



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

February 28, 2019

Mr. Joseph W. Shea
Vice President, Nuclear Regulatory
Affairs and Support Services
Tennessee Valley Authority
1101 Market Street, LP 4A
Chattanooga, TN 37402-2801

SUBJECT: BROWNS FERRY NUCLEAR PLANT, UNITS 1, 2, AND 3 – RELIEF FROM
THE REQUIREMENTS OF AMERICAN ASSOCIATION OF MECHANICAL
ENGINEERS CODE SECTION XI INSERVICE INSPECTION PROGRAM,
REQUEST FOR AN ALTERNATIVE ISI-46 (EPID L-2018-LLR-0074)

Dear Mr. Shea:

By letter dated May 11, 2018, as supplemented by letter dated October 17, 2018, Tennessee Valley Authority (the licensee) submitted to the Nuclear Regulatory Commission (NRC) a request to use an alternative to certain requirements of the American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code), Section XI regarding the inspection program for the third 10-year inservice inspection (ISI) interval for Browns Ferry Nuclear Plant (BFN), Unit 1, the fifth ISI interval for BFN, Unit 2, and the fourth ISI interval for BFN, Unit 3.

Specifically, pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR) Section 50.55a(z)(1), the licensee proposed an alternative to inspect reactor pressure vessel (RPV) nozzles based on ASME Code Case N-702, "Alternative Requirements for Boiling Water Reactor (BWR) Nozzle Inner Radius and Nozzle-to-Shell Welds." This alternative allows inspection of 25 percent of RPV nozzles (nozzle-to-vessel shell welds and nozzle-inner-radii) each ISI interval instead of the ASME Code, Section XI that requires 100 percent inspection.

The NRC staff has reviewed the subject request, as set forth in the enclosed safety evaluation, and determined that the licensee has demonstrated that the proposed alternative provides an acceptable level of quality and safety. Accordingly, the NRC staff concludes that the licensee has adequately addressed all of the regulatory requirements set forth in 10 CFR 50.55a(z)(1). Therefore, the NRC authorizes the use of ISI-46 at BFN for ASME Category B-D, Item Numbers B3.90 and B3.100 during the third 10-year ISI interval for Unit 1, the fifth 10-year ISI interval for Unit 2, and the fourth 10-year ISI interval for Unit 3, which all started on February 1, 2016, and are scheduled to end on January 31, 2026.

All other requirements of the ASME Code, Section XI, for which relief has not been specifically requested remain applicable, including third party review by the Authorized Nuclear Inservice Inspector.

J. Shea

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If you have any questions, please contact the Project Manager, Farideh Saba at (301) 415-1447 or via e-mail at farideh.saba@nrc.gov.

Sincerely,



Undine Shoop, Chief
Plant Licensing Branch II-2
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket Nos. 50-259, 50-260, and 50-296

Enclosure: Safety Evaluation

cc: Listserv



UNITED STATES
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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELIEF REQUEST NO. ISI-46 REGARDING

USE OF AN ALTERNATIVE BASED ON

ASME CODE CASE N-702

TENNESSEE VALLEY AUTHORITY

BROWNS FERRY NUCLEAR PLANT, UNITS 1, 2, AND 3

DOCKET NOS. 50-259, 50-260, AND 50-296

EPID L-2018-LLR-0074

1.0 INTRODUCTION

By letter dated May 11, 2018 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML18135A357), as supplemented by letter dated October 17, 2018 (ADAMS Accession No. ML18295A137), Tennessee Valley Authority (TVA or the licensee) submitted Request for Alternative ISI-46 for relief from the requirements of the American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code), Section XI regarding the inspection program for the third 10-year inservice inspection (ISI) interval for Browns Ferry Nuclear Plant (BFN), Unit 1, the fifth 10-year ISI interval for BFN, Unit 2, and the fourth 10-year ISI interval for BFN, Unit 3.

Specifically, pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR) Section 50.55a(z)(1), the licensee proposed an alternative to inspect reactor pressure vessel (RPV) nozzles based on ASME Code Case N-702, "Alternative Requirements for Boiling Water Reactor (BWR) Nozzle Inner Radius and Nozzle-to-Shell Welds." This alternative allows inspection of 25 percent of RPV nozzles (nozzle-to-vessel shell welds and nozzle inner radii) each ISI interval instead of the ASME Code, Section XI that requires 100 percent inspection.

2.0 REGULATORY EVALUATION

Adherence to Section XI of the ASME Code which is mandated by 10 CFR 50.55a(g)(4) states, in part, that ASME Code Class 1, 2, and 3 components will meet the requirements, except the design and access provisions and the pre-service examination requirements, set forth in Section XI of the ASME Code.

Section 50.55a(z) of 10 CFR states that alternatives to the requirements of paragraphs (b) through (h) of 10 CFR 50.55a, or portions thereof, may be used when authorized by the Director, Office of Nuclear Reactor Regulation. A proposed alternative must be submitted and

authorized prior to implementation. The licensee must demonstrate that: (1) the proposed alternatives provide 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.

Based on the above, and subject to the following technical evaluation, the Nuclear Regulatory Commission (NRC) staff finds that regulatory authority exists for the licensee to request the use of an alternative and the NRC to authorize the proposed alternative.

3.0 TECHNICAL EVALUATION

3.1 Licensee Evaluation

Component(s) for which Alternative is Requested (ASME Code Class 1)

Reactor Vessel Nozzles N2, N3, N5, N6, N7, and N8 specified in Enclosure 2 of the TVA letter dated May 11, 2018.

Examination Category

B-D, "Full Penetration Welded Nozzles in Vessels"

Examination Item Number

B3.90, "Nozzle-to-Vessel Welds" and B3.100, "Nozzle Inside Radius Section"

ASME Code Requirement for which Alternative is Requested

The ASME Code of record for BFN, Units 1, 2, and 3 for their respective 120-month interval ISI program is the ASME Code, Section XI, 2007 Edition through 2008 Addenda. This edition of the ASME Code, Section XI, Table IWB-2500-1, Examination Category B-D, Inspection Program B requires a volumetric examination of all nozzles with full penetration welds to the vessel shell (or head) and integrally cast nozzles each 10-year interval.

Licensee's Proposed Alternative to the ASME Code

Pursuant to 10 CFR 50.55a(z)(1), the licensee requested an alternative based on ASME Code Case N-702 to examine 25 percent of the nozzle-to-vessel shell welds and nozzle-inner-radii, including one nozzle from each system and nominal pipe size, in lieu of the ASME Code, Section XI requirement of 100 percent inspection.

The licensee proposed in ISI-46 the visual testing (VT)-1 examination as an alternative for the nozzle-inner-radii. In addition, the licensee states that for VT-1 examinations, it elects to apply the alternative VT-1 examination meeting the NRC conditions specified for ASME Code Case N-648-1, "Alternative Requirements for Inner Radius Examination of Class 1 Reactor Vessel Nozzles," with the provisions stipulated in Regulatory Guidance (RG) 1.147, Revision 18, "Inservice Inspection Code Case Acceptability, Section XI, Division 1," dated March 2017.

Licensee's Bases for Alternative

ASME Code Case N-702 was conditionally approved in RG 1.147, Revision 18, with the following condition to be addressed by the applicants:

The applicability of Code Case N-702 must be shown by demonstrating that the criteria in Section 5.0 of NRC Safety Evaluation regarding BWRVIP-108, ["Technical Basis for the Reduction of Inspection Requirements for the Boiling Water Reactor Nozzle-to-Vessel Shell Welds and Nozzle Blend Radii,"] dated December 18, 2007 (ML073600374) [the correct date is December 19, 2007] or Section 5.0 of NRC Safety Evaluation regarding BWRVIP-241, ["Probabilistic Fracture Mechanics Evaluation for the Boiling Water Reactor Nozzle-to-Vessel Shell Welds and Nozzle Blend Radii,"] dated April 19, 2013 (ML13071A240) are met. The evaluation demonstrating the applicability of the Code Case shall be reviewed and approved by the NRC prior to the application of the Code Case.

For 40 years of operation:

Consistent with the condition for ASME Code Case N-702 specified in RG 1.147, Revision 18, the licensee addressed in Enclosure 3 of its submittal dated May 11, 2018, the five criteria in Section 5.0 of the NRC's safety evaluation (SE) regarding BWRVIP-241. Based on the plant-specific RPV operating information, RPV geometry, and the bounding RPV nozzle geometry, the licensee presented calculated results to compare with the five criteria. These results are bounded by four of the five SE criteria for the RPV nozzles. The one that is not bounded is related to the recirculation outlet nozzle (the N1 nozzle). Therefore, the licensee excludes the N1 nozzles from Request for Alternative ISI-46 and concludes that the Code Case is applicable to the proposed RPV nozzles for BFN, Units 1, 2, and 3, for 40 years of operation.

For 60 years of operation:

BWRVIP-241, Appendix A (ADAMS Accession No. ML12290A017) provides guidelines for applying ASME Code Case N-702 for 60 years of operation. However, the licensee chose to perform additional probabilistic fracture mechanics (PFM) analysis for a low temperature over-pressurization (LTOP) event for 60 years of operation in Enclosure 3 to support this request for alternative. The PFM results are combined with the event frequency of the LTOP to give probability of failure (PoF) for the nozzle blend radius and the nozzle-to-shell weld of the RPV. They are below the NRC safety goal of 5×10^{-6} per year. Additional PFM results and PoF values for the two nozzle locations under the normal operating condition for 60 years of operation were provided by the licensee separately in the October 17, 2018, supplement to address this limiting event. Except for one of the four assumed flaw paths in nozzle blend radius of the plant-specific N1 nozzle, all other PoF values are below the NRC safety goal of 5×10^{-6} per year. The licensee calculated the change of core damage frequency for this particular case (flaw path) and found it meets the RG 1.174 criterion of 1×10^{-6} per year.

Period of application

This alternative is requested for the duration of the third 10-year ISI interval for BFN, Unit 1; the fifth ISI interval for BFN, Unit 2; and the fourth ISI interval for BFN, Unit 3; which all started on February 1, 2016, and are scheduled to end on January 31, 2026.

3.2 Staff Evaluation

For 40 Years of Operation

The condition for Code Case N-702 that is specified in RG 1.147, Revision 18, requires that the applicability of Code Case N-702 to an RPV of a unit must be shown by demonstrating that the five criteria in the SE for BWRVIP-108 or the SE for BWRVIP-241 are met. These criteria were developed to ensure that the PoFs from the supporting PFM results for RPV nozzles are below the NRC safety goal of 5×10^{-6} per year. In this application, the licensee applied the criteria in the SE for BWRVIP-241.

The licensee's evaluation presented in Section 3.1 of this SE indicated that the calculated BFN RPV nozzle parameters meet four of the five criteria for applying Code Case N-702. Since the criterion that the BFN units fail to meet is related to the N1 nozzles, these nozzles are not in the proposed nozzle list. The NRC staff found that the licensee's evaluation of the Code Case N-702 application for 40 years for BFN, Units 1 and 3 is identical to that used to support a similar application approved on October 28, 2010 (ADAMS Accession No. ML102440565) for the second ISI interval for Unit 1 and the third ISI interval for Units 2 and 3, and on March 24, 2011 (ADAMS Accession No. ML110310453), for the fourth ISI interval for Unit 2. Considering that the plant-specific RPV operating information, RPV geometry, and the bounding RPV nozzle geometry at the end of 40 years remain unchanged during the 40 years of operation, the NRC staff determined that ASME Code Case N-702 is applicable to the proposed RPV nozzles for BFN, Units 1 and 3. Also, meeting the five criteria means the proposed nozzle PoFs meet the NRC safety goal of 5×10^{-6} per year. Therefore, an acceptable level of quality and safety is maintained for the third ISI interval for BFN, Unit 1 and the fourth ISI interval for BFN, Unit 3.

For 60 Years of Operation

Although only BFN, Unit 2 needs evaluation of the Code Case N-702 for a 60-year application to support the proposed RPV nozzle inspection during its fifth ISI interval, the licensee's PFM analysis for 60 years of operation also applies to BFN, Units 1 and 3 for their future use beyond 40 years of operation. The licensee's PFM analysis is consistent with the methodology in BWRVIP-108 and BWRVIP-241. It considers the additional thermal cycles and fluence at the end of the 60 years of operation and is, therefore, acceptable. The PoF values based on the PFM results for the nozzle blend radius and the nozzle-to-shell weld of the RPV and the event frequency of the LTOP are below the NRC safety goal of 5×10^{-6} per year. Therefore, the PoF values under the LTOP support application of ASME Code Case N-702 to the proposed RPV nozzles for 60 years of operation for BFN, Units 1, 2, and 3.

Additional PFM results and PoF values for the two nozzle locations under the normal operating condition for 60 years of operation were provided by the licensee in the October 17, 2018, supplement to support the request for alternative. Except for one of the four assumed flaw paths in nozzle blend radius of the plant-specific N1 nozzle, all other PoF values are below the NRC safety goal of 5×10^{-6} per year. The licensee calculated the change of core damage frequency for this particular flaw path and found it meets the RG 1.174 criterion of 1×10^{-6} per year. In summary, this additional plant-specific PFM analyses further support the licensee's exclusion of the N1 nozzles from this request for alternative. It should be noted, however, that the SE for BWRVIP-108 indicated that the PoF values for other RPV nozzles are an order of magnitude lower than the N1 and N2 (recirculation inlet) nozzles. Based on this, the NRC staff determined that it is unlikely that the PoF values for the proposed BFN RPV nozzles will exceed the NRC safety goal of 5×10^{-6} per year. Therefore, the NRC staff finds that ASME Code

Case N-702 applies to the proposed RPV nozzles for BFN, Unit 1, 2, and 3 for 60 years of operation and Request for Alternative ISI-46 provides an acceptable level of quality and safety. Per licensee's request, this approval of 60 years of operation applies to the fifth ISI interval for BFN, Unit 2.

Implication of the Overlapped Fourth and Fifth ISI Intervals for BFN, Unit 2

The approved fourth ISI interval for ASME Code Case N-702 application for BFN, Unit 2 is from May 25, 2011, to May 24, 2021. The proposed fifth ISI interval for ASME Code Case N-702 application for BFN, Unit 2 is from February 1, 2016, to January 31, 2026. There is an approximate 5-year overlap between the approved fourth ISI interval and the proposed fifth ISI interval for Unit 2, which prompts the NRC staff to review the actual RPV nozzle inspection accomplished during the fourth ISI interval. The October 17, 2018, supplement clarified that BFN has completed, or will complete in upcoming outages, the required examinations to ensure at least 25 percent of the nozzles are examined by the end of the first inspection period from February 1, 2016, to January 31, 2019. Hence, the NRC staff determined that by the end of January 31, 2019, the licensee has or will have completed its ASME Code inspection requirements for BFN, Unit 2.

VT-1 Examination

ASME Code Case N-702 also stipulates that visual test (VT)-1 examination may be used in lieu of the volumetric examination for the nozzle inner radii. The licensee's supplement states that it will utilize Code Case N-648-1, with associated required conditions specified in RG 1.147, if a VT-1 examination is performed in lieu of a volumetric examination. This is permissible because the licensee proposed to use the NRC approved VT-1 for the nozzle-inner-radii when it is used.

4.0 CONCLUSION

As set forth above, the NRC staff determined that the licensee has demonstrated that the proposed alternative provides an acceptable level of quality and safety. Accordingly, the NRC staff concludes that the licensee has adequately addressed all of the regulatory requirements set forth in 10 CFR 50.55a(z)(1). Therefore, the NRC authorizes the use of ISI-46 at BFN for ASME Category B-D, Item Numbers B3.90 and B3.100 for the third 10-year ISI interval for Unit 1, the fifth ISI interval for Unit 2, and the fourth ISI interval for BFN, Unit 3; which all started on February 1, 2016, and are scheduled to end on January 31, 2026.

All other requirements of the ASME Code, Section XI, for which relief has not been specifically requested remain applicable, including third party review by the Authorized Nuclear Inservice Inspector.

Principal Contributor: Simon Sheng

Date: February 28, 2019

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