February 20, 2004

Mr. L. William Pearce
Vice President
FirstEnergy Nuclear Operating Company
Beaver Valley Power Station
Post Office Box 4
Shippingport, PA 15077

SUBJECT: BEAVER VALLEY POWER STATION, UNIT NOS. 1 AND 2 - EVALUATION OF INSERVICE INSPECTION (ISI) RELIEF REQUEST BV3-BF-01 (TAC NOS. MC0602 AND MC0603)

Dear Mr. Pearce:

By letter dated August 22, 2003, FirstEnergy Nuclear Operating Company (the licensee) requested relief from the requirements of the American Society of Mechanical Engineers, Boiler and Pressure Vessel Code, Section XI, Appendix VIII, Supplement 10, "Qualification Requirements for Inspection of Dissimilar Metal Piping Welds," for the Beaver Valley Power Station, Unit Nos. 1 and 2 (BVPS-1 and 2). The licensee requested approval to use an alternative inspection method utilizing the dissimilar metal weld criteria of the Electric Power Research Institute's Performance Demonstration Initiative Program.

The Nuclear Regulatory Commission (NRC) has completed its review of your relief request and the proposed alternative. As described in the enclosed safety evaluation, the NRC staff has authorized relief request BV3-BF-01 for BVPS-1's, third 10-year ISI interval, and BVPS-2's, second 10-year ISI interval, pursuant to Title 10 of the *Code of Federal Regulations*, Section 50.55a(a)(3)(i), on the basis that the proposed alternative provides an acceptable level of quality and safety.

If you have any questions regarding this approval, please contact the BVPS-1 and 2 Project Manager, Mr. Timothy G. Colburn, at (301) 415-1402.

Sincerely,

/RA/

Richard J. Laufer, Chief, Section 1
Project Directorate I
Division of Licensing Project Management
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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ACCESSION NUMBER: ML040270030 *No substantive changes made

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Beaver Valley Power Station, Unit Nos. 1 and 2

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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

REQUEST FOR RELIEF BV3-BF-01

BEAVER VALLEY POWER STATION, UNIT NOS. 1 AND 2

FIRSTENERGY NUCLEAR OPERATING COMPANY

DOCKET NOS. 50-334 AND 50-412

1.0 INTRODUCTION

By letter dated August 22, 2003, FirstEnergy Nuclear Operating Company (FENOC, the licensee) submitted a request for relief for Beaver Valley Power Station, Unit Nos. 1 and 2 (BVPS-1 and 2). Specifically, the licensee's request for relief proposed using the dissimilar metal weld (DMW) criteria of the Electric Power Research Institute's (EPRI's) Performance Demonstration Initiative (PDI) Program in lieu of select provisions of the American Society of Mechanical Engineers (ASME), Boiler and Pressure Vessel Code (Code), Section XI, Appendix VIII, Supplement 10.

2.0 REGULATORY EVALUATION

2.1 Regulatory Requirements

The inservice inspection (ISI) of the ASME Code, Class 1, 2, and 3 components are to be performed in accordance with Section XI of the ASME Code and applicable edition and addenda as required by Title 10 of the *Code of Federal Regulations* (10 CFR), Section 50.55a(g), except where specific written relief has been granted by the Commission pursuant to 10 CFR, Section 50.55a(g)(6)(i). Section 50.55a(a)(3) requires, in part, that alternatives to the requirements of paragraph (g) may be used when authorized by the Nuclear Regulatory Commission (NRC), 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, Section 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 pre-service examination requirements, set forth in 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, Section 50.55a(b), twelve months prior to the start of the 120-month interval, subject to the limitations and modifications listed therein. The ISI Code of record for BVPS-1 and 2 is the 1989 Edition, no addenda. The components (including supports) may

meet the requirements set forth in subsequent editions and addenda of the ASME Code incorporated by reference in 10 CFR, Section 50.55a(b), subject to the limitations and modifications listed therein and subject to Commission approval.

2.2 Components For Which Relief Is Requested

Category BF, pressure retaining dissimilar metal piping welds subject to examinations using procedures, personnel and equipment qualified to the 1995 Edition, 1996 Addenda, of the ASME Code, Section XI, Appendix VIII, Supplement 10, "Qualification Requirements for Dissimilar Metal Piping Welds."

2.3 Code Requirements

The following paragraphs or statements are the specific requirements from Supplement 10 that are included in the licensee's request for relief.

Item 1 - Paragraph 1.1(b) states in part - Pipe diameters within a range of 0.9 to 1.5 times a nominal diameter shall be considered equivalent.

Item 2 - Paragraph 1.1(d) states - All flaws in the specimen set shall be cracks.

Item 3 - Paragraph 1.1(d)(1) states - At least 50% of the cracks shall be in austenitic material. At least 50% of the cracks in austenitic material shall be contained wholly in weld or buttering material. At least 10% of the cracks shall be in ferritic material. The remainder of the cracks may be in either austenitic or ferritic material.

Item 4 - Paragraph 1.2(b) states in part - The number of unflawed grading units shall be at least twice the number of flawed grading units.

Item 5 - Paragraph[s] 1.2(c)(1) and 1.3(c) state in part - At least 1/3 of the flaws, rounded to the next higher whole number, shall have depths between 10% and 30% of the nominal pipe wall thickness. Paragraph 1.4(b) distribution table requires 20% of the flaws to have depths between 10% and 30%.

Item 6 - Paragraph 2.0 first sentence states - The specimen inside surface and identification shall be concealed from the candidate.

Item 7 - Paragraph 2.2(b) states in part - The regions containing a flaw to be sized shall be identified to the candidate.

Item 8 - Paragraph 2.2(c) states in part - For a separate length sizing test, the regions of each specimen containing a flaw to be sized shall be identified to the candidate.

Item 9 - Paragraph 2.3(a) states - For the depth sizing test, 80% of the flaws shall be sized at a specific location on the surface of the specimen identified to the candidate.

Item 10 - Paragraph 2.3(b) states - For the remaining flaws, the regions of each specimen containing a flaw to be sized shall be identified to the candidate. The candidate shall determine the maximum depth of the flaw in each region.

Item 11 - Table VIII-S2-1 provides the false call criteria when the number of unflawed grading units is at least twice the number of flawed grading units.

3.0 TECHNICAL EVALUATION

3.1 Licensee's Proposed Alternative And Its Basis

The licensee proposed the following alternatives in lieu of selected paragraphs in the 1995 Edition with 1996 Addenda, of the ASME Code, Section XI, Appendix VIII, Supplement 10, for use during the remainder of the current 10-year ISI intervals for both BVPS-1 and 2. The proposed alternatives are described in an enclosure to the submittal and will be implemented through the PDI Program.

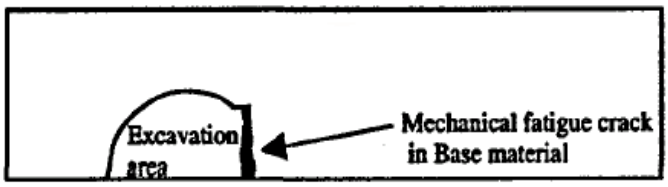
Paragraph 1.1(b) alternative:

> "The specimen set shall include the minimum and maximum pipe diameters and thicknesses for which the examination procedure is applicable. Pipe diameters within a range of ½ in. (13mm) of the nominal diameter shall be considered equivalent. Pipe diameters larger than 24 in. (610mm) shall be considered to be flat. When a range of thicknesses is to be examined, a thickness tolerance of ±25% is acceptable."
>
> "Technical Basis - The change in the minimum pipe diameter tolerance from 0.9 times the diameter to the nominal diameter minus 0.5 inch provides tolerances more in line with industry practice. Though the alternative is less stringent for small pipe diameters they typically have a thinner wall thickness than larger diameter piping. A thinner wall thickness results in shorter sound path distances that reduce the detrimental effects of the curvature. This change maintains consistency between Supplement 10 and the recent revision to Supplement 2."

Paragraph 1.1(d) alternative:

> "At least 60% of the flaws shall be cracks, the remainder shall be alternative flaws. Specimens with IGSCC [intergranular stress corrosion cracking] shall be used when available. Alternative flaws, if used shall provide crack-like reflective characteristics and shall be limited to the case where implantation of cracks produces spurious reflectors that are uncharacteristic of actual flaws. Alternative flaw mechanisms shall have a tip width of less than or equal to 0.002 in. (.05mm)."
>
> "Technical Basis - As illustrated below, implanting a crack requires excavation of the base material on at least one side of the flaw. While this may be satisfactory for ferritic materials, it does not produce a useable axial flaw in austenitic materials because the sound beam, which normally passes only through base

material, must now travel through weld material on at least one side, producing an unrealistic flaw response. In addition, it is important to preserve the dendritic structure present in field welds that would otherwise be destroyed by the implantation process. To resolve these issues, the proposed alternative allows the use of up to 40% fabricated flaws as an alternative flaw mechanism under controlled conditions. The fabricated flaws are isostatically compressed which produces ultrasonic reflective characteristics similar to tight cracks."



Paragraph 1.1(d)(1) alternative:

"At least 80% of the flaws shall be contained wholly in weld or buttering material. At least one and a maximum of 10% of the flaws shall be in ferritic base material. At least one and a maximum of 10% of the flaws shall be in austenitic base material."

"Technical Basis - Under the current ASME Code requirements [1995 Edition, 1996 Addenda of the ASME Code, Section XI, Appendix VIII, Supplement 10], as few as 25% of the flaws are contained in austenitic weld or buttering material. Recent experience has indicated that flaws contained within the weld are likely scenarios. The metallurgical structure of austenitic weld material is ultrasonically more challenging than either ferritic or austenitic base material. The proposed alternative is therefore more challenging than the current ASME Code."

Paragraph 1.2(b) alternative:

"Detection sets shall be selected from Table VIII-S10-1. The number of unflawed grading units shall be at least one and a half times the number of flawed grading units."

"Technical Basis - Table S10-1 provides a statistically based ratio between the number of unflawed grading units and the number of flawed grading units. The proposed alternative reduces the ratio to 1.5 times to reduce the number of test samples to a more reasonable number from the human factors perspective. However, the statistical basis used for screening personnel and procedures is still maintained at the same level with competent personnel being successful and less skilled personnel being unsuccessful. The acceptance criteria for the statistical basis are in Table VIII-S10-1."

Paragraphs 1.2(c)(1) and 1.3(c) alternative:

"The proposed alternative to the flaw distribution requirements of Paragraph 1.2(c)(1) (detection) and 1.3(c) (length) is to use the Paragraph 1.4(b) (depth) distribution table (see below) for all qualifications."

Flaw Depth (% wall Thickness)	Minimum Number of Flaws
10-30%	20%
31-60%	20%
61-100%	20%

"Technical Basis - The proposed alternative uses the depth sizing distribution for both detection and depth sizing because it provides for a better distribution of flaw sizes within the test set. This distribution allows candidates to perform detection, length, and depth sizing demonstrations simultaneously utilizing the same test set. The requirement that at least 75% of the flaws shall be in the range of 10-60% of wall thickness provides an overall distribution tolerance yet the distribution uncertainty decreases the possibilities for testmanship that would be inherent to a uniform distribution. It must be noted that it is possible to achieve the same distribution utilizing the present requirements, but it is preferable to make the criteria consistent."

Paragraph 2.0 first sentence alternative:

"For qualifications from the outside surface, the specimen inside surface and identification shall be concealed from the candidate. When qualifications are performed from the inside surface, the flaw location and specimen identification shall be obscured to maintain a "blind test"."

"Technical Basis - The current ASME Code [1995 Edition, 1996 Addenda of the ASME Code, Section XI, Appendix VIII, Supplement 10] requires that the inside surface be concealed from the candidate. This makes qualifications conducted from the inside of the pipe (e.g., PWR [Pressurized Water Reactor] nozzle to safe end welds) impractical. The proposed alternative differentiates between ID and OD [inner diameter and outer diameter] scanning surfaces, requires that they be conducted separately, and requires that flaws be concealed from the candidate."

Paragraphs 2.2(b) and 2.2(c) alternative:

" ... containing a flaw to be sized may be identified to the candidate."

"Technical Basis - The current ASME Code [1995 Edition, 1996 Addenda of the ASME Code, Section XI, Appendix VIII, Supplement 10] requires that the regions of each specimen containing a flaw to be length sized shall be identified to the candidate. The candidate shall determine the length of the flaw in each region

(Note, that length and depth sizing use the term “regions” while detection uses the term “grading units” - the two terms define different concepts and are not intended to be equal or interchangeable). To ensure security of the samples, the proposed alternative modifies the first “shall” to a “may” to allow the test administrator the option of not identifying specifically where a flaw is located. This is consistent with the recent revision to Supplement 2.”

Paragraphs 2.3(a) and 2.3(b) alternative:

“ ... regions of each specimen containing a flaw to be sized may be identified to the candidate.”

“Technical Basis - The current Code [1995 Edition, 1996 Addenda of the ASME Code, Section XI, Appendix VIII, Supplement 10] requires that a large number of flaws be sized at a specific location. The proposed alternative changes the “shall” to a “may” which modifies this from a specific area to a more generalized region to ensure security of samples. This is consistent with the recent revision to Supplement 2. It also incorporates terminology from length sizing for additional clarity.”

Alternative: Use the acceptance Table VIII-S10-1 in the submittal which is a modification of Table VIII-S2-1.

“Technical Basis - The proposed alternative adds new Table VIII-S10-1(...) It is a modified version of Table VIII-S2-1 to reflect the reduced number of unflawed grading units and allowable false calls. As provided by the PDI as part of ongoing Code activities, Pacific Northwest Laboratories has reviewed the statistical significance of these revisions and offered the revised Table VIII-S10-1.”

3.2 Justification For Granting Relief

Pursuant to 10 CFR, Section 50.55a(a)(3)(i), the licensee requests approval to use the proposed alternatives described above in lieu of the ASME Code, Section XI, Appendix VIII, Supplement 10, requirements. The licensee stated that compliance with the proposed alternatives will provide an acceptable level of quality and safety for ultrasonic examination of the affected welds.

3.3 Implementation Schedule

The licensee stated that the next scheduled ultrasonic examinations of welds governed by ASME Code, Section XI, Appendix VIII, Supplement 10, are:

BVPS-1 - 1R16 (fall 2004)
BVPS-2 - 2R11 (spring 2005)

The licensee stated that the potential to perform ultrasonic examinations of dissimilar metal welds exists now. The licensee stated that approval of the submitted alternatives to Supplement 10 examination requirements will allow implementation of the alternatives and expedite full compliance with 10 CFR, Section 50.55a(g)(6)(ii)(C)(2), as stated within RIS (Regulatory Issue Summary) 2003-01.

3.4 Evaluation

The licensee proposed to use the program developed by PDI that is similar to the ASME Code requirements. The differences between the Code and the PDI program are discussed below.

Paragraph 1.1(b)

The ASME Code requirement of "0.9 to 1.5 times the nominal diameter are equivalent" was established for a single nominal diameter. When applying the ASME Code-required tolerance to a range of diameters, the tolerance rapidly expands on the high side. Under the current Code requirements, a 5-in. OD pipe would be equivalent to a range of 4.5-inch- to 7.5-inch-diameter pipe. Under the proposed PDI guidelines, the equivalent range would be reduced to 4.5-inch- to 5.5-inch-nominal diameter. With the current code requirements, a 16-inch-nominal diameter pipe would be equivalent to a range of 14.4-inch- to 24-inch-diameter pipe.

The licensee's proposed alternative would significantly reduce the equivalent range of 15.5-inch- to 16.5-inch-diameter pipe. The difference between the ASME Code and the proposed alternative for diameters less than 5 inches is not significant because of the shorter metal path and beam spread associated with smaller diameter piping. The NRC staff considers the proposed alternative to be more conservative overall than the current ASME Code requirements. The NRC staff finds that the proposed alternative will provide an acceptable level of quality and safety and is, therefore, acceptable.

Paragraph 1.1(d)

The ASME Code requires all flaws to be treated as cracks. Manufacturing test specimens containing cracks free of spurious reflections and telltale indicators is extremely difficult in austenitic material. To overcome these difficulties, PDI developed a process for fabricating flaws that produce ultrasonic test acoustic responses similar to the responses associated with real cracks. PDI presented its process for discussion at public meetings held June 12 through 14, 2001, and January 31 through February 2, 2002, at the EPRI Nondestructive Examination Center, Charlotte, North Carolina. The NRC staff attended these meetings and determined that the process parameters used for manufacturing fabricated flaws resulted in acceptable acoustic responses. PDI is selectively installing these fabricated flaws in specimen locations that are unsuitable for real cracks. The NRC staff finds that the proposed alternative will provide an acceptable level of quality and safety and is, therefore, acceptable.

Paragraph 1.1(d)(1)

The ASME Code requires that at least 50% of the flaws be contained in austenitic material, and 50% of the flaws in the austenitic material shall be contained fully in the weld or buttering

material. This means that at least 25% of the total flaws must be located in the weld or buttering material. Field experience shows that flaws identified during ISI of dissimilar metal welds are more likely to be located in the weld or buttering material. The grain structure of austenitic weld and buttering material represents a much more stringent ultrasonic scenario than that of a ferritic material or austenitic base material. Flaws made in austenitic base material are difficult to create free of spurious reflectors and telltale indicators. The licensee's proposed alternative of 80% of the flaws in the weld metal or buttering material provides a challenging testing scenario reflective of field experience and minimizes testmanship associated with telltale reflectors common to placing flaws in austenitic base material. The NRC staff considers the proposed alternative to be more conservative than the current ASME Code requirements. The NRC staff finds that the proposed alternative will provide an acceptable level of quality and safety, and is, therefore, acceptable.

Paragraph 1.2(b) and Proposed Table VIII-S10-1-Paragraph 3.1

The ASME Code requires that detection sets meet the requirements of Table VIII-S2-1 which specifies the minimum number of flaws in a test set to be 5 with 100% detection. The current ASME Code also requires the number of unflawed grading units to be 2 times the number of flawed grading units. The licensee's proposed alternative would follow the detection criteria of the table beginning with a minimum number of flaws in a test set being 10, and reducing the number of unflawed grading units to 1.5 times the number of flawed grading units. The maximum number of allowable false calls is also reduced in order to maintain the statistical basis for the pass/fail criteria. The NRC staff has determined that the proposed alternative satisfies the pass/fail objective established for Appendix VIII performance demonstration. The NRC staff finds that the proposed alternative will provide an acceptable level of quality and safety, and is, therefore, acceptable.

Paragraph 1.2(c)(1) and 1.3(c)

For detection and length sizing, the ASME Code requires at least 1/3 of the flaws to be located between 10% and 30% through the wall thickness and 1/3 greater than 30% through the wall thickness. The remaining flaws would be located randomly throughout the wall thickness. The licensee's proposed alternative sets the distribution criteria for detection and length sizing to be the same as the depth sizing distribution, which stipulates that at least 20% of the flaws be located in each of the increments of 10-30%, 31-60%, and 61-100%. The remaining 40% would be located randomly throughout the pipe thickness. With the exception of the 10-30% increment, the proposed alternative is a subset of current ASME Code requirements. The 10-30% increment would be in the subset if it contained at least 30% of the flaws. The change simplifies assembling test sets for detection and sizing qualifications and is more indicative of conditions in the field. The NRC staff finds that the proposed alternative will provide an acceptable level of quality and safety, and is, therefore, acceptable.

Paragraph 2.0

The ASME Code requires the specimen inside surface to be concealed from the candidate. This requirement is applicable for test specimens used for qualifications performed from the outside surface. With the expansion of Supplement 10 to include qualifications performed from

the inside surface, the inside surface must be accessible while maintaining the specimens integrity. The proposed alternative requires that flaws and specimen identifications be obscured from candidates, thus maintaining blind test conditions. It is noted that these welds for PWRs are normally examined from their Reactor Pressure Vessel (RPV) inner surface, and for Boiling Water Reactors the examination is performed on the RPV outside surface. The licensee's proposed alternative is therefore applicable for PWRs. The staff finds the licensee's proposed alternative to be appropriate, and is, therefore, acceptable.

Paragraph 2.2(b) and 2.2(c)

The ASME Code requires that the location of flaws added to the test set for length sizing shall be identified to the candidate. The licensee's proposed alternative is to make identifying the location of additional flaws an option. This option provides an additional element of difficulty to the testing process because the candidate would be expected to demonstrate the skill of detecting and sizing flaws over an area larger than a specific location. The licensee's proposed alternative is more conservative than the ASME Code requirements. The NRC staff finds that the proposed alternative will provide an acceptable level of quality and safety, and is, therefore, acceptable.

Paragraph 2.3(a) and 2.3(b)

In paragraph 2.3(a), the ASME Code requires that 80% of the flaws be sized in a specific location that is identified to the candidate. The proposed alternative allows identification of the specific location to be an option. This permits detection and depth sizing to be conducted separately or concurrently. In order to maintain a blind test, the location of flaws cannot be shared with the candidate. For depth sizing that is conducted separately, allowing the test administrator the option of not identifying flaw locations makes the testing process more challenging. The NRC staff considers the proposed alternative to be more conservative than the current ASME Code requirements. The NRC staff finds that the proposed alternative will provide an acceptable level of quality and safety, and is, therefore, acceptable.

In paragraph 2.3(b), the ASME Code also requires that the location of flaws added to the test set for depth sizing shall be identified to the candidate. The licensee's proposed alternative is to make identifying the location of additional flaws an option. This option provides an additional element of difficulty to the testing process because the candidate would be expected to demonstrate the skill of finding and sizing flaws in an area larger than a specific location. The NRC staff considers the licensee's proposed alternative to be more conservative than the ASME Code requirements. The NRC staff finds that the licensee's proposed alternative will provide an acceptable level of quality and safety, and is, therefore, acceptable.

4.0 CONCLUSION

The NRC staff has determined that the proposed alternative to Supplement 10, as administered by the PDI program, will provide an acceptable level of quality and safety. Therefore, pursuant to 10 CFR, Section 50.55a(a)(3)(i), the staff authorizes the proposed alternative described in the licensee's letter dated August 22, 2003, for the third 10-year ISI interval for BVPS-1, and the second 10-year ISI interval for BVPS-2. All other ASME Code, Section XI, requirements for

which relief was not specifically requested and approved in this relief request remain applicable, including third party review by the Authorized Nuclear Inservice Inspector.

Principal Contributor: E. Reichelt

Date: February 20, 2004