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U. S. Nuclear Regulatory Commission
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Washington, D. C. 20555-0001

Vogtle Electric Generating Plant, Unit 1
Response to NRC Generic Letter 2016-01
Monitoring of Neutron-Absorbing Materials in Spent Fuel Pools

Ladies and Gentlemen:

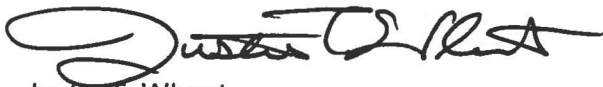
On April 7, 2016, the U.S. Nuclear Regulatory Commission (NRC) issued generic letter (GL) 2016-01, Monitoring of Neutron-Absorbing Materials in Spent Fuel Pools (SFPs), to address degradation of neutron-absorbing materials in wet storage systems for reactor fuel. Specifically, the NRC issued GL 2016-01 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 SFPs 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, and (2) to collect the requested information and determine if additional regulatory action is required.

The purpose of this letter is to provide a response for Vogtle Electric Generating Plant (Vogtle), Unit 1. Vogtle Unit 1 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 spent fuel pool. Because Vogtle Unit 1 credits Boral in the spent fuel rack criticality analysis, Southern Nuclear Operating Company is required to provide information requested in Areas 1, 2, and 4 as described in Appendix A of GL 2016-01. Southern Nuclear Operating Company's response is enclosed.

This letter contains no new regulatory commitments. If you have any questions, please contact Ken McElroy at (205) 992-7369.

Mr. Justin T. Wheat states he is the Nuclear Licensing Manager for Southern Nuclear Operating Company, is authorized to execute this oath on behalf of Southern Nuclear Operating Company and, to the best of his knowledge and belief, the facts set forth in this letter are true.

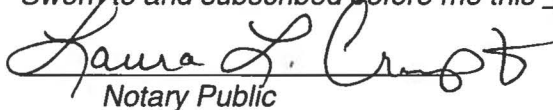
Respectfully submitted,



Justin T. Wheat
Nuclear Licensing Manager



Sworn to and subscribed before me this 2 day of November, 2016.


Notary Public

My commission expires: 10-8-2017

JTW/efb/lac

Enclosure:

Response to Areas of Requested Information in Appendix A of NRC Generic Letter 2016-01,
"Monitoring of Neutron-Absorbing Materials in Spent Fuel Pools"

- cc: Southern Nuclear Operating Company
Mr. S. E. Kuczynski, Chairman, President & CEO
Mr. D. G. Bost, Executive Vice President & Chief Nuclear Officer
Mr. B. K. Taber, Vice President - Vogtle 1 & 2
Mr. M. D. Meier, Vice President - Regulatory Affairs
Mr. B. J. Adams, Vice President - Engineering
Mr. J. B. Williams, Director - Nuclear Fuel
Mr. Earl Berry, Director - Vogtle Engineering
Mr. D. D. Sutton, Manager - Regulatory Affairs - Vogtle 1 & 2
RType: Vogtle=CVC7000
- cc: Nuclear Regulatory Commission
Ms. C. Haney, Regional Administrator
Mr. R. E. Martin, NRR Senior Project Manager - Vogtle 1 & 2
Mr. E. T. Coffman, Senior Resident Inspector - Vogtle 1 & 2

**Vogtle Electric Generating Plant, Unit 1
Response to NRC Generic Letter 2016-01
Monitoring of Neutron-Absorbing Materials in Spent Fuel Pools**

Enclosure

**Response to Areas of Requested Information in Appendix A of
NRC Generic Letter 2016-01, "Monitoring of Neutron-Absorbing
Materials in Spent Fuel Pools"**

Vogtle Unit 1 Licensing Basis for Monitoring of Neutron-Absorbing Materials in the Spent Fuel Pool

License Amendment for Vogtle Spent Fuel Racks Modification

On June 29, 1998, the Nuclear Regulatory Commission (NRC) issued Amendment 102 to Facility Operating License NPF-68 for Vogtle Electric Generating Plant (Vogtle) Unit 1. (See NRC Agencywide Documents Access and Management System (ADAMS) Accession No. (#) 9807060002). The amendment consisted of changes to the Technical Specifications (TS) in response to Southern Nuclear Operating Company (SNC) application dated September 4, 1997 (ADAMS# 9807060002) as supplemented by letters dated November 20, 1997 (ADAMS# 9806080264), May 19, 1998 (ADAMS# 9805270418) and June 12, 1998 (ADAMS# 9806180136). The amendment approved a modification to install high density spent fuel racks, previously used at Maine Yankee Atomic Power Plant (MYAPP). The NRC approved the criticality analysis, which takes credit for the presence of Boral absorber panels. In the related Safety Evaluation, the NRC stated the following:

“These spent fuel racks were approved for use at MYAPP in an NRC staff letter and accompanying Safety Evaluation (SE) dated June 16, 1982. [ADAMS# 8206250143] The spent fuel racks were observed to perform well in service at MYAPP and did not exhibit swelling or any other type of degradation.”

In the June 29, 1998 SE (ADAMS# 9807060002), the NRC went on to evaluate the Vogtle rack material compatibility considerations, including the potential for a small amount of deterioration of the Boral plates, concluding that the deterioration would have no effect on neutron shielding, attenuation properties or criticality considerations, and that a materials surveillance program was not necessary. The NRC noted that in the unlikely event that any adverse service experience was noted in material surveillance programs at plants with similar designs, there would be sufficient time to initiate corrective actions. The NRC concluded that any corrosion that would occur in the spent fuel pool environment should be of little significance during the remaining life of the plant.

License Amendment for Vogtle Updated Spent Fuel Racks Criticality Analyses

On September 22, 2005, the NRC issued Amendment 139 to Facility Operating License NPF-68 for Vogtle Unit 1 (ML052420110). The amendment consisted of changes to the TSs in response to SNC's application dated August 13, 2004 (ML042320393) as supplemented by letters dated May 3, 2005 (ML051260207) and July 7, 2005 (ML051940421). The amendment approved revised TSs to reflect the updated spent fuel rack criticality analysis. The updated criticality analysis assumed credit for the Boral neutron absorber material in Unit 1.

In the May 3, 2005 and July 7, 2005 responses to NRC requests for additional information (RAIs), SNC provided more specific information on the Boral plates, including information on the history of the plates at MYAPP, explanations of the MYAPP “new” and “reclaimed” Boral plates, plate thicknesses, B₄C core explanations, calculated ¹⁰B areal densities, and the conservative, bounding values used for ¹⁰B areal densities in the criticality analyses. SNC provided a discussion on Boral degradation mechanisms, including the analysis performed on effects of blistering and gas venting to prevent bulging. SNC provided the justification for why there is no coupon surveillance program for the Vogtle Unit 1 spent fuel pool.

In the September 22, 2005 SE, the NRC stated the following:

"As discussed above, the licensee does not have a coupon surveillance program, but appropriate measures have been taken to account for the possible degradation of the Boral panels. In its criticality analysis, the licensee chose to use the maximum thickness of the two designs ("reclaimed" and "new"), as well as the minimum areal density. By modeling each spent fuel rack with the thicker Boral panels, the amount of water between adjacent cells (the flux trap region) is minimized, thereby increasing reactivity. In addition, assuming the minimum area density represents using the lowest amount of boron carbide available to control the criticality of the SFP. These assumptions introduce more conservatism into the criticality calculations. In addition, any issues emerging from the use of Boral in the spent fuel racks will be monitored through its Operating Experience and Corrective Action Program.

Based on the discussion provided above, the NRC finds that the licensee's assumptions to account for possible Boral degradation in the criticality analysis and its continued monitoring of industry experience are appropriate measures for ensuring consistent material performance of the Boral panels." [ML052420110]

License Amendment for Vogtle Operating License Renewal

On June 3, 2009, the NRC issued a Renewed Facility Operating License No. NPF-68 for Vogtle Unit 1 (ML090920437). The NRC issued the renewed license based on the SNC application submitted June 27, 2007 (ML071840351), as supplemented by subsequent SNC letters. The NRC set forth the technical basis for issuing the renewed license in NUREG-1920, "Safety Evaluation Report Related to License Renewal of the Vogtle Electric Generating Plant, Units 1 and 2, Volumes 1 and 2. Among the NRC requests for information and SNC response letters were the following letters related to the subject of GL 2016-01: On November 18, 2008, the NRC issued seven RAIs concerning aging effects in the Boral used in the spent fuel storage racks (ML083170298). On December 16, 2008, SNC responded to the RAIs (ML083510900). On January 8, 2009 a telephone conference between the NRC and SNC was held to discuss and clarify the SNC responses. On January 16, 2009 the NRC issued a letter summarizing the teleconference (ML090090213). In resolution of the issues between SNC and the NRC staff, on January 20, 2009, SNC issued a letter updating its Vogtle License Renewal Future Action Commitment List (ML090210302) to revise commitment number 37 as follows:

"To ensure the Boral spent fuel racks will continue to perform their intended function during the period of extended operation, VEGP will monitor spent fuel pool aluminum concentrations and implement corrective actions if adverse trends are identified. Additionally, SNC will monitor industry experience related to Boral and will take appropriate actions if significant degradation of Boral is identified.

SNC will also perform a baseline inspection and a follow-up inspection to measure the effectiveness of the Boral neutron absorber panels on Unit 1 to provide reasonable assurance that the panels will continue to perform their reactivity

control function during the period of extended operation. These inspections will be included in the One-Time Inspection Program which is to be implemented for license renewal. The baseline inspection will be performed prior to the period of extended operation [January 16, 2027]. The follow-up inspection will be performed at a date to be determined based on the results of the baseline inspection and relevant industry guidance, not to exceed ten years after the baseline inspection."

In the license renewal SE (NUREG 1920, Vol. 1) Section 3.3.2.2.6, "Reduction of Neutron-Absorbing Capacity and Loss of Material Due to General Corrosion," after a discussion of SNC's aging management programs, including SNC's Water Chemistry Control Program, SNC's Operations Experience Program and responses to industry events, SNC's participation in the EPRI Neutron Absorbers Group, and SNC's Commitment 37, the NRC concluded:

"The staff reviewed the applicant's application and amendment, response to RAIs and the Commitment, and the staff concludes that the applicant's responses and programs meet SRP-LR Section 3.3.2.2.6 criteria. For those line items that apply to LRA Section 3.3.2.2.6, the staff concludes that the LRA is consistent with the GALL Report and the applicant has demonstrated that the effects of aging will be adequately managed so that the intended function(s) will be maintained consistent with the CLB during the period of extended operation, as required by 10 CFR 54.21(a)(3)."

Category 4 Responses to Generic Letter 2016-01 (Appendix A)

The following NRC questions were provided in GL 2016-01 Appendix A describing the level of detail for the information requested from Category 4 responders.

Areas of Requested Information

- 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 Boral panels used in the Vogtle Unit 1 spent fuel racks were manufactured for Maine Yankee Atomic Power Plant (MYAPP) by Brooks and Perkins (later AAR Advanced Structures). In 1976, MYAPP re-racked their spent fuel pool with high-density Boral racks. In the 1984-1985 time frame, MYAPP began replacing these racks. Some of the Boral panels in the replacement racks were "new", and some of the Boral panels in the replacement racks were "reclaimed" from the previous racks. SNC purchased, licensed, and installed the MYAPP racks in the Vogtle Unit 1 SFP in 1998. The Boral used in the Vogtle Unit 1 racks is described in docketed correspondence in the NCS AOR submitted on August 13, 2004 (ML042320393), explained further in Enclosure 2 of the May 3, 2005 response to RAIs (ML051260207), and approved by the NRC on September 22, 2005 (ML052420110).

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 boron carbide in an aluminum matrix (B_4C -Al) core, clad with 1100 series aluminum. The B_4C core of the "new" and "reclaimed" Boral plates are different thicknesses. The "new" Boral is nominally 50 weight-percent B_4C and the "reclaimed" Boral is nominally 35 weight-percent B_4C . A description of the Boral in the Vogtle Unit 1 racks is docketed in the NCS AOR submitted on August 13, 2004 (ML042320393) and approved by the NRC on September 22, 2005 (ML052420110). See, in particular, Section 2.3 of Enclosure 5 (Unit 1 Spent Fuel Pool Criticality Analysis Report) in the August 13, 2004 submittal. See also, Enclosure 2 of the May 3, 2005 response to RAIs (ML051260207).

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

After a reasonable search of the plants records, including docketed information, SNC has determined that the requested 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. However, the nominal areal density of the older, reclaimed Boral panels was about 0.029 g/cm² and the nominal areal density of the newer Boral panels was about 0.028 g/cm². The areal density used within the criticality analysis was conservatively assumed to be 0.0238 g/cm². A description of the Boral in the Vogtle Unit 1 racks is docketed in the NCS AOR submitted on August 13, 2004 (ML042320393) and approved by the NRC on September 22, 2005 (ML052420110). See, in particular, Section 2.3 of Enclosure 5 (Unit 1 Spent Fuel Pool Criticality Analysis Report) in the August 13, 2004 submittal. See also, Enclosure 2 of the May 3, 2005 response to RAIs (ML051260207).

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

A description of the Boral material characteristics, including density and dimensions, in the Vogtle Unit 1 SFP racks is docketed in the NCS AOR submitted on August 13, 2004 (ML042320393) and approved by the NRC on September 22, 2005 (ML052420110). See, in particular, Table 1-3 (Standard Material Compositions Employed in Criticality Analysis for Vogtle Unit 1 Spent Fuel Storage Racks) and Table 2-2 (Vogtle Unit 1 Storage Rack Geometry) of Enclosure 5 (Unit 1 Spent Fuel Pool Criticality Analysis Report) in the August 13, 2004 submittal. After a reasonable search of the plants records, including docketed information, SNC has determined that the remaining requested 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.

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

On June 29, 1998, the NRC issued Amendment 102 to Facility Operating License NPF-68 for Vogtle Unit 1 (ADAMS# 9807060002). The amendment approved a modification to install high density spent fuel racks, previously used at MYAPP. In Section 3.3, "Material Compatibility Considerations," of the June 29, 1998 SE, the NRC documents its previous conclusion stated in the June 16, 1982 SE for MYAPP (8206250143) approving the compatibility of the spent fuel rack materials with the SFP environment. Later, in Section 3.3 of the June 29, 1998 SE, the NRC concludes the following:

"As stated previously, the only modification performed on the MYAPP spent fuel racks, following issuance of the June 16, 1982, NRC staff SE, was the addition of vent and drain holes in pockets that contain the neutron-absorbing Boral material. Long-term contact between Boral and borated water is not expected to cause any problems (e.g., swelling or excessive corrosion) as demonstrated by the acceptable performance that the racks demonstrated at MYAPP.

The VEGP SFP environment is very similar to the SFP environment at MYAPP in that they both employ the same materials at similar temperatures and radiation levels. Both VEGP and MYAPP SFPs are lined with stainless steel and the pool water is of high quality and borated for criticality control. In addition, both MYAPP and VEGP store Zircaloy-clad fuel in the spent fuel racks. From the preceding, the NRC staff concludes that use of the MYAPP spent fuel racks in the VEGP Unit 1 SFP will be acceptable from a materials compatibility standpoint, as was concluded for the use of these racks in the MYAPP SFP." [ADAMS# 9807060002]

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

Each spent fuel storage rack cell consists of an inner stainless steel canister, an outer stainless steel wrapper, and four Boral plates. The Boral plate is a composite sandwich of core poison material surrounded on both sides by aluminum. A more detailed description of the Boral in the Vogtle Unit 1 racks is docketed in the NCS AOR submitted on August 13, 2004 (ML042320393) and approved by the NRC on September 22, 2005 (ML052420110). See, in particular, Section 2.3 and Figure 2-2 of Enclosure 5 (Unit 1 Spent Fuel Pool Criticality Analysis Report) in the August 13, 2004 submittal.

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

In Section 3.3, "Material Compatibility Considerations," of the June 29, 1998 SE (ADAMS# 9807060002), the NRC documents its previous conclusion from the June 16, 1982 (8206250143) MYAPP SE approving the compatibility of the spent fuel rack materials with the SFP environment. The June 29, 1998 NRC SE further acknowledges that the MYAPP modification adding vent and drain holes in spent fuel rack pockets that contain Boral "is not expected to cause any problems" as a result of the long-term contact between the Boral and borated water.

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

- i) estimated current minimum areal density;*

Based on the results of SNC's Water Chemistry Control Program, there have been no indications of a loss of neutron-absorbing material. Therefore, the estimated current minimum areal density is the same as when the material was fabricated and installed in the SFP, which has been provided in response to (1)(b)ii.

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

The currently credited areal density is 0.0238 g/cm².

- 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).*

Based on the results of SNC's Water Chemistry Control Program, there have been no indications of a loss of neutron-absorbing material.

As documented and approved in NRC SEs dated June 29, 1998 (ADAMS# 9807060002), September 22, 2005 (ML052420110), and June 3, 2009 (ML090920437), SNC does not have a coupon or in-situ testing program for Vogtle Unit 1. SNC has committed to perform a baseline inspection prior to the period of extended operation which begins January 16, 2027.

- 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.*

As described and approved in NRC SERs dated June 29, 1998 (ADAMS# 9807060002), September 22, 2005 (ML052420110), and June 3, 2009 (ML090920437), SNC has a Water Chemistry Control Program, Operations Experience and Corrective Action Programs, and participates in the EPRI Neutron Absorbers Group. SNC does not have a coupon or in-situ testing program for Vogtle Unit 1, but has committed to perform a baseline inspection prior to the period of extended operation which begins January 16, 2027.

- 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.

- 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.*

On September 22, 2005, the NRC issued Amendment 139 to Facility Operating License NPF-68 for Vogtle Unit 1 (ML052420110), which approved revised Technical Specifications to reflect updated spent fuel rack criticality analyses. SNC's application dated August 13, 2004 (ML042320393) as supplemented by letters dated May 3, 2005 (ML051260207) and July 7, 2005 (ML051940421) describes the technical basis for the method of modeling the neutron-absorbing material, Boral. Specifically, in the May 3, 2005 and July 7, 2005 responses to NRC RAIs, SNC provided specific information on the actions, considerations, and conservative assumptions used in the NCS AOR to account for potential Boral degradation mechanisms and ensure that the Boral being credited in the NCS AOR bounded expected conditions in the spent fuel pool.

- 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.*

In the May 3, 2005 (ML051260207) and July 7, 2005 (ML051940421) responses to NRC RAIs on the SFP NCS AOR, SNC provided a discussion on Boral degradation mechanisms, including the analysis performed on effects of blistering and gas venting to prevent bulging. SNC provided the justification for why there is no coupon surveillance program for the Vogtle Unit 1 spent fuel pool. In the September 22, 2005 SE, the NRC stated the following:

"As discussed above, the licensee does not have a coupon surveillance program, but appropriate measures have been taken to account for the

possible degradation of the Boral panels. In its criticality analysis, the licensee chose to use the maximum thickness of the two designs ("reclaimed" and "new"), as well as the minimum areal density. By modeling each spent fuel rack with the thicker Boral panels, the amount of water between adjacent cells (the flux trap region) is minimized, thereby increasing reactivity. In addition, assuming the minimum area density represents using the lowest amount of boron carbide available to control the criticality of the SFP. These assumptions introduce more conservatism into the criticality calculations. In addition, any issues emerging from the use of Boral in the spent fuel racks will be monitored through its Operating Experience and Corrective Action Program." [ML052420110]

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

See responses to 4.a and 4.b above.

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

See responses to 4.a and 4.b above.

- 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