



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

April 16, 2018

Mr. Dean Curtland  
Site Director, Duane Arnold Energy Center  
NextEra Energy Duane Arnold, LLC  
3277 DAEC Road  
Palo, IA 52324-9785

SUBJECT: DUANE ARNOLD ENERGY CENTER – REQUEST FOR RELIEF NO. RR-03  
RE: PROPOSED USE OF ALTERNATIVE REQUIREMENTS FOR NOZZLE  
INNER RADIUS AND NOZZLE-TO-SHELL WELD INSPECTIONS FOR FIFTH  
10-YEAR INSERVICE INSPECTION INTERVAL (CAC NO. MF9374; EPID  
L-2017-LLR-0110)

Dear Mr. Curtland:

By letter dated March 7, 2017<sup>1</sup>, supplemented by letters dated October 26, December 7, 2017, January 26, 2018, and March 27, 2018 (ADAMS Accession Nos. ML17300A195, ML17341A852, ML18026A779, and ML18086A495, respectively) NextEra Energy Duane Arnold, LLC (the licensee) requested 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 fifth 10-year inservice inspection (ISI) interval at Duane Arnold Energy Center (DAEC). Specifically, DAEC proposed the use of alternative Code Case N-702<sup>2</sup> for all reactor pressure vessel (RPV) nozzle-to-vessel shell welds and nozzle inner radii sections, with the exception of the Recirculation Outlet Nozzles (N1).

Based on the information provided in the licensee's request and responses to the U.S. Nuclear Regulatory Commission (NRC) staff's requested information, the staff has determined that the licensee's use of the proposed alternative is pursuant with Title 10 of the *Code of Federal Regulations*, Section 50.55a(z)(1). Furthermore, the NRC staff have concluded the licensee's use of Code Case N-702 for all DAEC RPV nozzle-to-vessel shell welds and nozzle inner radii sections, with the exception of the Recirculation Outlet Nozzles (N1), provides reasonable assurance of structural integrity and an acceptable level of quality and safety. Therefore, as requested, DAEC is authorized to use the proposed alternative for the remainder the fifth 10-year ISI interval which is scheduled to end on October 31, 2026.

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

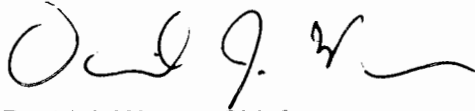
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<sup>1</sup> Agencywide Documents Access and Management System (ADAMS) Accession No. ML17069A172.

<sup>2</sup> ASME Code Case N-702, "Alternative Requirements for Boiling Water Reactor (BWR) Nozzle Inner Radius and Nozzle-to-Shell Welds, Section XI, Division 1."

If you have any questions regarding this matter, please contact Mr. Mahesh Chawla at (301) 415-8371 or by email at [Mahesh.Chawla@nrc.gov](mailto:Mahesh.Chawla@nrc.gov).

Sincerely,

A handwritten signature in black ink, appearing to read "D. J. Wrona", with a long horizontal flourish extending to the right.

David J. Wrona, Chief  
Plant Licensing Branch III  
Division of Operating Reactor Licensing  
Office of Nuclear Reactor Regulation

Docket No. 50-331

Enclosure:  
Safety Evaluation

cc: ListServ



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

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELIEF REQUEST RR-03 FOR RENEWED OPERATING LICENSE NO. DPR-49

DUANE ARNOLD ENERGY CENTER

FIFTH INSERVICE INSPECTION INTERVAL PROGRAM

NEXTERA ENERGY DUANE ARNOLD, LLC

DOCKET NO. 50-331

CAC NO. MF9374; EPID L-2017-LLR-0110

1.0 INTRODUCTION

By letter dated March 7, 2017 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML17069A172), NextEra Energy Duane Arnold, LLC (the licensee) requested 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 fifth 10-year inservice inspection (ISI) interval. Subsequently, by letters dated October 26, December 7, 2017, and January 26, 2018 (ADAMS Accession Nos. ML17300A195, ML17341A852, and ML18026A779, respectively), the licensee provided responses to the U.S. Nuclear Regulatory Commission (NRC or Commission) staff's request for additional information (RAI). Additionally, by letter dated March 27, 2018 (ADAMS Accession No. ML18086A495), the licensee informed the NRC of an error identified in the Probabilistic Fracture Mechanics (PFM) Evaluation and operating probability calculations. Section 3.2 of the staff's evaluation below addresses this information.

Specifically, pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR) 50.55a(z), the licensee proposed in relief request RR-03 revision of the inspection requirements in the ISI inspection program for certain reactor pressure vessel (RPV) nozzle-to-vessel welds and nozzle inner radii based on the ASME Code, Section XI, to an alternative based on ASME Code Case N-702.

2.0 REGULATORY EVALUATION

The ISI of the ASME Code Class 1, 2, and 3 components is performed in accordance with Section XI of the ASME Code and applicable addenda as a way to detect anomaly and degradation indications so that structural integrity of these components can be maintained. This is required by 10 CFR 50.55a(g), except where specific relief has been granted by the Commission pursuant to 10 CFR 50.55a(g)(6)(i). 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 applicant

Enclosure

or licensee must demonstrate that: (1) the proposed alternative would provide an acceptable level of quality and safety; or (2) compliance with the specified requirements of this section would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety.

For all RPV nozzle-to-vessel shell welds and nozzle inner radii, ASME Code, Section XI, requires 100 percent inspection during each 10-year ISI interval. However, Code Case N-702 provides an alternative which reduces the inspection of RPV nozzle-to-vessel shell welds and nozzle inner radii areas from 100 percent to 25 percent of the nozzles for each nozzle type during each 10-year interval. This Code Case was conditionally approved in Regulatory Guide (RG) 1.147, Revision 17.<sup>1</sup> For application of Code Case N-702, the licensee is required to address the conditions specified in RG 1.147, Revision 17, for ASME Code Case N-702, which states in part:

[T]he applicability of Code Case N-702 must be shown by demonstrating that the criteria in Section 5.0 of NRC Safety Evaluation regarding BWRVIP [Boiling-Water Reactor Vessel and Intervals Project]-108 dated December 19, 2007 (ML073600374) or Section 5.0 of NRC Safety Evaluation regarding BWRVIP-241 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.

BWRVIP-108, "Technical Basis for the Reduction of Inspection Requirements for the Boiling Water Reactor Nozzle-to-Vessel Shell Welds and Nozzle Inner Radii"<sup>2</sup> and BWRVIP-241, "Probabilistic Fracture Mechanics [PFM] Evaluation for the Boiling Water Reactor Nozzle-to-Vessel Shell Welds and Nozzle Blend Radii"<sup>3</sup> contain PFM analysis results supporting Code Case N-702 as both reports are for 40 years of operation. BWRVIP-241 contains additional PFM results supporting revision of the evaluation criteria under "Conditions and Limitations" in the safety evaluation (SE) for BWRVIP-108 and accepted the revised criteria.

Recently, the NRC issued an SE dated April 26, 2017 (ADAMS Accession No. ML17114A096), on a supplemental document for license renewal, BWRVIP-241, Appendix A, "BWR Nozzle Radii and Nozzle-to-Vessel Welds Demonstration of Compliance with the Technical Information Requirements of the License Renewal Rule (10 CFR 54.21)." This license renewal Appendix A extends the applicability of the BWRVP-108 and BWRVIP-241 methodologies, and, therefore, Code Case N-702 from 40 years to the period of extended operation.

The ASME Code of record for DAEC for the fifth 120-month interval ISI program is the 2007 Edition of the ASME Code, Section XI, through the 2008 Addenda.

### 3.0 TECHNICAL EVALUATION

#### 3.1 Licensee Evaluation

##### Components for which Alternative is Requested (ASME Code Class 1)

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<sup>1</sup> Inservice Inspection Code Case Acceptability, ASME Code, Section XI, Division 1, dated August 2014.

<sup>2</sup> ADAMS Accession No. ML02330203.

<sup>3</sup> ADAMS Accession No. ML11119A043.

Reactor Vessel Nozzles N2, N3, N5, N6, N7, N8, N11, N12, and N16, as specified in Attachment 1.<sup>4</sup>

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

ASME Code Section XI, 2007 Edition with the 2008 Addenda, 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 for each 10-year interval.

Licensee's Proposed Alternative to the ASME Code

Pursuant to 10 CFR 50.55a(z)(1), an alternative is requested from performing the required examinations on 100 percent of the reactor vessel nozzles identified above regarding B3.90 welds and B3.100 section. This alternative is in accordance with Code Case N-702, and proposes that a minimum of 25 percent of the nozzle-to-vessel welds and nozzle inner radius sections, including at least one nozzle from each system and nominal pipe size, be volumetrically examined. The nozzle number to be examined for each group of the reactor vessel nozzles is listed in an Attachment 1 table included as part of the relief request (RR)-03 submittal.

Volumetric examination of the nozzle inner radii is the licensee's preferred method. However, if a [visual testing-1] VT-1 examination is performed in lieu of a volumetric examination, the licensee will utilize ASME Code Case N-648-1.<sup>5</sup>

Licensee's Bases for Alternative

The alternative is based on the PFM results documented in the BWRVIP-108 report. The licensee addressed the evaluation criteria in the SE for BWRVIP-108 in the following:

(1) Max RPV Heatup/Cooldown Rate

First criterion - the maximum RPV heatup/cooldown rate is limited to < 115 °F/ hr. [degree Fahrenheit/hour].

The DAEC TS Surveillance Requirement (SR 3.4.9.1) that monitors reactor vessel heatup/cooldown limits the rate to less than 100 °F for Curve B and less than 20 °F for Curve A.

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<sup>4</sup> Attachment 1 of the licensee's submittal, dated March 7, 2017 (ADAMS Accession No. ML17069A172).

<sup>5</sup> Code Case N-648-1, "Alternative Requirements for Inner Radius Examination of Class 1 Reactor Vessel Nozzles, Section XI Division 1."

SR 3.4.9.1 states:

-----NOTE-----  
Only required to be performed during RCS heatup and cooldown  
operations and RCS inservice leak and hydrostatic testing.  
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Verify RCS pressure, RCS temperature, and RCS heatup and cooldown  
rates are within the limits specified in the PTLR.

This surveillance is in accordance with the Surveillance Frequency Control Program.

(2) Recirculation Inlet (N2) Nozzles

Second criterion -  $(pr/t) / C_{i-RPV} < 1.15$ , where

$p$  = RPV normal operating pressure (per square inch),  
 $r$  = RPV inner radius (inch),  
 $t$  = RPV wall thickness (inch), and  
 $C_{i-RPV} = 19332$ .

The NRC staff reviewed the licensee's furnished input parameters for the above Recirculation Inlet (N2) Nozzles criterion, as provided in Attachment 2<sup>6</sup> of the submittal, and verified the resulting value of 0.9748 meets this criterion.

(3) Recirculation Inlet (N2) Nozzles

Third criterion -  $[p(r_o^2+r_i^2)/(r_o^2-r_i^2)] / C_{i-NOZZLE} < 1.15$ , where

$r_o$  = nozzle outer radius (inch),  
 $r_i$  = nozzle inner radius (inch), and  
 $C_{i-NOZZLE} = 1637$ .

The NRC staff reviewed the licensee's furnished input parameters for the above Recirculation Inlet (N2) Nozzles criterion, as provided in Attachment 2 of the submittal, and verified the resulting value of 1.0923 meets this criterion.

(4) Recirculation Outlet (N1) Nozzles

Fourth criterion -  $(pr/t) / C_{o-RPV} \leq 1.15$ , where

$r$  = RPV inner radius (inch),  
 $t$  = RPV wall thickness (inch), and  
 $C_{o-RPV} = 16171$ .

The NRC staff reviewed the licensee's furnished input parameters for the above Recirculation Outlet (N1) Nozzles (forth) criterion, as provided in Attachment 2 of the submittal, and verified the resulting value of 1.17 does not meet this criterion.

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<sup>6</sup> Attachment 2 of the licensee's submittal, dated March 7, 2017 (ADAMS Accession No. ML17069A172).

### (5) Recirculation Outlet (N1) Nozzles

Fifth criterion -  $[p(r_o^2 + r_i^2)/(r_o^2 - r_i^2)]/C_{o-NOZZLE} \leq 1.15$ , where

$r_o$  = nozzle outer radius (inch),  
 $r_i$  = nozzle inner radius (inch), and  
 $C_{o-NOZZLE} = 1977$ .

The NRC staff reviewed the licensee's furnished input parameters for the above Recirculation Outlet (N1) Nozzles criterion, as provided in Attachment 2 of the submittal and verified the resulting value of 0.87 meets this criterion.

Since the fourth criterion is not met, the licensee stated in their submittal that:

Recirculation Outlet Nozzles do not meet all of the criteria and Code Case N-702 would not be applied. The licensee concludes that use of Code Case N-702 provides an acceptable level of quality and safety for all nozzle-to-vessel shell welds and nozzle inner radii sections, with the exception of the recirculation outlet nozzles.

### Period of application

This relief is requested for the duration of the fifth 10-year ISI interval beginning on November 1, 2016, and scheduled to end on October 31, 2026.

### 3.2 Staff Evaluation

The conditions for Code Case N-702 that are specified in RG 1.147, Revision 17, require that the applicability of Code Case N-702 must be shown by demonstrating that the criteria in the SE for BWRVIP-108 or the SE for BWRVIP-241 are met. These criteria were developed to ensure that the probabilities of failure (PoFs) from the supporting PFM results for RPV nozzles are below the NRC safety goal of  $5 \times 10^{-6}$  per year. The criteria in the SE for BWRVIP-241 are more relaxed than the criteria in the SE for BWRVIP-108. However, since the licensee failed to meet Criterion No. 4 (Section 3.1 above), which is the same in both the SE for BWRVIP-108 and the SE for BWRVIP-241, the licensee chose to use the criteria in the SE for BWRVIP-108 in its evaluation.

The SE on BWRVIP-108 established that: (1) the fracture toughness-related reference temperature ( $RT_{NDT}$ ) used in the PFM analyses were based on data from the entire fleet of BWR RPVs, making the PFM analyses bounding with respect to fracture resistance and leaving the driving force of the underlying PFM analyses the only item to be evaluated, and (2) except for the RPV heatup/cooldown rate, the plant-specific criteria are for the Recirculation Inlet and Recirculation Outlet nozzles because the conditional probability of failure (PoF) for other nozzles are an order of magnitude lower.

The licensee's evaluation discussed above in Section 3.1 of this SE, indicated that all RPV nozzle-to-shell welds and nozzle inner radii sections, with the exception of the Recirculation Outlet nozzles, meet the criteria for applying Code Case N-702. The NRC staff used the licensee's input geometric parameters in Attachment 2 (of the submittal) and arrived at the same plant-specific results. This effort confirmed the licensee's evaluation that only Criterion 4 related to Recirculation Outlet nozzles is not met. However, the licensee's evaluation is valid for

only 40 years of operation because the underlying PFM results in BWRVIP-108 are for 40 years. The NRC staff noted that the requested RR-03 is for the fifth 10-year ISI interval, beyond the original 40-year operation. Therefore, the NRC staff requested additional information from the licensee for justification of applying Code Case N-702 in the Fifth ISI interval. The licensee's response in a supplemental letter dated October 26, 2017, provided plant-specific PFM analysis, demonstrating that the total PoF for the low-temperature overpressure (LTOP) event for 60 years of operation is below the NRC safety goal of  $5 \times 10^{-6}$  per year. However, this response did not address the total PoF for the normal operation condition. In a supplemental letter dated December 7, 2017, the licensee used qualitative information to further explain that the PFM results for the LTOP condition is sufficient for this application. However, due to lack of quantitative assessment of the margin in the PFM analyses of BWRVIP-108, the NRC staff issued a follow-up RAI requesting more specific support.

The licensee's response in supplemental letter dated January 26, 2018, provided plant-specific PFM results for the normal operating condition, which showed that the PoF for the normal operation is less than the NRC safety goal of  $5 \times 10^{-6}$  per year with a significant margin. On the bases of this information, the NRC staff concluded that the criteria in the SE for BWRVIP-108 and, therefore, Code Case N-702 can also be applied during the period of extended operation at DAEC.

In summary, the plant-specific PFM results for the period of extended operation met the NRC safety goal on PFM results for RPVs. Accordingly, the licensee's proposed alternative for RPV nozzles provides an acceptable level of quality and safety.

ASME Code Case N-702 also stipulates that VT-1 examination may be used in lieu of the volumetric examination for the inner radii. The NRC has not endorsed use of Code Case N-702 for VT-1 examinations. The licensee states that it will utilize Code Case N-648-1 (see footnote 3 above), 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 when it is used.

The licensee provided information in the supplemental letter dated March 27, 2018,<sup>7</sup> correcting an errant condition associated in calculations from their original evaluation. Specifically, the licensee identified a software discrepancy which affected the PFM calculations related to the behavior of Stress Corrosion Crack Growth. The licensee stated that after using corrected software and performing a rerun of the analysis, the results were a slight increase in the calculated probabilities of failure. The licensee indicated these results remained well below the acceptance criteria and did not change the conclusions as documented in the request, as originally proposed. The NRC staff evaluated the licensee's corrected analysis and supporting documentation and have determined the licensee's results are acceptable.

#### 4.0 CONCLUSION

The NRC staff has reviewed the submittal regarding the licensee's address of the conditions specified in RG 1.147, Revision 17, for ASME Code Case N-702. The conditions require evaluation of the plant-specific RPV nozzle information against the five evaluation criteria specified in the December 19, 2007, SE for BWRVIP-108 or the April 19, 2013, SE for BWRVIP-241. Based on the evaluation in Section 3.2 of this SE, the NRC staff have determined that the licensee has adequately addressed the RG 1.147, Revision 17, conditions

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<sup>7</sup> ADAMS Accession No. ML18086A495.



for ASME Code Case N-702 to the end of the DAEC period of extended operation, and, therefore, the licensee's proposed alternative is in compliance with the ASME Code requirements and 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) and authorizes the licensee's proposed alternative for inspection of nozzle-to-vessel shell welds and nozzle inner radii for the RPV nozzles identified in Attachment 1 of the submittal for the remainder of DAEC's fifth 10-year ISI interval scheduled to end October 31, 2026.

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

Principle Contributor: S. Sheng

Date of issuance: April 16, 2018.

SUBJECT: DUANE ARNOLD ENERGY CENTER – REQUEST FOR RELIEF NO. RR-03  
RE: PROPOSED USE OF ALTERNATIVE REQUIREMENTS FOR NOZZLE  
INNER RADIUS AND NOZZLE-TO-SHELL WELD INSPECTIONS FOR FIFTH  
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SSheng, NRR

**ADAMS ACCESSION No. ML18053A209**

**\*via e-mail**

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