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

August 6, 2021

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

SUBJECT: SURRY POWER STATION, UNITS 1 AND 2 – PROPOSED ALTERNATIVE REQUESTS S1-I5-ISI-05 AND S2-I5-ISI-06 TO ELIMINATE EXAMINATION OF THREADS IN REACTOR PRESSURE VESSEL FLANGE (EPID L-2020-LLR-0139 AND L-2020-LLR-0140)

Dear Mr. Stoddard:

By letter dated October 22, 2020 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML20296A680), and supplemented by letter dated February 11, 2021 (ADAMS Accession No. ML21042B926), Virginia Electric and Power Company (the licensee) submitted a request to the U.S. Nuclear Regulatory Commission (NRC) for the use of proposed alternatives to certain American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code (BPV Code), Section XI requirements at the Surry Power Station (Surry), Units 1 and 2.

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 on the basis that the alternatives provide an acceptable level of quality and safety.

The NRC staff has reviewed alternative requests S1-I5-ISI-05 and S2-I5-ISI-06 and concludes, as set forth in the enclosed safety evaluation, that Virginia Electric and Power Company has adequately addressed all of the regulatory requirements set forth in 10 CFR 50.55a(z)(1). Therefore, the NRC staff authorizes the use of alternative request S1-I5-ISI-05 for Surry, Unit 1, fifth Inservice Inspection (ISI) program interval which began December 14, 2013, and ends on October 13, 2023, and S2-I5-ISI-06 for Surry, Unit 2, fifth ISI program interval which began May 10, 2014, and ends on May 9, 2024.

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.

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

Sincerely,

Michael T. Markley

Digitally signed by Michael T. Markley
Date: 2021.08.06 13:45:32 -04'00'

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

Docket Nos. 50-280 and 50-281

Enclosure:
Safety Evaluation

cc: Listserv

UNITED STATES
NUCLEAR REGULATORY COMMISSION
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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

PROPOSED ALTERNATIVE REQUESTS S1-I5-ISI-05 AND S2-I5-ISI-06

TO ELIMINATE EXAMINATION OF THREADS IN REACTOR PRESSURE VESSEL FLANGE

VIRGINIA ELECTRIC AND POWER COMPANY

SURRY POWER STATION, UNIT NOS. 1 AND 2

DOCKET NOS. 50-280 AND 50-281

1.0 INTRODUCTION

By letter dated October 22, 2020 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML20296A680), and supplemented by letter dated February 11, 2021 (ADAMS Accession Nos. ML21042B926), Virginia Electric and Power Company (the licensee) submitted a request to the U.S. Nuclear Regulatory Commission (NRC) for the use of alternatives to certain American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code (BPV Code), Section XI requirements at the Surry Power Station (Surry), Units 1 and 2.

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 on the basis that the alternatives provide 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 Surry, Units 1 and 2, is the 2004 Edition of ASME BPV Code, Section XI. The Surry, Unit 1, fifth 10-year ISI program interval is scheduled to end October 13, 2023, and the Surry, Unit 2, fifth 10-year ISI program interval is scheduled to end May 9, 2024.

3.0 TECHNICAL EVALUATION

3.1 The Licensee's Proposed Alternatives S1-I5-ISI-05 and S2-I5-ISI-06

The licensee submitted alternative S1-I5-ISI-05 and S2-I5-ISI-06 for Surry, Units 1 and 2, respectively. The licensee proposed the use of alternatives to the requirements of the 2004 Edition of 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 3002007626, "Nondestructive Evaluation: Reactor Pressure Vessel Threads in Flange Examination Requirements," dated March 2016 (ADAMS Accession No. ML16221A068).

3.2 NRC Staff Evaluation

The licensee's technical basis for the proposed alternatives, S1-I5-ISI-05 and S2-I5-ISI-06, is based on the technical analysis in the EPRI report No. 3002007626. The generic stress analysis and flaw tolerance evaluation which support eliminating the volumetric examination of the RPV threads in flange are contained in Section 6 of the EPRI report. Because the NRC staff has neither reviewed nor approved EPRI report No. 3002007626 for generic use, the NRC staff evaluated the EPRI report's applicability specific to Surry, Units 1 and 2. In a SE for a similar plant-specific alternative request transmitted by letter dated January 26, 2017 (ADAMS Accession No. ML17006A109), the NRC staff determined that the stress and flaw tolerance analyses contained in Section 6 of EPRI report 3002007626 were an acceptable basis for eliminating the ISI of the RPV threads in flange at the Vogtle Electric Generating Plant, Units 1 and 2, and Joseph M. Farley Nuclear Plant, Unit 1. In that plant-specific authorization, the NRC stated,

> The proposed alternative is based on stress analysis and flaw tolerance analysis results documented in an [EPRI] report entitled, "Nondestructive Evaluation: Reactor Pressure Vessel Threads in Flange Examination Requirements" (ADAMS Accession No. ML 16221A068). SNC has confirmed that [the Vogtle Electric Generating Plant, Units 1 and 2 (Vogtle)] and [Joseph M. Farley Nuclear Plant, Unit 1 (Farley)] plant-specific parameters (e.g., vessel diameter, number of studs, and inservice inspection findings) are consistent with or bounded by the EPRI report.

The alternative request for Surry, Units 1 and 2, uses the same technical basis as the proposed alternative in the Vogtle and Farley SE dated January 26, 2017. The NRC staff reviewed the configuration of the subject components to determine if the analyses in Section 6 of EPRI report No. 3002007626 applies to the alternatives request for Surry, Units 1 and 2.

The EPRI analysis calculates a bounding preload stress ($P_{preload}$) of 42.3 kilopound per square inch (ksi) at the modeled bolt based on the largest RPV diameter, smallest bolts, and the least number of bolts. The NRC staff reviewed the licensee's supplemental information in letter dated

February 11, 2021, which calculated the preload stress based on the applicable parameters. The NRC staff confirmed that the licensee's calculated value of $P_{preload}$ equal to 31.6 ksi for Surry, Units 1 and 2, was bounded by the EPRI report's value of 42.3 ksi. Because the licensee's $P_{preload}$ value is lower than the value of the bounding $P_{preload}$ stress in the EPRI report, the NRC staff finds the licensee's stress analysis justification acceptable.

The licensee references the linear elastic fracture mechanics evaluation contained in the EPRI report which was performed at various flaw depths in accordance with Article IWB-3600 of Section XI of the ASME Code. This evaluation determined that the allowable applied stress intensity factor (K_I) representative for the allowable flaw size in accordance with the ASME Code is 69.6 ksi$\sqrt{}$inch (ksi per square root of inch). The EPRI analysis also determined the maximum stress intensity factor (K) at two load conditions: (1) preload only and (2) preload and heat-up/cooldown (stresses due to thermal and internal pressure loads). For the second condition, the EPRI analysis determined a K value of 19.8 ksi$\sqrt{}$inch. Therefore, the crack driving force, or K_I value, of 19.8 ksi$\sqrt{}$inch is lower than the RPV flange fracture toughness, or K_{IC} value, of 69.6 ksi$\sqrt{}$inch. Surry, Units 1 and 2, have a larger number of bolts, smaller RPV diameter, and an equal stud size as the bounding case provided in the EPRI analysis. Because these configuration parameters would yield a K value lower than the 19.8 ksi$\sqrt{}$inch provided in the EPRI analysis, the NRC staff confirmed that Surry, Units 1 and 2, are bounded by the analysis in the EPRI report for preload and heat-up/cooldown conditions.

The licensee's supplemental information in letter dated February 11, 2021, provided an evaluation to show that the most limiting K value at preload only conditions was bounded by the K value of 17.4 ksi$\sqrt{}$inch as provided in the EPRI report. The licensee calculated a K_{IC} value based on the equation provided in Appendix A (Subarticle A-4200) of the ASME Code, Section XI, and used the heat-up and cooldown limits in the Surry technical specifications to determine the limiting nil-ductility reference temperature (RT_{NDT}) of 10 degrees Fahrenheit for the RPV flange region at Surry, Units 1 and 2, such that:

$$K_{IC} = 33.2 + 20.734 \exp [0.2(T\text{-}RT_{NDT})] = 89.56 \text{ ksi}\sqrt{}\text{inch}$$

The ASME Code acceptance criteria for an analytical evaluation of a flaw based on K_I is contained in Subarticle IWB-3612 of the ASME Code, Section XI, and is satisfied when $K_I < K_{IC} / \sqrt{10}$. Using this criterion and the calculated K_{IC} value, the NRC staff confirmed that the K value of 17.4 ksi$\sqrt{}$inch provided in the EPRI report for a preload only condition is less than the licensee calculated allowable K_I value of 28.32 ksi$\sqrt{}$inch for the same load condition. Therefore, since the crack driving force, or K_I value, of 17.4 ksi$\sqrt{}$inch is lower than the RPV flange fracture toughness at preload only, or K_{IC} value, at 28.32 ksi$\sqrt{}$inch, the NRC staff confirmed that Surry, Units 1 and 2, are bounded by the EPRI report for the preload only condition.

In summary, the NRC staff determined that the stress analysis and flaw tolerance evaluation in EPRI Report No. 3002007626 are bounding for Surry, Units 1 and 2. Based on the above, the NRC staff determined that eliminating the volumetric examinations for Examination Category B-G-1, Item No. B6.40, "Threads in Flange," as required by Section XI of the ASME Code, is acceptable for the fifth ISI program interval at Surry, Units 1 and 2.

4.0 CONCLUSION

The NRC staff has reviewed alternative requests S1-I5-ISI-05 and S2-I5-ISI-06 and concludes, as set forth in this safety evaluation, that Virginia Electric and Power Company has adequately addressed all of the regulatory requirements set forth in 10 CFR 50.55a(z)(1). Therefore, the

NRC staff authorizes the use of alternative request S1-I5-ISI-05 for Surry, Unit 1, fifth ISI program interval which began December 14, 2013, and ends on October 13, 2023, and S2-I5-ISI-06 for Surry, Unit 2, fifth ISI program interval which began May 10, 2014, and ends on May 9, 2024.

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Principal Contributor: Isaac Anchondo-Lopez, NRR

Date: August 6, 2021

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DATE	08/06/2021		

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