October 6,2006

Mr. James H. Lash
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SUBJECT: BEAVER VALLEY POWER STATION, UNIT NOS. 1 AND 2 (BVPS-1 AND 2), INSERVICE INSPECTION (ISI) PROGRAM, REQUEST FOR RELIEF NO. BV3-RV-1 (TAC NOS. MD1135 AND MD1136)

Dear Mr. Lash:

By letter dated April 7, 2006, as supplemented July 14, 2006, FirstEnergy Nuclear Operating Company (the licensee) submitted relief request BV3-RV-1, for the third 10-year ISI interval at BVPS-1 and for the second 10-year ISI interval at BVPS-2. The licensee requested Nuclear Regulatory Commission (NRC) approval to use an alternative remote mechanized examination technique for reactor vessel shell-to-flange welds.

The NRC staff has completed its review and evaluated the information regarding the relief request for BVPS-1 and 2. The results are provided in the enclosed safety evaluation. The staff concludes that an acceptable level of quality and safety will be maintained upon implementation of the licensee's proposed alternative examination and therefore, pursuant to 10 CFR 50.55a(a)(3)(i), the proposed alternative examination is authorized for the remainder of the third 10-year ISI interval at BVPS-1, and for the remainder of the second 10-year ISI interval at BVPS-2.

If you have any questions, please contact your NRC Project Manager, Mr. Timothy G. Colburn, at 301-415-1402.

Sincerely,

/RA/

Richard J. Laufer, Chief
Plant Licensing Branch I-1
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket Nos. 50-334 and 50-412

Enclosure:
Safety Evaluation

cc w/encl: See next page

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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

BV3-RV-1, INSERVICE INSPECTION (ISI) RELIEF REQUEST

FIRSTENERGY NUCLEAR OPERATING COMPANY

BEAVER VALLEY POWER STATION, UNIT NOS. 1 AND 2 (BVPS-1 AND 2)

DOCKET NOS. 50-334 AND 50-412

1.0 INTRODUCTION

By letter dated April 07, 2006 (Reference 1), as supplemented by letter dated July 14, 2006 (Reference 2), FirstEnergy Nuclear Operating Company (the licensee) submitted a relief request (RR) No. BV3-RV-1 from the requirements of the American Society for Mechanical Engineers *Boiler and Pressure Vessel Code* (ASME Code), Section XI, ultrasonic testing (UT) requirements for BVPS-1 and 2. In this RR, the licensee has proposed its alternative remote mechanized examination technique for reactor pressure vessel (RPV) shell-to-flange welds during the third 10-year ISI interval for BVPS-1 and the second 10-year ISI interval for BVPS-2.

2.0 REGULATORY REQUIREMENTS

The ISI of the ASME Code Class 1, Class 2, and Class 3 components shall be performed in accordance with Section XI, “Rules for Inservice Inspection of Nuclear Power Plant Components,” of the ASME Code and applicable editions and addenda as required by Paragraph 50.55a(g) of Title 10 of the *Code of Federal Regulations* (10 CFR), except where specific written relief has been granted by the Commission pursuant to 10 CFR 50.55a(g)(6)(i). Paragraph 50.55a(a)(3) of 10 CFR states, in part, that alternatives to the requirements of paragraph (g) may be used, when authorized by the Commission, if the licensee demonstrates that: (i) the proposed alternatives would provide an acceptable level of quality and safety, or (ii) compliance with the specified requirements would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety.

Pursuant to 10 CFR 50.55a(g)(4), ASME Code Class 1, 2, and 3 components (including supports) shall meet the requirements, except the design and access provisions and the preservice examination requirements, set forth in the ASME Code, Section XI, "Rules for Inservice Inspection of Nuclear Power Plant Components," to the extent practical, within the limitations of design, geometry, and materials of construction of the components. The regulations require that inservice examination of components and system pressure tests conducted during the first 10-year interval and subsequent intervals comply with the requirements in the latest edition and addenda of Section XI of the ASME Code incorporated by reference in 10 CFR 50.55a(b) on the date twelve months prior to the start of the 120-month

interval, subject to the limitations and modifications listed therein. The applicable ASME Code of record at BVPS-1 and 2 for the second 10-year ISI interval for BVPS-2 and the third 10-year ISI interval for BVPS-1 is the 1989 Edition with no Addenda of ASME Code, Sections XI and V, except Appendix VIII. The applicable ASME Code of record for Appendix VIII is the 1995 Edition of the ASME Code, Section XI, with the 1996 addenda.

3.0 TECHNICAL EVALUATION

3.1 *Components for Which Relief is Requested*

The affected components are the BVPS-1 and 2 RPVs; specifically, the components identified in the table below. The examination categories and item numbers are from Table IWB-2500-1 of the 1989 Edition of ASME Code, Section XI.

Examination Category	Item Number	Description	Component IDs
B-A	B1.30	Shell-to-flange weld	RC-R-1-C-1, 2RCS-REV21-C-1B

3.2 *Basis for Proposed Alternative*

The 1989 Edition of ASME Code, Section XI, Appendix I, Subparagraph I-2110, requires that UT of RPV shell-to-flange welds be conducted in accordance with Article 4 of ASME Code, Section V, supplemented by the requirements of Table I-2000-1. In addition, Regulatory Guide (RG) 1.150, Revision 1, "Ultrasonic Testing of Reactor Vessel Welds During Preservice and Inservice Examinations," serves as guidance for the UT examination of RPV welds.

Pursuant to 10 CFR 50.55a(a)(3)(i), the licensee proposes using procedures and personnel qualified for remote mechanized examination in accordance with the 1995 Edition, 1996 Addenda of the ASME Code, Appendix VIII, Supplements 4 and 6, in lieu of the techniques required by ASME Code, Section V, Article 4, when performing volumetric examination of the reactor vessel shell-to-flange weld.

Licensee's Basis for Relief (as stated):

> [T]he prescriptive, amplitude-based ultrasonic examination techniques of Section V, Article 4, supplemented by Appendix I, and augmented by RG [Regulatory Guide] 1.150, Revision 1 (hereafter referred to as Article 4), are technically inferior to the performance-based techniques specified in the 1995 Edition with 1996 Addenda of Section XI, Appendix VIII, Supplements 4 and 6, as modified by 10 CFR 50.55a(b)(2)(xv), and demonstrated through the Electric Power Research Institute (EPRI) Performance Demonstration Initiative (PDI) Program (Appendix VIII). The performance-based techniques of Appendix VIII are required for all other reactor vessel shell weld examinations, having replaced the Article 4 techniques.
>
> Radiation exposure will be reduced since change out of examination devices on

the inspection robot will not be necessary to perform the shell-to-flange weld examination. Additionally, the performance-based techniques of Appendix VIII offer several performance enhancements over the prescriptive amplitude-based techniques, as discussed below.

(a) Increased sensitivity to flaws: The Appendix VIII procedure is more sensitive to flaws because the examination sensitivity level compares to an ASME distance amplitude correction (DAC) level of 5 to 10 percent, the highest practical level for ultrasonic testing. Examinations in accordance with Article 4 are conducted at 50 percent DAC for the outer 80 percent of the wall thickness and 20 percent DAC for the inner 20 percent of the wall thickness. The Appendix VIII procedure requires all signals interpreted by the analyst as flaws to be measured and assessed in accordance with the applicable acceptance criteria, regardless of amplitude, recognizing that some flaws can exhibit a low amplitude response depending on orientation. The Article 4 techniques traditionally have a flaw response cut-off point of 20 percent DAC.

(b) Demonstrated flaw measurement capability using amplitude-independent sizing techniques: The procedure for the proposed shell-to-flange weld examination has been demonstrated in accordance with ASME [Code], Section XI, Appendix VIII, Supplements 4 and 6, to the EPRI PDI.

The proposed procedure complies with ASME Code, Section XI, 1995 Edition with 1996 Addenda, as modified by 10 CFR 50.55a. The procedure has been qualified by time-based sizing techniques such as tip diffraction rather than the amplitude-based ASME [Code], Section V techniques that have been proven inaccurate.

(c) Compatibility of the Appendix VIII examination technique with [BVPS-1 and 2] shell-to-flange weld geometry and previous examination history: The proposed Appendix VIII shell weld examination procedure will use the 45-degree beam angle in four orthogonal directions applied to the weld and volume by various transducer types, each covering a specified depth range. The increment size will be 0.5 inches and examination will be conducted to the maximum extent practical. When these examinations are combined with the manual examination performed from the flange seal surface, the coverage is expected to exceed 90 percent.

The previous remote mechanized examination of the shell-to-flange weld was conducted at [BVPS-1 and 2] in 1996. At that time, 45, 60, and 70-degree exam angles were used. Results were acquired and analyzed using an automated ultrasonic exam system with no indications found exceeding the allowable limits of Section XI. Data archival from the previous examination is available for comparison purposes should the need arise.

3.3 NRC Staff's Evaluation

The ASME Code requires that ultrasonic examination of shell-to-flange and head-to-flange welds in vessels of greater than 2 inches in thickness be conducted in accordance with Article 4

of ASME Code, Section V, as supplemented by requirements in Table I-2000-1. ASME Code, Section V, Article 4 provides a prescriptive process for qualifying UT procedures and performing examinations. The licensee instead proposes to use procedures and personnel qualified in accordance with performance-based criteria listed in the 1995 Edition, 1996 Addenda of the ASME Code, Section XI, Appendix VIII, Supplements 4 and 6 as implemented by the industry's PDI program. These performance-based methods are currently required by 10 CFR 50.55a for examination of all other RPV shell welds having replaced the Article 4 techniques.

Amplitude-based sizing techniques such as the prescriptive UT procedures that comply with the requirements of Article 4 of ASME Code, Section V, are based on the amplitude of the returned signal and correlating that amplitude with an equivalent machined reflector such as a notch or side-drilled hole. However, correlation between defect size and amplitude has been poor. This is not a surprise given the number of variables from the material, equipment and defect itself. The material has potential velocity and microstructural variations, and the equipment has potential amplitude variations due to the type of pulser, frequency band, cabling, and other inherent electrical parameters. Perhaps the biggest variable is the defect itself. Ultrasonic examination is highly sensitive to defect orientation. Also, transparency, roughness, curvature, and location play a role and conventional amplitude-based ultrasonics is particularly unreliable for vertical defects.

When prescriptive UT procedures that comply with the requirements of Article 4 of ASME Code, Section V, were used in round robin tests (PISC II) containing real flaws in RPV mockups, and the results statistically analyzed according to the screening criteria of ASME Code, Section XI, Appendix VIII, the procedures proved to be less effective than examinations that utilize Appendix VIII, Supplements 4 and 6, qualified procedures. Performance-based UT is generally applied with higher sensitivity, which increases the probability of detecting a flaw when compared to prescriptive Section V, Article 4 requirements. Also, flaw sizing is more accurately determined with the time-based tip diffraction criteria used by performance-based ultrasonics than with the less accurate amplitude criteria for prescriptive Section V, Article 4 requirements as evidenced in the licensee's reference to results of round robin tests conducted in the mid-1980's. Procedures, equipment, and personnel qualified through the PDI program have demonstrated their skill level to detect flaws common to nuclear power plants and have shown high probability of detection levels. This has resulted in an increased reliability of inspections for weld configurations subject to the requirements of Appendix VIII.

Appendix VIII first appeared in the 1989 Addenda of the ASME Code. In contrast to the prescriptive requirements contained in Section XI through the 1989 Edition, the requirements of Appendix VIII allow any combination of procedures, equipment and personnel to be used for ISI as long as this combination can pass a statistically-designed performance demonstration blind test on representative mockups containing realistic flaws. The capability to detect and size flaws has been successfully demonstrated through the qualification of BVPS inspectors by EPRI in accordance with ASME Code, Section XI, Appendix VIII requirements.

Furthermore, the licensee states that the vendor procedure used to meet the ASME Code, Section XI, Appendix VIII requirements for Supplements 4 and 6, PDI-ISI-254, Revision 7, qualifies it for detection and length/depth sizing of ferritic material with a nominal thickness of 0.0 to 12.30 inches. In addition, the licensee states that this procedure is qualified for single-sided examination, which indicates that it has been demonstrated to be capable of detecting

and length sizing flaws on either side of the weld when examining from one side of the weld.

The NRC staff concludes that use of UT procedures and personnel qualified to the 1995 Edition with 1996 Addenda of Section XI of the ASME Code, Appendix VIII, Supplements 4 and 6, as modified by 10 CFR 50.55a(b)(2)(xv) by demonstration through the EPRI PDI program for the RPV shell-to-flange weld, provides equivalent or better examination results than those realized from ASME Code, Section V, requirements and RG 1.150 recommendations. Therefore, based on the above analysis and the possibility of reduced radiation exposure of plant personnel, the staff concludes that an acceptable level of quality and safety will be maintained when using the licensee's proposed alternative examination.

5.0 CONCLUSION

The NRC staff concludes that the proposed alternative with PDI-qualified procedures and personnel applied from the RPV shell surface along with the inherent superior capabilities as mentioned above will provide equivalent or better examination results than those realized from the ASME Code, Section V, requirements and RG 1.150 recommendations. In addition, the staff concludes that any significant patterns of degradation occurring on the RPV shell-to-flange weld, if present, will be detected and that the proposed alternative provides that an acceptable level of quality and safety will be maintained when using the licensee's proposed alternative examination. Therefore, pursuant to 10 CFR 50.55a(a)(3)(i), the licensee's alternative is authorized for the remainder of the third 10-year ISI interval at BVPS-1 and the remainder of the second 10-year ISI interval at BVPS-2. 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 ISI inspector.

6.0 REFERENCES

1. FirstEnergy Nuclear Operating Company, letter dated April 7, 2006, from James H. Lash (Site Vice President, Beaver Valley Power Station) to Nuclear Regulatory Commission Document Control Desk, *Proposed Alternative to American Society of Mechanical Engineers Code Section XI Examination Requirements (Request No. BV3-RV-1)*

2. FirstEnergy Nuclear Operating Company, letter dated July 14, 2006, from James H. Lash (Site Vice President, Beaver Valley Power Station) to Nuclear Regulatory Commission Document Control Desk, *Response to Request for Additional Information Regarding Relief Request No. BV3-RV-1 (TAC Nos. MD1135 and MD1136)*.

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Date: October 6, 2006

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