TRANSNUCLEAR
AN AREVA COMPANY

July 30, 2009
E-28403

U. S. Nuclear Regulatory Commission
Attn: Document Control Desk
One White Flint North
11555 Rockville Pike
Rockville, MD 20852

Subject: Transnuclear, Inc. Comments on the Proposed Certificate of Compliance and Preliminary Safety Evaluation Report for the Transnuclear, Inc. NUHOMS® HD Horizontal Modular Storage System for Irradiated Nuclear Fuel, Amendment 1 (Docket No. 72-1030; TAC NO. L24153)

Reference: Letter from B. Jennifer Davis (NRC) to Don Shaw (TN), "Proposed Certificate of Compliance and Preliminary Safety Evaluation Report for the Transnuclear, Inc. NUHOMS® HD Horizontal Modular Storage System for Irradiated Nuclear Fuel, Amendment 1 (TAC NO. L24153)," dated July 28, 2009

The referenced letter forwarded the Proposed Certificate of Compliance (CoC) and Preliminary Safety Evaluation Report (SER) for the Transnuclear, Inc. (TN) NUHOMS® HD Horizontal Modular Storage System for Irradiated Nuclear Fuel, Amendment 1, for TN's review and identification of inaccuracies and omissions. The purpose of this submittal is to provide the results of TN's review. Enclosure 1 herein provides a listing of Proposed CoC and Preliminary SER pages for which TN has comments. Enclosure 2 provides those pages, with comments electronically annotated.

Should the NRC staff require additional information to support review of this application, please do not hesitate to contact me at (410) 910-6878.

Sincerely,

Don Shaw

Don Shaw
Licensing Manager

cc: B. Jennifer Davis (NRC SFST)

Enclosures:

1. Listing of Proposed CoC and Preliminary SER Pages for which TN has Comments
2. Proposed CoC and Preliminary SER Pages for which TN has Comments, with Comments Electronically Annotated

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NMSS01
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Listing of Proposed CoC and Preliminary SER Pages for which TN has Comments

No comments on CoC Pages

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Enclosure 2 to TN E-28403

Proposed CoC and Preliminary SER Pages for which TN has Comments, with Comments Electronically Annotated

SAFETY EVALUATION REPORT

Docket No. 72-1030
NUHOMS® HD Horizontal Modular Storage System for Irradiated Nuclear Fuel
Certificate of Compliance No. 1030
Amendment No. 1

SUMMARY

By application dated November 1, 2007, and as supplemented on December 15, 2008; February 19, 2009; April 30, 2009; May 26, 2009; and June 10, 2009; Transnuclear, Inc. (TN) requested approval of an amendment, under the provisions of 10 CFR Part 72, Subpart K and L, to Certificate of Compliance (CoC) No. 1030 for the NUHOMS® HD Horizontal Modular Storage System for Irradiated Nuclear Fuel.

TN requested a change to the CoC, including its attachments, and revision of the Final Safety Analysis Report (FSAR). The requested changes are as follows:

- Add Combustion Engineering (CE) 16x16 class fuel assemblies as authorized contents of the NUHOMS® HD System described in the Updated Final Safety Analysis Report (UFSAR). The NUHOMS® HD System is currently authorized to store CE 14x14, Westinghouse (WE) 15x15 and WE 17x17 classes, only.

- Reduce the minimum ambient temperature from -20°F to -21°F.

- Expand the authorized contents of the NUHOMS® HD System to include Pressurized Water Reactor (PWR) fuel assemblies with Control Components (CCs), also referred to as Non-Fuel Assembly Hardware (NFAH), in CoC 1030 Amendment 0, such as Burnable Poison Rod Assemblies (BPRAs), Thimble Plug Assemblies (TPAs), Control Rod Assemblies (CRAs), Control Element Assemblies (CEAs), Rod Cluster Control Assemblies (RCCAs), Vibration Suppressor Inserts (VSIs), Axial Power Shaping Rod Assemblies (APSRAs), Orifice Rod Assemblies (ORAs), Neutron Source Assemblies (NSAs), and Neutron Sources. All PWR fuel assemblies currently authorized for storage may be stored with CCs.

  The NUHOMS® HD System is currently authorized to store three types of CCs: BPRAs, TPAs and VSIs, for the WE 15x15 and WE 17x17 classes only.

- Reduce the minimum initial enrichment of fuel assemblies from 1.5 wt.% U-235 to 0.2 wt.% U-235.

- Clarify the requirements of reconstituted fuel assemblies.

- Add requirements to qualify metal matrix composite (MMC) neutron absorbers with integral aluminum cladding.

- Delete use of nitrogen for draining the water from the dry shielded canister (DSC), and allow only helium as a cover gas during DSC cavity water removal operations.

The 32PTH DSC is designed to store up to 32 intact PWR fuel assemblies. Non-Fuel Assembly Hardware are allowed for these fuel assemblies. The 32PTH DSC is also designed for storage of up to 16 damaged fuel assemblies, and remaining intact assemblies, utilizing top and bottom end caps. The maximum heat load per 32PTH DSC, including any integral insert components, is 34.8kW for WE 15x15, WE 17x17, and CE 16x16; and 33.8kW for CE 14x14 assemblies.

The Nuclear Regulatory Commission (NRC) staff has reviewed the application using the guidance provided in NUREG-1536, "Standard Review Plan for Dry Cask Storage Systems," January 1997. Based on the statements and representations in the application, as supplemented, the staff concludes that the TN NUHOMS® HD System, as amended, meets the requirements of 10 CFR Part 72.

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1 GENERAL DESCRIPTION

By application dated November 1, 2007 (Ref. 1), and as supplemented on December 15, 2008; February 19, 2009; April 30, 2009; May 26, 2009; and June 10, 2009 (Refs. 2, 3, 4, 5 and 6); Transnuclear, Inc. (TN) requested approval of an amendment, under the provisions of 10 CFR Part 72, Subpart K and L (Ref. 7), to Certificate of Compliance (CoC) No. 1030 for the NUHOMS® HD Horizontal Modular Storage System for Irradiated Nuclear Fuel (Ref. 8).

The objective of the review of the general description of Amendment 1 to the NUHOMS® HD System is to ensure that TN has provided a non-proprietary description that is adequate to familiarize reviewers and other interested parties with the pertinent features of changes to the system.

1.1 General Description and Operations Features

The NUHOMS® HD System is based on the Standardized NUHOMS® System described in Certificate of Compliance (CoC) No. 1004 (Ref. 9). The 32PTH dry shielded canister (DSC) included in this system is similar to the 24PTH DSC approved for use under Amendment ~~9~~ 8 to the Standardized NUHOMS® System.

The scope of Amendment 1 to CoC 1030 includes seven separate changes. These changes are:

- Add Combustion Engineering (CE) 16x16 class fuel assemblies as authorized contents of the NUHOMS® HD System described in the Updated Final Safety Analysis Report (UFSAR) (Ref. 10). The NUHOMS® HD System is currently authorized to store CE 14x14, Westinghouse (WE) 15x15 and WE 17x17 classes, only. (Note that originally allowed MK BW 17x17 class fuel assemblies have been deleted.)

- Reduce the minimum ambient temperature from -20°F to -21°F.

- Expand the authorized contents of the NUHOMS® HD System to include Pressurized Water Reactor (PWR) fuel assemblies with Control Components (CCs), also referred to as Non-Fuel Assembly Hardware (NFAH), in CoC 1030, such as Burnable Poison Rod Assemblies (BPRAs), Thimble Plug Assemblies (TPAs), Control Rod Assemblies (CRAs), Control Element Assemblies (CEAs), Rod Cluster Control Assemblies (RCCAs), Vibration Suppressor Inserts (VSIs), Axial Power Shaping Rod Assemblies (APSRAs), Orifice Rod Assemblies (ORAs), Neutron Source Assemblies (NSAs), and Neutron Sources. All PWR fuel assemblies currently authorized for storage may be stored with CCs.

  The NUHOMS® HD System is currently authorized to store three types of CCs: BPRAs, TPAs and VSIs, for the WE 15x15 and WE 17x17 classes only.

- Reduce the minimum initial enrichment of fuel assemblies from 1.5 wt.% U-235 to 0.2 wt.% U-235.

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- Clarify the requirements of reconstituted fuel assemblies.

- Add requirements to qualify metal matrix composite (MMC) neutron absorbers with integral aluminum cladding.

Delete use of nitrogen for draining the water from the DSC, and allow only helium as a cover gas during DSC cavity water removal operations.

1.1.1 Changes to the NUHOMS® HD Technical Specifications

A brief description for each of the major changes to the Technical Specifications (TS) is provided in the following ~~paragraphs~~.

bullets

- Revised the definition for Damaged Fuel Assembly.
- Added a definition for Fuel Class.
- Added a definition for Reconstituted Fuel Assembly.
- Revised the definition for Transfer Operations for clarity.
- Revised TS 2.1, "Fuel to be Stored in the 32PTH DSC, to revise the description of Fuel Class, add the description of Reconstituted Fuel Assemblies, revise the list of Control Components authorized for storage in the 32PTH DSC, specify the Location of Damaged Assemblies, add the Maximum Assembly plus CC weight (from original Table 2), add the Burnup, Enrichment, and Minimum Cooling Time for the 32PTH DSC; add the Maximum Assembly Average Initial Fuel Enrichment; and revise the Decay Heat per DSC limits.
- Revised the time limit from 30 days to 60 days (in accordance with the regulations in 10 CFR 72.75(g)) for the Functional and Operating Limits Violations report in paragraph 2.2.3.
- Revised paragraph 3.1, Fuel Integrity, (Limiting Condition for Operation (LCOs) 3.1.1, 3.1.2, and 3.1.3) to allow only helium as a cover gas during DSC cavity water removal operations, to clarify that the applicability is during Loading Operations, but before Transfer Operations, and to adjust time constraints.
- Revised paragraph 3.2, Criticality Control, (LCO 3.2.1) to clarify the applicability, and add an additional required action if the condition is not met.
- Revised paragraph 4.3.1 to indicate revised referenced FSAR sections.
- Revised paragraph 4.6.3(5) to reflect reduction of the minimum ambient temperature from -20°F to -21°F.
- Revised paragraph 5.2.5 to add an alternate surveillance activity with associated corrective actions (thermal performance), to add "Daily Visual Inspection" of the HSM-H inlets and outlets, and to add corrective actions for blocked air vents and damaged bird screens.
- Revised paragraph 5.3.2, Cask Drop, to clarify that it applies to transfer cask side drops.
- Added paragraph 5.6, Hydrogen Gas Monitoring, to ensure that the combustible mixture concentration remains below the flammability limit.
- Deleted Table 1, Fuel Specifications, which was replaced with TS 2.1, "Fuel to be Stored in the 32PTH DSC.
- Revised Table 2, (originally Fuel Dimension and Weights), now "Fuel Assembly Design Characteristics for the NUHOMS® -32PTH DSC," to reflect the changes in allowed fuel assemblies, and delete the information now incorporated in TS 2.1.

- Revised Table 3, Maximum Control Component Source Terms, to add allowed control component specifications, and to delete information pertaining to the MK BW 17x17 fuel assemblies.
- Revised Table 4, Fuel Qualification Table(s), to reflect the changes in allowed fuel assemblies, show maximum allowable assembly burnup as a function of assembly average enrichment, and to show minimum cooliing time as a function of assembly average enrichment.
- Deleted Table 5, NFAH Thermal Qualification, which was replaced with TS 2.1, "Fuel to be Stored in the 32PTH DSC.
- Revised Table 7, Maximum Assembly Average Initial Enrichment for Intact and Damaged Fuel Loading, to reflect the changes in allowed fuel assemblies.

1.2 System Description

1.2.1 Dry Shielded Canister (32PTH DSC)

The 32PTH DSC is designed to store up to 32 intact PWR Westinghouse 15x15 (WE 15x15), Westinghouse 17x17 (WE 17x17), Combustion Engineering 14x14 (CE 14x14), and/or Combustion Engineering 16x16 (CE 16x16) fuel assemblies. Non-Fuel Assembly Hardware (NFAH) such as Burnable Poison Rod Assemblies (BPRAs), Thimble Plug Assemblies (TPAs), Control Rod Assemblies (CRAs), Control Element Assemblies (CEAs), Rod Cluster Control Assemblies (RCCAs), Vibration Suppressor Inserts (VSIs), Axial Power Shaping Rod Assemblies (APSRAs), Orifice Rod Assemblies (ORAs), Neutron Source Assemblies (NSAs), and Neutron Sources are allowed for these fuel assemblies. The 32PTH DSC is also designed for storage of up to 16 damaged fuel assemblies, and remaining intact assemblies, utilizing top and bottom end caps. The maximum heat load per 32PTH DSC, including any integral insert components, is 34.8kW for WE 15x15, WE 17x17, and CE 16x16 assemblies; and 33.8kW for CE 14x14 assemblies.

The 32PTH consists of a stainless steel cylindrical shell with welded inner top cover/shield plug (including siphon/vent cover welds) and inner bottom cover plate which form the confinement boundary. Shield plugs are installed inside of the confinement boundary, at the top and bottom, to provide radiological shielding. Inside the 32PTH DSC is a basket assembly that consists of stainless steel square tubes and support strips for structural support and geometry control, and aluminum/borated aluminum for heat transfer and criticality control. The 32PTH DSC is very similar to the Standardized NUHOMS® System 24PTH DSC.

1.2.2 Horizontal Storage Module (HSM-H)

The HSM-H is constructed of reinforced concrete and structural steel. The key design parameters of the HSM-H are provided in Table 1-1 of the UFSAR. The HSM-H design is virtually identical to the HSM-H for the NUHOMS® 24PTH DSC included in Amendment ~~8~~ to CoC 1004). The HSM-H provides spent fuel decay heat removal, and physical and radiological protection for the 32PTH DSC. Ambient air enters the HSM-H through ventilation inlet openings located on both sides of the lower front of the HSM-H and circulates around the 32PTH DSC and the heat shields. Air exits through air outlet openings located on each side of the top of the HSM-H.

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1.2.3 Transfer System

The OS-187H Transfer Cask (TC) used with the NUHOMS® HD System, provides shielding and protection from potential hazards during 32PTH loading and closure operations, and transfer to the HSM-H. The OS-187H TC is very similar to the OS-197 and OS-197H TCs described in the SAR for the Standardized NUHOMS® System. The TC is constructed from two concentric stainless steel shells with a bolted and gasketed top cover plate and a welded bottom end assembly. The TC also includes an outer steel jacket ~~jacked~~ which is filled with water to provide neutron shielding. The top and bottom end assemblies also incorporate a solid neutron shield material. Two top lifing trunnions are provided for handling the TC using a lifting yoke and overhead crane. Lower trunnions are provided for rotating the cask from/to the vertical and horizontal positions on the support skid/transport trailer. A gasketed cover plate is provided to seal the bottom hydraulic ram access penetration of the cask during loading. The TC lid is also provided with gaskets so that a helium environment can be maintained during DSC transfer operations.

The transfer trailer is not important to safety because the NUHOMS® HD System Technical Specifications (TS) limit the lifting height of the 32PTH DSC to eighty inches, which is within the design basis drop for the DSC.

1.3 Drawings

Section 1 of the SAR contains the non-proprietary drawings for the NUHOMS HD System, including drawings of the structures, systems, and components (SSC) important to safety.

1.4 32PTH DSC Contents

The 32PTH DSC is designed to store up to 32 intact CE 14x14, CE 16x16, WE 15x15, and/or WE 17x17 assemblies. Non-Fuel Assembly Hardware like VSIs, BPRAs, or TPAs are allowed for these fuel assemblies. The 32PTH DSC is also designed for storage of up to 16 damaged fuel assemblies, and remaining intact assemblies. Additional fuel characteristics are discussed in Sections 2 and 6 of the SAR.

1.5 Technical Qualifications of the Applicant

Section 1.3 of the SAR contains identification of agents and contractors. This information has not changed with the amendment.

1.6 Notes on Review Areas

1.6.1 Radiation Protection Evaluation

Changes to the Radiation Protection aspects of this cask system are evaluated in Chapters 5 and 6 of this SER.

1.6.2 Materials Evaluation

Changes to the materials aspects of this cask system are discussed in Chapter 3 of this SER.

3.2 Materials

3.2.1 Changes to Package Contents

The amendment request expanded the authorized contents of the NUHOMS® HD System to include PWR fuel assemblies with Control Components (CCs) and neutron sources. These components include Burnable Poison Rod Assemblies (BPRAs), Thimble Plug Assemblies (TPAs), Control Rod Assemblies (CRAs), Control Element Assemblies (CEAs), Rod Cluster Control Assemblies (RCCAs), Vibration Suppressor Inserts (VSIs), Axial Power Shaping Rod Assemblies (APSRAs), Orifice Rod Assemblies (ORAs), Neutron Source Assemblies (NSAs) and Neutron Sources. The cladding for the control components (CCs) and neutron sources vary, and may be made of stainless steel, Inconel, or zirconium-based alloys such as Zircaloy, M5, or Zirlo. The materials contained inside the various CCs, which are all non-fuel material, vary among Inconel, B_4C, Ag-In-Cd, and Al_2O_3, depending on the specific component. The staff has previously evaluated these materials (for other applications) and found that no significant corrosion or galvanic effects would occur among these materials.

The staff finds these changes to the proposed contents of the package acceptable.

3.2.2 Definition of Damaged Fuel

3.1 and SAR

The applicant clarified the definition of damaged fuel assemblies to be a fuel assembly with known or suspected cladding defects greater than pinhole leaks or hairline cracks and which can be handled by normal means. This definition is consistent with the staff guidance outlined in Interim Staff Guidance Document, No. 1 (ISG-1) (Ref. 4).

3.2.3 Drying Operations

Amendment 1 (T.S. Section 8.1.1.3) specifies that only helium will be allowed for use as a cover gas during DSC cavity water removal operations. Formerly, both nitrogen and helium were specified as acceptable cover gasses. Use of a cover gas ensures that the cladding will not be exposed to an oxidizing environment during loading, drying, or unloading procedures, following the guidance in Interim Staff Guidance Document 22, "Potential Rod Splitting Due to Exposure to an Oxidizing Atmosphere During Short-Term Cask Loading Operations In LWR [Light Water Reactor]or Other Uranium Oxide Based Fuel" (Ref. 5).

During drying and backfilling operations, the fuel cladding reaches a maximum temperature of 734°F (390°C). This temperature limit is below the staff accepted 400°C limit for high burn-up fuel. This, and the lack of thermal cycling during drying operations are consistent with the guidance in Interim Staff Guidance Document, No. 11, Rev. 3, "Cladding Considerations for the Transportation and Storage of Spent Fuel" (Ref. 6).

The staff finds these changes acceptable.

3.2.4 Hydrogen Gas Monitoring

TS paragraph 5.6, and the FSAR (Sections 8.1.1.3 and 8.2.2) specify that hydrogen gas monitoring or mitigation measures will be followed during all lid welding and cutting operations. Welding operations will be stopped and the DSC cavity will be purged with helium if the hydrogen concentration exceeds 2.4%. This is a conservative limit which precludes an ignition event during welding of the cask lid. The Technical Specifications require that the hydrogen not exceed the ignition concentration of 4.0%, which is the actual ignition concentration of hydrogen.

The staff finds these changes acceptable.

3.2.5 Alternate Welding Configurations (Drawings)

Alternate, but nondescriptive, weld configurations, were removed from the licensing drawings. Since these configurations were not on the licensing drawings, they could not be evaluated by the staff.

The removal of these alternate weld configurations is acceptable to the staff.

3.2.6 Neutron Absorbing Materials

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Significant changes regarding the neutron absorbing materials were made in Amendment 1 to the NUHOMS HD application. These changes can be found in Section 9.1.7 of the FSAR, and in paragraph 4.3.1 of the TS.

The amendment permits the applicant to use aluminum clad boron carbide/aluminum metal matrix composites (MMCs) with up to ~~40~~% B_4C. The maximum permissible total porosity for aluminum clad MMCs was increased from 2% to 3% volume percent, with a maximum open porosity of 0.5%. The limitations on porosity ensure the consistent physical properties and corrosion resistance of the clad and unclad MMCs.

All panels of neutron absorbing material will be visually inspected. Panels which fail to meet the criteria listed in Section 9.1.7.4 of the application will be reworked, repaired, or scrapped. A reference to the Aluminum Standards and Data for the criteria of the visual acceptance tests was removed from the Technical Specifications, but retained in the application. Visual inspection of 100% plates to the criteria in Section 9.1.7.4 is sufficient to ensure that the neutron absorbing panels (or previously qualified material) will have the mechanical durability necessary for the application.

The thermal neutron beam diameter used for qualification and acceptance testing of the neutron absorbing materials has been increased to 1-inch. Although the position of the staff has not been formally stated in an interim staff guidance document (ISG), the staff has posed that thermal neutron beams up to 1-inch in diameter with a 10-percent tolerance are acceptable for qualification and acceptance testing of boron carbide/ aluminum-based neutron absorbing materials (Ref. 7).

Both homogenous and heterogeneous calibration standards can be used for neutron attenuation testing. The applicant clarified that such standards must be traceable to nationally recognized standards, or by attenuation of a monoenergic neutron beam to the known cross section of boron-10, of that energy. This clarification ensures that these calibration standards will be able to provide accurate results with neutron beam attenuation measurements.

The description of the neutron absorber statistical analysis was removed from the Technical Specifications, but retained in the application as an example methodology for determining the areal density of each lot of material with a 95% probability and 95%

confidence level. The staff finds that it is an unnecessary regulatory burden for the applicant to include the statistical methodology for determining the 95/95 criteria in the Technical Specifications.

Required mechanical testing of the neutron absorbers has been included in the Technical Specifications. The applicant has agreed not to use scanning electron microscopy (SEM) to demonstrate the ductility of the neutron absorbing material, as the bulk ductility of composite materials cannot be accurately determined using SEM of fracture surfaces. Qualitative mechanical testing, in accordance with the methods of ASTM E290 (Ref. 8), may be used to determine if the neutron absorbing materials have sufficient ductility for the application. Aluminum clad metal matrix composites (MMCs) must undergo mechanical testing after submersion in water and followed by heating in a pre-heated oven for 24 hours at 825°F. This condition was added to insure that the aluminum clad MMCs will not be damaged by cask drying operations.

Density testing of the metal matrix composites (clad and un-clad) is required by the Technical Specifications. This is to ensure that the open porosity, which could influence the corrosion of the composites, is limited to 0.5% or less. These changes, along with visual acceptance testing of each neutron absorbing panel ensure that the neutron absorbing material will be adequately resistant to mechanical damage and corrosion that cold result from cask loading or unloading operations.

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Radiography was proposed in the amendment as a methodology for determining uniformity of the boron-10 in the neutron absorbers. To date, no applicant has used radiography for determining the quantitative boron-10 content of a neutron absorber material for spent nuclear fuel, and no detailed procedure was provided to the staff for doing so. Therefore, the option of using radiography was considered unnecessary and redundant, and has been removed from the application.

The definition and general description of key process changes was added to the Technical Specifications, while specific examples of key process changes were removed from the Technical Specifications (but retained in the SAR). This change retains the applicant's intent that significant changes to fabrication of the neutron absorber will require a partial or full requalification of the material, but without the need to list every potential example of a key process change.

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The staff does not support the applicant's assumption that aluminum clad MMCs have isotropic thermal conductivity. However, the staff finds that the expected change in MMC thermal characteristics due to the presence of the aluminum cladding would not affect the safety of the package.

The staff finds the use of aluminum-clad metal matrix composites with ~~40~~% B_4C content does not compromise the safety of the design, and is acceptable. Furthermore, the staff finds the changes to the acceptance and qualification testing of the neutron absorbing material outlined in the body of the application and specified in the Technical Specifications adequate to ensure the expected performance of the design.

3.3 Evaluation Findings

F3.1 The proposed TS clarifications continue to meet the 10 CFR Part 72.44(c)(4) and (5), with regard to technical specifications pertaining to structural design features and administrative controls.

F3.2 The changes to the proposed contents of the package are acceptable. The staff finds that no significant corrosion or galvanic effects would occur among these materials.

F3.3 The definition of damaged fuel assemblies is consistent with the staff guidance outlined in Interim Staff Guidance Document, No. 1 (ISG-1).

F3.4 The staff finds the proposed changes for Drying Operations acceptable.

F3.5 The staff finds the proposed changes for Hydrogen Gas Monitoring acceptable.

F3.6 The staff finds the use of aluminum-clad metal matrix composites with ~~40~~ 50% B_4C content does not compromise the safety of the design, and is acceptable. Furthermore, the staff finds the changes to the acceptance and qualification testing of the neutron absorbing material outlined in the body of the application and specified in the Technical Specifications adequate to ensure the expected performance of the design.

3.4 References

1. Transnuclear, Inc., "Revision 1 to Transnuclear, Inc. (TN) Application for Amendment 1 to the NUHOMS® HD System, Response to Request for Additional Information (Docket No. 72-1030; TAC NO. L24153)," December 15, 2009. (ML083570513)

2. U.S. Nuclear Regulatory Commission, "Safety Evaluation Report For The Transnuclear Inc., NUHOMS® HD Horizontal Modular Storage System For Irradiated Nuclear Fuel, Docket No. 72-1030," January 10, 2007. (ML070160089)

3. U.S. Code of Federal Regulations, "Domestic Licensing Of Production And Utilization Facilities," Title 10, Part 50.

4. U.S. Nuclear Regulatory Commission, Division of Spent Fuel Storage and Transportation; Interim Staff Guidance Document -1 (ISG-1), "Classifying the Condition of Spent Nuclear Fuel for Interim Storage and Transportation Based on Function," Revision 2, May 2007.

5 SHIELDING EVALUATION

5.1 Summary

By application dated November 1, 2007, (Ref. 1), and as supplemented on December 15, 2008 (Ref. 2), Transnuclear, Inc. (TN) submitted a request for amendment to the Certificate of Compliance (CoC) No. 1030 for the NUHOMS® HD Horizontal Modular Storage System for Irradiated Nuclear Fuel under the provisions of 10 CFR Part 72 (Ref. 3).

The NUHOMS-32PTH dry shielded canister (DSC) provides confinement and criticality control for the storage and transfer of irradiated fuel. TN requested changes to the Technical Specifications (TS) attached to CoC No. 1030, with supporting revisions to the NUHOMS® HD Updated Final Safety Analysis Report (UFSAR), in order to reflect the addition of the Combustion Engineering 16x16 fuel (CE 16x16) as an allowable assembly class. The amendment also includes provisions to have control components (CC) allowed as authorized contents. In addition, TN proposed a more generalized fuel qualification table (FQT) which specifies allowable cask contents.

The amendment application included the proposed page changes and engineering analyses to be incorporated into the UFSAR. The technical bases supporting the requested changes to the CoC No. 1030 are similar to those included as a part of an exemption request submitted by PPL Susquehanna, LLC on January 31, 2006 (Ref. 4).

5.2 Shielding Evaluation

In its November 1, 2007 letter, TN discusses the shielding evaluation and radiation protection evaluation for the CE 16x16 fuel assembly. TN concludes that the results for each of those evaluations are bounded by those for existing evaluations for the NUHOMS® HD 32PTH DSC contained in Sections ~~K~~.5 and ~~K~~.10, respectively, of the original UFSAR for the NUHOMS® HD System (Ref. 5).

Regarding the shielding and radiation protection evaluations, the CE 16x16 class of assembly will be within the bounds of the original design basis assembly (Westinghouse Advanced MK BW 17x17) due to a lower heavy metal loading (uranium); therefore, for the same burnup and cool time, the source term from the CE 16x16 fuel assembly will be lower than for the MK BW 17x17. Design-basis heavy metal loading is 0.476 MTU per assembly. TN has presented many alternative cases at various burnup, enrichment and cooling times to indicate conditions that lie outside the bounding analysis. Additional burnup and cooling requirements are conservatively placed in the FQT to account for this. Additionally, the applicant stated that the CC hardware source term is bounded by the WE 17x17 class of fuel; all analyses have been made with the limiting class of CC regardless of the actual fuel assembly investigated. ing

TN's analysis of the design basis assembly does not use the most conservative initial assembly enrichment. The Standard Review Plan for Dry Cask Storage (Ref. 6) states that the lowest permissible enrichment for a given burnup should be used in the source term analysis. However, further analysis is presented to show that the lowest enrichment at each burnup level in the FQT is still bounded by the design basis assembly when the thermal limits are applied. A table presenting the external dose rate and decay heat power for the design basis assembly at varying enrichment, burnup and cooling time is included in the shielding analysis of the SAR. While fuel may meet the minimum cooling and maximum burnup constraints, the specific nature of the fuel may still fail the thermal limitations. A formula is provided to determine whether a particular assembly is acceptable for loading. A longer cooling time may be required in some cases.

U-235

Additional limitations are placed on fuel assemblies with an average enrichment less than 1.5 wt% U-235. Maximum burnup and minimum cooling times are presented in a table in the SAR. For extremely low weight-percent of U-235, burnup limit is set at 25 and 20 GWd/MTU for assemblies with a minimum average enrichment of 0.3 and 0.2 % respectively. Fuel assemblies with a minimum enrichment of 0.7 wt % are limited to 32 GWd/MTU. The minimum acceptable cooling time for all extremely low-enriched assemblies of 5 years allows placement in Zones 2 and 3. If the cooling time is extended to 7 years, there is no limit on the location of these fuel assemblies.

U-235,

5.2.1 Computer Codes and Cross Section Libraries

The applicant estimated the source term with the SAS2H/ORIGEN-S sequence in SCALE 4.4. The 44-group ENDF/B-V cross-section libraries were used. As discussed above, this is appropriate for use of most uranium fuel.

The applicant used the results of the SAS2H/ORIGEN analysis to specify the source in a separate MCNP shielding analysis. MCNP is a three-dimensional Monte Carlo code with continuous energy cross-sections. Developed by Los Alamos National Laboratory (LANL), this code has been used extensively in a variety of shielding evaluations.

5.2.2 Confirmatory Analysis

TN's analysis was conducted with SCALE 4.4; NRC staff uses SCALE 5.1. Staff analysis of the design-basis assembly with both SCALE 4.4 and SCALE 5.1 confirms TN's assessment of spent fuel activity. In addition, the results are in acceptable agreement among the versions of the code.

Since this was an amendment to an existing approved design, staff analyses focused on the changes made in the amendment. The analysis of external dose rates in normal and off-normal conditions will remain unchanged in the updated FSAR provided that the design-basis assembly source-term is still bounding of all other fuel classes, enrichment and burnup.

The staff ran confirmatory calculations with SAS2H to verify the source term of the design-basis assembly and several of the lowest initial enrichments and highest burnups allowed by the FQT. Staff confirmed that the limits on maximum burnup and cooling time due to thermal constraints adequately ensure that assemblies with initial enrichment higher than 1.5 wt % U-235 are bound by the design basis assembly. Using both the shielding analysis and the limits as written in the FQT, the staff was able to verify the requirements of 10 CFR Part 72 were met for fuel assemblies having an initial average enrichment greater than 1.5 wt % U-235.

Staff calculations were made with the 25.0 MW/assembly power described in the shielding analysis. In all cases, the design basis assembly is bounding given the thermal limits of the FQT. In particular, staff checked the lowest enrichments for the

6 CRITICALITY EVALUATION

6.1 Introduction

The objective of the criticality review is to ensure that the spent fuel will remain subcritical under all credible normal, off-normal, and accident conditions encountered during handling, packaging, transfer, and storage. The objective of this section includes a review of the changes to the criticality design criteria, configuration and material properties, features and fuel specifications, and verification for the NUHOMS® HD System. It also includes a review of the criticality analyses that includes computer programs, benchmark comparisons, and multiplication factors proposed in this amendment request. The applicant requested several changes to the NUHOMS® HD System design and Certificate of Compliance (CoC). Only those changes that may affect the criticality safety of the system are discussed in this section.

The staff reviewed proposed Amendment 1 to the NUHOMS® HD System criticality safety analysis to ensure that all credible normal, off-normal, and accident conditions have been identified and their potential consequences on criticality considered such that the NUHOMS® HD System, as revised, meets the following regulatory requirements: 10 CFR 72.124(a), 72.124(b), 72.236(c), and 72.236(g) (Ref. 1). The staff's review also involved a determination on whether the cask system satisfies the acceptance criteria listed in Section 6 of NUREG-1536 (Ref. 2). 1

The following proposed changes were considered for their impact on criticality safety:

a) add Combustion Engineering (CE) 16x16 class fuel assembly as authorized contents of the NUHOMS® HD System described in the UFSAR.

b) expand the authorized contents of the NUHOMS® HD System to include CE14x14 and CE16x16 class fuel assemblies for the storage with Control Components (CCs), also referred to as Non Fuel Assembly Hardware (NFAH) in CoC 1030 Amendment 0. CCs are components such as Burnable Poison Rod Assemblies (BPRAs), Thimble Plug Assemblies (TPAs), Control Rod Assemblies (CRAs), Control Element Assemblies (CEAs), Rod Cluster Control Assemblies (RCCAs), Vibration Suppressor Inserts (VSIs), Axial Power Shaping Rod Assemblies (APSRAs), Orifice Rod Assemblies (ORAs), Neutron Source Assemblies (NSAs) and Neutron Sources. All PWR fuel assemblies currently authorized for storage may be stored with CCs.

The staff's conclusions, summarized below, are based on information provided in proposed Amendment 1, as supplemented, to the NUHOMS® HD System FSAR.

6.2 Criticality Design Criteria and Features

The design criterion for criticality safety of the cask system is that the calculated value of the effective neutron multiplication factor, k_{eff}, including biases and uncertainties, ~~and~~ shall not exceed 0.95 under normal, off-normal, and accident conditions.

For this Amendment 1, the design criteria and features of the NUHOMS® HD System are the same as previously approved with the exceptions of the addition of CE16x16 class fuel assembly and changes to allow for the storage of CCs within the CE14x14 and CE16x16 class fuel assemblies.

Criticality safety of the NUHOMS® HD system depends on the geometry of the fuel baskets, the use of fixed neutron absorber panels, and the presence of soluble boron in the spent fuel pool water for absorbing neutrons. The NUHOMS® HD design includes the 32PTH Dry Shielded Canister (DSC), designed to store the CE14x14, CE16x16, WE15x15, and WE17x17 class fuel assemblies listed in Table 6-3 of the SAR. The fuel assemblies are placed in square, stainless steel fuel tubes held in place by aluminum panels and stainless steel straps in an egg-crate type basket design.

In the previous SAR, the basket design modeled in the calculation was based on the 32PTH basket detailed in Chapter 1 of the SAR, with a section length of 15.03" (13.28" basket section + 1.75" steel plate). However, in this amendment a slightly different, yet more conservative 32PTH basket model is used in the evaluation of the CE16 x16 fuel assemblies. Only a 15.03" (for the CE 16x16 models, this section is 13.48") section of the basket with fuel assemblies is explicitly modeled with periodic axial boundary conditions, therefore the model is effectively infinitely long.

The staff reviewed Sections 1, 2, and 6 of Amendment 1, and verified that the design criteria and features important to criticality safety are clearly identified and adequately described. The staff also verified that the SAR contains engineering drawings, figures, and tables that are sufficiently detailed to support an in-depth staff evaluation. Additionally, the staff verified that the design-basis off-normal and postulated accident events would not have an adverse effect on the design features important to criticality safety. ~~In~~ Section 3 of the SAR shows that the basket will remain intact during all normal, off-normal, and accident conditions. Based on the information provided in the SAR, the staff concludes that the NUHOMS® HD System design with the 32PTH DSC meets the double contingency requirements of 10 CFR 72.124(a).

6.3 Fuel Specification

The NUHOMS® HD System 32PTH DSC is capable of transferring and storing a maximum of 32 intact PWR fuel assemblies. Additionally, a maximum of 16 locations (out of 32 locations) per DSC can be loaded with damaged PWR fuel assemblies with the remaining locations loaded with intact PWR fuel assembly. In the previous SAR, the assembly types allowed are limited to the CE14x14, WE15x15, and WE17x17 PWR fuel assemblies described in Table 6-3 of the SAR. All assemblies, except the CE14x14, may contain CCs. In this Amendment 1, CE16x16 fuel assemblies are requested as authorized content as CCs within CE14x14 and CE16x16 fuel assemblies as well. The fuel specifications for the various types of assemblies are listed in Section 2.1 of the Technical Specifications (TS). Fuel dimensions and weights are listed in Table 2 of the TS described in detail in Table 6-4 of the SAR. The fuel specifications that are most important to criticality safety are:

- maximum initial enrichment
- number of fuel rods
- clad outer diameter
- minimum clad thickness
- fuel rod pitch
- number of guide tubes

The parameters listed above represent the limiting or bounding parameters for the fuel assemblies. In terms of criticality safety, the most important fuel specification is the fuel initial enrichment. The 32PTH DSC may contain 32 PWR assemblies with maximum initial enrichments up to 5.0 wt% U-235, depending on the DSC basket type, minimum soluble boron concentration in the canister water during loading, and the presence of damaged fuel in the DSC. The maximum initial enrichment for intact and damaged fuel loadings are given in Table 7 of the TS for all assembly types, for different basket types, and for minimum soluble boron concentrations. Specifications on the condition of the fuel are also included in the SAR and TS. The 32PTH DSC is designed to accommodate intact fuel assemblies, or up to 16 damaged fuel assemblies, as defined in the TS. The damaged fuel must be placed in the inner 16 fuel assembly positions in the DSC, as shown in Figure 1 of the TS. Fuel assembly compartments containing damaged fuel must contain top and bottom end caps, in order to maintain the fuel in a known, subcritical geometry. Reconstituted fuel assemblies, where the fuel pins are replaced by lower enriched fuel pins, or non-fuel ~~assemblies~~ pins (prior to initial irradiation or following initial irradiation) that displace the same amount of borated water, are considered intact fuel assemblies.

In Section 3.5 of the SAR, the applicant has shown that the fuel cladding will not fail during the cask drop accidents which bound all storage conditions. Thus the criticality analysis need only consider intact fuel pins for the undamaged fuel.

The staff verified that all fuel assembly parameters important to criticality safety have been included in the TS. The staff reviewed the fuel specifications considered in the criticality analysis and verified that they are consistent with the specifications given in Sections 1, 2, and 12 of the SAR and TS.

6.4 Model Specification

6.4.1 Configuration

The NUHOMS® HD System evaluated in this analysis consists of the 32PTH DSC, the OS187H transfer cask (TC), and the horizontal storage module (HSM-H). The applicant used 3–D calculation models in its criticality analyses. The bounding model for each basket type, soluble boron loading, assembly type, and enrichment is based on a 32PTH DSC in the TC, with optimum moderator density. Figures containing the details of the criticality models are provided in Figures 6-1 through 6-19 of the SAR. The models were based on the engineering drawings in Section 1 of the SAR and consider the worst-case dimensional tolerance values. The design-basis off-normal events do not affect the criticality safety design features of the cask system. The neutron shield of the TC was not included in the criticality model; however, unborated water was placed between the casks in an infinite array, as well as in the DSC to TC wall gap. Failure of the damaged fuel assemblies within the fuel compartments and top and bottom end caps was also considered.

The normal condition model combined the most reactive basket dimensions. The applicant performed a series of criticality analyses to determine the most reactive fuel spacing and basket dimension conditions. These analyses were performed with the WE 17x17 standard assembly, modeled in the 32PTH DSC over a 15.03-inch axial section, including the 13.28-inch neutron absorber plate section and one of the two 1.75-inch sections of perpendicular steel straps. This model included periodic boundary conditions, effectively representing an infinite axial canister. The calculation models also conservatively assumed the following:

1. fresh fuel isotopics (i.e., no burnup credit),
2. no burnable poisons present in the fuel,
3. pellet density of 97.5 % theoretical density with no dishing or chamfer,
4. maximum fuel enrichment modeled uniformly throughout the assembly (i.e., no axial or radial enrichment zones or natural uranium blankets),
5. omission of spacer grids, spacers, and hardware in the fuel assembly,
6. 75% credit for the ^{10}B content in the Boral® panels,
7. 90% credit for the ^{10}B content in the borated aluminum and aluminum-B_4C metal matrix composite,
8. flooding of the fuel rod gap regions with full density water, ~~and~~
9. infinite radial array of casks with interstitial water,
10. CCs like BPRA, TPA, and VSI are conservatively assumed to exhibit neutronic properties similar to $^{11}B_4C$.

, and

The applicant determined that the most reactive configuration for the CE16x16 and WE14x14 was the optimum pitch configuration of the rods. For the WE15x15 and the WE17x17 fuel the most reactive configuration was the double-ended rod shear with a shear ratio of one-half. The resulting most reactive configuration determined from these parametric studies was used as the baseline for all other criticality calculations.

The staff reviewed the applicant's criticality models for the NUHOMS® HD System and agrees that they are consistent with the description of the cask and contents given in Sections 1 and 2 of the SAR, including the engineering drawings. Based on the information presented, the staff has reasonable assurance that the most reactive combination of cask parameters and dimensional tolerances were incorporated into the calculation models, or are bounded by the assumptions used in these models.

For its confirmatory analyses, the staff independently modeled the cask system using the engineering drawings and bills of materials presented in Section 1.5 of the SAR. Models of the cask system and its contents created by the staff were similar to those presented by the applicant.

The staff reviewed the applicant's model descriptions and assumptions and agrees that they are consistent with the description of the contents given in FSAR Chapters 1 and 2. The staff reviewed the proposed CoC changes to ensure that the fuel specifications important to criticality safety are included.

6.4.2 Material Properties

From the previous review, the compositions and densities for the materials used in the criticality safety analysis computer models are provided in Table 6-9 of the NUHOMS® HD SAR. The applicant's models considered 75% of the specified ^{10}B areal density of the Boral® panels, in order to bound the effects of neutron channeling between B_4C particles in the neutron absorber plates. The applicant also considered 90% of the specified ^{10}B areal density of the borated aluminum and aluminum- B_4C metal matrix

7.2 Evaluation Findings

F7.1 The staff concludes that the conditions for use for the NUHOMS® HD Horizontal Modular Storage System for Irradiated Nuclear Fuel identify necessary technical specifications to satisfy 10 CFR Part 72 and that the applicable acceptance criteria have been satisfied. The proposed technical specifications provide reasonable assurance that the DSS will allow safe storage of SNF. This finding is based on the regulation itself, appropriate regulatory guides, applicable codes and standards, and accepted practices

The proposed technical specifications provide reasonable assurance that the cask will allow safe storage of spent fuel. This finding is reached on the basis of a review that considered the regulation itself, appropriate regulatory guides, applicable codes and standards, and accepted practices.

8 CONCLUSIONS

The NRC staff has performed a comprehensive review of the CoC amendment request and found that the proposed changes do not reduce the safety margin for the NUHOMS® HD Horizontal Modular Storage System for Irradiated Nuclear Fuel.

The areas of review addressed in NUREG-1536, "Standard Review Plan for Dry Cask Storage Systems," January 1997~~, are~~ consistent with the applicant's proposed changes. The Certificate of Compliance has been revised to include the TN requested changes. Based on the statements and representations contained in TN's application, as supplemented, the staff concludes that the proposed changes to the approved contents of the NUHOMS® HD System meet~~s~~ the requirements of 10 CFR Part 72.

Issued with Certificate of Compliance No. 1030, Amendment No. 1 on Draft.

APPENDIX A – LIST OF ABBREVIATIONS AND ACRONYMS

APSRA	Axial Power Shaping Rod Assemblies	
BPRA	Burnable Poison Rod Assemblies	
CC	Control Components	
CE	Combustion Engineering	
CEA	Control Element Assemblies	
CoC	Certificate of Compliance	
CRA	Control Rod Assemblies	
DSC	Dry Shielded Canister	← DSS Dry Storage System
FQT	Fuel Qualification Table	
FSAR	Final Safety Analysis Report	
GWd	Giga-Watt Days	
HSM-H	Horizontal Storage Module	← , Model H
ISFSI	Independent Spent Fuel Storage Installation	
ISG	Interim Staff Guidance	
K_{eff}	Effective Thermal Conductivity	
k_{eff}	Effective Neutron Multiplication Factor	
LANL	Los Alamos National Laboratory	
LCO	Limiting Condition for Operation	
LWR	Light Water Reactor	
MeV	Mega Electron Volts	
mg	Milligrams	
MMC	Metal Matrix Composite	
MTU	Metric Tons of Uranium	
MW	Mega Watts	
NFAH	Non-Fuel Assembly Hardware	
NSA	Neutron Source Assemblies	
ORA	Orifice Rod Assemblies	
ppm	Parts Per Million	
PWR	Pressurized Water Reactor	
QA	Quality Assurance	
RAI	Request for Additional Information	
RCCA	Rod Cluster Control Assemblies	

SAR	Safety Analysis Report (applicant)
SEM	Scanning Electron Microscopy
SER	Safety Evaluation Report (NRC staff)
SNF	Spent Nuclear Fuel
SSC	Structures, Systems, and Components
TC	Transfer Cask
TN	Transnuclear, Inc.
TPA	Thimble Plug Assemblies
TS	Technical Specifications
UFSAR	Updated Final Safety Analysis Report
USL	Upper Subcritical Limit
VSI	Vibration Suppressor Inserts
WE	Westinghouse
wt%	Weight Percent