June 3, 2004

Mr. George Vanderheyden, Vice President
Calvert Cliffs Nuclear Plant, Inc.
Calvert Cliffs Nuclear Power Plant
1650 Calvert Cliffs Parkway
Lusby, MD 20657-4702

SUBJECT: CALVERT CLIFFS NUCLEAR POWER PLANT, UNIT NO. 1 - AMENDMENT RE: INCREASING THE SPENT FUEL POOL MAXIMUM ENRICHMENT LIMIT (TAC NO. MB8896)

Dear Mr. Vanderheyden:

The Commission has issued the enclosed Amendment No. 267 to Renewed Facility Operating License No. DPR-53 for the Calvert Cliffs Nuclear Power Plant, Unit No. 1. This amendment consists of changes to the Technical Specifications (TSs) in response to your application transmitted by letter dated May 1, 2003 (ADAMS Accession No. ML031270288), as supplemented September 25, 2003 (ADAMS Accession No. ML032740122), November 3, 2003 (ADAMS Accession No. ML033140075), and February 25, 2004 (ADAMS Accession No. ML040610679).

The amendment adds TS 3.7.16, “Spent Fuel Pool Boron Concentration,” modifies TS 4.3.1, “Criticality” and adds an additional license condition that requires the licensee to develop a long-term coupon surveillance program for the Carborundum samples.

A copy of the related Safety Evaluation is enclosed. A Notice of Issuance will be included in the Commission's next regular biweekly *Federal Register* notice.

Sincerely,

/RA/

Guy S. Vissing, Senior Project Manager, Section 1
Project Directorate I
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Docket No. 50-317

Enclosures: 1. Amendment No. 267 to DPR-53
2. Safety Evaluation

cc w/encls: See next page

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cc w/encls: See next page

ADAMS Accession Numbers: Letter - ML041040129; TSs - ML ;
Package Number - ML041040160
*Safety evaluation provided - no significant changes made

OFFICE	PDI-1/PM	PDI-1/LA	SRXB:SC	SPLB:SC	EMCB:SC	OGC	PDI-1/SC
NAME	GVissing	SLittle	JUhle*	DSolorio	LLund*	THull	RLaufer
DATE	4/27/04	4/26/04	03/08/04	4/29/04	03/23/2004	5/12/04	6/2/04

OFFICIAL RECORD COPY

DATED: June 3, 2004

AMENDMENT NO. 267 TO RENEWED FACILITY OPERATING LICENSE NO. DPR-53
CALVERT CLIFFS UNIT 1

PUBLIC
PDI-1 R/F
RLaufer
SLittle
GVissing
Y. Diaz
R. Young
M. Langschwager
R. Taylor
OGC
GHill (2)
TBoyce
WBeckner
ACRS
CBixler, RI

cc: Plant Service list

Calvert Cliffs Nuclear Power Plant, Unit Nos. 1 and 2

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CALVERT CLIFFS NUCLEAR POWER PLANT, INC.

DOCKET NO. 50-317

CALVERT CLIFFS NUCLEAR POWER PLANT, UNIT NO. 1

AMENDMENT TO RENEWED FACILITY OPERATING LICENSE

Amendment No. 267
Renewed License No. DPR-53

1. The Nuclear Regulatory Commission (the Commission) has found that:

   A. The application for amendment by Calvert Cliffs Nuclear Power Plant, Inc. (the licensee) dated May 1, 2003 (ADAMS Accession No. ML031270288), as supplemented September 25, 2003 (ADAMS Accession No. ML032740122), November 3, 2003 (ADAMS Accession No. ML033140075), and February 25, 2004 (ADAMS Accession No. ML040610679), complies with the standards and requirements of the Atomic Energy Act of 1954, as amended (the Act) and the Commission's rules and regulations set forth in 10 CFR Chapter I;

   B. The facility will operate in conformity with the application, the provisions of the Act, and the rules and regulations of the Commission;

   C. There is reasonable assurance (i) that the activities authorized by this amendment can be conducted without endangering the health and safety of the public, and (ii) that such activities will be conducted in compliance with the Commission's regulations;

   D. The issuance of this amendment will not be inimical to the common defense and security or to the health and safety of the public; and

   E. The issuance of this amendment is in accordance with 10 CFR Part 51 of the Commission's regulations and all applicable requirements have been satisfied.

2. Accordingly, the license is amended by changes to the Technical Specifications as indicated in the attachment to this license amendment, and paragraph 2.C.2. of Renewed Facility Operating License No. DPR-53 is hereby amended to read as follows:

2. Technical Specifications

The Technical Specifications contained in Appendices A and B, as revised through Amendment No.   , are hereby incorporated into the license. The licensee shall operate the facility in accordance with the Technical Specifications.

3. This license amendment is effective as of the date of its issuance and shall be implemented within 30 days.

FOR THE NUCLEAR REGULATORY COMMISSION

/RA/

Richard J. Laufer, Chief, Section 1
Project Directorate I
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Attachment:
Changes to the Technical
Specifications

Date of Issuance: June 3, 2004

ATTACHMENT TO LICENSE AMENDMENTS

AMENDMENT NO. 267 TO RENEWED FACILITY OPERATING LICENSE NO. DPR-53

DOCKET NO. 50-317

Replace the following pages of the Appendix A Technical Specifications with the attached revised pages. The revised pages are identified by amendment number and contain marginal lines indicating the areas of change.

Remove Pages	Insert Pages
iii	iii
iv	iv
v	v
- - -	3.7.16-1
4.0-2	4.0-2
4.0-3	4.0-3

Add the following page to Appendix C Additional Conditions. The added page is identified by amendment number and contains marginal lines indicating the areas of change.

Remove Page	Insert Page
4	4

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO AMENDMENT NO. 267 TO RENEWED

FACILITY OPERATING LICENSE NO. DPR-53

CALVERT CLIFFS NUCLEAR POWER PLANT, INC.

CALVERT CLIFFS NUCLEAR POWER PLANT, UNIT NO. 1

DOCKET NO. 50-317

1.0 INTRODUCTION

By letter dated May 1, 2003 (ADAMS Accession No. ML031270288), as supplemented September 25, 2003 (ADAMS Accession No. ML032740122), November 3, 2003 (ADAMS Accession No. ML033140075), and February 25, 2004 (ADAMS Accession No. ML040610679). the Calvert Cliffs Nuclear Power Plant, Inc. (CCNPPI or the licensee) submitted a request for changes to the Calvert Cliffs Nuclear Power Plant, (CCNPP) Unit No. 1, Technical Specifications (TSs) and Appendix C Additional License Conditions. The requested changes would add TS 3.7.16, "Spent Fuel Pool Boron Concentration," modify TS 4.3.1, "Criticality" and add an additional license condition that requires the licensee to develop a long-term coupon surveillance program for the Carborundum samples. The September 25, 2003, November 3, 2003, and February 25, 2004, letters provided additional information that clarified the application, did not expand the scope of the application as originally noticed, and did not change the staff's original proposed no significant hazards consideration determination as published in the *Federal Register* on May 27, 2003 (68 FR 28846).

2.0 REGULATORY EVALUATION

2.1 Regulatory Requirements and Guidelines

Title 10 of the *Code of Federal Regulations* (10 CFR), Part 50 Appendix A, "General Design Criteria (GDC) for Nuclear Power Plants" (Reference 5), provides a list of the minimum design requirements for nuclear power plants. According to GDC 62, "Prevention of criticality in fuel storage and handling," the licensee must limit the potential for criticality in the fuel handling and storage system by physical systems or processes. The staff reviewed the amendment request to ensure that the licensee complied with GDC 62.

10 CFR Section 50.68, "Criticality accident requirements" (Reference 6), provides the Nuclear Regulatory Commission (NRC) regulatory requirements for maintaining subcritical conditions in spent fuel pools. Specifically, 10 CFR 50.68(b)(4) provides the SFP regulatory requirements if soluble boron is credited for criticality control. 10 CFR 50.68(b)(4) states that "If no credit for soluble boron is taken, the k-effective of the spent fuel storage racks loaded with fuel of the maximum fuel assembly reactivity must not exceed 0.95, at a 95 percent probability, 95 percent

confidence level, if flooded with unborated water. If credit is taken for soluble boron, the k-effective of the spent fuel storage racks loaded with fuel of the maximum fuel assembly reactivity must not exceed 0.95, at a 95 percent probability, 95 percent confidence level, if flooded with borated water, and the k-effective must remain below 1.0 (subcritical), at a 95 percent probability, 95 percent confidence level, if flooded with unborated water." This regulatory requirement directly pertains to the licensee's amendment, since it proposes to begin crediting soluble boron in the Unit 1 SFP.

Radiation monitors are provided in storage and associated handling areas when fuel is present to detect excessive radiation levels and to initiate appropriate safety actions.

The maximum nominal U-235 enrichment of the fresh fuel assemblies is limited to five (5.0) percent by weight.

The NRC defined acceptable methodologies for performing SFP criticality analyses in three documents:

1. NUREG-0800, Standard Review Plan, Section 9.1.2, "Spent Fuel Storage," Draft Revision 4, (Reference 7);

2. Proposed Revision 2 to Regulatory Guide 1.13, "Spent Fuel Storage Facility Design Basis," (Reference 8) and;

3. Memorandum from L. Kopp (NRC) to T. Collins (NRC), "Guidance on the Regulatory Requirements for Criticality Analysis of Fuel Storage at Light-Water Reactor Power Plants" (Reference 9).

In its safety evaluation of the Westinghouse Topical Report, WCAP-14416-P, the NRC staff found the report to be acceptable for referencing in license applications. The report includes a description of methodology for crediting soluble boron in the SFP when performing storage rack criticality analysis. Supporting documentation to the report specifies, in part, the following:

- All licensees proposing to use the new method described for soluble boron credit should submit a 10 CFR 50.36 TS change.

- All licensees proposing to use the new method described for soluble boron credit should identify potential events which would dilute the SFP soluble boron to the concentration required to maintain the 0.95 k-effective (K_{eff}) limit (as defined) and should quantify the time span of these dilution events to show that sufficient time is available to enable adequate detection and suppression of any dilution event. The effects of incomplete boron mixing, such as boron stratification, should be considered. This analysis should be submitted for NRC review and should also be used to justify the surveillance interval used for verification of the TS minimum pool boron concentration.

- Plant procedures should be upgraded, as necessary, to control pool boron concentration and water inventory during both normal and accident conditions.

The SFP cooling system (SFPCS) and spent fuel storage (SFS) are described in Chapter 9 of the Calvert Cliffs Updated Final Safety Analysis Report (UFSAR). SFPCS and SFS descriptions, along with the applicable design basis information in Chapter 9, provide criteria needed to evaluate the ability of equipment to comply with the applicable requirements of 10 CFR 50.68 and NRC-approved WCAP guidelines, as it relates to proposed license amendment request (LAR) changes.

The staff used these regulatory requirements and guidelines as the basis for its review of the licensee's amendment request.

2.2 Description of Proposed Technical Specification Changes

CCNPPI provided descriptive changes to the CCNPP TSs. The actual marked-up and revised TSs are located in Attachment 3 of Reference 1. The staff reviewed each of these changes against the regulatory requirements described in Section 2.1 of this report and found them acceptable. The basis for the staff's acceptance, and a description of the review it performed, is located in Section 3.0 of this report. The following is the descriptive list of proposed changes as provided by the licensee (Attachment 1 in Reference 1):

1. TS 3.7.16, "Spent Fuel Pool (SFP) Boron Concentration," will be added. This new section describes actions to be taken given the new reliance on credited soluble boron. The SFP concentration must remain above 2000 parts per million (ppm), with checks occurring weekly. Additionally, the licensee must take immediate action if the boron concentration drops below the required limit.

2. TS 4.3.1.1 is revised to accommodate the higher 5.0 weight percent enrichment for the Unit 1 SFP. TS 4.3.1.1a is revised to reflect the increased maximum enrichment of 5.0 weight percent for the Unit 1 SFP. TS 4.3.1.1b is revised to incorporate the new k_{eff} limits for Unit 1 that are required to ensure compliance with 10 CFR 50.68, while TS 4.3.1.1c contains the k_{eff} limits for Unit 2.

3.0 TECHNICAL EVALUATION

3.1 Spent Fuel Pool Design

The SFP is a large rectangular structure that holds the spent fuel assemblies from the reactors in both CCNPP units. Borated water fills the SFP and completely covers the spent fuel assemblies. The SFP is constructed of reinforced concrete (thickness of 6 feet) and is lined with a 3/16-inch stainless steel plate, which serves as a leakage barrier. A dividing wall (thickness of 3.5 feet) separates the SFP with the north half associated with Unit 1 and the south half associated with Unit 2. A slot in the dividing wall has removable gates, which allow movement of fuel assemblies between the two halves of the pool. The SFP is located in the auxiliary building between the two containment structures.

3.2 Boron Dilution Analysis

The first step in the boron dilution analysis is to identify potential initiating events that could cause dilution of the boron in the SFP and eventually lead to a substantial reduction of pool boron concentration. The licensee states that a boron dilution event in the SFP could be initiated by external events, a variety of human errors, or component malfunctions. The licensee's potential initiating events were developed based on a review of the events in

NUREG-1353 “Beyond Design Basis Accidents In Spent fuel Pools” and a systematic evaluation of the unborated water sources that interface with the pool. External events include fire in the vicinity of the pool, external floods at the site, storms causing runoff into the SFP area, seismic induced failures of piping, missile generation causing leaks in piping, and airplane crashes into the fuel-handling building. Other boron dilution events include small loss of inventory occurrences, tank ruptures in the vicinity of the SFP, breaks in SFP cooling system piping or heat exhangers, random breaks in piping, dilution events initiated in the reactor coolant system, and misalignment of valves interfacing with the SFP.

The methodology employed by the licensee involves calculation of the SFP volumes, dilution volumes, and dilution times for SFP boron dilution events with various dilution sources and flow rates.

The licensee determined that a minimum boron concentration of 350 ppm with uncertainties is required to credit soluble boron and safely store 5.0 weight percent fuel in the SFP. The normal boron concentration maintained in the SFP is expected to be at least the same as that for the refueling boron TS, which is greater than 2150 ppm. However, the licensee conservatively chose an initial boron concentration of 2000 ppm for boron dilution event analysis. The licensee’s proposed license amendment change includes the addition of TS 3.7.1.6 to provide sufficient negative reactivity to ensure acceptable levels of subcriticality for spent fuel storage, assuming a dilution event. TS 3.7.1.6 would require a SFP boron concentration greater than or equal to 2000 ppm, which supports the normal and accident conditions.

In the boron dilution event calculations, the licensee conservatively utilized a SFP net volume of 80,000 cubic feet up to the SFP overflow limit. This net volume equates to a SFP water inventory of 598,480 gallons and reflects the SFP gross volume minus volume displacements by structures in the SFP (e.g., racks for fuel assemblies). SFP water inventory at a height corresponding to the SFP low level alarm limit (66 feet, 6 inches) is 590,920 gallons. The SFP net volume is a summation of the volumes for the two halves of the SFP associated with CCNPP Units 1 and 2, respectively.

The potential boron dilution sources include the two pretreated water storage tanks (500,000 gallons each), the two condensate storage tanks (314,800 gallons each), the demineralized water storage tank (350,000 gallons), the two refueling water tanks (420,00 gallons each), and three well water pumps and filters at 175 gallons per minute (gpm) each. Water for the fire protection system is supplied by two full-capacity 2500 gpm fire pumps, which take suction from the two 500,000 gallon capacity pretreated water storage tanks. Plant service water isolation valves are in low flow rate systems which take suction on the two 500,000 gallon pretreated water storage tanks. Demineralized water isolation valves are in low flow rate (150 gpm) systems which take suction on the 350,000 gallon demineralized water storage tank. The plant heating system is in a low flow rate system which takes suction on the two 500,000 gallon pretreated water storage tanks. The two SFP cooling pumps (1390 gpm) can supply 420,000 gallons of borated water from each refueling water tank.

Based on the licensee’s boron dilution analysis, potential initiating events that could cause a dilution of the boron in the SFP to a level below that credited in the criticality analysis comprise three categories: 1) dilution by flooding, 2) dilution by loss of coolant induced makeup, and 3) dilution by loss of cooling system induced makeup.

Flooding

Dilution by flooding includes the effects of natural phenomena, failure of the fire protection system, failure of the plant service isolation valves, misalignment of the demineralized water isolation valves, failure of the plant heating system valves, effects of the SFP cooling pumps, tank rupture in the vicinity of the SFP, breaks in the SFP cooling system piping or heat exchangers, and reactor coolant system failures.

The large volume of water necessary to dilute the SFP to the boron endpoint (350 ppm) precludes many small tanks as potential dilution sources. No tanks containing any significant amount of water are stored in the vicinity of the SFP. The large borated water sources, such as reactor makeup water and demineralized water, are in tanks at elevations below the SFP, so that gravity feed from these tanks to the SFP is not possible.

The worst-case dilution by flooding source is a 2,500 gpm fire hose discharging directly into the SFP. At a dilution rate of 2,500 gpm, it will take 6.95 hours to dilute the SFP from 2000 ppm to 350 ppm. The licensee states that it is not credible that dilution could occur for this length of time without plant operator notice, since this event would activate the high level alarm and initiate auxiliary building flooding. In addition, an excess of 1,043,000 gallons of unborated water must be added to the SFP to reach a soluble boron concentration of 350 ppm. This is more water volume than is contained in both pretreated water storage tanks and also more water volume than is contained in the demineralized water storage tank and both condensate storage tanks combined. The licensee states that this dilution by flooding scenario bounds all others (e.g., break in the heat exchanger for SFP cooling system, which would take 12.5 hours to dilute the SFP boron concentration from 2000 ppm to 350 ppm at a dilution rate of 1390 gpm).

Based on the licensee's evaluation of other flooding dilution event scenarios where the time for dilution to the SFP minimum boron concentration is greater than that for the discharging fire hose scenario, the staff agrees that the discharging fire hose scenario bounds the other events.
.
Using the methodology described in Westinghouse Topical Report WCAP-14181-NP, the staff verified through independent calculations that the licensee's fire hose calculation of time (6.95 hours) and unborated water volume (1,043,000 gallons) required to dilute the SFP boron concentration from 2000 ppm to 350 ppm, is accurate. This calculation is based on the assumption that the SFP had complete mixing of boron and constant volume. The staff concurs that the calculated time for boron dilution to the minimum boron concentration of 350 ppm is adequate for detection of the boron dilution event and for CCNPP personnel to take mitigative action.

Loss of SFP Inventory

Dilution by loss of SFP coolant inventory includes the effects of natural phenomena, fuel cask drop, fuel assembly drop, airplane crash, pipe break and general SFP leakage. The licensee states that only partial structural failures, where makeup cannot compensate for the loss of coolant, can cause a boron dilution event. The licensee further states that even in the unlikely event that the SFP is completely diluted of boron by a total loss of inventory and a refill with unborated water, the SFP will remain subcritical by a design margin of k_{eff} not to exceed 0.986.

To detect low-flow, long-term dilution events, the proposed TS 3.7.16 require that the SFP boron concentration be sampled every 7 days to ensure that the appropriate minimum concentration is maintained. Using the methodology described in Westinghouse Topical Report WCAP-14181-NP, the staff independently determined that a dilution rate of 103.5 gpm would be required over 7 days to dilute the SFP boron concentration from 2000 ppm to 350 ppm. The staff concluded that the addition of unborated water to the SFP at a dilution rate of 103.5 gpm would be detectable by CCNPP personnel in sufficient time to take mitigative actions. For example, assuming the SFP water inventory is above the SFP low water level limit (66 feet, 6 inches) and a dilution rate of 103.5 gpm, approximately 1 hour would be required for the water level to reach the SFP overflow limit. If no mitigative actions were taken, other alarms monitored in the control room, including an alarm due to flooding in the auxiliary building, would follow.

The staff also independently determined that a dilution rate of 51.7 gpm would be required over 7 days to dilute the SFP boron concentration from 2000 ppm to 350 ppm, if boron dilution is assumed to occur in only one-half of the SFP (i.e., an assumption reflecting closure of the gate in the wall dividing the SFP into two halves). For this second example, approximately 2 hours would be required for the water level to reach the SFP overflow limit. Again, if no mitigative actions were taken, other alarms monitored in the control room, including an alarm due to flooding in the auxiliary building , would follow.

The staff thus finds that the 7-day sampling requirement of proposed TS 3.7.16 adequately ensures that the proper boron concentration will be maintained.

<u>Loss of SFP Cooling</u>

Dilution may also occur by loss of SFP cooling. Even though loss of SFP cooling is not part of the design basis, the effect of this event has been analyzed. The licensee states that assuming that the Units 1 and 2 SFPs contain 1830 assemblies generating the maximum possible heat load of 37.6E06 BTU/hr and assuming the worst-case initial SFP temperature of 155°F, then the time to boil can be calculated to be 7.34 hours. Time to core uncovery is calculated to be 78.9 hours. However, loss of coolant by boiling will not result in a loss of soluble boron, since the soluble boron is volatile. Thus, the licensee concludes that loss of SFPC system without makeup water flow is not a mechanism for boron dilution. The licensee further states that if sufficient unborated water is added to the SFP to just keep the water from boiling and if the excess fluid flows down the auxiliary building gravity drains associated with the SFP overflow level, it would take 24.88 hours to dilute the SFP to 350 ppm. It is not credible that the dilution could occur for this length of time without operator notice, since this event would activate the high level alarm and initiate auxiliary building flooding. In addition, in excess of 1,043,000 gallons of demineralized water must be added to the SFP to reach 350 ppm soluble boron concentration. This is three times more water volume than is contained in the demineralized water tank.

The staff concurs with the licensee's above rationale for evaluating potential boron dilution events associated with loss of SFP cooling.

The licensee states that SFP instrumentation available for detection of boron dilution include the following: radiation monitors and alarms, high level alarms, low level alarms, temperature alarm and cooling system alarms. Additional instrumentation is provided to monitor the pressure and flow of the SFPC system. The licensee further states that in addition, operating and administrative procedures are available for the detection and mitigation of boron dilution events. For example, during each 12-hour shift, plant operators will check the boron level indication in the SFP area. The plant operator also shall identify and contain all water leakage and look for damaged piping and instrument tubing, noting excessive vibration.

In summary, the licensee states that the potential initiating event that could cause dilution of the boron in the SFP to a level that is below that credited in the criticality analyses comprises three categories: 1) dilution by flooding, 2) dilution by loss of coolant induced makeup, and 3) dilution by loss of cooling system induced makeup. The licensee concludes that it is not credible that dilution could occur for the required length of time without operator notice, since the initiating event would activate the high level alarm and initiate auxiliary building flooding. In addition, in excess of 1,043,000 gallons of unborated water must be added to the SFP to reach a soluble boron concentration of 350 ppm. This is more water volume that is contained in the demineralized water storage tank and both condensate storage tanks combined. Even in the unlikely event that the SFP is completely diluted of boron, the SFP will remain subcritical by a design margin of k_{eff} not to exceed 0.986.

The staff concurs that the combination of the large volume of water required for a boron dilution event, flow rates and dilution times, licensee's administrative requirements, TS controlled SFP concentration, and 7 day sampling requirement would adequately detect a boron dilution event prior to k_{eff} reaching 0.95. Therefore, the staff finds that the licensee's boron dilation analysis meets the requirements of 10 CFR 50.68.

3.3 Evaluation Analysis Related to Criticality Analysis

In order to meet the requirements of 10 CFR 50.68, the licensee performed a criticality analysis on its Unit 1 SFP. The analysis determined the necessary boron concentrations for the proposed TS amendment. This safety evaluation summarizes the staff's review of the criticality analysis submitted by the licensee to justify the minimum boron concentration.

In determining the acceptability of the CCNPP's amendment request, the staff reviewed three aspects of the licensee's analysis: 1) the computer codes employed; 2) the methodology used to calculate the maximum effective multiplication factor (k_{eff}); and 3) the storage configurations and limitations proposed. For each part of the review, the staff evaluated whether the licensee's analysis and methodologies provided reasonable assurance that adequate safety margins in accordance with NRC regulations were developed and could be maintained in the CCNPP Unit 1 SFP.

3.3.1 Computer Codes

The licensee performed the analysis of the reactivity effects for the CCNPP Unit 1 SFP racks with the SCALE 4.4 package. The SCALE 4.4 package was benchmarked against criticality data under conditions which bound the range of variables in the CCNPP Unit 1 rack designs. The design input and primary reference for the validating calculation package came from NUREG/CR-6361, "Criticality Benchmark Guide for Lightwater-Reactor Fuel in Transportation and Storage Packages" (Reference 10). The criticality benchmark experiments considered the effects of varying fuel enrichment, Boron-10 loading, lattice spacing, fuel pellet diameter, and soluble boron concentration. The experimental data are sufficiently diverse to establish that the method bias and uncertainty will apply to CCNPP Unit 1 storage rack conditions. The licensee determined that the SCALE 4.4 package calculational (methodology) bias is -0.0008 with a 95/95 one sided uncertainty of +/- 0.0076. The licensee conservatively did not apply biases that reduce the calculated value of k_{eff}. The SCALE 4.4 results correlate well with the experimental data.

The staff reviewed the licensee's application of the codes to determine whether each could reasonably calculate the appropriate parameters necessary to support the maximum k_{eff} analyses. The staff concluded that the licensee's use of the SCALE 4.4 code package for calculation of the nominal k_{eff} was appropriate since it was benchmarked against experimental data which bound the proposed assembly and rack conditions for the CCNPP Unit 1 SFP.

3.3.2 Methodology

In accordance with the guidance contained in References 7, 8, and 9, the licensee performed criticality analyses of its SFP. The licensee employed a methodology which combines a worst-case analysis based on the bounding fuel and rack conditions, with a sensitivity study using 95/95 analysis techniques. The major components in this analysis were a calculated k_{eff} based on the limiting fuel assembly, code biases, and a statistical sum of 95/95 uncertainties and worst-case delta-k manufacturing tolerances.

In performing its criticality analysis, the licensee first calculated a k_{eff} based on nominal core conditions using the SCALE 4.4 code package. The licensee determined this k_{eff} from the limiting (highest reactivity) fuel assemblies stored in the SFP. The licensee performed its reactivity analyses using worst-case reactivity for moderator temperature, fuel cladding composition, enrichment, soluble boron concentration, and carborundum poison loading. In performing these calculations, the licensee also assumed appropriately conservative conditions such as an infinite radial and axial array geometry. The licensee modeled a single assembly in a storage cell with mirror boundary conditions on all surfaces for criticality calculations. A 10x10 assembly array with mirror boundary conditions served as the nominal array for all uncertainty calculations that the licensee performed in its respective SFP region.

To determine the maximum k_{eff}, the licensee summed the calculated value, the calculational bias, and the total uncertainty, defined as a statistical combination of the calculational and mechanical uncertainties. The licensee determined reactivity uncertainties for stack height density, storage cell pitch, storage cell rack steel thickness, carborundum poison loading, and eccentric loading within a storage cell for 0 and 300 ppm soluble boron concentration. All uncertainties assume worst-case conditions. The staff reviewed the licensee's methodology for calculating the reactivity effects associated with the uncertainties. The staff finds the licensee's methods conservative and acceptable.

3.3.3 Proposed Limitations

During the review of the licensee's proposal, the staff determined that the currently available data did not conclusively predict the maximum boron weight loss of the SFP Carborundum coupon samples, and the licensee would need to provide more data to accurately predict the boron loss over the 70 year expected life-span of the Carborundum. The staff was concerned that key boron loss data would be overlooked during the intervals of the current coupon removal plans. During a conference call, the licensee agreed to add a License Condition in Appendix C of the TSs that would require development of a coupon surveillance program for the Carborundum samples that would demonstrate the assumptions of conservative boron loss measurement. The licensee will submit the proposed program to the NRC no later than 3 years after this safety evaluation (Reference 4).

The licensee has concluded the 3-year time frame is acceptable for developing a surveillance program. The licensee supplied evidence from Reference 1 showing that boron degradation during the next 3 years would not approach the 26.25 percent total boron loss initially predicted for the SFP lifetime. The staff has reviewed the licensee's methods, and concluded that the current SFP monitoring is acceptable during the 3-year time frame.

3.4 Evaluation Related to the Degradation of the Carborundum Neutron Absorbing Panels

3.4.1 Background

The licensee's neutron absorbing material consists of borated plates inserted between the walls of the fuel rack cells. The plates used in the SFP are made of a composite material consisting of a boron carbide (B_4C) powder in a fiberglass matrix (carborundum sheet). The licensee's method of confirming the borated plates will maintain sufficient B_4C to a subcriticality minimum of 5 percent in the SFP consists of a long-term and accelerated coupon surveillance program to predict the degradation in the plates. The degradation of the neutron absorbing material can be monitored by periodic testing of the sample coupons that are representative of the materials in the SFP storage racks.

3.4.2 Evaluation

The licensee's coupon surveillance program is designed to provide both accelerated and long-term exposure to gamma radiation and borated pool water and it also allows for samples of the material to be removed from the SFP for examination. The coupon surveillance program provides for periodic monitoring of the condition of neutron absorbing material in the SFP. Accelerated exposure is achieved by placing a carborundum coupon surrounded by freshly discharged fuel and every outage moving it to a new location having freshly discharged fuel. The long-term exposure consists of initially surrounding a coupon by freshly discharged fuel but throughout the duration of the coupon surveillance program keeping it in the same location in the SFP, surrounded by the same fuel.

The licensee stated that the coupons are extracted from the SFP for examinations that consist of visual, weight and dimensional determinations. The visual examination consists of inspecting for evidence of gross changes or deterioration. The weight of each coupon is measured to within 0.001 grams and compared against the sample initial weight using a calibrated scale. The length and width of each sample is measured within 0.001 inch and compared against the sample initial length and width using a calibrated caliper. The licensee uses the loss of mass of the coupons as a measure of degradation and not the areal density as a measure of degradation because previous experience has indicated that mass loss was more significant in determining coupon degradation than the change in areal density.

The company that manufactured the carborundum conducted a carborundum qualification program in which test panels were simultaneously exposed to 10^{11} rad gamma radiation and borated water, simulating a 40-year lifetime similar to what is expected in the SFP. The results of this program showed that the material exhibited chemical stability, boron retention and mechanical property changes within design specifications. Since the installation of the coupon surveillance program, five coupons from the accelerated program have been removed and demonstrated less than 6 percent weight loss over a 14-year period. Only three coupons have been removed from the long-term program and demonstrated less than 5-percent loss over a 17-year period. The next accelerated coupon is scheduled for removal in 2005.

The licensee committed in its license renewal application to perform an analysis to demonstrate that the carborundum panels can perform their criticality control function for over a 70-year service life. The NRC acknowledged this commitment in NUREG-1705, Section 3.10.2.4. This commitment created a need to account for the boron loss during the additional 30-year exposure. The licensee calculated this loss performing a linear extrapolation of the loss rate to 70 years. This extrapolation was based on four data points measured from the coupons removed from the accelerated program (five points were measured, but only four were used due to an anomalous data point). From the measured data, a 0.414 percent loss per year was calculated. This corresponded to 26.2 percent of boron loss at the end of the 70-year period. This predicted value of boron loss was lower than the value determined by the conservative reactivity calculations to be required for the reactivity control during plant life. Although the calculated value of boron loss was acceptable, because it was based on a limited number of data, this prediction required future verification. Therefore, the licensee added a license condition which will be in effect for 3 years to provide a surveillance program for verification. This is acceptable because the licensee calculated that during these 3 years the loss of boron from the carborundum plates will be lower than 26.2 percent. The license condition reads as follows:

> "This amendment requires the licensee to develop a long-term coupon surveillance program for the Carborundum samples. This program must verify that the Carborundum degradation rates assumed in the licensee's analyses to prove subcriticality, as required by 10 CFR 50.68, remain valid over the seventy-year life span of the Unit 1 spent fuel pool. The licensee must submit this modified coupon surveillance program to the NRC under the 10 CFR 50.90 requirements for its review and approval."

This new surveillance program will allow the licensee to substantiate the assumptions made in the boron degradation program.

In response to an NRC question, the licensee stated that no other tests are performed on the full length panels in the fuel racks. The current licensing basis at CCNPP only requires a coupon surveillance program to monitor the condition of the rack poison materials.

Based on the discussion provided above, the NRC staff found the proposed license condition to be an acceptable solution for the next 3 years. The staff notes the surveillance coupon program for Carborundum should also include the measurement of boron carbide areal density to accurately determine the degree of any material degradation.

3.5 <u>Conclusion on the Technical Evaluation</u>

Based on our review of the licensee's rationale and evaluation, and the experience gained from our review of precedent license amendment requests (LARs) involving boron dilution analysis, the staff concludes that the licensee adequately identified the boron concentration necessary to (1) maintain k-effective less than 0.95, (2) verified subcriticality with unborated water as required by 10 CFR 50.68, (3) established a technical specification for boron dilution with a surveillance short enough to detect potential boron dilution, and (4) evaluated potential boron dilution scenarios to satisfy the staff's guidelines established in the safety evaluation for WCAP-14416. Therefore, the staff concludes that the boron dilution aspects of the proposed LAR are acceptable.

The staff reviewed the applicable section of the licensee's request related to carborundum degradation. Based upon its review of the information included in the licensee's submittal, the staff finds that the proposed changes are acceptable for the CCNPP Unit 1 SFP for the next 3 years. As required by the license condition, the licensee will submit a long-term coupon surveillance program to the staff for its review and approval within the next 3 years.

The staff has determined that the proposed TS changes meet the requirements of GDC 62 and 10 CFR 50.68. The staff finds that the proposed changes are acceptable for the CCNPP Unit 1 SFP for the next 3 years. As required by the license condition, the licensee will submit a long-term coupon surveillance program to the staff for its review and approval within the next 3 years.

4.0 STATE CONSULTATION

In accordance with the Commission's regulations, the Maryland State official was notified of the proposed issuance of the amendment. The State official had no comments.

5.0 ENVIRONMENTAL CONSIDERATION

The amendment changes a requirement with respect to installation or use of a facility component located within the restricted area as defined in 10 CFR Part 20. The NRC staff has determined that the amendment involves no significant increase in the amounts, and no significant change in the types, of any effluents that may be released offsite, and that there is no significant increase in individual or cumulative occupational radiation exposure. The Commission has previously issued a proposed finding that the amendment involves no significant hazards consideration, and there has been no public comment on such finding (68 FR 28846). Accordingly, the amendment meets the eligibility criteria for categorical exclusion set forth in 10 CFR 51.22(c)(9).

Pursuant to 10 CFR 51.21, 51.32 and 51.35, an environmental assessment and finding of no significant impact was published in the Federal Register on April 8, 2004 (68 FR 18654).

Accordingly, based upon the environmental assessment, the Commission has determined that issuance of this amendment will not have a significant effect on the quality of the human environment.

6.0 CONCLUSION

The Commission has concluded, based on the considerations discussed above that (1) there is reasonable assurance that the health and safety of the public will not be endangered by operation in the proposed manner, (2) such activities will be conducted in compliance with the

Commission's regulations, and (3) the issuance of the amendment will not be inimical to the common defense and security or to the health and safety of the public.

7.0 REFERENCES

1. Letter from Peter Katz, Vice President to U.S. Nuclear Regulatory Commission, "License Amendment Request: Increase to the Unit 1 Spent Fuel Pool Maximum Enrichment Limit with Soluble Boron Credit,," dated May 1, 2003.

2. Letter from George Vanderheyden, Vice President to U.S. Nuclear Regulatory Commission, "Response to Request for Additional License Amendment Request: Increase to the Unit 1 Spent Fuel Pool Maximum Enrichment Limit with Soluble Boron Credit,," dated September 25, 2003.

3. Letter from George Vanderheyden, Vice President to U.S. Nuclear Regulatory Commission, "Response to Second Request for Additional Information Concerning the License Amendment Request to Increase Unit 1 Spent Fuel Pool Maximum Enrichment Limit with Soluble Boron Credit," dated November 3, 2003.

4. Letter from Kevin Nietmann, Plant General Manager to U.S. Nuclear Regulatory Commission, "Response to Third Request for Additional Information Concerning the License Amendment Request to Increase Unit 1 Spent Fuel Pool Maximum Enrichment Limit with Soluble Boron Credit," dated February 25, 2004.

5. 10 Code of Federal Regulations, Part 50 Appendix A, General Design Criteria 62, "Prevention of criticality in fuel storage and handling".

6. 10 CFR Section 50.68, "Criticality accident requirements".

7. NUREG-0800, Standard Review Plan, Section 9.1.2, "Spent Fuel Storage," Draft Revision 4.

8. Regulatory Guide 1.13, "Spent Fuel Storage Facility Design Basis", Proposed Revision 2.

9. L. Kopp, Guidance on the Regulatory Requirements for Criticality Analysis of Fuel Storage at Light-Water Reactor Power Plants, NRC Memorandum from L. Kopp to T. Collins, August 19, 1998.

10. NUREG/CR-6361, "Criticality Benchmark Guide for Light-Water-Reactor Fuel in Transportation and Storage Packages," J. J. Lichtenwalter, S. M. Bowman, M.D. DeHart, and C. M. Hopper, March 1997.

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