April 18, 2003

Mr. Mark B. Bezilla
Vice President
FirstEnergy Nuclear Operating Company
Beaver Valley Power Station
Post Office Box 4
Shippingport, PA 15077

SUBJECT: BEAVER VALLEY POWER STATION, UNIT NO. 1 - RELAXATION OF THE REQUIREMENTS OF ORDER (EA-03-009) REGARDING REACTOR PRESSURE VESSEL HEAD INSPECTIONS (TAC NO. MB8174)

Dear Mr. Bezilla:

The U.S. Nuclear Regulatory Commission (NRC) has approved, upon good cause shown and subject to the conditions specified below, FirstEnergy Nuclear Operating Company's (FENOC's) request for relaxation of the specific requirements of Order EA-03-009 for Beaver Valley Power Station, Unit 1 (BVPS 1). That Order requires inspections of the reactor pressure vessel (RPV) and associated penetration nozzles at pressurized-water reactors. This relaxation is in response to your letter dated March 27, 2003, as supplemented by letter dated April 2, 2003.

FENOC requested relaxation of the requirements for BVPS 1 to perform the ultrasonic testing (UT) and eddy current testing (ET) prescribed in Section IV, paragraphs C.(1)(b)(i) and C.(1)(b)(ii) of the Order. These requirements direct licensees of plants in the highly susceptible category to either ultrasonically test each RPV head penetration nozzle from 2 inches above the J-groove weld to the bottom of the nozzle; or, eddy current test or dye penetrant test the wetted surface of each J-groove weld and RPV head penetration nozzle base material to at least 2 inches above the J-groove weld. This relaxation allows FENOC to perform UT and ET examinations to the lowest elevation that can be practically inspected on each nozzle, but no less than a minimum of at least 1 inch from the bottom of the J-groove weld, in lieu of the above UT and ET requirements. The requirement that UT and ET extend to 2 inches above the J-groove weld is unaffected. The acceptance is contingent upon the following conditions:

a. the examination coverage from the bottom of the J-groove weld shall be at least 1 inch.

b. If the NRC staff finds that the crack growth formula in industry report MRP-55 is unacceptable, the licensee shall revise its analysis that justifies relaxation of the Order within 30 days after the NRC informs the licensee of an NRC-approved crack growth formula. If the licensee's revised analysis shows that the crack growth acceptance criteria are exceeded prior to the end of the current operating cycle, this relaxation is rescinded and the licensee shall, within 72 hours, submit to the NRC written justification for continued operation. If the revised analysis shows that the crack growth acceptance criteria are exceeded during the subsequent operating cycle, the licensee shall, within 30 days, submit the revised analysis for NRC review. If the revised analysis shows that the crack growth acceptance criteria are not exceeded during either the current operating

cycle or the subsequent operating cycle, the licensee shall, within 30 days, submit a letter to the NRC confirming that its analysis has been revised. Any future crack growth analyses performed for this and future cycles for RPV head penetrations must be based on an acceptable crack growth rate formula.

The details of the NRC staff's review are contained in the enclosed safety evaluation. If you have any questions concerning this approval, please contact Mr. Timothy G. Colburn at (301) 415-1402.

Sincerely,

/RA/

Stuart Richards, Director
Project Directorate I
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Docket No. 50-334

Enclosure: Safety Evaluation

cc w/encl: See next page

cycle or the subsequent operating cycle, the licensee shall, within 30 days, submit a letter to the NRC confirming that its analysis has been revised. Any future crack growth analyses performed for this and future cycles for RPV head penetrations must be based on an acceptable crack growth rate formula.

The details of the NRC staff's review are contained in the enclosed safety evaluation. If you have any questions concerning this approval, please contact Mr. Timothy G. Colburn at (301) 415-1402.

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Enclosure: Safety Evaluation

cc w/encl: See next page

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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

ORDER (EA-03-009) RELAXATION REQUEST, EXAMINATION COVERAGE

FOR REACTOR PRESSURE VESSEL HEAD PENETRATION NOZZLES

BEAVER VALLEY POWER STATION, UNIT 1 (BVPS 1)

FIRSTENERGY NUCLEAR OPERATING COMPANY

DOCKET NUMBER 50-334

1.0 INTRODUCTION

Nuclear Regulatory Commission (NRC) Order EA-03-009 (Order), issued on February 11, 2003, requires specific examinations of the reactor pressure vessel (RPV) head and vessel head penetration (VHP) nozzles of all pressurized water reactor (PWR) plants. Section IV, paragraph F, of the Order states that requests for relaxation of the Order associated with specific penetration nozzles will be evaluated by the NRC staff using the procedure for evaluating proposed alternatives to the American Society of Mechanical Engineers Boiler and Pressure Vessel Code in accordance with Title 10 of the *Code of Federal Regulations* (10 CFR), Section 50.55a(a)(3). Section IV, paragraph F, of the Order states that a request for relaxation regarding inspection of specific nozzles shall address the following criteria: (1) the proposed alternative(s) for inspection of specific nozzles will provide an acceptable level of quality and safety, or (2) compliance with this Order for specific nozzles would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety.

For Beaver Valley Power Station, Unit No. 1 (BVPS-1) and similar plants determined to have a high susceptibility to primary water stress corrosion cracking (PWSCC) in accordance with Section IV, paragraphs A and B, of the Order, the following inspections are required to be performed every refueling outage in accordance with Section IV, paragraph C.(1) of the Order:

(a) Bare metal visual (BMV) examination of 100% of the RPV head surface (including 360° around each RPV head penetration nozzle), AND

(b) Either:

(i) Ultrasonic testing (UT) of each RPV head penetration nozzle (i.e., nozzle base material) from two (2) inches above the J-groove weld to the bottom of the nozzle and an assessment to determine if leakage has occurred into the interference fit zone, OR

(ii) Eddy current testing (ET) or dye penetrant testing (PT) of the wetted surface of each J-groove weld and RPV head penetration nozzle base material to at least two (2) inches above the J-groove weld.

Footnote 3 of the Order provides specific criteria for examination of repaired VHP nozzles.

By letter dated March 27, 2003, as supplemented April 2, 2003, FirstEnergy Nuclear Operating Company (FENOC, the licensee) requested relaxation to implement an alternative to the requirements of Section IV, paragraphs C.(1)(b)(i) and C.(1)(b)(ii) of the Order for VHP nozzles at BVPS-1.

2.0 ORDER EA-03-009 RELAXATION REQUEST FOR EXAMINATION COVERAGE FOR REACTOR PRESSURE VESSEL HEAD PENETRATION NOZZLES

2.1 Order Requirements for which Relaxation is Requested

Section IV.C.(1)(b) of Order EA-03-009 requires, in part, that the following inspections be performed every refueling outage for high susceptibility plants similar to BVPS-1:

Either:

(i) Ultrasonic testing of each RPV head penetration nozzle (i.e., nozzle base material) from two (2) inches above the J-groove weld to the bottom of the nozzle and an assessment to determine if leakage has occurred into the interference fit zone, OR

(ii) Eddy current testing or dye penetrant testing of the wetted surface of each J-Groove weld and RPV head penetration nozzle base material to at least two (2) inches above the J-groove weld.

The licensee has requested relaxation from Section IV, paragraphs C.(1)(b)(i) and C.(1)(b)(ii) of the Order for all VHP nozzles. The specific relaxation requested is related to the coverage requirements for nondestructive examinations performed on the lower portions of the nozzles where limited by design of the testing equipment and dose accumulation.

Relaxation was requested for the period in which Order EA-03-009 is in effect.

2.2 Licensee's Proposed Alternative Method

The proposed alternate examination is to perform UT and ET examination to the lowest elevation that can be practically inspected on each nozzle with the probe being used. In its April 2, 2003, supplement, FENOC stated that the examination coverage from the bottom of the J-groove weld is a minimum of at least 1 inch.

2.3 Licensee's Basis for Relaxation

The licensee stated that UT probes used to detect circumferential flaws are not effective near the end of the nozzle. These probes have separate transducers for sending and receiving the ultrasonic signal. The transducers in the probe are approximately one inch apart and are arranged vertically. This configuration causes the lower transducer to lose contact on the inside wall of the nozzle whenever the upper transducer is one inch or less from the bottom of the nozzle. Since the scanning process requires that both transducers remain in contact with the surface, the arrangement cannot scan the lower end of the nozzle, which equates to approximately one inch around the base for 360°.

For ET probes, the licensee states that the same condition exists because the probes do not maintain adequate contact with the nozzle at its lower end due to nozzle geometry. They state the bottom of each nozzle terminates in a rounded surface that begins more than 2 inches below the J-groove weld. This curvature causes lift-off of the probe as it approaches the bottom end of the nozzle and results in a 360° unscanned portion 1 inch around the base.

The licensee states that the proposed alternative will provide an acceptable level of quality and safety because the only portion of the nozzle involved is the portion below the J-groove weld. This area is essentially an open-ended tube and the nozzle wall in this portion is not part of the reactor coolant system pressure boundary. The magnitude of stresses in this area of the nozzles is low based on information from other plants of similar design and construction, and with the correspondingly low crack growth rates, there are no concerns with the structural integrity of the VHP nozzles from the unexamined portions of the nozzles. The licensee stated that the bottom portion of the nozzle below the J-groove weld is not involved in the phenomena of concern and that this alternative does not affect UT or ET testing of the portion of the nozzle involved in the phenomena of concern, which is the portion of the nozzle in the J-groove weld and above.

The licensee states that performing PT in lieu of ET or UT may result in significant radiation exposure to personnel without a compensating increase in the level of quality or safety. In its letter dated April 2, 2003, the licensee estimates that PT examination of this portion of the nozzles would require 15 additional days of outage time and increase the dose 100 person-rem to examine areas of no structural or safety significance.

2.4 Evaluation

The NRC staff's review of this request was based on criterion (2) of paragraph F of Section IV of the Order, which states: "Compliance with this Order would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety."

Within the context of the licensee's proposed alternative examination of the RPV penetration nozzles, the licensee has demonstrated the hardship that would result from implementing examinations to the bottom end of these nozzles. The hardship asserted by the licensee regarding the estimated additional radiation exposure of 100 person-rem that would be required to implement modifications to facilitate the required examinations is not a consideration in the NRC staff's evaluation. That is because the nozzles' geometry alone makes inspection of these nozzles in accordance with Order EA-03-009 very difficult and would result in hardship. This evaluation focuses on the issue of whether there is a compensating increase in the level of quality and safety such that these nozzles should be inspected despite this hardship.

The licensee's request to limit examination of the nozzle base material inner surface to exclude one inch from the bottom of the nozzle is supported by a finite element stress analysis of control rod drive mechanism (CRDM) penetrations for a reference three loop plant of similar design and construction as BVPS-1, and for which the arrangement of the penetrations on BVPS-1 is identical to that of the reference plant. This analysis used the approach described in footnote 1 of the Order as the criteria to set the necessary height of the examination. However, this analysis incorporates a crack growth formula different from that described in footnote 1, as provided in the Electric Power Research Institute's Material Reliability Program (MRP) report MRP-55, "Material Reliability Program (MRP) Crack Growth Rates for Evaluating Primary Water Stress Corrosion Cracking (PWSCC) of Thick Wall Alloy 600 Material (MRP-55)," Revision 1.

The NRC staff has performed a preliminary review of this report but has not made a final assessment regarding the acceptability of the report. If the NRC staff finds that the crack growth formula in industry report MRP-55 is unacceptable, the licensee shall revise its analysis that justifies relaxation of the Order within 30 days after the NRC informs the licensee of an NRC-approved crack growth formula. If the licensee's revised analysis shows that the crack growth acceptance criteria are exceeded prior to the end of the current operating cycle, this relaxation is rescinded and the licensee shall, within 72 hours, submit to the NRC written justification for continued operation. If the revised analysis shows that the crack growth acceptance criteria are exceeded during the subsequent operating cycle, the licensee shall, within 30 days, submit the revised analysis for NRC review. If the revised analysis shows that the crack growth acceptance criteria are not exceeded during either the current operating cycle or the subsequent operating cycle, the licensee shall, within 30 days, submit a letter to the NRC confirming that its analysis has been revised. Any future crack growth analyses performed for this and future cycles for RPV head penetrations must be based on an acceptable crack growth rate formula.

The licensee provided the following information as the basis for allowing the use of a similarly constructed plant's finite element analysis:

	Reference Plant	BVPS 1
RPV Head Inner Radius	79.094 inches	79.094 inches (1)
RPV Head Thickness	6.188 inches	6.188 inches (1)
CRDM Nozzle OD	4.000 inches	4.000 inches (2)
CRDM Nozzle ID	2.750 inches	2.750 inches (2)
RPV Head Operating Temp.	597°F	595°F (3)

Notes:

1. Combustion Engineering (CE) Drawing No. 233-718, Closure Head Forming & Welding, Revision 2
2. CE Drawing No. 233-723, Control Rod Mechanism Housing Details, Revision 3
3. PWR Materials Reliability Program Response to NRC Bulletin 2001-01 (MRP-48), TP-1006284

The NRC staff concludes from the information provided above by the licensee, that the reference plant is similar in design, construction, materials and operating temperature, therefore the stress analysis data provided by the licensee should be reasonably representative of any cracking that may occur in the BVPS-1 nozzle material.

The hoop stress distribution data provided by the licensee in its April 2, 2003, supplemental letter indicates that the hoop stresses in the unexamined areas of the nozzles are between 10,000 psi tensile and 10,000 psi compressive, for the outside and inside areas of the CRDM nozzles. The licensee indicated that the actual stresses in the BVPS-1 CRDM nozzles are even lower during operation than those of the reference plant because its operating temperature is 595 °F, two degrees lower than the reference plant's operating temperature. This data demonstrates that a flaw in the unexamined portion of the nozzle, when used with the crack

growth rate discussed above, does not have sufficient driving force to propagate a PWSCC flaw to the J-groove weld within an 18-month operating period.

The safety issues that are addressed by the inspections mandated by Order EA-03-009 are degradation (corrosion) of the low-alloy steel RPV head and ejection of the VHP nozzle due to circumferential cracking of the nozzle above the J-groove weld. The following three items provide reasonable assurance that these safety issues are addressed:

1. The BMV examination performed by the licensee visually demonstrated the integrity of the RPV head and the absence of on-going degradation of the head.

2. The licensee's analysis, which suggests that no flaw located within the unexamined portion of the nozzles of a similarly constructed RPV (i.e., more than one inch below the J-groove weld) would propagate to a level adjacent to the weld within an 18-month operating period, provides sufficient justification that there is a very low likelihood of through wall leakage or possible degradation of the BVPS-1 low-alloy steel RPV head prior to the next inspection due to such a flaw.

3. The UT examination of the RPV head penetration nozzles in accordance with Section IV, paragraph C.(1)(b)(i), of the Order from 2 inches above the weld to greater than or equal to one inch below the weld reasonably demonstrates that the RPV head penetration nozzles are intact throughout the region of concern. This examination provides reasonable assurance that no circumferential cracking of the nozzle above the J-groove weld is present and no through wall leakage and degradation of the RPV head should occur.

The inspections proposed by the licensee provide reasonable assurance of structural integrity and, thus, adequate protection of the public health and safety.

3.0 CONCLUSION

The NRC staff concludes that the licensee's proposed alternative to perform UT and ET examination to the lowest elevation that can be practically inspected on each nozzle, but no less than a minimum of at least one inch from the bottom of the J-groove weld, with the probe being used provides reasonable assurance of the structural integrity of the RPV head, VHP nozzles, and welds. Further inspection of these VHP nozzles in accordance with Section IV, paragraph C.(1)(b), of Order EA-03-009 would result in hardship without a compensating increase in the level of quality and safety. Therefore, pursuant to Section IV, paragraph F, of Order EA-03-009, the NRC staff finds that there is good cause shown to relax the Order and authorizes the proposed relaxation and alternative inspection for VHP head penetration nozzles at BVPS-1, subject to the following conditions:

1) the examination coverage from the bottom of the J-groove weld shall be at least 1 inch.

2) If the NRC staff finds that the crack growth formula in industry report MRP-55 is unacceptable, the licensee shall revise its analysis that justifies relaxation of the Order within 30 days after the NRC informs the licensee of an NRC-approved crack growth formula. If the licensee's revised analysis shows that the crack growth acceptance criteria are exceeded prior to the end of the current operating cycle, this relaxation is rescinded and the licensee shall, within 72 hours, submit to the NRC written justification for

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Date: April 18, 2003

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