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August 8, 2006
L-06-123

U. S. Nuclear Regulatory Commission
Attention: Document Control Desk
Washington, DC 20555-0001

Subject: Beaver Valley Power Station, Unit No. 2
Docket No. 50-412, License No. NPF-73
Response to Request for Additional Information Regarding Proposed Alternative to American Society of Mechanical Engineers Code Section XI Repair Requirements (Request No. BV2-PZR-01)

This letter forwards the FirstEnergy Nuclear Operating Company (FENOC) response to the July 26, 2006 U.S. Nuclear Regulatory Commission (NRC) request for additional information (RAI). The NRC issued the RAI in order to complete its review of a March 31, 2006 FENOC letter that requested relief from the requirements of the American Society of Mechanical Engineers Boiler and Pressure Vessel Code, Section XI, to perform an alternative weld overlay repair of certain pressurizer nozzle welds (Request No. BV2-PZR-01).

Based on further review, an additional modification to the provisions of ASME Code Case N-638-1 is requested. Information that describes the modification and the basis for the modification is provided in the attached RAI response. This information supplements the information provided in the March 31, 2006 FENOC relief request letter.

As stated in the March 31, 2006 letter, FENOC requests approval by September 2006 to support the BVPS Unit No. 2 maintenance and refueling outage, scheduled for early October 2006.

There are no regulatory commitments contained in this letter. If there are any questions or if additional information is required, please contact Mr. Gregory A. Dunn, Manager FENOC Fleet Licensing at (330) 315-7243.

Sincerely,

FOR James H. Lash

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Attachment - Response to Request for Additional Information dated July 26, 2006

c: Mr. T. G. Colburn, NRR Senior Project Manager
Mr. P. C. Cataldo, NRC Senior Resident Inspector
Mr. S. J. Collins, NRC Region I Administrator
Mr. D. A. Allard, Director BRP/DEP
Mr. L. E. Ryan (BRP/DEP)

Attachment to FENOC Letter L-06-123
Response to Request for Additional Information dated July 26, 2006

REQUEST FOR ADDITIONAL INFORMATION
RELIEF REQUEST NO. BV2-PZR-01
BEAVER VALLEY POWER STATION, UNIT NO. 2
FIRSTENERGY NUCLEAR OPERATING COMPANY
DOCKET NO. 50-412

1. **In the licensee's submittal dated March 31, 2006, the licensee states that a preemptive full structural weld overlay is proposed for each Alloy 82/182 nozzle-to-safe end weld. Please indicate what types of nondestructive examination (NDE) will be performed prior to the full structural weld overlay installation. If pre-welding NDE is not to be performed, please confirm that in all cases, a full structural overlay will be installed and discuss the justification for not performing the NDE prior to welding.**

Response:

Non-ultrasonic pre-welding NDE will be performed as follows:

- Bare metal visual examinations for evidence of leakage from the pressurizer steam space nozzles in accordance with FirstEnergy Nuclear Operating Company (FENOC) commitments. (Reference: 60-Day Response to NRC Bulletin 2004-01, dated July 27, 2004)

- Bare metal visual examinations for evidence of leakage from the pressurizer surge nozzle per the Beaver Valley Alloy 600 Program procedure.

- Liquid penetrant examinations of the safe end, welds, nozzle, and pipe pre-overlay surface preparations as required by ASME Code Case N-504-2, Paragraph (c), and ASME Code Section XI (2005 Edition) Nonmandatory Appendix Q, Article Q-2000.

In all cases, the design of the weld overlay is full structural. A 360 degree through-wall circumferential flaw in the original Alloy 82/182 weld is assumed in the sizing of each overlay. The location of the postulated flaw is discussed in response to Question 2 below.

As stated in the March 31, 2006 FENOC relief request letter, meaningful ultrasonic examinations of the Alloy 82/182 dissimilar metal weld is not possible using current ultrasonic inspection technology due to the short length of 1) the stainless steel safe end between the dissimilar metal and stainless steel welds, and 2) the nozzle between the dissimilar metal weld and the nozzle transition. These

configurations prohibit ultrasonic examination in accordance with the coverage requirements of American Society of Mechanical Engineers Code (ASME Code) Section XI, Appendix VIII (1995 Edition, 1996 Addenda) and were a major driving force in the decision to apply preemptive structural weld overlays.

2. **Please discuss the repair strategy as a result of NDE. That is, if a flaw is detected in the weld by the NDE prior to weld overlay, confirm that a full-structural weld overlay is applied, and confirm that the weld overlay thickness calculation is based on the worst case flaw.**

Response:

In all cases, the design of the weld overlay is full structural. A 360 degree through-wall circumferential flaw in the original Alloy 82/182 weld is assumed in the sizing of each overlay. Conservatively, the location of the flaw is based on the worst case, that is, the calculations of overlay thickness are based upon the thicknesses (inside and outside radii) of the original stainless steel and Alloy 82/182 welds at the thickest extent on either side of the welds.

3. **Please discuss whether flaw evaluations and shrinkage stress effects analyses required under Code Case N-504-2(g), Items 1, 2, and 3, will be performed. If the evaluations are to be performed after startup, please provide technical justification why it is acceptable to place these welded components into service without completing the analyses.**

Response:

Flaw evaluations and shrinkage stress effects analyses required under Code Case N-504-2(g), Items 1, 2, and 3, will be performed.

Flaw evaluation will be completed prior to the weld overlay for a range of postulated axial and circumferential flaw depths. The results of the flaw evaluation will be plotted in a flaw evaluation chart showing service life versus flaw depth. This flaw evaluation chart will be used to evaluate any detected flaws prior to plant startup based on the actual flaw size, if any, detected by the post-weld overlay inspection.

The weld shrinkage effects on the attached piping and support systems will be assessed prior to the weld overlay based on estimated weld shrinkage. Confirmatory analyses based on actual weld shrinkage measurements after the weld overlay will be completed prior to plant startup.

4. **On page 12 of your submittal, you indicate that "the weld overlay area may exceed 100 in^2 in some cases." The staff has not approved overlay areas exceeding 300 in^2 without a weld specific analysis. Since all the Beaver Valley Power Station design configurations are known, please provide your best estimate of the surface areas for all the full structural overlay configurations listed in your March 31, 2006 submittal. Part of your discussion should include similarities between your plant and those listed in your precedents section of the submittal and why the resultant overlay will not prevent the component from performing its design function.**

Response:

The estimated weld overlay area over the ferritic (nozzle) material of the structural weld overlays within the scope of this request are as follows:

Nozzle	Estimated Area (in^2)
Safety A	56
Safety B	55
Safety C	58
Relief	57
Spray	34
Surge	128

As such, only one of the six weld overlays within the scope of this request (the surge nozzle) will exceed the 100 square inch overlay area limitation on the ferritic base material. Review of the surge nozzle weld overlay design drawings indicates that a best estimate weld overlay surface area of 128 square inches will be applied to the nozzle material. All other nozzle weld overlay surface areas will be less than 100 square inches.

A similar request was granted to Three Mile Island Nuclear Station Unit 1 (TAC No. MC1201) in the repair of the pressurizer surge nozzle to hot leg weld in 2004. The Beaver Valley surge nozzle application is similar to the Three Mile Island application in that the full structural weld overlay induces compressive stress in the original 82/182 weld, which supports mitigation of the degradation mechanism of concern (pressurized water stress corrosion cracking), and the geometry, consisting of a carbon steel nozzle welded to a stainless steel safe end with Alloy 82/182, is of similar size and configuration.

Since the submittal of the March 31, 2006 FENOC relief request letter, ASME has approved Code Case N-638-3, which increased the 100 square inch limitation to 500 square inches. The technical basis accompanying the Code Case revision provides an expanded basis for the change in area limitation, citing no direct

correlation to the amount of surface area when comparing residual stresses for overlay repairs done using temperbead welding. As surface areas of up to 500 square inches have been shown through testing and analysis to continue to result in compressive residual stresses in the weld region, the proposed surge nozzle overlay will have no adverse impact on the pressure boundary function of the nozzle.

In addition, in a June 28, 2006 letter to Calvert Cliffs (TAC Nos. MC8530 AND MC8531), the NRC approved a relief request for weld overlays up to 500 square inches based on operational experience with structural weld overlays and the information provided by Calvert Cliffs. The Calvert Cliffs relief request involved application of full structural weld overlays for dissimilar Alloy 182/82 metal welds in nozzles ranging from two inches to 30 inches in size. This relief request for Beaver Valley is similar in that it involves full structural weld overlays for dissimilar Alloy 182/82 metal welds in nozzles ranging in size from four inches to 14 inches.

5. Please verify that NDE will be performed after 48 hours from the time the welded component has achieved ambient temperature per Code Case -638-1.

Response:

Post-weld overlay NDE will be performed after 48 hours from the time the welded component has achieved ambient temperature in accordance with ASME Code Case N-638-1, Paragraph 4.0(b).

6. On page 3 of your submittal, Figure 1: Generic Pressurizer Nozzle Configuration, provides a bounding representation of the configurations which you are going to be depositing a full structural overlay. Please discuss if the NDE requirement under 4.0(b) of -638-1, ultrasonic examination of the 1.5T band on either side of the overlay, will be achieved. If this area requirement cannot be met, please discuss the achievable amount of area that will be successfully examined for each preemptive weld overlay weld design configuration you wish to apply. Secondly, clarify whether the ultrasonic test examination will be performed on the maximum extent achievable.

Response:

No, the ultrasonic NDE examination requirements under 4.0(b) will not be achieved. Based upon further review of the weld overlay designs, which were not complete at the time of FENOC's initial request, FENOC proposes an alternative to the ASME Code Case N-638-1 requirement for ultrasonic examination of a band around the final weld surface that is at least 1.5 times the component thickness or five inches in width, whichever is less. The alternative surface

examination of a band at least 0.50 inches outward from the toe of the weld overlay around the entire circumference of the nozzle and pipe is identified in Table 3, "Pre-Service Examination Requirements" of the initial FENOC request, but was inadvertently omitted from the explicit modifications to Code Case N-638-1 in Table 4 of the initial FENOC request. This alternative examination encompasses the required surface examination stated in Paragraph (b) of Subarticle Q-4100 of ASME Section XI, 2005 Addenda, Nonmandatory Appendix Q.

This additional modification to the provisions of ASME Code Case N-638-1 and related basis are presented on pages 6 and 7 of this enclosure as a supplement to Table 4 of the March 31, 2006 FENOC relief request letter.

The alternative surface examinations will be conducted on a minimum of the 0.5 inch band outward from the toe of the weld overlay around the entire circumference of the nozzle and pipe to ensure that the most probable flaw mechanism is detected. The ultrasonic examination of the 1.5T band on either side of the overlay required by ASME Code Case N-638-1 and discussed in the supplement to Table 4 is limited in achievable coverage and ability to detect the most probable cracking mechanism, and as such, offers no additional benefit in terms of quality or safety.

In addition to the alternative surface examination discussed above, ultrasonic examinations will be performed as stated in Table 3 of the March 31, 2006 FENOC request. Pre-service ultrasonic examinations will be performed in accordance with Code Case N-504-2 and Q-4000 of Nonmandatory Appendix Q. These examinations include ultrasonic examination of a minimum of the outer 25 percent and 0.5 inch axially of the nozzle base material beyond the Dissimilar Metal (DM) weld. Examination of this volume, as supported in the supplement to Table 4, is sufficient to identify nozzle base material cracking in the Heat Affected Zone (HAZ) below the weld overlay where it is most likely to be observed.

7. **On page 9 of your submittal, you request that Code Case N-416-2 be used as an alternative to the hydrostatic testing requirement under Code Case N-504-2. Is Code Case N-416-2 listed in your current Inservice Inspection Program Plan?**

Response:

Code Case N-416-2 is listed in the current Beaver Valley Power Station Inservice Inspection Program.

Supplement to Table 4: Modifications to Code Case N-638-1

Code Case N-638-1 Section	Modification and Basis
Paragraph 4.0(b): The final weld surface and the band around the area defined in para. 1.0(d) shall be examined using a surface and ultrasonic methods when the completed weld has been at ambient temperature for at least 48 hours. The ultrasonic examination shall be in accordance with Appendix I.[3] *Paragraph 1.0(d) (by reference in 4.0(b)):* Prior to welding the area to be welded and a band around the area of at least 1-1/2 times the component thickness or 5 in., whichever is less shall be at least 50°F. [3] Refer to the 1989 Edition with the 1989 Addenda and later Editions and Addenda.	Modification: In lieu of the ultrasonic examination requirement, a surface examination of a band at least 0.50 inches outward from the toe of the weld overlay around the entire circumference of the nozzle and pipe will be performed, as identified in Table 3 of the March 31, 2006 FENOC relief request letter. Basis: With respect to the weld overlay process on Pressurizer nozzle dissimilar metal welds, the ASME Code Case N-638-1 defined band and examination volume would encompass the nozzle base metal volume below the outer diameter nozzle tapered surface and a part of the nozzle outer diameter blend region. Being that the inner diameter of the nozzle cannot be reasonably accessed, these outer diameter surfaces must be used as the ultrasonic test probe scanning surfaces. The outer diameter surfaces do not permit meaningful coverage of the examination volume due to non-coupling of the ultrasonic test probes over the surface; obstructions causing this non-coupling include the edge of the weld overlay, the transition between the outside diameter nozzle taper and the nozzle outer blend area, and the nozzle outer blend area. Appendix I of the ASME Code Section XI, 1998 Edition through the 2000 Addenda requires that the ultrasonic examination be conducted in accordance with ASME Code Section V, Article 4 and all supplements of Appendix I except Supplement 9 – Scan Angles. The most applicable examination requirements fall under Article 4 T-440 Vessel Examinations. These requirements include straight beam scanning for laminar and planar reflectors and angle beam scanning for planar reflectors. The straight beam scanning is not likely to detect any delayed hydrogen cracking due to mis-orientation of the cracking with respect to the beam and to the anticipated near surface location of such cracking. Essentially the straight beam is a repeat of the nozzle material examination required by the Construction Code. The angle beam

Supplement to Table 4: Modifications to Code Case N-638-1	
Code Case N-638-1 Section	**Modification and Basis**
	examinations will be largely impacted by the outer diameter surface configuration. To maximize angle beam examination coverage will entail a series of special transducers to be applied even though the most effective angle beam transducers would be those configured to detect near surface breaking planar reflectors. However, the most effective NDE method for detection of near surface breaking planar reflectors is not a volumetric method but a surface examination method. Code Case N-638-1 applies to any type of welding where a temper bead technique is to be employed and is not specifically written for a weld overlay repair. However, for a weld overlay any major base material cracking would take place in the Heat Affected Zone (HAZ) directly below the weld overlay or in the underlying Alloy 82/182 weld deposit and not in the required band of material out beyond the overlay. Therefore, if this cracking were to occur it would be identified by the ultrasonic examination of the weld overlay. This band is not in close proximity to the Dissimilar Metal (DM) weld and if flaws in the DM weld were to propagate, they would arrest at the interface with the ferritic base material or the Alloy 52/52M/152 weld metal and be contained in the volume of material that is subject to preservice examinations.