Ameren MISSOURI

Callaway Plant

November 3, 2016

ULNRC-06339

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

10CFR50.54(f)

Ladies and Gentlemen:

DOCKET NUMBER 50-483
CALLAWAY PLANT UNIT 1
UNION ELECTRIC CO.
RENEWED FACILITY OPERATING LICENSE NPF-30
GENERIC LETTER 2016-01: "MONITORING OF NEUTRON-ABSORBING MATERIALS IN SPENT FUEL POOLS"
ML16097A169

References: 1. NRC Generic Letter 2016-01, "Monitoring of Neutron-Absorbing Materials in Spent Fuel Pools," Dated April 7, 2016

NRC Generic Letter (GL) 2016-01, "Monitoring of Neutron-Absorbing Materials in Spent Fuel Pools," dated April 7, 2016 was issued pursuant to the requirements of 10 CFR Part 50.54(f). The Generic Letter requests that addressees submit information within 210 days which demonstrates that credited neutron-absorbing materials in the SFP of 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.

The Enclosure of this letter contains the requested information for Callaway Plant.

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This letter does not contain new commitments.

Sincerely,

Sarah Kovaleski

Sarah G. Kovaleski
Director, Engineering Design

JBL

Enclosure: Callaway Response to NRC Generic Letter 2016-01

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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 credited neutron-absorbing material in the Union Electric SFP NCS AOR is Boral (Ref. 1). The Boral was manufactured by AAR (Ref. 1) (also "AAR Manufacturing", "AAR Brooks & Perkins", and "AAR Advanced Structures") and installed in the SFP between January and July of 1999 (Ref. 2). After a reasonable search of plant records, including docketed information, Union Electric has determined that the dates of manufacture of the Boral panels were not part of the original licensing basis or previously requested by the NRC as a part of the licensing action that approved the installation of the neutron absorber.

    b) *neutron-absorbing material specifications, such as:*
        i. *materials of construction, including the certified content of the neutron-absorbing component expressed as weight percent;*

        Boral is a composite material made with 1100 series aluminum clad enclosing an inner core of compacted 1100 series aluminum and boron carbide (B_4C) powders (Ref. 3). It is not specified on a weight percent basis of the neutron-absorbing component; therefore, this sub-area is not applicable.

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

        The nominal B-10 areal density for these Boral panels is 0.0324 g/cm^2 with a certified minimum of 0.0300 g/cm^2 (Ref. 1). Although not utilized in the SFP NCS AOR, the as-built maximum and as-built minimum areal densities are 0.0414 g/cm^2 and 0.0301 g/cm^2 respectively (Ref. 4).

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

        The nominal geometric dimensions of each Boral panel are 145 in. length, 7.50 in. width, and 0.101 in. thickness (Ref. 1). The nominal density of the neutron-absorbing core is 2.639 g/cm^3 (Ref. 5). After a reasonable search of plant records, including docketed information, Union Electric has determined that the porosity of the Boral panels was not part of the original licensing basis or previously requested by the NRC as a part of the licensing action that approved the installation of the neutron absorber.

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

    Samples of Boral were subjected to water soluble boron tests and water soak tests. The water soluble boron tests used chemical analysis of the boron carbide powder to ensure the content of water soluble boron was within specification of 0.1 wt% to 1.0 wt%. This testing yielded water soluble boron contents ranging from 0.32 wt% to 0.56 wt%. The water soak tests used neutron attenuation to determine B-10 areal density of samples before and after prolonged immersion in heated, demineralized and heated, borated water. Prior to immersion, B-10 areal densities of samples ranged from 0.0333 g/cm^2 to 0.0400 g/cm^2. After immersion, B-10 areal densities of samples ranged from 0.0322 g/cm^2 to 0.0361 g/cm^2 (Ref. 4).

    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*

A vented sheet of stainless steel sheathing is skip/spot welded to each storage cell wall. A Boral panel is retained in each sheathing cavity (Ref. 1).

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

Stainless steel sheathing completely encloses each Boral panel. However, the sheathing is vented, allowing the SFP environment to make direct contact with the panel (Ref. 1).

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

i. *estimated current minimum areal density;*

There is no superficial indication of degradation that could lead to the loss of neutron-absorbing material. Therefore, the estimated current minimum areal density is the same as the installed minimum areal density (see response to sub-area 1.b.ii).

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

The current credited areal density of the neutron-absorbing material in the NCS AOR is 0.0300 g/cm^2 (Ref. 1).

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).*

There is no recorded degradation or deformations of the neutron-absorbing material in the SFP.

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.*

Union Electric did not institute a neutron absorber surveillance or monitoring program when the Boral was installed in the SFP. In January, 1999, the NRC issued Amendment No. 129 to Facility Operating License No. NPF-30. As concluded in its Safety Evaluation (Ref. 6):

> **… the staff finds that the materials in the spent fuel racks, manufactured by Holtec International, are compatible with the environment in the Callaway Plant, Unit 1 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 Union Electric licensing basis and the Safety Evaluation issued with Amendment No. 129, Union Electric does not have a surveillance or monitoring program to confirm that the credited neutron-absorbing material is performing its safety function. Therefore, the information requested in Area 2 is not applicable.

A neutron absorber monitoring program was created and approved as part of the Union Electric license renewal application. However, this program will not be activated until just prior to the period of extended operation.

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.*

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.*

   Union Electric does not credit Boraflex, Carborundum, or Tetrabor in the NCS AOR. Therefore, the information requested in Area 3 is not applicable.

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.*

      The modeling that supports the NCS AOR utilizes a conservative assumption that the Boral panels have the certified minimum areal density of 0.0300 g/cm^2 (Ref. 1). There is no allowance or reconciliation of the NCS AOR for the actual condition of the panels. This approach is consistent with the Safety Evaluation for Amendment No. 129 to Facility Operating License No. NPF-30.

   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.

As discussed in Area 2, Union Electric does not have an active surveillance or monitoring program. Therefore, the information requested in sub-areas 4.b, 4.c, & 4.d is not applicable.

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.*

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).*

Union Electric does not credit Boraflex, Carborundum, or Tetrabor in the NCS AOR. Therefore, the information requested in Area 5 is not applicable.

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.*

REFERENCES:

1. **HI-971769, Licensing Report for Reracking of the Callaway and Wolf Creek Nuclear Plants.**
2. **NED 01-006, Closure Information Associated with CMP 97-1016A: Spent Fuel Pool Rerack.**
3. **"Handbook of Neutron Absorber Materials for Spent Nuclear Fuel Transportation and Storage Applications," EPRI, 2009. Report 1019110.**
4. **DOC-70384-3, Boral Documentation Package**
5. **HI-971790, Criticality Safety Analysis of Spent Fuel Storage Racks for UE.**
6. **Amendment No. 129 to Facility Operating License No. NPF-30 (ADAMS accession number ML021640249).**