FENOC
FirstEnergy Nuclear Operating Company

Peter P. Sena III
Site Vice President

724-682-5234
Fax: 724-643-8069

February 12, 2008
L-08-060

10 CFR 54

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

SUBJECT:
Beaver Valley Power Station, Unit Nos. 1 and 2
BV-1 Docket No. 50-334, License No. DPR-66
BV-2 Docket No. 50-412, License No. NPF-73
License Renewal Application Amendment 1: Revision to Reactor Vessel Integrity Aging Management Program Information and Details of Reactor Vessel Surveillance Capsule Withdrawal Schedule Information

FirstEnergy Nuclear Operating Company (FENOC) is providing Amendment 1 to the Beaver Valley Power Station (BVPS) License Renewal Application submitted by FENOC Letter L-07-113 on August 27, 2007. Amendment 1 revises the description and details of the Reactor Vessel Integrity Program provided in Sections A.1.35 and B.2.35 of the License Renewal Application. FENOC identified the need to revise the program information during benchmarking of other license renewal applicants undergoing NRC review, from industry meetings, and from NRC license renewal audit questions and requests for additional information.

The Reactor Vessel Integrity Program revision includes detailed Reactor Vessel surveillance capsule withdrawal schedule information for BVPS Unit 1 and Unit 2. In addition, the revision provides clarification to the Reactor Vessel beltline and extended beltline metallurgical information for Unit 1 and Unit 2.

Attachment 1 provides the revised summary description for License Renewal Application Section A.1.35, "Reactor Vessel Integrity Program." Attachment 2 provides the revised program information for License Renewal Application Section B.2.35, "Reactor Vessel Integrity Program."

There are no regulatory commitments contained in this letter. If there are any questions or if additional information is required, please contact Mr. Clifford I. Custer, Fleet License Renewal Project Manager, at 724-682-7139.

A108
A008

NRR

I declare under penalty of perjury that the foregoing is true and correct. Executed on February 12, 2008.

Sincerely,

Peter P. Sena III

References:

1. FENOC Letter L-07-113, "License Renewal Application," dated August 27, 2007.
2. FENOC Letter L-07-500, "Editorial Corrections to the Beaver Valley Power Station License Renewal Application," dated December 21, 2007.

Attachments:

1. Revised Summary Description for License Renewal Application Section A.1.35, "Reactor Vessel Integrity Program."
2. Revised Program Information for License Renewal Application Section B.2.35, "Reactor Vessel Integrity Program."

cc: Mr. K. L. Howard, Project Manager
Mr. M. A. Mitchell, Branch Chief, Vessels and Internals Integrity
Mr. S. J. Collins, NRC Region I Administrator
Dr. P. T. Kuo, Director, Division of License Renewal
Mr. D. L. Werkheiser, NRC Senior Resident Inspector
Ms. N. S. Morgan, NRR Project Manager
Mr. D. J. Allard, Director BRP/DEP
Mr. L. E. Ryan (BRP/DEP)

ATTACHMENT 1
L-08-060

Revised Summary Description for
License Renewal Application Section A.1.35,
"Reactor Vessel Integrity Program"
Page 1 of 2

License Renewal Application Section A.1.35 is replaced in its entirety and is revised to read as follows (underline – added, strikethrough – deleted):

The Reactor Vessel Integrity Program manages loss of fracture toughness due to neutron embrittlement in reactor materials exposed to neutron fluence exceeding 1.0E+17 n/cm^2 (E>1.0 MeV). The program is based on 10 CFR 50, Appendix H, *Reactor Vessel Material Surveillance Requirements*, and ASTM Standard E 185-82, *Standard Practice for Conducting Surveillance Tests for Light-Water Cooled Nuclear Power Reactor Vessels* [Reference A.1-25] (incorporated by reference into 10 CFR 50, Appendix H). Capsules are periodically removed during the course of plant operating life. Neutron embrittlement is evaluated through surveillance capsule testing and evaluation, fluence calculations and monitoring of effective full power years (EFPYs). ~~Best-estimate values of Reactor Vessel accumulated neutron fluence are determined utilizing analytical models that satisfy the guidance contained in NRC Regulatory Guide 1.190, *Calculational and Dosimetry Methods for Determining Pressure Vessel Neutron Fluence* [Reference A.1-26].~~ Data resulting from the program is used to:

- Determine pressure-temperature limits, minimum temperature requirements, and end-of-life Charpy upper-shelf energy (C_VUSE) in accordance with the requirements of 10 CFR 50, Appendix G, *Fracture Toughness Requirements*; and,
- Determine end-of-life reference temperature for pressurized thermal shock (RT_{PTS}) values in accordance with 10 CFR 50.61, *Fracture Toughness Requirements for Protection Against Pressurized Thermal Shock.*

The Reactor Vessel Integrity Program provides guidance for removal and testing or storage of material specimen capsules. ~~All capsules that have been withdrawn were tested and stored.~~ Standby capsules are installed at Unit 1 and Unit 2 ~~will be available for future testing~~ and are available to provide neutron fluence monitoring and meaningful metallurgical test data for 60 and 80 years of operation. In the case where the reactor vessel has all surveillance capsules removed, the program requires use of alternative dosimetry (ex-vessel neutron dosimetry) to monitor neutron fluence during the period of extended operation.~~Standby capsules from each unit will be removed from the vessel when the neutron fluences are approximately equivalent to the expected vessel wall neutron fluence at 60 years of operation (corrected for lead and capacity factors).~~

~~In addition, the Reactor Vessel Integrity Program implements flux reduction programs as required by 10 CFR 50.61.~~ The limiting material in the Unit 1 beltline region is projected to exceed the 10 CFR 50.61 pressurized thermal shock (PTS) screening criteria in the period of extended operation. Several flux reduction options were identified which would maintain the limiting material below the PTS screening criteria to the end of life (60 years). The Reactor Vessel Integrity Program implements the Unit 1 flux reduction program to ensure compliance with 10 CFR 50.61.

License Renewal Application Section B.2.35 is replaced in its entirety and is revised to read as follows (underline – added, strikethrough – deleted):

Program Description

The Reactor Vessel Integrity Program is an existing plant-specific program.

The Reactor Vessel Integrity Program manages loss of fracture toughness due to neutron embrittlement in reactor materials exposed to a neutron fluence exceeding 1.0E+17 n/cm^2 (E>1.0 MeV). The program is based on 10 CFR 50 Appendix H, *Reactor Vessel Material Surveillance Requirements* [Reference 1.3-1], and ASTM Standard E 185-82, *Standard Practice for Conducting Surveillance Tests for Light-Water Cooled Nuclear Power Reactor Vessels* [Reference B.3-27] (incorporated by reference into 10 CFR 50, Appendix H). Capsules are periodically removed during the course of plant operating life. Neutron embrittlement is evaluated through surveillance capsule testing and evaluation, fluence calculations and monitoring of effective full power years (EFPYs). ~~Best-estimate values of Reactor Vessel accumulated neutron fluence are determined utilizing analytical models that satisfy the guidance contained in NRC Regulatory Guide 1.190, *Calculational and Dosimetry Methods for Determining Pressure Vessel Neutron Fluence* [Reference B.3-28].~~ Data resulting from the program is used to:

- Determine pressure-temperature limits, minimum temperature requirements, and end-of-life Charpy upper-shelf energy (C_VUSE) in accordance with the requirements of 10 CFR 50 Appendix G, Fracture Toughness Requirements [Reference 1.3-1], and,
- Determine end-of-life reference temperature for pressurized thermal shock (RT_{PTS}) values in accordance with 10 CFR 50.61, Fracture Toughness Requirements for Protection Against Pressurized Thermal Shock [Reference 1.3-1].

The Reactor Vessel Integrity Program provides guidance for removal and testing or storage of material specimen capsules. ~~All capsules that have been withdrawn were tested and stored.~~ Standby capsules are installed at Unit 1 and Unit 2 ~~will be available for future testing~~ and are available to provide neutron fluence monitoring and meaningful metallurgical test data for 60 and 80 years of operation. In the case where the reactor vessel has all surveillance capsules removed, the program requires use of alternative dosimetry (ex-vessel neutron dosimetry) to monitor neutron fluence during the period of extended operation.~~Standby capsules from~~

~~each unit will be removed from the vessel when the neutron fluences are approximately equivalent to the expected vessel wall neutron fluence at 60 years of operation (corrected for lead and capacity factors).~~

~~In addition, the Reactor Vessel Integrity Program implements flux reduction programs as required by 10 CFR 50.61.~~ The limiting material in the Unit 1 beltline region is projected to exceed the 10 CFR 50.61 pressurized thermal shock (PTS) screening criteria in the period of extended operation. Several flux reduction options were identified which would maintain the limiting material below the PTS screening criteria to the end of life (60 years). The Reactor Vessel Integrity Program implements the Unit 1 flux reduction program to ensure compliance with 10 CFR 50.61.

Aging Management Program Elements

The results of an evaluation of each of the 10 aging management program elements described in NUREG-1800 [Reference 1.3-4], Appendix A, are provided as follows:

- **Scope of Program**

  The program monitors changes in the fracture toughness properties of ferritic materials in the Reactor Vessel beltline region which result from exposure of these materials to neutron irradiation and the thermal environment. Under the program, fracture toughness test data are obtained from material specimens exposed in surveillance capsules, which are withdrawn periodically from the Reactor Vessel. The test data are then analyzed and used to establish operating limits and setpoints in compliance with the pressure and temperature requirements of 10 CFR 50 Appendix G and ASME Code Case N-640, *Alternative Reference Fracture Toughness for Development of P-T Limit Curves for Section XI, Division I.* The extended beltline materials that have projected fluence values of greater than 1.0E+17 n/cm^2 (E>1.0 MeV) at ~~the end-of-license-extended~~54 EFPY (60 years of operation) were also evaluated.~~, and none of these materials were determined to be limiting. Therefore, these materials need not be added to the material surveillance program for the license renewal term.~~

- **Preventive Actions**

  Surveillance capsule test data is used to determine operating pressure-temperature limits, minimum temperature requirements, and end-of-life C_VUSE in accordance with the requirements of 10 CFR 50 Appendix G.~~, and~~ Also, surveillance capsule test data is used to determine end-of-life RT_{PTS} values in accordance with 10 CFR 50.61. ~~In addition, the Reactor Vessel Integrity~~

~~Program implements flux reduction programs as allowed by 10 CFR 50.61. Flux reduction program documentation will be submitted in accordance with the requirements of 10 CFR 50.61.~~ The C_VUSE and RT_{PTS} values are calculated using the guidance provided in NRC Regulatory Guide 1.99, *Radiation Embrittlement of Reactor Vessel Materials* [Reference 4.2-6]. Neutron fluence calculations are performed using the guidance provided in NRC Regulatory Guide 1.190, *Calculational and Dosimetry Methods for Determining Pressure Vessel Neutron Fluence* [Reference B.3-28].

As presented in the License Renewal Application, Section 4.2, the beltline and extended beltline material end-of-life (60 years) C_VUSE values maintain 50 ft-lb or greater in accordance with the requirements of 10 CFR 50 Appendix G, and the end-of-life (60 years) RT_{PTS} values meet the 10 CFR 50.61 screening criteria, with the exception of the Unit 1 lower shell plate B6903-1 (heat C6317-1). The screening limit of 270°F for lower shell plate B6903-1 will be reached at a fluence level of 4.961E+19 n/cm^2 (E>1.0 MeV), which is equivalent to 43.87 EFPY. Several flux reduction options were identified which would maintain the Unit 1 limiting material below the PTS screening criteria to the end-of-life (60 years). The Reactor Vessel Integrity Program implements the Unit 1 flux reduction program to ensure compliance with 10 CFR 50.61.

- **Parameters Monitored / Inspected**

The Reactor Vessel Integrity Program monitors the loss of fracture toughness due to neutron irradiation embrittlement of the Reactor Vessel beltline materials in accordance with 10 CFR 50 Appendix H. Various environmental and metallurgical parameters are monitored, including fluence~~, and material chemistry. Once all surveillance capsules are removed, alternative dosimetry will be used to monitor neutron fluence during the period of extended operation.~~ In the case where a Reactor Vessel has all surveillance capsules removed, the program requires use of alternative dosimetry (ex-vessel neutron dosimetry) to monitor neutron fluence during the period of extended operation.

- **Detection of Aging Effects**

Fracture toughness test data are obtained from encapsulated, in-vessel material specimen surveillance coupons, which are withdrawn periodically from the Reactor Vessel and destructively tested. Charpy V-notch testing is conducted on the coupons to measure loss of fracture toughness. Test results are provided to the NRC in accordance with 10 CFR 50, Appendix H, Section IV. The program requires that tested and untested specimens removed from the Reactor Vessels remain in storage. All capsules that have been withdrawn were tested and stored. Standby capsules are installed at Unit 1 and Unit 2 and are available to provide neutron fluence monitoring and

meaningful metallurgical test data for 60 and 80 years of operation. Any change to the surveillance capsule withdrawal schedule is submitted to the NRC for approval prior to implementation in accordance with 10 CFR 50, Appendix H, Section III.

Unit 1 Reactor Vessel Surveillance Capsules

Unit 1 has one capsule (Capsule X) and three standby capsules (Capsules T, Z and S) that remain in the Reactor Vessel. As documented in Unit 1 UFSAR Table 4.5-3, Capsule X withdrawal EFPY is 25.9, based on a projected peak fluence of 5.87E+19 n/cm^2 (45 EFPY). Estimated Capsule X withdrawal date is in the year 2013. For the original license period (40 years), no other capsule withdrawal is required to meet 10 CFR 50, Appendix H and ASTM Standard E 185-82 requirements.

The three standby capsules (Capsules T, Z and S) will be managed to provide fluence data for 60 and 80 years of operation along with meaningful metallurgical test data for the Unit 1 surveillance materials. For example, Capsule S and Capsule T are in lagging lead factor locations and could be moved to higher lead factor locations to obtain meaningful metallurgical test data.

Unit 2 Reactor Vessel Surveillance Capsules

As documented in Unit 2 UFSAR Table 5.3-6, all capsule withdrawals have been completed for the original license period (40 years), and no other capsule withdrawal is required to meet 10 CFR 50, Appendix H and ASTM Standard E 185-82 requirements. Capsule X was the last capsule withdrawn, and was exposed to a peak neutron fluence of 5.601E+19 n/cm^2 (48 EFPY) as documented in WCAP-16527-NP, *Analysis of Capsule X From First Energy Nuclear Operating Company Beaver Valley Unit 2 Reactor Vessel Radiation Surveillance Program* [Reference 4.2-4].

Two standby capsules (Capsules Y and Z) remain in the Reactor Vessel. Both capsules have a lead factor of 3.25. Capsule Y or Z will be removed and tested such that, at the time of removal, the capsule will have been exposed to a peak neutron fluence in the range of 8.0 to 8.5E+19 n/cm^2. The corresponding peak neutron fluence at 72 EFPY (80 years of operation) is projected at 8.48E+19 n/cm^2, and the corresponding capsule withdrawal EFPY is 23.49. Projected withdrawal date is in the year 2014. The 2nd standby capsule is to remain in the Reactor Vessel to provide neutron fluence monitoring, and will be available for future testing.

- **Monitoring and Trending**

  The irradiated material properties (Charpy test results) are compared to available unirradiated properties, and the resulting irradiation shift is measured. The shift is a measure of the effect of irradiation on material toughness for the plate and weld materials. The BVPS data is not trended.

- **Acceptance Criteria**

  The program requirements are set forth in 10 CFR 50.61, 10 CFR 50, Appendices G and H, and ASTM Standard E 185-82, ~~*Standard Practice for Conducting Surveillance Tests for Light-Water Cooled Nuclear Power Reactor Vessels*~~, which is incorporated by reference into 10 CFR 50, Appendix H.

- **Corrective Actions**

  This element is discussed in Section B.1.3.

- **Confirmation Process**

  This element is discussed in Section B.1.3.

- **Administrative Controls**

  This element is discussed in Section B.1.3.

- **Operating Experience**

  The Reactor Vessel Integrity Program has provided materials data and dosimetry for the monitoring of irradiation embrittlement since plant startup. The use of this program has been reviewed and approved by the NRC during the period of current operation. Surveillance capsules have been withdrawn during the period of current operation, and the data from these surveillance capsules and sister plant data have been used to verify and predict the performance of BVPS Reactor Vessel beltline materials with respect to neutron embrittlement. Calculations have been performed as required to project the reference temperature for pressurized thermal shock (RT_{PTS}) and Charpy upper-shelf energy (C_VUSE) values to the end-of-license-extended (EOLE). BVPS pressure-temperature limit curves are valid up to a stated vessel fluence limit, and must be revised prior to operating beyond that limit. As part of the Extended Power Uprate review, the continued applicability of each unit's pressure-temperature limits was evaluated.

In 2001, a BVPS self-assessment of the program was conducted. As a result, program enhancements were made. The self-assessment identified two strengths and five areas for improvement for the program, which were documented in the Corrective Action Program. The areas for improvement dealt with the need to better document and control technical information used within the program. The Corrective Action Program was used as needed to track resolution of the areas for improvement. Program enhancements as a result of issues identified in a self-assessment provides reasonable assurance that the program is effective.

Actions to manage the Reactor Vessel fluence at the limiting location have been underway at BVPS Unit 1 since the 1990s. Starting with Cycle 11 in 1995, BVPS instituted a flux management program to manage the fluence effects on the RT_{PTS} value of the limiting plate (lower shell plate B6903-1). This flux management plan included the addition of hafnium rods in the peripheral fuel bundles and continued use of the standard L4P low-leakage core loading. The operation of Unit 1 with hafnium rods installed for three cycles (removed in fall of 2001) reduced the irradiation rate by approximately 25 percent during that time period.

The program operating experience provides reasonable assurance that the program will remain effective in managing aging effects of Reactor Vessel materials.

Enhancements

None

Conclusion

Continued implementation of the Reactor Vessel Integrity Program provides reasonable assurance that the aging effects will be managed so that the systems and components within the scope of this Program will continue to perform their intended functions consistent with the current licensing basis for the period of extended operation.