Proprietary Information
Withhold from Public Disclosure
Under 10 CFR 2.390

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SCE&G®
A SCANA COMPANY

November 3, 2016
RC-16-0147

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

Dear Sir / Madam:

Subject: VIRGIL C. SUMMER NUCLEAR STATION UNIT 1
DOCKET NO. 50-395
OPERATING LICENSE NO. NPF-12
RESPONSE TO GENERIC LETTER 2016-01, "MONITORING OF NEUTRON-ABSORBING MATERIALS IN SPENT FUEL POOLS"
RESPONSE TO NRC REQUEST FOR INFORMATION PURSUANT TO TITLE 10 OF THE CODE OF FEDERAL REGULATIONS 50.54(f)

Reference: NRC Generic Letter (GL) 2016-01, *Monitoring of Neutron-Absorbing Materials in Spent Fuel Pools*, dated April 7, 2016, ADAMS Accession Number ML16097A169

On April 7, 2016, the NRC issued GL 2016-01, referenced above, to all power reactor licensees except those that have permanently ceased operation with all power reactor fuel removed from on-site spent fuel pool storage.

The purpose of this letter is to provide a response for Virgil C. Summer Nuclear Station (VCSNS), Unit 1. VCSNS, 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. The VCSNS, Unit 1 spent fuel pool credits Boral.

Enclosure 1 contains Holtec Proprietary information entitled "VCS Boral Manufacturing Data from AAR," dated December 5, 2001. In addition, an accompanying affidavit is included in Enclosure 2 of this submittal.

As Enclosure 1 contains information proprietary to Holtec International, it is supported by an Affidavit signed by Holtec, the owner of the information. The Affidavit requests the information be withheld from public disclosure in accordance with 10CFR2.390.

A158
NRR

Enclosure 1, Pages 3 and 4, transmitted herewith contains Proprietary Information.
When separated from Enclosure 1, Pages 3 and 4, this transmittal document is decontrolled.

This letter contains no new regulatory commitments. If you have any questions regarding this submittal, please contact Bruce L. Thompson at 803-931-5042.

I certify under penalty of perjury that the foregoing is true and correct.

11/3/16
Executed on

George A. Lippard

TS/GAL/rp

Enclosure 1: Response to Areas of Requested Information in Appendix A of Generic Letter 2016-01, "Monitoring of Neutron-Absorbing Materials in Spent Fuel Pools" (Proprietary Version)
Enclosure 2: Holtec International Affidavit to Request Withholding of Proprietary Information from Public Disclosure
Enclosure 3: Response to Areas of Requested Information in Appendix A of Generic Letter 2016-01, "Monitoring of Neutron-Absorbing Materials in Spent Fuel Pools" (Non-Proprietary Version)

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VIRGIL C. SUMMER NUCLEAR STATION UNIT 1
DOCKET NO. 50-395
OPERATING LICENSE NO. NPF-12

ENCLOSURE 1

RESPONSE TO AREAS OF REQUESTED INFORMATION IN APPENDIX A OF GENERIC LETTER 2016-01, "MONITORING OF NEURTON-ABSORBING MATERIALS IN SPENT FUEL POOL" (PROPRIETARY VERSION)

REQUESTED INFORMATION FROM POWER REACTOR ADRESSEES

The NRC requests information in the following five areas for use in verifying compliance:

(1) a description of the neutron-absorbing material credited in the SFP NCS analysis of record (AOR) and its configuration in the SFP;

(2) a description of 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;

(3) a description of the technical basis for determining the interval of surveillance or monitoring for the credited neutron-absorbing material;

(4) a description of 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; and

(5) a description of 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.

As stated in Generic Letter 2016-01, the NRC will accept responses based on categorization. VCSNS Unit 1 monitoring program was not incorporated as a technical specification change or a license condition in license amendment No. 160 [ML022330203]; therefore, VCSNS Unit 1 is a Category 4. Boral is the material present and credited in the spent fuel pool.

Category 4: The NRC seeks information in five areas depending upon the type of neutron absorber material used by the licensee in the SFP. Table 1, below, contains the areas of information to be provided by the licensee with respect to each type of neutron absorber material. VCSNS SFP credits Boral; therefore, VCSNS is required to provide information for the following areas: 1, 2 (except 2(b)(iii)), and 4.

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

Boral is fully sheathed to prevent flow-induced degradation, but vented to allow gas to escape (Reference 2). Borated water with a concentration of greater than or equal to 2000 parts per million contacts the Boral panels.

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

i) estimated current minimum areal density;

Results of coupon testing of the neutron absorber have provided no indication of loss of neutron absorbing material. Results of chemistry testing of the spent fuel pool water have provided no indication of aluminum corrosion. Therefore, the estimated current minimum areal density is the same as when the material was fabricated in 2001and installed in the SFP in 2003 (Reference 10).

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

Minimum AOR areal density = 0.0300 g/cm^2 (Reference 4)

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).

No degradation of Boral in the SFP has been noted (Reference 10).

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.

The coupon surveillance program is administratively controlled by plant procedure VCS-REP-1801, *Surveillance Test Program for Neutron Absorbing Material Contained in the Spent Fuel Racks.* Every 10 years, coupons are removed for testing to verify that the coupon maintains its ability to absorb neutrons as designed (Reference 10).

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:

The coupon surveillance program at VCSNS is managed following guidance provided in draft NEI 16-03, *Guidance for Monitoring of Fixed Neutron Absorbers in Spent Fuel Pools*, May 2016 (Reference 11).

Coupons are constructed from surrogate material from the same manufacturing lots as the as-installed material. Coupons are able to detect aging/degradation mechanisms that the in-service neutron absorber materials experience. Coupons are placed in a location in the spent fuel pool near freshly discharged fuel, which provides exposure to gamma and neutron irradiation and higher than average water temperatures. Neutron attenuation testing is performed every 10 years on the coupon to verify the expected attenuation of thermal neutrons. The coupon is also measured to verify dimensional stability (Reference 10).

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

Due to good operational performance in nuclear power plants, Boral was deemed of sufficient robustness to not require a monitoring program (Reference 12). Many licensees (including SCE&G) that installed Boral therefore were not required to have a monitoring program. However, SCE&G continues to participate in industry operating experience sharing forums, such as EPRI's Neutron Absorber Users Group (NAUG) and spent fuel pool chemistry is monitored on a regular basis.

Blistering and pitting have been noted on coupons by several utilities, but no degradation in neutron absorption capability has been measured.

Sixteen (16) Boral coupons were provided at the time of manufacturing. They were mounted in the spent fuel pool for periodic sampling. Since Boral is an industry standard material with a good performance history, the planned sampling frequency is at least every 10 years, until degradation is noted (References 11 and 13). The sampling frequency was chosen per guidance provided in draft NEI 16-03 and NEI 12-16, *Guidance for Performing Criticality Analyses of Fuel Storage at Light-Water Reactor Power Plants*, 2014, Revision 1 (References 11 and 13).

One sample is removed for analysis each sampling period (Reference 10).

ii) parameters to be inspected and data collected;

Visual observations and photography (Reference 10)
Dimensional measurements (length, width, and thickness)
Coupon weight
Coupon density
Determination of B-10 content by neutron attenuation measurements

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;

1 - No increase in thickness at any point greater than 10% of the initial thickness at that point (10% increase would indicate swelling, which could indicate degradation).
2 - No more than a 5% decrease in Boron-10 content as determined by neutron attenuation measurements. (5% decrease would indicate measurable degradation)
3 – Measured B10 areal density remains higher than AOR requirement (Reference 10).

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

Coupon surveillance results are reviewed by qualified reactor engineers. The data is trended and recorded using qualified procedures. Any degradation noted in trending would be resolved by the corrective action program (Reference 10).

v) industry standards used.

NIST-traceable standard weights and gage blocks were used to verify the accuracy of the dimensional measurements and the weights used to calculate the coupon density (Reference 10).

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

No visual inspection is possible because the panels are fully sheathed (Reference 9).

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

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 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;

The coupons are representative 4x8 inch samples from the actual manufacturing lots which produced the in-service absorbers. The coupons are mounted in the same spent fuel pool. The coupons are maintained in a high dose area within Region 2. Each reload cycle, they are surrounded by four freshly-discharged fuel assemblies to ensure that the coupons experience a bounding radiation field (Reference 10). The coupons are bolted to a support structure to maintain their axial spacing. The support structure contacts the rack baseplate, so the coupons experience the same galvanic environment as the in-service panels (Reference 14).

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

A single set of 16 coupons was installed in the spent fuel pool in 2003 following reracking of the whole pool (References 14 and 15).

(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

No coupons have been returned to the SFP for further evaluation (Reference 10).

(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.

Fifteen (15) coupons remain to be tested. The schedule is for removal of one coupon every 10 years until a problem is noted during coupon testing or notification of other relevant Operating Experience. This should provide a sufficient sample inventory for the life of the spent fuel racks. The Unit 1 operating license currently extends to 2042. (Reference 10)

iii) If RACKLIFE is used:

VCSNS SFP credits Boral. RACKLIFE is not used.

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

No in-situ testing has been used (Reference 10).

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.

No Boraflex, Carborundum, or Tetrabor is credited (Reference 4).

4) For any Boraflex, Carborundum, Tetrabor, or Boral being credited, describe how the credited neutron-absorbing material is modeled in the SFP NCS AOR and how the monitoring or surveillance program ensures that the actual condition of the neutron-absorbing material is bounded by the NCS AOR.

a) Describe the technical basis for the method of modeling the neutron-absorbing material in the NCS AOR. Discuss whether the modeling addresses degraded neutron-absorbing material, including loss of material, deformation of material (such as blisters, gaps, cracks, and shrinkage), and localized effects, such as non-uniform degradation.

The AOR does not address degraded Boral. It models the minimum areal density of 0.03 g/cm^2, so any degradation below that value would require reanalysis (Reference 10).

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 minimum areal density allowed in the surveillance program ensures the AOR assumptions are met. If any degradation of the coupon is noted, additional testing would be performed in the affected area to determine the extent of degradation. If the degradation were significant, a change to the monitoring program or revision of the AOR may become necessary (References 4 and 10). No degradation has been noted in the single coupon that has been analyzed. No blistering, bulging, pitting, or warping was

observed. All measured dimension and parameters were within the expected range (Reference 10A).

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

The AOR (Reference 4) addresses the uncertainty of the rack manufacturing process, but does not address uncertainties in the monitoring program. The monitoring program is designed to monitor for degradation. Since no degradation has been noted, the AOR does not need to address degradation (Reference 10).

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

No degradation is modeled in the AOR (Reference 4).

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).

No Boraflex, Carborundum, or Tetrabor is credited (Reference 4).

References:

1. Holtec Purchase Order 1093PK to AAR Manufacturing for Boral Panels, dated 6/21/2001
2. VCS modification ECR-50183, Spent Fuel Pool Reracking, 2003
3. VCS Boral manufacturing data from AAR 12/5/2001
4. TR04110-001, Criticality Evaluation for the VC Summer Rerack Project, Rev. 0
5. "Overview of Boral Performance Based Upon Surveillance Coupon Measurements," EPRI, Palo Alto, CA: 2010. Report 1021052
6. "Strategy for Managing the Long-Term Use of Boral® in Spent Fuel Storage Pools," EPRI, Palo Alto, CA: 2012. Report 1025204
7. "Handbook of Neutron Absorber Materials for Spent Nuclear Fuel Transportation and Storage Applications," EPRI, Palo Alto, CA: 2009. Report 1019110
8. Letter from NRC to SCE&G, 8/30/2002, "Virgil C. Summer Nuclear Station, Unit No.1 -Issuance of Amendment Re: Spent Fuel Pool Expansion (TAC NO. MB2475)" [ML022330203]
9. VCS Drawing 1MS-15-242, Region 1 Spent Fuel Rack, 2003
   VCS Drawing 1MS-15-244, Region 2 Spent Fuel Rack, 2003
10. VCS-REP-1801, Surveillance Test Program For Neutron Absorbing Material Contained in the Spent Fuel Racks

10A. STTS#1009204-001 Coupon 1 removed 5/3/2011 HOLTEC REPORT NO: HI-2115011

11. NEI 16-03, (DRAFT) Guidance for Monitoring of Fixed Neutron Absorbers in Spent Fuel Pools, May 2016
12. NRC letter from Laurence I. Kopp to Dr. Krishna P. Singh, dated February 15, 1995 [ML9502230383]
13. NEI-12-16 Rev. 1, "Guidance for Performing Criticality Analyses of Fuel Storage at Light-Water Reactor Power Plants", 2014
14. Holtec Drawing 3371 Rev. 2, "Test Coupon and Coupon Tree", 2001
15. TracWorks Special Nuclear Material Database for Boral Specimen Tree, 2003 to 2015

VIRGIL C. SUMMER NUCLEAR STATION UNIT 1
DOCKET NO. 50-395
OPERATING LICENSE NO. NPF-12

ENCLOSURE 2

HOLTEC INTERNATIONAL AFFIDAVIT TO REQUEST WITHHOLDING OF PROPRIETARY INFORMATION FROM PUBLIC DISCLOSURE

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Document ID RC-16-0147-AFF

AFFIDAVIT PURSUANT TO 10 CFR 2.390

I, Kimberly Manzione, being duly sworn, depose and state as follows:

(1) I have reviewed the information described in paragraph (2) which is sought to be withheld, and am authorized to apply for its withholding.

(2) The information sought to be withheld is information provided in reference documents listed below as noted in SCE&G Letter RC-16-0147. These documents have been requested for transmittal via SCE&G Letter 2016-01. These following references contain Holtec Proprietary information:

- VCS Boral manufacturing data from AAR 12/5/2001

(3) In making this application for withholding of proprietary information of which it is the owner, Holtec International relies upon the exemption from disclosure set forth in the Freedom of Information Act ("FOIA"), 5 USC Sec. 552(b)(4) and the Trade Secrets Act, 18 USC Sec. 1905, and NRC regulations 10CFR Part 9.17(a)(4), 2.390(a)(4), and 2.390(b)(1) for "trade secrets and commercial or financial information obtained from a person and privileged or confidential" (Exemption 4). The material for which exemption from disclosure is here sought is all "confidential commercial information", and some portions also qualify under the narrower definition of "trade secret", within the meanings assigned to those terms for purposes of FOIA Exemption 4 in, respectively, Critical Mass Energy Project v. Nuclear Regulatory Commission, 975F2d871 (DC Cir. 1992), and Public Citizen Health Research Group v. FDA, 704F2d1280 (DC Cir. 1983).

(4) Some examples of categories of information which fit into the definition of proprietary information are:

a. Information that discloses a process, method, or apparatus, including supporting data and analyses, where prevention of its use by Holtec's competitors without license from Holtec International constitutes a competitive economic advantage over other companies;

b. Information which, if used by a competitor, would reduce his expenditure of resources or improve his competitive position in the design, manufacture, shipment, installation, assurance of quality, or licensing of a similar product.

c. Information which reveals cost or price information, production, capacities, budget levels, or commercial strategies of Holtec International, its customers, or its suppliers;

d. Information which reveals aspects of past, present, or future Holtec International customer-funded development plans and programs of potential commercial value to Holtec International;

e. Information which discloses patentable subject matter for which it may be desirable to obtain patent protection.

The information sought to be withheld is considered to be proprietary for the reasons set forth in paragraphs 4.a and 4.b above.

(5) The information sought to be withheld is being submitted to the NRC in confidence. The information (including that compiled from many sources) is of a sort customarily held in confidence by Holtec International, and is in fact so held. The information sought to be withheld has, to the best of my knowledge and belief, consistently been held in confidence by Holtec International. No public disclosure has been made, and it is not available in public sources. All disclosures to third parties, including any required transmittals to the NRC, have been made, or must be made, pursuant to regulatory provisions or proprietary

agreements which provide for maintenance of the information in confidence. Its initial designation as proprietary information, and the subsequent steps taken to prevent its unauthorized disclosure, are as set forth in paragraphs (6) and (7) following.

(6) Initial approval of proprietary treatment of a document is made by the manager of the originating component, the person most likely to be acquainted with the value and sensitivity of the information in relation to industry knowledge. Access to such documents within Holtec International is limited on a "need to know" basis.

(7) The procedure for approval of external release of such a document typically requires review by the staff manager, project manager, principal scientist or other equivalent authority, by the manager of the cognizant marketing function (or his designee), and by the Legal Operation, for technical content, competitive effect, and determination of the accuracy of the proprietary designation. Disclosures outside Holtec International are limited to regulatory bodies, customers, and potential customers, and their agents, suppliers, and licensees, and others with a legitimate need for the information, and then only in accordance with appropriate regulatory provisions or proprietary agreements.

(8) The information classified as proprietary was developed and compiled by Holtec International at a significant cost to Holtec International. This information is classified as proprietary because it contains detailed descriptions of analytical approaches and methodologies not available elsewhere. This information would provide other parties, including competitors, with information from Holtec International's technical database and the results of evaluations performed by Holtec International. A substantial effort has been expended by Holtec International to develop this information. Release of this information would improve a competitor's position because it would enable Holtec's competitor to copy our technology and offer it for sale in competition with our company, causing us financial injury.

(9) Public disclosure of the information sought to be withheld is likely to cause substantial harm to Holtec International's competitive position and foreclose or reduce the availability of profit-making opportunities. The information is part of Holtec International's comprehensive spent fuel storage technology base, and its commercial value extends beyond the original development cost. The value of the technology base goes beyond the extensive physical database and analytical methodology, and includes development of the expertise to determine and apply the appropriate evaluation process.

The research, development, engineering, and analytical costs comprise a substantial investment of time and money by Holtec International.

The precise value of the expertise to devise an evaluation process and apply the correct analytical methodology is difficult to quantify, but it clearly is substantial.

Holtec International's competitive advantage will be lost if its competitors are able to use the results of the Holtec International experience to normalize or verify their own process or if they are able to claim an equivalent understanding by demonstrating that they can arrive at the same or similar conclusions.

The value of this information to Holtec International would be lost if the information were disclosed to the public. Making such information available to competitors without their having been required to undertake a similar expenditure of resources would unfairly provide competitors with a windfall, and deprive Holtec International of the opportunity to exercise its competitive advantage to seek an adequate return on its large investment in developing these very valuable analytical tools.

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Document ID RC-16-0147-AFF

AFFIDAVIT PURSUANT TO 10 CFR 2.390

STATE OF NEW JERSEY)
) ss:
COUNTY OF BURLINGTON)

Kimberly Manzione, being duly sworn, deposes and says:

That she has read the foregoing affidavit and the matters stated therein are true and correct to the best of her knowledge, information, and belief.

Executed at Marlton, New Jersey, this 3rd day of November 2016.

Kimberly Manzione
Holtec International

Subscribed and sworn before me this 3rd day of November, 2016.

ERIKA GRANDRIMO

NOTARY PUBLIC
My Commission Expires 1/17/2017

VIRGIL C. SUMMER NUCLEAR STATION UNIT 1
DOCKET NO. 50-395
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ENCLOSURE 3

RESPONSE TO AREAS OF REQUESTED INFORMATION IN APPENDIX A OF GENERIC LETTER 2016-01, "MONITORING OF NEURTON-ABSORBING MATERIALS IN SPENT FUEL POOL" (NON-PROPRIETARY VERSION)

REQUESTED INFORMATION FROM POWER REACTOR ADRESSEES

The NRC requests information in the following five areas for use in verifying compliance:

(1) a description of the neutron-absorbing material credited in the SFP NCS analysis of record (AOR) and its configuration in the SFP;

(2) a description of 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;

(3) a description of the technical basis for determining the interval of surveillance or monitoring for the credited neutron-absorbing material;

(4) a description of 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; and

(5) a description of 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.

As stated in Generic Letter 2016-01, the NRC will accept responses based on categorization. VCSNS Unit 1 monitoring program was not incorporated as a technical specification change or a license condition in license amendment No. 160 [ML022330203]; therefore, VCSNS Unit 1 is a Category 4. Boral is the material present and credited in the spent fuel pool.

Category 4: The NRC seeks information in five areas depending upon the type of neutron absorber material used by the licensee in the SFP. Table 1, below, contains the areas of information to be provided by the licensee with respect to each type of neutron absorber material. VCSNS SFP credits Boral; therefore, VCSNS is required to provide information for the following areas: 1, 2 (except 2(b)(iii)), and 4.

Table 1 – Areas of Information by Neutron Absorber Material Types					
	Areas of Requested Information (described in Appendix A of GL-2016-01)				
Neutron-Absorbing Material Type	(1)	(2)	(3)	(4)	(5)
Boraflex Carborundum Tetrabor	x	x	x	x	x
Boral	x	x*		x	
Borated stainless steel Metamic Boralcan Other metallic matrix composites	x	x*			

*Except for 2(b)(iii).

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;

Boral manufacturer – AAR Manufacturing, Inc. (Reference 1)
Rack manufacturer – US Tool and Die
Rack designer – Holtec International
Boral panels manufactured in 2001
Spent fuel racks manufactured in 2002
Spent fuel racks installed in VC Summer Unit 1 spent fuel pool in 2003 (Reference 2)

b) neutron-absorbing material specifications, such as:

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

Material of construction – Boral (Reference 3)
Certified content – 0.030 g/cm^2 B-10 loading (Reference 4)

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

nominal as-built B10 areal density – 0.0324 g/cm^2 (Reference 4)
minimum certified B10 areal density – 0.0300 (Reference 4)
minimum as-built B10 areal density – [redacted] (Reference 3)
maximum as-built B10 areal density – [redacted] (Reference 3)
average as-built B10 areal density – [redacted] (Reference 3)

Minimum, average, and maximum as-built areal densities reported above are from the range of data points for the manufacturing data available to the licensee. This data is not available for each panel, but is reported for each manufacturing lot of material.

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

porosity – unknown. No porosity data was reported by the manufacturer (Reference 3).

Boral density = 2.43 to 2.46 g/cc measured on coupons. Boral is not specified on a density basis, so this parameter is only available for coupons.

dimensions:
Thickness = 0.101 inch [redacted] inch
Width = 7.5 [redacted] inch
Length = 145 [redacted] inch

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

Boral is an industry standard material with a history of good performance. Blistering and pitting have been noted on coupons by several utilities, but no degradation in neutron absorption capability has been identified. Appropriate NRC personnel are familiar with the qualification testing performed on the material prior to use in spent fuel pools. Since the material was installed in spent fuel pools, EPRI has coordinated information sharing between utilities and NRC to ensure all parties are aware of test results (References 5, 6, and 7). No qualification testing specific to VCSNS was requested by the NRC when license amendment No. 106 [ML022330203] for use of Boral was issued in 2002 (Reference 8).

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

Boral panels are covered with stainless steel sheathing, which is spot-welded to the rack structure (Reference 9).

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

Boral is fully sheathed to prevent flow-induced degradation, but vented to allow gas to escape (Reference 2). Borated water with a concentration of greater than or equal to 2000 parts per million contacts the Boral panels.

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

i) estimated current minimum areal density;

Results of coupon testing of the neutron absorber have provided no indication of loss of neutron absorbing material. Results of chemistry testing of the spent fuel pool water have provided no indication of aluminum corrosion. Therefore, the estimated current minimum areal density is the same as when the material was fabricated in 2001and installed in the SFP in 2003 (Reference 10).

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

Minimum AOR areal density = 0.0300 g/cm^2 (Reference 4)

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).

No degradation of Boral in the SFP has been noted (Reference 10).

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.

The coupon surveillance program is administratively controlled by plant procedure VCS-REP-1801, *Surveillance Test Program for Neutron Absorbing Material Contained in the Spent Fuel Racks*. Every 10 years, coupons are removed for testing to verify that the coupon maintains its ability to absorb neutrons as designed (Reference 10).

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:

The coupon surveillance program at VCSNS is managed following guidance provided in draft NEI 16-03, *Guidance for Monitoring of Fixed Neutron Absorbers in Spent Fuel Pools*, May 2016 (Reference 11).

Coupons are constructed from surrogate material from the same manufacturing lots as the as-installed material. Coupons are able to detect aging/degradation mechanisms that the in-service neutron absorber materials experience. Coupons are placed in a location in the spent fuel pool near freshly discharged fuel, which provides exposure to gamma and neutron irradiation and higher than average water temperatures. Neutron attenuation testing is performed every 10 years on the coupon to verify the expected attenuation of thermal neutrons. The coupon is also measured to verify dimensional stability (Reference 10).

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

Due to good operational performance in nuclear power plants, Boral was deemed of sufficient robustness to not require a monitoring program (Reference 12). Many licensees (including SCE&G) that installed Boral therefore were not required to have a monitoring program. However, SCE&G continues to participate in industry operating experience sharing forums, such as EPRI's Neutron Absorber Users Group (NAUG) and spent fuel pool chemistry is monitored on a regular basis.

Blistering and pitting have been noted on coupons by several utilities, but no degradation in neutron absorption capability has been measured.

Sixteen (16) Boral coupons were provided at the time of manufacturing. They were mounted in the spent fuel pool for periodic sampling. Since Boral is an industry standard material with a good performance history, the planned sampling frequency is at least every 10 years, until degradation is noted (References 11 and 13). The sampling frequency was chosen per guidance provided in draft NEI 16-03 and NEI 12-16, *Guidance for Performing Criticality Analyses of Fuel Storage at Light-Water Reactor Power Plants*, 2014, Revision 1 (References 11 and 13).

One sample is removed for analysis each sampling period (Reference 10).

ii) parameters to be inspected and data collected;

Visual observations and photography (Reference 10)
Dimensional measurements (length, width, and thickness)
Coupon weight
Coupon density
Determination of B-10 content by neutron attenuation measurements

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;

1 - No increase in thickness at any point greater than 10% of the initial thickness at that point (10% increase would indicate swelling, which could indicate degradation).
2 - No more than a 5% decrease in Boron-10 content as determined by neutron attenuation measurements. (5% decrease would indicate measurable degradation)
3 – Measured B10 areal density remains higher than AOR requirement (Reference 10).

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

Coupon surveillance results are reviewed by qualified reactor engineers. The data is trended and recorded using qualified procedures. Any degradation noted in trending would be resolved by the corrective action program (Reference 10).

v) industry standards used.

NIST-traceable standard weights and gage blocks were used to verify the accuracy of the dimensional measurements and the weights used to calculate the coupon density (Reference 10).

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

No visual inspection is possible because the panels are fully sheathed (Reference 9).

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

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 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;

The coupons are representative 4x8 inch samples from the actual manufacturing lots which produced the in-service absorbers. The coupons are mounted in the same spent fuel pool. The coupons are maintained in a high dose area within Region 2. Each reload cycle, they are surrounded by four freshly-discharged fuel assemblies to ensure that the coupons experience a bounding radiation field (Reference 10). The coupons are bolted to a support structure to maintain their axial spacing. The support structure contacts the rack baseplate, so the coupons experience the same galvanic environment as the in-service panels (Reference 14).

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

A single set of 16 coupons was installed in the spent fuel pool in 2003 following reracking of the whole pool (References 14 and 15).

(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

No coupons have been returned to the SFP for further evaluation (Reference 10).

(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.

Fifteen (15) coupons remain to be tested. The schedule is for removal of one coupon every 10 years until a problem is noted during coupon testing or notification of other relevant Operating Experience. This should provide a sufficient sample inventory for the life of the spent fuel racks. The Unit 1 operating license currently extends to 2042. (Reference 10)

iii) If RACKLIFE is used:

VCSNS SFP credits Boral. RACKLIFE is not used.

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

No in-situ testing has been used (Reference 10).

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.

No Boraflex, Carborundum, or Tetrabor is credited (Reference 4).

4) For any Boraflex, Carborundum, Tetrabor, or Boral being credited, describe how the credited neutron-absorbing material is modeled in the SFP NCS AOR and how the monitoring or surveillance program ensures that the actual condition of the neutron-absorbing material is bounded by the NCS AOR.

a) Describe the technical basis for the method of modeling the neutron-absorbing material in the NCS AOR. Discuss whether the modeling addresses degraded neutron-absorbing material, including loss of material, deformation of material (such as blisters, gaps, cracks, and shrinkage), and localized effects, such as non-uniform degradation.

The AOR does not address degraded Boral. It models the minimum areal density of 0.03 g/cm^2, so any degradation below that value would require reanalysis (Reference 10).

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 minimum areal density allowed in the surveillance program ensures the AOR assumptions are met. If any degradation of the coupon is noted, additional testing would be performed in the affected area to determine the extent of degradation. If the degradation were significant, a change to the monitoring program or revision of the AOR may become necessary (References 4 and 10). No degradation has been noted in the single coupon that has been analyzed. No blistering, bulging, pitting, or warping was

observed. All measured dimension and parameters were within the expected range (Reference 10A).

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

The AOR (Reference 4) addresses the uncertainty of the rack manufacturing process, but does not address uncertainties in the monitoring program. The monitoring program is designed to monitor for degradation. Since no degradation has been noted, the AOR does not need to address degradation (Reference 10).

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

No degradation is modeled in the AOR (Reference 4).

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).

No Boraflex, Carborundum, or Tetrabor is credited (Reference 4).

References:

1. Holtec Purchase Order 1093PK to AAR Manufacturing for Boral Panels, dated 6/21/2001
2. VCS modification ECR-50183, Spent Fuel Pool Reracking, 2003
3. VCS Boral manufacturing data from AAR 12/5/2001
4. TR04110-001, Criticality Evaluation for the VC Summer Rerack Project, Rev. 0
5. "Overview of Boral Performance Based Upon Surveillance Coupon Measurements," EPRI, Palo Alto, CA: 2010. Report 1021052
6. "Strategy for Managing the Long-Term Use of Boral® in Spent Fuel Storage Pools," EPRI, Palo Alto, CA: 2012. Report 1025204
7. "Handbook of Neutron Absorber Materials for Spent Nuclear Fuel Transportation and Storage Applications," EPRI, Palo Alto, CA: 2009. Report 1019110
8. Letter from NRC to SCE&G, 8/30/2002, "Virgil C. Summer Nuclear Station, Unit No.1 -Issuance of Amendment Re: Spent Fuel Pool Expansion (TAC NO. MB2475)" [ML022330203]
9. VCS Drawing 1MS-15-242, Region 1 Spent Fuel Rack, 2003
   VCS Drawing 1MS-15-244, Region 2 Spent Fuel Rack, 2003
10. VCS-REP-1801, Surveillance Test Program For Neutron Absorbing Material Contained in the Spent Fuel Racks

10A. STTS#1009204-001 Coupon 1 removed 5/3/2011 HOLTEC REPORT NO: HI-2115011

11. NEI 16-03, (DRAFT) Guidance for Monitoring of Fixed Neutron Absorbers in Spent Fuel Pools, May 2016
12. NRC letter from Laurence I. Kopp to Dr. Krishna P. Singh, dated February 15, 1995 [ML9502230383]
13. NEI-12-16 Rev. 1, "Guidance for Performing Criticality Analyses of Fuel Storage at Light-Water Reactor Power Plants", 2014
14. Holtec Drawing 3371 Rev. 2, "Test Coupon and Coupon Tree", 2001
15. TracWorks Special Nuclear Material Database for Boral Specimen Tree, 2003 to 2015