FENOC™
FirstEnergy Nuclear Operating Company

Perry Nuclear Power Plant
PO Box 97
10 Center Road
Perry, Ohio 44081

David B. Hamilton
Vice President

440-280-5382

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10 CFR 50.54

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

SUBJECT:
Perry Nuclear Power Plant
Docket Number 50-440, License Number NPF-58
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 Perry Nuclear Power Plant (PNPP), which has been determined to be a Category 4 licensee 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. PNPP uses BORAL® as a neutron absorber and uses two types of fuel storage racks, low and high density. PNPP's low density fuel racks do not use BORAL® as a neutron absorber, since geometry is used to maintain subcriticality. However, the high density fuel racks use BORAL® as a neutron-absorber. Therefore, PNPP is required to provide the information requested in Areas 1, 2 and 4 of Table 1 of Generic Letter 2016-01 for the high density fuel racks. The response is attached.

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 19, 2016.

Sincerely,

David B. Hamilton

Attachment:
PNPP Response to Generic Letter 2016-01, "Monitoring of Neutron-Absorbing Materials in Spent Fuel Pools"

cc: NRC Region III Administrator
NRC Resident Inspector
NRC Project Manager

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 Perry Nuclear Power Plant (PNPP).

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;**

      Brooks and Perkins Inc. fabricated the neutron-absorbing BORAL® panels, which were assembled into the high density spent fuel racks by Programmed and Remote (PaR) Systems Corporation. The spent fuel racks were manufactured from 1979 to 1981 and initially installed in March – April 1982. The spent fuel racks were subsequently removed, cleaned, and reinstalled in September - October 1984. For reference, the operating license for PNPP was issued in March 1986 and commercial operation commenced in November 1987.

   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 material composition information provided below is as documented within the manufacturer's fabrication specification, which was not necessarily expressed as weight percentages.

         - Clad material of 1100 alloy aluminum per ASTM B209, "Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate"

- Aluminum core binder material meeting the following chemical limits:
  - Iron 0.25% maximum
  - Silicon 0.15% maximum
  - Titanium 0.20% maximum
  - Other Elements 0.03% maximum each, 0.15% maximum total
  - Remainder 99.25% minimum aluminum (0.20% may be aluminum oxide)
- Boron carbide material shall meet the requirements of ASTM C-750-74, "Standard Specification for Nuclear-Grade Boron Carbide," Type 2, Nuclear Grade Boron Carbide Powder, except that:
  - Total boron and carbon content allowed is 95% by weight minimum
  - Total boron is 70.0 to 79.2% and
  - Boron-10 isotopic content in the boron is 19.75% + 1.0%

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

The specified minimum boron-10 areal density loading is 0.0233 gram per square centimeter (gm/cm^2).

No as-built or certified material documents, beyond the specifications previously provided were located. However, although not specified as a minimum and maximum as-built or nominal value, the neutron-absorber panel quality assurance specification did specify inspection testing results that listed the mean coupon boron-10 density as 0.02509 gm/cm^2 with a standard deviation of 0.00089 and a 95% minimum of 0.02361 gm/cm^2.

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

The material characteristics of porosity, density and dimensions for the BORAL® panels, as listed in the manufacturer's fabrication specifications, are provided below.

Porosity was not specified within the fabrication specification and therefore is not available.

The minimum specified areal density is 0.0233 gm/cm^2 boron-10 loading.

The dimensions for thickness, width and length are as follows:

- Mean thickness is 0.08033 inches with a standard deviation of 0.00271
- Width is 5.25 + 0.0625 – 0.03125 inches
- Length is 152 $\pm$ 0.15625 inches

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

The BORAL® panels are not in contact with the spent fuel pool (SFP) water, but are exposed to the gamma and neutron flux present in the SFP. The specifications for fabrication testing of the BORAL® panels are quoted below.

> Prior to joining the inner and outer cans [square tubes] to form a poison canister, the inner can shall be pressure leak tested with air to 4 pounds per square inch (psi) minimum. The pressure shall be maintained for a minimum of one minute before applying a low chloride (less than 2 parts-per-million (PPM) chlorides) bubble forming solution to the seam welds. The formation of bubbles shall be considered an indication of a leak, which shall be repaired and then retested. After final assembly of the poison canister, the cavity weldments shall again be pressure leak tested with nitrogen to 4 psi minimum. The pressure shall be maintained for a minimum of one minute before applying a low chloride (less than 2 PPM chlorides) bubble forming solution to the welds and any leaks shall be repaired and then retested.
>
> The final closure weld after leak testing shall be examined by the liquid penetrant method in accordance with Article 6, Section V of the ASME Boiler and Pressure Vessel Code. Acceptance criteria shall be as specified in Section III, Subsection NB-5350 of the ASME Boiler and Pressure Vessel Code.
>
> The largest span rack module shall be tested by dropping on a central grid intersection a weight having an impact

equivalent of a 700 pound channeled fuel bundle dropped from a height of seven feet. The purpose of the test is to demonstrate that this postulated accident will not cause the fuel configuration to attain an effective neutron multiplication factor (K_{eff}) of 0.95. This test was more severe than the test required by the specification. The test concluded that the nuclear reactivity will not increase due to the dropped fuel bundle test and the rack will maintain a safe fuel configuration of less than K_{eff} 0.95.

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 canister consists of two concentric square tubes with the BORAL® neutron-absorber panels located in the annular gap. The outer tube is folded into the inner tube at the ends and totally seal welded to isolate the BORAL® panels from the SFP water.

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

The BORAL® panels are not in contact with the SFP water, but are exposed to the gamma and neutron flux present in the SFP.

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

i) Estimated current minimum areal density;

No loss mechanisms for BORAL® panels have been identified to date; therefore, the minimum boron-10 loading areal density is estimated to remain as 0.0233 gm/cm^2.

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

The current credited boron-10 areal density is 0.01856 gm/cm^2.

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 loss mechanisms for BORAL® panels have been identified 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 or 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;**
ii) **Parameters to be inspected and data collected;**
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;**
iv) **Monitoring and trending of the surveillance or monitoring program data; and**
v) **Industry standards used.**

The PNPP does not have neutron-absorber coupons in the SFP but does comply with the FENOC spent fuel storage rack neutron-absorber monitoring program, which consists of the following three elements.

1. Industry Engagement – This requires tracking, analyzing and incorporating industry operating experience. Industry operating

experience has not indicated any degradation of BORAL® neutron-absorber reactivity effectiveness. Industry engagement with the plants with longer operating history provides reasonable assurance that issues involving the effectiveness of encapsulated BORAL® panels can be recognized and dispositioned.

2. Coupon Surveillance – These requirements do not apply to PNPP.

3. Storage Rack Boron-10 Measurements – These requirements do not apply to PNPP.

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

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

Detailed visual inspections to identify specific degradation mechanisms have not been performed.

ii) If there is a coupon-monitoring program:

Not Applicable – coupons are not installed at PNPP.

iii) If RACKLIFE is used:

Not Applicable – RACKLIFE is only applicable to the Boraflex® neutron-absorber material, and therefore is not applicable to PNPP.

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 performed at PNPP.

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 – BORAL® neutron-absorber racks are used at PNPP.

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.**

      There are no currently observed mechanisms for loss of neutron-absorber material in BORAL® panels. Therefore, panel degradation is not included in the NCS AOR. However, the PNPP NCS AOR includes conservative assumptions, since the width and thickness of the absorber panels are incorporated as below the nominal value specified by the panel manufacturer. The manufacturer specified the minimum value of width as 5.21875 inches and the nominal value of width as 5.25 inches. The original criticality analysis used a width of 5.120 inches, and the current criticality analysis uses a width of 90% of the 5.25 inches nominal value, or 4.725 inches. Also, the density of boron-10 is reduced by 20% from the minimum value specified by the panel manufacturer.

   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 PNPP does not have neutron-absorber coupons in the SFP for monitoring. PNPP does comply with the FENOC spent fuel storage rack neutron-absorber monitoring program, which consists of the following three elements.

1. Industry Engagement – This requires tracking, analyzing and incorporating industry operating experience. Industry operating experience has not indicated any degradation of BORAL® neutron-absorber reactivity effectiveness. Industry engagement with the plants with longer operating history provides reasonable assurance that issues involving the effectiveness of encapsulated BORAL® panels can be recognized and dispositioned.

2. Coupon Surveillance – These requirements do not apply to PNPP.

3. Storage Rack Boron-10 Measurements – These requirements do not apply to PNPP.

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

No quantitative boron-10 areal density monitoring, either via in situ blackness testing or using coupons, is performed. Therefore, no such biases or uncertainties associated with monitoring exist or are reflected in the SFP NCS AOR.

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

There are no currently observed mechanisms for loss of neutron-absorber material in BORAL® panels. Therefore, panel degradation is not included in the NCS AOR. However, the PNPP NCS AOR includes conservative assumptions, since the width and thickness of the absorber panels are incorporated as below the nominal value specified by the panel manufacturer. Per the manufacturer's specification, the minimum value of width = 5.21875 inches and the nominal value of width = 5.25 inches. The original criticality analysis used a value of width of 5.120 inches and the current criticality analysis uses a width value of 90% of the 5.25 inches nominal value, which is 4.725 inches. Also, the density of boron-10 is reduced by 20% from the minimum value specified by the panel manufacturer.

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 panels are used at PNPP.