Calvert Cliffs Nuclear Power Plant
Constellation Generation Group, LLC

1650 Calvert Cliffs Parkway
Lusby, Maryland 20657

Constellation Energy Group

December 21, 2004

U. S. Nuclear Regulatory Commission
Washington, DC 20555

ATTENTION: Document Control Desk

SUBJECT: Calvert Cliffs Nuclear Power Plant
Unit Nos. 1 & 2; Docket Nos. 50-317 & 50-318
Exemption Requested from the Requirements of 10 CFR Part 50, Paragraph 50.68(b)(1)

REFERENCE: (a) Letter from Mr. G. S. Shukla (NRC) to Mr. G. M. Rueger (Pacific Gas and Electric Company), dated January 30, 2004, "Diablo Canyon Nuclear Power Plant, Unit Nos. 1 and 2 – Exemption from the Requirements of 10 CFR Part 50, Section 50.68(b) (TAC Nos. MC0992 and MC0993)"

Pursuant to the provisions of 10 CFR 50.12, Calvert Cliffs Nuclear Power Plant, Inc. (CCNPP) requests an exemption from the requirement specified in 10 CFR 50.68(b)(1) concerning plant procedure requirements for handling and storage of fuel assemblies in unborated water. If granted, this exemption will allow spent fuel loading, unloading, and handling operations in the Calvert Cliffs spent fuel pool that support spent fuel transfer to an Independent Spent Fuel Storage Installation licensed under 10 CFR Part 72.

Calvert Cliffs uses a NUHOMS-24P® dry storage canister to store spent fuel in its Independent Spent Fuel Storage Installation. In addition to NUHOMS-24P® canister, CCNPP is currently in the process of licensing a NUHOMS-32P® canister which is expected to be in use beginning in mid-2005. The NUHOMS-32P® system uses an optimized storage arrangement to store eight more assemblies than the NUHOMS-24P® with the same external and internal dimensions. This exemption request applies only to the NUHOMS-32P® operation. The current loading and unloading operation of the NUHOMS-24P® canister in the spent fuel pool meets the 10 CFR 50.68 requirements.

Paragraph 10 CFR 50.12(a) states, the Commission may, upon application by any interested person or upon its own initiative, grant exemptions from the requirements of 10 CFR Part 50 when (1) the exemptions are authorized by law, will not present an undue risk to public health or safety, and are consistent with the common defense and security; and (2) when special circumstances are present. In an earlier exemption approved for Diablo Canyon Nuclear Power Plant (Reference a), the Nuclear Regulatory Commission staff established five criteria that, if met, satisfy the underlying intent of 10 CFR 50.68(b)(1), and satisfy the Paragraph 50.12(a)(2)(ii) requirement for special circumstances. In Attachment (1) to this letter, CCNPP presents a detailed discussion of how these five criteria are met. Calvert Cliffs Nuclear Power Plant believes the requested exemption is clearly authorized by law and is

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consistent with the common defense and security. In addition, CCNPP believes that this request meets the criteria established by the Nuclear Regulatory Commission staff for satisfying the underlying intent of 10 CFR 50.68(b)(1) as detailed in Attachment (1) and therefore will not present an undue risk to public health or safety.

Should you have questions regarding this matter, we will be pleased to discuss them with you.

Very truly yours,

STATE OF MARYLAND :
: **TO WIT:**
COUNTY OF CALVERT :

I, Bruce S. Montgomery, being duly sworn, state that I am Manager - Calvert Cliffs Nuclear Power Plant (CCNPP) Engineering Services, and that I am duly authorized to execute and file this exemption request on behalf of CCNPP. To the best of my knowledge and belief, the statements contained in this document are true and correct. To the extent that these statements are not based on my personal knowledge, they are based upon information provided by other CCNPP employees and/or consultants. Such information has been reviewed in accordance with company practice and I believe it to be reliable.

Subscribed and sworn before me, a Notary Public in and for the State of Maryland and County of St. Mary's, this 21st day of December, 2004.

WITNESS my Hand and Notarial Seal:

Notary Public

My Commission Expires:

March 25 2007
Date

BSM/GT/bjd

Attachment: (1) Exemption Requested from the Requirements of 10 CFR 50.68

cc: J. Petro, Esquire
J. E. Silberg, Esquire
R. V. Guzman, NRC
S. J. Collins, NRC
Resident Inspector, NRC
R. I. McLean, DNR

ATTACHMENT (1)

EXEMPTION REQUESTED FROM THE

REQUIREMENTS OF 10 CFR 50.68

I. BACKGROUND

Calvert Cliffs Nuclear Power Plant, Inc. (CCNPP) uses a NUHOMS-24P® dry storage canister to store spent fuel in its Independent Spent Fuel Storage Installation (ISFSI). In addition to the NUHOMS-24P® canister, CCNPP is currently in the process of licensing a NUHOMS-32P® canister which is expected to be placed in use beginning in mid-2005. The NUHOMS-32P® system uses an optimized storage arrangement to store eight more assemblies than the NUHOMS-24P® with the same external and internal dimensions. As explained below, this exemption request applies only to the NUHOMS-32P® operation. The current loading and unloading operation of the NUHOMS-24P® canister in the spent fuel pool (SFP) meets the 10 CFR 50.68 requirements.

The current CCNPP SFP criticality analyses credit 300 ppm of soluble boron in the SFP for Unit 1 and no soluble boron in the SFP for Unit 2. These analyses meet the requirements of 10 CFR 50.68. Technical Specification 3.7.16 (SFP Boron Concentration) requires 2000 ppm of soluble boron in the SFP, which is credited as part of the double contingency principle for postulated accidents. The double contingency principle, according to American National Standards Institute N 15.1-1975, requires two unlikely, independent, concurrent events to produce a criticality accident. Realistic initial conditions (e.g., the presence of soluble boron) may be assumed for the SFP and fuel assemblies.

The current CCNPP NUHOMS-24P® ISFSI analysis of record credits no soluble boron but does assume burnup credit, assuming a fresh fuel enrichment limit of 1.8 w/o U-235 and uses an equivalency calculation for higher enrichments. Independent Spent Fuel Storage Installation Technical Specification 3/4.2.1 (Dissolved Boron Concentration) requires 1800 ppm of soluble boron in the SFP, which is credited as part of the double contingency principle for postulated accidents and abnormal conditions (e.g., optimum moderation, assembly misloading).

The NUHOMS-32P® analyses credit 2450 ppm of soluble boron and assumes no burnup credit. Soluble boron dilution is not assumed to be a credible accident. However, 10 CFR 50.68(b)(1) requires that plant procedures prohibit the handling and storage at any one time of more fuel assemblies than have been determined to be safely subcritical under the most adverse moderation conditions feasible by unborated water. Since the NUHOMS-32P® analyses credit soluble boron to maintain subcriticality, it is necessary to obtain an exemption from the requirements of 10 CFR 50.68.

II. REQUEST

Pursuant to the provisions of 10 CFR 50.12, CCNPP requests an exemption from the requirement specified in 10 CFR 50.68, "Criticality Accident Requirements," concerning plant procedure requirements for handling and storage of fuel assemblies in unborated water. Specifically, Paragraph 50.68(b)(1) states, "Plant procedures shall prohibit the handling and storage at any one time of more fuel assemblies than have been determined to be safely subcritical under the most adverse moderation conditions feasible by unborated water." If granted, this exemption will allow spent fuel loading, unloading, and handling operations in the Calvert Cliffs SFP using the NUHOMS-32P® dry fuel storage canisters for transfer to an ISFSI licensed under 10 CFR Part 72.

III. JUSTIFICATION

In an earlier exemption approved for Diablo Canyon Nuclear Power Plant (Reference 1), the Nuclear Regulatory Commission (NRC) staff established five criteria that, if met, satisfy the underlying intent of 10 CFR 50.68(b)(1), and satisfy the Paragraph 50.12(a)(2)(ii) requirement for special circumstances. In lieu of complying with 10 CFR 50.68(b)(1), the staff determined that a criticality accident is unlikely to occur if the licensee meets the following five criteria:

(1) The cask criticality analyses are based on the following conservative assumptions:

a. All fuel assemblies in the cask are unirradiated and at the highest permissible enrichment,
b. Only 75 percent of the Boron-10 in the borated aluminum panel inserts is credited,
c. No credit is taken for fuel-related burnable absorbers, and
d. The cask is assumed to be flooded with moderator at the temperature and density corresponding to optimum moderation.

(2) The licensee's ISFSI Technical Specifications require the soluble boron concentration to be equal to or greater than the level assumed in the criticality analysis and surveillance requirements necessitate the periodic verification of the concentration both prior to and during loading and unloading operations.

(3) Radiation monitors, as required by General Design Criteria 63, "Monitoring Fuel and Waste Storage," are provided in fuel storage and handling areas to detect excessive radiation levels and to initiate appropriate safety actions.

(4) The quantity of other forms of special nuclear material, such as sources, detectors, etc., to be stored in the cask will not increase the effective multiplication factor above the limit calculated in the criticality analysis.

(5) Sufficient time exists for plant personnel to identify and terminate a boron dilution event prior to achieving a critical boron concentration in the cask. To demonstrate that it can safely identify and terminate a boron dilution event, the licensee must provide the following:

a. A plant-specific criticality analysis to identify the critical boron concentration in the cask based on the highest reactivity loading pattern.
b. A plant-specific boron dilution analysis to identify all potential dilution pathways, their flowrates, and the time necessary to reach a critical boron concentration.
c. A description of all alarms and indications available to promptly alert operators of a boron dilution event.
d. A description of plant controls that will be implemented to minimize the potential for a boron dilution event.
e. A summary of operator training and procedures that will be used to ensure that operators can quickly identify and terminate a boron dilution event.

A detailed discussion of how these five criteria are met is presented below.

CRITERION (1)

The cask criticality analyses are based on the following conservative assumptions:

(1.A) All fuel assemblies in the cask are unirradiated and at the highest permissible enrichment.

CCNPP Response

The design basis fuel assembly for this calculation is the CE 14X14 fuel assembly with an initial enrichment of 4.5 wt.% U-235. This is the highest enrichment allowed for the ISFSI standard fuel design. Burnup was not credited in the criticality analyses for the NUHOMS-32P® cask.

(1.B) Only 75 percent of the Boron-10 in the borated aluminum panel inserts is credited.

CCNPP Response

According to NUREG/CR-5661 (Reference 2):

> "Limiting added poison material credit to 75% without comprehensive tests is based on concerns for potential 'streaming' of neutrons due to nonuniformities. It has been shown that boron carbide granules embedded in aluminum permit channeling of a beam of neutrons between the grains and reduce the effectiveness for neutron absorption."

Furthermore:

> "A percentage of poison material greater than 75% may be considered in the analysis only if comprehensive tests, capable of verifying the presence and uniformity of the poison, are implemented."

The CCNPP criticality calculations use boron areal densities that are 90% of the minimum value of 0.0100g $B10/cm^2$. This is justified by the following considerations:

a. The coupons for neutronic inspection are removed contiguous to every finished plate. As such, they are taken from locations that are representative of the finished product.

b. Statistical analysis of the neutron transmission results on the coupons demonstrates that at any location in the plates, the B10 areal density will meet or exceed the specified minimum with 95% confidence and 95% probability.

c. Neutron radioscopy/radiography across the entire coupon will detect macroscopic nonuniformities in the B10 distribution which could be introduced by the fabrication process. The use of neutron transmission and neutron radioscopy/radiography of the coupons, satisfies the "uniformity" requirement emphasized in NUREG/CR-5661 on both a microscopic and macroscopic scale.

d. The recommendations of NUREG/CR-5661 are based upon testing of a poison with boron carbide particles averaging 85 microns. The boride particles in borated aluminum are much finer (5-10 microns). Both the manufacturing process and the neutron radioscopy assure that they are uniformly distributed. For a given degree of uniformity, fine particles will be less subject to neutron streaming than coarse particles. Furthermore, because the material reviewed in the NUREG was a sandwich panel, the thickness of the boron carbide containing center could not be directly verified by thickness measurement. The alloy specified here is uniform throughout its thickness.

A detailed discussion of CCNPP's poison acceptance tests and criteria is contained in Reference (3).

(1.C) No credit is taken for fuel-related burnable absorbers

CCNPP Response

No credit is taken for fuel-related burnable absorbers. This includes integral burnable absorbers, integral fuel burnable absorbers, and control element assemblies.

(1.D) The cask is assumed to be flooded with moderator at the temperature and density corresponding to optimum moderation

CCNPP Response

The criticality analysis for the NUHOMS-32P® Dry Storage Canister (DSC) system demonstrates that the maximum k_{eff} value is below the upper safety limit of 0.9422 for a variety of loading configurations under normal, off-normal and hypothetical accident conditions. The maximum k_{eff} value is based on an "inward" loading of all the 32 CE 14x14 fuel assemblies at the maximum enrichment of 4.5 wt.% U-235. This configuration includes the minimum compartment tube dimension of 8.47", an internal 2450 ppm borated moderator density of 70%, and an external moderator (pure water) density of 10%. It also conservatively includes allowances for uncertainties due to fuel positioning, basket rail modeling, compartment tube dimensions, poison plate thickness etc.

CRITERION (2)

The licensee's ISFSI Technical Specifications require the soluble boron concentration to be equal to or greater than the level assumed in the criticality analysis and surveillance requirements necessitate the periodic verification of the concentration both prior to and during loading and unloading operations.

CCNPP Response

By Reference (4) CCNPP has submitted proposed revisions to the following CCNPP ISFSI Technical Specifications:

- Limiting Condition for Operation 3.2.1.1 will require that the DSC cavity be moderated by water with a boron concentration greater than or equal to 2450 ppm to accommodate NUHOMS-32P® canister operations. The criticality analyses assume 2450 ppm soluble boron.

- Surveillance Requirement 4.2.1.1 will be modified to require verification of the boron concentration in the SFP within 24 hours prior to insertion of the first spent fuel assembly into a DSC. The boron concentration in the water shall be reconfirmed at intervals not to exceed 48 hours until such time as the DSC is removed from the SFP.

- Surveillance Requirement 4.2.1.2 will be modified to require verification of the boron concentration in the SFP within 24 hours prior to flooding the DSC cavity for unloading the fuel assemblies. The boron concentration in the SFP shall be reconfirmed at intervals not to exceed 48 hours until such time as the DSC is removed from the SFP.

CRITERION (3)

Radiation monitors, as required by General Design Criterion 63, "Monitoring Fuel and Waste Storage," are provided in fuel storage and handling areas to detect excessive radiation levels and to initiate appropriate safety actions.

CCNPP Response

Radiation monitors located at the fuel handling areas provide both audible and visual warning of high radiation levels in the event of a low SFP water level or dropped assembly in the SFP. Three area radiation monitors are provided for detecting high radiation levels in the fuel storage area. The monitors are located in the SFP area, on the spent fuel handling machine, and in the new fuel storage area. Each monitor contains a gamma sensitive Geiger-Mueller tube and has an indicating range of 10^{-4} to 10^{1} R per hour. The SFP area and new fuel storage area monitor alarm setpoint is $5x10^{-3}$ R per hour, while the spent fuel handling machine monitor alarm setpoint is $1x10^{-2}$ R per hour. At the alarm setpoint, audible and visual alarms annunciate locally and in the Control Room. The output of each monitor is also recorded in the Control Room. Radiation monitors are also installed in the service water return header from the SFP coolers to detect possible leakage of radioactive liquids through the heat exchangers.

CRITERION (4)

The quantity of other forms of special nuclear material, such as sources, detectors, etc., to be stored in the cask will not increase the effective multiplication factor above the limit calculated in the criticality analysis.

CCNPP Response

CCNPP ISFSI Technical Specification Limiting Condition for Operation 3.1.1 (1), "Fuel To Be Stored at ISFSI," allows only fuels (14x14 CE-type pressurized water reactor fuel) irradiated at Calvert Cliffs Units 1 or 2 to be stored in the ISFSI. Thus, no other forms of special nuclear material, such as sources, detectors, etc., are allowed to be stored in the Calvert Cliffs ISFSI.

CRITERION (5)

Sufficient time exists for plant personnel to identify and terminate a boron dilution event prior to achieving a critical boron concentration. To demonstrate that it can safely identify and terminate a boron dilution event, the licensee must provide the following:

(5.A) A plant-specific criticality analysis to identify the critical boron concentration in the cask based on the highest reactivity loading pattern.

CCNPP Response

Model

Calvert Cliffs Nuclear Power Plant utilized the SCALE 4.4 CSAS25 code module with the 44 group ENDF/B-V cross-section library to perform the required KENO criticality calculations. The criticality inputs, model, and methodology were developed by TransNuclear, Inc. A worst-case bounding k_{eff} value was determined for the NUHOMS-32P® system for Calvert Cliffs ISFSI loaded with CE 14x14 fuel assemblies containing UO_2 fuel enriched up to 4.50 wt.% U-235. A series of criticality calculations were performed for normal and accident storage conditions. Criticality was controlled by taking credit for the soluble boron poison present in the SFP and fixed neutron absorbers present in the NUHOMS-32P® basket.

The KENO model consists of the NUHOMS-32P® canister/basket loaded inside the transfer cask, flooded with an internal moderator of borated water and an external moderator of pure water. The model is 10.28" long in the axial direction representing a basic unit in the basket. Periodic boundary conditions are applied at the axial boundaries representing an infinite length model in the axial direction.

The CE 14x14 fuel assemblies within the basket are modeled explicitly. The fuel compartment surrounds each fuel assembly that is in-turn bounded by the basket plates consisting of 0.25" aluminum/borated aluminum plates. These plates are arranged to represent an egg-crate design with a 0.075"-borated aluminum and a 0.175"-aluminum plate. The thermal expansion and egg-crate slot gaps are conservatively not modeled assuming plate continuity, thus replacing the more absorbing internal moderator with the basket plate materials.

All assemblies that have face-to-face interaction have poison plates between them. Thus, all of the interior 16 fuel assemblies are surrounded by poison plates on all four faces and the outer 16 fuel assemblies do not have poison plates on the radially outward looking face.

The rails are modeled explicitly within the limitations of the geometry options in KENO. All the radial steel rails are all modeled conservatively as aluminum rails. The circumferential steel rails are modeled as a cylindrical ring with a thickness of 0.22".

The material in the transfer cask neutron shield is modeled as an external moderator with pure water. The radial boundary is based on specular reflection with a small amount of water (less than 0.1 cm) surrounding the transfer cask. Thus, the KENO model essentially represents an infinite array of casks in the radial direction with a small amount of external moderator separating each cask.

Benchmark

A series of 121 benchmark criticality calculations are documented in NUREG/CR-6361 "Criticality Benchmark Guide for Light-Water-Reactor Fuel in Transportation and Storage Packages." These calculations use the fresh fuel assumption for criticality analysis with the SCALE 4.4 computer code package. The upper safety limit was determined using the results of these 121 benchmark calculations. The benchmark problems used to perform this verification are representative of benchmark arrays of commercial light water reactor fuels with the following characteristics:

- water moderation
- boron neutron absorbers
- unirradiated light water reactor type fuel (no fission products or "burnup credit") near room temperature (vs. reactor operating temperature)
- close reflection
- Uranium Oxide

The 121 uranium oxide experiments were chosen to model a wide range of uranium enrichments, fuel pin pitches, assembly separation, concentration of soluble boron and control elements in order to test the code's ability to accurately calculate k_{eff}. The minimum value of the upper safety limit from the TransNuclear, Inc. criticality benchmarks over the parameter range (in this case, the assembly separation distance) is 0.9422. This upper safety limit value (0.9422) is based on a methodology bias and an administrative 5% margin on criticality. For this calculation, the criticality limits are shown in the following equation:

$$k_{eff} = k_{keno} + 2\sigma_{keno} \leq 0.9422$$

Uncertainty and Bias Calculations

The criticality analysis for the NUHOMS-32P® DSC system demonstrates that the maximum k_{eff} value is below the upper safety limit of 0.9422 for a variety of loading configurations under normal, off-normal, and hypothetical accident conditions. The maximum k_{eff} value is based on an "inward" loading of all 32 CE 14x14 fuel assemblies at the maximum enrichment of 4.5 wt.% U-235. This configuration includes the minimum compartment tube dimension of 8.47", an internal borated moderator density of 70%, and an external moderator (pure water) density of 10%. It also conservatively includes allowances for uncertainties due to fuel positioning, basket rail modeling, compartment tube dimensions, poison plate thickness etc.

Soluble Boron Calculation at k_{eff} of Unity

Criticality calculations at 2450, 2000, 1650, 1640, and 1500 ppm soluble boron were performed for 4.5 w/o U-235 standard fuel to determine the critical soluble boron concentration.

Case	Soluble Boron ppm	K_{KENO}	σ_{KENO}	σ_{BIAS}	K_{TOTAL}
bge070010a	2450	0.9394	0.0009	0.0078	0.9490
bge070010b	2000	0.96499	0.00084	0.0078	0.97447
bge070010e	1650	0.99039	0.00081	0.0078	0.99981
bge070010d	1640	0.99117	0.00072	0.0078	1.00041
bge070010c	1500	1.00024	0.00090	0.0078	1.00984

Thus, the soluble boron concentration at which a k_{eff} of 1.0 occurs is less than 1650 ppm.

(5.B) A plant-specific boron dilution analysis to identify all potential dilution pathways, their flowrates, and the time necessary to reach a critical boron concentration.

<u>CCNPP Response</u>

SFP Dilution Pathways

The inputs and methodology for the dilution analysis are similar to those submitted to the NRC for the NUHOMS-32P® submittal (Reference 4). The SFP is a large rectangular structure that holds the spent fuel assemblies from the reactors in both Units. Borated water fills the SFP and completely covers the spent fuel assemblies. The SFP is constructed of 6' of reinforced concrete and is lined with a 3/16" stainless steel plate, which serves as a leakage barrier. A 3.5' dividing wall separates the SFP, with the north half being 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.

Each half of the SFP is equipped with vertical spent fuel racks installed on the pool bottom. The fuel rack cells are individual double-walled containers approximately 14'-1" in height. The inner wall of each cell is made from a 0.06" thick sheet of stainless steel formed into a square cross-section container, indented on the corners, with an inside dimension of 8.5625". The outer or external wall is also formed from a stainless steel sheet 0.06" thick. Plates of borated, neutron absorbing material are inserted between the two walls, in each of the four spaces formed by the indentations in the inner wall. The plates are made of a boron carbide (B_4C) composite material (carborundum in Unit 1 and Boraflex in Unit 2) and are 6.5" wide by 0.09" thick. Each plate contains at least 0.020 grams of boron-10 per square centimeter of plate. The spacing between the cells is maintained at 10 3/32", center to center, by external sheets and welded spacers.

Elevations of interest for the SFP are as follows:

- The SFP low level alarm point is at 66'6".
- The SFP normal operating level is at 67'0".
- The SFP overflow level to the Auxiliary Building gravity drains is at 67'3".
- The SFP operating floor elevation is 69'0".
- The SFP curb elevation is 69'6".
- The SFP upper level alarm point is at 67'2.75".

	Gross Volume (ft^3)		Net Volume (ft^3)		
Water Elevation	Unit 1	Unit 2	Unit 1	Unit 2	Combined
66' 6"	43018.63	42820.63	40525.53	39816.90	80342.43
67' 3"	43894.06	43696.06	41400.97	40692.33	82093.30
67' 2.75"	43869.74	43671.74	41376.65	40668.02	82044.67

Net volume is calculated using the following assumptions:

- Unit 1 SFP contains 830 storage locations
- Unit 2 SFP contains 1000 storage locations
- Each fuel assembly has the following displacements:
  - 176 fuel pins = 2.259537 ft^3
  - 5 guides tubes = 0.057030 ft^3
  - Upper end fitting = 0.066427 ft^3
  - Lower end fitting = 0.028025 ft^3
- Each storage cell has a displacement of 0.592710 ft^3

Based on the above calculation, the volume of water between the lower alarm limit at 66'6" and the upper alarm limit at 67' 2.75" is 1702.24 ft^3. The volume of water between the lower alarm limit at 66' 6" and the overflow limit at 67' 3" is 1750.87 ft^3.

The water sources for SFP dilution are the following:

- **Flooding by Onsite Water Sources:** The large volume of water (242,575 gallons) necessary to dilute the pool to the boron endpoint (2450 to 1650 ppm) precludes many small tanks as potential dilution sources. It would be very unlikely that the large volumes of water necessary to dilute the SFP to the boron endpoint could be transferred from these tanks to the SFP without being detected by plant personnel. The tank sources for SFP dilution are the following:
  - 2 Pretreated Water Storage Tanks: Vol = 501792 gal each
  - 2 Condensate Storage Tanks: Vol = 314801 gal each
  - 1 Demineralized Water Storage Tank: Vol = 350135 gal each
  - 2 Refueling Water Tanks: Vol = 420000 gal each
  - Well water: 3 well water pumps and filters at 175 gpm each

- **Onsite flow sources:**
  - Water for the Fire Protection System is supplied by two full-capacity fire pumps. One pump is an electrically-driven 2500 gpm horizontal centrifugal pump, and the other is a diesel engine-driven 2500 gpm horizontal centrifugal pump. The fire pumps take suction from the two 500,000 gallon capacity pretreated water storage tanks. An evaluation has determined that the maximum flow from the most limiting fire hose (a 3" supply line with a 2" tip) is 1000 gpm.
  - The two 1390 gpm SFP cooling pumps can take suction from the 420,000 gallon refueling water tank.
  - Water for the Fire Protection System can also be supplied by a 400 gpm fire protection booster pump.

- o The plant service water and the plant heating system are low flow rate systems which take suction on the two 500,000 gallon capacity pretreated water storage tanks.
- o The demineralized water system is a low flow rate (150 gpm) system which takes suction on the 350,000 gallon demineralized water storage tank.
- o No fire protection sprinkler system exists in the fuel handling area.

- **Flooding by Tsunami:** Since there has been no record of tsunamis on the northeastern United States coast, it is not believed that the site will be subjected to a significant tsunami effect [Updated Final Safety Analysis Report (UFSAR) 2.6.6].

- **Flooding by Hurricane:** The relative frequency of hurricane occurrence for the CCNPP site is slightly more than one hurricane per year. For the Probable Maximum Hurricane, it is assumed that the peak hurricane surge is coincident with normal high tide and with a 99th percentile wave height. The total predicted wave run-up is to Elevation 27.1', which is considerably less than the 69' elevation of the top of the SFP. Thus the maximum hypothetical flood level is below the top of the SFP elevation (UFSAR 2.8.3).

- **Flooding by Storms:** The Auxiliary Building is a concrete structure and qualified for high winds. Therefore, severe storms with high winds are not expected to cause sufficient damage to the roof, thereby allowing a large volume of rain to enter the building and becoming an unborated source of water to the SFP. The 6" lip around the SFP should cause the bulk of any entering rain water to flow out of the SFP area via the 13 floor drains, 13 doors, and 2 tendon end cap shafts.

- **Incomplete Mixing via Stratification:** The evaluation of a boron dilution event reducing the SFP boron concentration to less than 1650 ppm is based on an assumption of complete mixing of the boron in the SFP. The complete mixing assumption may not always be valid, if the circulation flow in the SFP is insufficient to prevent stratification. Where stratification has occurred (Robinson 2 - December 20, 1988 and San Onofre 1 - January 23, 1989), it was observed that the diluted water floated on top of the more highly borated water. This suggests that if stratification does occur, the water with the higher boron concentration will tend to be in the lower level of the SFP where the fuel assemblies are located. The possibility of boron stratification in the SFP can be eliminated by circulating the SFP water via the SFP cooling or purification systems.

- **Incomplete Mixing via Ribbon Effect:** Another type of incomplete boron mixing is a ribbon effect, where a channel of unborated water bores its way to an SFP assembly location. Assuming that the SFP is being diluted by the worst case fire hose of 3" diameter and a 2" nozzle diameter, an analysis using turbulent jet and diffusion theory was performed to determine the extent of any ribbon effect. The change in concentration per length of the jet flow can be estimated via the algorithm $Q/Q_o = 0.42^* z/d$, where Q_o is the volumetric flow rate at the nozzle discharge, d is the nozzle diameter, and Q is the volumetric flow rate at a distance z from the nozzle along the axis of symmetry. The volumetric flow will increase along the jet flow path, due to entrainment of the bulk liquid as the jet flow diameter increases. The ratio of volumetric flow rate to the initial volumetric flow rate determines the amount of bulk fluid entrained in the jet flow and thus is representative of the boron concentration along the flow path

$$C * Q = Co * (Q - Qo)$$
$$Q/Qo = Co/(Co - C) = 0.42 * z / d$$

For a C_o of 2450 ppm and an 2" diameter nozzle, C will reach 1650 ppm within 15" of the nozzle discharge. Thus, it is unlikely that a diluted ribbon flow of less than 1650 ppm could reach the fuel in the dry storage cask, since the upper-end fittings of the assemblies are in excess of 15" from the active fuel region of the assemblies stored in the DSC.

- **Tank Rupture in the Vicinity of the SFP:** No tanks containing any significant amount of water are stored in the vicinity of the SFPs.

- **Breaks in the Spent Fuel Pool Cooling (SFPC) System Piping or Heat Exchangers:** A break in the heat exchanger could cause a dilution of the SFP due to the inflow of water from the cooling water system. The SFPC heat exchangers are cooled by service water (UFSAR 9.4.2). The Service Water System is a closed system and uses plant demineralized water with a corrosion inhibitor added. Additional makeup may be provided by the condensate system (UFSAR 9.5.2.2). In addition, the entire SFPC system is tornado-protected and is located in a Seismic Category I Structure (UFSAR 9.4.2). Thus, a line break in this system is not considered a credible event.

- **Dilution Events Initiated in the Reactor Coolant System:** Another set of dilution events could be initiated by failures that could dilute both the boron concentration in the Reactor Coolant System (RCS) and the SFP via the refueling pool. However, Fuel Handling Procedure FH-305 only allows core alterations and transfer tube opening if there is no ISFSI cask in the SFP. Thus, dilution of the SFP via the RCS while an ISFSI cask is in the SFP is not a credible event.

- **Small Dilution Event:** A slow, long-term dilution event where nonborated water enters the SFP, and the SFP outflow is small enough to go essentially unnoticed, could occur if the piping, pumps, or possibly the pool liner, was to leak. Normal makeup operations (with demineralized water) would continue on a regular basis at a slightly higher frequency than that required without leakage. Pool level is maintained within normal operation range for the spent fuel activities. The maximum flow rate that could be leaving the SFP unnoticed is assumed to be 5 gpm. This is on the same order as possible evaporative losses. With a leak rate of 5 gpm, SFP makeup would be required every 43 hours between lower alarm limit and the overflow limit. Spent fuel pool boron concentration could become slowly depleted if an equivalent amount of unborated inleakage were to occur. It requires approximately 33 days with a nonborated source to achieve a boron dilution of 1650 ppm (k_{eff} = 1.0). This condition would be detected by a sampling surveillance, which is conducted prior to initiating fuel loading or unloading operations and once every 48 hours thereafter.

- **Silica Removal Operations:** During silica removal skid start-up operations, the skid components and associated process hoses will be primed with plant de-ionized (DI) water. As the silica removal skid operates, the DI water that was added to prime the skid will be discharged to the SFP. The volume of DI water that is used to prime the skid is < ½% of the total volume of the SFP. Although, adding this volume to the SFP will not have a significant affect on SFP boron concentration administrative limits, silica removal skid operations are not expected to be performed during a cask loading operation.

- **Dilution by Loss of SFPC:** Loss of SFPC will not cause a dilution event, since the soluble boron is non-volatile.

- **Dilution by Loss of SFP Coolant Inventory and Subsequent Makeup:** The fuel handling and storage facilities are designed to prevent loss of water from the fuel pool that would uncover fuel from natural events (Seismic Category 1 design), dropping of heavy loads (single-failure proof crane), and small leaks (coolant makeup system and level and radiation monitors).

- Heavy loads in excess of 1600 lbs are prohibited from travel over spent fuel assemblies in the SFP unless such loads are handled by a single-failure proof device. The Spent Fuel Cask Handling Crane is designed in accordance with the single-failure proof criteria of NUREG-0554 and NUREG-0612, and is used to handle heavy loads in the SFP area. The maximum design rated load for the Spent Fuel Cask Handling Crane is 150 tons for the main hoist and 15 tons for the auxiliary hoist (UFSAR 9.7.2.4). Thus the cask or heavy object drop accident is not a credible event.

- The likelihood of a fuel handling incident is minimized by administrative controls and physical limitations imposed on fuel handling operations. All refueling operations are conducted in accordance with prescribed procedures. Inadvertent disengagement of a fuel assembly from the fuel handling machine is prevented by mechanical interlocks; consequently, the possibility of dropping and damaging a fuel assembly is remote. The maximum elevation to which the fuel assemblies can be raised is limited by the design of the fuel handling hoists and manipulators to assure that the minimum depth of water above the top of a fuel assembly required for shielding is always present. Even though the assembly drop is unlikely, the SFP concrete plus liner plate are stronger than the fuel assembly bottom casting. The bottom casting is, in turn, stronger than the fuel and guide tubes. Essentially all impact kinetic energy absorption will take place in the fuel and guide tubes. Interface forces between the bottom assembly and the liner plate would be limited by the buckling of the fuel and guide tubes, which is of insufficient magnitude to cause perforation of the liner plate. In addition, for an impact over the collection trenches in the SFP, the interface forces between the bottom assembly and the liner plate would be limited by the buckling of the fuel and guide tubes which is of insufficient magnitude to cause perforation of the liner plate. Therefore, for both full contact impact and impact over the collection trenches of a fresh or irradiated maximum weight fuel assembly with an inserted control element assembly (1350-1360 lbm), the liner plate would not be perforated.

- The most serious failure to the system is the loss of SFP water. This is avoided by routing all SFP piping connections and penetrations above the water level and providing them with siphon breakers to prevent gravity drainage. The SFP inlets to the SFP cooling and purification systems are above the spent fuel racks and penetrate the SFP liner at 65' 11" centerline elevation, while the SFP discharge pipes from the shutdown cooling system, purification system, refueling water tank, and demineralized water tank are also above the spent fuel racks and penetrate the SFP liner at 65' 11" centerline elevation. The SFP does not contain any permanent drains, thereby preventing accidental drain down.

- The SFP is located in the Auxiliary Building between the two containment structures. During refueling operations, the SFP is connected to the refueling pool in Containment by the water-filled transfer tube, which is the only SFP penetration below the waterline. The fuel transfer tube penetration consists of a 36" diameter stainless steel tube inside a 42" diameter stainless steel penetration sleeve. The two concentric tubes are sealed to each other by a bellows-type expansion joint. Therefore, transfer tube leakage would require an unlikely double pipe break. During plant operations, the fuel transfer tube is closed in the SFP by a 36" stainless steel gate valve. Inside the Containment, the fuel transfer tube is sealed with a double O-ring blind flange. Thus, leakage during plant operations would also require the simultaneous failure of the gate valve and blind flange. Loss of SFP level via a pipe break in the refueling pool during refueling operations would be minimized by rapid closure of the transfer tube valve.

- The SFP is designed to preclude the loss of structural integrity. A 3/16" solid stainless steel liner plate was used on the inside face of both pools for leak tightness, and all of the field welds have leak-test channels welded to the outer side of the liner plates. The channels are grouped into ten zones, each with its own detector pipe to localize leaks in the liner seams. Even with the precautions described, small leaks may still occur in the SFP. Early detection of pool leakage and prompt replacement of water is essential. Early leakage detection is assured by a surveillance, which requires that the minimum pool level be verified at least once every seven days. In practice, level is checked once every 12 hours as required by the Auxiliary Building log sheets. In addition, a level alarm keeps the Control Room Operator aware of level changes.

Dilution Evaluation

Dilution times are based on a straight dilution to the SFP overflow limit and on a feed and bleed operation thereafter with instantaneous complete mixing. The maximum dilution source would occur from the Fire Protection System. The maximum flow from the most limiting fire hose (a 3" supply line with a 2" tip) is 1000 gpm. At a dilution rate of 1000 gpm directly into the SFP, it will take 4.04 hours to dilute the SFP from 2450 to 1650 ppm. It is not credible that dilution could occur for this length of time without operator notice, since this event would activate the Fire Protection System alarm and the SFP high level alarm and initiate Auxiliary Building flooding. In addition, in excess of 242,575 gallons of pretreated water must be added to the SFP to reach 1650 ppm soluble boron concentration.

The possibility of fire fighting activities in the immediate SFP area leading to a boron dilution event is not credible. Typically, combustible loadings around the SFP area are minor. If the fire hose stations are used to extinguish a fire, the volume of water required to extinguish a local fire is not anticipated to be of sufficient magnitude to dilute the SFP such that a several hundred ppm reduction in the SFP boron concentration would occur.

However, a fire in the Auxiliary Building could result in a large amount of unborated water entering the SFP while attempting to extinguish the fire. The rate of addition of unborated water from a fire would be insufficient to exceed the minimum boron level of 1650 ppm, since sufficient time would exist to take compensatory measures (i.e., add additional boron to the SFP). In addition, the discussion on incomplete boron mixing indicates that the unborated water would tend to float on the surface of the pool and overflow the SFP as water continues to flow into the SFP. Thus the fuel assemblies should remain surrounded by borated water. Finally, assuming that the fire is not directly over the SFP, the 6" lip around the SFP should cause the bulk of the water used to extinguish the fire to flow out of the SFP area via the 13 floor drains, 13 doors, and 2 tendon end cap shafts.

Additional pathways dilution times include

- 400 gpm fire protection booster pump = 10 hours to reach critical boron concentration
- 150 gpm demineralized water system = 27 hours to reach critical boron concentration

(5.C) A description of all alarms and indications available to promptly alert operators of a boron dilution event.

__CCNPP Response__

It is conservatively assumed that the SFP water level is at the lower alarm limit of 66' 6" and the soluble boron concentration is at the minimum value of 2450 ppm, when the dilution event initiates. The dilution event at 1000 gpm comprises the worst case scenario of a 3" diameter fire hose with a 2" nozzle. There are at least five opportunities for operators to identify and act on these dilution conditions.

- The activation of the electrically-driven or diesel-driven fire pumps causes an alarm in the Control Room, which is not cleared until the pump is stopped by the operators. <u>This is the first indication of abnormal conditions to the operators in the Control Room.</u>
- The SFP level reaches the upper alarm limit at 67' 2.75". <u>This is the second indication of abnormal conditions to the operators in the Control Room.</u>
- Overflow from the SFP flows into the gravity drain header, which is aligned with the Miscellaneous Waste Processing System and which is then collected in the miscellaneous waste receiver tank (MWRT). The water introduced into the MWRT reaches the upper alarm limit about 16 minutes into the event. <u>This is the third indication of abnormal conditions to the operators in the Control Room.</u>
- Overflow from the MWRT flows into the miscellaneous waste monitor tank (MWMT). The water introduced into the MWMT reaches the upper alarm limit at about 20 minutes into the event. <u>This is the fourth indication of abnormal conditions to the operators in the Control Room.</u>
- Overflow from the MWMT and MWRT flows into the -15' and -10' of the Auxiliary Building. A high level alarm on the lowest level of the Auxiliary Building will provide indication of flooding. <u>This is the fifth indication of abnormal conditions to the operators in the Control Room.</u>

(5.D) A description of plant controls that will be implemented to minimize the potential for a boron dilution event.

<u>CCNPP Response</u>

The high SFP alarm initiation time is calculated above for the worst-case scenario, and annunciation would occur in less than 15 minutes. In addition to the SFP level alarm, annunciation alarms exist in the Control Room for detection of the Fire Protection System activation. As such, operators will be able to identify and terminate the worst-case boron dilution source well within one hour of receiving the alarms.

(5.E) A summary of operator training and procedures that will be used to ensure that operators can quickly identify and terminate a boron dilution event."

<u>CCNPP Response</u>

At the first indication of abnormal conditions to the operators in the Control Room, i.e., initiation of the Fire Protection System activation alarm (see response to Criterion 5.C for indications of abnormal conditions), the operators are directed by procedure to investigate the cause of the pump operation and determine when to stop the fire pump.

At the second indication of abnormal conditions to the operators in the Control Room, initiation of SFP high level alarm, the operators are procedurally directed to investigate the cause of the alarm and to request Chemistry to sample the SFP for adequate boron concentration. The SFP level is monitored to determine if level is trending up or down.

At the third indication of abnormal conditions to the operators in the Control Room, initiation of the MWRT high level alarm, the operators are procedurally directed to determine and isolate the source of the incoming water.

At the fourth indication of abnormal conditions to the operators in the Control Room, initiation of the MWMT high level alarm, the operators are directed by procedure to determine and isolate the source of the incoming water.

At the fifth indication of abnormal conditions to the operators in the Control Room, initiation of the -15' Auxiliary Building high level alarm, the operators are directed by procedure to determine and isolate the source of the high water level, including MWRT and MWMT overflow.

Note that simultaneous activation of the SFP high level alarm and the Fire Protection System alarm within 13 minutes of the start of the worst-case dilution event, assures discovery and termination of the dilution event prior to criticality. Less severe dilution events have at least 10 hours before criticality and are thus not credible criticality scenarios.

The operators perform comprehensive training and testing on the alarm manuals during initial qualification. They are requalified on a two-year cycle, thereafter.

In addition, dilution of the SFP to below the minimum boron level of 1650 ppm will be prevented by the following administrative activities.

- **Filling the SFP:** Filling the SFP with demineralized water from the demineralized water tank or with borated water from the refueling water tank is controlled by procedure. In each case, an operator must be stationed on the 69' level to monitor SFP level, while the valve lineup is being performed and while the pool is being filled. The operator monitoring the pool levels is in radio communication with the Control Room and with the person doing the valve lineup. If demineralized water is being added to the SFP via the 69' demineralized water hose connection (150 gpm), the rate of SFP level rise is very slow (~1 inch/hr), therefore a continuous SFP watch is not required. However, frequent tours of the SFP area are required and the level must be closely monitored in the Control Room.
- **SFP Skimmer Operation:** Prior to placing any skimmers in service, the SFP water level is at least one or two inches above the top edge of the skimmer plate. In addition, all SFP system evolutions are supervised by a Plant Watch Supervisor.
- **SFP Boron Level:** Proposed Independent Spent Fuel Storage Installation Technical Specification Surveillance Requirement 4.2.1.1 (Reference 4) requires verification of the boron concentration in the SFP within 24 hours prior to insertion of the first spent fuel assembly into the DSC. It also requires reconfirmation at intervals not to exceed 48 hours until such time as the DSC is removed from the SFP. Proposed Independent Spent Fuel Storage Installation Technical Specification Surveillance Requirement 4.2.1.2 (Reference 4) requires verification of the boron concentration in the SFP within 24 hours prior to flooding the DSC cavity for unloading of the fuel assemblies. It also requires reconfirmation at intervals not to exceed 48 hours until such time as the DSC is removed from the SFP.
- **Control of Shift Activities:**
  - During core alterations, a Senior Reactor Operator is designated as a Fuel Handling Supervisor and directly supervises fuel alteration from the Containment 69' elevation, and has no other concurrent duties. His duties shall also include implementation of appropriate abnormal operating procedures for abnormally rising count rates and reduction in SFP level.
  - Plant Operators shall make one complete round during each 12 hour shift including level indication in the SFP area. The operator shall identify and contain all water leakage and shall look for damaged piping and instrument tubing, noting excessive vibration.

- An operator shall normally be present at a pump prior to startup.

- **ISFSI Cask Loading:** Approximately 1000 gallons of borated water are pumped from the SFP to the DSC/transfer cask prior to insertion of the DSC/transfer cask into the SFP. In addition, demineralized water is used to wash down the transfer cask and cables to control contamination and is used to fill the DSC/transfer cask annulus. This has the potential to cause minor dilution of the SFP. However, the following administrative controls minimize the dilution potential: (1) the Control Room supervisor and plant chemistry are notified prior to the discharge of water into the SFP, (2) pipes and hoses passing into the SFP are not left unattended, (3) plant chemistry is notified to collect a SFP sample to verify the required boron concentration prior to DSC/transfer cask operations. Note that the maximum dilution rate for this operation is ~200 gpm, thus the consequences of this operation are bounded by those previously analyzed.

IV. CONCLUSION

Title 10 CFR 50.12(a) states, the Commission may, upon application by any interested person or upon its own initiative, grant exemptions from the requirements of 10 CFR Part 50 when (1) the exemptions are authorized by law, will not present an undue risk to public health or safety, and are consistent with the common defense and security; and (2) when special circumstances are present. In an earlier exemption approved for Diablo Canyon Nuclear Power Plant (Reference 1), the NRC staff established five criteria that, if met, satisfy the underlying intent of 10 CFR 50.68(b)(1), and satisfy the Paragraph 50.12(a)(2)(ii) requirement for special circumstances. In this attachment, CCNPP presented a detailed discussion of how these five criteria are met. Calvert Cliffs Nuclear Power Plant believes the requested exemption is clearly authorized by law and is consistent with the common defense and security. In addition, CCNPP believes that this request meets the criteria established by the NRC staff for satisfying the underlying intent of 10 CFR 50.68(b)(1) as detailed in this attachment and therefore will not present an undue risk to public health or safety.

V. REFERENCES

1. Letter from Mr. G. S. Shukla (NRC) to Mr. G. M. Rueger (Pacific Gas and Electric Company), dated January 30, 2004, "Diablo Canyon Nuclear Power Plant, Unit Nos. 1 and 2 – Exemption from the Requirements of 10 CFR Part 50, Section 50.68(b) (TAC Nos. MC0992 and MC0993)"
2. NUREG/CR-5661, "Recommendations for Preparing the Criticality Safety Evaluation of Transportation Packages," 1997
3. Letter from Mr. G. Vanderheyden (CCNPP) to Document Control Desk (NRC), dated May 12, 2004, Response to NRC Request for Additional Information Regarding License Amendment Request for Technical Specifications Revision to Support the ISFSI NUHOMS-32P® Upgrade and Supplemental Information
4. Letter from Mr. G. Vanderheyden (CCNPP) to Document Control Desk (NRC), dated December 12, 2003, License Amendment Request: Revision to the Technical Specifications to Support the ISFSI NUHOMS-32P® Upgrade