



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

July 18, 2012

Mr. Paul A. Harden
Site Vice President
FirstEnergy Nuclear Operating Company
Beaver Valley Power Station
Mail Stop A-BV-SEB1
P.O. Box 4, Route 168
Shippingport, PA 15077

SUBJECT: BEAVER VALLEY POWER STATION, UNIT NO. 2 – REQUEST FOR RELIEF
RELATING TO REACTOR VESSEL NOZZLE WELDS (TAC NO. ME7770)

Dear Mr. Harden:

By letter dated December 27, 2011 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML113620646), FirstEnergy Nuclear Operating Company (FENOC, the licensee), requested relief from the requirements of the American Society of Mechanical Engineers (ASME) *Boiler and Pressure Vessel Code* for Beaver Valley Power Station (BVPS), Unit No. 2. The relief request is associated with volumetric examinations of certain reactor vessel nozzle welds and was assigned request number 2-TYP-3-RVSE-1, by FENOC. Specifically, pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR) 50.55a(g)(5)(iii), the licensee requested relief from the depth-sizing uncertainty qualification requirement for ultrasonic examinations conducted from the inside diameter of pipes, i.e., root mean square error not greater than 0.125 inches, contained in ASME Code Cases N-695, "Qualification Requirements for Dissimilar Metal Piping Welds, Section XI, Division 1," and N-696, "Qualification Requirements for Appendix VIII Piping Examinations Conducted From the Inside Surface, Section XI, Division 1," due to impracticality. By letter dated June 1, 2012 (ADAMS Accession No. ML12156A227), the request was revised. The licensee initially requested that relief be granted for the remainder of the third 10-year inservice inspection interval of BVPS, Unit No. 2. However, in its June 1, 2012, submittal, the licensee revised its request to include only examinations conducted at BVPS, Unit No. 2, prior to the end of the fall 2012 refueling outage, which is scheduled to begin on September 24, 2012.

The U.S. Nuclear Regulatory Commission (NRC) staff has completed its review of the request, as revised by the letter dated June 1, 2012, and as discussed in the enclosed safety evaluation (SE). The NRC staff determined that granting relief pursuant to 10 CFR 50.55a(g)(6)(i) is authorized by law and 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 of the regulatory requirements set forth in 10 CFR 50.55a.

P. Harden

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Therefore, the NRC staff grants the use of the alternate depth-sizing qualification (0.189 inch for ASME Code Case N-695 welds and 0.245 inch for ASME Code Case N-696 welds), subject to the licensee providing, for NRC staff review and approval prior to the expiration of the relief, the information identified in the SE, should a crack requiring depth-sizing be identified. This relief is granted for BVPS, Unit No. 2, until prior to startup following the fall 2012 refueling outage. All other ASME Code, Section XI requirements for which relief was not specifically requested and approved in the subject request for relief remain applicable, including third-party review by the Authorized Nuclear Inservice Inspector.

If you have any questions, please contact the BVPS Project Manager, Mr. Peter J. Bamford, at 301-415-2833.

Sincerely,



Meena Khanna, Chief
Plant Licensing Branch I-2
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. 50-412

Enclosure:
As stated

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

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

REQUEST FOR RELIEF RELATING TO

REACTOR VESSEL NOZZLE WELDS

FIRSTENERGY NUCLEAR OPERATING COMPANY

BEAVER VALLEY POWER STATION, UNIT NO. 2

DOCKET NUMBER 50-412

1.0 INTRODUCTION

By letter dated December 27, 2011 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML113620646), FirstEnergy Nuclear Operating Company (FENOC, the licensee), requested relief from the requirements of the American Society of Mechanical Engineers *Boiler and Pressure Vessel Code* (ASME code) for Beaver Valley Power Station (BVPS), Unit No. 2. The relief request is associated with volumetric examinations of certain reactor vessel nozzle welds and was assigned request number 2-TYP-3-RVSE-1, by FENOC. Specifically, pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR) 50.55a(g)(5)(iii), the licensee requested relief from the depth-sizing uncertainty qualification requirement for ultrasonic examinations conducted from the inside diameter of pipes, i.e., root mean square error not greater than 0.125 inches, contained in ASME Code Cases N-695, "Qualification Requirements for Dissimilar Metal Piping Welds, Section XI, Division 1," and N-696, "Qualification Requirements for Appendix VIII Piping Examinations Conducted From the Inside Surface, Section XI, Division 1," due to impracticality. By letter dated June 1, 2012 (ADAMS Accession No. ML12156A227), the request was revised by the licensee in response to concerns raised by the U.S. Nuclear Regulatory Commission (NRC, or commission) staff regarding recent industry interactions on this issue. The licensee initially requested that relief be granted for the remainder of the third 10-year inservice inspection interval of BVPS, Unit No. 2. However, in its June 1, 2012, supplement, the licensee revised the request to include only examinations conducted at BVPS, Unit No. 2, prior to the end of the fall 2012 refueling outage, which is scheduled to begin on September 24, 2012.

2.0 REGULATORY EVALUATION

In its letters dated December 27, 2011, and June 1, 2012, the licensee requested relief from the depth-sizing acceptance criteria contained in ASME Code Cases N-695 and N-696 pursuant to 10 CFR 50.55a(g)(5)(iii). ASME Code Cases N-695 and N-696 are accepted for use in NRC Regulatory Guide (RG) 1.147, Revision 16, "Inservice Inspection Code Case Acceptability ASME Section XI, Division 1," and are incorporated by reference in 10 CFR 50.55a(b). Section 50.55a(g)(4)(ii) of 10 CFR states, in part, that inservice examination of components must comply with the latest edition of the Code incorporated by reference in 10 CFR 50.55a(b) or the optional ASME Code Cases listed in RG 1.147. Section 50.55a(g)(5)(iii) of 10 CFR states, in part, that

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licensees may determine that conformance with certain code requirements is impractical and that the licensee shall notify the Commission and submit information in support of that determination. Section 50.55a(g)(6)(i) of 10 CFR states, in part, that the Commission will evaluate determinations under 10 CFR 50.55a(g)(5) that ASME Code requirements are impractical and that the Commission may grant such relief, and may impose such alternative requirements as it determines are authorized by law, and will not endanger life or property.

Based on the above, and subject to the following technical evaluation, the NRC staff finds that regulatory authority exists for the licensee to request, and the Commission to grant, the relief requested by the licensee.

3.0 TECHNICAL EVALUATION

3.1 Component Descriptions

The licensee stated that this relief request addresses nozzle-to-safe end dissimilar metal welds and adjacent safe end-to-pipe or safe end-to-elbow stainless steel welds at the locations listed in Tables 1 and 2.

Table 1: Dissimilar Metal Welds Covered by Code Case N-695

Component	Description of Weld Inspection	Item
2RCS*REV21-N-24	Reactor Vessel Hot Leg Nozzle to Safe-End	A-2
2RCS*REV21-N-26	Reactor Vessel Hot Leg Nozzle to Safe-End	A-2
2RCS*REV21-N-28	Reactor Vessel Hot Leg Nozzle to Safe-End	A-2
2RCS*REV21-N-23	Reactor Vessel Cold Leg Nozzle to Safe-End	B
2RCS*REV21-N-25	Reactor Vessel Cold Leg Nozzle to Safe-End	B
2RCS*REV21-N-27	Reactor Vessel Cold Leg Nozzle to Safe-End	B

Table 2: Stainless Steel Welds Covered by Code Case N-696

Component	Description of Weld Inspection	Item
2RCS*001-F01	Reactor Vessel Hot Leg Safe-End to Pipe	R1.11
2RCS*004-F01	Reactor Vessel Hot Leg Safe-End to Pipe	R1.11
2RCS*007-F01	Reactor Vessel Hot Leg Safe-End to Pipe	R1.11
2RCS*003-F04	Reactor Vessel Cold Leg Safe-End to Pipe	R1.11
2RCS*006-F04	Reactor Vessel Cold Leg Safe-End to Pipe	R1.11
2RCS*009-F04	Reactor Vessel Cold Leg Safe-End to Pipe	R1.11

3.2 Applicable Code and Addenda

The code of record for the third inspection interval for BVPS, Unit 2, is the ASME Code Section XI 2001 Edition through the 2003 Addenda. For ASME Code Section XI Appendix VIII examinations, the code of record is the 2001 Edition of Appendix VIII with no addenda. The third 10-year inservice inspection interval began on August 29, 2008, and is scheduled to expire on August 28, 2018.

3.3 Applicable Code Requirement

Volumetric examinations of the components contained in Tables 1 and 2 are mandated in ASME Code Section XI, Table IWB-2500, Category B-F, Item B5.10. Requirements for ultrasonic examinations used to conduct these inspections are contained in ASME Code Section XI, Paragraph IWA-2232, and ASME Code Section XI, Appendix I, Paragraph I-2220. These paragraphs refer to ASME Code Section XI, Appendix VIII, including Supplements 2 and 10.

Code Case N-695 provides alternative requirements to Appendix VIII, Supplement 10. It is unconditionally approved for use in NRC Regulatory Guide 1.147, Revision 16. Paragraph 3.3(c) of Code Case N-695 states, "Examination procedures, equipment, and personnel are qualified for depth sizing when the root mean square (RMS) error of the flaw depth measurements, as compared to the true flaw depths, do not exceed 0.125 in. (3 mm)."

Code Case N-696 provides alternative requirements to Appendix VIII, Supplements 2, 3, and 10 examinations conducted from the inside surface. Code Case N-696 is unconditionally approved for use in NRC Regulatory Guide 1.147, Revision 16. Supplement 3 (Qualification Requirements for Ferritic Piping Welds) is not applicable to the welds referenced under this relief request. Paragraph 3.3(d) of Code Case N-696 states, "Supplement 2 or Supplement 3 examination procedures, equipment, and personnel are qualified for depth sizing when the flaw depths estimated by ultrasonics, as compared to true depths, do not exceed 0.125 in. (3 mm) RMS, when they are combined with a successful Supplement 10 qualification."

Additionally, the stainless steel welds detailed in Table 2 fall under the licensee's risk-informed in-service inspection (RI-ISI) program. Approval was given to the licensee to use an RI-ISI program for BVPS, Unit 2, for the third inspection interval by letter dated March 23, 2011 (ADAMS Accession No. ML110630403). The RI-ISI program at BVPS, Unit 2, is based on Westinghouse Owners Group, WCAP-14572, Revision 1-NP-A, "Westinghouse Owners Group Application of Risk-Informed Methods to Piping Inservice Inspection Topical Report," and WCAP-14572, Revision 1-NP-A, Supplement 1, "Westinghouse Structural Reliability Risk Assessment Model for Piping Risk Informed Inservice Inspection." All welds in Table 2 are assigned Category R-A, Item R1.11, and require volumetric examination. The Item R1.11 elements are either subject to thermal fatigue/stratification or are defaulted to "Thermal Fatigue" as the most likely degradation mechanism.

3.4 Impracticality of Compliance

The Licensee stated:

An Electric Power Research Institute (EPRI) letter dated September 23, 2011 states, "To date, no vendor has been capable of meeting this criterion [an overall error less than or equal to a 0.125 inch RMS error (RMSE)]."

When examining from the inside diameter (ID), the vendor attempts to meet the Supplement 10 (Code Case N-695) and combined Supplement 2 and 10 (Code Case N-696) required RMSE values for flaw depth sizing have been unsuccessful. Process enhancements including new delivery systems, new transducers, and software

modifications have been implemented, but have not achieved the desired improvements in performance. This result indicates the ASME Code acceptance requirement for flaw depth sizing is impractical for use with current ID ultrasonic examination technology.

Additionally, the inability to achieve the ASME Code requirement for flaw depth sizing may be, in part, attributed to ID interferences that include weld root and counterbore restrictions, or that the examination material consists of cast stainless steel.

The NRC staff also notes that inspection of these welds from the outer diameter (OD) of the pipe is often precluded by the geometry of the weld or the presence of obstructions. The staff further notes that, due to the location of these welds, OD inspections are normally associated with significant radiation dose to the inspector.

3.5. Licensee's Proposed Alternative

For welds governed by ASME Code Case N-695, the licensee proposed using an alternative depth sizing RMSE qualification criterion of 0.189 inches. To compensate for the greater uncertainty in the depth of a measured flaw which will result from this acceptance criterion, the licensee proposed to add a correction factor to the measured depth of any cracks detected a value equal to the difference between the proposed acceptance criterion (0.189 inches) and the acceptance criterion contained in the code case (0.125 inches), in this case, 0.064 inches.

For welds governed by ASME Code Case N-696, the licensee proposed using an alternative depth sizing RMSE qualification criterion of 0.245 inches. To compensate for the greater uncertainty in the depth of a measured flaw which will result from this acceptance criterion, as compared to the criterion of the code case, the licensee proposed to add a correction factor to the measured depth of any cracks detected. This correction factor would equal the difference between the proposed acceptance criterion (0.245 inches) and the acceptance criterion contained in the code case (0.125 inches), in this case, 0.120 inches.

3.6. Duration of Relief

In its original request, the licensee requested relief for the remainder of the third 10-Year inservice inspection interval for BVPS, Unit 2, which is currently scheduled to end August 28, 2018. In the letter dated June 1, 2012, the licensee revised its request to include only examinations conducted at BVPS, Unit 2, prior to the end of the fall 2012 refueling outage, which is scheduled to begin on September 24, 2012.

3.7. NRC Staff Evaluation

As described above, the licensee has requested relief from the requirements of ASME Code Case N-695 and ASME Code Case N-696. These code cases require that procedures used to inspect welds from the ID be qualified by performance demonstration. The acceptance criterion established by the code cases is an RMSE of not greater than 0.125 inches.

The NRC staff has confirmed that attempts have been made to qualify ID ultrasonic (UT) inspection procedures since 2002 and that, to date, no inspection vendor has been able to meet the acceptance criteria established by the code cases, despite the fact that numerous individuals

from several companies have attempted to do so. The staff agrees that this repeated inability to qualify ID UT inspection techniques, in accordance with ASME Code Cases N-695 and N-696, constitutes an impracticality as described in 10 CFR 50.55a(g)(5)(iii). The staff also agrees that the use of an alternate approach, such as an OD examination, represents a burden to the licensee, as access is restricted from the OD for the welds under consideration and inspectors will be subject to significant radiation dose in performing the inspections.

Paragraph 50.55a(g)(6)(i) of 10 CFR permits the Commission to grant relief in cases of impracticality when it determines (in part) that such relief will not endanger life or property. Given the fact that there is always some uncertainty in measuring cracks, and given that relaxation of the ASME Code Cases N-695 and N-696 acceptance criteria may increase the uncertainty of crack measurements, there is a possibility that, for a given crack, the depth measured using a technique which fails to meet the code case acceptance criteria will underestimate the depth of the crack to a greater extent than a similar measurement using a procedure which meets the acceptance criteria. This situation could be viewed as a decreasing assurance that structural integrity or leak tightness of the subject welds will be maintained and, therefore, a failure to meet the criteria contained in 10 CFR 50.55a(g)(6)(i).

To address the issue of increased potential for undersizing of flaws by inspection procedures which do not meet the ASME Code Cases N-695 and N-696 acceptance criterion, the licensee has proposed to apply a correction factor that would increase the measured depth of the crack by the difference between the actual RMSE obtained for the procedure employed and the code case acceptance criterion. In this case, the RMSE for the procedure employed is 0.189 inches for ASME Code Case N-695 welds and 0.245 inches for ASME Code Case N-696 welds. For example, a crack in an ASME Code Case N-696 weld which measured 0.2 inches deep would be treated as though it was 0.32 inches deep:

$$0.2" + (0.245" - 0.125") = 0.32"$$

While this approach provides some additional margin of safety when compared to not adjusting the crack length, the staff did not have sufficient evidence to confirm that the adjustment to the crack depth was sufficient to provide reasonable assurance that cracks measured using procedures with larger RMSE values would not be undersized, when compared to those meeting the RMSE criteria. This lack of assurance was primarily based on the difficulty of sizing cracks when the ID surfaces of the weld are rough and the fact that the Performance Demonstration Initiative (PDI) testing program was not designed to address this issue.

In November 2011, the staff reviewed the PDI program (administered by EPRI) data that were used to qualify welds for ASME Code Cases. Based on this review, the staff was able to determine:

1. When using inspection procedures which do not meet the ASME Code Case N-695 or N-696 acceptance criterion, a significant number of data points are undersized by greater than 0.064 inches ($0.189" - 0.125"$) for ASME Code Case N-695 welds and 0.12 inches for ASME Code Case N-696 welds ($0.245" - 0.125"$), indicating that reasonable assurance that cracks will not be significantly undersized, does not exist when using this approach;

2. When using inspection procedures which do not meet the ASME Code Case N-695 or N-696 acceptance criterion, only a very few data points are undersized by greater than twice the RMSE of the procedure employed (in this case $2 \times 0.189" = 0.378"$ for ASME Code Case N-695 welds and $2 \times 0.245" = 0.490"$ for ASME Code Case N-696 welds). The addition of twice the RMSE to the measured depths of any flaws found during the ID inspections provides reasonable assurance that cracks will not be significantly undersized.
3. Due to the qualification procedures used in ASME Code Case N-696, for some service providers, the reported RMSE value may understate the actual RMSE for austenitic stainless steel welds (Supplement 2 welds).

Based on discussions with the NRC staff regarding these industry issues,¹ the licensee revised their original submittal by letter dated June 1, 2012. In the revised submittal, the licensee proposed to submit flaw evaluations of detected flaws determined to be connected to the piping inner diameter surface during the examinations covered by this relief request to the NRC for review and approval. The information to be provided in the flaw evaluation includes:

1. The measured flaw size as determined by UT.
2. A FENOC determination of whether the flaw is surface breaking or not. In the case of the examinations planned for fall 2012, the contracted examination vendor deploys eddy current in order to make these determinations.
3. The ID profile of the weld, pipe, nozzle, and safe end (as applicable) in the region at and surrounding the transducer locations used to depth size the flaw.
4. The suspected flaw degradation mechanism and the process used to determine the degradation mechanism.

Based on the concerted efforts by the industry to meet the acceptance criteria contained in ASME Code Case N-695 and the difficulties associated with other inspection methods, the NRC staff finds that meeting the 0.125 inch acceptance criterion in ASME Code Cases N-695 and N-696 is impractical and represents a burden to the licensee. Therefore, the NRC staff grants the requested relief, subject to the licensee providing the information listed above, should a crack requiring depth-sizing be identified. On that basis, and subsequent to NRC staff review and approval of information submitted, the staff finds that this alternative provides reasonable assurance of structural integrity or leak tightness of the subject component and therefore will not endanger life or property, as required by 10 CFR 50.55a(g)(6)(i).

In its letter dated June 1, 2012, the licensee modified the relief request to include a flaw evaluation submittal, if required, for NRC review and approval, prior to the expiration of the relief. In addition to including this as part of the relief request, the licensee categorized the flaw evaluation submittal as a "regulatory commitment." The NRC staff considers the flaw evaluation

1. There has been an ongoing discussion between NRC Staff and industry groups on the depth sizing issue. This dialog includes public meetings that took place on March 16, 2012 (ADAMS Accession No. ML12097A071) and June 19, 2012 (ADAMS Accession Nos. ML12173A517 and ML12173A522).

submittal, and the associated NRC review and approval of the flaw evaluation submittal prior to startup, to be integral to the granting of this relief request. Thus, the licensee's flaw evaluation submittal, should it be required under this relief request, is an obligation that is not changeable under the licensee's commitment management program.

4.0 CONCLUSION

As set forth above, the NRC staff has determined that granting relief pursuant to 10 CFR 50.55a(g)(6)(i) is authorized by law and 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 of the regulatory requirements set forth in 10 CFR 50.55a.

Therefore, the NRC staff grants relief as specified above, i.e., the use of the alternate depth-sizing qualification (0.189 inch for ASME Code Case N-695 welds and 0.245 inch for ASME Code Case N-696 welds), subject to the licensee providing, for NRC staff review and approval prior to the expiration of the relief, the information identified above, should a crack requiring depth-sizing be identified. This relief is granted for BVPS, Unit No. 2, until prior to startup from the fall 2012 refueling outage.

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

Principal Contributor: S. Cumblidge

Date: July 18, 2012

P. Harden

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Therefore, the NRC staff grants the use of the alternate depth-sizing qualification (0.189 inch for ASME Code Case N-695 welds and 0.245 inch for ASME Code Case N-696 welds), subject to the licensee providing, for NRC staff review and approval prior to the expiration of the relief, the information identified in the SE, should a crack requiring depth-sizing be identified. This relief is granted for BVPS, Unit No. 2, until prior to startup following the fall 2012 refueling outage. All other ASME Code, Section XI requirements for which relief was not specifically requested and approved in the subject request for relief remain applicable, including third-party review by the Authorized Nuclear Inservice Inspector.

If you have any questions, please contact the BVPS Project Manager, Mr. Peter J. Bamford, at 301-415-2833.

Sincerely,

/ra/

Meena Khanna, Chief
Plant Licensing Branch I-2
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. 50-412

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