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UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

SOUTHERN NUCLEAR OPERATING COMPANY, INC.

VOGTLE ELECTRIC GENERATING PLANT, UNITS 1 AND 2

DOCKET NOS. 50-424 AND 50-425

EXEMPTION

1.0 BACKGROUND

Southern Nuclear Operating Company, Inc. (SNC, or the licensee) is the holder of Facility Operating License Nos. NPF-68 and NPF-81 that authorize operation of the Vogtle Electric Generating Plant, Units 1 and 2 (Vogtle, Units 1 and 2). The license provides, among other things, that the facility is subject to all rules, regulations, and orders of the Nuclear Regulatory Commission (NRC, the Commission) now or hereafter in effect.

The facility consists of two pressurized water reactors located in Burke County, Georgia.

2.0 REQUEST/ACTION

Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50, Appendix G requires that pressure-temperature (P-T) limits be established for reactor pressure vessels (RPVs) during normal operating and hydrostatic or leak rate testing conditions. Specifically, 10 CFR Part 50, Appendix G states that "[t]he minimum temperature requirements...pertain to the controlling material, which is either the material in the closure flange or the material in the beltline region with the highest reference temperature....the minimum temperature requirements and the controlling material depend on the operating condition (i.e., hydrostatic pressure and leak tests,

or normal operation including anticipated normal operational occurrences), the vessel pressure, whether fuel is in the vessel, and whether the core is critical. The metal temperature of the controlling material, in the region of the controlling material which has the least favorable combination of stress and temperature, must exceed the appropriate minimum temperature requirement for the condition and pressure of the vessel specified in Table 1 [of 10 CFR Part 50, Appendix G]." Footnote 2 to Table 1 in 10 CFR Part 50, Appendix G specifies that RPV minimum temperature requirements related to RPV closure flange considerations shall be based on "[t]he highest reference temperature of the material in the closure flange region that is highly stressed by bolt preload."

In order to address provisions of amendments to modify the Vogtle, Units 1 and 2 Technical Specifications to revise the pressure-temperature limits report methodology for each unit, SNC requested in its submittal dated February 26, 2004, that the staff exempt Vogtle, Units 1 and 2 from the application of specific requirements of 10 CFR Part 50, Appendix G, as they pertain to the establishment of minimum temperature requirements, for all modes of operation addressed by 10 CFR Part 50, Appendix G, based on the material properties of the material of the RPV closure flange region that is highly stressed by the bolt preload. The licensee's technical basis for this exemption request is contained in Enclosure 4 of its February 26, 2004, submittal: WCAP-16142-P, Revision 1, "Reactor Vessel Closure Head/Vessel Flange Requirements Evaluation for Vogtle Units 1 and 2," and a response to an NRC staff request for additional information contained in an SNC letter dated October 22, 2004. The requirements from which SNC requested that Vogtle, Units 1 and 2 be exempted shall be referred to, for the purpose of this exemption, as those requirements related to the application of footnote (2) to Table 1 of 10 CFR Part 50, Appendix G.

WCAP-16142-P, Revision 1 included a fracture mechanics analysis of postulated flaws in the Vogtle, Units 1 and 2 RPV closure flange regions under boltup, 100 EF per hour (/hr) heatup, 100 EF/hr cooldown, and steady-state conditions, with the heatup and cooldown transients being modeled in accordance with what would be permissible using P-T limit curves based on the most limiting Vogtle, Units 1 and 2 beltline materials. Westinghouse performed finite element analyses to calculate the stresses present at the flange region and determined two limiting locations: (1) the top head dome-to-torus weld at the end of the 100 EF/hr heatup transient, and (2) the torus-to-flange weld at the boltup condition. With these stresses, Westinghouse calculated the applied stress intensity factor ($K_{applied}$) for semi-elliptical, outside diameter initiated, surface breaking flaws with an aspect ratio (length vs. depth) of 6:1, and with depths ranging from 0 to 80 percent of the thickness of the component wall. The $K_{applied}$ values were calculated by using the Raju-Newman stress intensity factor influence coefficients for external surface cracks in cylindrical vessels and is in accordance with the American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code) Section XI, Appendix G, Subparagraph G-2220 requirements for the analysis of flange locations. Westinghouse then compared these $K_{applied}$ values to ASME Code lower bound plane strain fracture toughness (K_{Ic}) values determined from the nil-ductility transition reference temperature (RT_{NDT}) values for the Vogtle, Units 1 and 2 RPV closure flange materials. Westinghouse also provided an assessment of the potential for changes in the material RT_{NDT} values for the Vogtle, Units 1 and 2 RPV closure flange materials due to thermal aging resulting from exposure to the RPV operating environment.

The use of ASME Code K_{Ic} as the material property for the fracture mechanics analysis represents the most significant change between the analysis provided in WCAP-16142-P, Revision 1 and the analysis that was performed as the basis for establishing the minimum temperature requirements in 10 CFR Part 50, Appendix G. The minimum temperature

requirements related to footnote (2) to Table 1 of 10 CFR Part 50, Appendix G were incorporated into the *Code of Federal Regulations* in the early 1980s and were based on analyses that used ASME Code lower bound crack arrest fracture toughness (K_{IA}) as the parameter for characterizing a material's ability to resist crack initiation and propagation. The use of ASME Code K_{IA} is always conservative with respect to the use of ASME Code K_{IC} for fracture mechanics evaluations, and its use in the evaluations that established the requirements in 10 CFR Part 50, Appendix G was justified based on the limited knowledge of RPV material behavior that was available in the early 1980s. However, the use of ASME Code K_{IC}, not ASME Code K_{IA}, is consistent with the actual physical processes that would govern flaw initiation under conditions of normal RPV operation, including RPV heatup, cooldown, and hydrostatic and leak testing. Based on our current understanding of the behavior of RPV materials, the NRC staff has routinely approved licensees' utilization of ASME Code K_{IC} as the basis for evaluating RPV beltline materials to demonstrate compliance with the intent of 10 CFR Part 50, Appendix G through licensees' use of ASME Code Cases N-640 and N-641, which have been incorporated into Appendix G to Section XI of the 2001 Edition through the 2003 Addenda of the ASME Code endorsed in 10 CFR 50.55a.

Information in WCAP-16142-P, Revision 1 and the licensee's October 22, 2004, response to NRC staff questions indicated that the resulting margin ($K_{IC}/K_{applied}$) from the fracture mechanics analysis is 3.19 for the boltup condition and 4.06 for the heatup condition, assuming that the crack depth is one tenth of the wall thickness (1/10t). The margins show that the boltup condition with lower $K_{applied}$ (about one half the $K_{applied}$ of the heatup condition) is more limiting because the low temperature associated with the boltup condition gives a much lower K_{IC} value. Using these calculated margins and the $K_{applied}$ plot shown in WCAP Figures 4-1 and 4-2, the NRC staff found that the ASME Code Appendix G margin of 2 can be maintained for a flaw much deeper than 1/10t at these limiting locations.

In summary, the analysis provided in WCAP-16142-P, Revision 1 has demonstrated that, for the most limiting transient addressed by 10 CFR Part 50, Appendix G, the combination of factors (high stresses in the RPV flange region along with low temperature at the metal of the flange region) cannot exist simultaneously, and the structural integrity of the Vogtle, Units 1 and 2 RPV closure flange materials will not be challenged by facility operation in accordance with P-T limit curves based consideration of Vogtle, Units 1 and 2 beltline materials. Therefore, the more conservative minimum temperature requirements related to footnote (2) to Table 1 of 10 CFR Part 50, Appendix G are not necessary to meet the underlying intent of 10 CFR Part 50, Appendix G, to protect the Vogtle, Units 1 and 2 RPVs from brittle failure during normal operation under both core critical and core non-critical conditions and RPV hydrostatic and leak test conditions.

3.0 DISCUSSION

Pursuant to 10 CFR 50.12, the Commission may, upon application by any interested person or upon its own initiative, grant exemptions from the requirements of 10 CFR Part 50 when (1) the exemptions are authorized by law, will not present an undue risk to public health or safety, and are consistent with the common defense and security; and (2) when special circumstances are present. These circumstances include the special circumstances where application of the regulation in the particular circumstances is not necessary to achieve the underlying purpose of the rule.

The underlying purpose of 10 CFR Part 50, Appendix G, footnote (2) to Table 1 is to protect the integrity of the reactor coolant pressure boundary during hydrostatic pressure and leak tests, and during normal operations, including heatup, cooldown, and operational occurrences. This is accomplished through these regulations that, in part, specify the minimum temperature requirements in the closure flange region. The NRC staff accepts the licensee's determination that an exemption would be required to permit SNC to not meet those

requirements related to the application of footnote (2) to Table 1 of 10 CFR Part 50, Appendix G.

The NRC staff examined the licensee's rationale to support the exemption request. Based on a consideration of the information provided in WCAP-16142-P, Revision 1 and SNC's October 22, 2004 letter, an acceptable technical basis has been established to exempt Vogtle, Units 1 and 2 from requirements related to footnote (2) to Table 1 of 10 CFR Part 50, Appendix G. The technical basis provided by SNC has established that an adequate margin of safety against brittle failure would continue to be maintained for the Vogtle, Units 1 and 2 RPVs without the application of those requirements related to the application of footnote (2) to Table 1 of 10 CFR Part 50, Appendix G, for normal operation under both core critical and core non-critical conditions and RPV hydrostatic and leak test conditions.

Therefore, the NRC staff concludes that, pursuant to 10 CFR 50.12(a)(2)(ii), the underlying purpose of 10 CFR Part 50, Appendix G will be achieved without the application of those requirements related to the application of footnote (2) to Table 1 of 10 CFR Part 50, Appendix G, and the proposed exemption should be granted to SNC such that those requirements related to the application of footnote (2) to Table 1 of 10 CFR Part 50, Appendix G need not be applied to Vogtle, Units 1 and 2.

4.0 CONCLUSION

Accordingly, the Commission has determined that, pursuant to 10 CFR 50.12(a), the exemption is authorized by law, will not present an undue risk to the public health and safety, and is consistent with the common defense and security. Also, special circumstances are present. Therefore, the Commission hereby grants SNC an exemption from the requirements 10 CFR Part 50, Appendix G, Table 1, footnote (2), for Vogtle, Units 1 and 2.

Pursuant to 10 CFR 51.32, the Commission has determined that the granting of this exemption will not have a significant effect on the quality of the human environment (70 FR 13215).

This exemption is effective upon issuance.

Dated at Rockville, Maryland, this 24th day of March.

FOR THE NUCLEAR REGULATORY COMMISSION

/RA/
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