactor plants. The number of threads per foot for each reported unit is not listed. Please provide this information and confirm whether this parameter is approximately the same among different units (including the VEGP units). If not, please assess the impact of variation of this parameter on the generic analyses (stress analysis plus fracture mechanics analysis) in the EPRI report.

SNC RESPONSE

All plants considered in the EPRI report, including VEGP and FNP, use eight threads per inch configuration (8-pitch threads).

NRC RAI-5

To better assess the results from the finite element method (FEM) model reported in the EPRI report, please clarify the following:

NRC RAI-5, Question 1

Symmetry of both faces of the FEM model implies that the peaks and valleys of the threads are concentric circles. Please assess the impact of neglecting the forces due to the fact that these circular planes are not perpendicular to the thread axis.

SNC RESPONSE

Considering the smallest stud diameter of 6.5", the 8-pitch thread is approximately 4 degrees spiral off perpendicular around the thread axis. Given that the crack growth results demonstrate significant margin, the effects for neglecting the 4 degrees tilt is expected to be negligible and cause no impact to the conclusion.

NRC RAI-5, Question 2

Section 6.1.1 states, "To simulate the RPV head, the top of the cladding surface is fixed in the axial direction, and the bottom of the flange is coupled axially to simulate the rest of the vessel."

NRC RAI-5, Question 2a

Explain how the loads due to pressure and thermal transients are applied to the model. Are they applied uniformly to the bottom and inner surfaces of the model?

SNC RESPONSE

Internal pressure is applied uniformly on the inside surface of the model, and an endcap load is applied to the bottom surface. Thermal loads are applied as uniform surface convection on the inside surface only.

NRC RAI-5, Question 2b

Explain the validation that was taken to ensure that the FEM model could generate realistic stress results, considering assumptions regarding the axial extent of the model, the boundary conditions not described in the quote above, and the load distribution (uniform, linear, or higher order) over the surfaces.

SNC RESPONSE

Linear, low order elements were used in the finite element analysis. Hand calculations were performed to verify proper hoop and axial stresses due to pressure. The nominal preload stress was verified after the application. The resultant preload thread stress concentration contour, as shown in Figure 6-5 of the EPRI report, indicated reasonable response where the top 10 or so threads assumed majority of the preload. Verification was also performed to ensure that the stresses in the bottom region of the model trend toward uniform, indicating that the model includes sufficient axial length.

NRC RAI-5, Question 3

Section 6.1.2 states, "This transient typically consists of a steady 100°F/hour ramp up to the operating temperature." Please explain why this heatup transient is more limiting than the cooldown transient.

SNC RESPONSE

Since heatup and cooldown have the same temperature change rate, in linear elastic analysis they will produce identical maximum and minimum stress range for crack growth calculation, despite an opposite time history. Therefore, only one transient needs to be analyzed, and the heatup transient was chosen.

NRC RAI-5, Question 4

Section 6.2.1 did not provide sufficient details for the FEM model for the applied stress intensity factor (K) determination. Please:

NRC RAI-5, Question 4a

Confirm that the FEM model for the applied K determination is the same as the FEM model for the stress determination, except for the crack tip elements as shown in Figure 6-8.

SNC RESPONSE

It is confirmed that the FEM model for the applied K determination is the same as the FEM model for the stress determination.

NRC RAI-5, Question 4b

Explain what "ellipsoidal flaw shape around the circumference of the flange" means. (Question 1 seems to imply that flaws are of circular shapes.)

SNC RESPONSE

The initial flaw shape is circular just outside the periphery of the stud hole. However, in order to conservatively maximize crack size, the crack growth amount in the radial direction is assumed to be greater than that in the circumferential direction (with respect to the RV). This results in the flaw morphing into an elliptical shape as it grows, which can be seen in Figure 6-8 of the EPRI report.

NRC RAI-5, Question 5

Section 6.2.1 states, "When preload is not being applied, the bolt, bolt threads, and flange threads are not modelled." The NRC staff noted that the loads that were used to generate results in Table 6-1 all include preload. Please provide information for the cases that were simulated without preload and without flange threads, and explain how the results from these simulations (without preload and without flange threads) affect the results reported in Table 6-1.

SNC RESPONSE

The reactor pressure vessel (RPV) pressure and thermal transient loads were run without preload and without flange threads. The RPV pressure and thermal transient loads are global loads and they do not cause stress concentration in the threads. Since all analyses are linear elastic, the RPV pressure and thermal transient stresses are algebraically summed with the preload stresses for the crack growth iteration. A sensitivity analysis was performed with a representative number of threads included in the FEM model with internal pressure, and the results indicated that the stress distributions for models with and without the threads were very similar.

NRC RAI-5, Question 6

Justify use of the fracture toughness (K_{IC}) at the upper shelf energy temperature in the linear elastic fracture mechanics analysis, considering that the critical combination of applied K and K_{IC} may occur at a much lower temperature.

SNC RESPONSE

The closure head flange region is above the belt line region of the RPV and therefore not subjected to irradiation effects. As such, only the initial RT_{NDT} value need to be used in the analysis without any adjustment. The use of the upper shelf temperature in the acceptance criteria is based on the fact that the component is at this temperature the majority of the time when the RPV is at full operating pressure. To determine the effect of lower temperatures on the analysis, a conservative evaluation is performed by determining the maximum RT_{NDT} of the component to meet the acceptance criteria. In the analysis, the maximum calculated K at any crack depth is about 20ksi$\sqrt{\text{in}}$. This requires a K_{IC} of $20*\sqrt{10}$ = 3.2 ksi$\sqrt{\text{in}}$. Based on 2004 Edition of ASME Section XI, Appendix A, Figure A-4200-1, an RT_{NDT} of up to 70°F will not affect the results. For reference, the RT_{NDT} for the flange region is 20°F for VEGP Unit 1, 10°F for VEGP Unit 2, and 60°F for FNP Units 1 and 2.

NRC RAI-5, Question 7

Section 6.2.3 states, "The resulting crack growth as calculated by pc-CRACK is negligible." Please provide this value.

SNC RESPONSE

The resulting crack growth is 0.005 inches over 80 years of operation.