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

Edwin I. Hatch Nuclear Plant, Units 1 and 2
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 Edwin I. Hatch Nuclear Plant (Hatch), Units 1 and 2. Hatch Units 1 and 2 have been determined to be Category 4 licensees in accordance with GL 2016-01. As Category 4 licensees, 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 Hatch Units 1 and 2 credit 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 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. D. R. Vineyard, Vice President - Hatch
Mr. M. D. Meier, Vice President - Regulatory Affairs
Mr. B. J. Adams, Vice President - Engineering
Mr. J. B. Williams, Director - Nuclear Fuel
Mr. B. K. Hulett, Director - Hatch Engineering
Mr. G. L. Johnson, Regulatory Affairs Manager - Hatch
RType: Hatch=CHA02.004

cc: Nuclear Regulatory Commission
Ms. C. Haney, Regional Administrator
Mr. M. D. Orenak, NRR Project Manager - Hatch
Mr. D. H. Hardage, Senior Resident Inspector - Hatch

Edwin I. Hatch Nuclear Plant, Units 1 and 2
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"

Hatch Unit 1 and Unit 2 Licensing Basis for Monitoring of Neutron-Absorbing Materials in the Spent Fuel Pool

License Amendment for Hatch Spent Fuel Racks Modification
On April 21, 1980, the NRC issued Amendment 74 to License No. DPR-57 for Hatch Unit 1 and Amendment 15 to License No. NPF-5 for Hatch Unit 2. (See NRC Agencywide Documents Access and Management System (ADAMS) Accession No. (#) 8005130080.) The amendments consisted of changes to the Technical Specifications (TS) in response to SNC's application dated July 9, 1979 (ADAMS# 7907170066) (as amended by letters dated July 27, 1979 (ADAMS# 7908030148), September 21, 1979 (ADAMS# 7909250515), October 29, 1979 (ADAMS# 7911050199), November 30, 1979 (ADAMS# 7912050150), December 31, 1979 (ADAMS# 8001030770), and February 18, 1980 (ADAMS# 8002220327). The amendments authorized the installation and use of high density storage racks for the storage of spent fuel assemblies in the spent fuel storage pool. The NRC approved the spent fuel pool criticality analysis, which takes credit for the presence of Boral absorber panels.

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 high density spent fuel storage racks at Hatch were designed and supplied by General Electric Company. The Boral panels used in the spent fuel racks were manufactured in 1979-1980 by Brooks and Perkins (later AAR Advanced Structures). The spent fuel pool racks were installed at Hatch in 1980.

   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 plate consists of a core B_4C–Al composite material bonded between two thin sheets of aluminum cladding. A detailed description of the Boral used in the Hatch spent fuel pool racks is included in Sections 2, 5, and 7 of the Hatch license amendment application for installation of high density spent fuel storage racks dated July 9, 1979 (ADAMS# 7907170066). The certified content of the neutron-absorber was not expressed as weight percent, and after a reasonable search of the plant records, including docketed information, SNC has determined that this 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 NRC SE did reference the July 9, 1979 submittal which stated that "the minimum, equivalent homogenous, areal concentration of boron will be 0.013 grams of the boron ten isotope per square centimeter of Boral plate." (See Section 2.0 of NRC SE dated April 21, 1980 (ADAMS# 8005130080).)

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 plant 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 NRC SE did reference the July 9, 1979 submittal which stated that "the minimum, equivalent homogenous, areal concentration of boron will be 0.013 grams of the boron ten isotope per square centimeter of Boral plate." (See Section 2.0 of NRC SE dated April 21, 1980 (ADAMS# 8005130080).) The minimum allowable areal density used within the criticality analysis was conservatively assumed to be 0.013 g $^{10}B/cm^2$ as compared to the nominal areal density of 0.020 g $^{10}B/cm^2$. In addition, Section 5.0, Material Considerations, of the July 9, 1979 submittal (ADAMS# 7907170066) states the following:

> "To provide assurance that specification Boral sheet is used in the tube fabrication, a special quality control program is in effect at the manufacturer's facility. The concentration and distribution of the neutron absorbing material (B_4C) are verified by chemical analyses and/or neutron transmission tests, and each sheet is dimensionally inspected. Before each piece of Boral is inserted into a tube assembly, successful performance of the required inspections is verified."

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

A description of the Boral material characteristics, including density and dimensions, in the Hatch spent fuel racks is docketed in the July 9, 1979 submittal Section 7 Tables and Figures. (ADAMS# 7907170066). After a reasonable search of the plant 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;

Section 5 of the license amendment application for installation of high density spent fuel storage racks at Hatch dated July 9, 1979 (ADAMS# 7907170066) and as amended on November 30, 1979 (ADAMS# 7912050150) describes the qualification testing approach and material considerations for compatibility with the spent fuel pool environment. In Section 2.4.2 of the NRC SE dated April 21, 1980 (ADAMS# 8005130080), the NRC concludes:

"The aluminum in the Boral neutron absorber plates will experience some galvanic corrosion with the stainless steel tubes encapsulating the Boral being vented to the pool water environment, although in the high resistivity pure water environment, any galvanic corrosion will be minimized. The more noble stainless steel will not be affected by any galvanic attack when contacted with aluminum. Although slight galvanic corrosion may occur in the aluminum of the Boral plates, it should not have any significance on the neutron absorption capability of the Boral and certainly no effect on storage rack structural integrity for a period in excess of 40 years."

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 free standing spent fuel storage module is fabricated from fuel storage tubes, made by forming an outer tube and an inner tube of 304 stainless steel with an inner core of Boral into a single tube. The outer and inner tubes are welded together after being sized to the required dimensional tolerances. The completed storage tubes are fastened together by angles welded along the corners and attached to a base plate to form storage modules. The Boral plate is a composite material composed of a core poison (B_4C-Al) bonded between two thin sheets of aluminum cladding. A more detailed description of the Boral in the Hatch spent fuel racks is docketed in sections 2, 5, and 7 of the July 9, 1979 submittal (ADAMS# 7907170066) and the November 30, 1979 amendment (ADAMS# 7912050150) and as approved by the NRC on April 21, 1980 (ADAMS# 8005130080).

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

Section 5, Material Considerations, of the July 9, 1979 submittal (ADAMS# 7907170066) describes the sheathing and exposure of the Boral to the spent fuel pool environment. The Boral plates are sandwiched between the inner and outer wall of the storage tube and are not subject to dislocation, deterioration, or removal. The inner and outer walls of the storage tube are welded together at each end for mechanical rigidity. Small openings are formed in the top and bottom of each tube assembly by leaving gaps in the weld to allow for the venting of the envelope between the inner and outer tube walls. At normal pool operating temperature, there is no significant deterioration or corrosion of stainless steel or Boral.

A more detailed description of the configuration in the spent fuel pool as related to sheathing and exposure of Boral to the spent fuel pool environment is enclosed on Page Q11-1 of the November 30, 1979 (Amendment 4) submittal (ADAMS# 7912050150), which contains an answer to an NRC question concerning the possibility of swelling in the cell containing the Boral due to off-gassing pressure.

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 spent fuel pool rack coupon testing 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 current credited areal density is still 0.013 g $^{10}B/cm^2$ because there has been no loss of neutron-absorbing 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).*

There has been no recorded degradation or deformations of the Boral in the Hatch Unit 1 and Unit 2 spent fuel pools. Coupon test results are addressed in response to 4(b).

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.*

Hatch surveillance program procedures, applicable to both Unit 1 and Unit 2, provide instructions for the removal, installation, and relocation of the high density fuel storage system surveillance coupons, placement of fuel adjacent to the coupons, and coupon analysis. Coupon samples have been removed and examined from one of the two Unit spent fuel pools at least once each five years. The monitoring program has included visual examinations and measurements of weight and dimensions, neutron attenuation measurement, neutron radiography and ^{10}B areal density measurement by chemical analysis. Examinations and measurements are conducted in accordance with procedures and using calibrated equipment.

The results of the surveillance program have been satisfactory and indicate that there has been no loss of neutron-absorbing material in the Hatch Unit 1 and 2 spent fuel pools.

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 of the technical basis for the technique(s) and method(s) used in the surveillance or monitoring program, including:*

The coupon monitoring program uses the same material as the as-installed material and is designed to detect aging/degradation mechanisms that the in-service neutron absorber materials experience. The coupon tree is placed near freshly discharged fuel, as described by plant procedures, to provide exposure to gamma and neutron irradiation and higher than average water temperatures.

i) approach used to determine frequency, calculations and sample size

In general, the frequency of coupon inspections were initially determined based on results of the original qualification testing of the neutron absorbing materials prior to first use (e.g. accelerated corrosion testing at higher temperatures). Based on this qualification testing, the interval was established on a frequent basis (e.g. one to five years). As operational experience was gathered and actual in-service experience was obtained, less frequent intervals were justified. For more robust materials, such as Boral, monitoring programs were not deemed necessary at all. (See NRC letter from Laurence I. Kopp to Dr. Krishna P. Singh, dated February 16, 1995 (ADAMS# 9502230383) and NRC letter from Anthony C. Attard to Korea Hydro & Nuclear Power Company, dated October 2, 2003.) Nonetheless, Hatch has continued a coupon surveillance program and has been performing testing at least every 5 years.

In the November 30, 1979 submittal (ADAMS# 7912050150), in the discussion on material considerations, the approach to testing samples in the spent fuel pool were clarified as follows:

> "Boral's corrosion resistance is similar to that of standard aluminum sheet. Corrosion data and industrial experience confirm that aluminum and Boral are acceptable [citing four references below] for the proposed application. Although experience indicates that it is unnecessary, an inservice test program will be conducted, consisting of periodic examination of surveillance samples which will be suspended underwater in the fuel storage pool. These samples consist of two types: the first being 8-inch x 8-inch coupons of Boral plate with stainless steel sheet formed to both sides, and the second consisting of 6-inch square samples of Boral without stainless "cladding". The stainless "clad" coupons have two sides open to permit water access. Sufficient samples are included to permit destructive examination of a sample on inspection intervals of 1 to 5 years over the life of the facility." [Four references cited: (1) U.S. NRC Safety Evaluation for Yankee Rowe, dated December 29, 1976, page 4, Structural and Material Considerations; (2) U.E. Wolff, "Boral From Long-Term Exposures at BNL and Brooks and Perkins,", GE Report No. 78-212-0079, dated December 14, 1978; (3) Brooks and Perkins Report, "The Suitability of Brooks and Perkins Spent Fuel Storage Module For Use in BWR Storage Pool", Report No. 577; (4) A. J. Jacobs, "Boral Corrosion Test: 2022-Hour Results", GE Report No 77-688-120, dated December 15, 1977. (Proprietary)]

ii) parameters to be inspected and data collected

Parameters are visual observation of general conditions, weight and dimensional measurements, and ^{10}B areal density.

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

There has not been a strict "acceptance criteria" associated with the coupon testing program, in that the purpose of the program is to determine whether deformation or degradation is occurring and for any indications of deformation or degradation to be entered into the corrective action program for further assessment of impacts, extent of condition, trending, determination of functionality, and implementation of corrective actions. The visual examination is intended to detect missing Boral or surface anomalies. The ^{10}B areal density determination ensures that the areal density is greater than or equal to the amount assumed in the spent fuel pool criticality calculations (0.013 g $^{10}B/cm^2$).

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

As stated above, any indications of deformation or degradation would be entered into the corrective action program for further assessment of impacts, extent of condition, trending, determination of functionality, and implementation of corrective actions. However, there have been no indications of deformation or degradation of Boral in the Hatch spent fuel pools. Surveillance results have been generally consistent over the years.

v) industry standards used

The following standards have been used:

- ASTM E2971-14 "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 In a Pool Environment"
- EPRI TR-1019110, "Handbook of Neutron Absorber Materials for Spent Nuclear Fuel Transportation and Storage Applications, 2009 Edition."

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

i) If there is visual inspection of inservice material:

Not applicable

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 SFP water, location of coupons, configuration of 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 coupons;

A detailed description of the Boral used in the Hatch spent fuel pool racks and how the Boral is credited in the spent fuel pool criticality analysis is included in Sections 2, 5, and 7 of SNC's license amendment application for installation of high density spent fuel storage racks dated July 9, 1979 (ADAMS# 7907170066). After a reasonable search of the plant records for the remaining information requested, 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.

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

According to plant records, the samples were placed in the Hatch spent fuel pools on May 23, 1987.

(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.

(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.

SNC's documentation indicates that there are 9 coupons remaining in the Unit 1 spent fuel pool and 13 remaining in the Unit 2 pool. The last coupon testing was completed in May 2014. Assuming continued satisfactory test results and a ten-year testing period per pool, staggered such that one coupon is tested every 5 years, there are enough coupons for testing for the life of the spent fuel pools.

iii) If RACKLIFE is used:

Not applicable.

iv) *If in-situ testing with a neutron source and detector is used:*

Not applicable.

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.*

The Hatch spent fuel racks employ thermal neutron absorption in the ^{10}B of the Boral as the primary mechanism of reactivity control. The minimum certified ^{10}B areal density of 0.013 $g^{10}B/cm^2$ was modeled in the original criticality analysis for the GE high density fuel storage racks submitted with the July 9, 1979 license amendment application (ADAMS# 7907170066) and in the updated criticality safety analysis for GNF2 fuel as documented in SNC 10 CFR 50.59 No. FDC-H-13-005 and GEH report 0000-0141-6099-R1, "Generic Criticality Safety Analysis of GE High Density Fuel Storage Racks for GE14 and GNF2 Fuel"," Rev. 1 May 2012. The modeling does not address degraded neutron-absorbing material other than to use a conservative number that bounds a significant amount of deformation or 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.*

The visual and dimensional examinations of the coupons have been used to observe for any instances of surface corrosion, degradation or deformation of the material (e.g., blistering, bulging, pitting, or warping). The neutron attenuation and ^{10}B areal density measurements have been used to ensure that the results are within the assumptions of the spent fuel pool criticality analysis.

There have been no indications of deformation or degradation of Boral, and the surveillance results have been generally consistent over the years. No blisters have been observed, except for blisters that developed during the drying process. No corrosion has been observed, except for small, insignificant pits identifiable only under magnification.

The minimum allowable areal density used within the criticality analysis was conservatively assumed to be 0.013 g $^{10}B/cm^2$ as compared to the nominal areal density of 0.020 g $^{10}B/cm^2$. The test coupon results of the neutron attenuation and ^{10}B areal density measurements have been consistent with the material as fabricated and installed in the spent fuel pools, 0.020 g $^{10}B/cm^2$.

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

The minimum allowable areal density used within the criticality analysis was conservatively assumed to be 0.013 g $^{10}B/cm^2$ as compared to the nominal areal density of 0.020 g $^{10}B/cm^2$. The test coupon results of the neutron attenuation and ^{10}B areal density measurements have been consistent with the material as fabricated and installed in the spent fuel pools, 0.020 g $^{10}B/cm^2$. The conservative assumptions in the criticality analysis, as supported by the consistent surveillance results, are bounding of the bias and uncertainty of the surveillance program.

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

The minimum allowable areal density used within the criticality analysis was conservatively assumed to be 0.013 g $^{10}B/cm^2$ as compared to the nominal areal density of 0.020 g $^{10}B/cm^2$. The test coupon results of the neutron attenuation and ^{10}B areal density measurements have been consistent with the material as fabricated and installed in the spent fuel pools, 0.020 g $^{10}B/cm^2$. The conservative assumptions in the criticality analysis, as supported by the consistent surveillance results, are bounding of any potential degradation in adjacent panels.

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