UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

July 17, 2014

Mr. Eric A. Larson, Site Vice President
FirstEnergy Nuclear Operating Company
Beaver Valley Power Station
Mail Stop A-BV-SEB1
P.O. Box 4, Route 168
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SUBJECT: BEAVER VALLEY POWER STATION, UNITS 1 AND 2 – REVISION TO REACTOR VESSEL SURVEILLANCE CAPSULE WITHDRAWAL SCHEDULE (TAC NOS. MF1929 AND MF1930)

Dear Mr. Larson:

By letter dated May 28, 2013, as supplemented by letters dated December 13, 2013, and May 21, 2014, FirstEnergy Nuclear Operating Company submitted a request to revise the withdrawal schedule for the reactor vessel surveillance capsules for Beaver Valley Power Station, Units 1 and 2 (BVPS-1 and BVPS-2, respectively). The proposed changes were submitted pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50, Appendix H, Section III.B.3, which requires that: (1) withdrawal schedules be submitted, as specified in 10 CFR 50.4, and (2) the proposed schedule must be approved by the Nuclear Regulatory Commission (NRC) prior to implementation.

The NRC staff has reviewed the submittal and concludes that the proposed changes are acceptable and consistent with the intent and requirements of the applicable regulations and guidance found in Appendix H to 10 CFR Part 50, as well as American Society for Testing and Materials Standard E185-82, "Standard Practice for Conducting Surveillance Tests for Light-Water Cooled Nuclear Power Reactor Vessels," dated July 1, 1982. Furthermore, the proposed change meets the guidance in NUREG-1801, Revision 1, "Generic Aging Lessons Learned (GALL) Report," Section XI.M31. The NRC staff's related safety evaluation is enclosed.

Sincerely,

Robert G. Schaaf, Acting Chief
Plant Licensing Branch I-2
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket Nos. 50-334 and 50-412

Enclosure:
Safety Evaluation

cc w/encl: Distribution via Listserv

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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

REVISION TO REACTOR VESSEL SURVEILLANCE CAPSULE WITHDRAWAL SCHEDULE

FIRSTENERGY NUCLEAR OPERATING COMPANY

BEAVER VALLEY POWER STATION, UNITS 1 AND 2

DOCKET NOS. 50-334 AND 50-412

1.0 INTRODUCTION

By letter dated May 28, 2013,[1] as supplemented by letters dated December 13, 2013,[2] and May 21, 2014,[3] FirstEnergy Nuclear Operating Company (FENOC or the licensee) submitted a request to revise the withdrawal schedule for the reactor vessel (RV) surveillance capsules for Beaver Valley Power Station, Units 1 and 2 (BVPS-1 and BVPS-2, respectively). The licensee proposes to change the surveillance capsule withdrawal schedule consistent with the recommendations included in the analysis of WCAP-15571, "Analysis of Capsule Y from Beaver Valley Unit 1 Reactor Vessel Radiation Surveillance Program," Supplement 1, Revision 2, dated September 2011,[4] and WCAP-16527-NP, "Analysis of Capsule X from FirstEnergy Nuclear Operating Company Beaver Valley Unit 2 Reactor Vessel Radiation Surveillance Program," Supplement 1, Revision 1, dated September 2011.[5]

2.0 REGULATORY EVALUATION

2.1 Section 50.60 of Part 50 of Title 10 of the *Code of Federal Regulations* (10 CFR 50.60) and Appendix H to 10 CFR Part 50

The Nuclear Regulatory Commission (NRC) has established requirements and criteria in 10 CFR 50.60 for protecting the RVs of U.S. light-water reactors (LWRs) against fracture. The rule requires U.S. LWRs to meet the RV materials surveillance program requirements set forth in Appendix H to 10 CFR Part 50.

Appendix H to 10 CFR Part 50 provides the NRC staff's criteria for the design and implementation of RV material surveillance programs for operating LWRs. The rule, in part, requires RV surveillance program designs and withdrawal schedules to meet the requirements of the edition of American Society for Testing and Materials (ASTM) Standard Practice E185, "Standard Practice

[1] Agencywide Documents Access and Management System (ADAMS) Package Accession No. ML131510059.
[2] ADAMS Accession No. ML13350A581.
[3] ADAMS Accession No. ML14141A086.
[4] ADAMS Accession No. ML13151A059.
[5] ADAMS Accession No. ML13151A060.

for Conducting Surveillance Tests for Light-Water Cooled Nuclear Power Reactor Vessels" that is current on the issue date of the American Society of Mechanical Engineers *Boiler and Pressure Vessel Code* (ASME Code) to which the RV was purchased, although later editions of ASTM E185 may be used inclusive of the 1982 Edition of ASTM E185 (ASTM E185-82). The rule also requires proposed RV surveillance programs to be submitted to the NRC and approved prior to implementation. The applicable criteria in ASTM E185-82 are discussed below.

Table 1 of ASTM E185-82 requires that either a minimum of three, four, or five surveillance capsules be removed from the RVs, based on the limiting amount of Nil-Ductility Transition Reference Temperature (RT_{NDT}) shift that is projected to occur at the clad-vessel interface location of the RV at the end-of-licensed plant life (EOL), defined as 32 effective full-power years (EFPY) for 40 operating years. ASTM E185-82 establishes the following criteria for determining the minimum number of capsules that are to be removed in accordance with a withdrawal schedule and the number of capsules that are to be tested:

1. For plants with projected RT_{NDT} shifts (i.e., ΔRT_{NDT}) less than or equal to 100 degrees Fahrenheit (°F) (56 degrees Celsius (°C)), three capsules are required to be removed from the RV and the first two capsules are required to be tested (for dosimetry, tensile-ductility, Charpy-V impact toughness, and alloying chemistry).

2. For plants with projected ΔRT_{NDT} greater than 100°F (56°C) but less than or equal to 200°F (111°C), four surveillance capsules are to be removed from the RV and the first three capsules are required to be tested.

3. For plants with projected ΔRT_{NDT} above 200°F (111°C), five surveillance capsules are required to be removed from the RV and the first four capsules are required to be tested.

ASTM E185-82 also provides specific criteria for removal of surveillance capsules. The removal times are based on criteria that the surveillance capsules be removed after a certain amount of power operation has elapsed or at various times when the RV shell is projected to achieve certain levels of neutron fluence. The intent of the Standard Practice is to achieve a set of testing data over a range of neutron fluences for the RV that bounds the current life of the plant. Of key importance are the removal criteria for the second-to-last and final capsules required for capsule withdrawal. For the second-to-last required capsule in a withdrawal schedule, ASTM E185-82 requires that the capsules be pulled at either 15 EFPYs or at the time when the capsule fluence is equivalent to the limiting fluence projected for the clad-based metal interface of the RV at EOL, whichever time comes first. For the final capsule that is required for removal, ASTM E185-82 requires that the capsule be removed at a time when the neutron fluence projected for the capsule is between the limiting fluence value projected for the RVs at the EOL (32 EFPY) and two times that value.

2.2 NRC Administrative Letter (AL) 97-004 and NRC Memorandum and Order CLI-96-13

On September 30, 1997, the NRC issued AL 97-004, "NRC Staff Approval for Changes to 10 CFR Part 50, Appendix H, Reactor Vessel Surveillance Specimen Withdrawal Schedules," to all holders of operating licenses for domestic nuclear power plants (with the exception of those who have ceased operations of their facilities or have certified that fuel has been permanently removed from the reactor). In this AL, the NRC staff summarized the Commission's decision promulgated in Commission Memorandum and Order CLI-96-13, which was issued "In the Matter

of the Cleveland Electric Illuminating Company (Perry Nuclear Power Plant, Unit 1)" on December 6, 1996. In this Memorandum and Order, the Commission found that, while 10 CFR Part 50, Appendix H, III.B.3 requires prior NRC approval for all withdrawal schedule changes, only certain changes require the NRC staff to review and approve the changes through the NRC's license amendment process (10 CFR 50.90 process). Specifically, only those changes that are not in conformance with ASTM E185 referenced in 10 CFR Part 50, Appendix H, are required to be approved through the license amendment process, whereas changes that are determined to conform to the ASTM standard only require that the staff document its review and verification of such conformance.

2.3 GALL Guidelines

On August 27, 2007, the licensee submitted a license renewal application for BVPS-1 and BVPS-2 based on NUREG-1801, Revision 1, "Generic Aging Lessons Learned (GALL) Report." By letters dated November 5, 2009,[6] the NRC granted license renewal to BVPS-1 for a term expiring January 29, 2036, and to BVPS-2 for a term expiring May 27, 2047. Section XI.M31 of the GALL includes recommended changes to the surveillance capsule withdrawal schedule to address the period of extended operation.

3.0 TECHNICAL EVALUATION

3.1 Changes Proposed to the Withdrawal Schedule for BVPS-1

For BVPS-1, FENOC is applying the requirements of ASTM E185-82 as its basis for meeting the RV surveillance capsule withdrawal requirements of 10 CFR Part 50, Appendix H. The BVPS-1 RV has a limiting ΔRT_{NDT} value greater than 200 °F. As stated above in paragraph 2.1, since the ΔRT_{NDT} value is greater than 200°F, ASTM E185-82 requires that the licensee, at a minimum, remove five capsules from the reactor during the licensed operating period and test the first four capsules.

The licensee's letter dated May 28, 2013, provides the proposed revision to the RV surveillance capsule withdrawal schedule for BVPS-1. Capsules V, U, W, and Y have been removed and tested, so the withdrawal schedule did not change for these four capsules. However, the licensee did revise the capsule lead factors and the withdrawal EFPYs for these four capsules based on updated fluence calculations. Despite these revisions, the NRC staff notes that the withdrawal interval for Capsules V, U, W, and Y is still consistent with the guidelines of ASTM E185-82, which provides a recommended withdrawal schedule based on the predicted ΔRT_{NDT} at the RV inside surface.

The licensee indicated in its letter dated May 28, 2013, that in addition to the four capsules that have already been withdrawn and tested, one additional capsule (Capsule X) would be removed from the BVPS-1 RV at the end of refueling cycle 22, at a projected fluence of 5.01×10^{19} n/cm^2. As stated in WCAP-15571, "Analysis of Capsule Y from Beaver Valley Unit 1 Reactor Vessel Radiation Surveillance Program," Supplement 1, Revision 2, dated September 2011, the limiting neutron fluence for the BVPS-1 RV based on a design life of 32 EFPY would be 3.55×10^{19} n/cm^2. The NRC staff concludes that the withdrawal schedule for Capsule X is consistent with the guidelines of ASTM E185-82 for the fifth capsule based on a 40-year EOL (32 EFPY). In

[6] ADAMS Accession Nos. ML092670259 and ML092920050.

response to an RAI, the licensee clarified by letter dated December 13, 2013, that Capsule X was withdrawn on October 13, 2013. By the requirements of Appendix H, this capsule withdrawal and the test results must be the subject of a summary technical report to be submitted, as specified in 10 CFR 50.4, within one year of the date of capsule withdrawal, unless an extension is granted by the Director, Office of Nuclear Reactor Regulation.

The licensee indicated that it has three spare capsules (Capsules T, S, and Z) in the current surveillance capsule withdrawal schedule. In the proposed surveillance capsule withdrawal schedule, the licensee stated that Capsule Z, which formerly was classified as a standby capsule, should be withdrawn after 36.3 EFPY and that this corresponds to the peak RV fluence at 60-year EOL (50 EFPY, 5.58×10^{19} n/cm^2). Therefore, Capsule Z will meet the recommendations of GALL Section XI.M31.

The limiting neutron fluence projected for the BVPS-1 RV is approximately 5.57×10^{19} n/cm^2 at the end of the period of extended operation, as stated in WCAP-15571. Capsules V, U, W, and Y have been withdrawn and tested consistent with the guidelines of ASTM E185-82. Capsule X has been withdrawn consistent with the guidelines of ASTM E185-82 for the fifth capsule for the original 40 year licensing period. If Capsule Z is withdrawn at 5.58×10^{19} n/cm^2, it will meet the recommendations of GALL Section XI.M31. Therefore, the licensee's proposed change to the surveillance capsule withdrawal schedule is based on the guidelines of ASTM E185-82, as required by Appendix H to 10 CFR Part 50, and also is consistent with the recommendations of GALL Section XI.M31 for the 60 year period of extended operation. Since the licensee's proposed change is in conformance with ASTM E185 referenced in 10 CFR Part 50, Appendix H the change is not required to be approved through the license amendment process as discussed above in paragraph 2.2.

3.2 Changes Proposed to the Withdrawal Schedule for BVPS-2

For BVPS-2, FENOC is applying the requirements of ASTM E185-82 as its basis for meeting the RV surveillance capsule withdrawal requirements of 10 CFR Part 50, Appendix H. With respect to the period of extended operation, the BVPS-2 RV has a limiting ΔRT_{NDT} value between 100°F and 200°F. As stated above in paragraph 2.1, since the ΔRT_{NDT} value is greater than 100°F, but less than or equal to 200°F, ASTM E185-82 requires that the licensee, at a minimum, remove four capsules from the reactor during the licensed operating period and test the first three capsules.

The licensee's letter dated May 28, 2013, provides the proposed new RV surveillance capsule withdrawal schedule for BVPS-2. Capsules U, V, W, and X have been removed and tested already, so the withdrawal schedule did not change for these four capsules. However, the licensee did revise the capsule lead factors and the withdrawal EFPYs for these four capsules based on updated fluence calculations which are discussed in more detail in the paragraph below. Despite these revisions, the NRC staff notes that the withdrawal interval for Capsules U, V, W, and X is still consistent with the guidelines of ASTM E185-82, which provides a recommended withdrawal schedule based on the predicted ΔRT_{NDT} at the RV inside surface.

In its review, the NRC staff determined that fluence values projected for 48 EFPY of exposure for BVPS-2, which were contained in WCAP-16527-NP, differed significantly from values that had been previously reviewed by the NRC staff. By letter dated May 21, 2014, the licensee clarified that the values had been determined using the same methodology as the previous values. The calculated method was previously reviewed by the NRC staff and found acceptable as

documented in NUREG-1929, "Safety Evaluation Report Related to the License Renewal of Beaver Valley Power Station, Units 1 and 2."[7] The licensee further clarified that the difference in the projected fluence values was due to a change in the core designs used in the fluence projections, which eliminated an over-conservatism in the newer calculation. Since the fluence values were determined using acceptable methodology and the licensee explained why the newer fluence values were different from the previous values, the NRC staff determined that the updated fluence projections were acceptable.

The licensee indicated that BVPS-2 has two spare capsules (Capsules Y and Z) in the current surveillance capsule withdrawal schedule. In the proposed surveillance capsule withdrawal schedule, the licensee stated that one of these two capsules should be withdrawn at a time when the capsule fluence exceeds one times the projected peak 80-year EOL fluence, but before the capsule fluence reaches two times the projected 60-year EOL fluence. The licensee recommends that this withdrawal should occur during the refueling outage closest to 26.1 EFPY, which corresponds to a peak RV fluence of 8.5×10^{19} n/cm^2. This proposal is consistent with the recommendations of GALL Section XI.M31.

In addition to the six capsules (Capsules U, V, W, X, Y and Z) which contain specimens made from BVPS-2 material, the NRC staff notes that the proposed surveillance capsule withdrawal schedule adds a supplemental capsule (Capsule A), which contains material from BVPS-1, St. Lucie, and Fort Calhoun. The licensee plans to remove and test this capsule when it reaches a fluence value equivalent to the peak 80-year EOL RV fluence for BVPS-1, and that this proposal is consistent with the "Materials Reliability Program: CRVSP [Coordinated PWR Reacctor Vessel Surveillance Program] Guidelines (MRP-326)".[8] The CRVSP was designed by industry to generate high fluence PWR surveillance data in support of extended life operations, while maintaining compliance with 10 CFR Part 50, Appendix H.

The limiting neutron fluence projected for the BVPS-2 RV is approximately 5.21×10^{19} n/cm^2 at the end of the period of extended operation as stated in WCAP-16527-NP. Capsules U, V, W, and X have been withdrawn and tested consistent with the guidelines of ASTM E185-82. If Capsule Y or Z is withdrawn at 8.5×10^{19} n/cm^2, it will meet the recommendations in GALL Section XI.M31. Therefore, the licensee's proposed surveillance capsule withdrawal schedule is based on the guidelines of ASTM E185-82, as required by Appendix H to 10 CFR Part 50, and also is consistent with the recommendations of GALL Section XI.M31 for the 60 year period of extended operation. Since the licensee's proposed change is in conformance with ASTM E185 referenced in 10 CFR Part 50, Appendix H, the change is not required to be approved through the license amendment process as discussed above in paragraph 2.2.

4.0 CONCLUSION

The NRC staff has reviewed FENOC's proposed withdrawal schedules for BVPS-1 and BVPS-2 and has determined that the proposed schedules will meet the RV surveillance capsule withdrawal schedule criteria in ASTM E185-82, will be in compliance with 10 CFR Part 50, Appendix H, are consistent with the recommendations of GALL Section XI.M31, and meet the license condition, as described in NUREG-1929, regarding the capsule withdrawal schedules as part of the Reactor Vessel Integrity Program. The NRC staff, therefore, concludes that the

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[7] ADAMS Accession No. ML093020276.
[8] ADAMS Accession Nos. ML12040A314 and ML12040A315.

proposed RV surveillance capsule withdrawal schedules are acceptable to replace the current surveillance capsule withdrawal schedules.

Principal Contributor: J. Jenkins

Date: July 17, 2014

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SUBJECT: BEAVER VALLEY POWER STATION, UNITS 1 AND 2 – REVISION TO REACTOR VESSEL SURVEILLANCE CAPSULE WITHDRAWAL SCHEDULE (TAC NOS. MF1929 AND MF1930)

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Sincerely,
/RA/
Robert G. Schaaf, Acting Chief
Plant Licensing Branch I-2
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket Nos. 50-334 and 50-412

Enclosure:
Safety Evaluation

cc w/encl: Distribution via Listserv

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