



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

August 6, 2021

Mr. Daniel G. Stoddard  
Senior Vice President and  
Chief Nuclear Officer  
Innsbrook Technical Center  
5000 Dominion Boulevard  
Glen Allen, VA 23060-6711

SUBJECT: VIRGIL C. SUMMER NUCLEAR STATION, UNIT 1 – PROPOSED  
ALTERNATIVE REQUEST RR-4-25 TO ELIMINATE EXAMINATION OF  
THREADS IN REACTOR PRESSURE VESSEL FLANGE (EPID L-2020-LLR-  
0141)

Dear Mr. Stoddard:

By letter dated October 22, 2020 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML20296A708), Dominion Energy South Carolina (the licensee) submitted a request to the U.S. Nuclear Regulatory Commission (NRC) for a proposed alternative to certain American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code (BPV Code), Section XI requirements at the Virgil C. Summer Nuclear Station (Summer), Unit 1.

Specifically, pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR) 50.55a(z)(1), the licensee requested authorization to eliminate the ASME BPV Code requirement to volumetrically examine the threads in the reactor pressure vessel flange stud holes during the fourth inservice inspection interval that began on January 1, 2014, and is scheduled to end on December 31, 2023, on the basis that the proposed alternative provides an acceptable level of quality and safety.

The NRC staff has reviewed alternative request RR-4-25 and concludes, as set forth in the enclosed safety evaluation, that Dominion Energy South Carolina has adequately addressed all of the regulatory requirements set forth in 10 CFR 50.55a(z)(1). All other ASME BPV Code, Section XI, requirements for which an alternative was not specifically requested and authorized remain applicable, including third-party review by the Authorized Nuclear Inservice Inspector.

D. Stoddard

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If you have any questions, please contact the Project Manager at (301) 415-5897, or via email at [Vaughn.Thomas@nrc.gov](mailto:Vaughn.Thomas@nrc.gov).

Sincerely,

Michael T. Markley, Chief  
Plant Licensing Branch II-1  
Division of Operating Reactor Licensing  
Office of Nuclear Reactor Regulation

Docket No. 50-395

Enclosure:  
Safety Evaluation

cc: Listserv



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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

PROPOSED ALTERNATIVE REQUEST RR-4-25

TO ELIMINATE EXAMINATION OF THREADS IN REACTOR PRESSURE VESSEL FLANGE

DOMINION ENERGY SOUTH CAROLINA

VIRGIL C. SUMMER NUCLEAR STATION, UNIT NO. 1

DOCKET NO. 50-395

1.0 INTRODUCTION

By letter dated October 22, 2020 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML20296A708), Dominion Energy South Carolina (the licensee) submitted a request to the U.S. Nuclear Regulatory Commission (NRC) for a proposed alternative RR-4-25 to certain American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code (BPV Code), Section XI requirements at the Virgil C. Summer Nuclear Station (Summer), Unit 1.

Specifically, pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR) 50.55a(z)(1), the licensee requested authorization to eliminate the ASME BPV Code requirement to volumetrically examine the threads in the reactor pressure vessel flange stud holes during the fourth inservice inspection interval that began on January 1, 2014, and is scheduled to end on December 31, 2023, on the basis that the alternative provides an acceptable level of quality and safety.

2.0 REGULATORY EVALUATION

The regulations in 10 CFR 50.55a(z) state, in part, that alternatives to the requirements in paragraphs (b) through (h) of 10 CFR 50.55a may be authorized by the NRC if the licensee demonstrates that: (1) the proposed alternative provides an acceptable level of quality and safety, or (2) compliance with the specified requirements would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety.

The regulations in 10 CFR 50.55a(g)(4) state, in part, that ASME Code Class 1, 2, and 3 components (including supports) must meet the requirements, except the design and access provisions and the preservice examination requirements, set forth in Section XI of the applicable editions and addenda of the ASME Code to the extent practical within the limitations of design, geometry, and materials of construction of the components. The threads in the reactor pressure vessel (RPV) flange are categorized as an ASME Code Class 1 components. Therefore, per 10 CFR 50.55a(g)(4), inservice inspection (ISI) of these threads must be performed in accordance with Section XI of the applicable edition and addenda of the ASME Code.

The applicable ASME Code of record for the fifth 10-year ISI program interval at Summer, Unit 1, is the 2007 Edition through 2008 Addenda of the ASME BPV Code, Section XI. The Summer, Unit 1, fourth 10-year ISI program interval is scheduled to end December 31, 2023.

### 3.0 TECHNICAL EVALUATION

#### 3.1 The Licensee's Proposed Alternative RR-4-25

The licensee submitted alternative RR-4-25 for Summer, Unit 1. Table 1, "ASME Code Component(s) Affected," of the alternative request provides the element and description of the ASME Code component affected. The licensee proposed the use of alternatives to the requirements of the 2007 Edition through 2008 Addenda of the ASME BPV Code, Section XI, Examination Category B-G-1, Reactor Vessel Item Number B6.40, which requires volumetric examination of the threads in the RPV flange stud holes. The licensee's proposed alternative would eliminate the volumetric examination requirement in accordance with an industry initiative analyzed in Electric Power Research Institute (EPRI) Report 3002010354, "Reactor Pressure Vessel (RPV) Threads in Flange Examination Requirements," dated December 2017 (ADAMS Accession No. ML18277A154).

#### 3.2 NRC Staff Evaluation

The licensee's technical basis for proposed alternative, RR-4-25, is supported by the technical analysis in the EPRI Report No. 3002010354 (the EPRI report). By letter dated January 26, 2017 (ADAMS Accession No. ML17006A109), the U. S. Nuclear Regulatory Commission (NRC) staff authorized Southern Nuclear Operating Company, Inc. (Southern Nuclear) to use a similar alternative that was based on the generic stress analysis and flaw tolerance evaluation in the EPRI report for Vogtle Electric Generating Plant (VEGP) and Farley (FNP). In that report, the NRC stated,

The proposed alternative is based on stress analysis and flaw tolerance analysis results documented in an Electric Power Research Institute (EPRI) report entitled, "Nondestructive Evaluation: Reactor Pressure Vessel Threads in Flange Examination Requirements" (ADAMS Accession No. ML 16221A068). SNC has confirmed that VEGP and FNP units' plant-specific parameters (e.g., vessel diameter, number of studs, and inservice inspection findings) are consistent with or bounded by the EPRI report.

In Section 3.2.1, "The EPRI's Generic Stress Analysis and Flaw Evaluation," of the NRC staff evaluation dated January 26, 2017, the NRC concludes that the generic stress analysis and flaw tolerance evaluation in the EPRI report are acceptable for Vogtle and Farley, and the results can be used to support eliminating the RPV threads in flange examination. The NRC authorized elimination of the vessel threads inspection for the remaining third and fourth 10-year ISI interval for Vogtle and Farley, respectively.

For the licensee's request for Summer, the NRC staff confirmed that the licensee performed the stress analysis consistent with the EPRI report. The NRC staff also verified the licensee's calculation of the preload stress of the RPV parameters at Summer (31.6 kips per square inch (ksi)) and that it is bounded by the preload stress in the EPRI report (42.3 ksi). The NRC staff confirmed that the licensee performed a linear elastic fracture mechanics evaluation at various flaw depths consistent with the ASME B&PV Code, Section XI, IWB-3600, and the EPRI report. The licensee assumed a maximum stress intensity factor ( $K_I$ ) of 19.8 ksi $\sqrt{\text{inch}}$  (in) for the

operating condition (combined pressure, preload, and thermal stress), and a maximum  $K_I$  of 17.4 ksi $\sqrt{\text{in}}$  for the preload only condition, consistent with the EPRI report.

The licensee explained that, per Appendix G of Section XI to the ASME Code, a structural factor of 2 is applied to the membrane stress, and a structural factor of 1 is applied to the thermal stress; however, in its evaluation, the licensee applied a conservative structural factor of 2 to all stresses. The NRC staff finds this to be a conservative approach that exceeds the requirements in Appendix G of Section XI to the ASME Code. For its evaluation of the acceptance criterion for the preload only condition, the licensee calculated the fracture toughness ( $K_{IC}$ ) based on the equation in Appendix A of ASME Section XI (i.e.,  $K_{IC} = 33.2 + 20.734 \exp [0.2(T - RT_{NDT})]$ ) with temperature ( $T$ ) = 70 degrees Fahrenheit ( $^{\circ}\text{F}$ ) and  $RT_{NDT} = 0^{\circ}\text{F}$  at VCSNS, which equates to 117 ksi $\sqrt{\text{in}}$ . For its evaluation of the acceptance criterion for the operating condition, the licensee assumed a  $K_{IC}$  of 220 ksi $\sqrt{\text{in}}$ , which the NRC staff finds consistent with (1) the EPRI report and (2) Appendix G of Section XI to the ASME Code for a material operating in the upper shelf region (normal operating temperature).

Thus, the NRC staff noted that the acceptance criterion based on allowable stress intensity factor for the “preload” load case (i.e., 58.6 ksi $\sqrt{\text{in}}$ ) and the “preload + heat-up + pressure” load case (i.e., 110 ksi $\sqrt{\text{in}}$ ) were met when compared to the maximum  $K_I$  at Summer for the “preload” load case (i.e., 17.4 ksi $\sqrt{\text{in}}$ ) and the “preload + heat-up + pressure” load case (i.e., 19.8 ksi $\sqrt{\text{in}}$ ) at Summer.

Based on the above, the NRC staff finds that the threads in the RPV flange at Summer are adequately flaw tolerant because the allowable  $K$  (i.e.,  $K_{IC}$ ) is greater than the applied  $K$  (i.e.,  $K_I$ ) for all postulated crack depths.

The NRC staff reviewed the licensee’s description of the maintenance activities and inspections that will be performed on the RPV threads in the flange and studs each time the RPV head is removed. The licensee stated that the RPV threads would be inspected when the studs are removed, cleaned, and lubricated. The NRC staff finds that the licensee’s detailed and controlled maintenance activities provide sufficient opportunity, at frequent intervals, for the licensee to detect and mitigate degradation of the threads in flange during the fourth ISI interval. Based on the above, the NRC staff finds that these maintenance activities, combined with the linear elastic fracture mechanics evaluation provide defense-in-depth and reasonable assurance to preclude the possibility of component failure resulting from undetected and unmitigated cracking.

#### 4.0 CONCLUSION

The NRC staff has reviewed alternative request RR-4-25 and concludes, as set forth in this safety evaluation, that Dominion Energy South Carolina has adequately addressed all of the regulatory requirements set forth in 10 CFR 50.55a(z)(1). The NRC staff authorizes the use of proposed alternative RR-4-25 at Summer for the fourth 10-year ISI interval, which began on January 1, 2014 and is scheduled to end on December 31, 2023.

All other ASME BPV Code, Section XI, requirements for which an alternative was not specifically requested and authorized remain applicable, including third-party review by the Authorized Nuclear Inservice Inspector.

Principal Contributor: On Yee, NRR

Date: August 6, 2021

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**ADAMS Accession No. ML21173A163**

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