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October 31, 2016
L-16-299

10 CFR 50.54

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

SUBJECT:
Beaver Valley Power Station, Unit Nos. 1 and 2
Unit 1, Docket Number 50-334, License Number DPR-66
Unit 2, Docket Number 50-412, License Number NPF-73
Response to Generic Letter 2016-01, Monitoring of Neutron-Absorbing Materials in Spent Fuel Pools

On April 7, 2016, the Nuclear Regulatory Commission (NRC) issued Generic Letter 2016-01, "Monitoring of Neutron-Absorbing Materials in Spent Fuel Pools" to all power reactor licensees except those that have permanently ceased operation with all power reactor fuel removed from on-site spent fuel pool storage.

The purpose of this letter is to provide a response for the Beaver Valley Power Station (BVPS), Unit Nos. 1 and 2, which have been determined to be Category 4 licensees in accordance with Generic Letter 2016-01.

As a Category 4 licensee, information on the neutron absorber material, criticality analysis of record and neutron absorber monitoring program is requested depending on the type of neutron absorber material present and credited in the spent fuel pool. The BVPS Unit 1 spent fuel pool credits BORAL®; therefore the information requested in Areas 1, 2, and 4 of the generic letter will be provided for Unit 1. The BVPS Unit 2 spent fuel pool credits Metamic™; therefore the information requested in Areas 1 and 2 of the generic letter will be provided for Unit 2.

Attachments 1 and 2 provide the generic letter response for BVPS Unit Nos. 1 and 2, respectively.

There are no regulatory commitments contained in this submittal. If there are any questions or if additional information is required, please contact Mr. Thomas A. Lentz, Manager - Fleet Licensing, at (330) 315-6810.

I declare under penalty of perjury that the foregoing is true and correct. Executed on October 31, 2016.

Sincerely,

Marty L. Richey

Attachments:

1. BVPS Unit 1 Response to Generic Letter 2016-01, "Monitoring of Neutron-Absorbing Materials in Spent Fuel Pools"
2. BVPS Unit 2 Response to Generic Letter 2016-01, "Monitoring of Neutron-Absorbing Materials in Spent Fuel Pools"

cc: NRC Region I Administrator
NRC Project Manager
NRC Resident Inspector
Director BRP/DEP
Site BRP/DEP Representative

The requested information from Generic Letter 2016-01, Appendix A, "Guidance for Category 4 Responders to Generic Letter 2016-01," is presented in bold type, followed by the FirstEnergy Nuclear Operating Company (FENOC) response for the Beaver Valley Power Station (BVPS), Unit 1. Some of the requested information may not be provided, since it is not available and this is acceptable as documented in the September 10, 2015 NRC public meeting with the Nuclear Energy Institute (NEI) and the industry.

1. **Describe the neutron-absorbing material credited in the spent fuel pool (SFP) nuclear criticality safety (NCS) analysis of record (AOR) and its configuration in the SFP, including the following:**

   a. **Manufacturers, dates of manufacture, and dates of material installation in the SFP;**

      AAR Brooks & Perkins fabricated the BORAL® plates, and they were shipped in 1993 (January to August). The rerack of the BVPS Unit 1 Spent Fuel Pool (SFP) began in November 1993 and was completed in June 1994.

   b. **Neutron-absorbing material specifications, such as:**

      i) **Materials of construction, including the certified content of the neutron-absorbing component expressed as weight percent;**

         The materials of construction consist of a uniformly dispersed mixture of boron carbide (B_4C) and aluminum powders, clad in aluminum sheets. Boron carbide, in the form of granulated powder, is homogeneously dispersed throughout the central layer of the plate, which then is clad with 1100 alloy aluminum. Boron content (weight percent) in boron carbide is 78.28 percent (%).

ii) Minimum certified, minimum as-built, maximum as-built and nominal as-built areal density of the neutron-absorbing component; and

Although the maximum as-built areal density was not provided by the vendor, the supplied as-built materials are certified to meet the minimum requirement. The SFP is divided into two separate regions based on the spent fuel's accumulated burnup. The NCS AOR certifies the minimum and nominal boron-10 areal density in grams per square centimeter (g/cm^2) for each region is as follows:

	Minimum	*Nominal*
Region 1	*0.023*	*0.0248*
Region 2	*0.028*	*0.0302*

iii) Material characteristics, including porosity, density and dimensions;

The porosity is not available. BORAL® is clad with type 1100 aluminum sheets. After a search of the BVPS Unit 1 plant records, including docketed information, it was determined that the requested porosity information was not part of the original licensing basis or previously requested by the NRC as part of the licensing action that approved the neutron absorber monitoring program. The following are the available material characteristics.

Density:
1100 Aluminum: 2.713 grams per cubic centimeter (g/cc);
Boron Carbide: 2.51 g/cc

Dimensions (nominal):
Thickness: Region 1: 0.084 inches (in.) - Region 2: 0.098 in.
Width: 7.5 in.
Length: 144 in.

c. Qualification testing approach for compatibility with the SFP environment and results from the testing;

For qualification testing, a hot water soak test was performed on coupons that are representative of manufactured BORAL® plates to uncover any blistering or swelling that the BORAL® plates may experience in the water environment at elevated temperatures. At least two coupons from each

lot of BORAL® were immersed in demineralized water at 150 degrees Fahrenheit (°F) for at least 45 days, then were examined for evidence of swelling (change in thickness), delaminations, and water absorption and oxidation (change in weight). Testing results showed that the maximum change in thickness was 3.04%, and the maximum change in weight (after drying) was 0.75%.

d. Configuration in the SFP, such as:

i) Method of integrating neutron-absorbing material into racks (e.g. inserts, welded in place, spot welded in place, rodlets); and

The neutron absorber is contained in die formed "picture frame sheathing" that is attached to the spent fuel storage walls with skip welds. BVPS Unit 1 racks are arranged in two regions in the SFP. Region I racks have a water flux trap (gap) between two BORAL® plates (two storage cells), where Region 2 racks have a single BORAL® plate between the walls of adjacent storage cells.

ii) Sheathing and degree of physical exposure of neutron-absorbing materials to the SFP environment;

The BORAL® plates are contained in a sheathing that is vented to the spent fuel pool water. BORAL® is a rolled product consisting of a thin (approximately 0.01 inch thick) skin of aluminum, sandwiching a compressed cermet core made from aluminum and boron carbide powder. The skin protects the core but the edges are open to the environment.

e. Current condition of the credited neutron-absorbing material in the SFP, such as:

i) Estimated current minimum areal density;

No loss mechanisms have been identified to date. The most recently evaluated coupons were retrieved in 2011, and that coupon evaluation showed an average average boron-10 loading areal density of 0.0262 g/cm^2 for the Region 1 coupons and an average areal density of 0.0322 g/cm^2 for the Region 2 coupons.

ii) Current credited areal density of the neutron-absorbing material in the NCS AOR; and

The credited areal density of boron-10 is 0.0248 g/cm^2 for Region 1 and 0.0302 g/cm^2 for Region 2. A reactivity penalty was applied in the NCS AOR to account for manufacturing tolerances in the BORAL material.

iii) Recorded degradation and deformations of the neutron-absorbing material in the SFP (e.g. blisters, swelling, gaps, cracks, loss of material, loss of neutron-attenuation capability).

The following table summarizes the coupon visual inspection. There has been no identified loss of neutron attenuation capability. All tested coupons have met the surveillance criterion of less than a 5% decrease in boron-10 areal density and less than 10% increase in thickness at any point.

Year Coupon Tested	Noted Discrepancies
1996	Numerous lighter color area were noted (0.5 to 1.5 centimeters (cm) in diameter) with what appears to be a small corrosion pit (2 to 4 millimeters (mm) across) in the center. Localized pitting were primarily attributed to contamination of high chloride oil during the coupon manufacturing process.
1998	Similar pitting was noted. Lighter color area is believed to be an aluminum oxide film.
2002	In addition to pitting noted in the past, heavier oxide deposits were noted along the coupon edges. Also noted some swelling along the edge where heavy oxidation occurred. Few small blisters were also noted along the edge.
2007	In addition to similar findings in the past, multiple blisters (0.2 to 1 inch diameter) were discovered (22 to 29 blisters, per each side). Blisters grew in height and area after drying at 300°F and 500°F. Blisters were formed typically along the edge on both front and back of the coupon.
2011	Only pitting and the edge oxidation is noted. No blisters were found as received condition; however, a few blisters formed after drying at high temperatures.

2. **Describe the surveillance or monitoring program used to confirm that the credited neutron-absorbing material is performing its safety function, including the frequency, limitations, and accuracy of the methodologies used.**

   a. **Provide the technical basis for the surveillance of monitoring method, including a description of how the method can detect degradation mechanisms that affect the material's ability to perform its safety function. Also, include a description and technical basis for the technique(s) and the method(s) used in the surveillance or monitoring program, including:**

      i) **Approach used to determine frequency, calculations, and sample size;**

      The coupon surveillance program is based on measurements performed on the coupons and not calculations. The frequency of inspections (visual, coupons, or in-situ) was initially determined based on qualification testing of the neutron absorber material prior to first use, which typically includes accelerated corrosion testing at higher temperature. The qualification testing inspection frequency for new neutron absorber materials was established between two and five years. As operational experience of the neutron absorber was gathered and actual in-service experience was obtained, subsequent licensees were allowed to have less frequent inspection intervals. BVPS Unit 1 employs the coupon surveillance program, which uses coupon trees with test coupons taken from the same lot as that used for construction of the rack. One coupon per region is removed and analyzed per the vendor recommended interval. However, the monitoring frequency was increased based on the results from previous analysis, which showed a potential blistering issue with the BORAL® plates.

      ii) **Parameters to be inspected and data collected;**

      - Visual Observation and Photography
      - Neutron Attenuation
      - Dimensional Measurements (length, width and thickness)
      - Weight and Specific Gravity

iii) Acceptance criteria of the program and how they ensure that the material's structure and safety function are maintained within the assumptions of the NCS AOR;

Of the measurements to be performed on the Boral surveillance coupons, the most important are: 1) neutron attenuation measurements to verify the continued presence of the boron; and 2) the thickness measurement as a monitor of potential swelling. The acceptance criteria for these measurements are as follows: 1) less than 5% decrease in boron-10 content, as determined by neutron attenuation; and 2) less than 10% increase in thickness at any point. These criteria conform to the assumptions of the NCS AOR.

iv) Monitoring and trending of the surveillance or monitoring program data; and

Test results of surveillance coupons are evaluated against acceptance criteria in accordance with the FENOC monitoring program procedure NOP-NF-3201. In addition, it is standard practice to compare the test results from previous surveillance coupons to determine if there are any adverse trends. To date, there have been no adverse trends identified for BVPS Unit 1.

v) Industry standards used

American Society for Testing Materials (ASTM) C992, "Specification for Boron-Based Neutron Absorbing Material Systems for Use in Nuclear Spent Fuel Storage Racks"

b. For the following monitoring methods, include these additional discussion items:

i) If there is visual inspection of in-service material:

Not Applicable – visual inspection is not currently required; however, sample coupons are visually inspected when the surveillance is performed.

ii) If there is a coupon-monitoring program:

1) Provide a description and technical basis for how the coupons are representative of the material in the racks. Include in the discussion the material radiation exposure levels, SFP environment conditions, exposure to the SFP water, location of the coupons, configuration of the coupons (e.g., jacketing or sheathing, venting bolted on, glued on, or free in the jacket, water flow past the material, bends, shapes, galvanic considerations, and stress-relaxation considerations), and dimensions of the coupons;

Coupons have been manufactured from the same lot of material used to manufacture panels for the SFP. Prior to insertion in the pool, the surveillance coupons are pre-characterized for weight, dimensions (especially thickness), and neutron attenuation to provide reference initial values for comparison with measurements made after irradiation. Coupons are jacketed with stainless sheet (same material as storage cell sheathing) to simulate actual in-service conditions of the plates. Coupons are suspended on a mounting (called a "tree") that is placed in a designated cell, and surrounded by spent fuel. To assure that the coupons will have experienced a slightly higher radiation dose than the panels in the racks, the coupon tree was surrounded by freshly discharged fuel assemblies at each of the first seven refuelings following installation of the racks. Beginning with the eighth refueling, the coupons will continue to be surrounded by discharged fuel.

The surveillance program utilizes two types of coupons, each approximately 7 inches wide and 14 inches long. The Region 1 coupons are 0.084 inches thick nominal, and the Region 2 coupons are 0.098 inches thick nominal.

2) Provide the dates of coupon installation for each set of coupons;

The BVPS Unit 1 SFP re-racking was completed in June 1994. Coupon trees were installed as part of the re-racking project.

3) **If the coupons are returned to the SFP for further evaluation, provide the technical justification for why the reinserted coupons would remain representative of the materials in the rack; and**

Not Applicable – the coupons are not returned to SFP upon removal for analysis.

4) **Provide the numbers of coupons remaining to be tested and whether there are enough coupons for testing for the life of the SFP. Also provide the schedule for coupon removal and testing.**

Initially 10 coupons per region were inserted in the BVPS Unit 1 SFP, and there are five coupons remaining per region as of 2016. Unit 1 has received a license extension to operate to January 2036. The following table shows the scheduled coupon testing. Years pertains to sample analysis year. Based on this schedule, there are at least three extra coupons per region available for testing after the Unit 1 operating license expires.

Sample Year	Coupon testing	Sample
1996	One Region 1/One Region 2	Completed
1998	One Region 1/One Region 2	Completed
2002	One Region 1/One Region 2	Completed
2007	One Region 1/One Region 2	Completed
2011	One Region 1/One Region 2	Completed
2019	One Region 1/One Region 2	Projected
2027	One Region 1/One Region 2	Projected
2044	One Region 1/One Region 2	Projected

iii) **If RACKLIFE is used:**

Not applicable - RACKLIFE® is not used.

iv) **If in-situ testing with a neutron source and detector is used (e.g., BADGER testing, blackness testing):**

Not Applicable – In-situ testing is not currently performed.

3. **For any Boraflex, Carborundum, or Tetrabor being credited, describe the technical basis for determining the interval of surveillance or monitoring for the credited neutron-absorbing material. Include a justification of why the material properties of the neutron-absorbing material will continue to be consistent with the assumptions in the SFP NCS AOR between surveillances or monitoring intervals.**

   Not Applicable – BORAL® neutron absorber racks are used.

4. **For any Boraflex, Carborundum, Tetrabor, or BORAL® being credited, describe how the credited neutron-absorbing material is modeled in the SFP NCS AOR and how the monitoring or surveillance program ensures that the actual condition of the neutron-absorbing material is bounded by the NCS AOR:**

   a. **Describe the technical basis for the method of modeling the neutron-absorbing material in the NCS AOR. Discuss whether the modeling addresses degraded neutron-absorbing material, including loss of material, deformation of material (such as blisters, gaps, cracks, and shrinkage), and localized effects, such as non-uniform degradation.**

      Although degradation of the neutron absorbing material is not specifically evaluated in the NCS AOR, small reactivity changes associated with manufacturing uncertainties (tolerances) were evaluated, and that evaluation included the manufacturing uncertainties associated with boron-10 areal density. All uncertainties are statistically combined such that the final neutron multiplication factor (K_{eff}) will be equal to or less than 0.95 with 95% probability at a 95% confidence level.

   b. **Describe how the results of the monitoring or surveillance program are used to ensure that the actual condition of the neutron-absorbing material is bounded by the SFP NCS AOR. If a coupon monitoring program is used, provide a description and technical basis for the coupon tests and acceptance criteria used to ensure the material properties of the neutron-absorbing material are maintained within the assumptions of the NCS AOR. Include a discussion on the measured dimensional changes, visual inspection, observed surface corrosion, observed degradation or deformation of the material (e.g., blistering, bulging, pitting, or warping), and neutron-attenuation measurements of the coupons.**

The surveillance program is designed to monitor performance of the absorber material without disrupting the integrity of the storage system. Representative coupon samples are primarily measured for the thickness and neutron attenuation, such that there is a reliable indication that the BORAL® plates in the racks continue to perform their intended function. Two acceptance criteria used to ensure there is no degradation to BORAL® are: 1) a decrease of no more than 5% in boron-10 content (as determined by neutron attenuation); and 2) an increase in thickness at any point should not exceed 10% of the initial thickness. These acceptance criteria ensure that there is no loss in boron within the accuracy of the measurements. The 5% acceptance criteria on boron-10 content is within the AOR uncertainty for nominal versus minimum boron-10 areal density, which is greater than 7%.

c. **Describe how the bias and uncertainty of the monitoring or surveillance program are used in the SFP NCS AOR.**

The bias and uncertainty of the surveillance program is not included in the NCS AOR.

d. **Describe how the degradation in the adjacent panels is correlated and accounted for in the NCS AOR.**

The correlation of degraded adjacent panels are not accounted for in the NCS AOR.

5. **For any Boraflex, Carborundum, or Tetrabor being credited, describe the technical basis for concluding that the safety function for the credited neutron-absorbing material in the SFP will be maintained during design-basis events (e.g., seismic events, loss of SFP cooling, fuel assembly drop accidents, and any other plant-specific design-basis events that may affect the neutron-absorbing material).**

Not Applicable – BORAL® neutron absorber racks are used.

The requested information from Generic Letter 2016-01, Appendix A, "Guidance for Category 4 Responders to Generic Letter 2016-01," is presented in bold type, followed by the FirstEnergy Nuclear Operating Company (FENOC) response for the Beaver Valley Power Station (BVPS), Unit 2. Some of the requested information may not be provided, since it is not available and this is acceptable as documented in the September 10, 2015 NRC public meeting with the Nuclear Energy Institute (NEI) and the industry.

1. **Describe the neutron-absorbing material credited in the spent fuel pool (SFP) nuclear criticality safety (NCS) analysis of record (AOR) and its configuration in the SFP, including the following:**

   a. **Manufacturers, dates of manufacture, and dates of material installation in the SFP;**

      The Metamic™ neutron absorber panels that are used in BVPS Unit 2 were manufactured by Nanotec Metals Inc., division of Holtec International, between July – November 2008. The first rack with Metamic™ panels was installed in January 2012 with the the last rack installed in August 2013.

   b. **Neutron-absorbing material specifications, such as:**

      i) **Materials of construction, including the certified content of the neutron-absorbing component expressed as weight percent;**

         Metamic™ is a metal matrix composite consisting of a Type 6061 aluminum alloy, reinforced with Type 1 ASTM C-750 boron carbide. It is characterized by extremely fine aluminum (325 mesh or smaller) and boron carbide powder. Typically, the average boron carbide particle size is between 10 and 40 microns. Particles are solidified into a metal matrix composite structure by the powder metallurgy process. Nominal boron carbide loading is 30.5%.

ii) Minimum certified, minimum as-built, maximum as-built and nominal as-built areal density of the neutron-absorbing component; and

The minimum certified and as-built values are not provided by the vendor. Nanotec Metals Inc. has provided a certificate of compliance for the panels used in BVPS Unit 2 spent fuel racks and has certified that the products meet the dimensional and boron carbide loading requirements.

iii) Material characteristics, including porosity, density and dimensions;

Metamic™ is a porosity-free material.

The spent fuel rack of Metamic™ plate has a nominal boron-10 areal density of 0.031 g/cm^2

Dimensions (nominal):
Thickness: 0.106 inches (in.)
Width: 7.5 in.
Length: 146 in.

c. Qualification testing approach for compatibility with the SFP environment and results from the testing;

Metamic™ has been subjected to testing that mimics the conditions that the material may be exposed to during its service. The testing includes following:

1. Accelerated radiation testing at exposures up to 1.5×10^{11} rads gamma
2. Accelerated corrosion testing (195°F) for times in excess of one year
3. Neutron transmission testing of coupons before and after corrosion testing
4. Short term (48 hour) elevated temperature (900°F) testing
5. Long term elevated temperature (750°F) testing for times in excess of one year
6. Mechanical properties testing at temperatures up to 900°F

Test results:
Metamic™ maintains its physical and neutron absorption properties with little variation in its properties from the unirradiated state. The main conclusions in EPRI Report 1003137, "Qualification of METAMIC® for Spent Fuel Storage Application," which endorsed Metamic™ for dry and wet storage applications on a generic basis, are summarized below:

- The metal matrix configuration produced by the powder metallurgy process with almost a complete absence of open porosity in Metamic™ ensures that its density is essentially equal to the theoretical density.
- No detectable change in the neutron attenuation characteristics under accelerated corrosion test conditions has been observed.

d. Configuration in the SFP, such as

i) Method of integrating neutron-absorbing material into racks (e.g. inserts, welded in place, spot welded in place, rodlets); and

Metamic™ plates (sheets) are placed between the cells of the storage racks via stainless steel sheathing located on each external side of the cell. Sheathings are attached to the box (cell) using skip welds and spot welds. Composite cells are then arranged in a checkerboard array and welded to form a fuel rack.

ii) Sheathing and degree of physical exposure of neutron-absorbing materials to the SFP environment;

Metamic™ plates are completely enclosed in the sheathing, which is vented to the SFP environment.

e. Current condition of the credited neutron-absorbing material in the SFP, such as:

i) Estimated current minimum areal density;

A Metamic™ sample coupon was retrieved and analyzed in February 2016. Neutron attenuation testing results indicate no loss of boron-10 areal density. Therefore, current estimated boron-10 areal density is the same as when the material was fabricated and installed in SFP.

ii) Current credited areal density of the neutron-absorbing material in the NCS AOR; and

As addressed in the response to Item 1.b.ii, the minimum specified boron-10 areal density is not available. In order to account for measurement uncertainty, a 5% reduction in density is applied in the NCS AOR. Only the minimum tolerance is used since this results in an increase in reactivity.

iii) Recorded degradation and deformations of the neutron-absorbing material in the SFP (e.g. blisters, swelling, gaps, cracks, loss of material, loss of neutron-attenuation capability).

No degradation or deformation was observed with the one coupon tested to date.

2. Describe the surveillance or monitoring program used to confirm that the credited neutron-absorbing material is performing its safety function, including the frequency, limitations, and accuracy of the methodologies used.

a. Provide the technical basis for the surveillance of monitoring method, including a description of how the method can detect degradation mechanisms that affect the material's ability to perform its safety function. Also, include a description and technical basis for the technique(s) and method(s) used in the surveillance or monitoring program, including:

i) Approach used to determine frequency, calculations, and sample size;

The coupon surveillance program is based on measurements performed on the coupons and not calculations. The frequency of inspections (visual, coupons, or in-situ) was initially determined based on qualification testing of the neutron absorber material prior to first use, which typically includes accelerated corrosion testing at higher temperature. Based upon qualification testing, inspections for new neutron absorber materials were established on a relatively frequent basis, between two and five years. As operational experience of the neutron absorber was gathered, and actual in-

service experience was obtained, subsequent licensees were allowed to have less frequent inspection intervals.
BVPS Unit 2 employs the coupon surveillance program, which uses a tree with test coupons taken from the same lot as that used for construction of the rack. One coupon is removed and analyzed per the vendor recommended interval.

ii) Parameters to be inspected and data collected;

- Visual Observation and Photography
- Neutron Attenuation
- Dimensional Measurements (length, width and thickness)
- Weight and Specific Gravity

iii) Acceptance criteria of the program and how they ensure that the material's structure and safety function are maintained within the assumptions of the NCS AOR;

Two acceptance criteria are: 1) less than 5% decrease in boron-10 content, as determined by neutron attenuation; and 2) less than 10% increase in thickness at any point. These criteria conform to the assumptions of the NCS AOR.

iv) Monitoring and trending of the surveillance or monitoring program data; and

Test results of surveillance coupons are evaluated against acceptance criteria in accordance with the FENOC monitoring program procedure NOP-NF-3201. In addition, it is standard practice to compare the test results from previous surveillance coupons to determine if there are any adverse trends. To date, there have been no adverse trends identified for BVPS Unit 2.

v) Industry standards used.

- ASTM E-2971-14 "Standard Test Method for Determination of Effective Boron-10 Areal Density in Aluminum Neutron Absorbers using Neutron Attenuation Measurements"
- ASTM C1187-15, "Standard Guide for Establishing Surveillance Test Program for Boron-Based Neutron Absorbing Material Systems for Use in Nuclear Fuel Storage Racks"

- ASTM C992-89, "Standard Specification for Boron-Based Neutron Absorbing Material Systems for Use in Nuclear Spent Fuel Storage Racks"

b. For the following monitoring methods, include these additional discussion items

i) If there is visual inspection of in-service material:

Not Applicable – visual inspection is not currently required; however, sample coupons are visually inspected when the surveillance is performed.

ii) If there is a coupon-monitoring program:

1. Provide a description and technical basis for how the coupons are representative of the material in the racks. Include in the discussion the material radiation exposure levels, SFP environment conditions, exposure to the SFP water, location of the coupons, configuration of the coupons (e.g., jacketing or sheathing, venting bolted on, glued on, or free in the jacket, water flow past the material, bends, shapes, galvanic considerations, and stress-relaxation considerations), and dimensions of the coupons;

Coupons have been manufactured from the same lot of material used to manufacture panels for the SFP. Coupons are then jacketed in stainless steel sheet to simulate actual panel conditions. The surveillance coupons are pre-characterized for weight, dimensions (especially thickness) and boron-10 loading, prior to insertion in the pool, to provide reference initial values for comparison with measurements made after irradiation. Coupons are suspended on a mounting (called a "tree") that is placed in a designated cell, and surrounded by spent fuel. To assure that the coupons will have experienced a slightly higher radiation dose than the Metamic™ in the racks, at least one location adjacent to the coupon tree is loaded with freshly-discharged fuel assemblies after each refueling outage for the life of the racks. At the time of the first fuel offload following installation of the coupon tree, one of the four

storage cells surrounding the tree shall be loaded with a discharged fuel assembly, which is not scheduled to be returned to the core. Coupons are nominally 6 inches wide by 8 inches tall with 0.106 inch thickness.

2. **Provide the dates of coupon installation for each set of coupons;**

As of 2016, there is one coupon tree with 15 coupons (originally 16) in the BVPS Unit 2 SFP. The BVPS Unit 2 Metamic™ surveillance program became effective on September 28, 2012.

3. **If the coupons are returned to the SFP for further evaluation, provide the technical justification for why the reinserted coupons would remain representative of the materials in the rack; and**

Not Applicable – coupons are not returned to the SFP upon removal for analysis.

4. **Provide the numbers of coupons remaining to be tested and whether there are enough coupons for testing for the life of the SFP. Also provide the schedule for coupon removal and testing.**

Initially 16 coupons were inserted in the BVPS Unit 2 SFP, and there are 15 coupons remaining as of 2016. Unit 2 has received an operating license extension to May 2047. The following table shows the scheduled coupon testing. The year pertains to sample analysis year and based on this schedule, there are at least seven extra coupons past the current Unit 2 operating license.

Year	Coupon Testing	Status
2014	1	Completed
2016	1	Planned
2018	1	Projected
2020	1	Projected
2022	1	Projected
2027	1	Projected

2032	1	Projected
2037	1	Projected
2042	1	Projected
2052	1	Projected

iii) If RACKLIFE is used:

Not Applicable – RACKLIFE® is not used.

iv) If in-situ testing with a neutron source and detector is used (e.g., BADGER testing, blackness testing):

Not Applicable – In-situ testing is not currently performed.

3. **For any Boraflex, Carborundum, or Tetrabor being credited, describe the technical basis for determining the interval of surveillance or monitoring for the credited neutron-absorbing material. Include a justification of why the material properties of the neutron-absorbing material will continue to be consistent with the assumptions in the SFO NCS AOR between surveillances or monitoring intervals.**

Not Applicable - Metamic™ neutron absorber racks are used.

4. **For any Boraflex, Carborundum, Tetrabor, or Boral being credited, describe how the credited neutron-absorbing material is modeled in the SFP NCS AOR and how the monitoring or surveillance program ensures that the actual condition of the neutron-absorbing material is bounded by the NCS AOR:**

   a. **Describe the technical basis for the method of modeling the neutron-absorbing material in the NCS AOR. Discuss whether the modeling addresses degraded neutron-absorbing material, including loss of material, deformation of material (such as blisters, gaps, cracks, and shrinkage), and localized effects, such as non-uniform degradation.**

   b. **Describe how the results of the monitoring or surveillance program are used to ensure that the actual condition of the neutron-absorbing material is bounded by the SFP NCS AOR. If a coupon monitoring program is used, provide a description and technical basis for the coupon tests and acceptance criteria used to ensure the material properties of the neutron-absorbing material are maintained within the assumptions of the NCS AOR. Include a discussion on the**

measured dimensional changes, visual inspection, observed surface corrosion, observed degradation or deformation of the material (e.g., blistering, bulging, pitting, or warping), and neutron-attenuation measurements of the coupons.

c. **Describe how the bias and uncertainty of the monitoring surveillance program are used in the SFP NCS AOR.**

d. **Describe how the degradation in the adjacent panels is correlated and accounted for in the NCS AOR.**

Not Applicable - Metamic™ neutron absorber racks are used.

5. **For any Boraflex, Carborundum, or Tetrabor being credited, describe the technical basis for concluding that the safety function for the credited neutron-absorbing material in the SFP will be maintained during design-basis events (e.g., seismic events, loss of SFP cooling, fuel assembly drop accidents, and any other plant-specific design-basis events that may affect the neutron-absorbing material).**

Not Applicable - Metamic™ neutron absorber racks are used.