VIRGINIA ELECTRIC AND POWER COMPANY
RICHMOND, VIRGINIA 23261

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VIRGINIA ELECTRIC AND POWER COMPANY (DOMINION)
SURRY POWER STATION UNITS 1 AND 2
PROPOSED TECHNICAL SPECIFICATIONS CHANGE REQUEST
SPENT FUEL CASK LOADING REQUIREMENTS

Pursuant to 10 CFR 50.90, Dominion requests amendments, in the form of changes to the Technical Specifications (TS) to facility operating license numbers DPR-32 and DPR-37 for Surry Power Station Units 1 and 2. The proposed change adds a requirement to the 10 CFR 50 license to restrict the minimum cooling time and burnup of spent fuel assemblies that will be placed into storage in the NUHOMS HD spent fuel dry storage system at Surry starting in the summer of 2006.

The NUHOMS HD system provides for the storage of high burnup spent fuel assemblies in a dry shielded canister (DSC) that is placed in a horizontal storage module (HSM-H) utilizing a OS187H transfer cask. The NUHOMS HD spent fuel storage system, including the 32PTH DSCs that will be used at Surry, is being licensed for general use under 10 CFR 72, Subpart L. This system will be used at Surry under the general license provided to operators of power reactors in 10 CFR 72.210. Use of the general license for a spent fuel storage system represents a change from the current operation of the Surry ISFSI, for which all the previous cask designs were individually licensed under the Surry ISFSI site specific license. The spent fuel loading, unloading, and handling operations that occur at the station for the NUHOMS HD storage system are not required to be reviewed by the NRC for individual station application, but must be addressed under the Surry Power Station 10 CFR Part 50 license.

The regulatory requirements for monitoring criticality in areas of the station where the NUHOMS HD storage system will be loaded, unloaded, and handled are given in 10 CFR 70.24. In lieu of installing and maintaining a criticality monitoring system that meets the requirements specified in 10 CFR 70.24, licensees may either seek an exemption from 10 CFR 70.24, or may choose to comply with the requirements of 10 CFR 50.68, which focuses on criticality prevention. Surry currently operates under

10 CFR 70.24 with an exemption to 10 CFR 70.24(a), but beginning with the implementation of the NUHOMS HD storage system under a general license, Surry will comply with the requirements of 10 CFR 50.68(b).

However, should circumstances require that casks currently stored at the Surry site specific ISFSI (and under the provisions of that independent license) be returned to the station, required handling activities will be performed consistent with the current licensing basis for these casks (i.e., 10 CFR 70.24, with exemption to 10 CFR 70.24(a)).

Dominion has performed a criticality analysis to demonstrate that subcritical conditions will be maintained during loading, unloading, and handling operations with the NUHOMS HD storage system at Surry. Consistent with the requirements of 10 CFR 50.68, this new analysis takes no credit for the soluble boron in the Spent Fuel Pool (SFP). However, credit is taken for the burnup of the fuel that is placed in the NUHOMS HD 32PTH DSC to ensure that the DSC remains subcritical when flooded with unborated water. A new TS requirement has been developed to ensure compliance with the basis for this criticality analysis and is hereby proposed for NRC approval.

Spent fuel storage casks of several other designs are stored at the Surry ISFSI under the site specific license. Application of the ISFSI general license with 10 CFR 50.68(b) compliance holds the potential for an interpretation of 10 CFR 70.24(d)(2) which could render the existing site specific ISFSI license void as it applies to the current requirements for return and repair of older casks, since these casks were licensed to the provisions of 10 CFR 70.24 with an exemption. Should it be necessary to return these older casks under the site specific license to the station for any reason, it is proposed that the necessary loading, unloading, and handling activities be performed under the original licensing basis for these casks (i.e., 10 CFR 70.24, with an exemption to the criticality monitoring requirements of 10 CFR 70.24(a)). No further criticality analyses would be necessary for these casks. NRC approval of this approach and position is requested to avoid regulatory confusion regarding potential future activities with the older casks licensed under the site specific license.

A detailed description of the proposed license changes and the supporting criticality analysis is provided in Attachment 1. It has been determined that this change does not constitute a significant hazard as defined in 10 CFR 50.92, and qualifies for the categorical exclusion from performing an environmental assessment, as discussed in Attachment 1. The marked-up proposed Technical Specifications pages are provided in Attachment 2. Proposed replacement pages are provided in Attachment 3.

To support the planned loading of the first NUHOMS HD 32PTH DSC at Surry in August 2006, Dominion requests NRC approval of the proposed changes by June 30, 2006. The use of the NUHOMS HD system is also contingent upon NRC approval of the Transnuclear FSAR and issuance of the Certificate of Compliance for the NUHOMS HD system, which is currently expected before June 2006.

Dominion plans to continue loading Transnuclear TN-32 dry storage casks at Surry, under the existing licensing basis (10 CFR 70.24), through the summer of 2006. The proposed changes to the Surry Technical Specifications for the NUHOMS HD storage system would be implemented after the loading of the last TN-32 cask, but prior to the loading of the first NUHOMS HD 32PTH DSC, or approximately August 1, 2006. We therefore request a 60-day implementation period for this TS change.

If you have any questions or require any additional information concerning this request, please contact Mr. David A. Sommers at (804) 273-2823.

Very truly yours,

Leslie N. Hartz
Vice President - Nuclear Engineering

Attachments:

1. Discussion of Change
2. Marked-up Technical Specifications Change Pages
3. Proposed Technical Specifications Change Pages

Commitments made in this letter: None

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SN: 06-087
Docket Nos.: 50-280/281
Subject: Spent Fuel Cask Loading Requirements

COMMONWEALTH OF VIRGINIA)
)
COUNTY OF HENRICO)

The foregoing document was acknowledged before me, in and for the County and Commonwealth aforesaid, today by Leslie N. Hartz, who is Vice President - Nuclear Engineering, of Virginia Electric and Power Company. She has affirmed before me that she is duly authorized to execute and file the foregoing document in behalf of that Company, and that the statements in the document are true to the best of her knowledge and belief.

Acknowledged before me this 14TH day of February, 2006.

My Commission Expires: May 31, 2006.

Vicki L. Hull
Notary Public

(SEAL)

ATTACHMENT 1

DISCUSSION OF CHANGE

SURRY POWER STATION – UNIT NOS. 1 & 2
VIRGINIA ELECTRIC AND POWER COMPANY
DOMINION

DISCUSSION OF CHANGE

INTRODUCTION

Pursuant to 10 CFR 50.90, Virginia Electric and Power Company (Dominion[1]) requests revisions to the Technical Specifications for Surry Power Station Units 1 and 2. The proposed change revises Technical Specification 5.4 to include requirements for the spent fuel that will be loaded into the NUHOMS HD system. A new criticality analysis was performed to demonstrate compliance with 10 CFR 50.68(b) during loading, unloading, and handling of NUHOMS HD dry storage canisters in the Spent Fuel Pool (SFP). The proposed Technical Specifications requirements ensure compliance with the basis (burnup credit and minimum cooling time) assumed in the new criticality analysis for operation of the NUHOMS HD system.

The proposed change has been reviewed, and it has been determined that no significant hazards consideration exists as defined in 10 CFR 50.92. In addition, it has been determined that the change qualifies for categorical exclusion from an environmental assessment as set forth in 10 CFR 50.22(c)(9); therefore, no environmental impact statement or environmental assessment is needed in connection with the approval of the proposed change.

BACKGROUND

Nuclear Regulatory Commission (NRC) Regulatory Information Summary (RIS) 2005-05, "Regulatory Issues Regarding Criticality Analyses for Spent Fuel Pools and Independent Spent Fuel Storage Installations" (Reference 1), was issued to advise licensees regarding potential inconsistencies between the regulatory bases of their SFPs and Independent Spent Fuel Storage Installations (ISFSIs). RIS 2005-05 outlined

[1] The licenses for Surry Units 1 and 2 and the Surry ISFSI are held by the Virginia Electric and Power Company. However, the utility design organization supporting the Surry units does business as Dominion Generation, and will be identified as "Dominion" throughout this discussion.

differences in the NRC Part 50 criticality requirements for the SFP and Part 72 criticality requirements for spent fuel storage casks, and indicated that licensees are expected to comply with both Part 50 and Part 72 requirements during cask operations within the SFP.

Prevention of spent fuel criticality is addressed by the General Design Criteria for nuclear power plants (10 CFR Part 50, Appendix A) and 10 CFR 50.68. The requirements for monitoring criticality in the fuel storage and handling systems, including the SFP, are contained in 10 CFR 70.24, "Criticality accident requirements," which emphasizes detection, rather than prevention, of a criticality event. In lieu of installing and maintaining a criticality monitoring system as required by 10 CFR 70.24, licensees have typically either (a) obtained an exemption from 10 CFR 70.24 by demonstrating that the plants have adequate physical systems or processes to prevent an accidental criticality event, or (b) elected to comply with the requirements of 10 CFR 50.68, which the Code of Federal Regulations (CFR) identifies as an acceptable alternative to compliance with 10 CFR 70.24.

Surry Units 1 and 2 currently operate under 10 CFR 70.24 with an exemption to 10 CFR 70.24(a) granted July 15, 1998 (Reference 2). This exemption was granted based on Dominion providing reasonable assurance that: irradiated and unirradiated fuel will remain subcritical during handling and storage; the present design configuration, TS requirements, administrative controls, and the fuel handling equipment and procedures make an inadvertent criticality event extremely unlikely; and radiation monitoring is provided in fuel storage and handling areas, as required by General Design Criterion 63.

Dominion currently operates an ISFSI consisting of two concrete storage pads at the Surry Power Station under a site specific license. To date, five different spent fuel storage cask designs of the thick wall / bolted lid type have been licensed for use at the Surry Power Station and ISFSI. The majority of the fuel stored at the ISFSI has been placed in Transnuclear TN-32 casks, which is the storage cask design currently being loaded at Surry. Beginning in the summer of 2006, Surry plans to begin loading a new spent fuel storage cask design, the Transnuclear NUHOMS HD spent fuel dry storage system (Reference 3). The NUHOMS HD system provides for the storage of high burnup spent fuel assemblies in a dry shielded canister (DSC) that is placed in a concrete horizontal storage module (HSM-H) utilizing an OS187H transfer cask. This system, which is currently being reviewed by the NRC, is designed to be installed at power reactor sites under the provision of a general license in accordance with 10 CFR 72, Subpart K. Surry will be using this system (with the 32PTH canister) at a third pad constructed adjacent to the current site specific licensed ISFSI. This third pad will not be part of the Surry site specific licensed ISFSI but rather will be used under the general license provided to operators of power reactors by 10 CFR 72.210.

Use of the NUHOMS HD system under a general license represents a change from the current site specific licensing basis for Surry spent fuel storage and handling operations. Licensing of spent fuel storage casks is generally governed by 10 CFR 72, but loading of the casks occurs in the Surry SFP, for which the current licensing basis is 10 CFR 70.24. The previously used cask designs and their associated procedures were reviewed by the NRC and approved for use at the Surry Power Station and ISFSI as part of the site specific license, under the provisions of 10 CFR 72 and 10 CFR 70.24, including an exemption to 10 CFR 70.24(a). When using the general license for the NUHOMS system, the cask loading, unloading and handling operations that occur at the station must be addressed under the Surry Power Station 10 CFR Part 50 license.

As discussed in RIS 2005-05, exemptions to 10 CFR 70.24 are inherently based on the design and operation of the fuel handling and storage systems at the time of issuance. For the current Surry exemption to 10 CFR 70.24(a) to apply to the NUHOMS casks under a general license, use of these casks must not constitute a change to the licensing and design basis of the spent fuel pool, or to the operation of the spent fuel pool, as these existed when the current exemption to 10 CFR 70.24(a) was issued. RIS 2005-05 also indicates that since dry casks are loaded and unloaded in the cask pit area of a licensee's spent fuel pool, casks, while they are in the spent fuel pool, must meet both the 10 CFR Part 72 and Part 50 requirements for criticality.

Surry's current exemption to 10 CFR 70.24(a) relies in part on an evaluation which demonstrates that the K-effective of the spent fuel storage racks remains less than or equal to 0.95 for fuel of a maximum nominal enrichment of 4.3 weight percent U-235 under normal conditions. This evaluation assumes no credit for soluble boron in the spent fuel pool. The evaluation is also consistent with the requirement later incorporated in 10 CFR 50.68(b)(4) that, if no 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 unborated water. To show that the NUHOMS HD system (utilizing the 32PTH canister) meets the criticality requirements for both Part 72 and Part 50 while in the Surry SFP an additional criticality evaluation has been performed. This evaluation shows that use of the NUHOMS HD system (utilizing the 32PTH canister) meets the subcriticality requirements of the 70.24(a) exemption basis as well as the requirement of 50.68(b)(4). However, this new criticality evaluation assumes credit for the burnup of the fuel to be stored in the NUHOMS HD system. Implementation of this criticality analysis requires a change to the Part 50 Technical Specifications to include a requirement on the burnup of the fuel to be placed in the NUHOMS HD storage system. This constitutes a licensing change with respect to the storage of spent fuel at Surry applicable when a loaded NUHOMS HD canister is in the spent fuel pool, and so may be an invalid use of the current Surry exemption to 10 CFR 70.24(a) for these canisters. To accommodate loading the NUHOMS HD canisters in the SFP it would be necessary to obtain a new exemption to 10 CFR 70.24(a), or to show compliance with all the requirements of 10 CFR 70.24, or to show that Surry complies with the requirements of 10 CFR 50.68(b). Dominion is electing to demonstrate that Surry complies with the requirements of 10 CFR 50.68(b) for the NUHOMS HD dry storage canisters.

This submittal discusses how Surry complies with the requirements of 10 CFR 50.68. To supplement the criticality analyses of record for the New Fuel Storage Area and Spent Fuel Pool, it was necessary to perform an additional analysis to demonstrate that the criticality requirements of 10 CFR 50.68 will also be satisfied during loading, unloading, and handling operations with the NUHOMS HD storage system (utilizing the 32PTH canister) in the Surry SFP. A new Technical Specifications requirement is being proposed to ensure compliance with the basis for this new criticality analysis.

Discussions pertaining to the loading, unloading, and handling operations in the SFP in this submittal are confined to the NUHOMS HD storage system (32PTH canister). Dominion plans to continue loading Transnuclear TN-32 dry storage casks at Surry under the existing licensing basis (10 CFR 70.24, with an exemption to 10 CFR 70.24(a)) through the summer of 2006. The proposed changes to the Surry Technical Specifications and operation under 10 CFR 50.68(b) would be implemented after the loading of the last TN-32 cask, but prior to the loading of the first NUHOMS HD 32PTH canister, or approximately August 1, 2006. However, should circumstances require that casks currently stored at the Surry ISFSI under the site specific license be returned to the station, the necessary handling activities will be performed under the licensing basis applicable for these casks (i.e., 10 CFR 70.24, with the exemption to 10 CFR 70.24(a)).

CHANGES TO SURRY UNITS 1 AND 2 TECHNICAL SPECIFICATIONS

The aspects of fuel storage related to prevention of criticality in the Surry fuel storage areas are governed by the requirements of Surry Units 1 and 2 Technical Specification 5.4, "Design Features." To ensure that the fuel loaded in the NUHOMS HD 32PTH canister is consistent with the basis for the Surry site specific criticality calculation performed for this storage system, it is proposed that Figure 5.4-2 be added to the Technical Specifications. This new figure shows a curve of the minimum acceptable fuel assembly average burnup as a function of nominal initial enrichment that was used to demonstrate that the NUHOMS HD 32PTH canister remains subcritical during operations in the Surry SFP, even if flooded with unborated water. New Technical Specification 5.4.E is also proposed to require that administrative controls be employed with written procedures to ensure that only fuel assemblies that meet the assumed minimum cooling time and fall within the 'Acceptable' region of Figure 5.4-2 are placed in the NUHOMS

HD 32PTH canister. There are no changes to Technical Specification Bases, as there are no Bases for the Design Features section of the Surry Technical Specifications.

SAFETY SIGNIFICANCE SUMMARY

Operation under 10 CFR 50.68 and implementation of additional requirements on the cooling time and burnup of fuel that is to be loaded into the NUHOMS HD 32PTH canister will not require any physical changes to Part 50 structures, systems, or components, nor will there be any changes to the performance requirements of existing structures, systems, or components. The response of the plant to previously analyzed Part 50 accidents is not adversely impacted, and current analyses of radiological releases, including those for the fuel handling accident, will continue to bound activities related to spent fuel cask loading, handling, and storage. The possibility of a new or different kind of accident from any accident previously evaluated is not created, and there is no reduction in a margin of safety.

The NUHOMS HD storage system is under review for a general license under 10 CFR Part 72. Compliance with the proposed Surry Part 50 Technical Specification will further ensure that the system remains safely subcritical during all handling and storage operations (e.g., loading, unloading, handling, decontamination, etc.) that are conducted at the station prior to transfer of the canisters to the ISFSI under the criticality limits prescribed in 10 CFR Part 50.

The Code of Federal Regulations identifies compliance with 10 CFR 50.68(b), which emphasizes prevention of inadvertent criticality events, as an acceptable alternative to compliance with 10 CFR 70.24, in which the emphasis is on detection of criticality events. Operation under 10 CFR 50.68(b) for use of the NUHOMS HD system will ensure that Surry complies with the intent of General Design Criterion 62, which specifically directs that criticality should be prevented during fuel storage and handling.

TECHNICAL EVALUATION

1.0 Introduction

In the summer of 2006 Dominion plans to begin using the NUHOMS HD spent fuel storage system (utilizing the 32PTH canister) for fuel that has been irradiated in Surry Units 1 and 2. This system will be licensed for general use under 10 CFR 72, Subpart L, and Dominion will use this system under the general license provided to operators of power reactors in 10 CFR 72.210.

The evaluations in Reference 3 support the general license for the NUHOMS HD system (which includes the 32PTH canister) and demonstrate compliance with the criticality requirements of 10 CFR 72. Surry compliance with 10 CFR 50 when using the NUHOMS HD system requires that an additional criticality evaluation be performed to demonstrate that the Part 50 criticality requirements - which differ from the Part 72 requirements - are satisfied during cask loading, unloading, and handling operations in the Surry Spent Fuel Pool. This evaluation is described below.

Dominion is also electing to demonstrate that Surry complies with the requirements of 10 CFR 50.68(b) when using the NUHOMS HD system. Surry compliance with each of the requirements of 10 CFR 50.68(b) is also described below.

2.0 Surry Compliance with 10 CFR 50.68(b) Requirements

Licensees electing to comply with 10 CFR 50.68(b) in lieu of maintaining a monitoring system capable of detecting a criticality as described in 10 CFR 70.24 must satisfy eight (8) requirements. Surry compliance with each of these requirements is discussed below.

2.1 10 CFR 50.68 (b)(1)

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 for unborated water.

Normal storage of new fuel in the Surry New Fuel Storage Area, and new and spent fuel in the Surry Spent Fuel Pool, is addressed in Sections 2.2 and 2.3 of this evaluation, respectively. Handling and storage of the loaded and dried NUHOMS HD 32PTH canisters (i.e., during transport to and storage at the ISFSI) will be performed in accordance with the NUHOMS HD system Certificate of Compliance (C of C), and comply with the requirements of 10 CFR 72.

Other fuel storage and handling activities are discussed below.

2.1.1 Receipt of New Fuel

The shipping containers used to deliver new fuel assemblies to the Surry Power Station are covered by Certificate of Compliance (C of C) for Radioactive Material Packages Number 9239. This C of C certifies that the package meets the standards of 10 CFR 71. 10 CFR 71.55 specifically requires that packages used for fissile materials be designed so that the contents remain subcritical under both normal conditions of transport and hypothetical accident conditions (including water moderation to the most reactive credible extent consistent with the condition of the package and the physical form of its contents). New fuel on site that remains inside the shipping containers therefore will meet the requirements of 10 CFR 50.68 (b)(1). Additionally, Westinghouse is currently in the process of licensing a new shipping container (the "Traveller" design). Prior to deployment of this new shipping container within the U.S., it will be necessary for the fuel vendor to demonstrate that this container will similarly comply with the requirements of 10 CFR 71, which will ensure that there is no impact on the station compliance with the requirements of 10 CFR 50.68 (b)(1).

Transfer of fuel assemblies from the shipping containers to the New Fuel Storage Area occurs in air. These transfers are controlled by plant procedures, which limit the handling of the shipping containers (containing up to two fuel assemblies) to one at a time. The fuel handling equipment used to unload and transfer the new fuel assemblies from the shipping containers to the new fuel storage racks precludes handling more than one assembly at a time. Even if the new fuel assembly is somehow moderated during this transfer, a single isolated fuel assembly of the maximum possible reactivity allowed by Surry Technical Specifications will remain subcritical in unborated water. Therefore, transfer of the new fuel assemblies to the New Fuel Storage Area meets the requirement of 10 CFR 50.68 (b)(1).

2.1.2 New Fuel Transfers to the Spent Fuel Pool

Fuel assemblies are delivered to containment by transferring them from the New Fuel Storage Area to the Spent Fuel Pool and taking them through the fuel transfer system. The design of the fuel handling equipment used to move the fuel assemblies from the New Fuel Storage Area to the new fuel elevator, and from the new fuel elevator to either the Spent Fuel Pool storage racks or directly to the fuel transfer system upender/cart inherently limit the handling to a single assembly at a time. The new fuel elevator and upender/transfer cart similarly accommodate only a single fuel assembly. Fuel assemblies in the elevator and transfer cart are a sufficient distance from fuel in the SFP storage racks to ensure criticality does not occur, even if the pool were inadvertently filled with unborated water. Criticality concerns are therefore addressed during these evolutions and the requirement of 10 CFR 50.68 (b)(1) is met.

2.1.3 Fuel Transfers from SFP to Reactor Core

Refueling operations require movement of both irradiated and unirradiated fuel in the Reactor Vessel and Spent Fuel Pool, as well as movement between these two locations.

Fuel assemblies are transferred between the Spent Fuel Pool and containment using an underwater conveyor car and track system that extends from the Spent Fuel Pool through the transfer tube and into the refueling canal in containment. This fuel transfer system cart, which also holds the fuel assembly during the transition between the horizontal and vertical positions at each end of the fuel transfer tube, is designed to hold a single fuel assembly. A fuel assembly in the transfer system upender/cart is a sufficient distance from fuel in the SFP storage racks to ensure criticality does not occur, even if the pool were inadvertently filled with unborated water. A fuel assembly in the transfer system upender/cart is also isolated in containment, sufficiently far from the fuel in the reactor core to ensure criticality does not occur. As a single fuel assembly cannot attain criticality, even in unborated water, criticality concerns are precluded during transfers between the Spent Fuel Pool and Containment and the requirement of 10 CFR 50.68 (b)(1) is met.

The fuel handling equipment used in containment to move the fuel assemblies from the fuel transfer system upender/cart to the Reactor Vessel is designed to handle a single fuel assembly. All fuel movements are procedurally controlled and designed to preclude criticality. Handling of fuel in the reactor vessel complies with Surry Technical Specification 3.10, Refueling, which requires a minimum shutdown margin (K-effective < 0.95), specifies a minimum boron concentration, and identifies minimum requirements for source range neutron detectors whenever the Reactor Vessel head is unbolted for fuel movement. The core is also monitored when fuel is added to the reactor core to verify that the core remains subcritical and that the boron concentration is sufficient to assure the proper shutdown margin. Therefore, the fuel remains safely subcritical during fuel handling activities in containment.

2.1.4 Fuel Transfers from SFP to NUHOMS HD 32PTH Dry Storage Canister

The design of the fuel handling equipment used to move the fuel assemblies from the Spent Fuel Pool storage racks to the dry storage canister limits the handling to a single assembly at a time. As a single fuel assembly cannot attain criticality, even in unborated water, criticality concerns are therefore precluded during these fuel handling evolutions and the requirement of 10 CFR 50.68 (b)(1) is met.

A criticality analysis was performed to demonstrate that the criticality requirements of 10 CFR 50.68 will be satisfied for the NUHOMS HD 32PTH canister during loading, unloading, and handling operations. This analysis, which is described in Section 3.0 of this submittal, assumes a 5-year minimum cooling time and takes credit for the burnup of the fuel placed in the canister to demonstrate that the canister remains safely subcritical when flooded with unborated water. A proposed new Technical Specifications requirement will ensure compliance with the basis for this new criticality analysis. Therefore, the requirement of 10 CFR 50.68 (b)(1) is met. The fuel misload and all other non-dilution related accidents for the NUHOMS HD 32PTH canisters are analyzed in or bounded by the cask analysis in Reference 3.

2.2 10 CFR 50.68 (b)(2) and (b)(3)

10 CFR 50.68 (b)(2) requires that the estimated ratio of neutron production to neutron absorption and leakage (K-effective) of the fresh fuel in the fresh fuel storage racks be calculated assuming the racks are loaded with fuel of the maximum fuel assembly reactivity and flooded with unborated water, and must not exceed 0.95, at a 95 percent probability, 95 percent confidence level.

10 CFR 50.68(b)(3) places a similar constraint on the new fuel storage racks for hydrogenous material other than water, but allows a slightly higher value for K-effective. Specifically, if optimum moderation of fresh fuel in the fresh fuel storage racks occurs when the racks are assumed to be loaded with fuel of the maximum reactivity and filled with low-density hydrogenous fluid (foam), it is required that the K-effective corresponding to this optimum moderation must not exceed 0.98, at a 95 percent probability, 95 percent confidence level.

The most recent criticality analysis for the Surry New Fuel Storage Area is described in References 4 and 5. NRC approval of this analysis is given in Reference 6. This analysis assumed that the racks were loaded with fuel at the maximum U-235 enrichment allowed by the Surry Technical Specifications, which is consistent with the 10 CFR 50.68 requirement that the analysis be based on fuel of the maximum fuel assembly reactivity. As reported in References 4 and 5, the maximum K-effective for the new fuel storage area was determined to be less than 0.95 for even the optimum moderation condition. Therefore, Surry meets the requirements of 10 CFR 50.68 (b)(2) and (b)(3).

2.3 10 CFR 50.68(b)(4)

If no credit is taken for soluble boron in the SFP criticality analysis, 10 CFR 50.68(b)(4) requires that 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 (i.e., the fuel in the racks must remain subcritical), at a 95 percent probability, 95 percent confidence level, if flooded with unborated water.

The most recent criticality analysis for the Surry Spent Fuel Pool storage racks is described in References 4 and 5. This analysis assumed that the racks were loaded with fuel at the maximum U-235 enrichment allowed by the Surry Technical Specifications, which is consistent with the 10 CFR 50.68 requirement that the analysis be based on fuel of the maximum fuel assembly reactivity. The normal storage rack configuration was analyzed with no credit taken for soluble boron in the SFP (i.e., the SFP was assumed to be flooded with unborated water, even though Surry Technical Specifications require a minimum of 2300 ppm boron in the SFP during normal operation). The K-effective for this case was determined to be less than 0.95. For other postulated accident scenarios such as fuel misplacement, pool water temperature change, and a fuel storage cask handling accident that damages the racks adjacent to the cask loading area, soluble boron was assumed to be present in the SFP. (In other words, consistent with ANSI/ANS 8.1-1983, it was assumed that two unlikely, independent events - one of those being a boron dilution accident - did not occur concurrently.) The maximum K-effective for the SFP for these non-dilution accidents was determined to be less than 0.95.

As discussed in Section 3.0, a new criticality analysis was performed for loading, unloading, and handling operations for the NUHOMS HD 32PTH canisters in the Surry SFP. Consistent with the requirements of 10 CFR 50.68 (b)(4), it was determined that the maximum K-effective is less than 0.95 when flooded with unborated water, provided that the fuel in the canister meets the requirements of proposed Technical Specification 5.4.E.

Therefore, with implementation of these proposed Technical Specifications changes, Surry will meet the requirements of 10 CFR 50.68 (b)(4) for fuel handling and storage, including the loading and handling of the NUHOMS HD spent fuel storage system.

2.4 10 CFR 50.68(b)(5)

10 CFR 50.68(b)(5) requires that the quantity of Special Nuclear Material (SNM), other than nuclear fuel stored onsite, be less than the quantity necessary for a critical mass.

At Surry Power Station, SNM is present primarily as nuclear fuel. Other smaller quantities of SNM are used on site (e.g., in incore and excore detectors, in primary startup sources, and in neutron calibration sources). The amount used in non-fuel applications is very small, and the form in which it is used and stored precludes an inadvertent criticality.

A physical SNM inventory is performed at intervals not to exceed 12 months per 10 CFR 74.19(c), and a listing of the physical inventory is submitted in accordance with 10 CFR 72.76(a) and 74.13(a). The most recent Material Balance Report for the Surry Power Station shows that the amount of non-fuel SNM (Uranium-235, Uranium-233 and total Plutonium) currently stored at the site is far less than the amount for a critical mass defined in 10 CFR 70.4. Therefore, Surry Power Station complies with this requirement.

2.5 10 CFR 50.68(b)(6)

10 CFR 50.68(b)(6) requires that radiation monitors be provided in storage and associated handling areas when fuel is present to detect excessive radiation levels and to initiate appropriate safety actions.

Area radiation monitors are permanently installed in selected areas throughout the Surry Power Station, including the New Fuel Storage Area and on the Spent Fuel Pool bridge crane. These are fixed-position gamma-sensitive detectors that activate audible and visual alarms in both the control room and at their respective station location. These area radiation monitors were previously identified as being available to detect excessive radiation levels in fuel storage areas and initiate appropriate safety actions in accordance with the requirements of 10 CFR 50 Appendix A, General Design Criterion 63 (Reference 7). In locations that do not have permanently installed area radiation monitors, temporary monitors will be procedurally required when fuel is being stored or handled. These temporary gamma sensitive monitors alarm locally to alert personnel to excessive radiation levels. Investigation of the reason for the high radiation levels would initiate appropriate safety or protective actions, including evacuation of the area.

Nuclear employee training is also required of all nuclear employees prior to receiving a badge to enter the nuclear power station, and is provided annually to employees thereafter. For those individuals granted access to the Radiological Controlled Area, this training provides direction regarding their required response upon hearing an alarm associated with an area radiation monitor. Employees are trained to immediately leave the area, notify the Health Physics department, and not re-enter the area until authorized by Health Physics.

2.6 10 CFR 50.68(b)(7)

10 CFR 50.68(b)(7) requires that the maximum nominal U-235 enrichment of the fresh fuel assemblies be limited to five (5.0) percent by weight.

Per Surry Units 1 and 2 Technical Specification 5.4.B, the nominal U-235 enrichment of the Surry fuel assemblies is limited to 4.3 percent by weight. Therefore, Surry Power Station meets this requirement.

2.7 10 CFR 50.68(b)(8)

10 CFR 50.68(b)(8) requires that the FSAR be amended no later than the next update required by 10 CFR 50.71(e) to indicate that the licensee has chosen to comply with 10 CFR 50.68(b).

The necessary UFSAR changes have been identified, as discussed in Section 4.0. The Surry UFSAR will be updated to comply with 10 CFR 50.68(b)(8) after receipt of the SER for this Technical Specifications change, and upon implementation of the Technical Specification changes.

3.0 Criticality Evaluation for NUHOMS HD 32PTH Canister Operations in the Surry SFP

The licensing basis for the NUHOMS HD 32PTH canister (Reference 3) relies on the presence of soluble boron in the SFP to meet the Part 72 criticality requirement that K-effective be less than 0.95. Under 10 CFR 50.68, credit may be taken for soluble boron in the SFP criticality analyses for normal operation, but this requires an analysis of potential SFP dilution sources and dilution rates to address potential accident scenarios. For use of the NUHOMS HD 32PTH canister in the Surry SFP, Dominion has instead elected to determine the amount of fuel burnup required to ensure that K-effective remains below 0.95 for a fully loaded cask, immersed and filled with unborated water. The required burnup was determined for different nominal U-235 enrichments, and the resulting curve of minimum allowable fuel assembly average burnup versus nominal enrichment will be used as an additional constraint when identifying fuel that may be stored in the NUHOMS HD 32PTH canister.

Surry Technical Specification 5.4.C requires that at least 2300 ppm boron be present in the SFP under normal conditions. This means that a canister filled with unborated water represents a worst case dilution accident condition for canister operations in the Surry SFP. Consistent with ANSI/ANS 8.1-1983, it is assumed that two unlikely, independent events - one of those being a boron dilution accident - do not occur concurrently. Other non-dilution related accidents, such as a fuel assembly misload in which a fresh fuel assembly is loaded into the canister, can therefore credit the soluble boron in the SFP. The fuel misload and all other non-dilution related accidents for the NUHOMS HD 32PTH system are analyzed in or bounded by the analyses in Reference 3, which assumes the canister contains all fresh fuel of the maximum allowable enrichment.

3.1 Analytical Method

The methods and computer codes used to assess the NUHOMS HD 32PTH dry storage system against the criticality requirements of 10 CFR 50.68(b) are similar to those used in previous criticality analyses for the NUHOMS HD 32PTH system (Reference 3) and in Surry criticality analyses for the New Fuel Storage Area and Spent Fuel Pool (Reference 4). The primary steps in this analysis were:

1) A detailed 3D NUHOMS HD 32PTH canister / transfer cask model was developed using the Monte Carlo SCALE-4.4a/KENO-V.a code[2] and the 238 group ENDF/B-V cross section library (Reference 8). The model was evaluated for the potential non-conservative geometric modeling error discussed in NRC Information Notice 2005-13 (Reference 11) and the results of the criticality

[2] Throughout this discussion, references to the SCALE system are to the SCALE-4.4a code system, and references to the KENO code are to the KENO-V.a code that is part of the SCALE-4.4a system. Similarly, references to the CASMO code are to the CASMO-4 neutronics code.

evaluation were confirmed to be unaffected by the reported problem. KENO cases were run with 1300 generations (300 skipped) and 4000 neutrons per generation.

2) Conservative initial and operating conditions for calculation of the fuel isotopic content were determined. This assessment included consideration of the bounding axial fuel burnup shapes (Reference 9).

3) The fuel isotopic content as a function of initial enrichment and burnup was calculated using the CASMO-4[2] neutronics code (Reference 10). A five year cooling time was assumed, based on licensing conditions for the NUHOMS HD system given in Reference 3.

4) A SCALE/KENO code / model bias for the 238 group ENDF/B-V cross sections was determined by benchmarking the model to a set of applicable criticality experiments.

5) The most limiting normal operating conditions for the NUHOMS HD system in the Surry SFP (SFP temperature) were determined using a representative combination of fuel enrichment and burnup.

6) K-effective uncertainties due to variations in cask geometry, fuel enrichment, and fuel UO_2 loading were determined using a conservative fuel enrichment/burnup combination.

7) Using the variation uncertainties determined in Step 6 and the code / model bias determined in Step 4, the maximum acceptable K-effective per 10 CFR 50.68 was determined.

8) For several initial fuel enrichments, the minimum fuel burnup required to ensure K-effective will not exceed the maximum acceptable value (Step 7) at a 95 percent probability, 95 percent confidence level was determined.

9) Finally, a bounding curve of required burnup versus initial fuel enrichment (including a 5% fuel burnup uncertainty as proposed in RIS 2005-05) was determined.

3.2 Fuel Design Description and Storage System Model

The fuel design used for the NUHOMS HD system criticality analysis was 15x15 Surry Improved Fuel (SIF) with Zircaloy cladding and grids (Reference 12). In general, the SIF fuel design is the most reactive of the 15x15 fuel types that have been used at Surry due to the use of zirconium alloy grids in place of earlier Inconel grids. The original SIF fuel design with Zircaloy cladding, guide tubes and grids is also more reactive than current generation SIF fuel that uses ZIRLO (containing 1% niobium) for the cladding, guide tubes and grids (Reference 13). The differences between 15x15 fuel types relevant to neutronic performance are minor, involving primarily different grid designs and slight changes in guide/instrument thimble dimensions. Grids and end nozzles were ignored in the criticality model for simplicity. A sensitivity calculation (described in Section 3.6) confirmed that this model simplification had an insignificant impact on the calculated K-effective.

The SCALE/KENO model for the NUHOMS HD 32PTH transfer cask / canister design is based on information provided in Reference 3. Specific information obtained from Reference 3 included: the overall system description; the basket and canister dimensions and material specifications; neutron poison plate characteristics; and details of the basket assembly, including the minimum neutron poison plate B-10 areal density. The 32PTH DSC has multiple basket configurations, that differ in the material type and boron content in the poison plates. Two basket designs described in Reference 3, the "C" and "D" designs, were evaluated for Surry. The primary differences between these two basket designs are the use of Boral in the "C" basket and the use of borated aluminum absorber plates in the "D" basket design, and the fixed poison loading requirements (minimum B-10 areal density). The minimum B-10 areal density requirements for the baskets are specified in the technical specifications for the NUHOMS HD system (Reference 3).

Figures 1 through 4 visually represent the model for the geometry of the NUHOMS HD 32PTH canister within the OS178H transfer cask. Figures 1 and 2 represent X-Y cross sections of the system at different elevations. In these figures, material numbers shown are consistent with the KENO model inputs, and refer to the following materials:

1) First of eight fuel compositions
2) Fuel cladding
3) Water
4) SS-304
5) Basket poison plate
6) Basket plate
7) Lead shielding
8-14) Fuel composition regions 2-8

The fuel pins, guide thimble regions, East and West basket plates, North and South plate support bars and cask structure are all clearly visible. Figure 2 represents an elevation that shows all the basket plates. Figure 3 shows X-Z and Y-Z cross sections at the outer face of the basket showing the detail of the basket plates, support bars, and part of the cask structure. The poison plate gaps (slots) were modeled using the maximum design tolerance dimensions to minimize the poison plate coverage and maximize the amount of unborated water. Note that the axial elevations of the support bars differ for the X-Z and Y-Z cross sections, as do the plate orientations. It may be noted that the extension of the fuel storage tube above the basket poison plates was not modeled. Sensitivity calculations were performed to confirm that this model simplification had an insignificant impact on the calculated K-effective. Figure 4 is similar to Figure 3, but shows the axial region detail at the center of the basket.

3.3 Calculation of Fuel Isotopic Content

The isotopic content of the fuel was calculated using the CASMO code. This code is widely used for core modeling applications, and has been licensed for use for Surry and North Anna. The accuracy of CASMO (in conjunction with the SIMULATE model) has been demonstrated through extensive comparisons to operating core measurements, which reveal no significant reactivity bias at hot operating conditions. For Surry operating cores, CASMO has predicted K-effective results within 0.005 dK of measured critical conditions. Use of the CASMO fuel inventory in KENO, coupled with the conservative input data and conservative use of output data described below, ensures that conservative K-effective results are provided for the burnup credit cases.

To ensure that an appropriately conservative burnup credit was calculated, the initial fuel content and fuel depletion conditions were selected to maximize the depleted fuel reactivity. The primary considerations for initial fuel content are the initial U-234 and U-236 content and the fuel density (including the effect of pellet dishing and chamfer). U-234 and U-236 are predominantly neutron absorbers present in small quantities in low enriched UO_2 fuel. To maximize the depleted fuel reactivity, it was conservatively assumed that the initial fuel content did not include either of these isotopes. The nominal fuel density was conservatively chosen as the maximum batch average fuel density of all Surry fuel batches from initial operation through Batch 19 (10.38 g/cc, or approximately 95.8 % Theoretical Density). A sensitivity case was run that incorporated a 2% tolerance on this value to allow for fuel manufacturing variability. The conditions in this sensitivity case, therefore, represent a density of over 97.5% Theoretical Density with 1% total dish and chamfer volume, which is a reasonable upper bound on total fuel loading. Inclusion of this sensitivity into the K-effective total uncertainty is described in Section 3.6.

Conservative assumptions were also used to develop the isotopic data for the burnup credit calculations. The phenomena and parameters that are important in determining burnup credit are discussed in Reference 14. The significant variables, conservative direction, and values for the depletion of PWR fuel recommended in Reference 14 are shown in Table 1. Surry-specific values were determined for these parameters using core design data for two recent cycles (Surry 2 Cycle 19 and Surry 1 Cycle 20). These cycles represent both the low-low-leakage 18 month fuel management strategy that has been used at Surry for approximately 15 years and the more recent trend toward higher load factors (~98%) and short refueling outages (~25-35 days). The values used for these significant variables in the Surry depletion analysis are shown in Table 1, and are discussed below:

- The recommended fuel temperature of 1000K was assumed. This value conservatively bounds the burnup-weighted maximum fuel temperature that was determined for recent Surry cycles.

- A burnup weighted moderator temperature was developed for recent Surry cycles. The weighting took into account the higher moderator exit temperatures for fresh and once-burned fuel, and produced a temperature that was higher than the core average exit moderator temperature. The maximum value for the recent Surry cycles of 595.4K was used to develop the isotopic data.

- A cycle average critical boron value of 800 ppm, which conservatively bounds both recent Surry cycles and the Reference 14 recommendation, was used.

- Although different axial burnup regions have unique combinations of moderator temperature, fuel temperature, burnup, and depletion power, for simplicity the Surry depletion calculation used conditions that were conservative for the top of the fuel stack for all axial regions. A nominal average power was used, which is consistent with the "high but credible" recommendation of Reference 14. This power is conservative for the top approximate 15% of the fuel, which is the region of highest importance in the burnup credit cases, because this fuel actually operates at lower than average power due to neutron leakage. Similarly, use of the maximum fuel temperature and moderator temperature values for all axial fuel regions is conservative.

- Burnable absorber loading was maximized by modeling a discrete burnable poison rod assembly (BPRA) of the design currently used at Surry with the maximum B^{10} loading (a 20-rodlet BPRA, with 3 w/o B_4C encased in Zircaloy cladding) that was assumed to be present in the fuel assembly for the entire depletion. Introduction of integral fuel burnable absorber (IFBA) is planned at Surry. This burnable absorber design will be bounded by the depletion performed with the discrete burnable poison because the IFBA design does not displace water, resulting in less spectrum hardening.

- A 5 year cooling time was assumed, which bounds longer decay times. This cooling time is consistent with the requirements on fuel stored in the NUHOMS HD system specified in Reference 3.

A conservatively determined axial burnup shape representing fuel depleted with an axially non-uniform power was used to model the Surry fuel. For PWR fuel burnup credit calculations, the "end effect" is significant for the top of the fuel and results in strongly top peaked axial neutron flux profiles. Reference 9 provides a recommended set of bounding axial burnup profiles for burnup credit analyses. Comparison of the recommended profiles with a reference shape developed for Surry 1 Cycle 20 with the SIMULATE model revealed that some of the recommended profiles clearly represented conditions that were not relevant for Surry. These profiles were not used for the Surry burnup credit calculations. The bounding axial burnup profiles chosen for the Surry analysis are shown in Table 2. To limit the number of sets of isotopic data required, the 18 axial regions of Table 2 were collapsed into 8 unique values for the Surry CASMO depletions and resulting axial isotopic distributions in KENO. Any approximations made in the collapse were selected to conservatively result in lower modeled burnups.

Depletions using the previously described initial and operation conditions were then performed using the CASMO code. An iterative approach was used to determine the necessary enrichment and burnup combinations needed to bracket the required burnup credit (Table 3). This ensured that all burnup credit values were obtained by interpolation of the KENO burnups (no extrapolation).

Due to the decay during the 5 year cooling time, the number density of I-135, Xe-135, and several other isotopes are negligible. Although I-135 and Xe-135 were not included in the KENO model, some of these negligible isotopes were retained for simplicity of data processing from CASMO to KENO. The lumped fission product was not modeled as this has no direct analog in SCALE. Neglecting fission products results in a conservatively high KENO K-effective.

The conservatism of the K-effective values generated with the CASMO fuel inventory was also confirmed by comparison with the K-effective calculated using ORIGEN-ARP (Reference 8) isotopic data for the same conditions. ORIGEN-ARP is part of the SCALE computer code system and is also widely used in the industry for calculation of depleted fuel isotopic content. The ORIGEN-ARP cross section libraries are pre-calculated based on typical fuel assembly designs and operating conditions. For simplicity, a single burnup region was used to model 15x15 fuel at 3.5 w/o U-235 and 25 GWD/MTU (with a 5 year decay time following). Power density values approximately equal to the core average power density for Surry were specified for both ORIGEN-ARP (35 MW/MTU) and CASMO (95.91 KW/L). The KENO results shown below demonstrate that the CASMO fuel inventory produced a more conservative K-effective than the ORIGEN-ARP inventory.

D Basket CASMO vs ORIGEN-ARP Sensitivity Case

3.5 w/o 25 GWD/T	K-effective	Std. Dev.	Dif (% dK)
CASMO	0.86935	0.00038	N/A
ORIGEN-ARP	0.86555	0.00047	-0.38%

3.4 SCALE / KENO Code / Model Bias

The SCALE / KENO model bias must be incorporated when determining the maximum allowable K-effective. To determine the model bias, 59 critical experiments relevant for low enrichment (< 5 w/o U-235) PWR fuel were modeled using SCALE / KENO with the 238-group ENDF/B-V cross section library. Several subgroups of the 59 critical experiments were investigated. The most conservative estimate of the modeling bias for any relevant sub-grouping of the 59 critical experiments (0.00706 dK under-prediction of K-effective) was used as the SCALE / KENO model bias. Statistical methods were employed to determine if any significant parametric trends were present in the results. No significant trends that would change the estimated bias were identified.

3.5 Limiting Normal Operating Conditions of Cask

Conservative operating conditions for the cask in the Surry SFP were also incorporated into the analysis. The sensitivity of K-effective was therefore determined for normal operating temperatures in the Surry SFP and corresponding water densities. To bound the normal operating conditions, pool temperatures from 40°F to 140°F were considered. It was determined that 40°F is the most limiting normal operating temperature for the cask analysis. Temperatures lower than 40°F are not credible for the Surry spent fuel pool and were not evaluated.

3.6 K-effective Uncertainties

As discussed in Sections 3.1 through 3.5, certain aspects of the KENO analysis employed a clearly conservative or bounding modeling approach. Where nominal values were used in the model, such as the basket plate thickness and the basket fuel cell pitch, additional KENO cases were developed to determine the effect of allowable design tolerances on K-effective. These uncertainty cases are consistent with those considered in Reference 3 and include:

- Asymmetric fuel placement within the storage tube
- Fuel cell pitch variation
- Combined basket plate/storage tube thickness variation
- Effects of fuel assembly top nozzles and/or the transport cask end plug
- Effect of the presence of depleted BPRA
- Effect of a 0.05 weight percent increase in the fuel U-235 enrichment
- Effect of a 2% increase in the fuel pellet density

To model asymmetric fuel placement, each fuel assembly was conservatively positioned as close as possible to the most interior corner of the storage cell (toward the center of the cask/basket). This effectively minimized the fuel assembly pitch for the nominal basket design. Fuel pitch variation was modeled by uniformly reducing the fuel storage cell dimensions (water region around the fuel, storage tube, and basket plates) by 0.05 inch while leaving storage tube and basket plate thickness unchanged. To simulate the combined variation in basket plate / storage tube thickness, the SS304 storage tube total thickness was increased from 0.88 to 1.0 inch. This approach was used because it was both more conservative and simpler to increase the SS304 storage tube thickness in the model than to increase the poison plate thickness. The asymmetric fuel placement and pitch reduction cases both resulted in statistically significant increases in K-effective. K-effective was also observed to increase for the increased storage tube/basket plate thickness. Although increasing the metal thickness displaces water, which might be expected to reduce K-effective, the observed increase could be due to the reflective properties of the SS304 being greater at a more optimized distance from the fuel.

Assumptions made regarding the region above the fuel stack were verified by two upper reflector cases. One case added an arbitrary 30 cm SS304 region just above the top of the storage tubes to simulate a canister end shield plug. The second case was similar, but located the SS304 region at approximately the elevation of the fuel assembly top nozzle to confirm that it was conservative to ignore the fuel assembly top nozzle. These reflector variations did not result in statistically significant effects on K-effective.

To assess the impact of loading depleted burnable poison rods in the spent fuel, a case was developed which introduced a void region the size of a BPRA rodlet into each guide thimble. Because inclusion of BPRA rodlets in the fuel assembly displaces water (assumed to be unborated for this analysis), the calculated K-effective was reduced.

In addition to these geometric uncertainty cases, uncertainty cases were run to determine the effect of increasing the fuel density by 2% (discussed in Section 3.3) and the fuel enrichment by 0.05 weight percent to address fuel manufacturing variations. As expected, the increased amount of material in the fuel in both of these cases resulted in statistically significant increases in K-effective.

To obtain a total uncertainty, the various individual uncertainty and sensitivity values that had a significant adverse effect on K-effective (asymmetric placement within the tube, reduced assembly pitch, increased basket plate/storage tube thickness, increased fuel density, and fuel enrichment uncertainty) were combined using a square root of the sum of the squares (RSS). In a fuel cask flooded with unborated water, K-effective is typically more sensitive to geometry and other model changes at lower enrichments due to the relatively soft neutron spectrum. To ensure that a conservative total uncertainty was obtained, the total uncertainty was determined for enrichment and burnup combinations that bounded the burnup credit requirements (2.0 w/o U-235 fresh fuel, and 5.0 w/o U-235 fuel at 40 GWD/MTU), and for both basket designs. As shown in Table 4, the largest estimate of total uncertainty is 0.00976 dK, calculated for 2.0 w/o fresh fuel using the "C" basket cask design.

3.7 Maximum Acceptable K-effective

The maximum allowable K-effective for calculation of the fuel burnup credit was determined by subtracting the largest value for total uncertainty from Table 4 and the SCALE / KENO model bias from Section 3.3 from the 0.95 limit on K-effective required by 10 CFR 50.68. The maximum allowable K-effective for individual burnup credit cases is therefore 0.9332 (0.95 – 0.00976 total uncertainty – 0.00706 KENO model bias). A value of 0.933 was used as a practical limit for calculation of the burnup credit.

3.8 Calculation of Fuel Burnup Credit

Pairs of burnup credit cases were run for several initial fuel enrichments for both the "D" basket and "C" basket designs for the NUHOMS HD 32PTH canister. The initial enrichments range from 2.0 to 5.0 w/o U-235, in increments of 1.0 w/o for the "C" basket design and either 0.5 or 1.0 w/o for the "D" basket design. The extra "D" basket cases were run to verify that the shape of the burnup credit versus enrichment curve was sufficiently well-defined by the 1.0 w/o interval cases. "D" basket results are shown in Table 5 and "C" basket results are shown in Table 6. The value "K 95/95" is the KENO K-effective plus 1.65 times the K-effective standard deviation for the KENO case.

For each pair of burnup cases, a linear interpolation was performed to estimate the burnup at which K-effective 95/95 is predicted to equal the limiting K-effective of 0.933 (from Section 3.7). This typically involved interpolation over a range of 5 GWD/MTU or less. Within this range, the calculated K-effective is very nearly linear with burnup, and results in a conservative K-effective value due to the shape of the curve.

Figure 5 shows the minimum required fuel assembly average burnup versus nominal initial fuel enrichment for both basket designs, along with second order quadratic curves fitted to the data. These curves have been conservatively biased to bound the individual burnup points. Variations between the trend of the fit lines and the individual burnup points are small (< 1000 MWD/MTU), and are most likely due to KENO uncertainty and differences in the shapes of the bounding burnup profiles. The NUHOMS HD 32PTH canister K-effective will remain below 0.95 in unborated water if fully loaded with 15x15 fuel that has been cooled for at least 5 years and has attained a burnup that falls on or above the curves in Figure 5.

To generate the curves in proposed Surry Technical Specification Figure 5.4-2, an additional bias of 2500 MWD/MTU was conservatively added to the curves shown in Figure 5. This bias was included to provide additional margin that can be used by Dominion as needed, e.g., to offset the effects of non-conformances in as-built basket dimensions.

4.0 Affected UFSAR Sections

Chapter 1 of the Surry UFSAR describes the basic criteria to which Surry was designed, and discusses how the design meets each criterion. The sections on monitoring fuel and prevention of fuel criticality will be updated to clearly indicate that these criteria also apply and are satisfied during operations with loaded fuel casks.

Chapter 9 of the Surry UFSAR will be updated to indicate that operations with the NUHOMS HD storage system complies with the criticality and radiation monitoring requirements of 10 CFR 50.68(b). Chapter 9 also notes that fuel selection and loading of casks is governed by cask technical specifications. Because implementation of the proposed plant Technical Specification will also limit the loading of fuel in the NUHOMS HD 32PTH storage system, this text will also be revised to specify that these operations comply with applicable plant Technical Specifications.

Chapter 11 of the Surry UFSAR, which includes a description of the radiation monitoring system, currently notes that Surry complies with 10 CFR 70.24, and cites the exemption from 10 CFR 70.24(a). As required by 10 CFR 50.68(b)(8), this section will be updated to indicate that Surry has elected to comply with the requirements of 10 CFR 50.68(b) for ISFSI general license applications while maintaining the exemption to 10 CFR 70.24(a) for the site specific ISFSI license.

IMPACT ON PREVIOUSLY APPROVED CASK DESIGNS

The criticality analyses for the GNSI Castor V/21, NAC-128 S/T and Westinghouse MC-10 casks do not take credit for soluble boron in the SFP or for burnup of the fuel placed in the casks. Therefore, should it be necessary to return casks of these designs from the Surry ISFSI to the SFP for any reason, the loading, unloading, and handling operations with these casks would inherently be compliant with the criticality requirements of 10 CFR 50.68(b). However, the analyses for both the GNSI Castor X-33 and Transnuclear TN-32 cask designs credit the presence of soluble boron in the SFP water to maintain a subcritical condition, and so do not meet the requirements of 10 CFR 50.68(b)(1).

Although the fuel and cask handling operations in the fuel building are governed by the station 10 CFR Part 50 license, the procedures for handling these older cask designs inside the station were reviewed by the NRC as part of the process of licensing each cask design under the Surry site specific ISFSI license. Surry SFP compliance with 10 CFR 50.68(b) for use of the NUHOMS HD system will not adversely affect the conditions or operations in the SFP reviewed by the NRC during that approval process for the older cask designs. It is therefore proposed that, should it become necessary to return casks stored at the Surry ISFSI under the site specific license to the station, Surry be allowed to continue to load, unload, and handle the casks in accordance with the criticality limits that were reviewed as part of their site specific ISFSI approval, with no further criticality analyses. The handling of the fuel and the loaded casks would be consistent with the original licensing basis of these casks (i.e., in accordance with 10 CFR 70.24, with an exemption to 10 CFR 70.24(a)) and would be performed in the same safe manner used to initially load and move the casks. In addition, although these casks may not comply with the criticality limits specified in 10 CFR 50.68(b), the criticality requirements of 10 CFR Part 72 will remain satisfied, and the potential for a criticality event to occur will not have increased from the conditions that were found to be acceptable when these casks were initially licensed.

10 CFR 50.92 SIGNIFICANT HAZARDS EVALUATION

Dominion plans to implement the NUHOMS HD spent fuel dry storage system for fuel that has been irradiated in Surry Units 1 and 2. This system will be licensed for general use under 10 CFR 72, Subpart L, and Dominion will use this system under the general license provided to operators of power reactors in 10 CFR 72.210. Use of the general license for a spent fuel storage system represents a change from the current operation of the Surry ISFSI, for which all the previous cask designs were licensed under the Surry ISFSI site specific license. The spent fuel loading, unloading and handling operations that occur at the station for the NUHOMS HD system are not required to be reviewed by the NRC for Surry, and must be addressed under the station 10 CFR Part 50 license.

The regulatory requirements for monitoring criticality in areas of the station where the NUHOMS HD storage system will be loaded, unloaded, and handled are given in 10 CFR 70.24. In lieu of installing and maintaining a criticality monitoring system that meets the requirements specified in 10 CFR 70.24, licensees may either seek an exemption from 10 CFR 70.24, or may choose to comply with the requirements of 10 CFR 50.68, which focuses on criticality prevention. Surry currently operates under 10 CFR 70.24 with an exemption to 10 CFR 70.24(a), but will comply with the requirements of 10 CFR 50.68(b) when using the general license for the NUHOMS HD dry storage system.

The criticality requirements of 10 CFR 50.68(b) were reviewed, and it was determined that the existing analysis for the New Fuel Storage Area and the Spent Fuel Pool satisfy the defined limits. An additional analysis was performed for loading, unloading, and handling operations for the NUHOMS HD spent fuel storage system in the Surry SFP. Limits have been defined on minimum fuel assembly average burnup versus nominal initial enrichment that ensure the K-effective for the NUHOMS HD 32PTH dry shielded canister (DSC) will remain below 0.95 in unborated water if fully loaded with 15x15 fuel that has been cooled for at least 5 years. A new Technical Specification has been proposed that will incorporate the fuel assembly burnup limits and minimum cooling time to ensure operational compliance with the basis of this criticality calculation. The other requirements of 10 CFR 50.68(b) will also be satisfied.

Spent fuel storage casks of several other designs are stored at the Surry ISFSI under the site specific license. Should it be necessary to return these casks to the station for any reason, the necessary loading, unloading and handling activities will be performed under the original licensing basis for these casks (i.e., 10 CFR 70.24, with the exemption to 10 CFR 70.24(a)). The criticality limits that were reviewed as part of each cask design's site specific ISFSI approval remain applicable, and no further criticality analyses are required.

Surry's election to comply with the requirements of 10 CFR 50.68(b) for use of the NUHOMS HD dry storage system and implementation of the proposed Technical Specification were reviewed, and it was determined that these changes do not involve a significant hazards consideration as defined in 10 CFR 50.92. The basis for this determination is delineated below:

(1) The probability of occurrence or the consequences of an accident previously evaluated is not significantly increased.

Operation under 10 CFR 50.68 for use of the NUHOMS HD system and implementation of additional requirements on the cooling time and burnup of fuel that is to be loaded into the NUHOMS HD 32PTH DSC will not require any physical changes to Part 50 structures, systems, or components, nor will there be any changes to the performance requirements of existing structures, systems, or components. Handling of spent fuel storage casks has previously been evaluated for Surry. When older cask designs stored under the Surry ISFSI site specific license are returned to the station, they will be handled and controlled in the same manner as the initial loading and movement of these casks. The response of the plant to previously analyzed Part 50 accidents is not adversely impacted, and current analyses of radiological releases, including those for the fuel handling accident, will continue to bound activities related to spent fuel cask loading, handling, and storage.

(2) The possibility of a new or different kind of accident from any accident previously evaluated is not created.

Neither fuel handling nor the loading and handling of the NUHOMS HD 32PTH DSC will be affected by operation under 10 CFR 50.68(b) or by placing additional constraints on selection of fuel to be stored in the DSC. When older cask designs stored under the Surry ISFSI site specific license are returned to the station, they will be handled and controlled in the same manner as the initial loading and movement of these casks. The existing process used to ensure that fuel assemblies selected for dry storage comply with the specific cask and ISFSI licensing requirements will be used to select the fuel assemblies to be placed in the NUHOMS HD 32PTH DSC. The requirements of the proposed new Technical Specification will only represent additional limitations that must be considered during this selection process.

(3) There is not a significant reduction in a margin of safety.

The Code of Federal Regulations identifies compliance with 10 CFR 50.68(b) as an acceptable alternative to compliance with 10 CFR 70.24. The emphasis of 10 CFR 70.24 is on detection of criticality events, while the requirements of 10 CFR 50.68(b) emphasize prevention of inadvertent criticality events. Operation under 10 CFR 50.68(b) is therefore preferable to ensure that Surry complies with the intent of General Design Criterion 62, which specifically directs that criticality should be prevented during fuel storage and handling. The existing criticality limits for the Surry Spent Fuel Pool and New Fuel Storage Area will be maintained. The NUHOMS HD spent fuel storage system is currently under review for general licensing, and has been shown to comply with the criticality requirements identified in 10 CFR 72. Compliance with the proposed Surry Technical Specification will further ensure that the system remains safely subcritical during all handling and storage operations (e.g., load, unloading, handling, decontamination, etc.) that are conducted at the station prior to transfer of the DSC to the ISFSI, even under the more restrictive condition of assuming the DSC is fully loaded with fuel of the maximum allowable reactivity and flooded with unborated water. Application of a fuel burnup credit in this criticality analysis ensures that the full soluble boron concentration required in the Spent Fuel Pool water by Surry plant Technical Specifications is available to provide defense in depth to an inadvertent criticality event. The older cask designs stored under the Surry ISFSI site specific license will be handled in the same manner used to initially load and move these casks, and the criticality requirements that were previously determined to be acceptable for safe loading, unloading and handling of these casks will remain applicable.

Based on the above discussion, Surry operation under 10 CFR 50.68(b) and implementation of the proposed Technical Specification for use of the NUHOMS HD dry storage system, and continued handling of older cask designs under the original licensing basis for these casks, will not involve a significant increase in the probability or consequences of an accident previously evaluated. The possibility of a new or different kind of accident from any accident previously evaluated is also not created, and there is no significant reduction in a margin of safety. Therefore the requirements of 10 CFR 50.92(c) are met, and there is not a significant hazards consideration.

ENVIRONMENTAL ASSESSMENT

Surry compliance with 10 CFR 50.68(b) and implementation of the proposed Technical Specification for operation of the NUHOMS HD storage system meet the eligibility criteria for categorical exclusion from an environmental assessment set forth in 10 CFR 51.22(c)(9), as discussed below:

(i) As discussed in the attached Significant Hazards Evaluation, operation under 10 CFR 50.68(b) and implementation of the proposed Technical Specification for operation of the NUHOMS HD storage system will not involve a significant increase in the probability or consequences of an accident previously evaluated. The possibility of a new or different kind of accident from any accident previously evaluated is also not created, and there is no significant reduction in a margin of safety. Therefore, the requirements of 10 CFR 50.92(c) are met, and there is not a significant hazards consideration.

(ii) There is no significant change in the types or significant increase in the amounts of any effluents that may be released offsite. Operation under 10 CFR 50.68(b) and implementation of the proposed Technical Specification for operation of the NUHOMS HD storage system will not change the manner in which fuel and casks are physically loaded or handled, so there will be no impact on the integrity of the fuel cladding as a fission product barrier. There is no impact on operating fuel, and so no impact on normal operating plant releases. The radiological consequences of accident scenarios described in Chapter 14 of the Surry Units 1 and 2 UFSAR will continue to bound any possible accident scenarios that may occur when operating under the requirements of 10 CFR 50.68 and the proposed Technical Specification for operation of the NUHOMS HD storage system. Therefore, the proposed operating conditions will not significantly change the types, or significantly increase the amounts, of effluents that may be released offsite.

(iii) There is no significant increase in individual or cumulative occupational radiation exposure. Compliance with criticality and radiation monitoring requirements of 10 CFR 50.68 and implementation of the proposed Technical Specification for use of the NUHOMS HD system will not change the manner in which the fuel or casks are physically handled, operated, or stored. There will be no change to normal plant operating conditions. The minimum required storage times prior to placement of fuel in the casks are consistent with those assumed for the NUHOMS HD Safety Analysis Report, so there is no exposure to increased radiation levels during cask loading or handling operations. Individual and cumulative occupational exposures are therefore unchanged.

Based on the above, the proposed changes do not involve (1) a significant hazards consideration, (2) a significant change in the types or significant increase in the amounts of any effluents that may be released off-site, or (3) a significant increase in individual or cumulative occupational radiation exposures. Accordingly, the proposed changes qualify for a categorical exclusion from a specific environmental review by the Commission, as described in 10 CFR 51.22(c)(9).

SUMMARY AND CONCLUSIONS

Dominion is planning to implement the NUHOMS HD spent fuel storage system utilizing the 32PTH canister at the Surry Power Station, to store fuel that has been irradiated in Surry Units 1 and 2. While spent fuel storage casks previously loaded and stored at the Surry ISFSI were independently licensed under the site specific ISFSI license, the NUHOMS HD spent fuel storage system will be used under a general license in conjunction with the plant operating licenses. When using a general license for the NUHOMS HD system, the loading, unloading and handling operations that occur at the station must be addressed under the Surry Power Station 10 CFR Part 50 license. Although Surry, with only the site specific ISFSI, currently operates under 10 CFR 70.24 with an exemption to 10 CFR 70.24(a), Surry is electing to comply with the requirements of 10 CFR 50.68(b) when the NUHOMS HD storage system is used at Surry. However, should circumstances require that casks currently stored at the Surry site specific ISFSI be returned to the station, required handling activities will be performed consistent with the current licensing basis for these cases (i.e., 10 CFR 70.24, with an exemption to 10 CFR 70.24(a)). Operation in compliance with 10 CFR 50.68(b) will begin prior to implementation of the NUHOMS HD storage system at Surry.

The criticality requirements of 10 CFR 50.68(b) were reviewed, and it was determined that the existing analysis for the New Fuel Storage Area and the Spent Fuel Pool satisfy the defined limits. An additional analysis was performed for loading, unloading, and handling operations for the NUHOMS HD storage system (utilizing the 32PTH canister) in the Surry SFP.

Fuel burnup requirements that satisfy K-effective < 0.95 for a fully loaded NUHOMS HD 32PTH canister immersed and filled with unborated water were calculated using the SCALE 4.4a / KENO-V.a computer codes. The fuel isotopic data for the burned fuel was developed using the CASMO-4 code assuming a 5 year minimum cooling time. Two basket designs (the "C" and "D" designs for the NUHOMS HD 32PTH canister) were considered. The analysis was based on the Surry 15x15 "SIF" fuel design with Zircaloy-4 cladding, which conservatively bounds other 15x15 fuel types used at Surry. Conservative treatment of conditions, tolerances, and uncertainties were incorporated. Consistent with the requirements of 10 CFR 50.68 (b)(4), the NUHOMS HD 32PTH canister K-effective will remain below 0.95 in unborated water if fully loaded with 15x15 fuel that has been cooled for at least 5 years and has attained a burnup that falls on or above the curves in Figure 5. Proposed Technical Specification 5.4.E will require compliance with the minimum cooling time assumed in this evaluation, and will incorporate curves of fuel assembly average burnup versus nominal initial enrichment into the Surry Technical Specifications to ensure operational compliance with the basis of this criticality evaluation. An additional conservative bias was incorporated into the proposed Technical Specification curves to provide margin that can be used by Dominion as needed.

The other requirements of 10 CFR 50.68(b) were also reviewed for compliance. Plant procedures exist to limit the number of assemblies handled and stored, and Technical Specifications limit the enrichment of the fuel to a value that is less than the maximum allowed by 10 CFR 50.68(b). The quantity of SNM other than nuclear fuel is also well below the specified amount. Permanently installed area radiation monitors already exist in most areas where fuel is regularly stored. For areas that do not have permanently installed area radiation monitors, temporary monitors will be procedurally required whenever fuel is being stored or handled. Upon implementation of the proposed Technical Specification changes, the Surry UFSAR will be updated to indicate that Surry complies with 10 CFR 50.68(b) for use of the NUHOMS HD dry storage system.

Spent fuel storage casks of several other designs are stored at the Surry ISFSI under the site specific license. Dominion proposes to continue loading, unloading, and handling these casks in accordance with their original licensing basis (i.e., under 10 CFR 70.24, with the exemption to 10 CFR 70.24(a)) if it becomes necessary to return these casks to the station for any reason. The criticality limits that were reviewed as part of each cask design's site specific ISFSI approval also remain applicable, so no further criticality analyses are required.

Table 1

Assumptions for Developing Isotopic Data
for Burnup Credit Calculations

Parameter	**Conservative Direction**	**Recommended Value**	**Value Used for Surry Analysis**
Fuel temperature	Maximum	Maximum pellet averaged temperature or 1000K	1000 K
Moderator temperature	Maximum	Maximum core outlet temperature or 600K	595.4 K
Soluble boron	Maximum	Maximum cycle average boron or 750 ppm	800 ppm
Specific power	Indeterminate	High but credible	95.91 KW/L
Burnable absorber loading	Maximum	Maximum BPRA rod exposure	20 rodlets at 3.0 w/o B_4C
Cooling time	Shorter	5 year cooling time, bounds longer decay times	5 years

Table 2

Bounding Axial Burnup Profiles

Axial height (%)	Burnup ranges (GWd/MTU)						
(%)	38–42	34–38	30–34	22–26	18–22	6–10	<6
2.78	0.66	0.648	0.652	0.63	0.668	0.658	0.631
8.33	0.936	0.955	0.967	0.936	1.034	1.007	1.007
13.89	1.045	1.07	1.074	1.066	1.15	1.091	1.135
19.44	1.08	1.104	1.103	1.103	1.094	1.07	1.133
25	1.091	1.112	1.108	1.108	1.053	1.022	1.098
30.56	1.093	1.112	1.106	1.109	1.048	0.989	1.069
36.11	1.092	1.108	1.102	1.112	1.064	0.978	1.053
41.69	1.09	1.105	1.097	1.119	1.095	0.989	1.047
47.22	1.089	1.102	1.094	1.126	1.121	1.031	1.05
52.8	1.088	1.099	1.094	1.132	1.135	1.082	1.06
58.33	1.088	1.097	1.095	1.135	1.14	1.11	1.07
63.89	1.086	1.095	1.096	1.135	1.138	1.121	1.077
69.44	1.084	1.091	1.095	1.129	1.13	1.124	1.079
75	1.077	1.081	1.086	1.109	1.106	1.12	1.073
80.56	1.057	1.056	1.059	1.041	1.049	1.101	1.052
86.11	0.996	0.974	0.971	0.871	0.933	1.045	0.996
91.67	0.823	0.743	0.738	0.689	0.669	0.894	0.845
97.22	0.525	0.447	0.462	0.448	0.373	0.569	0.525

Note: The axial height value of 52.8 % represents a correction of a typographical error in Reference 9 (where this axial height is shown as 57.8%).

Table 3

Enrichment and Burnup Combinations
Used to Bracket Calculated Burnup Credit for Surry

Initial U-235 enrichment (w/o)	**CASMO-4 Burnups (GWD/T)**
2.0	0, 4
2.5	4, 9
3.0	9, 20
4.0	25, 30
4.5	30, 35
5.0	35, 40

Table 4

KENO K-effective Tolerance and Uncertainty Results
for NUHOMS HD 32PTH Canister
(Unborated Water)

2.0 w/o Fresh Fuel, "D" Basket		
Case Description	**K-effective**	**dK**
Base case: 2.0 w/o 15x15 fresh fuel, Nominal dimensions, Nominal fuel density, "D" basket, SFP @ 40F	0.93938	N/A
Assembly pitch reduced 0.05 inch		0.00200
Increase total can / plate wall thickness by 0.12 inch		0.00372
Maximum asymmetric fuel placement diagonally inward toward center of cask		0.00405
Increase fuel density 2%		0.00328
Enrichment uncertainty estimate (0.05 w/o)		0.00584
Total uncertainty (RSS of above dK values)		0.00890
SCALE/KENO model/method bias (Section 3.4)		0.00706
Maximum canister K-effective (0.95 - Total Unc - Bias)	**0.93404**	
2.0 w/o Fresh Fuel, "C" Basket		
Case Description	**K-effective**	**dK**
Base case: 2.0 w/o 15x15 fresh fuel, Nominal dimensions, Nominal fuel density, "C" basket, SFP @ 40F	0.95294	N/A
Assembly pitch reduced 0.05 inch		0.00135
Increase total can / plate wall thickness by 0.12 inch		0.00478
Maximum asymmetric fuel placement diagonally inward toward center of cask		0.00369
Increase fuel density 2%		0.00479
Enrichment uncertainty estimate (0.05 w/o)		0.00584
Total uncertainty (RSS of above dK values)		0.00976
SCALE/KENO model/method bias (Section 3.4)		0.00706
Maximum canister K-effective (0.95 - Total Unc - Bias)	**0.93318**	

Table 4 (continued)

KENO K-effective Tolerance and Uncertainty Results
for NUHOMS HD 32PTH Canister
(Unborated Water)

5.0 w/o Fuel at 40 GWD/MTU Burnup, "D" Basket		
Case Description	**K-effective**	**dK**
Base case: 2.0 w/o 15x15 fresh fuel, Nominal dimensions, Nominal fuel density, "C" basket, SFP @ 40F	0.91294	N/A
Assembly pitch reduced 0.05 inch		0.00247
Increase total can / plate wall thickness by 0.12 inch		0.00439
Maximum asymmetric fuel placement diagonally inward toward center of cask		0.00408
Increase fuel density 2%		0.00342
Enrichment uncertainty estimate (0.05 w/o)		0.00289
Total uncertainty (RSS of above dK values)		0.00788
SCALE/KENO model/method bias (Section 3.4)		0.00706
Maximum canister K-effective (0.95 - Total Unc - Bias)	**0.93506**	
5.0 w/o Fuel at 40 GWD/MTU Burnup, "D" Basket		
Case Description	**K-effective**	**dK**
Base case: 2.0 w/o 15x15 fresh fuel, Nominal dimensions, Nominal fuel density, "C" basket, SFP @ 40F	0.92612	N/A
Assembly pitch reduced 0.05 inch		0.00218
Increase total can / plate wall thickness by 0.12 inch		0.00446
Maximum asymmetric fuel placement diagonally inward toward center of cask		0.00458
Increase fuel density 2%		0.00479
Enrichment uncertainty estimate (0.05 w/o)		0.00289
Total uncertainty (RSS of above dK values)		0.00877
SCALE/KENO model/method bias (Section 3.4)		0.00706
Maximum canister K-effective (0.95 - Total Unc - Bias)	**0.93417**	

Table 5

"D" Basket KENO Burnup Credit Case Results

Burnup Credit Results: D Basket	**K-eff**	**S.D.**	**K 95/95**	
2.0 w/o 15x15 fuel				Burnup
SY_0ppm_D_20_4G_40f_nomptd	0.91454	0.00038	0.91517	4000
SY_0ppm_D_20_0G_40f_nomptd	0.93938	0.00038	0.94001	0
Interpolated to 0.933 K-eff * 1.05				1185
2.5 w/o 15x15 fuel				Burnup
SY_0ppm_D_25_9G_40f_nomptd	0.93204	0.00041	0.93272	9000
SY_0ppm_D_25_4G_40f_nomptd	0.9721	0.00034	0.97266	4000
Interpolated to 0.933 K-eff * 1.05				9413
3.0 w/o 15x15 fuel				Burnup
SY_0ppm_D_30_20G_40f_nomptd	0.90554	0.00036	0.90613	20000
SY_0ppm_D_30_9G_40f_nomptd	0.97793	0.00037	0.97854	9000
Interpolated to 0.933 K-eff * 1.05				16714
4.0 w/o 15x15 fuel				Burnup
SY_0ppm_D_40_30G_40f_nomptd	0.91571	0.00042	0.9164	30000
SY_0ppm_D_40_25G_40f_nomptd	0.95093	0.00035	0.95151	25000
Interpolated to 0.933 K-eff * 1.05				29018
4.5 w/o 15x15 fuel				Burnup
SY_0ppm_D_45_35G_40f_nomptd	0.92188	0.0004	0.92254	35000
SY_0ppm_D_45_30G_40f_nomptd	0.94737	0.00039	0.94801	30000
Interpolated to 0.933 K-eff * 1.05				34594
5.0 w/o 15x15 fuel				Burnup
SY_0ppm_D_50_40G_40f_nomptd	0.91294	0.00032	0.91347	40000
SY_0ppm_D_50_35G_40f_nomptd	0.94988	0.00038	0.95051	35000
Interpolated to 0.933 K-eff * 1.05				39231

Table 6

"C" Basket KENO Burnup Credit Case Results

Burnup Credit Results: C Basket	**K-eff**	**S.D.**	**K 95/95**	
2.0 w/o 15x15 fuel				Burnup
SY_0ppm_C_20_4G_40f	0.92993	0.00031	0.93044	4000
SY_0ppm_C_20_0G_40f	0.95294	0.00037	0.95355	0
Interpolated to 0.933 K-eff * 1.05				3735
3.0 w/o 15x15 fuel				Burnup
SY_0ppm_C_30_20G_40f	0.91903	0.00037	0.91964	20000
SY_0ppm_C_30_9G_40f	0.99189	0.00036	0.99248	9000
Interpolated to 0.933 K-eff * 1.05				18862
4.0 w/o 15x15 fuel				Burnup
SY_0ppm_C_40_30G_40f	0.92924	0.0004	0.9299	30000
SY_0ppm_C_40_25G_40f	0.96506	0.00036	0.96565	25000
Interpolated to 0.933 K-eff * 1.05				31045
5.0 w/o 15x15 fuel				Burnup
SY_0ppm_C_50_40G_40f_nomptd	0.92612	0.00037	0.92673	40000
SY_0ppm_C_50_35G_40f_nomptd	0.96501	0.00038	0.96564	35000
Interpolated to 0.933 K-eff * 1.05				41154

Figure 1

Base KENO Model X-Y Plot:
Radial Slice Through North and South Basket Plate Support Bars

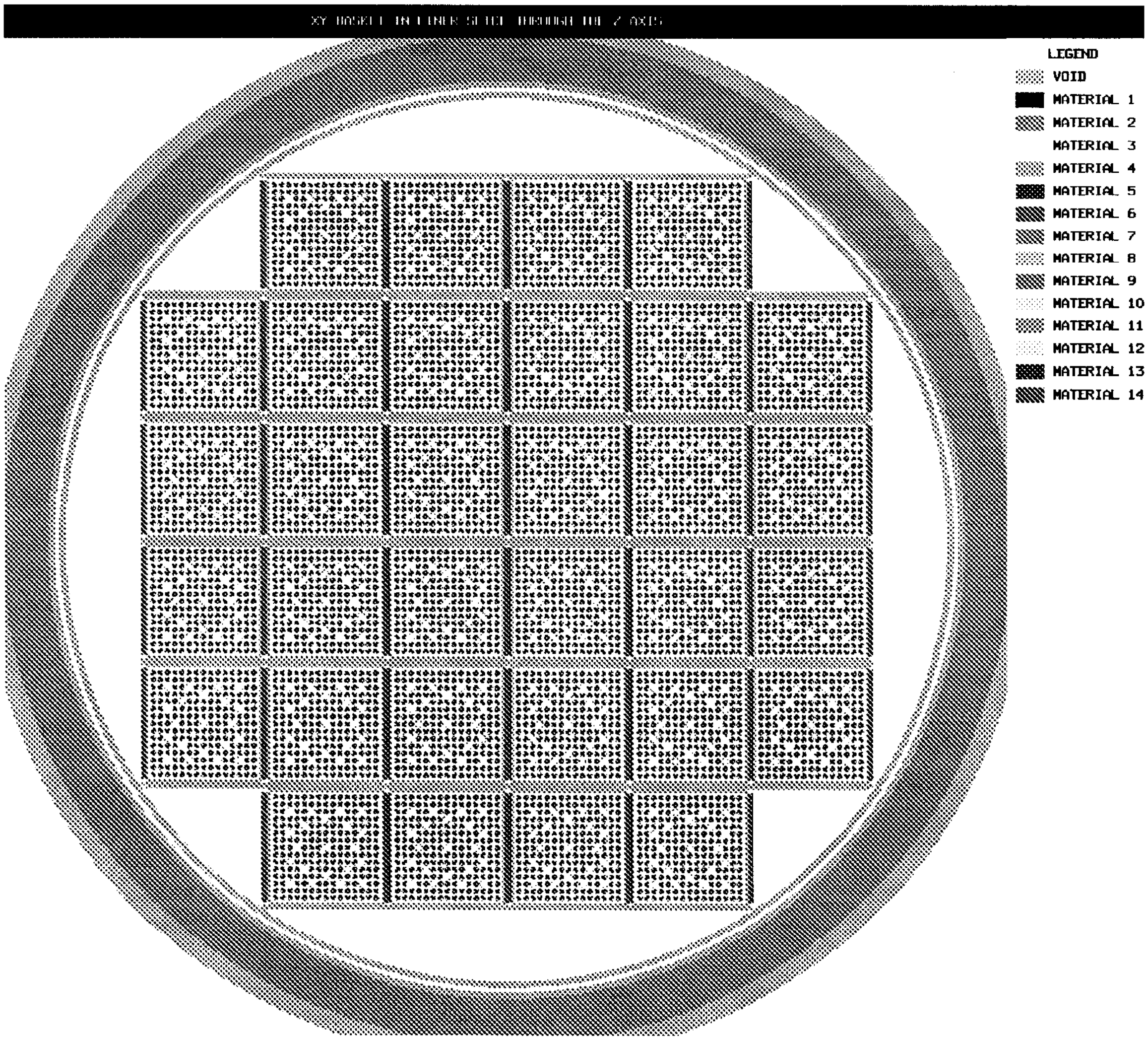


Figure 2

Base KENO Model X-Y Plot:
Radial Slice Through Middle of Basket Plates

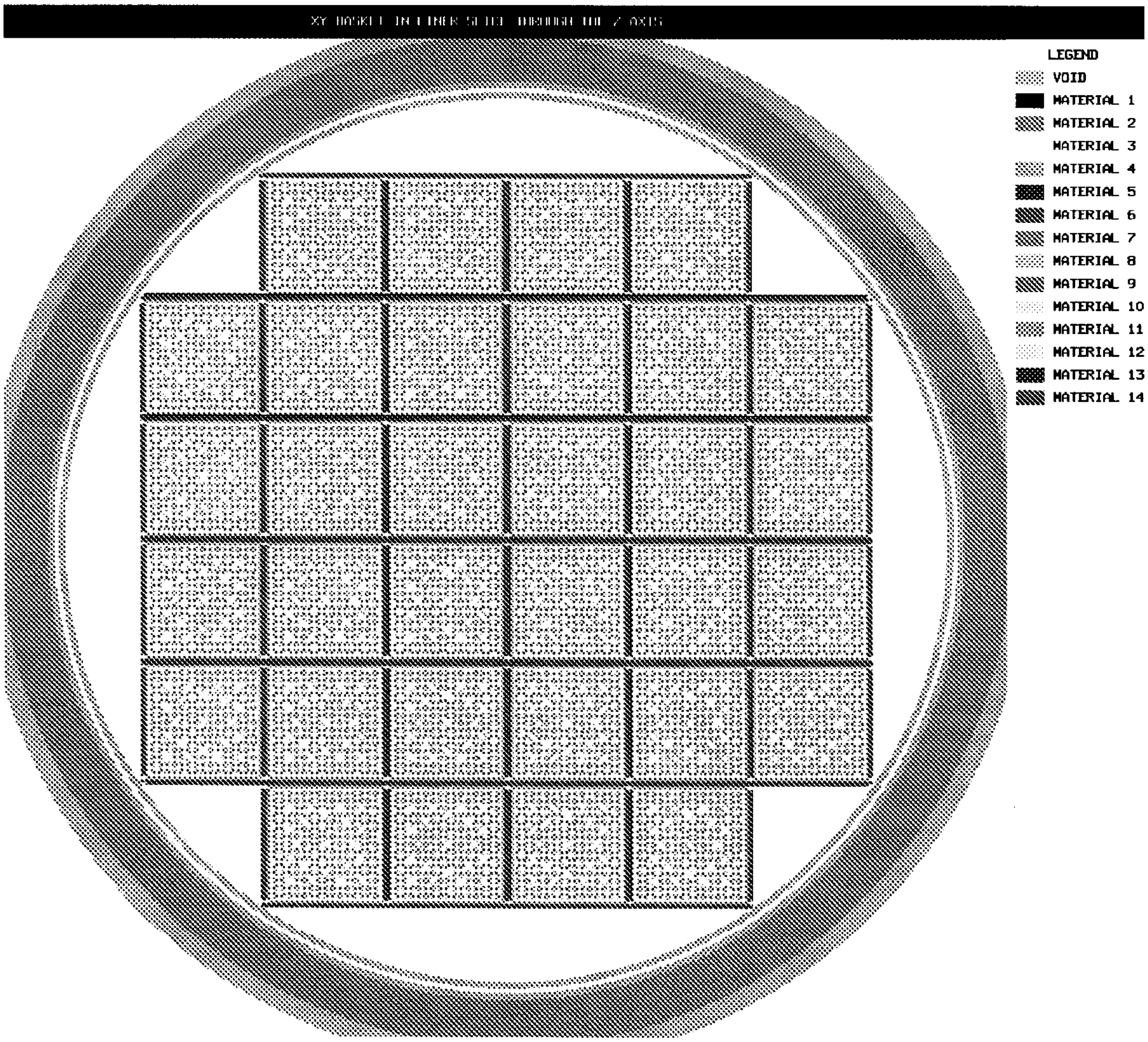


Figure 3

Base KENO Model X-Z and Y-Z Plots:
Axial Slices Through Middle of Outer Row of Basket Plates

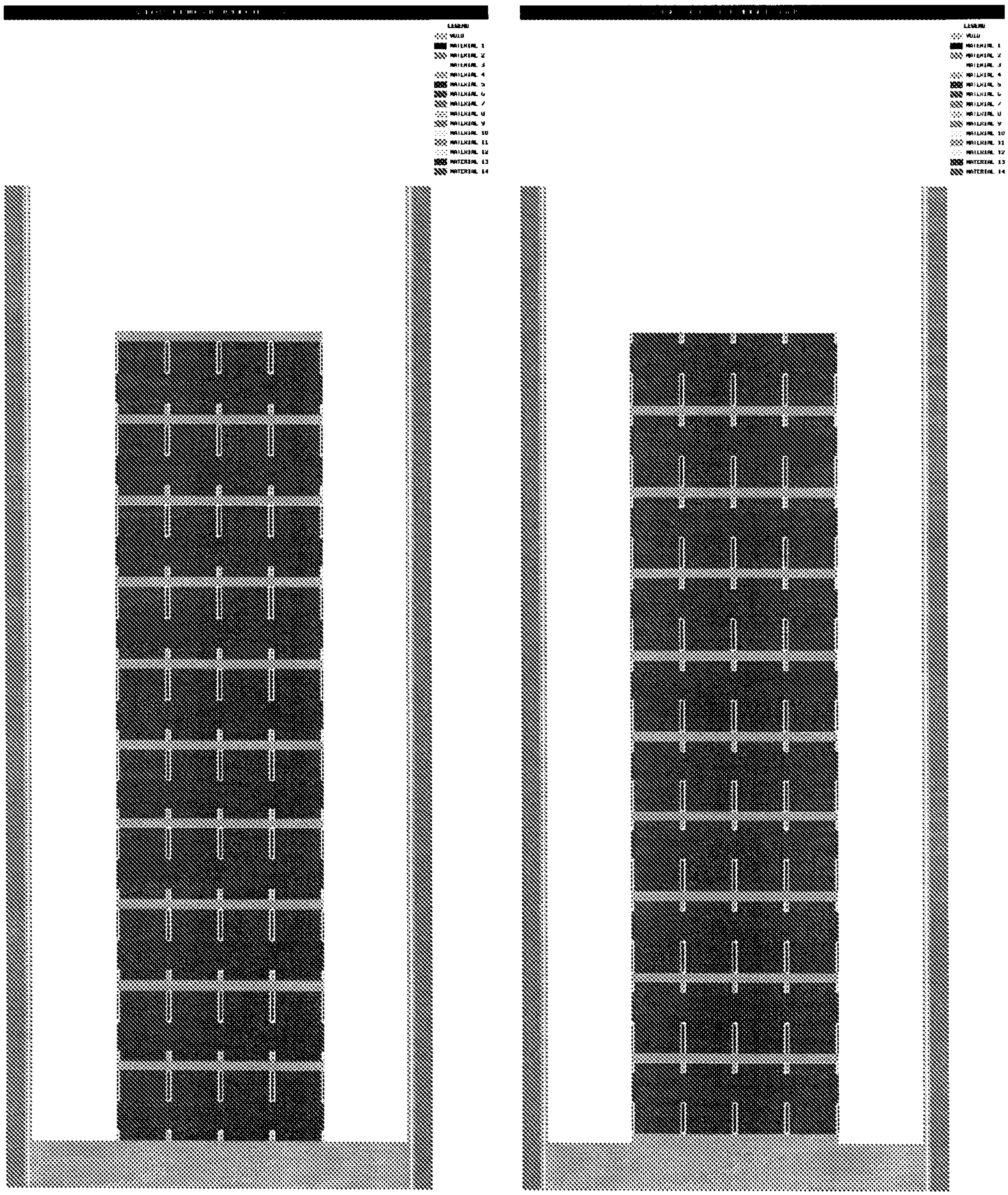


Figure 4

Base KENO Model X-Z Plot:
Axial Slice Through Inner Row of Fuel

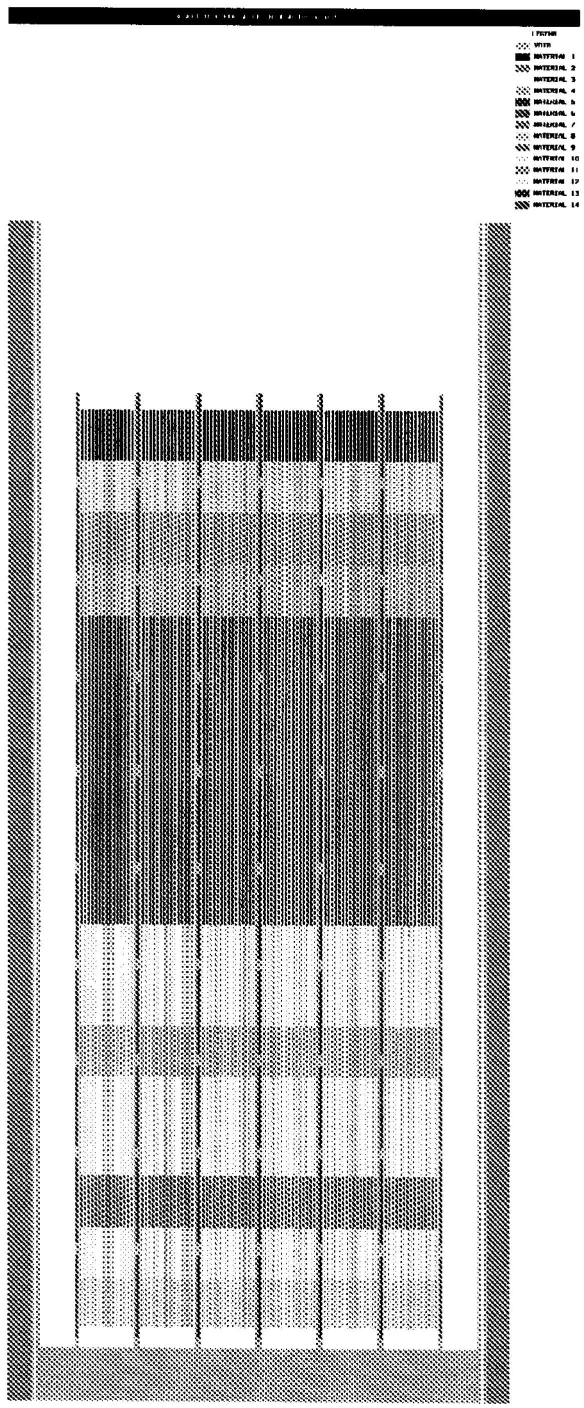
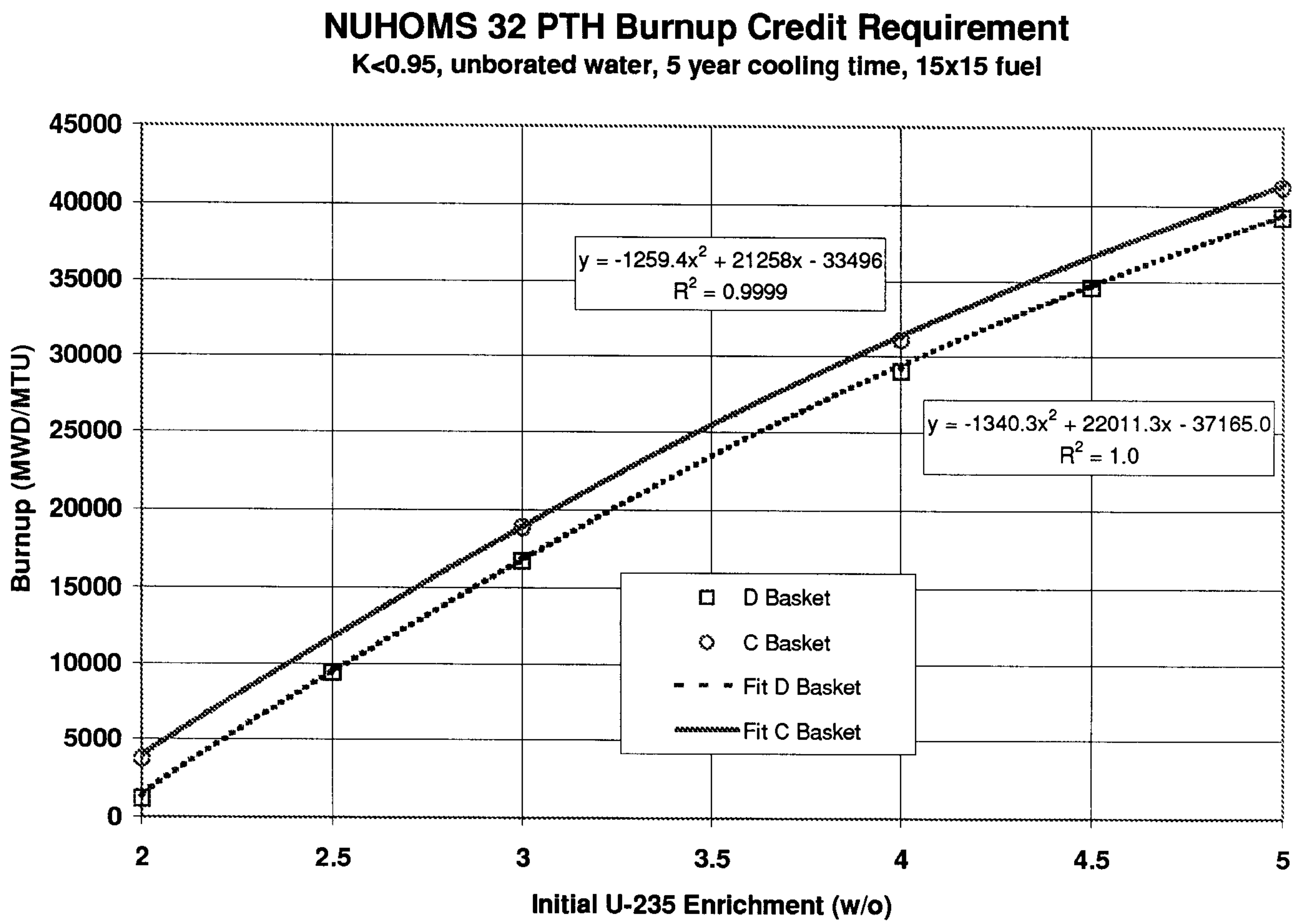


Figure 5


NUHOMS 32 PTH Burnup Credit Requirement
K<0.95, unborated water, 5 year cooling time, 15x15 fuel
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
Burnup (MWD/MTU)
2
2.5
3
3.5
4
4.5
5
Initial U-235 Enrichment (w/o)
y = -1259.4x2 + 21258x - 33496
R2 = 0.9999
y = -1340.3x2 + 22011.3x - 37165.0
R2 = 1.0
D Basket
C Basket
Fit D Basket
Fit C Basket

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3. Transnuclear report, "NUHOMS HD Horizontal Modular Storage System for Irradiated Nuclear Fuel, Safety Analysis Report," Revision 2, February 2005 (Proprietary).

4. Letter from James P. O'Hanlon to U. S. Nuclear Regulatory Commission, "Virginia Electric and Power Company, Surry Power Station Units No. 1 and 2, Proposed Technical Specifications Change for Increased Enrichment of Reload Fuel," Serial No. 97-614, November 5, 1997. (Describes results of criticality analyses for NFSA and SFP racks.)

5. Letter from James P. O'Hanlon to U. S. Nuclear Regulatory Commission, "Virginia Electric and Power Company, Surry Power Station Units No. 1 and 2, Increased Fuel Enrichment Technical Specifications Change, Response to NRC Request for Additional Information," Serial No. 98-010, January 28, 1998. (Responses to 4 questions on criticality analyses presented in above letter.)

6. Letter from Gordon E. Edison to J. P. O'Hanlon, "Surry Units 1 and 2 - Issuance of Amendments Re: Increased Enrichment of Reload Fuel (TAC Nos. MA0122 and MA0123)," June 19, 1998.

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11. NRC Information Notice 2005-13, "Potential Non-Conservative Error in Modeling Geometric Regions in the KENO-V.a Criticality Code," May 17, 2005.

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13. Letter from J. P. O'Hanlon to U. S. Nuclear Regulatory Commission, "Surry Power Station Units 1 and 2, Proposed Technical Specification Changes to Implement ZIRLO Fuel Cladding," Serial No. 94-673, November 29, 1994.

14. C. V. Parks, M. D. DeHart and J. C. Wagner, "Phenomena and Parameters Important to Burnup Credit," International Atomic Energy Agency (IAEA) Technical Committee Meeting on the Evaluation and Review of the Implementation of Burnup Credit in Spent Fuel Management Systems, Vienna, Austria, July 10, 2000.

ATTACHMENT 2

MARKED-UP TECHNICAL SPECIFICATIONS CHANGE PAGES

SURRY POWER STATION – UNIT NOS. 1 & 2
VIRGINIA ELECTRIC AND POWER COMPANY
DOMINION

assemblies to ensure $k_{eff} \leq 0.95$, even if unborated water were used to fill the spent fuel storage pit. The spent fuel pool is divided into a two-region storage pool. Region 1 comprises the first three rows of fuel racks (324 storage locations) adjacent to the Fuel Building Trolley Load Block. Region 2 comprises the remainder of the fuel racks in the fuel pool. During spent fuel cask handling, Region 1 is limited to storage of spent fuel assemblies which have decayed at least 150 days after discharge and shall be restricted to those assemblies in the "acceptable" domain of Figure 5.4-1. Administrative controls with written procedures will be employed in the selection and placement of these assemblies. The enrichment of the fuel stored in the spent fuel racks shall not exceed 4.3 weight percent of U-235.

C. Whenever there is spent fuel in the spent fuel pit, the pit shall be filled with borated water at a boron concentration not less than 2300* ppm to match that used in the reactor cavity and refueling canal during refueling operations.

D. The only drain which can be connected to the spent fuel storage area is that in the reactor cavity. The strict step-by-step procedures used during refueling ensure that the gate valve on the fuel transfer tube which connects the spent fuel storage area with the reactor cavity is closed before draining of the cavity commences. In addition, the procedures require placing the bolted blank flange on the fuel transfer tube as soon as the reactor cavity is drained.

SEE INSERT 5.4.E →

* This limit takes effect at the time the Unit 2 reactor cavity is flooded following the end of Operating Cycle 10.

References

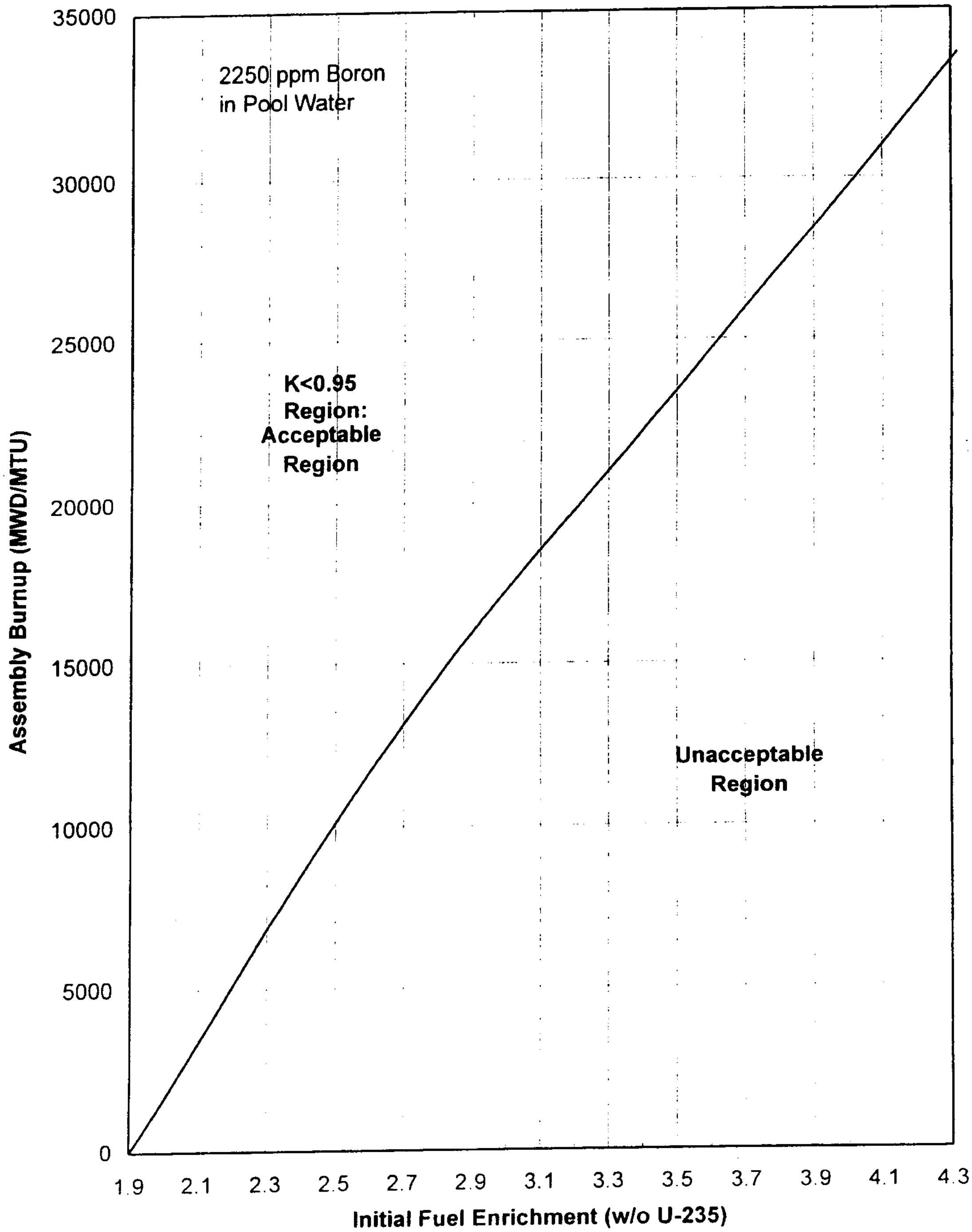
FSAR Section 9.5 Fuel Pit Cooling System

FSAR Section 9.12 Fuel Handling System

INSERT 5.4.E:

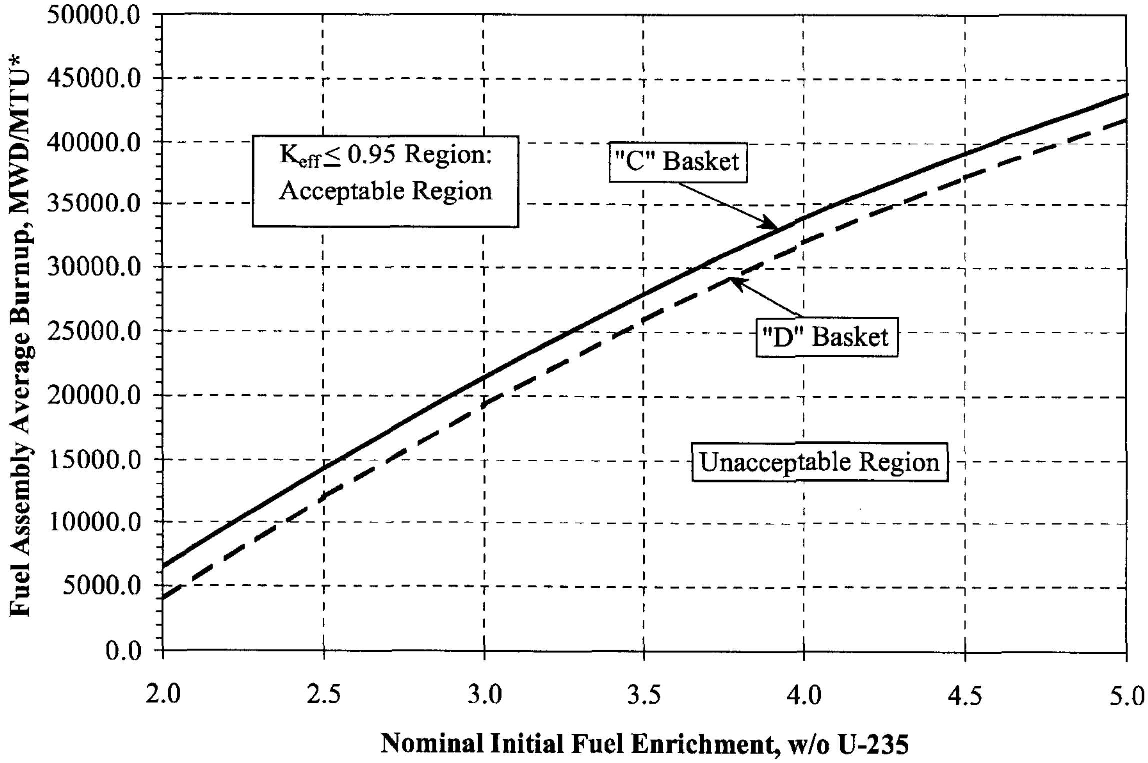
E. During loading, unloading, or handling of the NUHOMS HD 32PTH dry shielded canister (DSC) in the spent fuel pit, the combination of nominal initial enrichment and assembly average burnup of each spent fuel assembly loaded into a 32PTH DSC shall be within the 'Acceptable' domain of Figure 5.4-2. For each fuel assembly loaded into a 32PTH DSC, a minimum of 5 calendar years must also elapse between final irradiation and loading into the DSC. Compliance with these constraints ensures that $k_{eff} \leq 0.95$ for a fully loaded NUHOMS HD 32PTH DSC, even if unborated water were to fill the canister. Administrative controls with written procedures will be employed to verify that the assemblies selected for placement in the NUHOMS HD 32PTH DSC are in compliance with Figure 5.4-2 prior to placing the fuel assemblies in the canister.

[NO CHANGE TO THIS PAGE]



S_CTS013

Figure 5.4-1
MINIMUM FUEL EXPOSURE VERSUS INITIAL ENRICHMENT
TO PREVENT CRITICALITY IN DAMAGED RACKS



* Curves are based on a 5-year cooling time, and include 5% conservatism on fuel assembly average burnup.

Figure 5.4-2
MINIMUM FUEL EXPOSURE VERSUS NOMINAL INITIAL ENRICHMENT TO PREVENT CRITICALITY IN NUHOMS HD 32PTH DRY SHIELDED CANISTER (DSC) IN THE SPENT FUEL PIT

ATTACHMENT 3

PROPOSED TECHNICAL SPECIFICATIONS CHANGE PAGES

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assemblies to ensure $k_{eff} \leq 0.95$, even if unborated water were used to fill the spent fuel storage pit. The spent fuel pool is divided into a two-region storage pool. Region 1 comprises the first three rows of fuel racks (324 storage locations) adjacent to the Fuel Building Trolley Load Block. Region 2 comprises the remainder of the fuel racks in the fuel pool. During spent fuel cask handling, Region 1 is limited to storage of spent fuel assemblies which have decayed at least 150 days after discharge and shall be restricted to those assemblies in the "acceptable" domain of Figure 5.4-1. Administrative controls with written procedures will be employed in the selection and placement of these assemblies. The enrichment of the fuel stored in the spent fuel racks shall not exceed 4.3 weight percent of U-235.

C. Whenever there is spent fuel in the spent fuel pit, the pit shall be filled with borated water at a boron concentration not less than 2300* ppm to match that used in the reactor cavity and refueling canal during refueling operations.

D. The only drain which can be connected to the spent fuel storage area is that in the reactor cavity. The strict step-by-step procedures used during refueling ensure that the gate valve on the fuel transfer tube which connects the spent fuel storage area with the reactor cavity is closed before draining of the cavity commences. In addition, the procedures require placing the bolted blank flange on the fuel transfer tube as soon as the reactor cavity is drained.

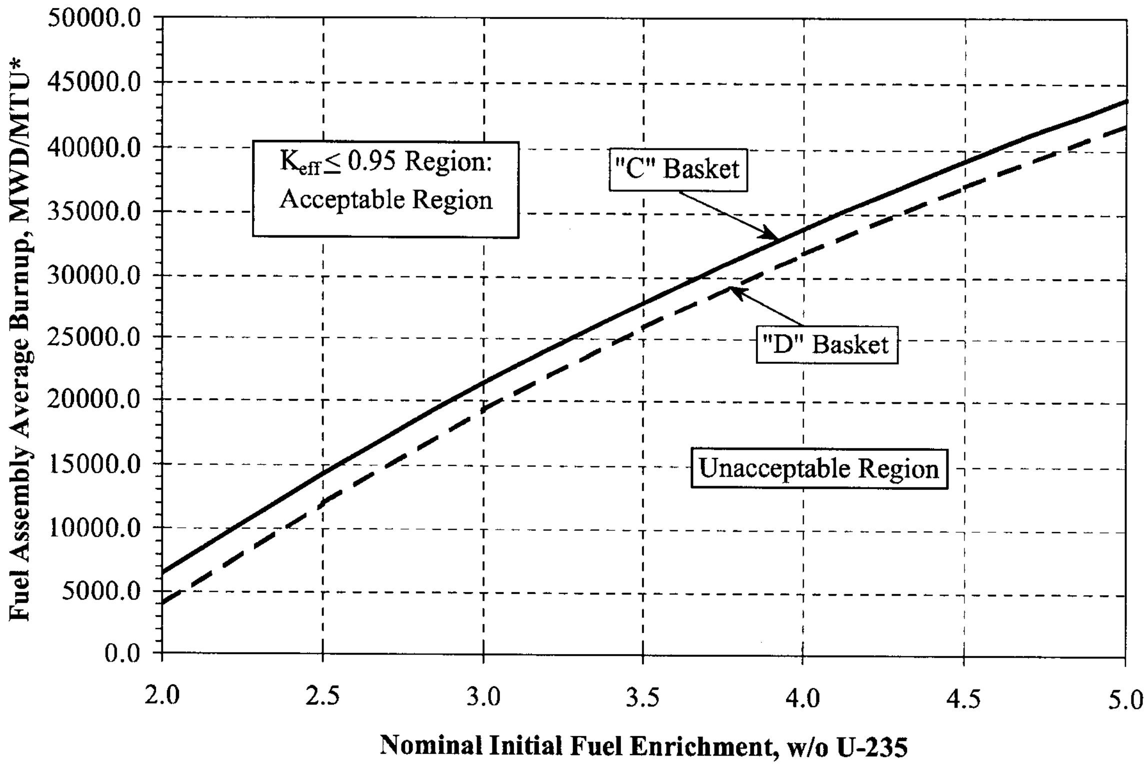
E. During loading, unloading, or handling of the NUHOMS HD 32PTH dry shielded canister (DSC) in the spent fuel pit, the combination of nominal initial enrichment and assembly average burnup of each spent fuel assembly loaded into a 32PTH DSC shall be within the 'Acceptable' domain of Figure 5.4-2. For each fuel assembly loaded into a 32PTH DSC, a minimum of 5 calendar years must also elapse between final irradiation and loading into the DSC. Compliance with these constraints ensures that $k_{eff} \leq 0.95$ for a fully loaded NUHOMS HD 32PTH DSC, even if unborated water were to fill the canister. Administrative controls with written procedures will be employed to verify that the assemblies selected for placement in the NUHOMS HD 32PTH DSC are in compliance with Figure 5.4-2 prior to placing the fuel assemblies in the canister.

* This limit takes effect at the time the Unit 2 reactor cavity is flooded following the end of Operating Cycle 10.

<u>References</u>

FSAR Section 9.5 Fuel Pit Cooling System

FSAR Section 9.12 Fuel Handling System



* Curves are based on a 5-year cooling time, and include 5% conservatism on fuel assembly average burnup.

Figure 5.4-2
MINIMUM FUEL EXPOSURE VERSUS NOMINAL INITIAL ENRICHMENT
TO PREVENT CRITICALITY IN
NUHOMS HD 32PTH DRY SHIELDED CANISTER (DSC)
IN THE SPENT FUEL PIT