WOLF CREEK
NUCLEAR OPERATING CORPORATION

Jaime H. McCoy
Vice President Engineering

November 2, 2016

ET 16-0024

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

Subject: Docket No. 50-482: Response to NRC Generic Letter 2016-01, "Monitoring of Neutron-Absorbing Materials in Spent Fuel Pools"

Gentlemen:

Nuclear Regulatory Commission (NRC) Generic Letter (GL) 2016-01, "Monitoring of Neutron-Absorbing Materials in Spent Fuel Pools," dated April 7, 2016, was issued to all power reactor licensees except those that have permanently ceased operation with all power reactor fuel removed from onsite spent fuel pool (SFP) storage. The NRC has issued GL 2016-01 for two purposes:

1) To request that addressees submit information, or provide references to previously docketed information, which demonstrates that credited neutron-absorbing materials in the SFP of power reactors and the fuel storage pool, reactor pool, or other wet locations designed for the purpose of fuel storage, as applicable, for non-power reactors, are in compliance with the licensing and design basis, and with applicable regulatory requirements; and that there are measures in place to maintain this compliance.

2) To collect the requested information and determine if additional regulatory action is required.

Wolf Creek Generating Station (WCGS) has been determined to be a Category 4 licensee in accordance with GL 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 SFP. The WCGS SFP credits Boral. Therefore, Wolf Creek Nuclear Operating Corporation (WCNOC) is required to provide information in the following areas: 1, 2, and 4 as described in Appendix A of GL 2016-01.

The NRC requested that licensees submit a written response consistent with the information requested in GL 2016-01 within 210 days of the date of the GL. In accordance with 10 CFR 50.54(f), the Attachment to this letter contains WCNOC's responses to the information requested in GL 2016-01.

A158
NRR

This letter contains no commitments. If you have any questions concerning this matter, please contact me at (620) 364-4156, or Cynthia R. Hafenstine (620) 364-4204.

Sincerely,

Jaime H. McCoy

JHM/rlt

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

cc: K. M. Kennedy (NRC), w/a
B. K. Singal (NRC), w/a
N. H. Taylor (NRC), w/a
Senior Resident Inspector (NRC), w/a

STATE OF KANSAS)
) SS
COUNTY OF COFFEY)

Jaime H. McCoy, of lawful age, being first duly sworn upon oath says that he is Vice President Engineering of Wolf Creek Nuclear Operating Corporation; that he has read the foregoing document and knows the contents thereof; that he has executed the same for and on behalf of said Corporation with full power and authority to do so; and that the facts therein stated are true and correct to the best of his knowledge, information and belief.

By _____
Jaime H. McCoy
Vice President Engineering

SUBSCRIBED and sworn to before me this 1st day of November, 2016.

STATE OF KANSAS NOTARY PUBLIC
GAYLE SHEPHEARD
My Appointment Expires
July 24, 2019

_____
Notary Public

Expiration Date 7/24/2019

WCNOC Response to Generic Letter 2016-01, "Monitoring Neutron-Absorbing Materials in Spent Fuel Pools"

Below is Wolf Creek Nuclear Operating Corporation's (WCNOC) response to Nuclear Regulatory Commission (NRC) Generic Letter (GL) 2016-01, "Monitoring of Neutron-Absorbing Materials in Spent Fuel Pools," dated April 7, 2016. Each of the five areas of requested information from Appendix A to GL 2016-01 is provided in italics followed by WCNOC's response in that area.

NRC Requested Information Area 1:

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;*

   b) *neutron-absorbing material specifications, such as:*

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

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

      iii) *material characteristics, including porosity, density, and dimensions;*

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

   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*

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

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

      i) *estimated current minimum areal density;*

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

      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).*

WCNOC Responses Area 1:

a) Boral is the neutron-absorbing material credited in the SFP NCS AOR for Wolf Creek Generating Station (WCGS). The Boral panels were manufactured by AAR Manufacturing, Inc. (Reference 1). The installation of the SFP racks with the Boral panels was initiated in October 1999 and completed in April 2000 (Reference 2).

After a reasonable search of the plant records, including docketed information, WCNOC has determined that the date of manufacture of the Boral panels was not part of the original licensing basis or previously requested by the NRC as part of the licensing action that approved the installation of the Boral panels in the SFP racks and is not available in current WCNOC documentation.

b) Boral specifications:

i) The Boral in the WCGS SFP racks is made from boron carbide particles embedded in a Type 1100 aluminum matrix clad in Type 1100 aluminum sheets.

Boral is not specified on a weight percent basis of the neutron-absorbing component, therefore this sub-item is not applicable to this material.

ii) The nominal B-10 areal density is 0.0324 g/cm^2. The vendor's manufacturing tolerance limit is $\pm$ 0.0024 g/cm^2 B-10 content. Therefore, minimum B-10 areal density is 0.0300 g/cm^2 and maximum is 0.0348 g/cm^2 (Reference 3).

iii) After a reasonable search of the plant records, including docketed information, WCNOC has determined that the porosity of the Boral was not part of the original licensing basis or previously requested by the NRC as part of the licensing action that approved the installation of the Boral panels in the SFP racks and is not available in current WCNOC documentation. The Boral panels are 145 x 7.5 x 0.101 inches (Reference 3). The Boral density is 2.639 g/cm^3 (Reference 3).

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

When the license amendment for the use of Boral was issued in 1999 the NRC did not request any qualification testing specific to WCGS prior to its use (Reference 4). Subsequently, EPRI performed several studies to determine how Boral reacts to the SFP environment over a long period of time (References 5, 6, and 7). These studies have shown that:

- There have been no surveillance data or observed cases where there has been significant loss or redistribution of B-10 from Boral.
- No mechanisms have been identified or observed that would lead to severe degradation of the Boral core material.
- No mechanisms have been identified that would lead to a sudden loss or reconfiguration of the Boral core material.

These considerations demonstrate that Boral has met all the criticality safety performance requirements over its service lifetime to date.

d) Configuration in the SFP:

i) A stainless steel sheathing is spot welded to the rack structure with the Boral panel installed in the sheathing cavity. The panel-sheath construction is vented to prevent buildup of gases within the sheath (Reference 8).

ii) The Boral panels are completely enclosed by the stainless steel sheathing to prevent flow-induced degradation. However, the sheathing is vented in order to prevent deformation from hydrogen gas buildup. SFP water contacts the Boral Panels (Reference 8).

e) Current condition of Boral in the SFP

i) There is no indication that the Boral panels have lost neutron-absorbing material. Therefore, the estimated current minimum areal density is the same as when the Boral was fabricated and installed in the SFP, which is provided in the response to question 1.b.ii.

ii) The credited areal density of the B-10 in the NCS AOR is 0.0300 g/cm^2 (Reference 3).

iii) There are no recorded degradations or deformations of the Boral panels.

NRC Requested Information Area 2:

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 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.

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

i) If there is visual inspection of inservice material:

(1) describe the visual inspection performed on each sample; and

(2) describe the scope of the inspection (i.e., number of panels or inspection points per inspection period).

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;

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

(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

(4) provide the number 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.

iii) If RACKLIFE is used:

(1) note the version of RACKLIFE being used (e.g., 1.10, 2.1);

(2) note the frequency at which the RACKLIFE code is run;

(3) describe the confirmatory testing (e.g., in-situ testing) being performed and how the results confirm that RACKLIFE is conservative or representative with respect to neutron attenuation; and

(4) provide the current minimum RACKLIFE predicted areal density of the neutron-absorbing material in the SFP. Discuss how this areal density is calculated in RACKLIFE. Include in the discussion whether the areal densities calculated in RACKLIFE are based on the actual as-manufactured areal density of each panel, the nominal areal density of all of the panels, the minimum certified areal density, the minimum as-manufactured areal density, or the areal density credited by the NCS AOR. Also discuss the use of the escape coefficient and the total silica rate of Boraflex degradation in the SFP.

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

(1) describe the method and criteria for choosing panels to be tested and include whether the most susceptible panels are chosen to be tested. Provide the statistical sampling plan that accounts for both sampling and measurement error and consideration of potential correlation in sample results. State whether it is statistically significant enough that the result can be extrapolated to the state of the entire pool;

(2) state if the results of the in-situ testing are trended and whether there is repeat panel testing from campaign to campaign;

(3) describe the sources of uncertainties when using the in-situ testing device and how they are incorporated in the testing results. Include the uncertainties outlined in the technical letter report titled "Initial Assessment of Uncertainties Associated with BADGER Methodology," September 30, 2012 (Agencywide Document Access and Management System Accession No. ML12254A064). Discuss the effect of rack cell deformation and detector or head misalignment, such as tilt, twist, offset, or other misalignments of the heads and how they are managed and accounted for in the analysis; and

(4) describe the calibration of the in-situ testing device, including the following:

(a) describe how the materials used in the calibration standard compare to the SFP rack materials and how any differences are accounted for in the calibration and results;

(b) describe how potential material changes in the SFP rack materials caused by degradation or aging are accounted for in the calibration and results; and

(c) if the calibration includes the in-situ measurement of an SFP rack "reference panel," explain the following:

(i) the methodology for selecting the reference panel(s) and how the reference panels are verified to meet the requirements;

(ii) whether all surveillance campaigns use the same reference panel(s); and

(iii) if the same reference panels are not used for each measurement surveillance, describe how the use of different reference panels affects the ability to make comparisons from one campaign to the next.

WCNOC Response Area 2:

WCGS does not have a surveillance or monitoring program for the Boral panels in the SFP.

In March, 1999 the NRC issued Amendment No. 120 to Facility Operating License No. NPF-42 (ADAMS accession number ML022050079). As discussed in its safety evaluation, the NRC noted that the Boral panels that were to be installed in the SFP (and have since been installed) consist of boron carbide particles embedded in an aluminum matrix clad in aluminum. In addition, the Boral panels have vented sheathings to allow any generated hydrogen to escape so as not to cause swelling. The NRC concluded:

> ...the staff finds that the materials in the spent fuel racks, manufactured by Holtec International, are compatible with the environment in the WCGS SFP. These new SFP racks will not undergo material degradation which could affect their ability to safely store spent and new fuel. A vented design of the Boral sheathings prevents the corrosion generated hydrogen from building up pressures which could cause distortion of the fuel cells. The staff concludes, therefore, that all the materials used in the new spent fuel racks are acceptable.

Consistent with the WCGS original licensing basis, and the safety evaluation performed to approve License Amendment No. 120, WCGS does not have a surveillance or monitoring program for the neutron-absorbing material used in the spent fuel racks installed in the SFP. Therefore, the information requested in Area 2 is not applicable.

NRC Requested Information Area 3:

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.*

WCNOC Response Area 3:

The only neutron-absorbing material used in the SFP at WCGS is Boral. Therefore the information requested in Area 3 is not applicable.

NRC Requested Information Area 4:

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 or surveillance program are used in the SFP NCS AOR.*

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

WCNOC Response Area 4:

a) The Boral absorber panels in the SFP are credited in the NCS AOR. The nominal B-10 areal density of the Boral absorber panels is 0.0324 gm/cm^2. The minimum B-10 areal density is 0.0300 gm/cm^2. The NCS AOR conservatively utilizes the minimum B-10 areal density in the Boral panel modeling. There is no allowance or reconciliation of the NCS AOR for the actual condition of the Boral panels. This approach is consistent with the original SER for installation of our SFP racks and NRC regulatory position on Boral at the time (Reference 4).

b) Since WCGS does not have a SFP neutron-absorber monitoring or surveillance program Items b, c, and d are not considered in the WCGS NCS AOR (Reference 3).

NRC Requested Information Area 5:

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).

a) For each design-basis event that would have an effect on the neutron-absorbing material, describe the technical basis for determining the effects of the design-basis event on the material condition of the neutron-absorbing material during the design-basis event, including:

i) shifting or settling relative to the active fuel;

ii) increased dissolution or corrosion; and

iii) changes of state or loss of material properties that hinder the neutron-absorbing material's ability to perform its safety function.

b) Describe how the monitoring program ensures that the current material condition of the neutron-absorbing material will accommodate the stressors during a design-basis event and remain within the assumptions of the NCS AOR, including:

i) monitoring methodology;

ii) parameters monitored;

iii) acceptance criteria; and

iv) intervals of monitoring

WCNOC Response Area 5:

The only neutron-absorbing material used in the SFP at WCGS is Boral. Therefore the information requested in Area 5 is not applicable.

REFERENCES

1. WCNOC Specification C-175A-00002 W01, Procurement Specification for Boral Neutron Absorber Material.

2. WCNOC Work Order 99-206649-000 Spent Fuel Pool Rerack per Design Change Package 07484.

3. WCNOC Document C-175A-00063 W04, Criticality Safety Analysis of the Spent Fuel Storage Racks for Callaway and Wolf Creek Plants.

4. Amendment No. 120 to Facility Operating License No. NPF-42. ADAMS Accession No. ML022050079.

5. EPRI Report 1021052, "Overview of Boral Performance Based Upon Surveillance Coupon Measurements," 2010.

6. EPRI Report 1025204, "Strategy for Managing the Long-Term Use of Boral® in Spent Fuel Storage Pools," 2012.

7. EPRI Report 1019110, "Handbook of Neutron Absorber Materials for Spent Nuclear Fuel Transportation and Storage Applications," 2009.

8. WCNOC Drawing C-175A-00046 W01, Rack Construction Spent Fuel Storage Racks.