Don E. Grissette
Vice President

Southern Nuclear Operating Company, Inc.
40 Inverness Center Parkway
Post Office Box 1295
Birmingham, Alabama 35201

Tel 205.992.6474
Fax 205.992.0341

SOUTHERN COMPANY
Energy to Serve Your World℠

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NL-05-0803

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

Vogtle Electric Generating Plant
Request to Revise Technical Specifications to Reflect Updated Spent Fuel
Rack Criticality Analyses for Units 1 and 2
Response to Request for Additional Information (RAI)

Ladies and Gentlemen:

On August 13, 2004, Southern Nuclear Operating Company (SNC) submitted a request to revise the Vogtle Electric Generating Plant (VEGP) Technical Specifications to reflect updated spent fuel rack criticality analyses for Units 1 and 2 (letter NL-04-0973).

By electronic communication on November 30, 2004, and on February 11, 2005, the NRC requested additional information. During a phone call between SNC and the Staff on February 17, 2005, the Staff provided additional clarification of their questions in the February 11, 2005, RAI. On February 24, 2005, SNC and the Staff had a phone call to discuss the November 30, 2004, RAI. As a result of this discussion, the Staff revised the RAI and electronically forwarded the revised RAI to SNC on March 24, 2005. At the request of the Staff, a phone call was held between SNC and the Staff on April 7, 2005, to ensure that the revised questions were understood.

Enclosure 1 of this letter contains the responses to the RAI of February 11, 2005.
Enclosure 2 of this letter contains the responses to the RAI of March 24, 2005.

(Signature and affirmation are on the following page.)

A001

Mr. D. E. Grissette states he is a Vice President of 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.

This letter contains no NRC commitments. If you have any questions, please advise.

Sincerely,

Don E. Grissette

Sworn to and subscribed before me this 3rd *day of* May, *2005.*

Notary Public

My commission expires: 11/10/06

DEG/RJF/daj

Enclosures: 1. Response to Request for Additional Information Forwarded to SNC on February 11, 2005
2. Response to Request for Additional Information Forwarded to SNC on March 24, 2005

cc: Southern Nuclear Operating Company
Mr. J. T. Gasser, Executive Vice President
Mr. W. F. Kitchens, General Manager – Plant Vogtle
RType: CVC7000

U. S. Nuclear Regulatory Commission
Dr. W. D. Travers, Regional Administrator
Mr. C. Gratton, NRR Project Manager – Vogtle
Mr. G. J. McCoy, Senior Resident Inspector – Vogtle

State of Georgia
Mr. L. C. Barrett, Commissioner – Department of Natural Resources

Enclosure 1

Vogtle Electric Generating Plant
Responses to Request for Additional Information
Forwarded to SNC on February 11, 2005

Enclosure 1
Vogtle Electric Generating Plant
Responses to Request for Additional Information
Forwarded to SNC on February 11, 2005

Question 1

The vendor for the rack analysis stated that the methodology proposed in the application dated August 13, 2004, would not be used again. Please explain the basis for basing your application on this methodology.

Question 2

The shortcomings of the Westinghouse methodology are alluded to on page E1-1 of Enclosure 1, namely, the axial shape bias and the reactivity equivalencing techniques. The first of these is dealt with on page 29 of Enclosure 5. Section 3.3 discusses the modeling utilized to simulate the axial depletion. However, upon reading this section, it is apparent that axial depletion is not being performed, rather, the method appears to assume a uniform axial distribution. Does the methodology use a uniform axial distribution, and if so, why, when the majority of the industry depletes the assemblies using a number of axial zones?

Responses to Questions 1 and 2

During the teleconference between SNC and the Staff on February 17, 2005, the Staff requested that SNC provide a description of how axial reactivity effects were addressed in lieu of responses to Questions 1 and 2.

There were three axial effects that were explicitly addressed in the Unit 1 and Unit 2 analyses presented in Enclosures 5 and 6, respectively, in the amendment request. The effects are:

1. Distributed burnup profile,
2. IFBA cutback, and
3. Boral® panel cutback.

Distributed Burnup Profile

On page E1-1 of Enclosure 1 of the amendment request, SNC does identify the axial shape bias as one of the potential non-conservatisms in the current analyses. This was the subject of Westinghouse Nuclear Safety Advisory Letter NSAL-00-015 as discussed on page E1-3 of Enclosure 1 of the amendment request. The issue was that burnup credit calculations were performed in two dimensions and that an axial burnup reactivity bias was applied to quantify the axial burnup effects. The corresponding calculations in the revised analyses presented in the amendment request were performed using three-dimensional methods to explicitly account for the axial burnup reactivity effects.

Enclosure 5 of the amendment request presents the analyses for the Unit 1 spent fuel pool. Enclosure 6 of the amendment request presents the analyses for the Unit 2 spent fuel pool.

As described in Section 3.3 of Enclosure 5 for Unit 1, for the "all-cell" storage configuration for depleted fuel, the burnup requirement is very low. Table 3-7 on page 45 of Enclosure 5 shows that for a fuel assembly with an initial enrichment of 5 weight-percent U-235, a burnup of only 8,477 MWD/MTU is required to store depleted fuel in the "all-cell" storage configuration. Section 3.3 of Enclosure 5 references "Topical Report on Actinide-Only Burnup Credit for PWR Spent Fuel Packages," DOE/RW-0472, Rev. 1, May 1997, as demonstrating that a positive axial versus distributed reactivity bias usually begins with a minimum assembly burnup of around 25,000 MWD/MTU. Because of this, depleted assemblies for the "all-cell" storage configuration in the Unit 1 rack were modeled with a uniform burnup distribution.

Section 3.3 of Enclosure 6 for Unit 2 discusses the modeling of axial burnup distributions. As described in Section 3.5 of Enclosure 6, burnup credit was used for depleted fuel stored in the "3-out-of-4"and "all-cell" storage configurations, as well as for depleted peripheral fuel assemblies in the "3x3" storage configuration. For these storage configurations, the enrichment versus burnup calculations were performed using both a uniform and distributed axial burnup profile. To determine the limiting burnup requirement for each enrichment, the more limiting burnup for each profile was used. As can be seen from the results in Tables 3-15 through 3-21, the distributed burnup profile does not become more limiting until burnup exceeds around 20,000 MWD/MTU or higher depending on the initial enrichment. For that matter, it should be noted from Table 3-15 of Enclosure 6 that for the "3-out-of-4" storage configuration in the Unit 2 racks, the uniform axial burnup profile is more limiting for enrichments up to the 5 weight-percent limit. This is the same effect discussed in the previous paragraph for the Unit 1 "all-cell" storage configuration.

IFBA Cutback

This effect applies to the "All-Cell" storage configuration in the Unit 1 racks and to the "Center" fuel assembly in the "3x3" storage configuration in the Unit 2 racks. These are the only fuel storage configurations that credit the presence of Integral Fuel Burnable Absorbers (IFBA).

The as-built IFBA length is 132 inches. The IFBAs were conservatively modeled as 120 inches in length and centered about the midplane of the active fuel. Therefore, the IFBA coating is modeled with a 6-inch "cut-back" at both the top and bottom of the fuel assembly. The axial reactivity effects are explicitly modeled in the KENO calculations.

This is discussed in Section 1.5 of Enclosures 5 and 6 for Unit 1 and 2, respectively.

Boral® Panel Cutback

This effect only applies to the Unit 1 racks. The Unit 2 racks do not credit neutron absorber panels.

The Boral® material (core poison plus aluminum clad) was conservatively modeled with a length equal to 136 inches and centered about the midplane of the active fuel height. The actual Boral® length is 140 inches. This assumption conservatively represents the amount of active fuel above and below the Boral® plates. The axial reactivity effects are explicitly modeled in the KENO calculations.

This is discussed in Sections 1.3, 1.5, 2.3, 3.1.1, and 3.1.2 of Enclosure 5 in the amendment request.

Question 3

a. In the second paragraph of Section 3.3 of attachment 5, reference is made to average moderator and temperature profiles utilized to perform spectral calculations. However, no basis was provided for these choices. Please provide the basis for these selections.

b. In the third paragraph of Section 3.3, reference is made to the use of boron in all the DIT (Discrete Integral Transport) calculations. Were these calculations performed in compliance with NUREG-6683, "A Critical Review of the Practice of Equating Reactivity of Spent Fuel to Fresh Fuel in Burnup Credit Criticality Safety Analyses for PWR Spent Fuel Pool Storage," September 2000.

Response to Part "a"

The core average moderator and fuel temperature employed for this analysis is indicative of a 4-loop Westinghouse PWR. VEGP is licensed to allow the full-power core average temperature to vary between 575 °F and 593 °F. The actual value used for the generation of the isotopics is 579.95 °F. Note that the isotopics are more influenced by the core average moderator density. At a system pressure equal to 2250 psia, there is very little difference in the core average moderator density that was employed to generate the isotopics for the Vogtle analysis compared to the actual core average moderator density.

The core average fuel temperature, 944.12 °F, was determined with a fuel temperature correlation which is a function of linear heat rate, burnup, and core average moderator temperature. The value employed for the generation of the isotopics is very close to the actual operating core average fuel temperature.

Response to Part "b"

The soluble boron concentration employed in the DIT calculations represents a mid-cycle value and is used to approximate the borated neutronic environment under which fuel assemblies are depleted. The topics discussed in NUREG-6683 do not apply to the borated condition under which fuel assemblies are depleted. As discussed in the response to Question 4 below, NUREG-6683 expressed concerns regarding the determination of soluble boron requirements in the spent fuel racks.

Question 4

It is not clear to the NRC staff where the subject of reactivity equivalencing is discussed and employed. If so, why is the practice being used when practically every other licensee and vendor has stopped using it. Please provide chapter and section pointing to this subject matter.

Response to Question 4

Reactivity equivalencing is not employed anywhere in the amendment request.

The spent fuel pool criticality analysis did not use the reactivity equivalencing method as described in NUREG/CR-6683. The spent fuel pool criticality analysis described in the amendment request specifically modeled burned assemblies with the effect of fission products and depleted isotopics directly included. The method used in this analysis, to determine the soluble boron concentration required to maintain K_{eff} less than 0.95, specifically modeled burned fuel assemblies and did not credit reactivity equivalent fresh fuel assemblies as was done in the NUREG.

During the teleconference between SNC and the Staff on February 17, 2005, the Staff requested further discussion of the IFBA reactivity equivalencing described in the current VEGP Technical Specifications 4.3.1.1 and 4.3.1.2.

On page E1-3 of Enclosure 1 in the amendment request, SNC references Westinghouse Nuclear Safety Advisory Letter NSAL-99-003. This NSAL discussed potential non-conservatisms in the calculated Integral Fuel Burnable Absorber (IFBA) requirements using the reference K_{∞} technique for reactivity equivalencing. This technique is discussed in Section 4.2.2 of WCAP-14416-NP-A and in VEGP Technical Specifications 4.3.1.1 and 4.3.1.2. The concern with this technique was that the calculations were performed with a lattice code in reactor core geometry and the results applied to storage of fuel in rack geometry. NSAL-99-003 notified customers of potential non-conservatisms in this technique.

In the summary of the Technical Specification changes on page E1-2 of Enclosure 1 in the amendment request, it was noted that this technique is being removed from the VEGP Technical Specifications (Technical Specifications 4.3.1.1 and 4.3.1.2). Because it is being removed and will no longer be in the Technical Specifications, it was not discussed any further in the amendment request.

Enclosure 2

Vogtle Electric Generating Plant
Responses to Request for Additional Information
Forwarded to SNC on March 24, 2005

Enclosure 2
Vogtle Electric Generating Plant
Responses to Request for Additional Information
Forwarded to SNC on March 24, 2005

Question 1

On page 20 of attachment 5 to your submittal, you stated that the Boral® replacement Phase I racks were manufactured with "new" Boral® plates and the Phase II racks were manufactured with both "new" and "reclaimed" Boral® plates. The staff requests the licensee to answer the following questions:

a. Explain the difference between what is considered a "new" and what is considered a "reclaimed" Boral® plate.

Response to Part "a"

The following is based on information provided by Maine Yankee (MY).

Around 1976, MY re-racked their spent fuel pool with racks that utilized Boral® poison material. In 1984–1985 timeframe, MY began replacing these racks with higher density racks. Some of the replacement racks used "new" Boral® plates. The remainder of the replacement racks used "new" Boral® plates as well as Boral® plates that were "reclaimed" from the previous racks. The "new" and "reclaimed" Boral® plates are of different thicknesses with the "reclaimed" plates being thicker as described on page 20 of Enclosure 5 of the submittal. The B_4C core of the "new" and "reclaimed" Boral® plates are also of different thicknesses with the B_4C core of the "reclaimed" plates being thicker. Based on information provided by MY, the "new" Boral® was nominally 50 weight-percent B_4C and the "reclaimed" Boral® was nominally 35 weight-percent B_4C.

b. The licensee stated that the Boral® replacement racks were originally constructed for the Maine Yankee spent fuel pool (SFP). Please clarify if these racks were ever used in the Maine Yankee SFP. If the racks were used, then clarify if the racks were checked to ascertain the physical state of the racks and tested for any degradation (e.g., blistering, etc.) prior to installation in the Vogtle SFP.

Response to Part "b"

As described in the Response to Question 1a, the MY racks installed at VEGP were previously placed into service at MY.

To address bulging issues with the Boral® enclosures, the enclosures were vented. In a prior vintage of racks with water-tight Boral® enclosures, bulging occurred due to gas buildup. The concern was that bulging of the storage cell wall could interfere with fuel assembly insertion and withdrawal.

For the racks supplied to VEGP, MY had implemented a surveillance procedure once per cycle just prior to each refueling outage. This procedure was in place during the entire time the racks were in service at MY. The surveillance involved drag testing and visual inspection of the cells to monitor for signs of bulging. Prior to shipping the racks to VEGP, the results of the last two surveillances showed no signs of swelling or bulging. During the process of removing the racks to be shipped to VEGP, a considerable amount of fuel shuffling had to be performed and no difficulty was noted.

The above was previously discussed in response to questions from the Staff during the initial licensing of the racks for use at VEGP (Enclosure 5 of letter LCV-0828-D, May 19, 1998, SNC to NRC). Upon receipt at VEGP, the racks were visually inspected. As part of the installation program, each storage cell was drag tested. At the time the MY racks were installed at VEGP, information regarding Boral® blistering was not widespread. No inspections for blistering were performed. In addition, no testing was performed on the Boral® plates for B-10 content.

c. Was the B-10 content verified prior to installation? Is it the same amount for both the "new" and reclaimed" plates?

Response to Part "c"

As part of the installation of the racks at VEGP, the B-10 content was not verified. The areal density of B-10 for both "new" and "reclaimed" plates is essentially the same. The value of the B-10 areal density used in the criticality analyses was chosen to bound both the "new" and "reclaimed" Boral® plates.

d. Are there any manufacturing or material differences between these types of plates? If there are differences, the licensee should explain how these differences are accounted for in the expected performance of Boral®.

Response to Part "d"

Differences in the Boral® plate thickness and B_4C weight fraction were discussed in the response to Part "a" above. As discussed above, by using a bounding B-10 areal density in the criticality analyses, no significant differences in the neutronic performance of the Boral® plates is expected.

Based on discussions with the Boral® plate manufacturer, there are no known or identified differences in the manufacturing process used in the manufacture of the "new" and "reclaimed" Boral® plates. The manufacturer indicated that there is no difference in the expected performance of the two different vintages of Boral® - either neutronically or materially. The manufacturer also indicated that the raw material specifications, production equipment, and processing methods used to manufacture Boral® have remained the same since the early 1970's until recently.

Question 2

On page 8 of attachment 5 to your submittal, you stated that for conservatism, all of the Vogtle Unit 1 storage cells were simulated with the dimensions associated with the thickest (0.2 inches) Boral® plates. The staff believes that instead of using the "reclaimed" plates, more conservatism would be introduced by using the "new" plates, which have a thickness of 0.081 inches. Please explain how more conservatism would be introduced in the computer model by using the thickest Boral® plates.

Response to Question 2

The Unit 1 criticality analysis employed a single B-10 areal density for the Boral®. The value chosen conservatively bounds both the "reclaimed" and "new" plates. By choosing the maximum thickness of the two designs, the amount of water between adjacent fuel assemblies (the flux trap region) is minimized which acts to increase reactivity.

Question 3

Recently, incidents of Boral® blistering have been reported and the impact on the expected performance of this material is not yet known. The staff requests the licensee to explain if a Boral® coupon surveillance program is in place to monitor Boral® degradation. The licensee should include a complete description of its program (see below). Discuss your plans to implement a coupon surveillance program to ensure consistent material performance. A coupon surveillance program should monitor the physical and chemical properties of Boral® over time and should include the following:

I. A description of the coupons used (e.g., from the same lot as the panels).
II. The technique for measuring the initial Boron-10 (B-10) content of the coupons.
III. Frequency of coupon removal and its justification.
IV. Tests to be performed on the coupons (e.g., weight and dimension measurement: length, width and thickness), and B-10 content.

In addition, the licensee should discuss the impact it would have on the analyses should the coupons reveal a change in material performance from that assumed in the analyses.

Response to Question 3

VEGP does not have a Boral® coupon surveillance program. VEGP does not have any Boral® surveillance coupons. Creating coupons from the racks would require destruction of storage cells. The MY surveillance program, as discussed in Question 1b above, did not involve Boral® coupons.

The racks were licensed for use at VEGP in 1998 (Amendment 102 to FOL NFP-68 and Amendment 80 to FOL NFP-81 date June 29, 1998) with no requirement for a Boral® surveillance program. This is the current licensing basis for the Unit 1 spent fuel storage racks.

There is limited industry data available on blister properties (namely dimensional). The analyses and results described in Enclosure 5 of the amendment request contain several conservatisms which would offset the reactivity effects of blistering given this industry data.

Westinghouse has performed a sensitivity evaluation of the effect that the blistering of the Boral® aluminum clad has on the criticality analyses. The effects are that water is displaced by the blisters, thereby reducing the size and effectiveness of the flux trap. Also, soluble boron is displaced as the water is displaced. The evaluation considered a one-inch wide region along both edges on both sides of the Boral® plates in all storage cells. The thickness of this region was such that it filled the space between the Boral® plate and the cell wall on one side and the wrapper on the other side. Refer to Figure 2-2 on page 25 of Enclosure 5 of the amendment request for the storage cell geometry. The evaluation considered the Unit 1 "all-cell" and the "3-out-of-4" storage configurations. The "all-cell" storage configuration allows for burnup credit and Integral Fuel Burnable Absorber (IFBA) credit. The "3-out-of-4" storage configuration does not require burnup or IFBA credit.

The estimated effects are considered to be well within the conservatisms in the modeling and analyses such that the proposed burnup and IFBA requirements remain valid. The analyses, as reported in Enclosure 5 of the amendment request, have several conservatisms. These include: the IFBA length is modeled as 120 inches compared to the actual length of 132 inches; the IFBA strength (B-10 content) is uniformly reduced by 10%; the Boral® plate length is modeled as 136 inches compared to the actual length of 140 inches; the limiting flux trap size is modeled; and, a more limiting criterion than K-eff < 1 is applied.

SNC continues to monitor issues regarding the application of Boral® in spent fuel racks through its Operating Experience and Corrective Action programs. In addition, SNC continues to monitor the internal operating experience at one of its other plants that has a Boral® surveillance program.

Question 4

In your submittal dated November 20, 1997, an areal density of 0.0238 gm/cm^2 was assumed for the criticality analysis. In your submittal dated August 13, 2004, this same value is also assumed. Given that the racks have been exposed to radiation for many years at Maine Yankee and approximately 7 years at Vogtle; and tests have not been performed to verify the areal density of the panels prior to installation, provide the technical basis for the assumed areal density value and its continued use in the current criticality analysis. This justification should address Reference 4 of your November 20, 1997 submittal and industry experience.

Response to Question 4

Fabrication data were used to determine the areal density for both "new" and "reclaimed" Boral®. The bounding value (lower) of 0.0238 gm/cm^2 was used in the analyses. This was demonstrated in Reference 4 of Enclosure 5 of the November 20, 1997, amendment request.

The neutron flux in the spent fuel pool results from two sources of neutrons -- neutrons yielded from spontaneous fissions and capture events of alpha particles which produce neutrons. These two sources of neutrons together have an order of magnitude of about 10^7 neutrons per second per assembly. Combined with the area of the Boral®, the flux level at the surface of the Boral® is so low that B-10 depletion need not be considered. The resulting thermal flux level at the surface of the Boral® panels is further minimized by competing neutron capture events in the fuel rods and in the borated water.

Based on discussions with the Boral® plate manufacturer, various chemical and attenuation tests have shown that no degradation occurs in the levels of B-10 present in the Boral® or in its ability to absorb thermal neutrons from the long-term exposure of a spent fuel pool environment. This is supported by the results of Boral® surveillances performed at another SNC plant.