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

October 16, 2019

Mr. Rod L. Penfield
Site Vice President
FirstEnergy Nuclear Operating Company
Beaver Valley Power Station
Mail Stop P-BV-SSEB
P.O. Box 4, Route 168
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SUBJECT: BEAVER VALLEY POWER STATION, UNIT 2 – ISSUANCE OF RELIEF REQUEST REGARDING PROPOSED ALTERNATIVE TO REACTOR VESSEL NOZZLE WELD EXAMINATION FREQUENCY REQUIREMENTS IN LIEU OF SPECIFIC AMERICAN SOCIETY OF MECHANICAL ENGINEERS CODE REQUIREMENTS (EPID L-2019-LLR-0013)

Dear Mr. Penfield:

By application dated February 20, 2019 (Agencywide Documents Access and Management System Accession No. ML19051A108), FirstEnergy Nuclear Operating Company (the licensee) submitted a request for proposed alternative 2-TYP-4-RV-05, Revision 0, to the U.S. Nuclear Regulatory Commission (NRC or the Commission) for the Beaver Valley Power Station, Unit 2 (BVPS-2). The proposed alternative would allow the licensee to use an alternative to the examination frequency requirements of Title 10 of the Code of Federal Regulations (10 CFR) Section 50.55a(g)(6)(ii)(F) for reactor pressure vessel inlet nozzle to safe end dissimilar metal butt welds at BVPS-2. The American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel (BPV) Code Case N-770-2, "Alternative Examination Requirements and Acceptance Standards for Class 1 PWR [power water reactor] Piping and Vessel Nozzle Butt Welds Fabricated with UNS N06082 or UNS W86182 Weld Filler Material With or Without Application of listed Mitigation Activities Section XI, Division 1," requires volumetric examination not to exceed 7 years for unmitigated butt welds in the cold leg operating in the temperature range of 525 - 580 degrees Fahrenheit (274 - 304 degrees Celsius). The proposed alternative requests a one-time extension of the inspection period from 7 years up to 9 years.

Specifically, pursuant to 10 CFR 50.55a(z)(2), the licensee requested to use a proposed alternative on the basis that compliance with the specified requirements would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety.

The NRC staff has reviewed the subject request and concludes, as set forth in the enclosed safety evaluation, that FirstEnergy Nuclear Operating Company has adequately addressed all the regulatory requirements set forth in 10 CFR 50.55a(z)(2). The proposed alternative provides reasonable assurance of the structural integrity of the subject components and that complying with the specified ASME BPV Code requirements would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety. Therefore, the NRC staff authorizes the use of 2-TYP-4-RV-05 at BVPS-2 for a one-time extension of the volumetric inspection interval from the 2R21 refueling outage to the 2R23 refueling outage currently scheduled for the spring of 2023.

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

If you have any questions please contact the Beaver Valley Project Manager, Jennifer Tobin, at 301-415-2328 or Jennifer.Tobin@nrc.gov.

Sincerely,

/RA/

James G. Danna, Chief
Plant Licensing Branch 1
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. 50-410

Enclosure:
Safety Evaluation

cc: Listserv

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

REGARDING ALTERNATIVE REPAIR

FOR REACTOR VESSEL NOZZLE WELD EXAMINATION FREQUENCY REQUIREMENTS

FIRSTENERGY NUCLEAR OPERATING COMPANY

BEAVER VALLEY POWER STATION, UNIT 2

DOCKET NO. 50-410

1.0 INTRODUCTION

By application dated February 20, 2019 (Agencywide Documents Access and Management System Accession No. ML19051A108), FirstEnergy Nuclear Operating Company (the licensee) submitted a request for proposed alternative 2-TYP-4-RV-05, Revision 0, to the U.S. Nuclear Regulatory Commission (NRC or the Commission) for the Beaver Valley Power Station, Unit 2 (BVPS-2). The proposed alternative would allow the licensee to use an alternative to the examination frequency requirements of 10 CFR 50.55a(g)(6)(ii)(F) for reactor pressure vessel (RPV) inlet nozzle to safe end dissimilar metal butt welds (DMBWs) at BVPS-2. The American Society for Mechanical Engineers (ASME) Boiler and Pressure Vessel (BPV) Code Case N-770-2, "Alternative Examination Requirements and Acceptance Standards for Class 1 PWR [power water reactor] Piping and Vessel Nozzle Butt Welds Fabricated with UNS N06082 or UNS W86182 Weld Filler Material With or Without Application of listed Mitigation Activities Section XI, Division 1," requires volumetric examination not to exceed 7 years for unmitigated butt welds in the cold leg operating in the temperature range of 525 - 580 degrees Fahrenheit (274 - 304 degrees Celsius). The proposed alternative requests a one-time extension of the inspection period 7 years up to 9 years.

Specifically, pursuant to 10 CFR 50.55a(z)(2), the licensee requested to use a proposed alternative on the basis that complying with the specified requirements would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety.

2.0 REGULATORY EVALUATION

The licensee's request proposes an alternative to the requirements of the ASME Code, Section XI, Code Case N-770-2, Table 1, for the Class 1 pressure retaining dissimilar metal piping and vessel nozzle butt welds containing Alloy 82/182. Pursuant to 10 CFR 50.55a(g)(4), ASME Code Class 1, 2, and 3 components (including supports) must meet the requirements, except design and access provisions and preservice examination requirements, set forth in the ASME BPV Code, Section XI, to the extent practical within the limitations of design, geometry, and materials of construction of the components.

Pursuant to 10 CFR 50.55a(g)(6)(ii), "Augmented ISI Program," the NRC may require licensees to follow an augmented inservice inspection (ISI) program for systems and components for which the Commission deems that added assurance of structural reliability is necessary.

Pursuant to 10 CFR 50.55a(g)(6)(ii)(F)(1), "Augmented ISI requirements: Examination requirements for Class 1 piping and nozzle dissimilar-metal butt welds-(1) Implementation," licensees shall implement the requirements of ASME BPV Code Case N-770-2 instead of ASME BPV Code Case N-770-1, subject to the conditions specified in paragraphs (g)(6)(ii)(F)(2)-(13), by the first refueling outage starting after August 17, 2017.

The regulation in 10 CFR 50.55a(z) states, in part, that alternatives to the requirements of paragraph (g) of 10 CFR 50.55a may be used, when 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.

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

3.0 TECHNICAL EVALUATION

3.1 Background

The relief request addresses the examination of Class 1 pressure retaining dissimilar metal piping and vessel nozzle butt welds containing Alloy 82/182 for the fourth ISI interval at BVPS-2. The examination category and item numbers are addressed in Table 1 of the ASME Code Case N-770-2, 2013 Edition with no Addenda.

3.2 ASME Code Requirements

Paragraph 50.55a(g)(6)(ii)(F)(1) of 10 CFR requires volumetric examination of unmitigated butt welds at cold leg operating temperatures greater than or equal to 525 degrees Fahrenheit (°F) (274 degrees Celcius (ºC)) and less than 580 °F (304 ºC) every second inspection period not to exceed 7 years as specified in ASME BPV Code Case N-770-2.

Of note, the inspection requirement under 10 CFR 50.55a(g)(6)(ii)(F), is a requirement regardless and irrespective of the 10-year ISI interval for which is applicable to BVPS-2. This is because it is an augmented ISI program as described in 10 CFR 50.55a(g)(6)(ii), and is included directly into 10 CFR 50.55a (instead of being incorporated by reference via NRC Regulatory Guide like most of the other ASME BPV Code Cases).

3.3 Applicable ASME Code Edition and Addenda

For the fourth 10-year ISI interval at BVSP-2, the code of record for the inspection of ASME Code Class 1, 2, and 3 components is the ASME Code, Section XI, 2013 Edition with no Addenda.

3.4 Licensee's Proposed Alternative

The licensee's proposed alternative is for a one-time extension of the volumetric inspection interval for the BVPS-2 RPV inlet nozzle-to-safe-end DMBWs listed in Section 3.1 of this safety evaluation from 7 years to 9 years. With the proposed alternative, the next volumetric examination of the BVPS-2 reactor vessel cold leg nozzle-to-safe-end welds would be performed during the 2R23 refueling outage, which is currently scheduled for the spring of 2023.

3.5 Proposed Alternative and Basis for Use

The licensee is seeking the NRC's authorization of the proposed alternative in accordance with 10 CFR 50.55a(z)(2) on the basis that complying with the specified requirements would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety. In its application, the licensee indicated that its proposed alternative does not adversely impact the level of safety or quality and provides reasonable assurance that the structural integrity and the leak tightness of the weld will be maintained for several reasons, including but not limited to:

- Results of the most recent volumetric examinations, which were performed in the spring of 2014, met the requirements of the ASME Code, Section XI, Appendix VIII, and achieved essentially 100 percent coverage, found no reportable primary water stress corrosion cracking (PWSCC) indications. In addition, no recordable indications were observed during in-service volumetric examinations that were performed on these welds in 1996 and 2008.

- Eddy current examinations were also performed in the spring of 2014, as an inside surface examination obtaining 100 percent of the inspection coverage. No indications were identified both during the initial examination and follow-up evaluation by a Level III examiner that exceeded 0.16 inch in length on the inside surface of the weld.

- A plant-specific flaw tolerance evaluation (ADAMS Accession No. ML19051A109) was performed for the BVPS-2 welds. It concluded that more than 9 years is required for growth from the standard detectability limit to the allowable size per the ASME Section XI IWB-3640 flaw evaluation procedure.

The licensee also provided a summary of the technical basis from Electric Power Research Institute's "Materials Reliability Program: PWR Reactor Coolant System Cold-Loop Dissimilar Metal Butt Weld Reexamination Interval Extension" (MRP-349) which included: 1) there is no service experience that has identified PWSCC in RPV inlet nozzle-to-safe-end DMBWs, 2) crack growth rates in these welds at cold leg temperature are relatively small, and 3) the likelihood of cracking or through-wall leaks is very small in these welds.

3.6 Duration of Proposed Alternative

The licensee requested relief for the fourth ISI interval for BVPS-2, which began on August 29, 2018, and will conclude on August 28, 2028.

3.7 NRC Staff Evaluation

Pursuant to 10 CFR 50.55a(g)(5)(iii), the licensee submitted this request for relief from the examination requirements of the ASME Code, Section XI. The NRC staff's evaluation of the

licensee's request for relief focused on: (1) whether the ASME Code requirement is impractical, (2) whether the imposition of the ASME Code required inspections would result in a burden to the licensee, and (3) whether the licensee's examination coverage provides reasonable assurance of structural integrity and leak tightness of the subject welds.

The NRC staff has reviewed and evaluated the licensee's request on the basis that the proposed alternative would provide reasonable assurance of structural integrity of the subject welds. The applicable requirement is the qualified volumetric inspection of the subject welds within 7 years from the previous qualified volumetric inspection. This requirement is based on a general assessment of the necessary qualified volumetric inspection frequency for all cold leg operating temperature DMBWs, of any size, in the reactor coolant system to maintain structural integrity. Under this inspection requirement, the welds are expected to have no previous indications of PWSCC. The licensee stated in its submittal that no PWSCC has been found in these welds. The NRC staff verified this information and confirms that the licensee-identified DMBWs that are the subject of this proposed alternative are applicable to this inspection category and technical basis for qualified volumetric inspection frequency.

The licensee identified a hardship associated with the performance of the qualified volumetric inspection frequency within the required 7 years. The licensee noted that the current required volumetric inspection frequency would require either an additional core barrel removal or examination from the outside diameter of the welds to facilitate inspection of the subject DMBW. Since the licensee typically performs a core barrel lift only when required and generally, in an attempt, to combine all planned inspection requirements (i.e., vessel internals), the NRC staff accepts the licensee's position that an additional core barrel lift to meet the existing examination requirement for the RPV inlet nozzle-to-safe-end DMBWs would cause hardship due to increased risk to safety and radiological dose exposure. The licensee also estimated that the hardship associated with performing the volumetric examination from the outside diameter of the DMBW would require work in a high radiation area causing a significant radiological dose. The NRC staff finds the licensee's analysis of the radiological dose near the reactor vessel is reasonable compared to the inspection of similar DMBW at other facilities. The NRC staff finds the licensee has provided sufficient information to demonstrate a hardship associated with the current required volumetric inspection frequency of the subject DMBW. Therefore, the NRC staff finds the licensee meets the hardship requirement of 10 CFR 50.55a(z)(2).

The NRC staff reviewed the level of quality and safety of the licensee's proposed alternative to allow an approximately 2-year delay in the qualified volumetric examination, beyond the current regulatory requirement of 7 years. As part of this analysis, the NRC staff reviewed the licensee's technical basis regarding past operating history, fabrication history, and plant specific flaw analysis. The NRC staff also considered additional supporting information provided by the licensee, as necessary, to provide additional supporting technical basis on a plant specific basis for the proposed alternative, but did not fully review these items for generic acceptance of the documentation. Furthermore, the NRC staff performed a series of flaw evaluation of hypothetical flaws in the subject welds to evaluate margins of safety and verify the conclusions of the licensee's analysis.

The NRC staff reviewed the effect of the licensee's previous inspection findings. The licensee provided the results of the most recent volumetric examinations of these DMBW, which resulted in no reportable PWSCC indications. The NRC staff notes that this information is necessary to ensure the correct classification of the inspection category of the DMBW, Inspection Item B of Table 1 of ASME Code Case N-770-2, such that the required volumetric inspection should be performed within 7 years. However, since an Inspection Item B DMBW in Table 1 of ASME

Code Case N-770-2, requires no previous indications of PWSCC, the NRC staff finds that this factor, although favorable, does not provide enough technical basis to support the proposed alternative by itself. The NRC staff evaluated additional factors that would support the licensee's technical basis as discussed below.

The licensee also performed both an axial and circumferential flaw tolerance analysis to support the extension of the required volumetric inspection frequency from 7 years to 9 years. The purpose of these analyses is to state that a hypothetical PWSCC flaw would have to be of a sufficient size during the previous volumetric examination that the postulated flaw size would have been within the qualified detection limits of the ultrasonic and eddy current examinations performed at that time. Further, the licensee noted that any flaw of a size smaller than the qualified examination detection capability would not grow to an unacceptable size within the period of extended inspection frequency of 9 years.

The NRC staff used risk insights to review the licensee's methodology of the flaw tolerance approach. The NRC staff reviewed the licensee's flaw analyses' inputs and found the licensee's inputs are acceptable. The licensee's analysis documented the time for a flaw to meet an ASME BPV Code limit of 75 percent through-wall depth of the weld. The NRC staff notes that a circumferential flaw would take longer to reach a leaking condition, and longer still to cause failure of the structural integrity of the weld. The NRC staff notes that the growth of only a circumferential flaw could result in a loss of structural integrity because a circumferential flaw can grow around the circumference of the weld, and it could lead to a guillotine break in the pipe. Alternatively, given that PWSCC does not propagate through either the stainless steel or low alloy steel adjacent to the weld, the NRC staff recognizes that axial flaws cannot grow sufficiently in length to cause a rupture of the weld and adjacent piping base metal. The NRC staff, through risk insights, concurs that the licensee's methodology was consistent with a limiting analysis.

The NRC staff's review of the licensee's flaw tolerance analysis finds it is conservative for circumferential flaw growth and axial flaw growth. Given these failure mechanisms, the NRC staff finds the licensee's flaw analysis demonstrates structural integrity of the subject DMBWs will be maintained if the volumetric inspection frequency is extended from 7 to 9 years.

The NRC staff also performed a series of flaw evaluations to evaluate the licensee's analysis. The NRC staff also performed sensitivity analyses to determine the margin to leakage and rupture of the subject DMBWs. The NRC staff recognizes that there are significant uncertainties in flaw analyses performed by licensees and the NRC staff. In general, conservative assumptions are used to address these uncertainties. The level of conservatism applied can significantly affect the analytical results. Therefore, variations in results between the licensee's calculations and the NRC staff's calculations should not be viewed as either correct or incorrect but rather as an input to the overall assessment of the licensee's proposed alternative. The NRC staff's calculations utilize the same guidelines as the licensee used, Electric Power Research Institute (EPRI) Report, "Materials Reliability Program: Primary Water Stress Corrosion Cracking (PWSCC) Flaw Evaluation Guidance (MRP-287)," dated December 2010. The NRC endorsed EPRI Report MRP-287 in a letter dated February 28, 2011 (ADAMS Accession No. ML 110620628).

The NRC staff's flaw analysis used the licensee's inputs and NRC-accepted industry inputs for sensitivity analyses. The NRC staff calculation results verify the conclusions of the licensee's flaw analysis for both hypothetical axial and circumferential flaw growth. The NRC staff calculations for circumferential flaws confirmed the licensee's conclusion that structural integrity

would be maintained during the period of the licensee's requested volumetric inspection extension to 9 years. Furthermore, the NRC staff's sensitivity analysis confirmed significant margin for time to rupture beyond the 9-year time frame even under earthquake loading conditions. In summary, the NRC staff calculations verified that structural integrity would be maintained by the subject DMBWs with significant margin for the licensee's proposed inspection interval.

Finally, the NRC staff used the following risk insights to evaluate the results of the NRC staff's calculations and review: licensee-provided inspection history of the subject welds, including previous finding of no reportable PWSCC indications; the NRC staff's conclusions regarding PWSCC propagation and axial flaw growth; and conservative assumptions used in the NRC staff's flaw evaluations that account for analysis uncertainties. From a safety perspective, the NRC staff notes that the degradation mechanism of concern is PWSCC. As noted previously, only circumferential PWSCC flaws can challenge the structural integrity of the DMBWs. While the NRC staff's analysis found that a hypothetical axial PWSCC flaw, with conservative inputs, could cause leakage during the period of extended inspection interval, these axial flaws would be limited in size by the width of the weld. Beyond the weld, the base material of the pipe and nozzle are not susceptible to PWSCC. Furthermore, PWSCC flaws are very tight intergranular flaws that have limited leak rates such that no concerns for a loss-of-coolant accident could occur simply because of an axial PWSCC flaw in a DMBW. Additionally, the NRC staff notes that there are several conservative assumptions in the flaw analyses performed by both the licensee and the NRC staff.

The primary conservatism among both evaluations is that an axial flaw of 10 percent depth has already initiated and is growing immediately after the last volumetric inspection. While the NRC staff recognizes that the hypothetical axial flaw could cause leakage during the proposed inspection interval, the NRC staff finds that this consequence is unlikely based on the conservative assumption that an axial flaw has already initiated of a precise size to be missed by a qualified volumetric examination and in a tensile stress condition that would allow continued growth. Furthermore, the NRC staff notes that volumetric inspections are not the only method used by licensees to assess structural integrity of the subject welds. The licensee has existing plant procedures such as plant walkdowns and leakage monitoring systems for the reactor coolant system which also provide defense-in-depth measures to assess the leak tight integrity of the subject welds. Therefore, the NRC staff finds, through an analysis using risk insights, that the licensee's proposed alternative has a minimal, if any, impact on safety.

Given the licensee's identified hardship and the NRC staff's assessment of the volumetric inspection frequency extension of 2 years, the NRC staff finds the licensee's proposed alternative is acceptable on the basis that compliance with the specified requirements would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety and is authorized under 10 CFR 50.55a(z)(2).

4.0 CONCLUSION

As set forth above, the NRC staff determines that the licensee has demonstrated that the proposed alternative provides reasonable assurance of structural integrity of the standby liquid control nozzle. The NRC staff determines that granting relief pursuant to 10 CFR 50.55a(g)(6)(ii) is authorized by law, will not endanger life or property or the common defense and security, and is otherwise in the public interest, giving due consideration to the burden upon the licensee that could result if the requirements were imposed on the facility. Accordingly, the NRC staff concludes that the licensee has adequately addressed all the regulatory requirements set forth in

10 CFR 50.55a(g)(6)(ii). Therefore, the NRC staff grants the use of this alternative for the fourth ISI interval for BVPS-2 that started August 29, 2018, and will conclude on August 28, 2028.

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

Principal Contributor: J. Collins

Date: October 16, 2019

SUBJECT: BEAVER VALLEY POWER STATION, UNIT 2 – ISSUANCE OF RELIEF REQUEST REGARDING PROPOSED ALTERNATIVE TO REACTOR VESSEL NOZZLE WELD EXAMINATION FREQUENCY REQUIREMENTS IN LIEU OF SPECIFIC AMERICA SOCIETY OF MECHANICAL ENGINEERS CODE REQUIREMENTS (EPID L-2019-LLR-0013) DATED OCTOBER 16, 2019

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